LOUISIANA

STANDARD SPECIFICATIONS
FOR
ROADS AND BRIDGES

2006
EDITION

STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION
AND DEVELOPMENT

FOREWORD

This 2006 edition of the Louisiana Standard Specifications for Roads and Bridges is hereby approved for use on construction contracts awarded by the Louisiana Department of Transportation and Development and other governing bodies. These standard specifications are subject to amendment whenever necessary by supplemental specifications and special provisions applicable to specific contracts.

These standard specifications contain dual units of measurement: the United States Standard measure (English units) and the International System of Units (SI or "metric" units). The English units are expressed first with the SI (or metric) units following in parentheses. The measurements expressed in the two systems of units are not necessarily equal and must be used independently of each other. Combining values from the two systems may result in nonconformance with the specifications. The contract will designate whether the work is to be constructed in English units (English project) or SI units (metric project). The dimensions, measurements, and requirements stated in the system of units designated in the contract are the applicable specification requirements. All contractor submittals shall be prepared in the designated system of units. Pay item quantities will also be measured in the designated system of units.

Use of these standard specifications by any organization or individual will be at the user's risk. Organizations or individuals citing these standard specifications by reference in their contract work will be responsible for furnishing prospective bidders copies of the specifications along with any amendments that may affect their contract.

WILLIAM H. TEMPLE. P.E.
CHIEF ENGINEER

Table of Contents

Section No. **Page No.**

PART I -- GENERAL PROVISIONS

PART II -- EARTHWORK

PART III -- BASE COURSES

PART IV -- SURFACE COURSES

PART V -- ASPHALTIC PAVEMENTS

Section No. **Page No.**

PART VI -- RIGID PAVEMENT

PART VII -- INCIDENTAL CONSTRUCTION

Section No. **Page No.**

PART VIII--STRUCTURES

PART IX -- PORTLAND CEMENT CONCRETE

Section No. **Page No.**

PART X -- MATERIALS

List of Tables

Description **Page No.**

PART I -- GENERAL PROVISIONS

Section 101
General Information, Definitions, and Terms

101.01 REFERENCES. Section, subsection, and heading titles are for convenience and do not bear on the meaning of the text.

Unless specified by year or date, cited publications refer to the most recent issue, including interim publications, in effect on the date bids are received.

101.02 ACRONYMS AND ABBREVIATIONS. Wherever the following abbreviations or acronyms are used in the contract documents, they are to be interpreted as follows:

AA	Aluminum Association
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors of America
AGMA	American Gear Manufacturers Association
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
API	American Petroleum Institute
AREMA	American Railway Engineering and Maintenance Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
AWS	American Welding Society
DEQ	Department of Environmental Quality (Louisiana)
DOTD	Department of Transportation and Development (Louisiana)
EDSM	Department's Engineering Directives and Standards Manual
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration, Department of Transportation
FHWA	Federal Highway Administration, Department of Transportation

FSS	Federal Specifications and Standards, General Services Administration
ICEA	Insulated Cable Engineers Association
IMSA	International Municipal Signal Association
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
LRS	Louisiana Revised Statutes
MIL	Military Specifications
MUTCD	Manual on Uniform Traffic Control Devices (Louisiana)
NCHRP	National Cooperative Highway Research Program
NEC	National Electrical Code
NEMA	National Electric Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
QC/QA	Quality Control/Quality Assurance
QPL	Qualified Products List (DOTD)
RMA	Rubber Manufacturers Association
SAE	Society of Automotive Engineers
SI	Systeme Internationale or International System of Units
SSPC	Steel Structures Painting Council
STB	Surface Transportation Board
TIMED	Transportation Infrastructure Model for Economic Development
UL	Underwriters Laboratories, Inc.

101.03 DEFINITIONS. Whenever the following words or expressions are used in the contract documents they are to be defined as follows:

Adjustment. A change in contract time or compensation provided in accordance with Subsections 108.07 and 109.04.

Advertisement. A public announcement inviting bids, generally describing the project to be constructed; how to obtain the contract documents; and giving general bidding instructions including the time and place of opening bids.

Assembly Period. Time the contractor is given to acquire approvals of required drawings, brochures and other submittals, begin the purchase and assembly of materials, and to perform specified preconstruction activities. Contract time will not be charged during an assembly period.

Award of Contract. Transmission of the official written notice to the contractor that the Department has accepted the contractor's bid.

Base Course. The layer or layers of specified material of designed thickness constructed on the subgrade to support a surface course.

Bid. The binding offer of a responsible bidder that was submitted to the Department on the bid forms, or via approved electronic media, in accordance with the bidding documents.

Bid Express. An on-line service provided by Bidx.com, an Info Tech company, which is under contract to DOTD to facilitate two-way Internet electronic bidding.

Bid Forms. The portion of the bidding documents required to be submitted, in accordance with the bidding documents, in order to constitute a bid.

Bidder. An individual, partnership, corporation, or any other legal entity, or any acceptable combination thereof, or joint venture submitting a bid.

Bidding Documents. The advertisement, plans, specifications, bid forms, bidding instructions, addenda, special provisions, and all other written instruments prepared by or on behalf of the Department for use by bidders.

Bid Forms. The portion of the bidding documents, either paper or electronic, required to be submitted in accordance with the bidding documents, in order to constitute a bid.

Bidx.com. The subsidiary company owned by Info Tech that provides the Bid Express service.

Bridge. A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway, which has a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments, spring lines of arches, or extreme ends of openings for multiple boxes. A bridge may include multiple pipes where the clear distance between openings is less than 1/2 the smaller contiguous opening.

Bridge Length: The greater dimension of a structure measured along the

center of the roadway between backs of abutment backwalls or between ends of bridge floor.

Bridge Roadway Width: The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or if curbs are not used, between the inner faces of parapet or railing.

Calendar Day. Every day on the calendar, beginning and ending at midnight.

Change Order (Plan Change) or Special Agreement. The standard form normally used to describe and detail changes to the contract. When approved and fully executed, the document becomes a part of the contract.

Conditional Notice to Proceed. Written notice to the contractor to proceed with ordering of materials, and when specified, performing other activities which would hinder progress in the beginning stages of construction.

Construction Proposal. Document furnished to prospective bidders by the Department consisting of, but not limited to, the notice to contractors, special provisions, supplemental specifications, and bid forms.

Contract. The written agreement between the Department and the contractor setting forth obligations of the parties thereunder for performance of the prescribed work.

The contract documents include the advertisement, bid forms, contract form, payment/performance/retainage bond form, specifications, supplemental specifications, special provisions, plans, standard plans, change orders/special agreements, and supplemental agreements that are required to complete the work in an acceptable manner, and contract time, including authorized extensions thereof, all of which constitute one instrument.

Contract Item. See "Pay Item."

Contract Time. The number of working days or calendar days allowed for completion of the contract, including authorized time extensions.

When a calendar date of completion is shown in the contract in lieu of a number of working or calendar days, work shall be completed by that date including authorized time extensions.

Contractor. The individual, partnership, corporation, joint venture, other

legal entity, or acceptable combination thereof, that is awarded a contract.

Controlled Access Highway. Any highway to or from which access is denied or controlled from or to abutting land or intersecting streets, roads, highways, alleys, or other public or private ways.

Controlling Item(s) of Work. Item(s) of work that should be in progress at the time, essential to the orderly completion of the work within the time limit specified, in accordance with the contractor's approved construction progress schedule.

Control of Access. The condition where the right of owners or occupants of abutting land or other persons to access, light, air, or view in connection with a highway is controlled by public authority.

Full Control: Preference is given to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.

Partial Control: Preference is given to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossings at grade and some private driveway connections.

Culvert. Any drainage structure under a roadway or other facility not defined as a bridge.

Dedicated Stockpile. A stockpile assembled for a specific project.

Department. The Department of Transportation and Development of the State of Louisiana.

Department of Transportation and Development. The Louisiana Department of Transportation and Development through its offices and officers, responsible for developing and implementing programs to ensure adequate, safe, and efficient transportation and other public works facilities and services in the state in accordance with Chapter 11 of LRS Title 36 as amended.

Electronic Bid Bond. An instrument by which a contractor and surety can submit a bid guarantee with a bid electronically in lieu of a written signed paper.

Electronic Bidding. The process by which the Department and the bidder can utilize the Internet to facilitate the bidding process.

Electronic Signature: A secure and verifiable alpha-numeric code assigned to an individual, replacing or acting instead of a traditional signature.

Engineer. The Chief Engineer, acting directly or through duly authorized representatives, who is responsible for contract administration including engineering supervision of the work. When the term "Chief Engineer" is used, it shall mean the Department's Chief Engineer in person or the Department's duly appointed designee.

Engineering Directives and Standards Manual. A set of manuals containing directives and standards of the Department.

Equipment. All machinery, equipment, tools, and apparatus necessary for acceptable completion of the work.

Expedite. Software developed for AASHTO by Info Tech that enables and facilitates electronic bidding.

Extra Work. Work not provided for in the contract as awarded but found essential by the Department for satisfactory completion of the contract within its intended scope.

Falsework. Temporary construction work on which a main work is wholly or partly built and supported until it is strong enough to support itself; a temporary framework used to support part or all of a structure during demolition.

Force Account. Payment for directed construction work based on the cost of labor, equipment, materials furnished, overhead, and profit, in accordance with Subsection 109.04

Highway, Street, or Road. A public way for vehicular travel, including the entire area within the right-of-way.

Incidental Work. Work required by the contract that is not directly measured and for which no specific pay item is provided.

Inspector. The engineer's authorized representative assigned to make detailed inspections of contract performance.

Invitation For Bids. See "Advertisement."

Item. See "Pay Item."

Laboratory. The Department's testing laboratory or any other testing laboratory approved by the engineer.

Local Street or Local Road. A street or road not in the state maintained system.

Major Item. A pay item included in the contract with a total cost equal to or greater than 10 percent of the original total contract amount.

Manual of Uniform Traffic Control Devices (MUTCD). The manual adopted by the Department to describe the uniform system of traffic control devices used on state highways.

Materials. Any substances used in the work.

Materials Sampling Manual. The manual used to establish and standardize construction and maintenance sampling and material acceptance requirements for the Department.

Median. The portion of a highway separating traveled ways for traffic in opposite directions.

Minor Item. A pay item included in the contract as awarded with a total cost of less than 10 percent of the original total contract amount.

Notice to Proceed. Written notice to the contractor to proceed with the contract work which will stipulate the dates that work shall commence and contract time shall begin.

Parish. The parish in which the specified work is to be done.

Pavement Structure. The combination of base course and surface course placed on a subgrade across the roadbed.

Pay Item. A specific portion of work for which a price is provided in the contract.

Payment/Performance/Retainage Bond. The approved form of security, executed by the contractor and surety, guaranteeing complete execution of the contract and supplemental agreements thereto, and payment of all legal debts, including liens and monies due the Department, pertaining to the contract.

Plans. The contract drawings, which show location, type, dimensions and other details of the prescribed work.

Plan Change. See "Change Order."

Profile Grade. The trace of a vertical plane intersecting the top surface of the proposed wearing surface or other designed course usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

Project. A specific undertaking of work as described by the contract within prescribed limits.

Project Engineer. The engineer assigned to represent the Chief Engineer in the administration of the contract.

Project Number. A number used to identify the project.

Proposal. See "Bid."

Proposal Form. See "Bid Forms."

Proposal/Bid Guaranty. The required security furnished with a bid.

Qualified Products Lists. Lists maintained by the Department's Materials and Testing Section for products that do not lend themselves to the preparation of meaningful specifications, or for which repetitive full testing is too time consuming or expensive to be practical for routine project control.

Quality Assurance. The combined efforts of quality control and acceptance processes to ensure that a project adheres to the contract

requirements.

Quality Control is the process used by the contractor to monitor, assess, and adjust material selection, production, and project construction to control the level of quality so that his product continuously and uniformly conforms to specifications.

Acceptance is the process of sampling, testing and inspection to determine the degree of compliance with the specifications for acceptance of materials and/or the contractor's work.

Right-of-Way. Land, property or interest therein, acquired for or devoted to transportation purposes.

Roadbed. The graded portion of a highway within the top of the side slopes, prepared as a foundation for the pavement structure including the shoulder.

Roadside. The area adjoining the outer edge of the roadway. Extensive areas between roadways of a divided highway may also be considered roadside.

Roadside Development. Those items necessary to the complete highway which provide for preservation of landscape materials and features; rehabilitation and protection against erosion of areas disturbed by construction through seeding, sodding, mulching and placing of other ground covers; and suitable planting or other improvements to increase the effectiveness and enhance the appearance of the highway.

Roadway. The portion of a highway within the limits of construction.

Secretary. The Secretary for the Louisiana Department of Transportation and Development.

Service Road or Frontage Road. A street or road on the side of the mainline roadway for service to abutting property and adjacent areas, and for control of access.

Special Provisions. Additions and revisions to the standard and supplemental specifications or plans covering conditions applicable to the project.

Specialty Item. A pay item designated in the contract that may be

performed by subcontract and the cost of such may be deducted from the total contract cost before computing the amount of work required to be performed by the contractor with the contractor's own organization.

Specifications. The compilation of provisions and requirements for the performance of prescribed work.

Standard Specifications: A book of specifications for general application and repetitive use.

Supplemental Specifications: Additions and revisions to the Standard Specifications.

Project Specifications: All Standard Specifications, Supplemental Specifications, Special Provisions and other provisions applicable to the project.

Specified. Required or stipulated in the contract documents.

Standard Plans. Department drawings approved for repetitive use, showing the details to be used where appropriate.

State. The State of Louisiana, acting through its authorized representative.

Structures. Bridges, culverts, catch basins, junction boxes, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains and other similar features encountered in the work.

Subcontractor. An individual, partnership, corporation, joint venture, other legal entity or acceptable combination thereof, to which the contractor sublets part of the work. Any individual, partnership, corporation, joint venture, other legal entity or acceptable combination thereof shall not be considered to be a subcontractor if it is a subsidiary, wholly owned or majority owned by the contractor or the principals of the contractor, or an affiliate of the contractor or affiliated or otherwise controlled by the contractor or the principals of the contractor such that a true and independent subcontractor-contractor relationship reached by bidding or arms-length negotiation does not result therefrom.

Subgrade. The surface upon which the pavement structure, including shoulders, are constructed.

Subgrade Layer. The surface layer of the subgrade, which requires

treatment with lime, portland cement, or portland-pozzolan cement. The subgrade layer may be constructed with stone, crushed slag, recycled portland cement concrete, or asphaltic concrete.

Substructure. That part of the structure below the bearings of simple and continuous spans, skewbacks or arches, and tops of footings of rigid frames, including backwalls, wingwalls, and wing protection railings.

Superintendent. The contractor's authorized representative in responsible charge of the work.

Superstructure. The entire structure except the substructure.

Surety. The corporation, partnership, or individual other than the contractor, executing a bond furnished by the contractor.

Surface Course. The top course of the pavement structure.

Technician. The contractor's or the Department's representative who shall be either certified or authorized as required in the specifications.

Testing Procedures Manual. The manual in which specific testing procedures used by the DOTD Laboratories are published. This manual is used to standardize testing procedures used by DOTD Laboratories.

Through and Local Traffic.

(a) Through Traffic - Traffic that has neither its origin nor destination within the limits of the project.

(b) Local Traffic - Traffic that has either its origin or destination, or both, within the limits of the project.

Traffic/Travel Lane. The portion of traveled way for movement of a single lane of vehicles.

Traveled Way. The portion of roadway for movement of vehicles, exclusive of shoulders and auxiliary lanes.

Unit. A quantity adopted as a standard for measurement of work.

Work. The furnishing of labor, materials, services, equipment, and

incidentals necessary for successful completion of the project and the carrying out of all obligations imposed by the contract.

Working Day. A calendar day on which weather or other conditions not under control of the contractor will permit construction operations to proceed in accordance with Subsection 108.07.

Working Drawings. Supplemental design sheets or similar data that the contractor is required to submit to the engineer in accordance with Subsection 105.02.

101.04 UNDERSTOOD WORDS OR EXPRESSIONS. In order to avoid cumbersome repetition of the following words or expressions in the contract or plans, it is provided that whenever anything is, or is to be done, if, as, or, when or where "contemplated, required, determined, directed, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, condemned, waived, or written consent," it shall be understood as if the expression were followed by the words "by the engineer" or "to the engineer."

Whenever the contract or plans contain the expressions "no direct pay, no direct payment, not measured for payment, at no additional cost or expense to the Department, will not be measured for payment, considered incidental to other items of work, no payment will be made for this work, shall not be entitled to extra payment," or any variation of one of these expressions it shall be understood by the bidder that the designated work is to be considered incidental work and the cost of such work shall be included in the price bid on other pay items.

Section 102
Bidding Requirements

102.01 PREQUALIFICATION OF BIDDERS. To qualify for submission of a bid, the bidder shall comply with all rules and regulations of the Louisiana State Licensing Board for Contractors.

102.02 CONTRACTORS' LICENSING LAWS. Attention is directed to the rules and regulations of the State Licensing Board for Contractors. Information relative to licensing may be obtained from the offices of said Board in Baton Rouge.

If the estimated project cost is $50,000 or more, only licensed contractors may receive bid forms, unless FHWA funds are involved. When FHWA funds are involved, nonlicensed contractors may receive bid forms and submit bids; however, if the contractor's bid is $50,000 or more, the successful nonlicensed bidder will be required to obtain the proper license before beginning work under the contract.

When the estimated project cost is greater than $50,000 and no FHWA funds are involved, the contractor shall show his license number on the bid envelope unless the contractor submits the bid via the Department approved electronic bidding process. The contractor awarding a subcontract becomes an awarding authority; consequently, if the subcontract amount is $50,000 or more, both the contractor and subcontractor are subject to rules and regulations of the State Licensing Board for Contractors.

When landscaping is the predominant work on the project and no FHWA funds are involved, prior to receiving bid forms, the prospective bidder will be required to possess a current Landscape Contractors license from the Horticulture Commission of the Louisiana Department of Agriculture and Forestry.

102.03 CONTENTS OF BIDDING DOCUMENTS. Upon request, the Department will furnish prospective bidders with bidding documents. A prospective bidder will be required to pay the Department the sum stated in the Notice to Contractors for each construction proposal and set of plans. The prospective bidder may use the Bid Express services through Bidx.com. The use of these services will require payment by the contractor of additional fees to the service provider.

The construction proposal will state the location and description of the

contemplated work, will show the estimated quantities and kinds of work to be performed, and will include the bid forms to be completed and returned by the bidder. The construction proposal will state the time in which the work must be completed, and the date, time, and place of opening bids. The construction proposal will also include any specifications or requirements, which vary from or are not contained in the Standard Specifications. The plans, specifications and other documents designated in the construction proposal will be considered a part of the construction proposal whether attached or not.

Unless the contractor properly submits the bid forms electronically, the bid forms bound with or attached to the construction proposal should be detached, completed, and returned by the bidder. The bid forms consist of the Schedule of Items, the Proposal/Bid Guaranty as required by Subsection 102.09, the Construction Proposal Signature and Execution Form, and any other returnables if required in the construction proposal.

Unless explicitly stated otherwise in the contract, when the name of a certain brand, make, manufacture, or definite specifications limit the product or source to be supplied under or pursuant to a specification in this contract to a single product or source, that specification shall not restrict bidders to the specified brand, make, manufacture, product or source, but to set forth and convey to prospective bidders the general style, type, character, quality and salient performance criteria desired by the Department of the product or source specified. The specified product or source shall be a standard by which substitute products or sources will be compared to determine if the substitute product or source will be approved for substitution as equal to or superior to the general style, type, character, quality and salient performance criteria of the product or source specified. Bidders are informed that substitute products or sources should be submitted to the Chief Engineer for prior approval no later than seven (7) working days prior to the opening of bids in accordance with LRS 38:2295(C). The Department will approve or deny substitution of the product or source submitted within three (3) days, exclusive of holidays and weekends. If a product or source sought to be used as a substitute for the product or source specified is not submitted prior to the opening of bids as provided in LRS 38:2295(C), the Department has the right to require the product or source specified. Substitution of a product or source submitted in substitution of the product or source specified after the seven-day period prior to the opening of bids may only be allowed after that time in the Chief Engineer's sole discretion pursuant to Subsection 105.01.

102.04 ISSUANCE OF BID DOCUMENTS. The Department may refuse to issue bid documents to a bidder, or allow a bidder access to Bid

Express for bidding purposes, for any of the following reasons:

(a) Failure of the bidder to comply with any prequalification requirements of the Department.

(b) Disqualification of the bidder in accordance with Subsection 108.04.

(c) If the bidder is in default of a contract in accordance with Subsection 108.09 and a notice of default has been issued to the bidder. Bid documents will not be issued to the bidder until such time as the project on which the bidder has defaulted has been issued a final acceptance.

(d) On Federal-Aid Projects, the bidder being included on the List of FHWA Suspension/Debarment Actions or having been found unacceptable for employment on Federal-Aid Projects.

(e) When requested, within 24 hours before the opening of bids.

(f) Any bidder debarred in accordance with Part XIII-B of Chapter I of LRS 48.

(g) Any bidder disqualified for Proposal/Bid Guaranty forfeiture or non-payment in accordance with Subsection 103.07.

102.05 INTERPRETATION OF QUANTITIES IN SCHEDULE OF ITEMS. The quantities in the Schedule of Items are prepared for comparison of bids and are approximate. Payment will be made in accordance with measurement and payment requirements for pay items and other requirements of the contract. Pay item quantities may be increased, decreased or eliminated by the Department. Nothing in the Bidding Requirements or anywhere else in the contract is intended to amend, prohibit or release the contractor from performance of the work specified in the plans and specifications for which no direct pay item is included without compensation in addition to that in the Schedule of Items. The contractor shall perform all work required in the plans and specifications and accept payment pursuant to the Schedule of Items as full and final compensation for all work performed under the contract including all incidental, overhead and subsidiary costs and work not measured for payment as described under the individual pay items listed in the Schedule of Items.

102.06 EXAMINATION OF BID DOCUMENTS AND SITE OF WORK. Written instructions necessary to use the electronic bidding service and prepare and submit a bid electronically are provided on the Bidx.com Internet site. Fees payable to Bidx.com are required of the contractor to use the service and to establish electronic signatures. The contractor is advised to timely make all necessary arrangements with Bidx.com and to familiarize himself with system and process requirements prior to using the service to

submit a bid.

The bidder shall examine carefully the site of the proposed work and the bidding documents before submitting a bid. In the event the bidder's site investigation reveals that the site conditions are inconsistent with the contract documents, the bidder shall immediately notify the Department. Submission of a bid shall be considered conclusive evidence that the bidder has made such examination and is satisfied as to conditions to be encountered in performing the work and as to requirements of the bidding documents.

If the contractor discovers an error, omission, or ambiguity, prior to the date of the bid opening, he shall immediately notify the DOTD Chief Engineer who will then make such corrections, interpretations, or issue addenda as deemed necessary to fulfill the intent of the plans and specifications.

Any subsurface tests and boring data which have been compiled by the Department and furnished to the bidder shall not be considered as fully representative of subsurface conditions and is not intended as a substitute for personal investigation, interpretations and judgment of the bidder.

102.07 PREPARATION OF BID. Bids shall be submitted on bid forms provided by the Department or accessed through Bidx.com. Only that portion of the construction proposal designated as Bid Forms must be completed and returned by the bidder. The bid forms include the Schedule of Items, the Proposal/Bid Guaranty as required by Subsection 102.09, the Construction Proposal Signature and Execution Form, and any additional returnables if required in the construction proposal.

A unit bid price, in English and U. S. dollars, shall be specified in the Schedule of Items in words or numerals, either typed or printed in ink, or computer printed in the spaces provided for each pay item or alternate pay item. If no alternate pay items are included in the Schedule of Items, bidders shall bid on all items; if alternate items are included, bidders shall bid on all "General Items" and on one of the groups of items under each set of "Alternate Items." When additive alternates are included, the bidders shall bid on all additive alternates.

The Construction Proposal Signature and Execution Form shall be signed either with an authorized electronic signature or with ink by the individual; or a member of the partnership; or an officer of one of the firms representing a joint venture; or an officer of a corporation; or an agent of the contractor legally qualified and acceptable to the state. The bidder's business street address and mailing address, if different, and the business telephone number of the individual signing the form and that of a contact person shall be shown on the Construction Proposal Signature and Execution Form.

Execution, signature, and submission of the Construction Proposal Returnables shall constitute a legally binding and irrevocable offer by the bidder.

Bid bonds may be furnished and completed by a Department approved electronic bond verification service if the contractor elects to prepare and submit an electronic bid.

102.08 IRREGULAR BIDS. Bids may be considered irregular or non-responsive and will be subject to rejection for any of the following conditions:

(a) If the bid, except for legible facsimiles, is on a form other than that furnished by the Department or Bidx.com or if the bid forms are materially altered.

(b) If there are unauthorized additions, conditional or alternate bids or irregularities which make the bid incomplete, indefinite or ambiguous as to its meaning.

(c) If the bidder adds provisions reserving the right to accept or reject the award or to enter into the contract pursuant to the award.

(d) If the bid does not contain a legible unit price in U.S dollars and cents, written in English, for each pay item listed, except in the case of authorized alternate pay items.

(e) If the bid is submitted by a bidder other than the one to whom the construction proposal was issued.

(f) If the bidder is in default of a contract in accordance with Subsection 108.09 and a notice of default has been issued to the bidder.

(g) If an owner or a principal officer(s) of the bidding entity is an owner or a principal officer(s) of a contracting entity which has been declared by the Department to be ineligible to bid.

(h) If the proposal/bid guaranty does not meet requirements of Subsection 102.09.

(i) If more than one bid for the same work is received from an individual, partner, corporation, or any other legal entity, joint venture or combination thereof under the same or a different name.

(j) If the portion of the construction proposal form designated as Bid Forms is not properly executed either by hand or electronically and submitted with the bid.

(k) If unit prices are obviously distorted or unbalanced to reflect an advantage to the contractor which would result in undue expenditure of public funds and/or overrun of total cost of project.

(l) If it is determined by the Department that collusion and/or the bid rigging has occurred on a project.

(m) If the bidder is disqualified in accordance with Subsection 108.04.

(n) If the bidder is debarred in accordance with Part XIII-B of Chapter 1 of LRS 48.

(o) If the bidder is disqualified for Proposal/Bid Guaranty forfeiture or non-payment in accordance with Subsection 103.07.

102.09 PROPOSAL/BID GUARANTY. Each bid shall be accompanied by a proposal/bid guaranty in an amount not less than five percent of the total bid amount when the bidder's total bid amount as calculated by the Department in accordance with Subsection 103.01 is greater than $250,000. No proposal/bid guaranty is required for projects when the bidder's total bid amount as calculated by the Department is $250,000 or less. The official total bid amount for projects that include alternates is the total of the bidder's base bid and all alternates bid on and accepted by the Department. The proposal/bid guaranty submitted by the bidder shall either be a certified check, cashier's check, bidder's company check, postal money order, bank money order or bid bond made payable to the contracting agency as specified on the bid bond.

When the proposal/bid guaranty submitted by the bidder is a bid bond, this bond shall be on the "Bid Bond" form provided in the construction proposal; on a form that is materially the same in all respects to the "Bid Bond" form provided, or an electronic form that has received Department approval prior to submission. The bid bond shall be filled in completely, shall be signed by an authorized officer, owner or partner of the bidding entity, or each entity representing a joint venture; shall be signed by the surety's agent or attorney-in-fact; and shall be accompanied by a notarized document granting general power of attorney to the surety's signer. The bid bond shall not contain any provisions that limit the face amount of the bond.

When a bid bond is used it will be written by a surety or insurance company that is in good standing and currently licensed to write surety bonds in the State of Louisiana by the Louisiana Department of Insurance and also conform to the requirements of LSA-R.S. 48:253.

All signatures required on the bid bond may be original, mechanical reproductions, facsimiles or electronic. Electronic bonds issued in conjunction with electronic bids must have written Departmental approval prior to use. The Department will make a listing of approved electronic sureties providers on the Bidx.com site.

102.10 DELIVERY OF BIDS. Unless delivered electronically through the approved electronic bid submission service, each bid should be submitted in

the envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its content. When an envelope other than the one furnished by the Department is used, it shall be the same general size and shape and be similarly marked to indicate its contents. Bids shall be received no later than the time and at the place specified in the Notice to Contractors. Paper bids received after the time set for opening bids will be returned to bidders unopened. Electronic bids shall be submitted via the Internet in accordance with Subsection 102.07. Electronic bids transmitted by the bidder after the time set for bid opening will not be accepted.

A proposal guarantee and all other required returnables not submitted electronically with an electronic bid must be delivered by the contractor to the Department in a sealed envelope as specified above prior to the date and time of the bid opening.

102.11 WITHDRAWAL OR REVISION OF BIDS. A bidder may withdraw or revise a bid after it has been deposited with the Department, provided the request for such withdrawal or revision is received by the Department in person, in writing, or by telegram, before the time set for opening bids and at the location set forth in the Notice to Contractors. Electronic bids submitted to Bid Express may be withdrawn prior to the specified bid opening time by the authorized bidder.

102.12 PUBLIC OPENING OF BIDS. Paper or electronic bids will be publicly opened and read or presented at the time and place indicated in the Notice to Contractors.

102.13 WITHDRAWAL OF BIDS DUE TO MISTAKE.

(a) Criteria:

(1) Withdrawal of Bid: The Department may allow a bidder to withdraw a bid after the scheduled time of bid opening in accordance with state law upon a determination that:

a. A mistake was in fact made in preparation of the bid; and,

b. The mistake in the bid is of a mechanical, clerical or mathematical nature and not one of bad judgment, careless inspection of the work site, or in reading the plans and specifications; and,

c. The mistake is found to be in good faith and was not deliberate or by reason of gross negligence; and,

d. The mistake is patently obvious on the face of the bid; and,

e. The notice of the mistake, request for withdrawal of the bid by reason of the mistake, and written evidence of the mistake, is delivered to the

DOTD Chief Engineer within 72 hours after the bid opening, excluding Saturdays, Sundays, and legal holidays. The written evidence of the mistake supplied to the DOTD Chief Engineer shall be duly sworn before a Notary Public as original, unaltered documents used in the preparation of the bid or any other facts relevant to the bidder's request to withdraw the bid as evidence of the existence of a mistake; and,

f. The sworn, written evidence furnished to the DOTD Chief Engineer within 72 hours of the bid opening, excluding Saturdays, Sundays, and legal holidays, constitutes clear and convincing evidence of the bidder's mistake.

(2) Other Bid Protests: The Department may also allow a bidder to protest any matter regarding the bidding or award of a contract after the scheduled time of bid opening in accordance with the following provisions:

a. The protest of a bidder must be submitted in writing and, specifically set forth the grounds and/or reasons for the protest; and,

b. The written protest must be delivered to the DOTD Chief Engineer within 72 hours after notice of bid rejection, irregularity or any other action regarding the bidding of the contract, excluding Saturdays, Sundays, and legal holidays.

(b) Hearing by the DOTD Chief Engineer--Prior to Contract: If a bidder files a notice of mistake along with a request to withdraw the bid, or protests in a timely manner any other matter regarding the bidding or award of the contract, the DOTD Chief Engineer, or designee, will hold a hearing within a reasonable period of time after a request has been delivered. The DOTD Chief Engineer will give the requesting bidder reasonable notice of the time and place of the hearing. The bidder may appear at the hearing and present evidence together with other facts and arguments in support of the request, except, for a request to withdraw a bid for reason of mistake, the bidder making such request will be limited to the sworn written evidence submitted within the time period prescribed in this subsection.

(c) Action by the Secretary--Prior to Contract: The DOTD Chief Engineer will present findings to the Secretary for action on the bidder's request or protest. A determination may be made by the Secretary that a bidder meets the criteria for withdrawal of the bid as set forth in this subsection upon the basis of the evidence supplied within the period specified in this subsection, or for other protests of matters involving bidding or award of contracts, upon the evidence submitted to the DOTD Chief Engineer at hearing of protest. The DOTD Chief Engineer will advise the bidder of the Secretary's decision prior to the Department's consideration of award of the contract for matters involving bidding and, for matters involving award of the

contract, prior to execution of the contract.

(d) Proposal / Bid Guaranty: When notice of a bid mistake and a request to withdraw the bid is made, the proposal/bid guaranty shall continue in full force and effect until and unless there is a determination by the Secretary that the conditions of this Subsection 102.13 have been met. If the Secretary determines that a mistake occurred in the preparation of the bid in compliance with the statutory and contractual requirements, the Department will return the proposal/bid guaranty to the bidder.

(e) Subcontracting: If it has been determined that a mistake has been made and the bidder allowed to withdraw a bid, the individual, partnership, corporation, or any other legal entity or joint venture submitting the bid will not be allowed to perform work under this contract as a subcontractor.

Section 103
Award and Execution of Contract

103.01 CONSIDERATION OF BIDS. After paper or electronic bids are opened and read, they will be compared on the basis of the summation of the products of the quantities and the unit bid prices in the Schedule of Items. Results of such comparisons will be available to the public.

The right is reserved to reject bids, waive technicalities and informalities, or advertise for new bids.

(a) The right is reserved to reject the low bid for any of the following reasons and contract with the next lowest responsive bidder or advertise for new bids:

(1) A low bidder's bid is considered irregular as indicated in Subsection 102.08.

(2) On DBE Goal Projects, the low bidder fails to submit the required information and satisfy the DBE requirements as specified in the DBE contract provisions for the project.

(3) The low bidder fails to agree to mutually extend the period required for Award of Contract as indicated in Subsection 103.02.

(4) The low bidder successfully withdraws the bid in accordance with Subsection 102.11.

(b) All bids may be rejected for just cause consisting of any of the following:

(1) The Department's unavailability of funds sufficient for the construction of the project or the unavailability of funding participation in the project by anticipated funding sources.

(2) The failure of all bidders, not considered as irregular, to submit a bid within the established threshold of the advertised construction estimate for the project by the Department's engineers.

(3) A substantial change in scope or design of the project occurring prior to award.

(4) A determination of the Department or the funding agency not to build the proposed project within twelve months of the letting date.

(5) The disqualification or rejection by the Department of all bidders.

(6) The discovery, by the Department prior to award, that an error, defect, or ambiguity was contained within the bidding documents, that these defects may have affected the integrity of the competitive bidding process or may have led to a potential advantage or disadvantage to one or more of the

bidders.

103.02 AWARD OF CONTRACT. The Department shall award the contract to the lowest responsible bidder within 45 calendar days after the receipt of bids or within 20 days after the receipt by the Department of concurrence in award from all funding agencies or sources, whichever occurs last. Where concurrence in award is required, the total time from receipt of bids to award of contract, shall not exceed 60 calendar days unless extended by mutual agreement between the Department and the successful low bidder. Should the successful low bidder not agree to extend the deadline for award of contract, the proposal/bid guaranty may be returned to the bidder and the Department, at its discretion, may award the contract to the next lowest bidder or may readvertise the project.

103.03 CANCELLATION OF AWARD. The Department reserves the right to cancel the award of contract at any time before execution of said contract by all parties without liability against the Department for any of the following reasons:

(a) Any of the just causes contained in Subsection 103.01(b).

(b) The low bidder fails to agree to mutually extend the period required for issuance of the Notice to Proceed as indicated in Subsection 103.08.

(c) The contract, satisfactory bonds, proof of all required policies of insurance with minimum insurance coverages and all other required contract documents are not properly executed and returned to the Department within the required time period specified in Subsection 103.06.

103.04 RETURN OF PROPOSAL/BID GUARANTY. The proposal/bid guaranty of the successful bidder will be returned after the contract, satisfactory bonds, and all other required contract documents are properly executed and returned to the Department within the required time period specified in Subsection 103.06. Unsuccessful bidders proposal/bid guaranties in the form of checks or money orders will be returned to the bidder not later than sixty days after receipt of bids. The Department will destroy the bid bonds of unsuccessful bidders not later than sixty days after receipt of bids. Electronic bid bonds of unsuccessful bidders will not be returned but will be deemed by the Department to have no force or effect after sixty days.

This subsection will not apply where the forfeiture of the proposal/bid guaranty is warranted.

103.05 PAYMENT, PERFORMANCE, AND RETAINAGE BONDS. At the time of execution of the contract, the successful bidder shall furnish the following bonds on the forms provided by the Department.

(a) Payment bond in a sum equal to one hundred percent (100%) of the contract amount.

(b) Performance bond in a sum equal to one hundred percent (100%) of the contract amount.

(c) Retainage bond in a sum equal to five percent (5%) of the contract amount for contract amounts greater than $500,000 unless an election is made to have the Department withhold five percent (5%) of the contract amount; and, retainage bond in a sum equal to ten percent (10 %) of the contract amount for contract amounts equal to or less than $500,000 unless an election is made to have the Department withhold ten percent (10 %) of the contract amount.

The bonds shall be written by a surety or insurance company that is in good standing and currently licensed to write surety bonds in the State of Louisiana by the Louisiana Department of Insurance and also conform to the requirements of LSA-R.S. 48:255.

All signatures required on the "Bond Form" shall be original signatures, in ink, and are not to be mechanical reproductions or facsimiles.

103.06 EXECUTION AND APPROVAL OF CONTRACT. The contract, satisfactory bonds, proof of all required policies of insurance with minimum insurance coverages and all other required contract documents shall be properly executed and returned to the Department within 15 calendar days after transmission to the bidder. If the contract is not executed by the Department within 20 calendar days following receipt of all required documents, the bidder shall have the right to withdraw his bid without penalty.

103.07 FAILURE TO EXECUTE CONTRACT. Failure by the bidder to comply with Subsection 103.06 will be cause for cancellation of the award and forfeiture of the proposal/bid guarantee. For those projects wherein a proposal/bid guarantee was not provided with the bid, failure to comply with Subsection 103.06 will be cause for cancellation of the award and bidder to be disqualified from bidding or subcontracting for a period of one year from the award date. Awards, which were cancelled, may then be made to the next lowest responsible bidder or the work may be readvertised for bids, at the Department's discretion.

Should a proposal/bid guaranty be required to be forfeited by the bidder to the Department or other named obligee, and if for any reason the full amount

of the proposal/bid guaranty is not collected or collectable by the Department upon demand, the bidder will be disqualified from bidding or subcontracting for a period of one year from the date of non-payment.

103.08 NOTICE TO PROCEED. The Department will issue the contractor a Notice to Proceed or a Conditional Notice to Proceed as soon as possible after award of the contract, and in no case will issue the contractor a Notice to Proceed or a Conditional Notice to Proceed later than 60 days after contract execution unless written consent of the contractor has first been obtained. If the Department has not issued the contractor a Notice to Proceed or a Conditional Notice to Proceed within 60 days of contract execution, and written consent of the contractor to extend this time period has not been obtained prior to its expiration, the contractor may demand cancellation of the contract.

When federal-aid funds are involved, prior to issuance of a Notice to Proceed, the contractor will be required to possess all required licenses before beginning work under the contract. Failure of the contractor to provide satisfactory licenses will be cause for cancellation of the award and forfeiture of the proposal guaranty, which shall become the property of the Department, not as a penalty, but in liquidation of damages sustained. Award may then be made to the next responsible bidder or the work may be readvertised for bids, at the Department's discretion.

After award of the contract, the project engineer will schedule a preconstruction conference. The preconstruction conference will be held prior to performing any work on the project, preferably not later than the issuance of a Notice to Proceed or a Conditional Notice to Proceed. The project engineer will schedule the conference sufficiently in advance to permit the attendance of all parties concerned. The contractor is urged to have all subcontractors in attendance at the preconstruction conference.

Section 104
Scope of Work

104.01 INTENT OF CONTRACT. The intent of the contract is to provide for performance and completion of the work described. The contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, project specifications and terms of the contract.

When an item in the contract contains a choice to be made by the contractor, the contractor shall indicate the choice to the engineer in writing.

When the project specifications reference or require the use of "manufacturer's recommendations or specifications", the contractor shall provide the engineer with a current copy of these recommendations or specifications.

104.02 ALTERATION OF THE CONTRACT. The Department reserves the right to order such alterations in quantities and plans, within the general scope of the contract, including alterations in grade and alignment, as deemed necessary or desirable in order to complete the work as contemplated. Pay items affected by such alterations shall be performed in accordance with the project specifications and payment will be made at the same unit prices as other parts of the work, except as provided in Subsections 109.03 and 109.04.

The Department reserves the right to order work not provided for in the contract whenever such extra work is found essential or desirable to satisfactory completion of the contract within its intended scope. Such extra work shall be performed in accordance with specifications and as directed. Payment for such extra work will be made as provided in Subsection 109.04.

The Department reserves the right to order changes in details, including changes in materials, processes and sequences, whenever such changes are in the best interests of the public or are necessary or desirable to satisfactory completion of the work. Such changes in details shall be performed in accordance with the specifications and as directed, and payment will be made as provided in Subsection 109.04. Changes ordered in details, when such changes are allowed or required by the contract, are not alterations to the contract and payment for the affected work will be made at the contract unit prices.

Alterations to the contract as provided for by this subsection shall not invalidate the contract nor release the surety, and the contractor agrees to

accept the work as altered, as if it had been part of the original contract. The contractor shall notify the surety of any alterations to the contract.

Alterations of the contract shall not involve work beyond the termini of the proposed work except as necessary to satisfactorily complete the project.

No change order will be assumed to be approved until the signed and approved change order is returned to the originator.

(a) Differing Site Conditions:

(1) During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the contract, or if unknown physical conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

(2) Upon written notification, the engineer will investigate the conditions and if he determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made and the contract modified in writing accordingly. The engineer will notify the contractor of his determination whether or not an adjustment of the contract is warranted.

(3) No contract adjustment, which results in a benefit to the contractor, will be allowed unless the contractor has provided the required written notice.

(b) Suspensions of Work Ordered by the Engineer.

(1) If the performance of all or any portion of the work is suspended or delayed by the engineer in writing for an unreasonable period of time (not originally anticipated, customary or inherent to the construction industry) and the contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the contractor shall submit to the engineer in writing a request for adjustment within 7 calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

(2) Upon receipt, the engineer will evaluate the contractor's request. If the engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the contractor, its suppliers, or subcontractors, and not caused by weather, the engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly. The engineer will notify the contractor of his

determination whether or not an adjustment of the contract is warranted.

(3) No contract adjustment will be allowed unless the contractor has submitted the request for adjustment within the time prescribed.

(4) No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this contract.

(c) Significant Changes in the Character of Work.

(1) The engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the contractor agrees to perform the work as altered.

(2) If the alterations or changes in quantities significantly change the character of the work under the contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the contractor in such amount as the engineer may determine to be fair and equitable.

(3) If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

(4) The term "significant change" shall be construed to apply only to the following circumstances.

a. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction or;

b. When a major item of work, as defined elsewhere in the contract, is increased, or decreased, in excess of 25 percent of the contract quantity as awarded. Any adjustment in unit price will be made on only that portion of the major item exceeding the 25 percent increase, or, in the case of a decrease of the item by 25 percent or more the remaining portion will be adjusted.

(d) Eliminated Items. Should any items contained in the contract be found unnecessary for proper completion of the work, the engineer may, upon written order to the contractor, eliminate such items from the contract. Such action shall not invalidate the contract.

When an item is eliminated, the contractor will be reimbursed for authorized work done toward completion of the item. No allowance, except as provided herein, will be made for any increased expense, loss of expected

reimbursement or loss of anticipated profits claimed by the contractor resulting either directly from such elimination or indirectly from unbalanced allocation among the pay items of overhead expense by the contractor and subsequent loss of expected reimbursements therefor or for other reasons.

The change order authorizing reimbursements shall show how the reimbursements were derived. Except when otherwise authorized by the Chief Engineer, such derivation shall show breakdowns of costs as detailed in Subsection 109.04, Headings (a) through (g).

(e) Extra Work. When necessary or desirable to complete the project, the engineer may direct the contractor to perform unforeseen work for which there is no pay item or unit price in the contract. The Department will pay for such work in accordance with Subsection 109.04 based on an approved change order.

104.03 MAINTENANCE OF TRAFFIC. Reasonable provisions for local traffic through the length of the project and the life of the contract shall be made by the contractor during construction, at no direct pay.

When specified, the contractor may also be required to provide for through traffic over the entire project, or designated portion thereof, at no direct pay.

The contractor shall keep the portion of the project being used by public traffic, whether through or local traffic, in such condition that traffic (including mail delivery) will be adequately accommodated. The contractor shall furnish, erect and maintain barricades, warning signs and delineators, and shall provide flaggers and pilot cars in accordance with the plans and the MUTCD. The contractor shall maintain existing drainage and also provide and maintain in a safe condition all temporary approaches or crossings, intersections with roads, streets, businesses, parking lots, residences, garages and farms, at no direct pay.

When the engineer directs additional measures for the benefit of the traveling public, payment to the contractor will be made at the contract unit prices in the contract or as provided in Subsection 109.04. The engineer will be the judge of work to be classed as additional measures.

All lane closures, including ramps, shall be authorized by the engineer. Unless otherwise authorized, lane closures will only be allowed while work is being performed. The contractor shall provide the engineer a five calendar day notice, prior to any lane closure unless a shorter notification period is allowed by the engineer. A late lane opening rental will be charged to the contractor for any lane closure on any roadway or ramp that extends beyond the allowed closure times. The rental shall be computed in hourly increments only, with fractions of an hour rounded up to the next whole hour. The rental will also

apply to any unauthorized lane closures by the contractor, whether short term or long term. Any rental monies assessed for a late lane opening or for an unauthorized lane closure will be deducted from payments due the contractor. The late lane opening rental or unauthorized lane closure rental will be in accordance with Table 104-1 for a maximum of four continuous hours.

Table 104-1
Unauthorized Lane Closure or Late Lane Opening Rental

Current Average Daily Traffic (Vehicles per Day)	Hourly Rate ($/Hour)
<10,000	250
10,000 - 20,000	1,250
20,000 - 35,000	5,000
35,000 - 50,000	11,500
>50,000	15,000

104.04 FINAL CLEANING UP. Before final acceptance, the right-of-way, borrow and local material sources, and areas occupied by the contractor in connection with the work shall be cleaned of rubbish, excess materials, temporary structures, haul roads and equipment. All parts of the work, including property adjacent to the right-of-way, which have been damaged or rendered unsightly during the work shall be left in satisfactory condition and when required, the right-of-way shall be mowed in accordance with DOTD maintenance standards, all at no direct pay.

104.05 GUARANTEES. The contractor guarantees, by signing the contract, all installed project equipment, apparatus, materials and workmanship provided under the contract for a period of 1 year after final acceptance.

Instruction sheets that are required to be furnished by the manufacturer for installed project equipment, materials, supplies, and operation shall be delivered by the contractor to the engineer prior to final acceptance of the project, with the following written warranties and guarantees.

1. The manufacturer's standard warranty for each piece of installed project equipment or apparatus furnished under the contract.

2. The contractor's guarantee that, during the guarantee period, necessary repair or replacement of the warranted equipment or apparatus will be made by the contractor at no direct pay.

3. The contractor's guarantee for satisfactory operation of installed project

equipment including, but not limited to, the mechanical and electrical systems furnished and constructed under the contract for the guarantee period.

If it should be found that parts failed due to defective material or faulty workmanship and if such parts should, within the manufacturer's warranty period, cause any breakdown or accident, the contractor will not only be required to furnish and install the replacement part, but will also be held responsible to the Department for all expenses due to accident or breakdown caused by such a failure. The contractor shall insert one copy of all warranties and guarantees into the maintenance manuals specified. Routine maintenance during the guarantee period will be performed by the Department.

Section 105
Control of Work

105.01 AUTHORITY OF THE ENGINEER. The engineer, acting directly or through duly authorized representatives in accordance with Subsection 105.09, will decide all questions which arise as to quality and acceptability of materials furnished and work performed, rate of progress of the work, interpretation of plans and specifications, and acceptable fulfillment of the contract by the contractor.

The engineer will have the authority to suspend the work wholly or in part due to failure of the contractor to correct conditions unsafe for workmen or the general public; for failure to carry out provisions of the contract; for failure to carry out orders; for such periods as deemed necessary due to unsuitable weather; for conditions considered unsuitable for prosecution of the work; or for other conditions or reasons deemed to be in the public interest.

Orders to suspend the work will be in writing and will include the reasons for the suspension. The order to resume work will also be in writing.

The approval or acceptance by the engineer of submissions by the contractor will be subject to satisfactory installation and performance. Such approval shall not relieve the contractor of responsibility under the contract for successful completion of the work or responsibility for compliance with the terms and conditions of the contract.

The Chief Engineer has the authority to suspend the work if, at any time, the required policies of insurance become unsatisfactory to the Department, as to form or substance, or if a company that has issued any policies becomes unsatisfactory to the Department.

105.02 PLANS AND WORKING DRAWINGS. The contractor will be supplied a maximum of five sets of plans without charge. Additional copies will be furnished upon request at the appropriate charge for reproduction services. Reduced (half-sized) plans will be furnished unless full-sized plans are requested. Plans will show lines, grades, typical cross sections, location and details of structures, and a summary of pay items. Only general features will be shown for steel bridges. The contractor shall keep one set of plans available at the work site at all times.

Standard plans required for the work, but included only by reference, will be furnished free of charge to the contractor upon request.

Working drawings, unless included in the plans, shall be furnished by the

contractor and shall consist of detailed plans required to adequately control the work. They shall include stress sheets, shop drawings, erection plans, falsework plans, form drawings, cofferdam plans, bending diagrams for reinforcing steel, proposed location of construction joints or other supplementary plans or data required of the contractor. Working drawings will be approved by the engineer and such approval will not relieve the contractor of responsibility under the contract for successful completion of the work or responsibility for details shown on the working drawings to conform to the contract.

Type and size of drawings furnished shall conform to Subsection 801.03.

105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS. All work and materials shall conform to the lines, grades, cross sections, dimensions and material requirements of the contract.

When the engineer finds the materials furnished, work performed, or the finished product not in compliance with the contract but that reasonably acceptable work has been produced, the engineer will determine to what extent the work will be accepted and remain in place. If accepted, the engineer will document the basis of acceptance by change order and/or special agreement. The change order and/or special agreement will contain appropriate documentation for an adjustment in the contract price for the work or materials as necessary to support the engineer's determination. Reduced pay schedules will be used when such schedules are a part of the project specifications.

If the engineer finds the materials, work performed, or the finished product not in compliance with the contract and have resulted in an unsatisfactory or unacceptable product, the work or materials shall be removed and replaced or otherwise corrected by the contractor to the satisfaction of the engineer at no direct pay.

If due to the contractor's negligence or selected method of operation in performing the work, the engineer deems it necessary to make changes, the contractor will be liable for the additional design cost to the Department. The amount of such design cost will be the salary cost of design personnel plus 110 percent. The amount thus determined will be deducted from payments for the work.

105.04 COORDINATION AND PRECEDENCE OF CONTRACT DOCUMENTS. These specifications, the supplemental specifications, the plans, special provisions and supplementary documents are essential parts of the contract. A requirement occurring in one is as binding as though

occurring in all. They are intended to be complementary and to describe and provide for a complete work.

In case of discrepancy, the following order of precedence will apply:

1) Special Provisions
2) Plans
3) Supplemental Specifications
4) Standard Specifications
5) Standard Plans

Calculated dimensions will govern over scaled dimensions.

The contractor shall take no advantage of any error or omission in the plans or project specifications. If the contractor discovers such an error or omission, he shall immediately notify the engineer. The engineer will then make such corrections and interpretations as deemed necessary to fulfill the intent of the plans and project specifications.

105.05 COOPERATION BY CONTRACTOR. The contractor shall keep one complete set of plans and other contract documents available at the work site.

The contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the engineer, inspectors and other contractors.

The contractor shall have on the work site at all times, as the contractor's agent, a competent representative capable of reading and understanding the plans and project specifications and experienced in the type of work being performed, who shall receive and execute directions from the engineer. At the preconstruction conference or upon request, the contractor shall furnish the engineer written notice of the name and home telephone number of the representative. The representative shall have authority to execute orders or directions of the engineer without delay and to promptly supply such materials, equipment, tools, labor and incidentals as required. The representative shall be furnished regardless of the amount of work sublet.

The contractor shall furnish the engineer written notice of the names of persons authorized to sign for him in matters pertaining to change orders, force account or extra work, contract time charges and other documents. No work shall commence on the project until the contractor has complied with this requirement. Such written notice shall also be furnished when a person so designated is removed and replaced.

105.06 COOPERATION WITH UTILITIES. The Department will notify all known utility companies, pipeline owners or other parties affected by the

work and endeavor to have the necessary adjustments of public or private utility fixtures, pipelines and other appurtenances within or adjacent to the limits of construction made as soon as possible.

Upon award of the contract, utility companies affected will be advised by the Department of the name and address of the contractor, approximate date work will begin and other pertinent information.

Except as hereinafter provided, and regardless of whether the utility is shown on the plans or referred to in the project specifications, all water lines, gas lines, wire lines, fiber optic cables, telephone lines, cable television lines, service connections, water and gas valve boxes, light standards, cableways, signals and other utility appurtenances within construction limits which prevent completion of the contractor's work will be relocated or adjusted by the owners at no expense to the contractor. The contract will indicate utility items to be relocated, adjusted or constructed by the contractor.

Where a utility crosses or otherwise occupies an area within construction limits of the project and the utility will not have the Department's required clearance when the work is completed, it shall be the Department's responsibility to arrange for necessary relocation to the required clearance. When the required clearance will exist when the work is completed, but relocation is considered necessary by the contractor for construction purposes, the contractor shall make arrangements with the owner for any relocation or adjustment necessary to the operations at no direct pay. In such cases, upon completion of the work and prior to final acceptance, the final location of the utility will be acceptable to the Department. Nothing herein shall be interpreted to mean that the Department waives its rights to control entrance onto, or location on, its right-of-way of any utility or appurtenance.

It is agreed that the contractor has considered in the bid all permanent and temporary utility appurtenances in their present or proposed relocated positions and that no additional compensation will be allowed for delays, inconvenience or damage sustained due to interference from the said utility appurtenances or the operation of moving them.

When the engineer determines that the contractor is experiencing significant delays in the controlling items of work because of delays by others in removing, relocating or adjusting utility appurtenances, contract time extensions will be considered for such delays in accordance with Subsection 108.07.

On the date stipulated in the Notice to Proceed, the contractor shall begin work in connection with fencing, clearing, grubbing, removal of structures and obstructions, and relocation and demolishing of other structures, and shall prosecute such work to completion to avoid delays in removal or adjustment

of utilities. The contractor shall cooperate with the utility companies to avoid delays in completion of work due to nonremoval or nonadjustment of utilities.

When the contractor's work involves excavating or underground demolition activity, the contractor is required to reach Louisiana One Call, prior to starting any work, by calling (225) 275-3700 or toll-free 1-800-272-3020, or by fax (225) 272-1967 in order to comply with the Louisiana Underground Utilities and Facilities Damage Prevention Law.

105.07 COOPERATION BETWEEN CONTRACTORS. The Department reserves the right to contract for and perform additional work on or near the work covered by the contract.

When separate contracts are let within, adjoining, or adjacent to the limits of the project, each contractor shall conduct the work not to hinder the progress of work by other contractors and shall cooperate with each other as directed.

The contractor shall arrange the work and shall place and dispose of materials being used not to interfere with the operation of other contractors within, adjoining, or adjacent to the limits of the project. The contractor shall acceptably join the work with that of other contractors and shall perform the work in proper sequence to that of the others and without causing disruption or delay to the schedule of project completion.

The contractor shall assume all liability, financial or otherwise, in connection with the contract and shall hold the Department harmless and indemnify the Department from all damages or claims that may arise because of inconvenience, delay, or loss experienced by the contractor or caused to other contractors due to the presence and operations of other contractors working within, adjoining or adjacent to the limits of the projects.

105.08 CONSTRUCTION STAKES, LINES AND GRADES. Unless otherwise provided for in the contract, the engineer will set construction stakes establishing lines and continuous profile grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as deemed necessary, and will furnish the contractor all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control by and in accordance with which the contractor shall establish other necessary controls and perform the work.

The contractor shall be responsible for preservation of all stakes and marks established by the engineer. When any construction stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost

of replacing same will be charged to the contractor and will be deducted from payments for the work.

105.09 AUTHORITY AND DUTIES OF PROJECT ENGINEER. As the direct representative of the Chief Engineer, the Project Engineer has immediate charge of the Department's engineering details of the construction project. The Project Engineer is responsible for administration of the contract. The Project Engineer shall have authority to give directions pertaining to the work and for consideration of the public, to reject defective materials and equipment, and to suspend work in accordance with Subsection 105.01.

Except as permitted and instructed by the Chief Engineer, the Project Engineer is not authorized to alter or waive provisions of the contract, alter quantities, order extra and force account work, or accept any portion of the project. In no case will the Project Engineer perform any duties for or act as the representative of the contractor.

When the work is being done by force account, the contractor shall have the responsibility to supervise the work and provide a product meeting the requirements of the contract. The Project Engineer, however, shall have the authority to require the contractor to revise operations, including but not limited to, sequence and location of work; number, category and caliber of workers; number and type of equipment; and hours of work.

105.10 DUTIES OF THE INSPECTOR. Inspectors representing the Department are authorized to inspect all work. Such inspection extends to any part of the work and to preparation, fabrication or manufacture of materials to be used. The inspector is not authorized to alter or waive contract provisions. The inspector is not authorized to issue instructions contrary to the contract; however, the inspector will have authority to reject work or materials until any question can be referred to and decided by the engineer. In no case will the inspector perform any duties for, or act as the representative of the contractor.

105.11 INSPECTION OF WORK. All materials and each part or detail of the work shall be subject to inspection by the engineer. The engineer shall be allowed safe and convenient access to all parts of the work and shall be furnished with such information and assistance by the contractor as required to make a complete inspection. Such inspection will not relieve the contractor from the obligation to furnish acceptable materials or to perform all work in accordance with the contract.

If ordered by the engineer, the contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as

directed. After examination, the contractor shall restore said portions of the work to the standard required by the project specifications. Should the work thus exposed prove acceptable, the uncovering or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but, should the work so exposed prove unacceptable, the uncovering or removing, and the replacing of the covering or making good of the parts removed, will be at no direct pay.

Work done or materials used without supervision or inspection by an authorized Department representative, when the Department is not provided adequate notice or opportunity to provide inspection, may be ordered uncovered for examination and recovered, or removed and replaced, all at the contractor's expense.

When a unit of government or political subdivision or other public or private entity is to pay a portion of the cost of the work covered by the contract, its representatives shall have the right to inspect the work. Such inspection shall not make any unit of government, political subdivision or corporation a party to the contract and shall not interfere with the rights of either party thereunder.

105.12 INSPECTOR'S STAMP FOR SHIPMENT.

(a) Approval for Shipment: When materials requiring shop or plant inspection are ready for shipment, the Department's inspector shall affix the stamp of the Department. Each shipment piece, keg, box or bound pallet shall be marked by the inspector by direct stamping.

Application of the inspector's stamp implies that at the time of stamping it was the opinion of the inspector that the product was fabricated or manufactured from accepted materials by approved processes and painted, if required, in accordance with the contract. Application of the inspector's stamp for shipment does not imply that the products will not be rejected by the Department if subsequently found to be defective.

(b) Rejection: The inspector will reject material and workmanship that do not conform to the contract.

Stamping of products by Department representatives shall not preclude further testing and inspection by the Department.

Defective materials and workmanship, whenever discovered, will be rejected and shall be repaired or replaced at no direct pay. All repair procedures shall be approved.

(c) Shipment of Material Not Stamped: Materials and fabricated items subjected to shop inspection will not be accepted at the project site if they do not bear the inspector's stamp for shipment. If the products are not

stamped because they were not offered for shop inspection, or were shipped after rejection at the shop, the products shall be returned to the shop for inspection and correction as necessary.

In lieu of this requirement, the Department may allow inspection to be performed at the project site at the contractor's expense.

105.13 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK. Work not conforming to the contract will be considered unacceptable, unless otherwise determined acceptable under the provisions in Subsection 105.03.

Unacceptable work found to exist prior to final acceptance of the work shall be removed and acceptably replaced.

No work shall be done without lines and grades having been given by the engineer, except that work which is specified as construction layout. No payment will be made for work done contrary to instructions of the engineer, work done beyond lines shown on the plans or as given, or extra work done without authority. Work so done may be ordered removed or replaced at the contractor's expense.

Upon failure of the contractor to comply with any order of the engineer made under the provisions of this Subsection, the engineer will have authority to cause unacceptable work to be remedied or removed and replaced and unauthorized work to be removed and to deduct the costs from payments for the work.

105.14 LOAD RESTRICTIONS. The contractor, subcontractors or suppliers shall observe legal load restrictions when hauling equipment or materials on public roads beyond project limits. A special permit does not decrease the contractor's liability for damage.

Except for specified equipment contractor shall obtain the engineer's written permission to exceed legal load limits within the project limits. Operating equipment or hauling loads that may damage structures, roadway, or any construction is prohibited.

105.15 MAINTENANCE DURING CONSTRUCTION. The contractor shall satisfactorily maintain the entire area within the right-of-way limits of the project, from the effective date of the Notice to Proceed until the date of final acceptance. This maintenance responsibility includes, but is not necessarily limited to, maintaining drainage, periodic mowing and removing of debris and remains, to the satisfaction of the engineer, as well as such striping, patching and shoulder maintenance which will provide safe and

convenient conditions at all times for the public. The contractor shall continuously and effectively satisfy his maintenance responsibilities with such equipment and forces as may be necessary to maintain a safe and satisfactory condition for the duration of the project.

The contractor shall maintain the roadway in a satisfactory condition to allow traffic to safely travel through the work zone at the posted speed limit.

Adjacent and parallel roadways within the project limits, not affected by construction shall not be the maintenance responsibility of the contractor.

105.16 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE. If the contractor fails to comply with Subsections 104.03 and 105.15, the engineer will immediately notify the contractor in writing of such noncompliance. If the contractor fails to remedy the condition within 24 hours after receipt of the written notice, the Department will have the option to immediately remedy the condition with its own in-house forces or by another contractor, and the cost thereof will be deducted from payments for the work.

When the condition requires more immediate remedy due to hazard to life, health and property, the engineer will immediately remedy the condition as above and the costs thereof will be deducted from payments for the work.

105.17 ACCEPTANCE.

(a) Partial Acceptance: When the contractor satisfactorily completes a portion of the project that can be used advantageously for traffic or other use, the contractor may request the engineer to make final inspection of that portion. When the engineer finds upon inspection that the portion has been completed in compliance with the contract, the engineer may accept that portion as being completed and the contractor will be relieved of further responsibility for that portion and from further liability to the public.

Partial acceptance of a project will not be made until the portion being accepted has been completed in its entirety, including all safety devices, signs and striping. When partial acceptance is made, the terms of acceptance, including the responsibilities of all parties and any allowance of additional contract time, shall be set forth in a change order, mutually agreed to by the engineer and the contractor. Such partial acceptance shall not void or alter any terms of the contract, except as set forth in the change order.

(b) Final Acceptance: Upon notice from the contractor of presumptive completion of the entire project, the engineer will make an inspection. When the work provided for in the contract is found satisfactorily completed, that inspection will constitute the final inspection. The engineer will make final acceptance and notify the contractor in writing of this acceptance as of the

date of final inspection.

When the inspection discloses any work as being unsatisfactory, the engineer will give the contractor instructions for correction of same. The contractor shall immediately comply with such instructions. Upon correction of the work, another inspection will be made which will constitute final inspection provided the work has been satisfactorily completed. In such event, the engineer will notify the contractor in writing of this acceptance as of the date of final inspection.

105.18 CLAIMS FOR ADDITIONAL COMPENSATION. If the contractor deems additional compensation is due for work, material, delays, inefficiencies, disruptions or other additional costs/or expenses not covered in the contract or not ordered as extra work, the contractor shall notify the engineer in writing of his intention to make a claim for such additional compensation before beginning the work on which the claim is based or immediately upon encountering the conditions or effects which the contractor claims entitle him to additional compensation. Notification of claims shall conform to the requirements of EDSM III.1.1.28. If such notification is not given or the engineer is not afforded proper facilities by the contractor for keeping account of actual costs incurred by the contractor, the contractor hereby agrees and shall be deemed to waive any claim for such additional compensation. Such notice by the contractor and the fact that the engineer has kept account of the costs as aforesaid shall not be construed as proving or substantiating the validity of any claim. If the claim, after consideration by the Chief Engineer, or judicial determination, is found to be just, payment will be made as specified in Subsection 109.04 by force account or negotiated price. Nothing in this subsection shall be construed as establishing any claim contrary to Subsection 104.02.

105.19 VALUE ENGINEERING PROPOSALS. This provision is to share with the contractor only the cost savings generated on this contract as a result of a Value Engineering (VE) Proposal(s) offered by the contractor and approved by the Department. Any time savings resulting from a VE Proposal will be considered at the completion of the project as an incentive to the contractor, provided the contract contains an incentive clause for early completion of the work and the contractor has not met the incentive limit in the contract. A time only reduction will not be considered as a VE Proposal. The purpose is to encourage the use of the contractor's ingenuity and experience in arriving at alternative construction methods, which will reduce the overall construction cost. After award of the contract, the successful

bidder will be permitted to submit to the engineer, written VE Proposals, for modifying the plans, specifications, or other requirements of the contract for the purpose of reducing the total cost of construction. The VE Proposal shall not impair, in any manner, the essential functions and characteristics of the project, including but not limited to safety, service life, reliability, economy of operation, ease of maintenance, desired appearance, traffic flow during construction, or necessary standardized features.

The VE Proposal shall be specifically identified by the contractor as a cost reduction proposal. VE Proposals will be considered by the Department in the same manner as change orders.

The contractor has the option of submitting a conceptual VE Proposal to the Department for review prior to making formal submission. However, the contractor may submit the formal VE Proposal directly.

The conceptual VE Proposal shall provide the following minimum information:

(a) A description of the proposal.

(b) A listing of work items affected by the proposed change, including any change in contract time and/or traffic maintenance.

(c) An initial estimate of the net cost savings which the change is expected to generate, including elimination of any planned work.

The contractor may proceed to the formal VE Proposal upon the Department's approval of the conceptual VE Proposal. The Department is not obligated to approve the contractor's formal VE Proposal, even if the conceptual VE Proposal is initially considered acceptable.

As a minimum, the following information shall be submitted by the contractor with the formal VE Proposal.

(a) A statement that the proposal is submitted as a VE Proposal.

(b) A description of the difference between the existing contract requirements and the proposed change(s), and the comparative advantages and disadvantages of each, including effects on service life, economy of operations, ease of maintenance, desired appearance, necessary standardized features, reliability, traffic flow during construction, safety, and contract time.

(c) Any or all of the following submittals as required by the engineer showing proposed revisions relative to the original contract features and requirements: Plans, sketches, engineering calculations, specifications or stamped plans bearing the signature and seal of a professional engineer licensed to practice in the State of Louisiana.

(d) Detailed estimates of the cost to the Department for performing the work under the existing contract and under the VE Proposal, including a listing of contract items affected by the proposal, and quantity variations

attributable thereto with the related costs.

(e) An assessment of any effects that adoption of the VE Proposal could have on other costs to the Department, including future maintenance and operation.

(f) A statement of the latest time or date that any agreement adopting the VE Proposal must be executed in order to obtain the maximum cost reduction during the remainder of the contract and the reasoning for this time schedule. This date must allow the Department time for review and processing of a change order. Should the Department find insufficient time is available for review and processing, it may reject the VE Proposal on such basis. If the Department fails to respond to the VE Proposal by the date or time specified, the contractor shall consider the proposal rejected and shall have no claim against the Department.

(g) A statement of the effect that adoption of the VE Proposal will have on the time for completion of the contract.

(h) A description of any previous use or testing of the final VE Proposal on another Department project or elsewhere and the conditions and results therewith. If the final VE Proposal was previously submitted on another Department project, indicate the date, the project, and the action taken by the Department.

The provisions of this subsection shall not be construed to require the Department to consider any VE Proposal which may be submitted. The Department reserves the right to reject any and all VE Proposals. The bidder is cautioned not to base any bid prices on the anticipated approval of a VE Proposal and to recognize that the proposal may be rejected. In the event of rejection, the contractor will be required to complete the contract at the contract bid prices. Proposed changes in basic configuration and design of a bridge, hydraulic capacity of drainage facilities, typical roadway section, type or minimum thickness of pavements, or changes in grade or alignment which do not meet the geometric standards of the project as conceived, will not be considered as acceptable VE Proposals. Typically, changes in materials for roadway sections will also not be considered as acceptable VE proposals. Plan errors which are identified by the contractor and result in a cost reduction will not qualify as a VE proposal. If the Department is already considering certain revisions to the contract or has approved certain changes in the contract for general use, which are subsequently incorporated in a VE Proposal, the Department will reject the contractor's proposal and may proceed without obligation to the contractor. The Department will not be liable to the contractor for failure to act upon or accept any VE Proposal nor for any delays to the work attributable to any such proposal. The contractor

may withdraw, in whole or in part, any VE Proposal not accepted by the Department within the period specified in the proposal. The decision of the Department as to the acceptance or rejection of VE Proposals shall be final and shall not be subject to the provisions of Subsection 105.19.

The contractor will be notified in writing of the Department's decision to accept or reject each VE Proposal submitted under these provisions. If a VE Proposal is accepted, the necessary contract modifications will be implemented by execution of a change order, which will provide for equitable price adjustments giving the contractor and the Department equal shares in the resulting net savings. Until a VE Proposal is affected by such contract modification, the contractor shall perform the work in accordance with the terms of the existing contract.

The net cost savings to be shared shall be determined as the difference in costs between the original contract costs for the involved work items and the actual final costs to the Department occurring as a result of the proposed change. Only those work items directly affected by the change order will be considered in making the final determination of net cost savings. Subsequent change orders affecting the modified work items but not related to the VE Proposal, will be excluded from such determination. In reviewing the VE Proposal, the Department reserves the right to reject the proposal if, in its judgment, the proposed net cost savings do not represent a reasonable measure of the value of the work to be performed or deleted.

All costs incurred by the contractor in developing the VE Proposal shall be borne by the contractor. The change order implementing the necessary contract modifications shall include a pay item for and a lump sum estimate of the approximate net cost savings anticipated as a result of the VE Proposal, and a proportionate amount thereof shall be included in partial payment estimates as the work on the modified contract items is performed. The contractor's 50 percent share of the net cost savings shall constitute full compensation for implementing all changes pursuant to the agreement. Any time savings for early completion of the project resulting from the VE Proposal will be considered upon completion of the project as an incentive to the contractor provided the contract contains an incentive clause for early completion of the work and the contractor has not met the incentive limit in the contract.

The Department reserves the right to include in the agreement any conditions it deems appropriate for consideration, approval, and implementation of the VE Proposal. The Department also reserves the right to require the contractor to share in the Department's costs of investigating a VE Proposal submitted by the contractor as a condition of considering such

proposal. The Department will have the option to perform the investigation in-house or by consultants. When such a condition is imposed, the contractor shall indicate his acceptance in writing, and such acceptance shall constitute full authority for the Department to deduct amounts payable to the Department from any monies due or that may become due to the contractor under the contract.

The Department reserves the right to adopt a VE Proposal for general use when it determines that said proposal is suitable for application to other contracts. When an accepted VE Proposal is adopted for general use, only the contractor who first submitted such proposal will be eligible for compensation pursuant to this subsection, and in that case, only as to those contracts awarded to him prior to submission of the accepted proposal. VE Proposals identical or similar to previously submitted proposals will be eligible for consideration and compensation under these provisions if the identical or similar previously submitted proposals were not adopted for general application to other Department contracts. Subject to the provisions contained herein, the State or any other public agency shall have the right to use all or any part of any submitted VE Proposal without obligation or compensation of any kind to the contractor.

Any changed conditions arising as a result of the acceptance of a VE Proposal will not be considered as the basis for any claim for additional compensation.

105.20 NIGHTTIME CONSTRUCTION OPERATIONS.

(a) Description: This work consists of furnishing, installing, operating, maintaining, moving, and removing portable light towers and equipment-mounted fixtures for nighttime construction operations. Nighttime construction operations are defined as work performed after sunset and before sunrise.

(b) Equipment Requirements: Materials and equipment shall be in good operating condition and in compliance with applicable OSHA, NEC, and NEMA codes.

The contractor shall furnish, to the engineer, two light meters capable of measuring the level of illuminance. These light meters will be used by the engineer to check the adequacy of illumination throughout the nighttime construction operations. The light meters will become the property of the contractor after final acceptance.

Suitable brackets and hardware shall be provided to mount lighting fixtures on equipment and machinery. Mountings shall be designed so that light fixtures can be positioned as necessary to reduce glare and provide the

required illumination. Mounting brackets and fixtures shall not interfere with the equipment operator or any overhead structures and shall be securely connected to the fixtures to insure minimum vibration.

Equipment-mounted systems shall be attached to construction equipment to provide Level II and Level III illuminance. Equipment mounted lighting shall be designed and positioned to be operated independently of general illumination.

Portable systems may consist of ground-mounted, trailer-mounted, or equipment mounted light towers. Portable light towers shall be sturdy and free-standing without the aid of guy wires or bracing. Towers shall be capable of being moved as necessary to keep pace with the construction operation. Extreme caution shall be used when moving portable light towers in the vicinity of overhead utilities. Portable lighting systems shall be positioned to minimize the risk of being impacted by traffic on the roadway or by construction equipment.

Conventional vehicle headlights shall not be permitted as the sole means of illumination while working. All motorized vehicles shall be equipped with conventional vehicle headlights to permit safe movement in non-illuminated areas. Use of strobe lights on vehicles and equipment is prohibited. Use of flashing lights shall be kept to a minimum to prevent motorist distraction. Flashing lights shall not be used behind barrier protection systems.

Switches shall be provided to adequately control the various lights. All wiring shall be weatherproof and installed according to local, state, federal, and OSHA requirements. Ground fault circuit interrupters shall be provided for electrical outlets used for electrical tools and extension cords. The contractor shall provide sufficient fuel, spare lamps, generators and qualified personnel to ensure that all required lights operate continuously during nighttime construction operations. In the event of any failure of the lighting system, the construction operation shall be discontinued until the required level of illumination is restored. In residential areas, generator systems shall be selected to comply with local noise ordinances. A supply of emergency flares shall be maintained by the contractor for use in the event of emergency or unanticipated situations.

(c) Illumination Requirements: All operations that are performed during nighttime hours shall be properly illuminated to allow for the safe performance and inspection of the work.

Work area is defined as a minimum of 50 feet (15 m) ahead and behind the employee, where work is to be performed. A minimum of 5 foot-candles (54 lux) shall be maintained throughout the work area during nighttime construction operations, and during the setup and removal of lane or roadway

closures.

Lighting shall be adequate to meet the required level of illuminance and uniformity over the work area as follows:

(1) Level I (5 foot-candles, 54 lux): This level of illuminance shall be provided for all work areas of general construction operations, such as excavation and embankment; cleaning and sweeping; landscaping; planting and seeding. Stockpiles shall also be illuminated to Level I to enhance safety and improve work efficiency.

(2) Level II (10 foot-candles, 108 lux): This level of illuminance is required for areas on or around construction equipment such as that used for drainage installations, striping, base course construction, milling, asphalt paving operations, and concrete placement and removal. This level is necessary for safe operation of equipment and for obtaining an acceptable level of accuracy.

(3) Level III (20 foot-candles, 215 lux): This level of illuminance is required for tasks requiring a higher level of visual performance or for tasks with a higher level of difficulty. Such tasks include, pavement or structural crack filling, joint repair, joint cleaning, joint sealing, pavement patching and repairs, saw-cutting, installation of signal equipment or other electrical/mechanical equipment, and other tasks involving fine details or intricate parts and equipment.

(d) Glare Control: All lighting provided under this item shall be designed, installed, and operated to avoid glare interference with roadway traffic or discomfort for residences adjoining the roadway. The contractor shall locate, aim, and adjust the lights to provide the required level of illuminance and uniformity in the work area without the creation of objectionable glare. The engineer shall determine when glare exceeds acceptable levels, either for traffic or adjoining residences. The contractor shall provide shields, visors, or louvers on luminaries as necessary to reduce objectionable levels of glare.

At a minimum, the following requirements shall be met to avoid objectionable glare to oncoming traffic:

(1) Tower-mounted luminaries shall generally be aimed either parallel or perpendicular to the roadway.

(2) All luminaries shall be aimed such that the center of the beam axis is no greater than 60 degrees from the vertical.

(3) Luminous intensity of any luminary shall not exceed 20,000 candelas at an angle of 72 degrees from the vertical.

(e) Operational Requirements: Thirty days prior to the start of night time operations, the contractor shall submit a lighting plan to the

engineer for approval. The contractor shall select appropriate lighting systems and design a lighting plan to achieve the required illuminance levels.

The lighting plan shall include location of lights necessary for every aspect of work; description of light equipment to be used; description of power source; attachment and mounting details for lights to be attached to equipment; technical details pertaining to the lighting fixtures; details on hoods, louvers, shields, or other glare control methods; and lighting calculations confirming that the illumination requirements will be met by the layout plan.

Lighting inspection will include (1) light meter measurements to determine illumination levels, (2) subjective observation of the lighting setup to evaluate glare potential for drivers and workers, and (3) a physical check of the lighting equipment to ensure that it complies with the specification requirements included in the contractor's lighting plan.

Prior to the first night of operation, the engineer will check the adequacy of the installed lighting using a light meter. A summary of these measurements will be noted in the inspection records to provide a basis for comparing subsequent measurements. If the required illuminance levels are not met, the contractor shall make the necessary adjustments before any work proceeds.

Operational checks shall be made when construction phasing changes and lighting plan changes are required to accommodate different phases of construction. Periodic checks will be made throughout the duration of nighttime operations. If the required illuminance levels are not met, the contractor shall make the necessary adjustments to the lighting plan before work continues.

During construction operations, in the event of any failure of the lighting system, the operations shall be discontinued until the required level of illumination is restored.

Section 106
Control of Materials

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS.

Materials used in the work shall meet all quality requirements of the contract. To expedite inspection and testing of materials, the contractor shall notify the engineer of his proposed sources of materials prior to delivery. With written authorization, materials may be approved at the source of supply before delivery is started. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the contractor shall furnish materials from other sources or make necessary changes to provide acceptable materials.

106.02 LOCAL MATERIAL SOURCES.

(a) Designated Sources: Possible sources of local materials may be designated in the plans or specifications. The quality of material in such deposits will be acceptable in general, but the contractor shall determine the amount of equipment and work required to produce a material meeting specifications. It shall be understood that it is not feasible to ascertain from samples the limits for an entire deposit and that variations are to be expected. The engineer may order procurement of material from any portion of a deposit and may reject portions of the deposit as unacceptable.

The Department may acquire and make available to the contractor the right to take materials from the sources designated in the plans or specifications, with the right to use such property as specified for plant site, stockpiles or haul roads.

When the contractor desires to use material from sources other than those designated, the contractor shall acquire the necessary rights or permits to take materials from the sources and shall pay all costs related thereto, including any which may result from increased haul length. All costs of exploring and developing such sources shall be borne by the contractor. Use of material from other than designated sources will not be permitted until representative samples taken by the engineer have been approved and written authority is issued for the use thereof.

(b) Contractor Furnished Sources: When material deposits are not designated in the plans or specifications, the contractor shall provide sources of acceptable material. When sources of materials are provided by the contractor, the Department may assume the cost of processing samples to

determine suitability of material.

(c) Use of Materials Found on the Project: Unless otherwise specified, the contractor may incorporate into the work materials found or produced on the project such as reclaimed asphaltic pavement, recycled portland cement concrete, stone, gravel, sand, topsoil or other materials found acceptable by the engineer. Payment for removal of such materials will be made under the designated contract items such as cold planing asphaltic pavement, removal of portland cement concrete pavement, excavation, etc. Payment will also be made for the pay items into which these materials are incorporated.

The contractor shall replace at no direct pay with acceptable material all removed material which was needed for embankments, backfills, approaches or otherwise. No charge for materials so used will be made against the contractor. The contractor shall not excavate or remove material from within the right-of-way which is not within construction limits, as indicated by slope and grade lines, without written authorization from the engineer. If authorization is obtained, payment will not be made for excavation beyond slope and grade lines, nor will payment be made for any required replacement.

Materials from existing structures may be used temporarily by the contractor in erection of new structures. Modification of such material will not be permitted without written approval.

106.03 ACCEPTANCE SAMPLES AND TESTS. Materials will be inspected, tested and approved before incorporation into the work. Work in which untested and unapproved materials are used shall be performed at the contractor's risk. Payment will not be made for materials or work found to be unacceptable and, when directed, shall be removed at the contractor's expense. Sampling and testing will be performed in accordance with the contract or the cited standard method of the Department's Materials Sampling Manual and Testing Procedures Manual; if not contained therein, by AASHTO methods. If a procedure is not available in AASHTO methods, the ASTM procedure will be used, except for any resampling or retesting procedures included therein. Resampling or retesting procedures shall be as determined by the Department's Materials Engineer Administrator. When allowable variations or conflicts occur within an ASTM or AASHTO test procedure, the established DOTD procedure and publications shall govern. Sampling and testing procedures not contained in the above publications shall be as determined by the engineer. All procedures will be the most recent cited which are current on the date of advertisement for bids. Acceptance testing will be made by and at the expense of the Department. Samples for

acceptance testing will be taken by an authorized representative of the Department. Materials being used will be subject to inspection, sampling, testing, retesting, or rejection at any time prior to final acceptance. The contractor will be notified of a failing test. Copies of all tests reports will be furnished to the contractor's representative upon request.

106.04 CERTIFICATES. Certificates shall include Certificates of Analysis, Certificates of Compliance, and Certificates of Delivery. These certificates shall be furnished prior to use of materials for which the certificates are required. They shall be signed by the material manufacturer, the manufacturer of assembled materials or the material supplier.

Materials used on the basis of these certificates may be sampled and tested at any time. The fact that material is used on the basis of a certificate shall not relieve the contractor of responsibility for incorporating material in the work which conforms to the plans and specifications.

Distribution of certificates and requirements for further sampling and testing of certified materials shall be as outlined in the Department's Materials Sampling Manual.

The Department reserves the right to refuse to permit the use of material on the basis of a certificate.

106.05 CONTRACTOR QUALITY CONTROL. The contractor shall establish and maintain an effective quality control process. The quality control process shall consist of plans, procedures, and organization necessary to provide materials, equipment, workmanship, fabrication, construction and operations which comply with the contract requirements. The process shall cover construction operations both onsite and offsite, and shall be keyed to the proposed construction sequence.

Quality Control requirements shall be as specified in the latest edition of the Department's "Quality Control / Quality Assurance Manual" for the appropriate specification section.

Contractor personnel performing sampling and testing, observation, or inspection for the quality control process shall be evaluated and approved by the Department in accordance with Departmental requirements.

106.06 PLANT INSPECTION. The Department reserves the right to inspect plants and operations producing materials and to test materials, prior to incorporation into the work as necessary to ensure contract compliance.

When plant inspection is undertaken, the following conditions shall be met:

(a) The engineer shall have the cooperation and assistance of the contractor and the producer with whom the contractor has contracted for materials.

(b) The engineer shall have entry at all times to such parts of the plant as concern the manufacture or production of materials being furnished.

Certification of specified plants and operations will be in accordance with Department requirements.

106.07 FIELD LABORATORY. The contractor shall provide project site laboratories as required by the specifications to be used exclusively for quality assurance purposes by the Department. The buildings shall be installed, furnished, equipped and maintained in accordance with Section 722, and ready for use prior to the time the contractor's operations require testing.

106.08 FOREIGN MATERIALS. Materials manufactured outside the United States shall be delivered to approved locations within the United States, where they shall be retained until sampling and testing can be completed.

The contractor shall, at no direct pay, arrange for any required testing which the Department is not equipped to perform. Testing by the contractor shall be performed within the State and be subject to witnessing by the engineer.

Each lot of foreign material shall be accompanied by a Certificate of Compliance prepared in accordance with Subsection 106.04. Certificates of Analysis prepared in accordance with Subsection 106.04 shall be attached to the Certificate of Compliance for those materials for which Certificates of Analysis are required. These certificates shall clearly identify the lot to which they apply.

Structural materials requiring Certificates of Analysis (Mill Test Reports) will be accepted only from foreign manufacturers who have previously established to the satisfaction of the engineer the adequacy of their in-plant quality control.

Adequacy of quality control shall be established, at the option of the engineer, by submission of detailed written proof of adequate quality control or through a plant inspection by the engineer.

No structural materials will be accepted which cannot be properly identified with Certificates of Analysis and Certificates of Compliance.

106.09 MATERIAL STORAGE AND PLANT SITE. Materials shall be stored to assure preservation of their quality and fitness for the work. Stored

materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located to facilitate their prompt inspection. Approved portions of the right-of-way may be used for storage and for placing the contractor's plant and equipment. Additional space required shall be provided by the contractor at no direct pay.

106.10 HANDLING MATERIALS. Materials shall be handled to preserve their quality and fitness for the work. Materials shall be transported from storage site to the work in tight vehicles constructed to prevent loss or segregation of materials after loading and measurement in order that there will be no inconsistencies in quantities of materials loaded and quantities received at the place of operations.

106.11 UNACCEPTABLE MATERIALS. Materials not conforming to specifications will be rejected and shall be removed immediately from the work unless otherwise directed. No rejected material, the defects of which have been corrected, shall be used until approval has been given.

106.12 DEPARTMENT-FURNISHED MATERIAL. The contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Department.

Material furnished by the Department will be delivered or made available to the contractor at the points specified.

The cost of handling and placing materials after they are delivered to the contractor shall be considered as included in the contract price for the item in connection with which they are used.

The contractor will be responsible for material delivered. Deductions will be made from payments for the work to make good any shortages and deficiencies, for any damage which occurs after such delivery, and for any demurrage charges.

Section 107
Legal Relations and Responsibility to Public

107.01 LAWS TO BE OBSERVED. The contractor shall keep informed of and comply with all Federal, State and local laws, ordinances and regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which affect those employed on the work or which affect the conduct of the work. The contractor shall indemnify the State and its representatives against any claim or liability arising from violation of any such law, bylaw, ordinance, code, regulation, order or decree, whether by the contractor or the contractor's employees.

Soil and soil-moving equipment operating in regulated areas will be subject to plant quarantine regulations. These regulations provide for cleaning soil from equipment before it is moved from regulated areas to prevent spread of harmful agricultural pests from areas quarantined by the State or U. S. Department of Agriculture. Complete information may be obtained from the appropriate district office of the USDA Plant Protection Division.

When the Department is the contracting agency, any litigation arising under or related to the contract or the bidding or award thereof shall be instituted in the 19th Judicial District Court in and for the Parish of East Baton Rouge, State of Louisiana.

107.02 PERMITS, LICENSES, TAXES AND INSURANCE. Contractors shall procure temporary permits and licenses for the work, pay charges, fees, and taxes, and give notices necessary to due and lawful prosecution of the work.

The contractor shall maintain, at a minimum, the following insurance coverages:

(a) Workers Compensation in compliance with state law, with the exception that the contractor’s Employer liability is to be at least $1,000,000 when work is to be over water and involves maritime exposures. For the coverage provided in this subpart the contractor’s Insurer will have no right of recovery or subrogation against the State of Louisiana or the Louisiana Department of Transportation and Development.

(b) Commercial General Liability Insurance with a combined single limit per occurrence for bodily injury and property damage. The aggregate loss limit must be on a per project basis. This insurance shall include coverage for bodily injury and property damage, and include coverage for Premises-

Operation; Broad form Contractual Liability; Products and Completed Operation; Use of Contractors and Subcontractors; Personal Injury; Broad form Property Damage; and Explosion, Collapse and Underground (XCU) coverage. The required combined single limit amount of insurance shall be as provided in Table 107-1.

(c) A separate Owner's and Contractor's Protective (OCP) Liability Policy shall be furnished by the contractor naming the Louisiana Department of Transportation and Development as the named insured. The required combined single OCP limit amount shall be as provided in Table 107-1.

(d) Business Automobile Liability Insurance with a combined single limit per occurrence for bodily injury and property damage. This insurance shall include bodily injury and property damage coverage for owned automobiles, hired automobiles and non-owned automobiles. The required combined single limit amount of insurance shall be as provided in Table 107-1 below.

Table 107-1
Insurance Requirements

Initial Contract Amount	Minimum Insurance
Up to $1,000,000	$ 1,000,000
From $1,000,001 to $2,000,000	$ 2,000,000
Over $2,000,000	$ 5,000,000

The following shall be included as provisions in each policy:

(a) The insurance company (ies) issuing the policy (ies) shall have no recourse against the State of Louisiana and the Department for payment of any premiums or for assessments under any form of the policy.

(b) Any and all deductibles in the above described insurance policy (ies) shall be assumed by and be at the sole risk of the contractor.

Insurance is to be placed with insurance companies authorized in the State of Louisiana with an A. M. Best's rating of A-: VI or higher. This rating requirement may be waived for Workers Compensation coverage only.

Should any policies be canceled, the contractor shall immediately notify the Department.

Upon failure of the contractor to furnish, deliver and maintain such insurance as required, this contract, at the election of the Department, may be immediately declared suspended, discontinued or terminated. Failure of the contractor to maintain any required insurance shall not relieve the contractor from any liability under the contract, nor shall the insurance requirements be construed to conflict with the obligations of the contractor concerning indemnification under Subsection 107.17.

The contractor is responsible for requiring and verifying that all subcontractors working on the project maintain appropriate types and levels of insurance coverage.

107.03 PATENTED DEVICES, MATERIALS AND PROCESSES. If the contractor uses any design, device, material or process covered by patent or copyright, the contractor shall be responsible for such use. The contractor and surety shall indemnify the State, any affected third party or political subdivision from claims for infringement due to the use of any such patented design, device, material or process, or any trademark or copyright and shall indemnify the State for any costs, expenses and damages due to any infringement during prosecution or after completion of the work.

If the contractor submits proposed plans, specifications, manufacturer's data, or any other information or documents to the Department for a proposed change order, value engineering proposal or for any other purpose which may be protected by copyright or trade secret protection, the contractor shall first obtain permission or license from the licensor or any other party having a proprietary interest in such documents or information and shall hold harmless, indemnify and defend the Department at the contractor's sole cost from any damages, expenses or actions arising out of or related to use by the Department of information or documents supplied by the contractor to the Department.

107.04 RESTORATION OF SURFACES OPENED BY PERMIT. The right to construct or reconstruct any utility service in the highway or to grant permits for same, at any time, is reserved by the Department for proper authorities of the municipality in which the work is done and the contractor will not be entitled to damages either for digging up of the highway or delays occasioned thereby.

When an individual, corporation, or any other legal entity is authorized through an executed permit from the Department, the contractor shall allow parties bearing such permits to make openings in the highway. The contractor shall, when ordered, make all necessary repairs due to such openings. Payment for such work will be made as extra work or as provided in these specifications, and will be subject to the same conditions as original work performed.

107.05 FEDERAL AID PARTICIPATION. When the United States Government participates in the cost of the work covered by the contract, the work shall be under the supervision of the State, but subject to inspection and

approval of the proper official of the United States Government, in accordance with applicable Federal Statutes, and rules and regulations pursuant thereto. Such inspection shall not make the Federal Government a party to the contract and will not interfere with the rights of either party thereunder.

On FHWA Federal-Aid Projects, when required by the project specifications, the contractor shall complete Federal-Aid Form PR-47, "Statement of Materials and Labor used by Contractors on Highway Construction Involving Federal Funds," prior to the time of final acceptance of the project. The final acceptance will not be executed until this form has been submitted to the engineer

107.06 SANITARY, HEALTH AND SAFETY PROVISIONS. The contractor shall not require any worker to work under conditions which are unsanitary, hazardous or dangerous to health or safety. The contractor shall maintain the work in a sanitary, safe and nonhazardous condition.

The contractor shall provide and maintain in a neat, sanitary condition, restrooms and other such accommodations for use of employees and Department personnel. Such facilities shall comply with requirements of the State and local Boards of Health or other bodies or tribunals having jurisdiction.

107.07 PUBLIC CONVENIENCE AND SAFETY. The contractor shall conduct the work to assure the least possible obstruction to traffic. The project site and haul route shall be kept reasonably free from dust and in such condition that the public can travel in safety.

When the highway under construction is to be kept open for traffic, the subgrade and surfacing shall be kept reasonably free from dust and in such condition that the public can travel in safety. Safety and convenience of the general public and the residents along the work, and protection of persons and property, shall be a primary responsibility of the contractor.

When the contractor works at night, adequate artificial lighting shall be provided in accordance with Subsection 105.20. Signs, flaggers, or other traffic controls shall be provided to protect workers, the work, and the traveling public. When such work affects traffic safety, the contractor shall submit to the engineer for approval a plan of lighting, signing, flagmen or other traffic controls. If the approved plan proves inadequate after work begins, the contractor shall make such changes as directed. If the engineer finds that the night work is so hazardous as to preclude the beginning or require the discontinuing of such work, the contractor shall immediately cease all such operations.

107.08 RAILWAY-HIGHWAY PROVISIONS. All work to be performed by the contractor in construction on railway right-of-way shall be in accordance with the following provisions.

(a) The contractor shall notify the Railway's duly designated representative at least 10 days in advance of the date on which the contractor is expected to begin work on the Railway's premises.

(b) During the progress of work on or about the Railway's tracks or premises, the contractor shall maintain contact and liaison with the Railway's officers or representatives designated by the Railway so as to ascertain time of passage of trains at the work in order to clear Railway's tracks and facilities of people, equipment and obstructions to permit free flow of railway traffic. The contractor shall perform work on the Railway's premises without materially interfering with the Railway's tracks, structures and facilities or operations, or the operations of the Railway's tenants or licensees, or with communication and signal lines upon said premises, except under arrangement effected between the contractor and the Railway. The contractor shall protect the Railway's property and avoid accidents. The contractor shall keep the Railway's track and roadbed free of earth, rock, construction materials, debris and obstructions.

The contractor shall immobilize equipment parked near the Railway's track, when such equipment is unattended, to prevent its movement by unauthorized persons.

(c) The contractor shall, before entering upon the Railway's right-of-way for performance of any construction work, or work preparatory thereto, secure permission from the Railway's representative for the occupancy and use of the Railway's right-of-way outside the limits of the highway servitude area and shall confer with the Railway relative to requirements for railway clearances, operation and general safety regulations.

(d) The Railway's representative will at all times have jurisdiction over the safety of railway operation. The decision of the Railway's representative as to procedures which may affect the safety of railway operation shall be final. The contractor shall be governed by such decision.

(e) Should any damage occur to railway property, as a result of the contractor's unauthorized or negligent operations, and the Railway deems it necessary to repair such damage or perform work for protection of its property, the required materials, labor and equipment shall be furnished by the Railway. The contractor shall reimburse the Railway for costs incurred.

(f) If the contractor requires access across the Railway's right-of-way and tracks at any location which is not an existing permanent type of open public railway-highway crossing in or incident to the construction of the project, the

contractor shall contact the Railway and request access across said right-of-way and tracks and execute a license agreement with the Railway. The contractor shall reimburse the Railway for the cost of providing and removing any temporary at-grade and grade-separated structure access crossing, including warning devices, watchmen expense or other costs which the Railway deems necessary for protection of Railway property and operations. The type of temporary crossing required shall be determined by the Railway. The contractor shall not cross the Railway's right-of-way and tracks with vehicles or equipment except at existing open public road crossings or at such crossings established pursuant to this paragraph. The foregoing requirements include new grade crossings which will become part of the finished highway being constructed under the contract.

The contractor shall comply with requirements for insurance contained under Heading (n) hereinafter during operations hereunder.

The contractor shall cooperate with the Railway during all phases of the work including sufficient advance notice for project completion in order for the Railway to remove the temporary grade crossing and perform final grade crossing improvements under the agreement with the Department prior to final acceptance.

(g) Any engineering, inspection, training, flagging and watcher service required by the Railway for the safety of Railway operations because of work being performed by the contractor or in connection therewith, shall be provided by the Railway and the cost thereof shall be reimbursed to the Railway, by the contractor, on the basis of the Railway's bills, to be rendered monthly. The contractor will be reimbursed, by the Department, for the actual incurred cost for such services. The contractor shall furnish documentation of railway invoices and evidence of payment before reimbursement. When it is determined that railroad services and/or crossings are no longer in the best interest of the Department, the contractor will be issued written notification that no further reimbursement will be made by the Department for railroad services. Work done or services provided for the contractor's convenience will not be reimbursed by the Department.

The contractor shall notify the Railway 72 hours in advance of when railway services are required.

(h) The contractor will be required to reimburse monthly the Railway for the cost of all services performed by the Railway for the contractor, and furnish the Department satisfactory evidence that the Railway has acknowledged receipt of payment before final acceptance.

(i) During construction of piers or other supports or structures adjacent to any track or of drainage pipe or structure under or adjacent to any track of the

Railway, the contractor shall make adequate provisions against sliding, shifting, sinking or in any way disturbing the railway embankment and track adjacent to said piers, supports or structures due to construction operations by driving temporary sheeting or by other means satisfactory to the Department and Railway.

(j) Before commencing work on any pier or structure adjacent to any track, or on any structure and parts thereof which carry Railway facilities, the contractor shall submit to the engineer for approval, prints of the proposed sheeting, shoring, bracing and falsework details for protection of the Railway's track and embankment and shall submit prints of the shop drawings or other contractor's detailed plans for structures and parts thereof which will carry Railway facilities. This submittal shall include proposed methods of construction and be accompanied by supporting data, including design computations, soil descriptions and other pertinent information.

After approval by the engineer, four prints of the above plans, shop drawings and details bearing the seal of a registered Civil Engineer, with supporting data and documents, shall be forwarded to the Railway for approval. Prior to beginning work on Railway right-of-way, the shop drawings and details, with supporting data and documents, shall be approved by the Railway.

(k) The contractor shall notify the Railway's representative in writing at least one week in advance of the proposed time of the beginning of construction of piers, supports or structures adjacent to the track or of drainage pipe or structure under or adjacent to the track.

(l) The following temporary clearances are the minimum which shall be maintained during construction operations:

Vertical: 22.5 feet (6.86 meters) above top of highest rail.

Horizontal: 10.0 feet (3.05 meters) from centerline of the nearest track measured at right angles thereto.

If lesser clearances are required for any part of the work, the contractor shall secure written authorization from the Railway's representative for such lesser clearances in advance of the start of work on that portion of the project along, on, over, under or across the right-of-way or tracks of the Railway.

(m) The contractor shall not store or construct falsework or store materials, supplies or equipment closer than 15.0 feet (4.57 meters) from the centerline of any railway track, measured at right angles thereto, or 22.5 feet (6.86 meters) vertically from top of rail.

(n) Unless otherwise specified by special provisions, the contractor shall provide insurance of the following kinds and amounts:

(1) Regular Contractor's Public Liability and Property Damage

Insurance, including automobile, issued in the name of the contractor shall be written to furnish protection to the contractor respecting operations in performing work covered by the contract in regard to the liability with respect to bodily injury to or death of persons, and injury to or destruction of property, which may be suffered by persons other than the contractor's employees as a result of operations in connection with construction of highway projects located wholly or partly within railroad right-of-way.

(2) When a contractor sublets a part of the work on any project to a subcontractor, the contractor shall be required to secure insurance protection in the contractor's own behalf under Contractor's Public Liability and Property Damage Insurance policies to cover any liability imposed on the contractor by law for damages due to bodily injury to or death of persons and injury to or destruction of property as a result of work undertaken by such subcontractors.

In addition, the contractor shall provide for, and on behalf of, any such subcontractors protection to cover like liability imposed upon the latter as a result of their operations by means of separate and individual Contractor's Public Liability and Property Damage policies. As an alternative, each subcontractor shall provide satisfactory insurance as described herein on the subcontractor's own behalf to cover the subcontractor's individual operations.

(3) Railroad Protective Liability Insurance shall be purchased on behalf of the Railway by the contractor. The standards for Railroad Protective Liability Insurance shall be in accordance with provisions of the Federal-Aid Policy Guide (FAPG) Part 646 as amended.

The limits of liability for the kinds of insurance required above shall be as follows:

NORMAL COVERAGE (other than AMTRAK)

(1), (2) and (3)

Combined Single Limit for Bodily Injury Liability, Property Damage Liability and Physical Damage to:
Property - $2,000,000 per occurrence
Aggregate Limit - $6,000,000 for the term of the policy

AMTRAK COVERAGE

(1), (2) and (3)

Combined Single Limit for Bodily Injury Liability, Property Damage Liability and Physical Damage to:
Property - $6,000,000 per occurrence
Aggregate Limit - $12,000,000 for the term of the policy

The name of the Railway and the ratio of the estimated cost of operations within the Railway's property to the total estimated project cost, expressed by percent, will be specified in the project specifications. No direct payment will be made for providing the required insurance coverages by the contractor.

The contractor shall furnish to the Railway the Railroad Protective Policy and certificates evidencing the other insurance coverage required above. The Railroad Protective Insurance Policy and all insurance certificates shall be approved by the Railway before any work may be started on the Railway's property by the contractor or subcontractors. In addition, the contractor shall furnish evidence of commitment by the insurance company to notify the Railway and the engineer in writing of any material change, expiration or cancellation of the policy not less than 30 calendar days before such change, expiration or cancellation is effective.

The insurance specified shall be kept in force until final acceptance of the contract.

(o) The contractor shall indemnify the Railway, its officers and employees from all suits, actions or claims brought because of injuries or damages sustained by any person or property due to operations of the contractor; due to negligence in safeguarding the work; or use of unacceptable materials in constructing the work; or any negligent act, omission or misconduct of the contractor; or claims or amounts recovered from infringements of patent, trademark or copyright.

(p) Upon completion of the work, the contractor shall, within 10 calendar days, remove from within the limits of the Railway's right-of-way all machinery, equipment, surplus materials, falsework, rubbish or temporary buildings of said contractor, and restore the Railway's premises substantially to their former condition satisfactory to the Railway's representative.

Should the contractor fail to make such removal and restoration within 10 calendar days, the Railway shall have the right to make such removal or restoration. The expense incurred shall be chargeable to the project on the Railway's force account statement and the Department will reimburse the Railway for such work. The amount will be deducted from payments due the contractor.

All costs incurred under this subsection, other than as provided in Subsection 107.08(g), or for which payment is elsewhere provided, shall be included in the contract prices of other pay items.

Prior to final acceptance of the project, the contractor shall secure a Certificate of Release from the railroad company and furnish same to the Department stating that the contractor has satisfactorily restored the Railway's premises and has completed payments for all railway services performed for

the contractor's account, and that the Railway waives all claims for damages due to the contractor's operations within railway right-of-way under the contract. If the contractor is unable to secure a Certificate of Release from the Railway, the contractor shall submit an executed Contractor's Affidavit, to the engineer.

107.09 NAVIGABLE WATERS AND WETLANDS. All work in, over, or adjacent to navigable waters or wetlands shall be conducted in accordance with rules and regulations of the U. S. Army Corps of Engineers and U. S. Coast Guard.

Navigable clearances on waterways shall not be infringed upon, and existing navigable depths shall not be impaired except as allowed by permits issued by the responsible agency.

The Department will obtain a permit from the U. S. Coast Guard and U.S. Army Corps of Engineers relative to approval of construction plans for bridges, causeways, embankments, dredging, spoil disposal, etc., for work in navigable waters or wetlands. The contractor will be furnished a copy of the permit and shall comply with all provisions and conditions of the permit. When required by permit, upon completion and before final acceptance of the project, the contractor shall furnish the Bridge Design Engineer 8-by-10-inch color photographs of the bridge from abutment to abutment, two photographs looking upstream and two looking downstream. The prints shall be glossy finish, mounted on linen. These photographs will be furnished at no direct pay.

The contractor shall prepare reproducible drawings complying with the standards of the U. S. Coast Guard and the U. S. Army Corps of Engineers showing falsework construction, test piles or other temporary pile driving operations, erection sequence, temporary navigational lighting, location of equipment and barges in the navigable limits and other drawings required by the permit agencies. Drawing sizes shall be 8-by-10 1/2 inches with a 1-inch border on the top or short side. The drawings shall be submitted to the Bridge Design Engineer for approval and transmittal to the appropriate agency. Construction of falsework, test pile operations and erection or operation of construction equipment within the navigable limits shall not commence until drawings are approved.

The contractor shall display lights on equipment operating, berthed or moored in navigable streams, and provide temporary navigational lighting on temporary and permanent construction in the navigable limits as required by the U. S. Coast Guard.

Should the contractor sink, lose or throw overboard any material,

machinery or equipment which may be dangerous to navigation, it shall be immediately removed or recovered. The contractor shall give immediate notice of such obstruction to proper authorities and, if required, shall mark or buoy such obstruction until it is removed.

The contractor shall not deposit excavated material into the water-way or wetland without a permit from the appropriate agency.

All operations in connection with the work shall be in accordance with permits, rules and regulations of the U. S. Army Corps of Engineers and the U. S. Coast Guard. Deviations therefrom shall be only by special permission or special permit which shall be the responsibility of the contractor. Failure of the contractor to become familiar with the terms, conditions and provisions of the permits, rules and regulations applicable to the work shall not relieve the contractor of responsibility under the contract.

The contractor shall conduct operations to cause minimum interference with marine operations. If such interference is necessary, the contractor shall notify the Bridge Design Engineer, in writing, sufficiently in advance so that the Department may obtain approval from the U. S. Coast Guard at least 3 weeks prior to said interference.

Copies of Department obtained permits are available in the Bridge Design Section.

Copies of any special permits obtained by the contractor shall be submitted immediately to the Bridge Design Engineer.

107.10 BARRICADES AND WARNING SIGNS. The contractor shall provide, erect and maintain necessary barricades, suitable lights, danger signals, signs and other traffic control devices, including flaggers, and shall take all necessary precautions for protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades. Suitable warning signs shall be provided to direct traffic.

The contractor shall erect and maintain warning signs in advance of any place on the project where operations may interfere with traffic, and at intermediate points where new work crosses or coincides with an existing road.

Barricades, warning signs, lights, temporary signals and other protective devices shall conform to the details shown on the plans and the MUTCD.

107.11 USE OF EXPLOSIVES. Explosives shall not be used without written approval. When explosives are used, the contractor shall not endanger life or property. The use of explosives shall be in compliance with all laws and ordinances. The contractor shall be responsible for all damage resulting

from the use of explosives.

Explosives shall be securely stored, in compliance with all laws and ordinances. Such storage places shall be clearly marked. When no local laws or ordinances apply, satisfactory storage shall be provided not closer than 1,000 feet (304.8 meters) from any road, building or place of human occupancy.

The contractor shall notify, in writing, each utility company and affected property owner having facilities in proximity to the site of work of the intention to use explosives. Such notices shall be given sufficiently in advance to enable them to protect their property from damage.

107.12 PRESERVATION OF PUBLIC AND PRIVATE PROPERTY. The contractor shall be responsible for preservation of public and private property and shall protect from disturbance and damage all land monuments, property line markers or horizontal and vertical control monuments such as those established by the United States Coast and Geodetic Survey, National Geodetic Survey, Louisiana Geodetic Survey, Louisiana DOTD, Corps of Engineers, or United States Geological Survey.

Before removing and/or resetting any survey monuments, the contractor shall give sufficient written advance notice to the engineer with a copy to the Department's Location and Survey Section for coordination with the appropriate agency. The contractor shall not disturb or move any such monument without written approval. The contractor shall give immediate written notice to the engineer, with a copy to the Department's Location and Survey Section, of damage to survey monuments. The engineer will designate the location and manner in which monuments are to be reset in accordance with current Department procedures.

The contractor shall be responsible for damage to property during the work due to any negligent act, omission or misconduct in executing the work, or due to defective work or materials. This responsibility will not end until final acceptance.

When damage is done to public or private property by the contractor due to any negligent act, omission or misconduct in execution of the work, or in consequence of nonexecution thereof by the contractor, such property shall be restored at the contractor's expense, to a condition similar or equal to that existing before such damage was done, by repairing, rebuilding or otherwise acceptably restoring as directed, or making good such damage in an acceptable manner.

107.13 FOREST PROTECTION. In carrying out work within or adjacent

to State or National Forests, the contractor shall comply with all regulations of the Department of Public Safety Office of the State Fire Marshal Department of Wildlife and Fisheries/Wildlife Division, and the Department of Agriculture and Forestry or other authority having jurisdiction governing protection of forests and performance of work within forests. The contractor shall observe all sanitary laws and regulations with respect to performance of work in forest areas. The contractor shall keep the areas in an orderly condition, dispose of all refuse, and obtain permits for construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks and other structures in accordance with requirements of the forest supervisor.

The contractor shall take reasonable precaution to prevent and suppress forest fires and shall require employees and subcontractors, both independently and at the request of forest officials, to do all reasonable within their power to prevent and suppress forest fires and to notify a forest official at the earliest possible moment of the location and extent of any fire seen by them.

107.14 ENVIRONMENTAL PROTECTION. The contractor shall comply with federal, state and local laws and regulations controlling pollution of the environment, including air, water and noise. The contractor shall take precautions to prevent pollution of waters and wetlands with fuels, oils, asphalts, chemicals or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

Attention is directed to Section 204, Temporary Erosion Control.

The contractor certifies under penalty of law that he understands and will abide by the terms and conditions of the Storm Water Pollution Prevention Plan (SWPPP) and the National Pollution Discharge Elimination System (NPDES) General Permit that require the discharges from construction sites be managed to prevent pollutants from entering waters of the United States in accordance with the Environmental Protection Agency's (EPA) regulations for storm water discharges with respect to 33 U.S.C. § 1342 (Sections 402 (p) and 405 of Public Law 100-4).

The use of erosion control features or methods other than those in the contract shall be as directed.

The Storm Water Pollution Prevention Plan shall be comprised of all components specified in the U.S. Environmental Protection Agency document entitled, “Storm Water Management for Construction Activities”, and shall include Section 204, Temporary Erosion Control of the standard specifications along with applicable supplemental specifications, special provisions, and the

plans.

Construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals and other impoundments will be restricted to areas where it is necessary to perform filling or excavation to accomplish the work and areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, streams and impoundments shall be cleared of obstructions placed therein or caused by construction operations.

Frequent fording of streams with construction equipment will not be permitted.

No residue from dust collectors or washers shall be dumped into a stream.

Attention is further directed to the federal, state and local air pollution control programs and their rules and regulations regarding air pollution, especially open burning, fugitive dust and asphaltic concrete plant restrictions.

The contractor shall maintain and operate equipment to minimize noise and vibration. Engines shall be equipped with properly functioning mufflers. The contractor shall assure the activities near noise and vibration sensitive areas, such as churches, hospitals and schools are not unduly disruptive.

107.15 AIR NAVIGATION. The Department will obtain a permit (or a determination of no hazard to air navigation) from the FAA for all permanent structures. The contractor will be furnished a copy of the permit, if requested. If the contractor's equipment, falsework, etc. is classified as a hazard to aerial navigation, the contractor shall prepare, on tracing cloth or approved reproducible medium, drawings complying with the FAA current requirements for temporary lighting for protection of aerial navigation. These drawings shall be submitted to the Bridge Design Engineer for review and transmittal to the FAA for approval. Operations in connection with the work for protection of aerial navigation shall be in accordance with the approved drawings and applicable federal regulations. Failure of the contractor to be familiar with applicable rules and regulations of the FAA will not relieve the contractor of responsibility under the contract.

107.16 HAZARD ZONES. If any portion of the work is determined to be within a known hazard zone, the presence of such hazards will be noted in the plans or project specifications to the extent that definite information can be obtained on these situations.

It shall be the responsibility of the contractor to arrange and coordinate the work in the area with the agency or agencies concerned.

The contractor shall obtain from the Department and submit to the engineer the Department's Standard Release Form signed by the agency involved

stating that the contractor has satisfactorily discharged the obligations under terms of the arrangements. This form shall be submitted with the required signatures.

Failure of the Department to determine the presence of all hazards and to so note in the plans or project specifications shall not relieve the contractor from performing any required work.

107.17 DAMAGE CLAIMS. The contractor shall indemnify the Department, its officers and employees from all suits, actions or claims brought because of injuries or damage sustained by any person or property due to operations of the contractor; due to negligence in safeguarding the work; or use of unacceptable materials in constructing the work; or any negligent act, omission or misconduct of the contractor; or claims or amounts recovered from infringements of patent, trademark or copyright; or from claims or amounts arising or recovered under the Workmen's Compensation Act or other law, ordinance, order or decree; any money due the contractor as considered necessary by the Department for such purpose, may be retained for use of the State; or, in case no money is due, the surety bond may be held until such suits, actions, claims for injuries or damages have been settled and suitable evidence to that effect furnished to the Department; except that money due the contractor will not be withheld when the contractor produces satisfactory evidence that adequate Workman's Compensation, Public Liability, and Property Damage Insurance are in effect.

107.18 OPENING SECTIONS TO TRAFFIC. Opening of sections of the work to traffic prior to completion of the entire contract may be desirable from a traffic service standpoint, or may be necessary due to conditions inherent in the work or by changes in the contractor's work schedule, or may be required due to conditions or events unforeseen at the time of the contract. Such openings shall be made when directed and shall not constitute acceptance of the work nor a part thereof or a waiver of any provisions of the contract.

The plans or project specifications will specify, insofar as possible, which sections shall be opened prior to completion of the contract. On any section opened by order of the engineer, when not specified, the contractor will not be required to assume any expense entailed in maintaining the road for traffic. Such expense will be borne by the Department or compensated for in accordance with Subsection 109.04. On portions of the project which are ordered to be opened for traffic, in the case of unforeseen necessity not the fault of the contractor, compensation for additional expense to the contractor and allowance of additional time for completion of other work on the opened

portions of the project shall be as set forth in a change order mutually agreed on by the engineer and the contractor.

When the contractor's progress is undesirably slow in completing shoulders, drainage structures or other features of the work, the engineer may notify the contractor in writing and establish therein a reasonable period of time in which the work is to be completed. If the contractor fails to make a reasonable effort toward completion in this time period, the engineer may order all or a section of the project opened to traffic. On such sections ordered to be opened, the contractor shall conduct the remainder of construction operations to cause the least obstruction to traffic and shall not receive any added compensation due to the added cost of the work by reason of opening such section to traffic.

On any section opened to traffic under the foregoing conditions, whether specified in the contract or opened by necessity of the contractor's operations or unforeseen necessity, any damage to the highway not attributable to traffic that occurs on such section (except slides) shall be repaired by the contractor at no direct pay. Removal of slides shall be done by the contractor on a basis agreed to prior to removal of such slide.

107.19 CONTRACTOR'S RESPONSIBILITY FOR WORK. Until final acceptance, the contractor shall have the charge and care of the work and shall take every precaution against damage to any part thereof by action of the elements, vandalism, theft, or from other cause, whether arising from execution or non-execution of the work. The contractor shall rebuild, repair, restore, or pay for damages, including theft and vandalism, to the work before final acceptance and shall bear the expense thereof, except for the following:

(a) Guard rail and permanent impact attenuators shall be repaired as soon as possible after damage. If the engineer determines that the contractor did not contribute to the damages, the Department will reimburse the contractor for such repairs by force account in accordance with Subsection 109.04.

(b) Unavoidable damage due to Acts of God such as earthquake, tidal wave, tornado, hurricane, or other cataclysmic phenomenon of nature or acts of governmental authorities.

In case of suspension of work, the contractor shall be responsible for the project. The contractor shall take such precautions as necessary to prevent damage to the project, maintain traffic, provide for normal drainage and erect any necessary temporary structures, signs or other facilities at no direct pay. During such period of suspension, the contractor shall acceptably maintain all living material in newly established plantings, seedings and soddings furnished under the contract, and shall take adequate precautions to protect

new tree growth and other important vegetative growth against damage. Should suspension of the work not be attributed to any actions of the contractor, the contractor will be reimbursed for additional work.

107.20 UTILITY PROPERTY AND SERVICES. The contractor's operations adjacent to properties of railway and utility companies or adjacent to other property, damage to which might result in considerable expense, loss or inconvenience, shall not commence until after all arrangements necessary for the protection thereof have been made.

The contractor shall cooperate with owners of utility lines in their removal and rearrangement, in order that these operations may progress in a reasonable manner, that duplication of rearrangement work may be minimized and that services rendered by those parties will not be unnecessarily interrupted.

In the event of interruption of utility services due to accidental breakage or being exposed or unsupported, the contractor shall promptly notify the proper authority and shall cooperate with such authority in restoration of service. If utility service is interrupted, continuous cooperation will be required until service is restored. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

107.21 FURNISHING RIGHT-OF-WAY. The Department will be responsible for securing all necessary rights-of-way, servitudes and easements in advance of construction.

107.22 PERSONAL LIABILITY OF PUBLIC OFFICIALS. In carrying out the provisions of these specifications, or in exercising any authority granted to them by the contract, there shall be no liability upon the Secretary, Chief Engineer or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as representatives of the State.

107.23 NO WAIVER OF LEGAL RIGHTS. Upon completion of the work, the Department will make final inspection and then notify the contractor of acceptance within 30 calendar days. Such final acceptance shall not prevent the Department from correcting any measurement, estimate or certificate made before or after completion of the work, nor shall the Department be prevented from recovering from the contractor or the surety, or both, such overpayment it may sustain by failure of the contractor to fulfill obligations under the contract. A waiver by the Department of any breach of

any part of the contract shall not be a waiver of any other breach.

The contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud or such mistakes as amount to fraud, or as regards the Department's rights under any warranty or guaranty.

107.24 THIRD PARTY LIABILITY. It is agreed between the parties executing the contract that it is not intended by any provisions of the contract to create the public nor any member thereof a third party beneficiary hereunder, nor to authorize anyone not a party to this contract to maintain a suit for personal injuries or property damage pursuant to the contract.

107.25 ANTI-TRUST VIOLATIONS. By execution of the contract, the contractor conveys to the Department all rights, title and interest in and to all causes of action it may acquire under Federal and State anti-trust laws, relating to the goods or services purchased by the Department pursuant to the contract.

107.26 CONTRACTOR'S PAYROLLS. When predetermined minimum wage rates are included in the contract, the minimum wage determination shall be posted by the contractor in a prominent and easily accessible place at the site of work.

On Federal-Aid Projects, the contractor's payrolls shall be in accordance with the project specifications.

107.27 ARCHAEOLOGICAL AND HISTORICAL FINDINGS. If the contractor encounters cultural artifacts or archaeological or historical sites, operations shall be discontinued. The engineer will contact the proper authorities in order that an appropriate assessment may be made to determine the disposition thereof and necessary actions relative to the site. When directed, the contractor shall excavate the site to preserve the artifacts encountered. Such excavation will be paid for as extra work, including an appropriate adjustment in contract time. Borrow and muck disposal areas furnished by the contractor will be subject to such assessment prior to use.

Section 108
Prosecution and Progress

108.01 SUBLETTING OF CONTRACT. The contractor shall not sublet any portion of the contract, excluding material, without written consent, including work sublet to an authorized Disadvantaged Business Enterprise. If such consent is given, the contractor will be permitted to sublet a portion of the work, but shall perform with the contractor's own organization work amounting to at least 50 percent of the total contract cost. Any items designated in the contract as "Specialty Items" may be performed by subcontract and the cost of such may be deducted from the total contract cost before computing the amount of work required to be performed by the contractor with the contractor's own organization.

A subcontractor shall not further subcontract to a third party any portion of this authorized work, excluding material, without written consent, including work sublet to an authorized Disadvantaged Business Enterprise.

No subcontract shall relieve the contractor of liability under the contract and bonds.

108.02 COMMENCEMENT OF WORK. The "Notice to Proceed" will stipulate the date on which the contractor shall begin work, which date shall be the beginning of contract time charges.

108.03 CONSTRUCTION PROGRESS SCHEDULE. Prior to or at the preconstruction conference and before beginning work on the project, the contractor shall submit to the project engineer a Construction Progress Schedule giving a satisfactory schedule of operations that provides for completion of the work within the contract time. This schedule shall be on the prescribed bar graph form. The contractor shall have copies of the schedule available at the preconstruction conference.

If the contractor's operations are affected by changes in the plans or amount of work, or if the contractor has failed to comply with the approved schedule, or if requested by the engineer, the contractor shall submit a revised Construction Progress Schedule for approval. This revised schedule shall show how the contractor proposes to prosecute the balance of the work. If a revised schedule has been requested by the engineer, the contractor shall submit the revised schedule within 14 calendar days after the date of request or progress payments may be withheld.

The approved Construction Progress Schedule will be used as the basis of establishing the controlling item of work, charging contract time and as a check on the progress of the work. The Construction Progress Schedule shall show only one controlling item of work for each contract day. If the Construction Progress Schedule has not been approved prior to the issuance of the Notice to Proceed, the engineer will establish the controlling work item and charge contract time accordingly.

108.04 PROSECUTION OF WORK.

(a) General: The contractor shall provide sufficient materials, equipment and labor to complete the project in accordance with the plans and specifications within the contract time. If the completed work is behind the approved progress schedule, the contractor shall take immediate steps to restore satisfactory progress and shall not transfer equipment or forces from uncompleted work without prior notice to, and approval of, the engineer. Each item of work shall be prosecuted to completion without delay. If prosecution of the work is discontinued for an extended period of time, the contractor shall give the engineer written notice at least 24 hours before resuming operations.

(b) Disqualification: The contractor's progress will be determined monthly at the time of each partial estimate, and will be based on the total amount earned by the contractor as reflected by the partial estimate. If the contractor's progress is more than 20 percent behind the elapsed contract time, the contractor will be notified that disqualification may occur if progress becomes delinquent by more than the percentages specified. Such additional notification will be made as deemed necessary concerning the progress delinquency of the contractor.

Prior to the elapsing of 55 percent of the contract time, the contractor will be disqualified if progress is more than 40 percent behind the elapsed contract time. After 70 percent of the contract time has elapsed, the contractor will be disqualified if progress is more than 25 percent behind the elapsed contract time. Disqualification will be applied between 55 and 70 percent contract time elapsed on a pro-rata basis; for example, when 60 percent of the contract time has elapsed, the contractor will be disqualified if progress is more than 35 percent behind the elapsed contract time.

During the period of disqualification, the contractor will not be permitted to bid on contracts nor be approved as a subcontractor on contracts. Any bid submitted by the contractor during the period of disqualification will not be considered and will be returned. The period of disqualification will continue until the completed work on the contract is within the foregoing percentages

or until all work on the contract has been satisfactorily completed.

(c) Disqualification Review Board: After disqualification, the contractor may submit a written appeal to the Chief Engineer for review by the Departmental Disqualification Review Board. The written appeal shall be submitted within 7 days, excluding weekends and holidays, after issuance of written notice of disqualification and may either request a meeting with the review board or that the review board consider a written appeal only. A meeting of the review board will be scheduled within 5 days, excluding weekends and holidays, after receipt of appeal.

The review board will be composed of the Chief Engineer, or his designee, and five other members appointed by the Secretary. The Chief Engineer, or his designee, and two other members will constitute a quorum.

After all pertinent information has been considered, the contractor will be notified of the decision of the review board in writing within 5 days, excluding weekends and holidays. The decision of the review board will not operate as a waiver by the Department of its rights concerning the assessment of stipulated damages as specified under Subsection 108.08.

108.05 LIMITATION OF OPERATIONS. The contractor shall conduct the work in such manner and sequence to assure the least interference with traffic. The contractor shall have due regard to the location of detours and provisions for handling traffic. The contractor shall not begin new work to the prejudice of work already started. The engineer may require the contractor to finish a section on which work is in progress before starting on additional sections if the finishing of such section is essential to public convenience and safety.

108.06 LABOR, METHODS AND EQUIPMENT. The contractor shall employ sufficient labor and equipment to prosecute the work to completion in accordance with the contract.

Workers shall have sufficient skill and experience to properly perform the work.

Any representative of the contractor or subcontractor who, in the opinion of the engineer, does not perform in a skillful manner or is disorderly shall be, upon written request, immediately removed by the contractor or subcontractor. A person removed shall not return to the work without written approval. If the contractor fails to remove such a person or fails to furnish suitable and sufficient personnel to properly prosecute the work, the engineer may suspend the work by written notice.

Equipment proposed for use in the work shall be of sufficient size and in

such mechanical condition as to meet requirements of the work and produce a satisfactory quality of work. No damage to the roadway, adjacent property or other highways shall result from the use of equipment.

When methods and equipment are not specified, the contractor may use any methods or equipment that will accomplish the work in conformity with the contract.

The contractor may request permission to use a method or type of equipment other than specified in the contract. The request shall be in writing and shall include a description of the methods and equipment proposed and the reasons for requesting the change. If approval is given, it will be on the condition that the contractor will be responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the engineer determines that the work produced does not meet contract requirements, the contractor shall discontinue use of the substituted method or equipment and shall complete the work with the specified methods and equipment. The contractor shall remove the deficient work and replace it with work of specified quality or take other corrective action as directed. No change will be made in payment for pay items involved nor in contract time as a result of authorizing a change in methods or equipment.

108.07 DETERMINATION AND EXTENSION OF CONTRACT TIME.

The number of days allowed for completion of the work will be stated in the contract.

When the contract time is a fixed calendar date, it shall be the date on which all work on the project shall be completed.

The contract time for the work as awarded is based on the original quantities as defined in Subsection 102.05 and includes time to procure material, equipment and an adequate labor force to complete the work. If satisfactory fulfillment of the contract requires performance of work in greater quantities than those specified, or requires performance of extra work in accordance with Subsection 104.02 and the contractor requests additional contract time, the document authorizing or ordering alterations will show the number of additional days justified.

If the contractor finds it impossible, for reasons beyond the contractor's control, to complete the work within the contract time as specified or as extended in accordance with the provisions of this *s*ubsection, the contractor shall, at the time the delay occurs make written request to the engineer for an extension of time setting forth therein the reasons which justify granting the request. Such written request shall conform to the requirements of EDSM

III.1.1.28. If the request does not so conform, the contractor hereby agrees to and shall be deemed to have expressly waived any claim for such additional time. The contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the engineer finds that the work was delayed because of conditions beyond the control and without the fault of the contractor, the engineer may extend the contract time in such amount as conditions justify.

Upon satisfactory final inspection, daily time charges will cease.

(a) Working Day Contracts. On working day contracts, a working day will be charged when weather or other conditions not under the control of the contractor will permit construction operations to proceed for at least 5 continuous hours of the day or 65 percent of the normal work day, whichever is greater, with the normal working force engaged in performing the controlling item of work.

Should the contractor prepare to begin work on any day in which inclement weather, or the conditions resulting from the weather, prevent work from beginning at the usual starting time, and the crew is dismissed as a result, the contractor will not be charged for a working day whether or not conditions change during the day and the rest of the day becomes suitable for work.

No working days will be charged for the following days:

(1) Saturdays and Sundays when no work is performed.

(2) State recognized holidays that are defined as regular legal holidays or special holidays that are proclaimed by the Governor or fixed by the Legislature on which no work is performed.

(3) Days on which delays, attributable solely to the Department or other governmental agencies, prevent contractor from proceeding with the controlling item of work at time of delay.

(4) Days on which delays are attributable to the direct effect of strikes, riots or civil commotions

When the contract time is on a working day basis, the engineer will furnish the contractor a monthly statement showing the number of days charged to the contract for the preceding month and the number of days specified for completion of the contract. The contractor will be allowed 14 calendar days in which to file a written protest setting forth in what respect said monthly statement is incorrect; otherwise, the contractor hereby agrees to abide by the monthly statement and shall be deemed under the contract to have waived any claim that the monthly statement is incorrect.

If a protest is filed by the contractor, the Department will conduct such reviews and investigations as required to rule on the protest within 30 calendar days from the date the statement is furnished the contractor. The number of

days charged as listed, or revised within the allotted time, shall become final at the end of this 30-day period, subject to change only through the claims process.

(b) Calendar Day Contracts. When the contract time is on a calendar day basis, it shall consist of the number of calendar days stated in the contract beginning with the date stipulated in the Notice to Proceed. All calendar days will be charged contract time, including days elapsing between the effective dates of written orders to suspend work and to resume work for suspensions not the fault of the contractor. Contract time extensions will be granted for any delays for which the Department is responsible.

(c) Excusable, Non-Compensable Delays. Excusable non-compensable delays are delays that are not the contractor's or the Department's fault or responsibility. The engineer will not grant additional payment for excusable, non-compensable delays, but will grant additional contract time.

(d) Excusable, Compensable Delays. Excusable, compensable delays are delays that are not the contractor's fault or responsibility, but are the Department's fault or responsibility or determined by judicial proceeding to be the Department's sole responsibility or are the fault and responsibility of a local government. The contractor will be granted additional contract time and payment in accordance with Subsections 104.02, 105.18, and 109.04.

(e) Non-Excusable Delays. Non-excusable delays are delays that are the contractor's fault or responsibility. All non-excusable delays are non-compensable.

(f) Concurrent Delays. Concurrent delays are separate critical delays that occur at the same time. When a non-compensable delay is concurrent with a compensable delay, the contractor is entitled to additional time but not additional payment.

108.08 FAILURE TO COMPLETE ON TIME. For each calendar day or working day, as specified, that the work remains uncompleted after expiration of the contract time, the sum specified in Table 108-1 will be deducted from payments for the work, not as a penalty but as stipulated damages.

Permitting the contractor to continue work after expiration of the contract time will not operate as a waiver by the Department of its rights under the contract.

Based on the amount of the original contract, the charges given in Table 108-1 will be made for each contract day after expiration of the contract time.

Table 108-1
Stipulated Damages

Original Contract Amount (Dollars)		Daily Charge (Dollars)	
From More Than	To and Including	Calendar Day or Fixed Date	Working Day
$ 0	$ 25,000	$ 80	$ 195
25,000	50,000	210	345
50,000	100,000	240	400
100,000	500,000	270	510
500,000	1,000,000	330	595
1,000,000	2,000,000	400	695
2,000,000	5,000,000	480	825
5,000,000	10,000,000	600	975
10,000,000	-------	630	1,115

The contractor will automatically be subject to stipulated damages by the expiration of contract time on the project. The amount of stipulated damages will be deducted from payments for the work under the contract or any other contract the contractor has with the Department. The contractor hereby waives any requirement of written notice of default prior to any deduction for stipulated damages from any payments. The contractor and the surety shall be liable for stipulated damages in excess of amounts due the contractor under the contract.

108.09 DEFAULT AND TERMINATION OF CONTRACT.

(a) The contractor will be in default if the contractor:

(1) Fails to complete the project within the contract time,

(2) Becomes insolvent or a petition is filed in the Bankruptcy Courts of the United States under Chapters 7 or 13 of the Bankruptcy Code naming the contractor as debtor or conversion of a proceeding or petition from Chapter 11 to Chapter 7 or 13 of the Bankruptcy Code or seeks a forced respite under the laws of this State or similar debtor protection by courts of other states,

(3) Allows any final judgment to stand unsatisfied for a period of 14 calendar days,

(4) Makes an assignment or arranges for performance by others of all or part of the performance of the contract, other than by subletting pursuant to Subsection 108.01, without written approval and consent in advance of the Department, and the surety in the case of an assignment of the entire contract, or makes an assignment of contract proceeds for the benefit of one or more

creditors other than pursuant to a security interest in accordance with LRS 10:9-101, et seq., without prior written approval and consent of the Department; any such purported assignment will not be honored without evidence of compliance with this subparagraph,

(5) Discontinues prosecution of the work,

(6) Fails to begin work within 10 calendar days of the "Notice to Proceed",

(7) Fails to perform with sufficient workers, equipment or materials to assure prompt completion of the work,

(8) Performs the work unsuitably or neglects or refuses to remove materials, or replace or repair rejected work,

(9) Fails to resume discontinued work within 10 calendar days after notice to do so,

(10) Fails to perform the work in an acceptable manner, violates any provision in the contract, or fails to follow any federal, state or local laws pertaining to performance,

(11) Fails to follow federal, state or local laws, rules and regulations concerning construction safety and health standards or permits conditions upon the site of the work which are unsanitary, hazardous or dangerous to the health or safety of the contractor's workmen or the public, or

(12) Is a party to fraud.

(b) The Department will give written notice to the contractor, with a copy to the contractor's surety, of the Department's determination that the contractor is in default for any cause specified in this subsection. The Department may give notice to the contractor of its intent to put the contractor in default under this subsection and specify a period of time in which the contractor shall cure the deficiency or a notice of default will be issued. Upon notice of default, the Department will have authority, without violating the contract, to take prosecution of the work out of the hands of the contractor as provided in Heading (c).

(c) Within thirty days after default by the contractor, the Department will notify the contractor's surety by certified mail or overnight delivery of such default. Within thirty days of receipt of such notification, the surety shall present to the Department either a plan to assume performance of the contract and procure completion of the project, or provide the Department in writing with a reasonable response for the contractor's default. If no plan is presented by the surety, or at any time if immediate action must be taken to protect the public interest or the safety of the public or workers, the Department will take prosecution of the work out of the hands of the contractor or surety, may appropriate or use the materials and/or equipment on the project, or may enter

into an agreement for completion of the contract or use other methods as required for completion of the contract in an acceptable manner. The surety shall then be responsible for payment to the Department of the cost of completion of the project and stipulated damages assessed by the public entity up to the total amount of the bond. If the surety has not timely completed the project and a court of competent jurisdiction has determined that the surety has in bad faith refused to take over the project, the surety shall be responsible for the payment of any stipulated damages for any delay in completion of the project as specified in the original contract and any reasonable attorney's fees and court costs incurred by the Department in collection of payments required by this subsection.

(d) Nothing herein shall be construed to require or obligate the Department to suspend contract time or to release the obligation of the contractor and surety for stipulated damages in accordance with Subsection 108.08.

(e) The costs incurred by the Department due to the contractor's default including attorney's fees, or for completing the work under contract, will be deducted from any monies due or which may become due the contractor. When this expense exceeds the sum which would have been payable under the contract, the contractor and surety shall be liable and shall pay the Department the amount of such excess.

108.10 TERMINATION OF CONTRACTOR'S RESPONSIBILITY. The contract will be considered complete when all work has been satisfactorily completed, the final inspection made, and the work accepted by the DOTD Chief Engineer. The contractor will then be released from further obligation except as set forth in the contractor's payment/performance/ retainage bond and Subsection 107.24.

108.11 TERMINATION OF CONTRACT. The Department may, by written notice, terminate the contract or any portion thereof when, for reasons beyond either the Department's or contractor's control, the contractor is prevented from proceeding or completing the work as originally contracted, or when termination would be in the public interest. Such reasons for termination may include, but will not be limited to, executive orders of the President relating to prosecution of war or national defense, national emergency which creates a serious shortage of materials, orders from duly constituted authorities relating to energy conservation and restraining orders or injunctions obtained by third-party citizen action resulting from national or local environmental protection laws or where the issuance of such order or

injunction is primarily caused by acts or omissions of persons or agencies other than the contractor.

When a contract, or a portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits will be considered.

Reimbursement for organization of the work, and other overhead expenses (when not otherwise included in the contract), and moving equipment and materials to and from the project will be considered.

Acceptable materials obtained or ordered by the contractor for the work that are not incorporated in the work shall, at the option of the contractor, be purchased by the Department at actual cost as shown by receipted bills and actual cost records at such points of delivery as designated.

Termination of a contract or a portion, thereof, shall not relieve the contractor of responsibility for the completed work, nor shall it relieve the surety of obligation for any just claim arising from the work performed.

Section 109
Measurement and Payment

109.01 MEASUREMENT OF QUANTITIES. All work completed under the contract will be measured according to United States standard measure. The International System of Units, generally known as SI or metric units will be used to measure quantities if specified under the contract, or if shown on the plans or is directed by the engineer. Standard practice used in these specifications will be to show values in the United States standard measure units followed in parentheses by the International System of Units values. Tables and Figures for both United States standard measure and SI units will be referenced by the same number in the specification text. Applicable units of measure will defined in the table or figure titles. The terms weight and mass will be used interchangeably in these specifications when SI units are used.

The engineer shall be the judge of the accuracy of measurements, or approximations made in lieu of accurate determinations and these decisions shall be binding upon both parties.

When project specifications or plans indicate that quantities for certain pay items have been computed with sufficient accuracy for payment, the pay quantities for those items will be the design quantities subject to the following adjustments. Design quantities will be adjusted if the engineer makes changes to fit field conditions, if plan errors are proven, or if design changes are necessary.

When measurement of excavation and embankment is based on a cubic yard (cubic meter)(net section), the design quantities will be verified or revised in accordance with Departmental policy.

Longitudinal measurements for area computations will be made horizontally. Transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing.

Structures will be measured according to neat lines shown on the plans or as directed.

Items measured by the linear foot (meter), such as pipe culverts, underdrains, etc., will be measured parallel to the foundation upon which such structures are placed.

In computing volumes of excavation, the average end area method or other acceptable methods will be used.

Thickness of plates and galvanized sheet metal used in the manufacture of

corrugated metal pipe and metal plate pipe culverts and arches will be measured in decimal fractions of inches (millimeters).

When United States standard units are used, the pound or the ton will be the standard units of weight. The term "ton," in the United States standard, will mean the short ton of 2,000 pounds avoirdupois. When SI units are used, the kilogram will be the standard unit of mass, however the megagram (1000 kg) will be used to measure large masses. Materials measured or proportioned by weight shall be weighed on approved scales by qualified personnel at designated locations. If material is shipped by rail, the car weight may be accepted provided the weight of material only will be paid for; however, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid by measured weight shall be weighed empty at such times as directed; and each truck shall bear a plainly legible identification mark.

Materials specified to be measured by volume in hauling vehicles shall be hauled in approved vehicles and will be measured therein at the point of delivery on the project. Vehicles may be of any acceptable size or type, provided the body is of such shape that the volume can be readily and accurately determined. Vehicles shall be loaded to at least a predetermined permanently fixed mark, which defines a known volume, upon arrival at the point of delivery. Vehicles will be measured in increments of 0.5 cubic yard (cubic meter), except that when tailgate spreaderboxes are used to place aggregate materials for asphaltic surface treatment, the volume of the spreaderbox will be added to the volume of the vehicle. When materials are measured by weight (mass) and converted to volume for payment, conversion will be made to the nearest 0.1 cubic yard (cubic meter).

Asphaltic materials will be measured by the gallon (liter) or by the ton (megagram). When specified, volumes of liquid asphaltic materials will be converted to gallons at 60°F (liters at 15°C) in accordance with DOTD TR 321.

Net certified scale weights or weights based on certified volumes (in the case of shipments by rail, truck or other transport) will be used as a basis of measurement, subject to correction when material has been lost in transit, wasted or otherwise not incorporated in the work.

When asphaltic materials are shipped by truck or transport, net certified weights or volume, subject to correction for loss or foaming, may be used for computing quantities.

Portland cement will be measured by the ton (megagram).

Timber will be measured by the thousand feet board measure (MFBM) (cubic meter) incorporated in the structure. Measurement will be based on

nominal widths and thicknesses and the extreme length of each piece.

The terms "lump sum, each, or unit" when used as a unit of measure for payment will mean complete payment for the work described in the contract.

When a complete structure or structural unit is specified as the unit of measurement, the unit of measurement will include the necessary fittings and accessories. Incidental work will not be measured for payment.

When standard manufactured items are specified, and these items are identified by gage, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

When conversion is necessary from United States standard units to International System of Units (SI units) or from SI units to U. S. Standard units the guidelines, terminology, conversion factors, and rules for rounding in the Standard Metric Practice Guide, AASHTO R1 will be used.

109.02 SCOPE OF PAYMENT. The contractor shall receive and accept compensation as provided in the contract as full payment for furnishing materials and for performing work in an acceptable manner and for all risk, loss, damage or expense arising out of prosecution of the work subject to the provisions of Subsection 107.23.

When the "Payment" clause in the specifications relating to any unit price in the Schedule of Items requires that the said unit price be considered compensation for certain work, such work will not be measured nor payment made under any other pay item.

109.03 COMPENSATION FOR ALTERED QUANTITIES. When contract quantities are altered in accordance with Subsection 104.02, or when final quantities vary for other reason*s* from the quantities in the Schedule of Items, the contractor shall accept as payment in full, payment at the contract unit prices for the accepted quantities of work done. No allowance, except as provided hereinafter, will be made for any increased expense, loss of expected reimbursement or loss of anticipated profits claimed by the contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the pay item expenses of the contractor for labor, materials, equipment, subcontractor costs, profits and overhead and subsequent loss of expected reimbursements therefor or for other cause.

When alterations of quantities are caused by alteration in the plans, and such alterations affect the methods or sequence of construction, an allowance will be made, either for or against the contractor, in such amounts and basis as

agreed to in advance of the performance of the work. The change order authorizing or ordering the work shall show how the allowance was derived. Except when otherwise authorized by the Chief Engineer, such derivation shall show, as a minimum, breakdowns of costs as detailed in Subsection 109.04, Headings (a) through (g), except that projected costs rather than actual costs will be used.

When alterations in quantities result in an increase or decrease of more than 25 percent in the contract quantity as awarded on any major item of the contract, a supplemental agreement to the contract may be executed between the Department and the contractor at the request of either party, prior to performance of any work in excess of 25 percent of the contract quantity. When the supplemental agreement is executed, the consent of the contractor's surety shall be obtained and furnished to the engineer.

A "Major Item" is an item included in the contract as awarded with a total cost equal to or greater than 10 percent of the original total contract amount.

Any adjustment in unit price will be made on only that portion of the major item exceeding 25 percent increase, or, in the case of a decrease of the item by 25 percent or more the remaining portion will be adjusted. The actual costs shall be itemized in accordance with Subsection 109.04, Headings (a) through (g), except that projected costs will be used in case of an increase in quantity.

A "Minor Item" is an item included in the contract as awarded with a total cost of less than 10 percent of the original total contract amount. A minor item shall become a major item if it is increased by such an amount that its total cost is equal to or greater than 10 percent of the original total contract amount. If a minor item is increased to the extent that it becomes a major item, only that part of the item that exceeds 12.5 percent of the original total contract amount will be considered on any change order and/or special agreement. The agreement shall be executed prior to performance of any work in excess of 12.5 percent of the contract amount. The requirements of the special agreement shall be as described above for increases in major items. If a minor item is decreased, no adjustment will be made in the unit price.

109.04 COMPENSATION FOR ALTERATIONS OF THE CONTRACT.

Payment for work performed in accordance with Subsections 104.02 and 105.19 will first be made at the contract’s established unit prices. If unit prices are not applicable, the second basis of payment will be negotiated prices agreed to by change order prior to the start of the work. If an acceptable negotiated price cannot be established prior to the work being performed, the Department may require the contractor to perform the work on

a "force account" basis.

(1) Unit Prices – When payments are made at the contract's established unit prices, and the work requires a material change in construction method or sequence, adjustment to the unit prices for or against the contractor shall be made in accordance with Subsections 104.02 and 109.03.

(2) Negotiated Prices – The Department's objective is to compensate the contractor using the same pricing formulas established in determining the original bid contract prices. Therefore, reasonable rates for labor burden, company owned equipment internal cost recovery rates, jobsite overhead items and rates, home office overhead and profit mark-upon direct costs, and other subjective pricing components established by the contractor at the time the original contract bid prices were determined will also be used in determining the negotiated prices for the change order work. The change order authorizing the work shall include a detail cost breakdown showing direct labor, materials, equipment, and subcontractor costs, as well as each of the subjective pricing components listed above.

(3) Force Account -When "force account" is the method of payment, the contractor shall be paid the direct cost of the work as determined and documented in Headings (a) through (g) below. Jobsite and home office overhead indirect expenses, and profit for all parties shall be considered fully compensated by a 15 percent mark-up on allowable direct cost items described in the Headings (a) through (d) below, and the mark-up on direct cost for the subcontractor and contractor described in Heading (e) below. The Department may consider additional reimbursement to the contractor for indirect fixed jobsite overhead costs for excusable compensable delays as defined in Subsection 108.07(d) when the change order results in extension of the project's critical work path and the 15 percent mark-up on direct costs is deemed by the Department to be insufficient.

(a) Direct Labor: For labor and working foremen in direct charge of operations, the contractor shall receive the wage rates agreed on in writing before beginning work for each hour that said labor and foremen are engaged in such work. Jobsite and home office supervisory personnel shall not be included as direct labor.

The contractor shall receive the actual costs paid to, or in behalf of, workers for subsistence and travel allowances, health and welfare benefits, pension fund benefits or other benefits when such amounts are required by collective bargaining agreement or other employment contract applicable to the classes of labor employed on the work, but limited to a maximum daily rate for subsistence and travel allowances. This maximum shall be agreed

upon prior to the contractor incurring such charges.

(b) Direct Materials: For materials accepted by the engineer and used, the contractor shall receive the actual cost of such materials delivered to the work, including transportation charges and sales taxes if applicable.

(c) Equipment: For authorized machinery or special equipment the contractor shall receive the rental rates agreed on in writing before such work is begun. For equipment rented from independent outside sources, the contractor will be reimbursed the reasonable actual cost as shown on paid rental invoices. For company owned equipment, the contractor will be reimbursed his internal cost recovery equipment charge rate consistent with his original bid cost estimates. The Department's Engineering Directives and Standards Manual, EDSM III.1.1.27, entitled Equipment Rental Rates, provides additional guidance concerning allowable equipment rental rates and their application. If the contractor chooses to use a rental rate guide book instead of his internal cost recovery rates to establish rental rates for company owned equipment, adjustments to the allowable type of equipment and hours per day must be made as described in the EDSM. In addition, no 15 percent mark up on equipment direct cost for jobsite and home office overhead expenses and profit will be allowed if the contractor chooses to use rental rate guide book prices instead of his internal cost recovery rates.

(d) Bond, Insurance and Tax: For property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, social security taxes, and bond costs on force account work, the contractor shall receive the actual cost thereof. The contractor shall furnish satisfactory evidence of the rates paid for such bond, insurance and tax.

(e) Subcontractor Costs: For change order work performed by an approved subcontractor, the subcontractor shall receive the subcontractor’s actual and reasonable allowable direct cost of such work as described in Headings (a) through (d) above plus a 15 percent mark-up for the subcontractor’s indirect jobsite and home office overhead expenses and profit. In addition, the contractor will be paid a 10 percent mark-up on the subcontractor’s total direct and indirect costs, and profit for general supervision and sequencing of the change order work.

(f) Non-allowable Costs: No additional contractor cost reimbursement will be made for general superintendence, small tools or craft specific tool allowances, or other direct or indirect costs not specifically included in Headings (a) through (e) above.

(g) Statements: No payment will be made for force account work until the contractor has furnished the engineer with duplicate itemized statements of the cost of such work detailed as follows:

(1) Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.
(2) Designations, dates, daily hours, total hours, rental rate and extension for each unit of machinery and equipment.
(3) Quantities of materials, prices and extensions.
(4) Transportation of materials.
(5) Cost of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, social security taxes, and bond costs.

The contractor's representative and the engineer shall compare records of the cost of work done as ordered on a force account basis. Such comparison shall be made daily. Statements shall be accompanied by invoices for materials used and transportation charges. If materials used on force account work are not purchased for such work, but are taken from the contractor's stock, in lieu of invoices, the contractor shall furnish an itemized list of such materials showing that the quantity claimed was actually used, and that the price and transportation costs claimed represent the actual cost to the contractor. Invoices shall be accompanied by the contractor's notarized statement that payment in full has been made for the materials.

109.05 PARTIAL PAYMENTS. Provided the work is prosecuted in accordance with the provisions of the contract and with satisfactory progress, the engineer will make the first progress estimate within 2 months from the date indicated to begin work in the Notice to Proceed. The Department will determine the progress estimate date. Each successive progress estimate will be made on this same date of each month thereafter until completion of the contract. Each progress estimate will be an approximation of the value of work performed up to the date the estimate is made. Prior to the progress estimate date the contractor will be allowed to review the progress estimate with the engineer.

Monthly estimates will be approximate and subject to correction in subsequent estimates.

If an election has been made to have retainage withheld from contract payments due the contractor in accordance with Subsection 103.05, the Department will deduct from the monthly payment estimate an amount equal to five percent of the monthly payment estimate. In addition should defective work or material be discovered or reasonable doubt arise as to the integrity of any part of the work prior to final acceptance and payment, an amount will be deducted from subsequent estimates equal in value to the defective or questioned work. Payment for this work will not be included in

subsequent estimates until defects have been remedied or causes for doubt removed.

Payment of the monthly estimate shall not be taken as an admission that the work is done or that its quality is satisfactory, nor as a release of the contractor from the responsibility for any portion thereof, but the whole work and all particulars relating thereto shall be subject to revision and adjustment by the engineer at the time of final acceptance and payment of the final estimate.

109.06 PAYMENT FOR STOCKPILED OR STORED MATERIAL.

(a) General: Payment for stockpiled or stored material will be considered only for materials anticipated to be stored for periods in excess of 30 calendar days. When approved, advance payments may be made for fabricated or natural materials that are to be incorporated in the project when stockpiled materials are stored on the project or in a dedicated stockpile at an approved site outside the limits of the project within the State of Louisiana. Payments shall be limited to durable materials described herein and shall represent a significant portion of the project cost. Perishable articles and small warehouse items are not included. These materials shall meet the requirements of the specifications. Payment for stockpiled or stored materials will not constitute acceptance. It shall be the contractor's responsibility to protect the material from damage while in storage.

Payment for materials stored outside the State of Louisiana will be considered, subject to approval of the Chief Engineer. This will generally be limited to adjacent states, except in cases where it will be in the best interest of the Department to pay for these materials. If payment for stockpiled materials outside the State will affect the bid price for an item, the contractor shall submit a written request to the Chief Engineer prior to bidding.

Payment may be made for the invoice price for the materials, which shall not exceed 85 percent of the contract price for the items where the materials are to be incorporated. For fabricated materials purchased from commercial sources and delivered to approved storage, partial payment may be the invoice price plus freight and taxes. The quantity of material for payment will not exceed the total estimated quantity required to complete the project.

The amounts advanced on stockpiled or stored materials will be recovered by the Department through deductions made on payments as the materials are incorporated in the work.

Partial payment for stockpiled materials shall be requested by the contractor in writing and the following documents shall be furnished:

(1) A copy of the invoices from supplier or manufacturer verifying the

cost and quantity of material.

(2) If storage is on private property, a copy of the lease or agreement granting the Department right of entry to property.

Within 30 calendar days after payment by the Department, the contractor shall submit a certified copy of invoices from the supplier for each item for which payment has been made. All such invoices submitted shall state the amount received by the supplier as payment in full for the materials. If this certification of payment is not presented within the 30-day period, the advanced payment will be deducted from future progress payments.

Title and ownership of materials for which advancements have been made by the Department shall not vest in the Department until such materials are incorporated in the work and the work accepted by the Department. The making of advancements by the Department shall not release the contractor from the responsibility for any portion thereof.

(b) Fabricated or Manufactured Materials: Fabricated or manufactured materials may include but is not limited to the following:

Structural steel, fabricated structural steel items, steel piling; reinforcing steel; electrical equipment; mechanical equipment; precast concrete items; structural timber; timber piling; fencing and guard rail materials; fabricated sign structures and sign panels.

(c) Other Material: These materials will normally be large quantities of natural or manufactured aggregate. The contractor's request for payment of stockpiled natural material shall give a detailed description of the material, its intended use and location of the site. This material will be inspected and approved after placement in stockpiles on the project. Approval of the stockpiled material will be in writing.

109.07 ADJUSTMENT FOR CHANGES IN COMMON CARRIER RATES. It is agreed that the accepted proposal for the work is based on common carrier rates on file with the Surface Transportation Board (STB) or with a corresponding intrastate commission or body in effect on the date of opening of bids. Payments to the contractor will be adjusted upon request to compensate for increases in cost due to changes in common carrier rates becoming effective after the date of opening of bids and before expiration of the contract time. The adjustment shall be limited to an amount determined as follows.

The adjustment shall be the product of the increase in common carrier rates multiplied by the net quantity of material shipped at the new rates to the work and incorporated therein, all as shown by receipted common carrier bills.

If the freight cost by common carrier to the job site is included in the

quotation by the supplier to the contractor, in addition to receipted freight bills, the supplier shall furnish on each invoice a breakdown showing the freight rate, quantity of material and total freight cost. The contractor shall furnish the supplier's written quotation made prior to the date of bid opening and a notarized statement that the increased freight rate has been paid.

The contractor's request for payment adjustment due to increased common carrier rates shall be submitted as soon as possible after shipments to the project have been completed. Only one request for such payment adjustment shall be made for each project, and any payment adjustment due the contractor for increased common carrier rates will be included in the final estimate for the project. No request for such payment adjustment will be considered unless submitted to the Department, with the required receipted bills and forms, within 30 calendar days after final acceptance.

109.08 ACCEPTANCE AND FINAL PAYMENT. Upon acceptance of the work, the Chief Engineer will execute a certificate that the work provided for in the contract has been completed and accepted under the terms of the contract. The Certificate of Acceptance will be recorded in the office of the Recorder of Mortgages of the parish in which the work has been done. The entire balance due the contractor, including the amounts withheld as retainage in accordance with Subsection 103.05, will be paid to the contractor after the Department has determined that quantities shown on the final estimate are correct; however, before payment of the final estimate, the contractor shall submit to the Department a certificate from the Recorder of Mortgages of the parish in which the work has been done to the effect that there are no claims or liens recorded against the contract. The date of the certificate shall not be prior to the expiration of 45 calendar days, but shall be prior to the expiration of 90 calendar days, after the Certificate of Acceptance was recorded in the Mortgage Office.

Prior to payment of the final estimate, all releases or waivers on buildings, wells, utilities and railroads shall be furnished as well as any maintenance bonds, certificates from Health Department, tracings, brochures or other items required by the contract.

Payment of the final estimate shall not release the contractor or sureties from liability for any fraud in construction, or in obtaining progress payments, or in payment for materials, labor or other supplies or services for the work, or for any claims for damages, loss or injury sustained by any person through the fault, negligence or conduct of the contractor or any employees, agents, subcontractors, suppliers or representatives.

PART II -- EARTHWORK

Section No. **Page No.**

Section 201
Clearing and Grubbing

201.01 DESCRIPTION. This work consists of required clearing, grubbing, removing and disposing of vegetation and debris within the limits of the right-of-way and easement areas, except such items that are designated to remain or to be removed under other items.

This work consists of cutting trees, logs, brush, stumps and debris; excavating and removing stumps, roots, submerged logs, snags, and other vegetative or objectionable material; disposing of removed material in accordance with Subsection 202.02; and cleaning the area. When fencing or utility relocation is required, an area 10 feet (3.0 m) wide, adjacent to and inside the right-of-way line, shall be cleared and grubbed.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

Erosion control shall be in accordance with Section 204.

201.02 GENERAL CONSTRUCTION REQUIREMENTS. The engineer will designate trees, shrubs, plants and other items to remain. The contractor shall preserve the items designated to remain. Equipment, materials and supplies shall not be stored in proximity of items designated to remain. Trees shall be removed without damaging items marked to remain. The contractor shall, at no direct pay, use a licensed landscape arborist to repair damage to bark, trunks, limbs or roots of vegetation marked to remain using horticultural and tree surgery practices published by the American Association of Nurserymen (AAN). Trees shall not be felled outside of the right-of-way. Damage outside the right-of-way caused by the contractor's operations shall be the contractor's responsibility.

201.03 CLEARING AND GRUBBING. Clearing and grubbing shall be done within the construction limits and to a point in fills 15 feet (4.5 m) beyond the toes of foreslopes and in cuts 15 feet (4.5 m) beyond the tops of backslopes, when width of right of way permits, or to the limits shown on the plans; also from areas required for outfall ditches and channel changes. Trees, stumps, roots and other protruding vegetative obstructions not designated to remain shall be cleared and grubbed (including mowing when required by the engineer). Some loose limbs and roots approximately 2

inches x 2 feet (50 mm x 600 mm) and smaller may be allowed to remain, however excessive amounts will not be allowed.

Explosives, when used, shall be in accordance with Subsection 107.11.

Stump holes and other holes left from clearing and grubbing shall be filled by blading the area or backfilling with existing materials or soil complying with Subsection 203.06(a) and compacted to at least the density of the surrounding soils.

Burning of material shall be under the constant care of watchmen. Burning of materials shall not jeopardize anything designated to remain on the right-of-way, the surrounding forest cover, or other adjacent property. The contractor shall be responsible for burning in accordance with all laws and ordinances, including, but not limited to, the current regulations of the Louisiana Department of Environmental Quality and Subsections 107.13 and 107.14.

Materials and debris which cannot be burned and materials which are not burned shall be removed from the right-of-way and disposed of in accordance with Subsection 202.02.

Merchantable timber in the area to be cleared, which has not been removed from the right-of-way prior to the beginning date stipulated in the Notice to Proceed, shall become the property of the contractor.

Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed at no direct pay. Branches of trees extending over the roadbed shall be trimmed to a height of 20 feet (6.0 m) above the pavement. Trimming shall be done in accordance with accepted horticultural and tree surgery practices published by AAN.

201.04 MEASUREMENT. No measurement of area will be made for payment.

201.05 PAYMENT. When a pay item is included in the contract, payment for clearing and grubbing will be made at the contract lump sum price. Partial payment will be limited to 10 percent of the original total contract amount until the contractor has earned 40 percent of the original total contract amount. When clearing and grubbing consists of more than 50 percent of the contract amount, payment will be made for the work completed.

T201.05T

Payment will be made under:

Item No.	Pay Item	Pay Unit
201-01	Clearing and Grubbing	Lump Sum

Section 202
Removing or Relocating Structures and Obstructions

202.01 DESCRIPTION. This work consists of the removal or the relocation of structures, facilities or obstructions, hereinafter referred to as "structures" from the project right-of-way unless specified otherwise.

The removal of a structure from the project right-of-way is the razing, demolishing, and disposal of the structure after salvageable parts, components, and materials, as designated on the plans, have been recovered by the contractor.

The relocation of a structure from the project right-of-way is its movement, resiting, reassembly, restoration, reconstruction or equivalent replacement at a new location outside of, and adjacent to, the project right-of-way including all service connections, appurtenances and accessories as directed.

For the purposes of this section, structures may include buildings, floor slabs, foundations, fuel tanks, septic tanks, fences, pipes, bridges, drainage structures, pavements, walks, curbs, abandoned pipelines and other similar facilities or obstructions not designated or permitted to remain within the project right-of-way. This work also includes backfilling of resulting trenches, holes and pits. If structures or obstructions are encountered which differ materially from those ordinarily encountered, the provisions of Subsection 105.18 shall apply.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

Erosion control shall be in accordance with Section 204.

202.02 GENERAL CONSTRUCTION REQUIREMENTS. The contractor shall remove and dispose of all portions of structures or obstructions on the right-of-way, except utilities and those items for which other provisions have been made for removal or relocation. When specified, the contractor shall remove structures and appurtenances that extend beyond the right-of-way or that are entirely on private property. Specified salvageable material shall be removed, without unnecessary damage, in sections which may be readily transported. Salvageable material shall be stacked at specified storage areas by the contractor. When

no storage sites are specified, salvaged materials shall be delivered to the nearest DOTD maintenance unit. Materials not specified to be salvaged shall be disposed of off the project outside the view of the traveling public with written permission of the property owner on whose property the material is placed. Copies of agreements with property owners shall be furnished to the engineer by the contractor prior to beginning of work. The agreement must contain language holding the Department harmless from any liabilities from the contractor or property owners, otherwise a Certificate of Release from the property owner will be required before final acceptance. Holes left by structure removal or the removal of materials associated with contaminated soils or sites, shall be filled by blading the area or backfilling with surrounding soil types or soil complying with Subsection 203.06(a) and shall be compacted as directed to at least the density of the surrounding soils.

If any fuel storage tanks or other environmentally sensitive or contaminated sites are located during construction, the contractor shall stop construction activity in the immediate vicinity of the environmentally sensitive or contaminated site and notify the project engineer who in turn will notify the Materials and Testing Section immediately for guidance. Testing and clean-up by the contractor shall be coordinated through the Materials and Testing Section.

The Department reserves the right to eliminate work items for the removal or relocation of any structures under these items. Such elimination shall not affect contract unit prices on remaining structures to be removed or relocated or unit prices on other items of the contract. The contractor will not be entitled to compensation due to such elimination.

202.03 REMOVING STRUCTURES. Unsalvageable materials in a structure designated for removal shall become the property of the contractor and shall be removed and disposed of by the contractor.

Appurtenances forming a part of a structure to be demolished, whether integral or not integral to the structure, shall be demolished and removed by the contractor. Washhouses, garages, cisterns, and other buildings and appurtenances used in conjunction with a structure shall be demolished and removed in the same manner as the structure. Existing yard fences, drives and walks, and shrubbery shall also be removed. The above are all considered part of the structure to be demolished and removed.

All abandoned wells shall be plugged and sealed in accordance with the "Water Well Rules, Regulations, and Standards, State of Louisiana."

Demolishing of a structure, any part of which is used as a service

station, shall include the removal of gasoline pumps, tanks, pipes, signs and other appurtenances. Underground fuel tanks will be removed in accordance with Subsection 202.05. Existing underground fuel tanks shall not be reused or used for other purposes.

Material in existing foundations, concrete or masonry floors, chimneys and other appurtenances, shall be removed and disposed of by the contractor.

Cattle pens, cane derricks, cattle guards or other such structures shall be removed and disposed of by the contractor.

(a) Pavement, Base Courses, Walks, and Curbs: Pavements, stabilized or treated base courses, walks, curbs, gutters, etc., designated for removal, shall be disposed of in accordance with these specifications and as directed. Unless otherwise noted, base materials under pavements shall be removed with the pavement at no additional pay.

When the existing shoulder underdrain at the pavement edge is to remain in place and in service and removal of the shoulder surfacing and base is required, the work shall be done in such manner as to avoid damaging the existing shoulder underdrains. Damaged shoulder underdrains shall be satisfactorily repaired at no direct pay.

(b) Pipe: Pipe to be relaid shall be removed and stored so that there will be no loss or undue damage before relaying. The contractor shall replace sections lost from storage or unduly damaged at no direct pay. When specified, pipe not to be relaid and considered usable shall be salvaged, cleaned of soils or other materials, stored and stacked.

(c) Bridges and Drainage Structures: Bridges, including approach slabs, and drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise directed or shown on the plans, substructures shall be removed to natural stream bottom and those parts outside the stream shall be removed to 1 foot (0.3 m) below natural ground surface. Existing structures within the limits of a new structure shall be removed as necessary to accommodate construction of the new structure.

Steel or wood bridges to be salvaged shall be dismantled without unnecessary damage. Dismantling shall include stripping all hardware. Structural members shall be match-marked before dismantling.

Explosives, when used, shall be in accordance with Subsection 107.11. Blasting or other operations necessary for removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.

202.04 RELOCATING STRUCTURES. Structures to be relocated shall be placed in their new locations as directed, and be restored to their original condition. Structures to be relocated shall be placed on foundations of the same type and character as the original foundations.

Appurtenances forming a part of a structure to be relocated, whether integral or not integral to the structure, shall be relocated in the same manner as the structure. Appurtenances associated with the structure shall be relocated or replaced as directed with appurtenances of the same size, type, and character as existed before the structure was relocated.

Sanitary sewers, water, gas, electric, television cable, and telephone service lines connected to structures being relocated shall be disconnected and reconnected as quickly as possible. The contractor shall be responsible for all notices to public utility companies and for all fees charged by them. The contractor shall also relocate existing yard fences, drives and walks and extend same as necessary. Existing shrubbery shall be removed and replanted at new locations as designated. All of the above shall be considered as appurtenances not integral to the structures to be removed and relocated.

Material in existing foundations, concrete or masonry floors, chimneys and other appurtenances, when not used in reconstruction of appurtenances, shall be removed and disposed of in accordance with Subsection 202.02. New material required in performing any of these operations shall be furnished by the contractor at no direct pay.

Contents of structures shall be relocated with the structure to its new site. When not feasible to relocate structures with contents therein, the contents shall be removed from the structure at its original location, properly stored, and replaced in the relocated structure without damage or loss to contents.

Cattle pens, cane derricks, cattle guards or other such structures, shall be relocated on or beyond the right-of-way line as directed. Materials in structures suitable for reuse may be utilized in their reconstruction. New materials required shall be similar in kind to that in place and shall be furnished by the contractor at no direct pay, including foundations.

Prior to removal of butane or propane gas tanks, the contractor shall obtain the written approval of the Louisiana Liquefied Petroleum Gas Commission. Existing underground butane or propane gas tanks shall not be reused or used for other purposes. The contractor will be reimbursed for the cost of the new tank upon presentation of the original receipted bill.

The contractor shall furnish the engineer a Certificate of Release from each property owner, and in case of separate ownerships of structure and

property, a Certificate of Release from each owner shall be furnished. This certificate shall state that the relocated structures are in an acceptable condition and that said owner waives all claims for damages to the property and structures relocated. When the contractor is unable to secure a Certificate of Release from the property owner, the contractor shall submit an executed Form 671-A, Contractor's Affidavit, to the engineer.

202.05 REMOVING ENVIRONMENTALLY SENSITIVE MATERIALS. When removal or remediation of any environmentally sensitive or contaminated sites is required during construction, the contractor's operations shall be coordinated through the Materials and Testing Section. If the contractor fails to follow the guidelines of the Materials and Testing Section, and subsequently causes or increases harm or damage to the environment, then all resulting fines and clean-up costs shall be the responsibility of the contractor.

(a) Non-Friable Asbestos: When a structure contains non-friable asbestos, the contractor shall carefully remove the asbestos without excessive breakage or crushing before removal, relocation or demolition of the structure. The non-friable asbestos material shall be disposed of at an approved industrial landfill.

(b) Friable Asbestos: When a structure contains friable asbestos, the contractor shall immediately notify the Department of Environmental Quality (DEQ), Air Quality Division and request that DEQ provide a confirmation letter with an Asbestos Disposal Verification Form (ADVF). The contractor shall complete the ADVF within 90 calendar days from the date of issue. When this information is available, the Department will indicate on the plans which structures contain friable asbestos. Only contractors or subcontractors certified by DEQ as Asbestos Abatement Entities shall remove friable asbestos from structures. The asbestos removal shall be performed before removal, relocation or demolition of the structure. Friable asbestos removal, handling and disposal shall be performed in accordance with the latest requirements for asbestos abatement of the DEQ, Air Quality Division.

The contractor shall maintain, and furnish to the engineer, within 21 calendar days, Chain of Custody verification records for the friable asbestos from the work site to the disposal site. These records will become part of the permanent project records.

(c) Underground Fuel Tanks: Before removal, underground fuel tanks shall be registered with the DEQ by the Materials and Testing Section as abandoned underground storage tanks. The contractor shall

notify the project engineer in writing at least 45 calendar days prior to removal of tanks. The engineer will immediately notify the Materials and Testing Section. All site activities, including the collection of closure samples and tank removal, as defined in the latest DEQ Underground Storage Tank (UST) regulations, shall be performed by a DEQ approved contractor. Closure test results, all documentation, and all necessary forms shall be submitted by the contractor to the Materials and Testing Section to be approved and forwarded to DEQ. The contractor and/or the subcontractor shall note that all contact and/or coordination with the DEQ is to be the responsibility of the Materials and Testing Section.

The contractor shall take all necessary precautions to prevent the infiltration of water into tanks and tank excavations during the work.

During routine site closure, the removal, transportation and disposal of tanks, and the handling of contaminated soil and contaminated fluid shall be in accordance with all local, state, and federal laws and regulations. Limits of excavation and quantities of contaminated soil and contaminated fluid to be removed, transported and disposed shall be as specified.

When underground storage tanks (UST) have been filled with concrete, sand, or other such material and are designated on the plans for removal, the contractor or certified UST subcontractor shall remove, transport and dispose of such tanks in accordance with the recommendations of the American Petroleum Institute (API) and the requirements of the Louisiana Department of Environmental Quality (DEQ) or other regulatory agency of jurisdiction. When such UST are discovered during construction and removal is necessary to achieve soil compaction or to meet other construction requirements, the contractor shall stop construction activity in the immediate vicinity of the UST and notify the project engineer in accordance with this subsection The DOTD Materials and Testing Section will verify the closure status of such filled UST discovered during construction prior to any UST site activity by the contractor or certified UST subcontractor.

The contractor or certified UST subcontractor shall collect and submit for laboratory analysis, a representative sample of the storage tank fill material for landfill acceptance. The results of the laboratory analysis shall be used to determine the disposition of the UST fill material. The contractor or certified UST subcontractor shall provide a copy of all laboratory analyses to the Department's Materials and Testing Section for verification prior to profiling materials for landfill acceptance.

(d) Contaminated Soils: Soil contaminated with Benzene, Toluene, Ethyl Benzene, Xylene (BTEX), Total Petroleum Hydrocarbons-

Gasoline (TPH-G), Total Petroleum Hydrocarbons-Diesel (TPH- D), Total Petroleum Hydrocarbons-Oil (TPH-O), or other identified toxic materials, in areas of underground fuel tanks or other areas, at levels above the regulatory limits and is non-protective of groundwater shall be excavated by the contractor as shown on the plans or as directed. Determination of groundwater protection shall be through the use of the Synthetic Precipitation Leachate Procedure (SPLP) or as directed.

The contractor shall remove the overburden above the contaminated soil to the dimensions shown on the plans or as directed. The contractor shall also excavate the contaminated soil at the locations shown on the plans or as directed. The contaminated soil shall be loaded into approved hauling vehicles by the contractor and be disposed of in a disposal site approved by the Department of Environmental Quality. The contractor shall furnish the engineer, within 21 calendar days, Chain of Custody verification records for the contaminated soil. The Materials and Testing Section will verify that all contaminated soil has been removed.

While the excavation is open, the contractor shall construct and maintain a soil berm around the excavation to prevent surface water runoff from entering the excavation. The removed overburden may be used to construct the berm and backfill the excavation.

Removal and disposal of contaminated soils will be in accordance with all local, state and federal laws and regulations.

(e) Contaminated Fluids: Contaminated fluid in underground fuel tanks, in areas of underground fuel tanks or other areas as shown on the plans or as directed shall be removed and disposed of by the contractor.

The Department will determine the quantity of contaminated fluid to be removed.

The contractor shall pump the contaminated fluid into approved hauling vehicles. Contaminated fluid in underground fuel tanks shall be removed before tank removal.

The contaminated fluid shall be disposed of in a disposal site approved by the Department of Environmental Quality. The contractor shall furnish the engineer, within 21 calendar days, Chain of Custody verification records for the contaminated fluid.

The Department will verify the removal of the contaminated fluid.

Removal and disposal of contaminated fluids will be in accordance with all local, state and federal laws and regulations.

(f) Paint Containing Lead or Other Hazardous Materials on Metal Surfaces: Steel members of structures protected by paint containing lead or other hazardous materials as shown on the plans or as

discovered in the field shall be removed and prepared for transport by methods approved by the Department.

Such steel members shall be delivered to a licensed recycling center capable of processing steel members coated with paint identified by the Resource Conservation and Recovery Act (RCRA) as hazardous.

Prior to removal, transport, treatment or disposal of any steel members, the contractor shall submit the following to the engineer.

(1) Plan of removal of steel members.

(2) Plan for transport of steel members.

(3) Name and address of the licensed recycling center.

All steel members shall be transported in accordance with all federal, state and local laws. Certificates of Disposal, Chain of Custody forms, or other applicable documents shall be provided within 21 calendar days following each shipment.

(g) Treated Timber: Creosoted and other treated timber or lumber shown on the plans or discovered in the field shall be removed and prepared for transport by methods approved by the Department. All materials that are not designated to be salvaged by the Department or salvaged by the contractor are to be disposed of in an appropriate landfill. Certificates of Disposal, Chain of Custody forms, or other applicable documents shall be provided within 21 calendar days following each shipment.

(h) Universal Wastes: Universal wastes are hazardous wastes defined in LAC Title 33, Part V, Chapter 38, Section 3813 to include batteries, pesticides, thermostats, lamps and antifreeze. Universal wastes shall be removed by the contractor in accordance with the plans and shall be stored and prepared for transport as specified in LAC Title 33, Part V, Chapter 38 and herein.

A lamp is the bulb or tube portion of an electric lighting device. Universal waste lamps include, but are not limited to, fluorescent, high intensity discharge, neon, mercury vapor, high pressure sodium, and metallic halide. Such lamps shall be removed and stored in containers or packages that are structurally sound, adequate to prevent breakage, and compatible with the contents of the lamps. Such containers shall remain closed and lack evidence of leakage, spillage or damage that could cause releases of mercury or other hazardous constituents to the environment under reasonably foreseeable conditions. The containers shall be clearly labeled or marked with the words “Universal Waste – Lamps” and with the earliest date that any lamp in the container was discarded as waste. If a container develops a leak, it shall be placed into an over-pack container.

The contractor shall immediately clean up any leakage and place in a container any lamp that shows evidence of breakage, leakage, or damage.

Universal waste lamps will not be allowed to accumulate for a period longer than one year from the date the lamps were discarded. The waste lamps shall be delivered to a universal waste disposal site or destination facility by a Universal Waste Transporter in accordance with the applicable U.S. Department of Transportation Regulations, 49 CFR, Parts 172-180.

The contractor shall be responsible for informing all employees who handle universal wastes of the proper handling and emergency procedures appropriate to the type of waste.

202.06 PLUGGING OR RELOCATING EXISTING WATER WELLS. All abandoned wells shall be plugged and sealed at the locations shown on the plans, or as directed by the engineer, in accordance with the "Water Well Rules, Regulations, and Standards, State of Louisiana." Well abandonment must be accomplished by a DOTD licensed water well contractor. Relocated wells shall conform to the Sanitary Code of the State of Louisiana as prepared and promulgated by the Louisiana State Board of Health.

202.07 MEASUREMENT. Removing structures and obstructions will be measured on a lump sum basis or by the unit as stipulated in the contract and shall include appurtenances, foundations, etc. When the contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item will include all required removal of structures and obstructions.

Hauling salvaged materials to specified storage sites will not be measured for payment.

When an item is included for removal of bridges, the removal of the approach slabs, superstructure, and substructure will be considered part of the work unless otherwise specified or shown on the plans.

Removing or relocating structures will be measured by the unit stipulated in the contract. Each principal structure with its associated appurtenances, whether integral or not integral to the structure being removed or relocated, will be considered as a separate unit including its associated appurtenances.

Plugging of existing abandoned water wells or relocating water wells will be measured per each well plugged and accepted or relocated.

Measurement for removal of contaminated soil and non-contaminated overburden will be by the cubic yard (cu m) using the in-place quantities as determined by cross-sections.

Measurement for contaminated fluid will be by the gallon (L).

Removing steel members of structures protected by paint containing lead or other hazardous materials, or creosoted timbers or lumber, and transporting them to the designated recycling center or landfill will be considered part of the work when shown on the plans and will not be measured for payment.

When a structure to be removed or relocated is shown on the plans to contain universal wastes, the removal, storage and transport of the universal waste to an approved disposal site or destination facility will not be measured for payment but will be included in the structure to be removed or relocated.

202.08 PAYMENT. Payment for removal of structures or specific obstruction items stipulated for removal and disposal under unit price or lump sum pay items will be made at the contract price per unit or lump sum as specified. This will include demolishing, removing and disposing of such items and the excavation and backfill incidental to their removal when required. When the removal is in an area to be excavated and payment for excavation is made under other items, no deduction will be made from the excavation quantities. The price shall also include salvage of materials, their custody, preservation, storage on the right-of-way or as designated on the plans**,** and disposal.

Payment for the removal of bridges will include removal of the approach slabs, superstructure, and substructure.

Payment for the relocation of structures will be made at the contract unit price which will include all costs for moving, resiting, reassembly, restoration, reconstruction or equivalent replacement of the structures.

Payment for plugging and sealing existing abandoned water wells or relocating existing water wells will be made at the contract unit price which will include all labor, material, tools, equipment, and incidentals necessary to complete the work.

If a structure is to be removed or relocated as a unit under Pay Items 202-01, 202-02, or 202-03 and the contractor enters into an agreement with a property owner for disposition of the structure other than as shown on the plans; or if it is subsequently determined that said structure can remain in place, in whole or in part, with or without minor adjustments, and the contractor enters into an agreement with the property owner incorporating

such revised determination and any accompanying adjustments regarding said structure, including any damages for leaving the structure in place; the contractor shall furnish such agreement to the engineer for approval. If approval is given by the engineer, the contractor shall furnish the Department with a Certificate of Release from the property owner for the unit. In case of separate ownership of structure and property, a Certificate of Release from each owner shall be furnished. This certificate shall state that said owner waives all claims for damages to the property and structure to be removed, relocated, left in place or otherwise handled to the owner's satisfaction. The contractor will be paid for removing, relocating or other handling of the structure at the contract unit price as listed under Pay Items 202-01, 202-02, or 202-03. If a determination to allow the structure to remain in place involves a decrease in cost to the contractor, including any allowance for damages to the property owner and other adjustment of the contract amount for removal, relocation or other handling of said unit under Pay Items 202-01, 202-02, or 202-03, an allowance will be made in such amount as the engineer deems equitable.

When a structure has been identified on the plans as containing friable or non-friable asbestos, the price for asbestos removal and disposal will be included in the bid price for removal, relocation or demolition of the structure. When a structure is found to contain friable or nonfriable asbestos and it has not been identified on the plans as containing asbestos, payment for the removal and disposal of the asbestos will be made in accordance with Subsection 109.04, including the cost of all testing.

Payment for removal, transportation, and disposal of contaminated soils and fluids will be in accordance with rates specified in applicable appendices (currently Appendices A and B) of the “Louisiana Motor Fuels Underground Storage Tank Trust Fund Cost Control Guidance Document” as maintained and updated by the Louisiana Department of Environmental Quality (DEQ). The DEQ cost control guidance document can be obtained at www.deq.state.la.us/financial/usttf/index.htm. All payments under this item will be in accordance with industry standards, which include all equipment, labor, and materials necessary to complete the work, including backfilling any excavation. Payment for work not covered in the cost control guidance document, or any disputed payments, will be negotiated and resolved prior to performance of work. The Department will reimburse the contractor monthly for the incurred cost. The contractor shall furnish documentation with the request for reimbursement. The provisions of Subsection 109.04 regarding percentage markup for the contractor shall not apply to this reimbursement.

Payment for removing steel members of a structure identified on the plans as being protected by paint containing lead or other hazardous materials, or creosoted timbers or lumber, and transporting them to the designated recycling center or landfill, will be included in the bid price for removal or relocation of the structure. When a structure is found to have steel members protected by paint containing lead or other hazardous materials, or creosoted timber or lumber, and it has not been identified on the plans as such, payment for removal and transport of the members to a licensed recycling center or landfill will be made in accordance with Subsection 109.04.

Unless otherwise directed or shown on the plans, the contractor will be allowed to retain any steel member protected by paint containing lead or other hazardous materials provided the paint is not damaged during removal of the member and a Chain of Custody form or other applicable documentation is submitted to the engineer within 21 calendar days.

When the plans show that a structure to be removed or relocated contains a universal waste, payment for the removal of the universal waste will be included in the contract unit price for the removal or relocation of the structure which will also include all equipment, labor, and materials required for the removal, storage, and transport of the universal waste in accordance with LAC Title 33, Part V, Chapter 38. When a structure to be removed or relocated is found to contain a universal waste and it is not identified as such on the plans, payment for the removal, storage and transport of such universal waste in accordance with LAC Title 33, Part V, Chapter 38 will be made in accordance with Subsection 109.04.

Payment will be made under:

Item No.	Pay Item	Pay Unit
202-01	Removal of Structures and Obstructions	Lump Sum
202-02	Removal of _____	Each
202-03	Relocation of _____	Each
202-04	Excavation, Disposal and Backfilling of Non-Contaminated Overburden	Cubic Yard (Cu m)
202-05	Excavation, Disposal and Backfilling of Contaminated Soil	Cubic Yard (Cu m)
202-06	Removal and Disposal of Contaminated Fluid	Gallon (L)
202-07	Plugging Existing Water Wells	Each

Section 203
Excavation and Embankment

203.01 DESCRIPTION. This work consists of excavation, disposal, placement and compaction of materials for which provisions have not been made under other sections of these specifications. This work shall include excavation and embankment construction for roadways and other structures, excavation for ditches and channels, and other grading operations necessary for the work in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown on the plans or established. When contaminated soils or underground tanks are encountered, handling shall be in accordance with Section 202.

Disposal of material shall be in accordance with Subsection 202.02.

The plans may include data regarding the boring and classification of existing materials. The Department does not guarantee that individual samples are representative of the entire project, and bidders are required to study, make interpretations and additional investigations, as necessary, at no direct pay.

The contractor shall comply with Subsection 107.09 for work in, over or adjacent to navigable waters and wetlands, and shall comply with Subsection 107.27 when cultural artifacts, historical sites or archaeological sites are encountered.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

Excavated material may be used in accordance with Subsection 203.06.

Erosion control shall be in accordance with Section 204.

203.02 GENERAL EXCAVATION. General excavation consists of the excavation of materials, as required by the plans, except drainage excavation and structural excavation. General excavation also includes unsuitable material in accordance with Subsection 203.04.

203.03 DRAINAGE EXCAVATION. Drainage excavation includes the excavation for drainage beyond the limits of the roadway section. Drainage excavation also includes inlet and outlet ditches to structures or roadways; changes in or deepening of channels of streams, berm ditches,

ditches parallel or adjacent to the roadway beyond the limits of the roadway section; and material excavated from areas under bridges.

203.04 UNSUITABLE MATERIAL. Unsuitable materials are soils containing significant amounts of debris or organic matter including stumps, roots, logs, and humus, or other materials which will decay or produce subsidence, including highly saturated soils, which the engineer determines are not satisfactory for use in the embankment or other construction purposes. Unsuitable materials shall be removed and disposed of as general excavation. Unsuitable materials determined to be environmentally sensitive shall be removed and disposed of in accordance with Subsection 202.05.

203.05 BORROW. Borrow is defined as soils required for construction of embankments or other portions of the work in excess of soils obtained from excavation. Borrow shall be obtained from an approved source and shall be used in accordance with Subsection 203.06. The contractor shall make arrangements for obtaining borrow at no direct pay.

Securing of an exclusive option by a contractor on borrow areas or materials for the work will be considered a violation of Louisiana law and will be a basis for rejection of bids or such other action the Department deems advisable.

The contractor shall notify the engineer in writing a minimum of 30 calendar days in advance of borrow operations so that samples may be taken and soil tests completed prior to beginning borrow operations.

Prior to requesting the borrow pit to be bored, the contractor shall furnish the Department a written agreement with the property owner to allow the Department access to the property. The written agreement shall also state that the contractor has agreed to purchase the borrow material from the property owner for this particular site if the material meets contract specifications. A separate agreement shall be obtained from each property owner through which access will be necessary.

Sites from which material has been removed shall, upon completion of the work, be left in an acceptable condition.

Unless otherwise authorized in writing, borrow pits, gravel pits and quarry sites shall be located at least 300 feet (90 m) from the right-of-way.

When sources of borrow are located adjacent to a stream or river listed on the National System of Wild and Scenic Rivers or the Louisiana Natural and Scenic Rivers System, borrow pits, and any stockpiled materials shall be located at least 300 feet (90 m) from the natural stream or river bank.

The borrow pit and access shall be cleared to allow access for DOTD boring equipment. The borrow area shall be surveyed with a base line staked. Both the engineer and laboratory shall be furnished with a location plat and borrow pit plat. The contractor will not be permitted to begin borrow operations until materials are approved for use.

Sampling of soils from open excavations made by the contractor in lieu of borings will be allowed provided the open excavations display and allow sampling of each soil strata and the excavation is at no cost to the Department**.**

203.06 SOIL USAGE. The laboratory will test and classify soil in accordance with DOTD TR 423 from samples taken in the original location or from designated stockpiles. Soil shall be classified and approved prior to its being placed in embankments or other final positions on the project. Blending in the pit by approved methods to adjust percent silt or sand will be permitted. Soils which do not meet Liquid Limit or PI requirements shall not be blended to reduce Liquid Limit or PI. Soils may be treated with lime to reduce PI in accordance with Subsection 203.06(e).

Soil properties will be determined by the test methods shown in Table 203-1.

Table 203-1
Soil Properties

Property	Test Method
Plasticity Index (PI)	DOTD TR 428
Liquid Limit (LL)	DOTD TR 428
% Organic	DOTD TR 413
% Silt	DOTD TR 407
pH	DOTD TR 430

(a) Usable Soils: Usable soils shall have a maximum PI of 25 and a maximum organic content of 5 percent. Soils with a silt content of 50 percent or greater and also a PI of 10 or less will not be allowed.

(b) Selected Soils: Selected soils are natural soils with a maximum PI of 20, maximum Liquid Limit of 35, and a maximum organic content of 5 percent. Soils with a silt content of 50 percent or greater and also a PI of 10 or less will not be allowed. Soils to be used for in-place cement stabilization shall be in accordance with Subsection 302.02(a).

(c) Nonplastic Embankment: Nonplastic embankment shall be as specified in Subsection 203.09.

(d) Headers: Headers are that portion of the embankment within 500 feet (150 m) of a bridge end. Headers shall be constructed for their full height with usable soils having a minimum PI of 11, a maximum PI of 25, and a maximum silt content of 65 percent. No lime treatment to the soil to meet the PI requirements will be permitted. Headers shall be compacted to 98 percent of maximum dry density in accordance with Subsection 203.07.

(e) Embankments other than Headers:

(1) Embankments shall be constructed with usable soils, except soil with a PI greater than 25 and less than 35 will be permitted when treated with a minimum of 6 percent lime, by volume, provided the organic content and silt requirements given in Heading (a) are met. If the contractor uses lime treatment, it will be at no direct pay. Lime treatment shall be Type E Treatment conforming to Section 304.

(2) The contractor may request in writing that usable soils for temporary detour roads have a PI not to exceed 45 and a maximum silt content of 75 percent provided:

a. This material will be removed and not become part of the permanent embankment.

b. The contractor agrees to take responsibility for any additional maintenance required.

(f) Plastic Soil for Slopes:

(1) Embankment Material: The outside layer of embankment (fill sections) will consist of a plastic soil blanket in accordance with Subsection 203.10. Sampling in the pit may be allowed if an identifiable strata can be isolated. Otherwise, sampling will be from dedicated stockpiles.

(2) Cut Slopes, PI Less than 10: When soils having a PI less than 10 exists on cut slopes, the contractor shall undercut 12 inches (300 mm) and place a plastic soil blanket conforming to Subsection 203.10.

(3) Cut Slopes, PI 10 or Greater: When soils having a PI of 10 or greater but with a pH less than 5.5, or greater than 8.5, exist on cut slopes, the contractor shall undercut and place a plastic soil blanket complying with Subsection 203.10. In lieu of furnishing a plastic soil blanket, the soil may be modified in place so that the pH of the soil complies with the requirements of Subsection 203.10, at the option of the engineer and concurrence of the contractor. In such case payment will be in accordance with existing items or Subsection 109.04, as applicable, not to exceed the cost of undercut and replacement.

(g) Usable Soils for Slope Adjustments and Shoulder Widening: When the thickness of embankment material used for slope adjustment is less than 12 inches (300 mm), a plastic soil complying with Subsection 203.10 will be required. If the thickness is greater than 12 inches (300 mm), the contractor will be allowed to substitute plastic soil for usable soil, provided the widening is not directly below a paved shoulder.

203.07 GENERAL REQUIREMENTS. Excavation and embankment construction consists of constructing roadway embankments, including preparation of areas on which they are to be placed; constructing drainage excavation; backslope construction; constructing dikes, when required; placing and compacting approved material in areas where unusable material has been removed; placing and compacting embankment material in holes, pits and other depressions; and placing and compacting embankment materials for backfilling structures. Prior to beginning excavation, grading or embankment operations in an area, all necessary clearing and grubbing in that area shall have been completed. Prior to any embankment operations in an area, all corresponding roadside ditches shall be cut to facilitate drainage in that area. Embankment materials shall not be placed or spread on portland cement concrete or asphaltic concrete pavements. Pavement surfaces, edges and joints shall not be damaged during embankment operations.

Final excavation and embankment slope lines shall be uniform in appearance. Measurements shall be made as necessary to assure that the elevations at the top, bottom, and intermediate breaks in the slope are such that a minimum acceptable slope is achieved. The slopes shall be straight without valleys or humps, as determined by visual inspection. If an apparent discrepancy is discovered upon visual inspection, measurements shall be taken a minimum of every 10 feet (3.0 m) measured along the slope between theoretical break points in the embankment. When these measurements reveal slope variances by more than 0.03 ft/ft (0.03 m/m), too steep, or 0.15 ft/ft (0.15 m/m), too flat, the slopes shall be reworked by the contractor until these criteria have been met. The top of embankment shall not vary from the established grade by more than ±0.1 foot (0.030 m).

Embankment material shall be in accordance with Subsection 203.06 and shall be placed in uniform layers not exceeding 12 inches (300 mm) of uncompacted thickness. Each layer shall be placed for the full width of embankment, blended as necessary to obtain a uniform material**,** brought to a uniform moisture content, and compacted by approved methods to a minimum of 95.0 percent of maximum dry density before the next layer is

placed. Maximum dry density will be determined in accordance with DOTD TR 415 or TR 418 and percent in-place density in accordance with DOTD TR 401. The density of the embankment shall be such that the density of the type of base course being constructed as given in Table 301-1 shall be met. The moisture content at the time of compaction, tested in accordance with DOTD TR 403, shall be within a range of ±2.0 percent of optimum moisture established in accordance with DOTD TR 415 or TR 418 or the lifts shall be reprocessed and recompacted until these requirements are met. Operations shall be conducted to prevent lamination between lifts. Laminations between lifts shall be corrected prior to placing additional lifts. Surfaces of excavated areas and embankments shall be smooth and uniform. Material outside construction limits shall not be disturbed.

Excavated material shall become the property of the contractor. Soils from excavation areas may be used when approved in embankments or other finished sections. Surplus or unusable excavated material shall be disposed of by the contractor in accordance with Subsection 202.02 or as provided in this Subsection.

Drainage excavation and rough grading shall be performed simultaneously, unless otherwise directed or permitted. Roots, stumps or other vegetative obstructions in sides and bottom of ditches and channel changes shall be cut to conform to required cross section and grade. Excavated material shall be placed sufficient to protect the integrity of the slope but in no case closer than 3 feet (1.0 m) from the edge of ditch.

When obliteration of old roadways is required, it shall include grading operations necessary to satisfactorily incorporate the old roadway into the new roadway and surroundings in order to provide a pleasing appearance and to allow drainage.

When preparing surface layers on which the embankment or base is to be placed, the engineer will require the contractor to attempt all normal earthwork construction methods before undercutting or modifying the soil with additives. Such construction methods may include, but are not limited to, the following and will be at no direct pay:

(a) Draining and drying of the surface until the material is within the limits of optimum moisture before compaction is attempted.

(b) Using lighter construction equipment for manipulating, disking, drying and compacting the material.

(c) Dumping successive loads of material in a uniformly distributed layer of a thickness necessary to support equipment while placing subsequent layers.

(d) Rerouting heavy construction equipment around the area until the embankment can support the equipment without damage to foundation soils.

Unstable materials shall be removed by undercutting, unless otherwise directed, and backfilled to required section with usable soils as directed.

When undercutting is required, the contractor shall conduct the operations in such manner that the engineer can make necessary measurements before backfill is placed.

When excavation and embankment construction results in surface soils having a PI less than 10 or pH less than 5.5 or greater than 8.5, the contractor shall place a plastic soil blanket complying with Subsection 203.10.

The contractor shall be responsible for the stability of embankments until final acceptance. Construction activities, which may lead to subsequent embankment damage will not be permitted.

When embankments are constructed on a surface sloping more than 6:1 from the horizontal, the slope of the ground on which the embankment is to be placed shall be cut into steps, as directed, before fill is placed.

When a new roadway is to be constructed on an existing roadbed, and the surface of the existing roadbed is within 2 feet (0.6 m) of finished sub-grade, the existing roadbed shall be scarified full width to a depth of not less than 9 inches (230 mm) and recompacted in accordance with this subsection.

When an embankment is to be constructed to a height of less than 5 feet (1.5 m), heavy sod and objectionable vegetation shall be removed from the area on which the embankment is to be placed. The area shall be scarified to a depth of approximately 9 inches (230 mm). This area shall be recompacted to at least 95.0 percent of maximum dry density. Maximum dry density will be determined in accordance with DOTD TR 415 or TR 418 and percent in-place density in accordance with DOTD TR 401. When height of fill is 5 feet (1.5 m) or more, removal of sod will not be required but the area on which embankment is to be placed shall be disked to the satisfaction of the engineer and recompacted before construction of embankment.

When embankment material is to be deposited only on one side of abutments, wing walls, piers, or culvert head walls, the area immediately adjacent to the structure shall not be compacted to the extent that it will cause excessive pressure against the structure. Fill adjacent to the end bent of a bridge shall not be placed higher than the top of the substructure until the superstructure is in place. When the embankment is to be deposited on

both sides of a concrete wall or similar structure, operations shall be conducted so that the embankment is always at approximately the same elevation on both sides of the structure. Backfilling of structures shall be performed in accordance with Section 802.

When embankments are constructed in lakes, streams, swamps or other unstable areas and unstable material cannot be removed or the area drained, the requirement for placing material in layers as outlined above may be waived. When this requirement is waived, the embankment shall be placed by end dump or other approved methods to an elevation where normal construction methods can begin. Embankments placed above this elevation shall be constructed in layers as specified above. When a wave of unsuitable material is forced up in front of the end dumping operation, it shall become the property of the contractor and be removed as necessary, and will not be allowed to be trapped and be incorporated in the embankment except as part of plastic soil for slopes.

203.08 CUT AREA PREPARATION. The top 12 inches (300 mm) shall be scarified and compacted to such density that the compaction requirements of the type base course being constructed given in Table 301-1 shall be met. Construction, compaction, and testing requirements shall be in accordance with Subsection 203.07.

When unstable soils are encountered, the engineer will determine the limits to be undercut. The contractor shall excavate to a stable foundation or to the depth required by the engineer and backfill to existing grade. Undercut shall be constructed and tested in accordance with Subsection 203.07.

When a stable foundation cannot be reached, the embankment materials shall be "bridged-in" and the remaining embankment constructed in accordance with Subsection 203.07 to existing grade.

203.09 NONPLASTIC EMBANKMENT.

(a) Materials: Nonplastic embankment material shall comply with Subsection 1003.09 or the following, unless otherwise specified on the plans.

(b) General Requirements: Unsuitable material defined in Subsection 203.04 shall not be entrapped in the embankment. The contractor shall remove any such material at no direct pay.

Surcharge materials shall remain on the embankment for at least the specified number of days after approval of the increment. Damage to embankment increments due to the contractor's operations shall be

satisfactorily repaired by the contractor at no direct pay. The contractor will be permitted to remove excess surcharge materials after the surcharge period. Verification cross sections of the final embankment will be taken after removal of the surcharge. The Department will assume liability for subsidence after these cross sections are taken. After all embankment increments have been surcharged, excess surcharge material shall be satisfactorily disposed of in accordance with Section 202.02 at no direct pay.

Except for shell or stone embankments, the contractor shall furnish and place a plastic soil blanket complying with Subsection 203.10.

(c) Nonplastic Embankment Construction: Nonplastic embankments shall be constructed by mechanical methods.

Unless otherwise shown on the plans, material shall be placed in lifts not exceeding 15 inches (375 mm) uncompacted thickness after establishing a working table as directed. Each lift shall be compacted and tested in accordance with Subsection 203.07.

(d) Blended Calcium Sulfate Embankment Construction: Water shall be added or other suitable means shall be taken to prevent dust resulting from the transporting and placing of dry material. Blended embankment material shall be placed in lifts not exceeding 12 inches (300 mm) in thickness (loose) after establishing a working table as directed. Each lift shall be compacted to at least 95 percent of maximum dry density prior to placement of subsequent lifts. The maximum density shall be determined in accordance with DOTD TR 418 modified to include a drying temperature not to exceed 140°F (60°C). Field density testing shall be in accordance with Subsection 203.07 except that moisture content determinations for density corrections shall be determined by oven drying the material at 140°F (60°C) for a minimum of 24 hours. A forced draft type oven capable of maintaining this temperature shall be provided by the contractor. The contractor shall furnish and place a plastic soil blanket complying with Subsection 203.10.

Blended calcium sulfate shall not be placed within 10 feet (3.0 m) of metal drainage structures. The contractor will be allowed to substitute natural stone, flowable fill under Section 710, or other material in Subsection 1003.08 as approved by the Department.

203.10 PLASTIC SOIL BLANKET. Plastic soil blanket shall consist of soils having a minimum PI of 11, maximum PI of 35, a maximum silt content of 65 percent, and a pH not less than 5.5 or greater than 8.5, and a minimum organic content of 3 percent. The contractor will be allowed to

blend organic materials to achieve the minimum 3 percent organic content. The plastic soil blanket shall support a satisfactory stand of grass in accordance with Sections 714 or 717. The minimum thickness of the soil blanket will be 12 inches (300 mm). Areas requiring a plastic soil blanket shall be approved prior to placement of the plastic soil blanket. After materials are placed and spread, lumps, stones, roots and other foreign matter shall be removed from the area. Soil blanket material shall be spread and rolled in a manner that leaves a uniform surface. Any remaining ridges or grooves, including cleat tracks from the dozer, will be parallel to the roadway during the period of time between placement and seeding.

Plastic soil blanket shall be placed in a timely manner to prevent erosion.

203.11 GEOTEXTILE FABRICS.

(a) General: This work consists of furnishing and placing geotextile fabric in accordance with these specifications and in conformance with the details shown on the plans.

(b) Materials: The geotextile fabric shall comply with Section 1019.

(c) Construction Requirements: Rolls of geotextile fabric shall be kept covered and protected from ultraviolet degradation at all times until use. Geotextile fabric that has been installed shall be covered with embankment within 7 calendar days. When ultraviolet damage occurs, the geotextile fabric shall be removed and replaced. The geotextile fabric shall be placed at the locations shown on the plans or as directed. Adjacent rolls of geotextile fabric will be overlapped or sewn. When rolls are overlapped, the overlap shall be a minimum of 18 inches (450 mm), or as specified in the plans, including the ends of the rolls. The top layer of the geotextile fabric shall be parallel with adjacent rolls and in the direction of embankment placement. When rolls are sewn, the contractor shall join adjacent rolls by sewing with polyester or kevlar thread. Field sewing shall employ the "J" seam or "Butterfly" seam with the two pieces of geotextile fabric mated together, turned in order to sew through 4 layers of fabric and sewn with 2 rows of Type 401, two-thread chain stitch. Factory seams other than specified may be submitted to the Materials and Testing Section for approval. Where the ground is covered with water or soil is saturated, sewing of the geotextile fabric will be required.

The geotextile fabric shall be placed as smooth as possible with no wrinkles or folds, except in curved road sections. For curved road sections, the geotextile fabric shall be folded to accommodate the curve. The fold

shall be in the direction of construction and pinned or stapled. Ruts that occur during construction shall be filled and compacted prior to placement of geotextile fabric.

Damaged geotextile fabric shall be either removed and replaced with new geotextile fabric or covered with a second layer of geotextile fabric extending 2 feet (0.6 m) in each direction from the damaged area.

203.12 QUALITY CONTROL. The contractor shall locate, select, and place material conforming to specification requirements. The contractor shall control his processes, including performing tests and making adjustments as necessary, to result in a uniform quality product meeting all the requirements of the plans and specifications. Tests for in-place moisture content shall be performed by the contractor in accordance with DOTD TR 403, at a frequency that will ensure that the material is within the tolerances of optimum moisture. Tests for in-place density shall be performed by the contractor in accordance with DOTD TR 401 at a frequency that will ensure that the compactive effort is producing a uniform product that conforms to specification requirements. The contractor shall control placement and finishing to ensure conformance with the lines, grades, thickness, and typical cross-sections shown on the plans or established.

Sections will be inspected prior to acceptance testing. Obviously deficient areas shall be corrected prior to acceptance testing.

203.13 ACCEPTANCE. The Department will perform inspection, sampling, and testing for acceptance. Any area that is deficient will require correction whether identified by inspection or testing.

The embankment (with surcharge, if required) will be approved in increments of 1,000 feet (300 m), except terminal increments which may be less than 1,000 feet (300 m).

Maximum density for earthwork will be determined in accordance with DOTD TR 415 or DOTD TR 418; in-place density will be determined in accordance with DOTD TR 401.

203.14 MEASUREMENT.

(a) General: Unless otherwise specified, borrow material in accordance with 203.05 and plastic soil for slopes in accordance with 203.06(f) will be considered incidental to the embankment and will not be measured separately, but will be measured as embankment.

Measurement of undercut will be from subgrade or original ground, whichever is lower.

No measurement will be made for excavation for culverts or culvert headwalls.

When the grade line of a pipe or box culvert is raised or lowered more than 2 feet (0.6 m) from the grade line shown on the plans or is relocated to a site requiring an equivalent change in excavation, payment will be increased or decreased accordingly at the rate of three times the contract unit price for General Excavation (or Embankment if General Excavation is not a contract pay item). The volume to be used in the increase or decrease will be a rectangular solid the length of the pipe or box culvert, the outside width of the pipe or box culvert plus 3 feet (1.0 m), and the average change in invert elevation minus 2 feet (0.6 m).

(b) General Excavation, Embankment and Nonplastic Embankment:

The measurement of quantities will be computed by the average end area method and will be that area bound by (1) the original ground line established by location (plan) cross sections (if accurate) or new original cross sections obtained by the contractor, and (2) the final theoretical pay line as shown on the plans, or established by the engineer, adjusted for field changes.

After clearing and grubbing operations, the contractor will take original cross sections for the entire length of the project. All original cross sections shall be taken in the presence of a designated DOTD employee. Cross sections shall be taken at sufficient intervals to accurately determine earthwork quantities, not to exceed 100 linear feet (30 lin m). The cross sections shall be taken in accordance with DOTD procedures, and results must be furnished to the Department in a format satisfactory to the engineer. The Department reserves the right to take additional cross sections as needed to verify the contractor's cross sections. In the event the cross sections do not verify, the contractor will investigate and reconcile any differences.

The original cross sections will be used to determine the accuracy of the location cross sections by using random sections not farther apart than 1000 linear feet (300 lin m) and centerline elevations at intervals of 100 linear feet (30 lin m). The location cross sections will be considered to be usable if the average of the differentials do not exceed ±0.3 foot (±0.1 m). For significant portions of the project with obvious errors between location and original cross sections, the contractor's original field cross sections will

be used, and will not be part of the verification process. In all cases where location sections are unavailable, new originals are to be taken and used.

The final theoretical pay line shall be derived from the profile grade, typical section and ditch grades shown in the plans, along with approved plan changes and other field changes made by the engineer. No increase in quantities will be authorized for overbuilding unless directed by the engineer.

Pay lines for surcharged embankments will be the theoretical surcharge lines shown on the plans. No measurement will be made for removing and disposing of excess surcharge materials.

When payment is made for embankment in its final position, no additional quantity will be measured due to settlement, compaction, erosion or other cause.

Excavation and embankment for crossovers, turnouts, driveway approaches or other minor installations will not be included in the measurement.

A depth and width tolerance of ±1.5 feet (±0.5 m) will be allowed for excavation of unsuitable material. Overdepth and overwidth will be waived at no direct pay; however, no measurement for payment will be made for additional embankment material required to backfill areas beyond theoretical unsuitable material lines.

Measurement will be made by one or more of the following methods:

(1) Plan Quantity: The quantities of excavation and embankment will be those shown in the plans, provided the project is constructed essentially to the theoretical pay line.

When the plans have been revised or when disagreement exists between the contractor and the engineer as to the accuracy of the plan quantities for the entire project, or any substantial portion thereof, either party may require that quantities be revised. The party requesting the revision will be responsible for isolating and detailing the error in an easily understood format which may include cross sections, sketches, and computations. The revision will be verified and agreed to by the other party.

No payment will be made to the contractor to recompute new plan quantities.

(2) Final Field Cross Sections: When payment lines are not shown on the plans and cannot be established, in lieu of final theoretical pay lines, final field cross sections will be used to determine pay quantities for excavation and embankment.

(c) Drainage Excavation: After completion of excavation operations at each individual location, measurement will be made in

accordance with Subsections 203.14(b)(1) or 203.14(b)(2). Elevations for underwater excavation will be determined in accordance with DOTD TR 426.

(d) Excavation and Embankment:

(1) Linear Measurement: When excavation or embankment is to be measured on a linear basis, the length will be measured along the centerline or the baseline used in the plans and includes performing the excavation, embankment and grading work necessary for construction of the project. It is the contractor's responsibility to determine quantities of earthwork necessary to complete this item.

(2) Lump Sum Measurement: When excavation and embankment is to be measured by the lump sum, this item includes performing the excavation, embankment, and grading work necessary for construction of the project. It is the contractor's responsibility to determine the correct quantities of earthwork required to complete this item. No adjustment in contract price will be made.

(e) Borrow (Vehicular Measurement): The material will be measured by the cubic yard (cu m) in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

(f) Geotextile Fabric: Geotextile fabric will be measured by the square yard (sq m) of covered area in place.

203.15 PAYMENT. Payment for the accepted quantities will be made at the contract unit prices which includes furnishing the equipment, labor and materials necessary to complete the items.

Payment for roadway obliteration will be made under appropriate roadway removal and excavation items. Existing asphaltic pavement, 5 inches (125 mm) thick or less, will be paid for as general excavation. Removal of asphaltic pavement greater than 5 inches (125 mm) thick will be paid for under Section 202. Blading and shaping to drain will be considered incidental and will not be measured for pay. Excavation, other than blading and shaping, generally over 1 foot (0.3 m) in depth over a substantial area, will be paid as general excavation for the full depth of cut.

Payment for undercut will be as general excavation, and payment for required backfill will be made as embankment. In cases when undercut operations are separate from normal earthwork and separate records can be kept, undercut may be paid in accordance with Subsection 109.04 when requested by the contractor in advance, or if the project engineer has sufficient records, without an advance request.

Plastic soil blanket will be included in the pay volume for the embankment.

No direct payment will be made for acquisition of borrow materials outside the right-of-way; acquisition of right-of-way and constructing haul roads; stockpiling and rehandling of materials; precautionary measures to protect private property and utilities; or furnishing necessary water and watering equipment.

Excavation for plastic soil blanket in cut sections, when required, will be made as general excavation and payment for the required plastic soil blanket will be made as embankment.

Payment will be made under:

Item No.	Pay Item	Pay Unit
203-01	General Excavation	Cubic Yard (Cu m)
203-02	Drainage Excavation	Cubic Yard (Cu m)
203-03	Embankment	Cubic Yard (Cu m)
203-04	Nonplastic Embankment	Cubic Yard (Cu m)
203-05	Excavation and Embankment	Lump Sum
203-06	Excavation and Embankment	Linear Foot (Lin m)
203-07	Borrow (Vehicular Measurement)	Cubic Yard (Cu m)
203-08	Geotextile Fabric	Square Yard (Sq m)

Section 204
Temporary Erosion Control

204.01 DESCRIPTION. This work consists of constructing and maintaining temporary erosion control features shown on the plans or as directed. Installation of temporary erosion control features shall be coordinated with construction of permanent erosion control features to the extent necessary to ensure economical, effective and continuous control of erosion and water pollution throughout the life of the contract.

The contractor shall comply with a Storm Water Pollution Prevention Plan (SWPPP) approved by the Department when conducting clearing or earthwork operations. The SWPPP shall include the erosion control features as shown on the plans, or as directed, in addition to other required components of the SWPPP specified by the US Environmental Protection Agency (EPA) and the Louisiana Department of Environmental Quality (LDEQ). The plan shall indicate the use of contract items and the coordination of this work with the scheduling of clearing and earthwork.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

204.02 CONTROL OF ERODIBLE SOIL.

(a) General: The contractor shall prevent the transmission of soil particles into streams, canals, lakes, reservoirs or other waterways.

Except as necessary for construction, excavated material shall not be deposited into streams or impoundments, or in a position close enough to be washed in waterways by high water or runoff.

The contractor shall not disturb lands or waters outside the limits of construction, except as authorized.

(b) Adjacent to Waterways: Stream banks shall be kept in their natural state. The contractor shall not unnecessarily strip protective vegetation in the vicinity of stream banks and shall conduct operations without damage to banks. Banks shall not be excavated except as shown on the plans or as otherwise approved in writing. Work roads requiring bank cuts shall be approved by the project engineer prior to making such cuts. The banks shall be restored by the contractor to the satisfaction of the project engineer.

(c) Adjacent to Property: The location of, and method of operation in, borrow pits, material pits and disposal areas obtained by the contractor for waste material from the project (other than commercially operated sources) shall be the contractor's responsibility.

204.03 MATERIALS. Materials not covered by project specifications shall meet commercial grade standards and shall be approved before being incorporated into the project. No testing of materials used in temporary erosion control features will be required. Acceptance of temporary erosion control materials will be by visual inspection.

(a) Mulches: Mulch shall comply with Subsection 1018.19 and emulsified asphalt shall conform to Section 1002.

(b) Seeding: Grass shall be an approved quick-growing species suitable to the area, providing a temporary cover which will not compete with permanent grasses. Rye grass is the only acceptable grass for winter cover.

(c) Slope Drains: Slope drains may be constructed of pipe, fiber mats, rubble, portland cement concrete, asphaltic concrete, plastic sheets or other acceptable material.

(d) Fertilizer: Fertilizer shall comply with Subsection 1018.16.

(e) Silt Fencing: Silt fencing shall be wire-supported or self-supported systems. Other silt fencing systems may be used when approved.

(1) Wire-Supported: Wire-supported silt fencing shall consist of standard woven livestock wire, and minimum of 14-gage (2.0 mm diameter) wire, a minimum of 36 inches (900 mm) in height with a maximum wire spacing of 6 inches (150 mm). Posts shall be either wood or steel installed a minimum of 2 feet (0.6 m) in the ground. Filter material shall be burlap weighing approximately 7 1/2 ounces per square yard (0.25 kg per sq m), approved jute fabric or approved geotextile fabric. Geotextile fabric shall comply with Section 1019, Class F.

(2) Self-Supported: Self-supported silt fencing shall consist of an approved geotextile fabric suitably attached to posts of either wood or steel installed in accordance with plan details. Geotextile fabric shall comply with Section 1019, Class G.

(f) Lime: Agricultural lime shall comply with Subsection 1018.17.

(g) Temporary Construction Entrance: Temporary construction entrances shall consist of stone or recycled portland cement concrete complying with Subsection 711.02, 2 lb (1 kg) class placed on geotextile fabric complying with Section 1019, Class D. The geotextile fabric

underliner shall be placed at the locations designated for temporary construction entrances before stone or recycled portland cement concrete is placed. The stone or recycled portland cement concrete shall be placed and compacted to the required thickness as directed. This work also includes additional measures required to remove mud from truck tires, such as wash racks, etc.

(h) Hay Bales: Hay or straw bales shall be rectangular bales, acceptable to the project engineer. The average length of bales shall be 34 inches (850 mm) minimum.

204.04 EXPOSURE OF ERODIBLE EARTH. The engineer may direct the contractor to provide immediate permanent or temporary erosion or pollution control measures to prevent contamination of streams, lakes, tidal waters, reservoirs, canals or other impoundments or prevent detrimental effects on property outside the right-of-way and damage to the project. Limitations of areas in which excavation and embankment operations are underway shall be commensurate with the contractor's capability and progress in keeping finish grading, temporary erosion control, and permanent erosion control measures in accordance with the accepted schedule.

204.05 INCORPORATION OF EROSION CONTROL FEATURES. Use of temporary erosion control features will be authorized to correct unforeseen conditions that develop during construction; to control erosion prior to the time it is practical to construct permanent control features; or to provide immediate temporary control of erosion that develops during normal construction operations but is not associated with permanent erosion control features. Permanent erosion control features shall be incorporated into the project at the earliest practical time.

Temporary erosion control features will be used as directed in areas where stage construction or other conditions not under control of the contractor preclude completion of a section of roadway in a continuous manner, or where subsequent construction operations will cause damage to permanent erosion control features.

204.06 CONSTRUCTION REQUIREMENTS. Temporary erosion control features shall consist of, but not be limited to, temporary seeding, temporary mulching, sandbagging, slope drains, sediment basins, sediment check dams, erosion checks, artificial coverings, berms, and stone entrances. The engineer may direct use of temporary erosion control

features or methods other than those included in the original contract. Soil deposits outside the right-of-way shall be immediately removed and the surface repaired at no direct pay. The engineer shall have the authority to require the contractor's operations to be discontinued until erosion deposits have been cleared and the area restored.

(a) Temporary Seeding: Seeding shall be done in accordance with Section 717, except that ground preparation will be limited to blading the area. Lime or fertilizer shall be applied in accordance with Section 718; however, lime or fertilizer may be omitted or the application rate reduced as directed.

(b) Temporary Mulching: Mulch and emulsified asphalt shall be furnished and applied in accordance with Section 716. Mulch may be omitted or the application rate reduced as ordered. When permanent seeding operations begin, temporary mulch materials shall be plowed under during ground preparation.

(c) Sandbagging: Sandbags shall be placed as directed.

(d) Baled Straw or Hay: Baled straw or hay shall be placed as directed to form checks or dams to control erosion and siltation. Bales shall be properly staked or otherwise secured as directed, as shown on the plans. The bales shall be buried as necessary to prevent scour under the bales. A minimum of 2 stakes shall be driven through each bale.

(e) Slope Drains: Slope drains shall be constructed with acceptable materials in accordance with plan details or as directed, if necessary to prevent scour. The discharge area shall be stabilized or protected by temporary riprap as directed. Cost of discharge area protection will be included under the slope drain item.

(f) Sediment Basins: Sediment basins shall be constructed in accordance with plan details or as directed.

(g) Sediment Check Dams: Check dams shall be constructed at locations shown on the plans or as directed. Check dams shall be constructed before clearing and grubbing or grading in the area is begun unless otherwise directed.

(h) Silt Fencing: Silt fencing shall be furnished and constructed at designated locations or other locations, as directed by the engineer.

(i) Berms: Earth berms shall be constructed as directed to divert the flow of water from erodible surfaces.

(j) Unforeseen Conditions: When unforeseen conditions are encountered, the engineer may direct the contractor to construct such temporary devices as required to control erosion during construction. Details may be developed jointly by the engineer and the contractor.

(k) Maintenance of Erosion Control Features: The contractor shall install, construct, repair, and maintain temporary erosion control features within 7 calendar days of being instructed to do so by the project engineer. Temporary erosion control features shall be inspected at least once every 14 calendar days and within 24 hours after a rainfall event of 0.5 inches or greater. The features are to be maintained as described below or replaced as directed at no direct pay.

(1) Temporary Seeding: The seeded areas showing erosion after inspection shall be reseeded if necessary.

(2) Mulches: Mulched areas showing erosion shall be repaired and the mulch reapplied if necessary.

(3) Straw or Hay Bale Barriers: The bale barriers shall be inspected after each rainfall and time frame as defined above and at least daily during prolonged rainfall. Close attention shall be paid to the repair of damaged bales, "end runs" and undercutting beneath bales.

(4) Slope Drains: Slope drains shall be inspected weekly and after each rainfall as defined above, and repairs made if necessary. The contractor shall avoid the placement of any material on and prevent construction traffic across the slope drain.

(5) Sediment Check Dams: Sediment deposits shall be removed when the deposits reach one-half the height of the check dam. Inspections shall be made to insure that the center of the dam is lower than the edges. Erosion around the edges shall be corrected immediately.

(6) Silt Fencing: Sediment deposits shall be removed when the deposits reach one-half the height of the fence. If the fabric on the silt fence decomposes or becomes ineffective, the fabric shall be replaced promptly.

(7) Temporary Stone Construction Entrance and/or Wash Racks: The construction entrance shall be maintained to allow for removal of mud from the tires. The sediment from the wash rack runoff shall be removed once the wash rack is no longer performing as intended.

(l) Removal of Temporary Erosion Control Features: Temporary erosion control features existing at the time of construction of permanent erosion control features shall be removed or incorporated into the soil in such manner that no detrimental effect will result. The engineer may direct that temporary features be left in place. Sediment in sediment basins, silt fences, check dams, and other catchment areas shall be removed, replaced with acceptable soils in accordance with Subsection 203.06, and compacted as directed at no direct pay.

204.07 PROTECTION DURING SUSPENSION OF OPERATIONS. Prior to the suspension of operations, the contractor shall shape the top of the earthwork in such manner as to permit runoff of rainwater and shall construct earth berms along the top edges of embankments to intercept runoff water. Temporary slope drains shall be provided in the earth berm to carry runoff. When such preventive measures fail, the contractor shall immediately take other action as necessary to prevent erosion and siltation. The engineer may direct the contractor to perform other erosion control work during suspensions of contract time.

204.08 MEASUREMENT. When temporary erosion and pollution control measures are required due to the contractor's negligence or failure to install permanent controls, such work shall be performed by the contractor at no direct pay.

Required temporary erosion and pollution control work which is not due to the contractor's negligence will be measured as follows:

When separate items for temporary erosion control devices are included in the contract, and the work is ordered, the quantities to be paid for will be the weight in pounds (kg) of Temporary Seeding and in tons (Mg) of Temporary Mulching; the volume in cubic yards (cu m) of Sandbagging with the measurement of sand being made in a batch box or other satisfactory means; the number of hay bales placed; the length in feet (m) of Temporary Slope Drains measured along the ground surface and Silt Fencing measured along ground surface between end posts; the number of Sediment Basins and Sediment Check Dams acceptably constructed; the number of gallons (L) of emulsified asphalt, and the number of construction entrances.

Temporary erosion control items may be eliminated when conditions do not justify their use.

When temporary erosion control work is ordered and is not covered by contract items, the work shall be performed as extra work in accordance with Subsection 109.04 except that no extra work order will be required prior to starting work.

The construction of temporary earth berms along edges of the roadway to prevent erosion during grading and subsequent operations will not be measured for payment.

In case of failure of the contractor to control erosion, or siltation, the engineer may employ outside assistance or use his own forces to provide the necessary corrective measures, and the cost thereof will be deducted

from payments for the work. Partial payments will be withheld until satisfactory temporary erosion control is established.

204.09 PAYMENT. Payment for temporary erosion control items that are included as contract items will be made at the contract unit prices. Payment for temporary mulching, emulsified asphalt and seeding will be made under Sections 716 or 717. Temporary erosion control work not covered by contract items that is ordered will be paid for in accordance with Subsection 109.04.

Temporary Sandbagging and Baled Hay or Straw will be paid for directly when used other than in construction of Temporary Slope Drains, Temporary Sediment Basins and Temporary Sediment Check Dams. When sandbags and baled hay or straw are used in construction of slope drains, sediment basins and sediment check dams, payment will be made under these items.

Payment for devices used to correct unforeseen conditions will be made at the contract unit price for similar devices shown on the plans, or as extra work if plan details are not applicable.

Payment will be made under:

Item No.	Pay Item	Pay Unit
204-01	Temporary Sandbagging	Cubic Yard (Cu m)
204-02	Temporary Hay or Straw Bales	Each
204-03	Temporary Slope Drains	Linear Foot (Lin m)
204-04	Temporary Sediment Basins	Each
204-05	Temporary Sediment Check Dams	Each
204-06	Temporary Silt Fencing	Linear Foot (Lin m)
204-07	Temporary Stone Construction Entrance	Each

PART III -- BASE COURSES

Section No. **Page No.**

Section 301
Class I Base Course

301.01 DESCRIPTION. This work consists of furnishing and placing Class I Roadway and Shoulder Base Courses on a subgrade layer conforming to Section 305 in accordance with these specifications and in conformance with the lines, grades, thicknesses and typical cross sections shown on the plans or established. The contractor shall control the selection, placement, mixing and compaction of materials so that the completed base course is uniform and conforms to plan dimensions and other acceptance requirements.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankments and Base Course."

When not specified, any of the following types may be used.

(1) Soil Cement
(2) Stone or Crushed Slag
(3) Cement Stabilized Sand-Clay-Gravel
(4) Asphaltic Concrete Base Course on Treated Layer
(5) Recycled Portland Cement Concrete

The base course shall be a selected base course type required to meet the structural requirements for a specific pavement structure. Unless approved in writing, the same type of Class I Base Course shall be used throughout the project.

With concurrence of the project engineer, concrete complying with Section 901, or asphaltic concrete base course complying with Section 502, may be used in lieu of the specified base course material, on an inch (mm) for inch (mm) basis, in areas inaccessible to compaction equipment in turnouts and crossovers, and in other isolated or irregular areas. Concrete shall be placed, consolidated, finished and cured as directed in accordance with Section 706.

301.02 MATERIALS. Materials shall comply with the following Sections and Subsections and requirements.

Asphaltic Concrete	502
Portland Cement Concrete	901
Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Emulsified Asphalt	1002
Asphalt Materials	1002
Sand-Clay-Gravel	1003.01 & 1003.03(a)
Stone	1003.01 & 1003.03(b)
Recycled Portland Cement Concrete	1003.01 & 1003.03(c)
Crushed Slag	1003.01 & 1003.03(d)
Water	1018.01

(a) Soils for Soil Cement: Soils for soil cement base course shall consist of materials that will stabilize with cement in accordance with DOTD TR 432. Such materials are those soils classified as A-1-a, A-1-b, A-2-4, A-2-6, A-4 and A-6 in accordance with DOTD TR 423. Soil with a Liquid Limit greater than 35, a Plasticity Index greater than 12, or an organic content greater than 2 percent shall not be used. Liquid Limit and Plasticity Index will be determined in accordance with DOTD TR 428. Organic content will be determined in accordance with DOTD TR 413. Soil with over 79 percent sand or 60 percent silt when tested in accordance with DOTD TR 407, shall not be used. Soils which do not meet any of these requirements shall not be blended or treated. Topsoil shall not be used. The contractor shall obtain the material to be stabilized from outside right-of-way limits except as provided in Subsection 106.02(c).

(b) Portland Cement: Portland cement shall be Type I or II. The quantity of cement used shall be supported by Certificate of Delivery.

(c) Portland-Pozzolan Cement: The cement shall be Type IP. The quantity of cement used shall be supported by Certificate of Delivery.

(d) Asphaltic Concrete Base Course: The material requirements for asphaltic concrete base course shall be as described in Section 502.

(e) Treated Layer Under Asphaltic Concrete Base Course: The treated layer under asphaltic concrete shall consist of the same material and treatment as the top layer of embankment, including the prime coat requirements. No raw, untreated material shall be placed between a treated embankment and the asphaltic concrete.

301.03 EQUIPMENT. Equipment shall be approved prior to use.

(a) Soil Cement and Cement Stabilized Sand-Clay-Gravel:

(1) General: Central mix plants shall be certified in accordance with current Department procedures. Central mix plants may be either batch or continuous mix process and shall proportion aggregates, soils, and additives in a manner that will meet specification requirements. Safe, convenient facilities shall be provided for sampling mixture components prior to their introduction into the weigh hopper or pugmill. Mixing units shall have no dead areas which allow materials to remain unmixed or which permit improperly mixed materials to be discharged into hauling or storage units. The minimum capacity shall be 100 tons per hour (90 Mg/hr).

A control system shall be provided that will automatically stop plant operations when the material in any storage facility or working bin becomes empty or the flow of material is interrupted. The plant will not be permitted to operate unless this automatic control system is in good working order. When this control system malfunctions during production, operations shall be immediately discontinued.

The soil or aggregate feeder system shall be interlocked with the feeder system for cement, additives, and water such that the proportions of the components of the approved mix design are continuously maintained.

The complete process, including the plant with necessary auxiliary equipment and controls, operating procedures, and sampling and testing methods shall be approved by the Department prior to use. Any modifications to plant equipment or operations shall be approved prior to use.

The contractor shall provide plant site and project site laboratories conforming to Section 722 at no direct pay.

Measuring devices shall be subject to approval and shall be tested, inspected and certified by an approved independent scale service or the Weights and Measures Division, Louisiana Department of Agriculture and Forestry, at no direct pay, every 90 days or as often as deemed necessary to ensure their accuracy.

Scales shall be accurate to ±0.5 percent throughout the range of use. Maximum graduation on scales shall be 0.1 percent of the rated scale capacity.

The cement, soil and aggregate feeders, and water measuring devices shall be equipped with devices by which the rate of feed can be determined while the plant is in operation.

Water measuring devices shall be accurate to 1 percent of the metered quantity. Water meters shall have a maximum graduation of 1 gallon (4 L).

Methods and equipment for adding liquid additives shall be approved. Equipment for metering additives shall be capable of measuring the component to an accuracy of 3 percent of the required weight.

(2) Batch Process: When a batch mixing process is used, the mixer shall be equipped with a timing device which will indicate by an obvious signal the completion of the mixing period. The time of mixing a batch shall begin after all components are in the mixer and shall continue until the mixture is uniformly blended. The mixing time shall be approved. Cement for each batch shall be weighed on scales separate from those weighing other components and shall meet the requirements of this subsection.

(3) Continuous Mix Process: When a continuous mix operation is controlled by weight (mass), the contractor shall provide belt scales for conveyor systems for all components except water.

(4) Hauling Equipment: The mixture shall be hauled from the plant in approved covered trucks that will maintain the moisture content and prevent segregation and the loss of fine material. The cover shall be waterproof, shall completely cover the bed of the truck, shall be equipped with tie downs, and shall not have any rips, tears or holes.

(5) Compaction Equipment: Compaction equipment shall be conventional sheepsfoot type roller or a self-propelled tamping foot compactor-type roller for initial compaction. The spikes shall be sufficient in size and number to provide uniform compaction for the full width and depth of the base course. Finish rolling shall be with a pneumatic tire roller. For depths over 9 inches (225 mm), the contractor shall establish a rolling pattern to obtain the required density. Based on these results, the Department may allow 1 lift construction. Otherwise, lift thickness will be 9 inches (225 mm) maximum.

(b) Asphaltic Concrete: Equipment for asphaltic concrete shall conform to Section 503.

(c) Stone, Crushed Slag, and Recycled Portland Cement Concrete: Equipment used to mix stone, crushed slag, and recycled portland cement concrete shall produce a uniform blend conforming to the requirements elsewhere herein. When a central mix plant is used, it shall conform to Heading (a).

(1) Hauling Equipment: Stone, crushed slag, and recycled portland cement concrete shall be hauled in trucks with tight, smooth beds of sufficient size and condition to prevent segregation and the loss of material.

(2) Compaction Equipment: Stone and recycled portland cement concrete compaction equipment shall be designed for the compaction of these materials and may be static or vibratory. Finish rolling shall be with static, smooth steel-wheel or pneumatic tire rollers. Pneumatic tires shall have smooth tread, shall be the same size and ply rating, shall be inflated to a uniform pressure not varying more than ±5 psi (±35 kPa) between tires. Wheels shall not wobble and shall be aligned such that gaps between tires on one axle are covered by tires of the other axle.

(d) Automatic Finishing Machine: For all Class I Base Courses except asphaltic concrete an approved automatic finishing machine shall be used. The approved automatic finishing machine shall be capable of operating from an erected stringline capable of automatically controlling grade and cross-slope conforming to Subsection 502.08(b)(2).

301.04 STORAGE AND HANDLING OF MATERIALS PRIOR TO MIXING. Stockpiles of materials shall be uniform; separation into material sizes may be required. Equipment and methods for stockpiling shall be such that no segregation will result. Foreign material shall not be incorporated into the materials. Materials, which have become contaminated, shall not be used. Stockpiles shall be of uniform moisture content and well drained.

Soils and aggregates shall be stockpiled in dedicated stockpiles and shall be approved prior to mixing with cement. The moisture content of the stockpiles shall be controlled so that the blended mixture when tested in accordance with DOTD TR 403 shall be within ±2.0 percent of the optimum moisture content at the time of compaction. Storage facilities containing soil or fine aggregate shall be equipped with vibrators which will effectively vibrate the side walls of the feeder, prevent any accumulation of material and ensure a constant, uniform supply of material to the mixing unit.

(a) Storage of Cement: Cement shall be transported in watertight conveyances and stored in watertight buildings, silos or other approved facilities to protect the cement from dampness or water intrusion. Cement which has become contaminated, partially set, or which contains lumps of caked cement will be rejected.

Cement shall be certified by the manufacturer in accordance with the Department's current procedure. The contractor shall keep accurate records of cement deliveries and its use. Copies of these records shall be supplied to the engineer as required.

(b) Soils for Soil Cement: Soils for soil cement shall be one or more components, each meeting the requirements of Subsection 301.02(a).

(c) Sand-Clay-Gravel: Sand-clay-gravel for cement stabilized sand-clay-gravel-shall be a single component which meets the requirements of Subsection 1003.03(a) or multiple components which, when combined, meet the requirements of Subsection 1003.03(a). The single component material or each separate component of a composite material shall be sampled, tested and approved prior to mixing with cement.

(d) Asphaltic Concrete: Asphaltic concrete shall be stored and handled in accordance with Section 502.

(e) Stone, Crushed Slag, and Recycled Portland Cement Concrete: Stone, crushed slag, and recycled portland cement concrete base courses shall be sampled, tested, and approved from dedicated stockpiles prior to placement on the subgrade.

301.05 GENERAL CONSTRUCTION REQUIREMENTS. Class I Base Courses shall be placed on a subgrade layer prepared in accordance with Section 305.

(a) Cement Stabilized Base Course: All cement stabilized base courses shall be mixed in a central mix plant conforming to Subsection 301.03. The percentage of cement for soil cement will be determined in accordance with DOTD TR 432 prior to mixing. Samples for determination of the percent cement will be obtained from material in stock piles. For cement stabilized sand-clay-gravel, the minimum cement content shall be 5.0 percent by weight (mass) if Type I cement is used. Depending on the type of cement and soil or soil-aggregate to be used, normal testing time to determine suitability of the soil and the required cement content may require up to 21 calendar days. The cement content using Types II and I-P cement will be determined in accordance with DOTD TR 432 for sand-clay-gravel.

(b) Asphaltic Concrete: Asphaltic concrete base course shall be constructed in accordance with Section 502. The treated layer under asphaltic concrete base course shall be constructed in accordance with Section 305.

(c) Stone, Crushed Slag, and Recycled Portland Cement Concrete: Stone, crushed slag, and recycled portland cement concrete base courses shall not segregate during construction. Water added to facilitate compaction shall not cause moisture damage to the subgrade layer.

301.06 MIXING OF SOIL CEMENT AND CEMENT STABILIZED SAND-CLAY-GRAVEL. Soil cement, and cement stabilized sand-clay-gravel materials shall be mixed in a central mix plant by either batch or continuous mixing process. Soils, aggregates, additives, and water may be proportioned by either weight (mass) or volume. The plant shall be calibrated by weight (mass) and equipped with a means to readily verify the quantity of each component. The time and points at which each component is introduced into the mixing process will be approved. The components shall be combined and mixed to produce a uniform, well-blended mixture. The total quantity of materials introduced into the mixing unit shall not exceed the approved capacity of the mixer.

When a continuous mix process is used, soils and aggregates shall be drawn from the storage area by a feeder or feeders which will continuously supply the correct amount of soil or aggregate in proportion to the cement. Soil and aggregate storage areas or feed bins shall be arranged so that the proportion of each size can be separately adjusted if more than one size is used.

Individual aggregates and soils shall be blended within 2 percent of the individual weight (mass) of that component and the total weight (mass) of aggregate and soils shall be within 1 percent of the required weight (mass) of the total material. Cement shall be incorporated within 1.0 percent of the required weight (mass) of cement.

Optimum moisture of the mixture will be determined in accordance with DOTD TR 415 or TR 418. The percentage of moisture in the mixture, by dry weight, shall not vary from optimum moisture within ±2.0 percent at the time of compaction. Moisture content at the time of mixing shall be controlled so that these tolerances are met. When these tolerances are not met and satisfactory control adjustments are not being made, operations shall be discontinued until proper adjustments and uniform operations are established.

301.07 QUALITY CONTROL OF PLANT OPERATIONS. The contractor shall have a Certified Soil and Base Course Technician at the plant at all times when the plant is producing material for the Department.

The Certified Soil and Base Course Technician shall be capable of conducting any test or analysis necessary to put the plant into operation and producing cement stabilized mixtures conforming to the specifications. Daily plant operations shall not begin unless the Certified Soil and Base Course Technician is at the plant. The Soil and Base Course Technician

certification will be awarded by the Department upon satisfactory completion of the Department's requirements.

(a) Soil Cement and Cement Stabilized Sand-Clay-Gravel: The contractor shall be responsible for quality control of materials during handling, storing, blending, mixing, and transport. The contractor shall be responsible for adjusting equipment to provide the approved percent of each component in the mixture at optimum moisture content. The contractor shall provide suitable equipment for the determination of moisture content, gradation, proper pulverization, and proper combination of components as required.

The contractor shall be responsible for building and maintaining stockpiles of soils and aggregates which meet Department requirements and shall perform testing as necessary to ensure that materials delivered to the plant site meet the Department's specifications prior to requesting acceptance sampling and testing. The contractor shall be responsible for maintaining the quality of materials placed in dedicated stockpiles which have been approved for use. When inspection by the Department indicates contamination or segregation of dedicated stockpiles, the affected materials will be rejected and shall be removed from the dedicated stockpile. Materials shall be sampled, tested and approved by the Department prior to inclusion in an approved dedicated stockpile.

Water shall be incorporated into the mixing chamber through a multi-nozzle spray bar capable of spraying water uniformly, leaving no wet or dry areas. Water shall be added after mixing soils, soil aggregates, and cement.

The contractor's Certified Soil and Base Course Technician shall continually monitor plant operations to ensure that systems are functioning properly and that the proportions of materials are correct. At the beginning of each day's operation, and at least four times daily during continuous operation, the contractor shall check the percent cement being incorporated into the mixture. The contractor's Certified Soil and Base Course Technician shall test for moisture content of the soil or aggregate components in accordance with DOTD TR 403 at the beginning of each day's operations and at least twice per day during continuous operation. The contractor's Certified Soil and Base Course Technician shall test the moisture content of the mixture including the cement, as needed, to control the finished product within specification requirements. When a composite gradation is specified for the soil or aggregate material, gradation shall be checked at least twice per day in accordance with DOTD TR 112 and TR

113. Tests shall be documented in accordance with the Department's current procedures.

The contractor's Certified Soil and Base Course Technician shall check the percent pulverization in accordance with DOTD TR 431 at least twice per day. At least 80 percent shall pass the No. 4 (4.75 mm) sieve.

When any quality control test does not meet the applicable specifications, the contractor shall make immediate corrections and notify Department personnel of the change, or the operations shall be discontinued.

(b) Asphaltic Concrete: Asphaltic concrete plant operations shall conform to Section 502.

(c) Stone, Crushed Slag, and Recycled Portland Cement Concrete: When stone, crushed slag, or recycled portland cement concrete are mixed in a central mixing plant, the requirements of Heading (a) shall be met.

301.08 LOADING, TRANSPORTING AND PLACING ON SUBGRADE. The base course materials shall not segregate during loading. Soil cement or cement stabilized sand-clay-gravel mixtures shall be covered immediately with an approved waterproof cover that will prevent loss of moisture or fines or exposure to the elements. The cover shall be tied securely in place and shall not be removed until placement of the mixture.

Transportation, placing and spreading methods shall not damage the subgrade. The contractor shall place and spread sufficient material to obtain required width and compacted thickness within the tolerances set forth in Subsection 301.16. Soil cement and cement stabilized sand-clay-gravel shall be placed and spread within 1 hour of mixing cement with the soils or soil-aggregates. Base course materials shall not be contaminated with subgrade layer. Any contamination will require retesting and correction of deficiencies. Base course material shall not be placed or spread on portland cement concrete or asphaltic concrete pavements. Pavement surfaces, edges and joints shall not be damaged during construction.

301.09 GRADE AND CROSS SLOPE CONTROL. Unless otherwise specified, Class I Base Courses (except asphaltic concrete) shall be constructed to the required grade and cross slope, using an automatic finishing machine controlled from an erected stringline conforming to Subsection 502.08(b)(2). Asphaltic concrete base course shall be

constructed with an erected stringline in accordance with Subsection 502.08(b)(2).

301.10 COMPACTING AND FINISHING.

(a) Soil Cement and Cement Stabilized Sand-Clay-Gravel: The mixture shall be compacted immediately after placement. Initial compaction shall be completed with an approved conventional sheepsfoot-type roller or a self-propelled tamping foot compactor-type roller in such a manner that no internal laminations occur in the completed base course. Final compaction shall be with a pneumatic-tire roller operated so that no surface laminations occur. The surface shall be kept uniformly moist during compaction and shaping.

During the compaction and finishing, areas which are low or have surface imperfections which need correction shall be corrected using fresh material. The surface shall be thoroughly scarified before placing and blending new base material. Final compaction of the corrected surface shall be completed within the same time limit applied to the initial placement of base materials as outlined in this subsection.

Compaction and initial finishing shall be completed within 2 hours after initial mixing of cement with base course materials. Each lift of base course shall meet the requirements of Subsection 301.16. After the base has been compacted, water shall be uniformly applied as needed to maintain the proper moisture content for intermediate finishing (tight blading). The surface shall be thoroughly rolled and finished to grade; loosened material shall be removed from the section. The surface shall be finish rolled with either a pneumatic-tire or static steel-wheel roller to provide a smooth, tightly knit surface conforming to finish grade or slightly higher.

Final finishing shall be with an automatic finishing machine and shall result in a surface free of cracks, ridges, waves, surface laminations, or loose material. The cross-slope shall not vary by more than ±0.003 ft/ft (±3 mm/m). The grade shall not vary by more than ±0.04 ft. (±12 mm) from plan grade. In areas inaccessible to the automatic finishing machine, final finishing will not be required provided the grade and cross-slope is satisfactory to the project engineer. Final finishing shall be done far enough in advance to allow the Department to perform width and depth check tests.

At places inaccessible to rollers, such as edges adjacent to curb and gutter sections, the mixture shall be compacted using devices that will obtain the specified density without damage to adjacent structures.

Transport vehicles and heavy construction equipment shall not operate on compacted base course for a period of 72 hours after placement.

(b) Asphaltic Concrete Base: Compaction and finishing requirements shall be as follows.

(1) The asphaltic concrete layer shall be compacted and finished in accordance with Section 502. Vibratory rollers will not be allowed when it is detrimental to the underlying layers or areas with high water table.

(2) The treated layer under asphaltic concrete shall meet the requirements of the subgrade layer.

(c) Stone, Crushed Slag, and Recycled Portland Cement Concrete: Compacting and finishing requirements shall be the same as specified in Heading (a), except that the time limitations will not apply. Water added to facilitate compaction shall not damage underlying materials. Vibratory rollers will not be allowed when it is detrimental to the underlying layers or in areas with high water table.

301.11 QUALITY CONTROL OF ROADWAY OPERATIONS. The contractor shall control the selection, placement, compaction, moisture content, density, thickness, width, surface finish, and grade so that the completed base course is uniform and conforms to plan dimensions and other acceptance requirements as provided herein. The base course shall be constructed so that contamination, segregation, soft spots, wet spots, laminations, and other deficiencies are prevented. The contractor shall perform tests to control moisture content, thickness, width and density.

301.12 PROTECTION AND CURING.

(a) Soil Cement, Cement Stabilized Sand-Clay-Gravel, and Treated Layer Under Asphaltic Concrete: Upon completion of intermediate finishing, the base course shall immediately be protected against drying by applying an asphalt curing membrane in accordance with Section 506. Asphalt curing membrane shall be placed on the same day as treatment. Complete coverage of curing membrane shall be maintained from initial application until the placement of the next course. When traffic, including construction equipment, is allowed on the base course, at least the first lift of surfacing shall be placed within 30 calendar days unless otherwise directed.

(b) Stone, Crushed Slag, and Recycled Portland Cement Concrete: The completed base course shall be covered with asphalt prime coat in accordance with Section 505 as soon as practical to prevent water infiltration due to rainfall. Complete coverage of asphalt prime coat shall be maintained from initial application until the placement of the next course. When traffic, including construction equipment, is allowed on the base course, the prime coat application may be delayed. However, the first lift of surfacing shall be placed within 30 calendar days unless otherwise directed.

301.13 CONSTRUCTION JOINTS. On soil cement base courses, each day's construction shall be tied into the completed work of the previous day by a straight transverse construction joint formed by cutting back into the total width of the base to form a true vertical face free of loose and broken material at a point where the base conforms to the typical section shown on the plans.

Longitudinal joints constructed between parallel lanes or similar joints between lanes and ramps, etc., shall be reasonably vertical and free of contaminated loose and/or broken material.

The base at all joints is to be constructed so that the materials at and adjacent to the joint are stable, uniformly compacted and are tightly knit.

301.14 MAINTENANCE OF BASE COURSE. The contractor shall protect the completed base course from damage from public traffic or the contractor's operations, and shall satisfactorily maintain the completed base course including the asphalt curing membrane or prime coat. Damaged base course shall be repaired by the contractor at no direct pay. When patching of the base course is required, in addition to removing damaged or unsound base course, the contractor shall remove a sufficient width and depth of base course to ensure satisfactory placement of patching material. The engineer will approve the type of patching material before use. Patching or other base course repair shall restore a uniform surface, shall conform to the requirements of the material being used, and shall be completed before paving operations begin. Failures detected during paving may be patched as detected.

When maintenance of traffic is not required, neither public traffic nor construction traffic shall be allowed on the completed base course during the 72-hour curing period. When maintenance of traffic is required, both public traffic and construction traffic shall be routed off the completed base

course onto shoulders or other suitable areas during the 72-hour curing period, when conditions permit.

When traffic is permitted to use the completed base course subsequent to the 72-hour curing period and prior to construction of the surface course, the base shall be further protected by additional applications of asphalt curing membrane or prime coat as directed in accordance with Subsection 301.12 at no direct pay.

Prior to surface course construction, the contractor shall correct deficiencies, clean the base course surface, repair any damages caused by traffic, and apply additional asphalt curing membrane or prime coat as directed at no direct pay. This work shall be completed at least 24 hours prior to construction of the next layer.

Any weak spots that develop shall be satisfactorily corrected and the base kept free from deficiencies and true to grade and cross section at no direct pay.

When the surfacing is asphaltic concrete and traffic, including construction equipment, is allowed on the base, the first lift of surfacing shall be placed within 30 calendar days.

301.15 WEATHER LIMITATIONS. Construction of the base course will not be permitted when the subgrade or stockpiles are frozen, when raining, or, in the case of cement treated bases, when the ambient air temperature is below 35°F (2°C), or the temperature is forecasted by the U.S. Weather Service to be 25°F (-3°C) or less within the 24 hour period following placement.

301.16 ACCEPTANCE REQUIREMENTS. Soils and aggregates will be tested for acceptance by the Department prior to the addition to a dedicated stockpile.

Plant operations will be checked for uniformity and the proportioning of the components. The percent cement will be checked at least twice per day in accordance with DOTD TR 436. The percent cement being incorporated into the mixture shall not be more than 0.1 percent by weight (mass) of the total material below the approved percent cement, or operations shall be discontinued until corrections have been made.

The moisture content of the soil cement or cement stabilized mixtures will be tested for conformance to optimum moisture content in accordance with DOTD TR 403 at placement at least twice per day. When the moisture content is not within specification limits, the contractor shall take immediate corrective actions or operations shall be discontinued. When

the moisture content is not within specification limits the in-place material may be required to be removed.

Pulverization of the soil cement or cement stabilized mixtures will be tested in accordance with DOTD TR 431 at the plant at least twice per day. At least 80 percent shall pass the No. 4 (4.75 mm) sieve.

Base courses, except asphaltic concrete, will be checked for determining acceptance in increments of 1,000 linear feet (300 lin m) per roadway or 2,000 linear feet (600 lin m) per shoulder constructed separately. Asphaltic concrete base course will be accepted in accordance with Section 502.

(a) Density Requirements: Upon completion of compaction operations, base course density, except asphaltic concrete, will be determined in accordance with DOTD TR 401. Density requirements of asphaltic concrete base course shall be in accordance with Section 502.

The density requirements for Class I Base Course materials shall be in accordance with Table 301-1.

Table 301-1
Class I Base Course Density

Base Course Type	Maximum Density Test Method	Percent of Maximum Density (Min.)
Soil Cement	DOTD TR 418	95.0
Cement Stabilized Sand-Clay-Gravel	DOTD TR 418	95.0
Stone, Crushed Slag, Recycled Portland Cement Concrete	DOTD TR 418	98.0
Treated Layer Under Asphaltic Concrete	DOTD TR 418	95.0

(1) Soil Cement, Cement Stabilized Sand-Clay-Gravel, and Treated Layer Under Asphaltic Concrete: When the density test value for the section is below 95.0 percent, a payment adjustment will be applied in accordance with Table 301-2.

Table 301-2
Density Acceptance and Payment Schedule

Density Test Value	Percent of Contract Unit Price
95.0 & Above	100
94.0 to 94.9	90
93.0 to 93.9	75
Below 93.0	50 or Remove[1]

[1]At the option of the Department after investigation.

(2) Asphaltic Concrete: The density requirements for asphaltic concrete base course shall be as specified in Section 502.

(3) Stone, Crushed Slag, and Recycled Portland Cement Concrete: When any test value is less than that required in Table 301-1, compaction shall continue until the specified density is obtained.

(b) Thickness Requirements: The thickness of the completed base course will be determined in accordance with DOTD TR 602. The underthickness requirements for asphaltic concrete base course shall be in accordance with Section 502.

Underthickness of base courses, except asphaltic concrete, shall not vary from plan thickness in excess of 1/2 inch (15 mm). Base course thickness deficiencies in excess of this tolerance shall be corrected as specified herein at no direct pay. When reconstruction is used as a method of correction, this tolerance shall apply.

Overthickness may be waived at no direct pay when grade requirements are met. When grade requirements are not met and no grade adjustments are permitted, correction will be required at no direct pay.

Failing areas will be isolated longitudinally for purposes of correction for the entire width.

(1) Soil Cement, Cement Stabilized Sand-Clay-Gravel and Treated Layer Under Asphaltic Concrete: When no grade adjustments are permitted, underthickness deficiencies shall be corrected by removing and replacing the full depth of base course in deficient areas with one of the following materials:

a. The same type of base course.
b. Asphaltic concrete complying with Section 502.
c. Concrete complying with Section 901.

When grade adjustments are permitted, the contractor shall have the option of correcting underthickness deficiencies by furnishing and placing a supplemental layer of asphaltic concrete conforming to Section 502 for the full width of base course in lieu of removing and replacing deficient

base course. Thickness of the supplemental layer of asphaltic concrete shall be in accordance with Table 301-3 as follows.

Table 301-3
Supplemental Asphaltic Concrete Layer Thickness

Underthickness, Inches (mm)	Minimum Thickness of Supplemental Asphaltic Concrete, Inches (mm)[1]
3/4 to 1 1/4 (20 to 35)	1 1/4 (35)
1 1/2 to 1 3/4 (40 to 45)	1 1/2 (40)
2 to 2 1/2 (50 to 65)	2 (50)
Over 2 1/2 (Over 65)	Remove and Replace[2]

[1]May be included in the subsequent lift.
[2]At the option of the Department after investigation.

(2) Asphaltic Concrete Base Course: When grade adjustments are not permitted, underthickness in excess of the tolerances given in Subsection 502.12 shall be corrected to plan thickness by removing and replacing the full depth of base course. When grade adjustments are permitted, underthickness shall be corrected by placing and compacting a 1 1/4-inch (35 mm) thick minimum supplemental layer of asphaltic concrete complying with Section 502 at no direct pay.

(3) Stone, Crushed Slag, and Recycled Portland Cement Concrete: When grade adjustments are permitted, underthickness in excess of 1/2 inch (15 mm) shall be corrected to plan thickness by furnishing, placing, mixing, reworking, shaping, and compacting an additional thickness of the same type of base course material. When grade adjustments are not permitted, the base course shall be removed and replaced.

(c) Width Requirements: The width of the completed base course will be determined in accordance with DOTD TR 602. Roadway base course width shall not vary from plan width in excess of +6 inches (+150 mm). Shoulder base course width shall not vary from plan width in excess of +3 inches (+75 mm). No tolerances are provided for underwidths of shoulder or roadway bases. When the base course for both roadway and shoulders are constructed at the same time, the 6-inch (150 mm) tolerance will be applied. Base course width deficiencies in excess of the above tolerances shall be corrected as follows at the contractor's expense:

(1) Overwidth: Overwidths on all base courses may be waived at no direct pay.

(2) Underwidth: Underwidths of all base courses shall be corrected to plan width by furnishing and placing additional materials; however, the width of widening materials shall be not less than 12 inches (300 mm). The thickness of the widening shall be plan thickness. Materials for widening deficient base course shall be one of the following:

1. The same type of base course.
2. Asphaltic concrete complying with Section 502.
3. Concrete complying with Section 901.

(d) Correction of Other Deficiencies: The contractor shall correct deficiencies in surface finish, grade, contamination, segregation, soft spots, wet spots, laminations and other deficiencies at no direct pay. These deficiencies shall be corrected by removing and replacing or as directed.

(e) Grade and Cross-Slope: The finished grade shall be within ±1/2 inch (±15 mm) of the established grade. The cross-slope shall not vary by more than ±0.003 ft/ft (±3 mm/m).

301.17 MEASUREMENT. The quantities of Class I base course for payment will be the design volumes or areas specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions and theoretical compacted thickness of the completed base course shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary.

301.18 PAYMENT. Payment for Class I Base Course will be made at the contract unit price, adjusted as specified in Subsection 301.16 and the following provisions, which includes furnishing and placing required base course materials, portland cement, portland-pozzolan cement, water, erected stringline, asphalt curing membrane and prime coat.

Failure to add the specified amount of cement in soil cement and cement stabilized sand-clay-gravel will result in a payment adjustment in accordance with Table 301-4 below.

Any payment adjustment in asphaltic concrete shall be in accordance with Section 502 and shall apply to the cubic yard (cu m) total quantity of base course. For other materials, when payment adjustments are made for more than one deficiency, they shall be cumulative.

Table 301-4
Payment Adjustment Schedule

	Percent of Contract Unit Price			
	100	90	80	50 or Remove and Replace[1]
Cement content (Percent by dry weight) less than required	0.0-0.1	0.2-0.4	0.5-1.0	more than 1.0

[1]At the option of the Department after investigation.

Payment will be made under:

Item No.	Pay Item	Pay Unit
301-01	Class I Base Course	Cubic Yard (Cu m)
301-02	Class I Base Course ____in(mm) Thick	Square Yard (Sq m)
301-03	Class I Base Course for Shoulders	Cubic Yard (Cu m)
301-04	Class I Base Course for Shoulders ____in(mm) Thick	Square Yard (Sq m)

Section 302
Class II Base Course

302.01 DESCRIPTION. This work consists of furnishing and placing Class II roadway and shoulder base course on a prepared surface in accordance with these specifications, in conformity with the lines, grades, thickness, and typical sections shown on the plans or established. The contractor shall control the selection, placement, mixing and compaction of materials so that the completed base course is uniform and conforms to plan dimensions and other acceptance requirements.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

When not specified, any of the following types may be used.

(1) Soil Cement
(2) Cement Treated Sand-Clay-Gravel
(3) Stone or Crushed Slag
(4) Asphaltic Concrete Base Course on Embankment Layer
(5) Recycled Portland Cement Concrete

Unless approved in writing, the same base course material shall be used throughout the project.

With approval, concrete complying with Section 901 or asphaltic concrete base course complying with Section 502 may be used in lieu of the specified Class II Base Course material in areas inaccessible to mixing and compacting, in turnouts and crossovers, and in other isolated or irregular areas. Concrete shall be placed, consolidated, finished and cured as directed in accordance with Section 706.

In order to meet air quality standards, the contractor may be required to use central plant mixing of cement treated mixtures in dust sensitive areas at no direct pay. The contractor may use other types of Class II Base Course in dust sensitive areas at no direct pay. The Department will identify the dust sensitive areas in the plans.

302.02 MATERIALS. Materials shall comply with the following Sections or Subsections and requirements.

Geotextile Fabric	203.11 & 1019
Asphaltic Concrete	502
Portland Cement Concrete	901
Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Asphalt Materials	1002
Sand-Clay-Gravel	1003.01 & 1003.03(a)
Stone	1003.01 & 1003.03(b)
Recycled Portland Cement Concrete	1003.01 & 1003.03(c)
Crushed Slag	1003.01 & 1003.03(d)
Water	1018.01

(a) Soils for Soil Cement: Soils for soil cement base course shall consist of materials that will stabilize with cement in accordance with DOTD TR 432. Such materials are those soils classified as A-1-a, A-1-b, A-2-4, A-2-6, A-4 and A-6 in accordance with DOTD TR 423. Soil with a Liquid Limit greater than 35, a Plasticity Index (PI) greater than 15, or an organic content greater than 2 percent shall not be used. Liquid Limit and Plasticity Index will be determined in accordance with DOTD TR 428. Organic content will be determined in accordance with DOTD TR 413. Soil with over 79 percent sand or 60 percent silt when tested in accordance with DOTD TR 407 shall not be used. Soils may be blended to adjust the percentages of sand or silt to meet specification requirements; however, in-place blending will not be allowed. The District Laboratory Engineer will approve materials prior to blending and the final product. Soils that do not meet Liquid Limit or PI requirements shall not be blended or treated to reduce Liquid Limit or PI. Topsoil shall not be used. The contractor shall obtain the material to be stabilized from outside right-of-way limits except as provided in Subsection 106.02(c).

(b) Portland Cement: Portland cement shall be Type I or II. The quantity of cement used shall be supported by Certificate of Delivery.

(c) Portland-Pozzolan Cement: The cement shall be Type IP. The quantity of cement used shall be supported by Certificate of Delivery.

(d) Asphaltic Concrete Base Course: The material requirements for asphaltic concrete base course shall be as described in Section 502. The top half of the base thickness shall be asphaltic concrete and the remaining thickness shall be the same type and construction as the top layer of embankment.

302.03 EQUIPMENT. Equipment shall be subject to approval prior to use. When in-place mixing is used, the equipment shall conform to Subsection 303.03. When central mixing is used, the equipment shall conform to Subsection 301.03(a). Compaction equipment shall conform to Subsection 301.03(a)(5).

302.04 GENERAL CONSTRUCTION REQUIREMENTS. Base course material shall be placed on a subgrade prepared in accordance with Sections 203, 304, 305 or 306 as specified. Asphaltic concrete base course shall be constructed in accordance with Section 502.

If an aggregate base course is to be placed on untreated or lime-treated soils, a Class D geotextile separator fabric will be required.

302.05 MIXING.

(a) Soil Cement: Soil shall be combined with cement and water by in-place mixing or in a central plant and shaped on the subgrade. When in-place mixing is done, the cement shall be spread and mixed prior to any additional water being added.

A minimum of 70 percent of the pulverized soil, as determined by DOTD TR 431, shall pass the No. 4 (4.75 mm) sieve after mixing. The optimum moisture of the mixture will be determined in accordance with DOTD TR 415 or TR 418. The percentage of moisture in the mixture, by dry weight, shall not vary from the optimum moisture by more than ±2.0 percent at the time of compaction when tested in accordance with DOTD TR 403.

(1) In-Place Mixing: After placement of soil and prior to mixing with cement, the soil shall be shaped to required section and compacted to at least 93.0 percent of maximum dry density at the required grade. Samples to determine optimum moisture, percent cement, and maximum dry density will be taken by the project engineer. Maximum dry density will be determined in accordance with DOTD TR 415 or TR 418 and in place density will be determined in accordance with DOTD TR 401.

The percentage of cement will be determined in accordance with DOTD TR 432 prior to mixing, from materials sampled in-place on the project. Water needed to bring the moisture content of the mixture within the tolerance shall be added and uniformly mixed with the materials. During the mixing process, water shall be added only through the spray bar of the in-place mixer which is adjusted to provide uniform coverage across the completed width of the roadway for the full depth of the base. Wet streaks or spots will not be allowed. Depending on the type of cement and soil to

be used, normal testing time to determine required cement content may require 21 calendar days.

The method of cement distribution shall be such that the amount of cement used can be readily determined. The spread rate of cement shall be determined in accordance with DOTD TR 436.

When the moisture content is not within ±2.0 percent of optimum, operations shall be discontinued and will not be allowed to resume until the contractor demonstrates that moisture content is controlled within this tolerance. No more than one transport shall be placed and pulverized until moisture content is within ±2.0 percent of optimum.

(2) Central Plant Mixing: Mixing in a central mix plant shall conform to Section 301. When central plant mixing is used, a reduction of 1.0 percent in the volume of cement required will be permitted.

(b) Cement Treated Sand-Clay-Gravel: Sand-clay-gravel shall be combined with cement and water by in-place mixing or in a central plant and shaped on the subgrade.

Optimum moisture of the mixture will be determined in accordance with DOTD TR 415 or TR 418. The percentage of moisture in the mixture, by dry weight, shall not vary from optimum moisture by more than ±2.0 percent at the time of compaction when tested in accordance with DOTD TR 403.

(1) In-Place Mixing: In-place mixing shall conform to Heading (a)(1) except that the percentage of Types I or IB portland cement required will be 6 percent by volume. The cement content for Types II or I-P cement will be determined in accordance with DOTD TR 432.

When the moisture content is not within ±2.0 percent of optimum, operations will be discontinued and will not be allowed to resume until the contractor demonstrates that moisture content is controlled within this tolerance. No more than one cement transport shall be placed and pulverized until moisture content is within ±2.0 percent of optimum.

(2) Central Plant Mixing: Central plant mixing shall conform to Section 301 except that a reduction of 0.5 percent in the required volume of cement will be permitted.

(c) Stone, Crushed Slag, and Recycled Portland Cement Concrete: Stone, crushed slag, and recycled portland cement concrete base courses shall not segregate during construction. Water added to facilitate compaction shall not cause moisture damage to the subgrade layer.

302.06 TRANSPORTING AND PLACING ON SUBGRADE. Transportation and spreading methods shall not damage the subgrade. The contractor shall place and spread sufficient base course material to obtain required width and compacted thickness within the tolerances set forth in Subsection 302.12. Subgrade material shall not contaminate the base course. Any contamination will require retesting and correction of deficiencies. Base course material shall not be placed, spread or mixed on portland cement concrete or asphaltic concrete pavements. Base course construction operations shall not damage adjacent pavement surfaces, edges and joints.

302.07 COMPACTING AND FINISHING.

(a) General: The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, waves, laminations or loose material. The surface shall be thoroughly rolled and finished to grade. The cross-slope shall not vary by more than ±0.003 ft/ft (±3 mm/m). Density requirement shall be in accordance with Subsection 302.12.

(b) Soil Cement and Cement Treated Sand-Clay-Gravel: When central plant mixing is used, these materials shall be compacted and finished in accordance with Subsection 301.10, except that the automatic grade machine will not be required. When in-place mixing is used, these materials shall be compacted and finished in accordance with Subsection 303.06.

Compaction and finishing operations shall be completed within 3 hours after initial placement of cement on base course materials. Upon expiration of the 3-hour period after initial placement, only tight blading of the base course surface will be allowed. Bladed material shall not be drifted along the base, but shall be wasted. Stabilized material shall be utilized in the base course except for that small amount necessary for tight blading. Excessive blading to achieve plan depth will not be allowed. The contractor shall complete operations, including tight blading, before beginning the next day's operations. The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, waves, laminations, or loose materials. No cement shall be spread within 2 hours of sunset, unless otherwise approved by the project engineer.

(c) Stone and Recycled Portland Cement Concrete: These materials shall be compacted using an approved sheepsfoot-type roller and finish-rolled with an approved pneumatic tire roller or a smooth steel wheel roller. The surface shall be kept uniformly moist during compaction and final finishing.

(d) Asphaltic Concrete: Asphaltic concrete shall be compacted and finished in accordance with Section 502. The soil layer shall be compacted and finished in accordance with the top layer of embankment.

302.08 QUALITY CONTROL OF ROADWAY OPERATIONS. The contractor shall control the selection, placement, compaction, cement spread, mixing, moisture content, density, thickness, width, surface finish, cross-slope and grade to produce a completed base course that is uniform and conforms to plan dimensions and other acceptance requirements as provided herein. The contractor shall control his operations to prevent contamination, segregation, soft spots, wet spots, laminations and other deficiencies. The contractor shall be responsible for taking tests necessary to adequately control the work.

302.09 PROTECTION AND CURING.

(a) Soil Cement and Cement Treated Sand-Clay-Gravel: Upon completion of intermediate finishing, the base course shall immediately be protected against drying by applying an asphalt curing membrane in accordance with Section 506. Asphalt curing membrane shall be placed on the same day as treatment. Complete coverage of curing membrane shall be maintained from initial application until the placement of the next course. When traffic, including construction equipment, is allowed on the base course, at least the first lift of surfacing shall be placed within 30 calendar days unless otherwise directed.

(b) Stone, Recycled Portland Cement Concrete, and Soil Layer Under Asphaltic Concrete: The base course shall be covered with asphalt prime coat in accordance with Section 505 as soon as practical to avoid water infiltration due to rainfall. Complete coverage of asphalt prime coat shall be maintained from initial application until the placement of the next course.

302.10 MAINTENANCE OF BASE COURSE. The contractor shall protect the base course from damage from public traffic or the contractor's operations, and shall satisfactorily maintain the base course including the asphalt curing membrane or prime coat. Damaged base course shall be repaired by the contractor at no direct pay. When patching of the base course is required, in addition to removing damaged or unsound base course, the contractor shall remove a sufficient width and depth of base course to ensure satisfactory placement of patching material. The engineer will approve the type of patching material before use. Patching or other

base course repair shall restore a uniform surface, shall conform to the requirements of the material being used, and shall be completed before paving operations begin. Failures detected during paving may be patched as detected.

When maintenance of traffic is not required, neither public traffic nor construction traffic shall be allowed on the completed base course during the 72-hour curing period. When maintenance of traffic is required, both public traffic and construction traffic shall be routed off the completed base course onto shoulders or other suitable areas during the 72-hour curing period, when conditions permit.

When traffic is permitted to use the completed base course subsequent to the 72-hour curing period and prior to construction of the surface course, the base shall be further protected by additional applications of asphalt curing membrane or prime coat as directed in accordance with Subsection 301.12 at no direct pay.

Prior to surface course construction, the contractor shall correct deficiencies, clean the base course surface, repair any damages caused by traffic, and apply and maintain additional asphalt curing membrane or prime coat as directed at no direct pay.

Any weak spots that develop shall be satisfactorily corrected and the base kept free from deficiencies and true to grade and cross section at no direct pay.

When the surfacing is asphaltic concrete the first lift of surfacing shall be placed within 30 calendar days.

302.11 WEATHER LIMITATIONS. Construction of base course will not be permitted when the subgrade or stockpiles are frozen, when raining, or, in the case of cement treated bases, when the ambient air temperature is below 35°F (2°C), or the temperature forecasted by the U.S. Weather Service is to be 25°F (-3°C) or less within the 24 hour period following placement.

302.12 ACCEPTANCE REQUIREMENTS. Soils and aggregates will be sampled for acceptance by the Department in accordance with the Materials Sampling Manual.

For central plant mixing, the cement content will be determined in accordance with Subsection 301.16. For in-place mixing, the cement content will be determined in accordance with Subsection 302.05.

The moisture content of the soil cement or cement treated mixtures will be tested for conformance to optimum moisture content in accordance with DOTD TR 403.

The pulverization of the soil cement or cement treated mixtures will be tested in accordance with DOTD TR 431 and shall be at least 70 percent passing the No. 4 (4.75 mm) sieve.

Base course, except asphaltic concrete, will be checked for determining acceptance in increments of 1,000 linear feet (300 lin m) per roadway or 2,000 linear feet (600 lin m) per shoulder constructed separately. Asphaltic concrete will be accepted in accordance with Section 502.

(a) Density Requirements: Upon completion of compaction operations, base course density, except asphaltic concrete, will be determined in accordance with DOTD TR 401. The density requirements for asphaltic concrete base course will be determined in accordance with Section 502.

The density requirements for Class II Base Course materials shall be in accordance with Table 302-1 as follows.

Table 302-1
Class II Base Course Density

Base Course Type	Maximum Density Test Method	Percent of Maximum Density (Min.)
Soil Cement	DOTD TR 418	95.0
Cement Treated Sand-Clay-Gravel	DOTD TR 418	95.0
Stone, Crushed Slag, Recycled Portland Cement Concrete	DOTD TR 418	95.0
Treated Layer under Asphaltic Concrete	DOTD TR 418	95.0
Soil Layer Under Asphaltic Concrete	DOTD TR 418	95.0

(1) Soil Cement, Cement Treated Sand-Clay-Gravel, and Treated Layer Under Asphaltic Concrete: When the density test value for the section is below 95.0 percent, a payment adjustment will be applied in accordance with Table 302-2 as follows.

Table 302-2
Density Acceptance and Payment Schedule

Density Test Value	Percent of Contract Unit Price
95.0 & Above	100
94.0 to 94.9	90
93.0 to 93.9	75
Below 93.0	50 or Remove[1]

[1]At the option of the Department after investigation.

(2) Stone, Crushed Slag, Recycled Portland Cement Concrete, and Soil Layer under Asphaltic Concrete Base Course: When any test value is less than the required density, compaction shall continue until the specified density is obtained.

(b) Thickness Requirements: The thickness of the completed base course will be determined in accordance with DOTD TR 602.

The completed base course shall not vary from plan thickness in excess of the tolerances in Table 302-3 below. Base course thickness deficiencies in excess of these tolerances shall be corrected as specified herein at no direct pay.

Table 302-3
Base Course Thickness Tolerance

(All Bases Except Asphaltic Concrete) Underthickness, Inches (mm)	(Stabilized & Treated Bases) Overthickness, Inches (mm)
3/4 (20)	1 1/2 (40)

Any failing area will be isolated for purposes of correction.

Asphaltic concrete base thickness will be determined in accordance with Section 502.

When central plant mixing is used, overthickness may be waived at no direct pay.

(1) Soil Cement, Cement Treated Sand-Clay-Gravel, and Treated Layer Under Asphaltic Concrete: When no grade adjustments are permitted, underthickness deficiencies in excess of tolerance shall be corrected by removing and replacing the full depth of base course in deficient areas with one of the following materials:

a. The same type of base course.
b. Asphaltic concrete complying with Section 502.
c. Concrete complying with Section 901.

When grade adjustments are permitted, the contractor shall have the option of correcting thickness deficiencies by furnishing and placing a supplemental layer of asphaltic concrete complying with Section 502 for the full width of base course in lieu of removing and replacing deficient base course. When approved, corrections may be made by restabilizing the existing material in accordance with this section. Thickness of the supplemental layer of asphaltic concrete shall be in accordance with Table 302-4 as follows.

Table 302-4
Supplemental Asphaltic Concrete Layer Thickness

Underthickness, Inches (mm)	In-Place Mixing Overthickness, Inches (mm)	Minimum Thickness of Supplemental Asphaltic Concrete, Inches (mm)[1]
1 to 1 1/4 (30 to 35)	1 3/4 to 2 (45 to 50)	1 1/4 (35)
1 1/2 to 1 3/4 (40 to 45)	2 1/4 to 2 1/2 (60 to 65)	1 1/2 (40)
2 to 2 1/2 (50 to 65)	2 3/4 to 3 (70 to 80)	2 (50)
Over 2 1/2 (Over 65)	Over 3 (Over 80)	Remove and Replace[2]

[1] May be included in the subsequent lift
[2] At the option of the Department after investigation.

When reconstruction is the method of correction, the above tolerances shall apply.

(2) Stone, Crushed Slag, and Recycled Portland Cement Concrete: When grade adjustments are allowed, underthickness in excess of 3/4 inch (20 mm) shall be corrected to plan thickness by furnishing, placing, reworking, shaping, and compacting additional base course material as required. When no grade adjustments are allowed the material shall be removed and replaced at no direct pay.

(3) Asphaltic Concrete Base Course: When no grade adjustments are allowed, underthickness in excess of the tolerances given in Subsection 502.12 shall be corrected to plan thickness by removing and replacing the full depth of base course. When grade adjustments are allowed, underthickness in excess of the tolerances given in Subsection 502.12 shall be corrected to plan thickness by placing and compacting a 1 1/4 inch (35 mm) thick minimum supplemental layer of asphaltic concrete complying with Section 502 at no direct pay.

(c) Width Requirements: The width of the completed base course will be determined in accordance with DOTD TR 602. Roadway base course width shall not vary from plan width in excess of +6 inches (+150 mm). Shoulder base course width shall not vary from plan width in excess

of +3 inches (+75 mm). No tolerances are provided for underwidths of shoulder or roadway bases. When the base course for both roadway and shoulders are constructed at the same time, the 6-inch (150 mm) tolerance will be applied. Base course width deficiencies in excess of the above tolerances shall be corrected as follows at the contractor's expense:

(1) Soil Cement, Cement Treated Sand-Clay-Gravel, and Asphaltic Concrete Base Course:

a. Overwidth: Overwidths of asphaltic concrete and treated base courses mixed in a central plant may be waived at no additional cost to the Department. When no grade adjustments are allowed, the full depth and width of base course in areas having overwidths in excess of the foregoing tolerances shall be removed and replaced to the plan width with one of the following materials:

1. The same type of base course.
2. Asphaltic concrete complying with Section 502.
3. Concrete complying with Section 901.

In lieu of removing and replacing the overwidth areas of base course, at the Department's option, any base course less than 12 inches (300 mm) overwidth will be allowed to remain in place at an adjusted payment of 90 percent of the contract unit price for the complete section. Overwidth in excess of 12 inches (300 mm) shall be removed and replaced as indicated above. When approved, corrections may be made by restabilizing the existing material in accordance with this subsection.

When grade adjustments are permitted, the contractor shall correct base course width deficiencies by removing and replacing as specified above, or by furnishing and placing a 1 1/4 inch (35 mm) thick supplemental layer of asphaltic concrete complying with Section 502 on the 1,000-foot (300 m) section for the full width of the base course.

b. Underwidth: Underwidths of base course in excess of the foregoing tolerances shall be corrected to plan width and thickness by furnishing and placing additional materials; however, the width of widening materials shall be not less than 12 inches (300 mm). When approved, corrections may be made by restabilizing the existing material in accordance with this section. Materials for widening deficient base course shall be either asphaltic concrete complying with Section 502 or concrete complying with Section 901, at the option of the contractor.

(2) Sand-Clay-Gravel, Stone, Crushed Slag, and Recycled Portland Cement Concrete: Overwidths will be waived at no additional cost to the Department. Underwidths in excess of the foregoing tolerances shall be corrected to plan widths by furnishing, placing, reworking, shaping, and compacting additional base course material as required.

(d) Grade and Cross-slope: The finished grade shall be within ±1/2 inch (±15 mm) of the established grade. The cross-slope shall not vary by more than ±0.003 ft/ft (±3 mm/m).

(e) Correction of Deficiencies: The contractor shall correct deficiencies in surface finish, cross-slope, grade, contamination, segregation, soft spots, wet spots, laminations and other deficiencies at no direct pay. Deficiencies shall be corrected by removing and replacing or as directed.

302.13 MEASUREMENT. The quantities of base course for payment will be the design volumes or areas specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions and compacted thickness of the completed base course shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary.

Geotextile fabric used beneath the base course will not be measured for payment.

302.14 PAYMENT. Payment for base course will be made at the contract unit price, adjusted as specified in Subsection 302.12 and the following provisions, which includes furnishing and placing required base course materials, portland cement, portland-pozzolan cement, water, asphaltic curing membrane and prime coat.

Any payment adjustment in asphaltic concrete shall be in accordance with Section 502 and shall apply to the cubic yard (cu m) total quantity of base course when payment is by cubic yard (cu m). For other materials, when payment adjustments are made for more than one deficiency, they shall be cumulative.

Payment for geotextile fabric will be included in the contract unit price for base course.

302.14

Payment will be made under:

Item No.	Pay Item	Pay Unit
302-01	Class II Base Course	Cubic Yard (Cu m)
302-02	Class II Base Course ____in(mm)Thick	Square Yard (Sq m)

Section 303
In-Place Cement Stabilized Base Course

303.01 DESCRIPTION. This work consists of scarifying, pulverizing, blending, shaping and stabilizing roadbed material with portland cement or portland-pozzolan cement in accordance with the lines, grades, thickness and sections established or shown on the plans.

This cement stabilization is primarily for existing roadbed materials. When specified, the contractor shall furnish and place materials under different pay items to be stabilized in accordance with this section.

With approval, concrete complying with Section 901 or asphaltic concrete complying with Section 502 may be used in lieu of the specified base course material in areas that are inaccessible for mixing and compacting in turnouts and crossovers, and in other isolated or irregular areas. The concrete shall be placed, consolidated, finished, and cured as directed in accordance with Section 706. The contractor shall remove and satisfactorily dispose of existing materials as required to accommodate placement of the portland cement concrete or asphaltic concrete at no direct pay. Excess material shall be disposed of in accordance with Subsection 202.02.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

303.02 MATERIALS. Materials shall comply with the following Sections or Subsections:

Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Emulsified Asphalt	1002
Water	1018.01

Portland cement shall be Type I or II. Portland-pozzolan cement shall be Type IP. The quantity of cement used shall be supported by proof of delivery.

Soils or soil-aggregate combinations furnished by the contractor for stabilization in accordance with this section shall comply with the requirements of Subsection 302.02(a).

303.03 EQUIPMENT. Equipment necessary to produce a finished base course which meets specification requirements shall be furnished and maintained by the contractor. Equipment shall be approved prior to use. Pulverization shall be accomplished using an approved in-place mixer.

The in-place mixer shall be equipped with a spray bar which has the capability of applying water across the full width of the cut and shall be adjustable to prevent overlap of water distribution on adjacent paths.

Cement may be distributed from transports using spreader bars approved by the engineer. The engineer may require the use of a cement spreader capable of width adjustment and equipped with a calibrated spreader box if a uniform cement spread cannot be achieved, or to control dust. The distribution of dry additives shall be monitored using DOTD TR 436, Method A.

Compaction equipment shall be conventional sheepsfoot type roller or a self-propelled tamping foot compactor-type roller for initial compaction. The spikes shall be sufficient in size and number to provide uniform compaction for the full width and depth of the base course. Finish rolling shall be with a pneumatic tire roller.

303.04 PREPARATION OF ROADBED. Unless otherwise designated in the plans, all existing asphaltic concrete surfacing except the bottom 1 inch (25 mm) shall be removed in accordance with Section 509 prior to cement stabilization. Removed asphaltic concrete surfacing shall be used in accordance with Subsection 509.03 as amended by the project specifications. During these removal and replacement operations, the contractor shall maintain the areas being used by public traffic in a safe condition. The contractor shall scarify and pulverize materials to be stabilized for the full width and depth of the base course. Existing asphaltic surfacing which is not removed shall be pulverized and uniformly mixed with materials below the surfacing.

Preparation of roadbed shall not be performed in excess of 2 miles (3 km) in advance of roadway base course stabilization. When approved by the project engineer, the 2-mile (3 km) limit may be extended. However, when the 2 mile (3 km) limit is extended, the lag between preparation of roadbed and base stabilization shall not exceed 5 working days. When

shoulders are stabilized separately from roadway base, the 2-mile (3 km) limitation will not apply.

The scarified and pulverized material shall be blended from edge of base to edge of base to achieve uniform blending. When existing material is not uniform across the full width to be stabilized, the material shall be blended to form a uniform blend for the full width and depth of the base course.

The roadbed shall be scarified and pulverized to at least 60 percent passing the No. 4 (4.75 mm) sieve in accordance with DOTD TR 431 prior to mixing with cement. The contractor shall identify and remove existing concrete or asphaltic concrete patches encountered during roadbed preparation operations. Patches will be removed and disposed of in accordance with Subsection 202.02. The provisions of Subsections 303.12 and 303.13 will apply for measurement and pay.

After the roadbed has been prepared as specified above, the contractor shall shape the roadbed to the required section and uniformly compact the roadbed material to at least 93.0 percent of maximum dry density prior to mixing with cement. Maximum dry density will be determined in accordance with DOTD TR 415 or TR 418 and in-place density will be determined in accordance with DOTD TR 401. Areas which cannot be compacted to 93.0 percent of maximum dry density shall be corrected at no direct pay.

303.05 MIXING. The percent of cement to be used will be determined by the laboratory in accordance with DOTD TR 432 from materials sampled in-place on the project. If the percent cement has not been predetermined, samples to determine percent cement shall be taken from isolated areas selected by the project engineer, prepared for sampling by the contractor. Depending on the type of cement to be used and materials to be stabilized, normal testing time to determine the required cement content may require up to 21 calendar days. The sampling area shall be thoroughly pulverized and mixed to the satisfaction of the project engineer. Sampling areas shall be resurfaced as directed after samples are taken and maintained to the satisfaction of the project engineer. Payment for resurfacing will be made under the appropriate asphaltic concrete roadway or maintenance aggregate items.

The method of spread shall be such that the amount of cement used can be readily determined when tested in accordance with DOTD TR 436. Cement shall be uniformly spread and mixed with the material. A

minimum of two passes with the mixer (stabilizer) will be required. The mixture shall be shaped to the required section.

Water shall be added as needed by means of the mixer and shall be uniformly incorporated in the mixture in amounts required to attain optimum moisture for the mixture. During the mixing process, water shall be added only through the spray bar of the in-place mixer which is adjusted to provide uniform coverage across the completed width of the roadway for the full depth of the base. Wet streaks or spots will not be allowed.

Optimum moisture of the mixture will be determined in accordance with DOTD TR 415 or TR 418. The percentage of moisture determined in accordance with DOTD TR 403 in the mixture by dry weight shall not vary from optimum moisture by more than ±2 percent at the time of compaction.

303.06 COMPACTING AND FINISHING. The mixture shall be uniformly compacted immediately upon completion of mixing to the specified depth and width shown in the plans. Initial compaction shall be completed with an approved sheepsfoot-type roller or a self-propelled tamping foot compactor-type roller in such a manner that no internal laminations occur in the completed base course. Final compaction shall be with a pneumatic tire roller.

The surface shall be kept uniformly moist during compacting and final finishing. Compaction shall continue until each lift of base course has met the requirements of Subsection 303.11.

At places inaccessible to rollers, such as edges adjacent to curb and gutter sections, the mixture shall be compacted using devices that will obtain the specified density without damage to adjacent structures.

Compaction and finishing operations shall be completed within 3 hours after initial placement of cement on base course materials. Upon expiration of the 3-hour period after initial placement, only tight blading of the base course surface will be allowed. Bladed material shall not be drifted along the base, but shall be wasted. Stabilized material shall be utilized in the base course except that small amount necessary for tight blading. Excessive blading to achieve plan depth will not be allowed. The contractor shall complete operations, including tight blading, before the end of the day. The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, waves, laminations, or loose material. No cement shall be spread within two hours of sunset, unless otherwise approved by the project engineer.

303.07 QUALITY CONTROL. The contractor shall control the preparation of roadbed, selection and placement of materials, cement spread, mixing, compaction, moisture content, density, thickness, width, surface finish, grade and cross slope so that the completed base course is uniform and conforms to plan dimensions and other acceptance requirements as provided herein. The contractor shall control his operations so that contamination, segregation, soft spots, wet spots, laminations and other deficiencies are prevented. The contractor shall be responsible for taking such tests as necessary to adequately control the work.

303.08 PROTECTION AND CURING. Upon completion of final finishing, the base shall be immediately protected against rapid drying by applying an asphalt curing membrane in accordance with Section 506. Asphalt curing membrane shall be placed on the same day as stabilizing. Complete coverage of curing membrane shall be maintained from initial application until the placement of the next course. When traffic, including construction equipment, is allowed on the base course, at least the first lift of surfacing shall be placed within 30 calendar days unless otherwise directed.

303.09 MAINTENANCE. The contractor shall protect the completed base course from damage due to either public traffic or the contractor's operations, and shall satisfactorily maintain the completed base course including asphalt curing membrane. Damaged base course shall be repaired by the contractor at no direct pay. When patching of the base course is required, in addition to removing damaged or unsound base course, the contractor shall remove a sufficient width and depth of base course to ensure satisfactory placement of patching material. The engineer will approve the type of patching materials before use. Patching or other repair of the base course shall be made in such manner as to restore a uniform surface, shall conform to the requirements of the material being used and shall be completed prior to surfacing operations.

When maintenance of traffic is not required, neither public traffic nor construction traffic shall be allowed on the completed base course for a 72-hour curing period. When maintenance of traffic is required, both public traffic and construction traffic shall be routed off the completed base course onto shoulders or other suitable areas during the 72-hour curing period when conditions permit.

When traffic is permitted to use the completed base after a 72-hour curing period and prior to the construction of the surface course, the base

shall be further protected by additional applications of asphalt curing membrane as directed at no direct pay in accordance with Subsection 302.10.

Prior to surface course construction, the contractor shall clean the base course and apply and maintain additional asphalt curing membrane as directed at no direct pay.

Any weak spots that develop shall be satisfactorily corrected and the base kept free from deficiencies and true to grade and cross section at no direct pay. When the surfacing is asphaltic concrete the first lift of surfacing shall be placed within 30 calendar days.

303.10 WEATHER LIMITATIONS. Mixing will not be permitted when the base course material is frozen, when raining, when the ambient air temperature is below 35°F (2°C), or the temperature forecasted by the U.S. Weather Service is to be 25°F (-3°C) or less within the 24 hour period following placement.

303.11 ACCEPTANCE REQUIREMENTS. Soils and aggregates will be tested by the Department from samples taken after preparation of the roadbed.

Cement spread rate will be tested in accordance with DOTD TR 436.

The moisture content of the cement stabilized mixtures will be tested for compliance with optimum moisture content in accordance with DOTD TR 403 at placement at least twice per day.

The pulverization of the prepared roadbed will be tested in accordance with DOTD TR 431, and shall be at least 60 percent passing the No. 4 (4.75 mm) sieve.

The completed base course will be checked for determining acceptance in increments of 1,000 linear feet (300 lin m) per roadway or 2,000 linear feet (600 lin m) per shoulder constructed separately.

(a) Density Requirements: Upon completion of compaction operations, in-place density will be determined in accordance with DOTD TR 401.

The density requirement as based on DOTD TR 415 or TR 418 will be 95.0 percent of maximum density.

When the density test value for the section is below 95.0 percent, a payment adjustment will be applied in accordance with Table 303-1 below.

Table 303-1
Density Acceptance and Payment Schedule

Density Test Value	Percent of Contract Unit Price
95.0 & Above	100
93.0 to 94.9	90
90.0 to 92.9	75
Below 90.0	50 or Remove[1]

[1]At the option of the Department after investigation.

(b) Thickness Requirements: The thickness of the completed base course will be determined in accordance with DOTD TR 602.

The completed base course shall not vary from plan thickness in excess of the tolerances in Table 303-2 as follows. Base course thickness deficiencies in excess of these tolerances shall be corrected as specified herein at no direct pay.

Table 303-2
Base Course Thickness Tolerance

Underthickness, Inches (mm)	Overthickness, Inches (mm)
3/4 (20)	1 1/2 (40)

Any failing area will be isolated for purposes of correction. Base course thickness deficiencies in excess of the foregoing tolerances shall be corrected as follows.

When no grade adjustments are permitted, thickness deficiencies shall be corrected by restabilizing with cement or removing and replacing the full depth of base course in deficient areas with one of the following materials:

(1) Cement stabilized base course.
(2) Asphaltic concrete complying with Section 502.
(3) Concrete complying with Section 901.

When grade adjustments are permitted, the contractor shall have the option of correcting deficiencies by furnishing and placing a supplemental layer of asphaltic concrete complying with Section 502 for the full width of base course in lieu of removing and replacing deficient base course. When approved, corrections may be made by restabilizing the existing material in accordance with this section. Thickness of the supplemental layer of asphaltic concrete shall be in accordance with Table 303-3 as follows.

Table 303-3
Supplemental Asphaltic Concrete Layer Thickness

Underthickness, Inches (mm)	Overthickness, Inches (mm)	Minimum Thickness of Supplemental Asphaltic Concrete[1], Inches (mm)
1 to 1 1/2 (30 to 40)	1 3/4 to 2 (45 to 50)	1 1/4 (35)
1 3/4 to 2 (45 to 50)	2 1/4 to 2 1/2 (60 to 65)	1 1/2 (40)
2 1/4 to 2 1/2 (60 to 65)	2 3/4 to 3 (70 to 80)	2 (50)
Over 2 1/2 (Over 65)	Over 3 (Over 80)	Remove and Replace[2]

[1]May be placed with subsequent lift of asphaltic concrete.
[2]At the option of the Department after investigation

(c) Width Requirements: The width of the completed base course will be determined in accordance with DOTD TR 602. Roadway base course width shall not vary from plan width in excess of +6 inches (+150 mm). Shoulder base course width shall not vary from plan width in excess of +3 inches (+75 mm). No tolerances are provided for underwidths of shoulder or roadway bases. When the base course for roadway and shoulders are constructed at the same time, the 6-inch (150 mm) width tolerance will be applied. Base course width deficiencies in excess of foregoing tolerances shall be corrected as follows at the contractor's expense.

(1) Overwidth: When no grade adjustments are permitted, the full depth and width of base course in isolated areas having overwidths in excess of the foregoing tolerances shall be restabilized full width with cement or removed and replaced to the plan width with asphaltic concrete complying with Section 502 or concrete complying with Section 901.

In lieu of removing and replacing overwidth base course, areas of the deficient base course will be allowed to remain in place at a payment adjustment of 90 percent of the contract unit price for the entire lot.

When grade adjustments are permitted, the contractor shall correct base course width deficiencies by removing and replacing as specified above, or by furnishing and placing a 1 1/4 inch (35 mm) thick supplemental layer of asphaltic concrete complying with Section 502 for the full width of the roadway.

(2) Underwidth: Underwidths of base course in excess of the foregoing tolerances shall be corrected to plan width by restabilizing the full width with cement or by furnishing and placing additional materials; however, the width and thickness of the widening materials shall be not less than 12 inches (300 mm). Materials used for widening the deficient

base course shall be the same as specified for overwidth correction in Heading (1).

(d) Grade and Cross-slope: The finished grade shall be within ±1/2 inch (±15 mm) of the established grade. The cross-slope shall not vary by more than ±0.003 ft/ft (±3 mm/m).

(e) Correction of Deficiencies: The contractor shall correct deficiencies in surface finish, grade, contamination, segregation, soft spots, wet spots, laminations and other deficiencies at no direct pay. Deficiencies shall be corrected by removing and replacing or as directed.

303.12 MEASUREMENT. The quantity of in-place cement stabilized base course for payment will be the design areas as specified in the plans and adjustments thereto. The design quantity is based on the horizontal dimensions of the completed base course shown on the plans. The design quantity will be adjusted if the engineer makes changes to adjust to field conditions, if design errors are proven, or if design changes are necessary.

Removal of existing patches will be measured by the square yard (sq m). This measurement will be determined and documented jointly by the contractor and project engineer. If no item is included in the contract, measurement will be in accordance with 109.04.

303.13 PAYMENT. Payment for in-place cement stabilized base course will be made at the contract unit price, adjusted as specified in Subsection 303.11 and the following provisions, which include furnishing required portland cement, water, and asphalt curing membrane, and performing necessary roadbed preparation. Payment for removing all existing asphaltic concrete surfacing will be made under Section 509 except for the bottom 1 inch (25 mm). No direct payment will be made for removal and disposal of the remaining [bottom 1 inch (25 mm)] of asphaltic surfacing or maintaining the areas in safe condition for traffic.

If the actual required percent of cement differs from that required by the contract documents, payment will be increased or decreased based on the difference in required quantity of cement at the price of cement shown on paid invoices (total of all charges). The contractor shall provide copies of paid invoices for this determination. If the contract documents do not specify a percent cement, 8 percent cement will be used for bid purposes.

Removal of existing patches will be paid at the contract unit price or if no item is provided, in accordance with Subsection 109.04. However, no payment will be made unless the contractor identifies the patches and participates in the measurement and documentation.

Payment adjustments will be applied for specification deviations of asphalt materials in accordance with Section 1002 based on the invoice price per gallon (L). The Materials and Testing Section will provide the payment adjustment percentage for properties of asphaltic materials.

Item No.	Pay Item	Pay Unit
303-01	In-Place Cement Stabilized Base Course ___ in (mm) Thick	Square Yard (Sq m)
303-02	Removal of Existing Patches	Square Yard (Sq m)

Section 304
Lime Treatment

304.01 DESCRIPTION. This work consists of constructing one or more courses of a mixture of lime and soil, or soil-aggregate, and water in accordance with these specifications, in conformity with the lines, grades, thickness and sections shown on the plans.

Lime treatment will be designated as Type B, C, D, or E. Type B shall be used for base or subbase. Type C shall be used for conditioning for cement treatment or stabilization. Type D shall be used for working table treatment under an embankment. Type E shall be used for conditioning and drying of subgrades under a base course. Lime treatment shall be in accordance with these specifications and Table 304-2.

304.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Emulsified Asphalt	1002
Water	1018.01
Lime	1018.03

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

In order to meet air quality standards, the contractor may be required to use central plant mixing, lime slurry, or granular lime in dust sensitive areas at no direct pay. The Department will identify dust sensitive areas in the plans.

304.03 EQUIPMENT. Equipment necessary to produce a finished product meeting specification requirements shall be furnished and maintained by the contractor. An approved in-place mixer meeting the requirements of Subsection 303.03 shall be used for Type B and C treatments. An approved in-place mixer meeting the requirements of Subsection 303.03 shall be used for Types D and E treatments unless the engineer approves other equipment.

304.04 GENERAL CONSTRUCTION REQUIREMENTS. Lime shall be protected from moisture prior to use. Water shall be added as needed during mixing and remixing operations, during the curing period, and to keep the cured material uniformly moist until covered.

When granular quicklime is applied in dry form, precautions shall be taken to prevent injury to persons, livestock and plants. Quicklime spilled or deposited outside areas designated for treatment shall be immediately collected and buried or satisfactorily slaked.

Lime shall not be applied on a frozen foundation or when the ambient air temperature is below 35°F (2°C).

(a) Type B Treatment: Lime shall be incorporated in the following sequence: Spreading the lime; initial mixing; watering; sealing and mellowing for at least 48 hours; and mixing until pulverization requirements are met; compacting; finishing; and maintaining in accordance with Subsection 304.10. The percent of lime for Type B treatment will be determined in accordance with DOTD TR 416. After lime treatment, the treated soil shall have a maximum Liquid Limit of 40 and a maximum PI of 10.

(b) Type C Treatment: Lime shall be incorporated in the following sequence: Spreading the lime; initial mixing; watering; sealing and mellowing for a minimum of 48 hours; mixing until pulverization requirements are met; compacting; finishing; and maintaining. The percent lime for Type C treatment will be as required by the plans or as directed.

(c) Type D Treatment: One increment of lime shall be spread and mixed with materials to be treated, watered as required and compacted to the satisfaction of the engineer. The percent of lime for Type D treatment will be as required by the plans or as directed.

(d) Type E Treatment: One increment of lime shall be spread and mixed with materials to be treated and compacted and finished in accordance with the normal embankment construction procedures of Section 203. Unless specified, the percent of lime for Type E treatment will be determined in accordance with DOTD TR 416.

304.05 SPREADING AND MIXING. The percentage of lime to be incorporated shall be as specified. When not specified, the required percentage of lime will be determined by the laboratory in accordance with DOTD TR 416.

A unit weight of 35 pounds per cubic foot (560 kg/cu m) will be used to compute the required application rate of hydrated lime or granular quicklime regardless of the actual unit weight of the lime used.

Lime may be furnished in bags or bulk and distributed, in powder form, granular or in a slurry, and in the required proportion. Dry lime shall be prevented from blowing by adding water or by other suitable means.

Lime shall be uniformly spread and mixed with the soil to the width and depth shown on the plans or as directed. The Department will determine lime spread rate in accordance with DOTD TR 436. Any procedure, which results in excessive loss, or displacement of lime, shall be discontinued.

Areas to which lime is applied shall be processed on the same day as application is made. Any lime not processed within 6 hours and lime lost or damaged before incorporation due to rain, wind or other cause will be rejected, deducted from measured quantities, and shall be replaced by the contractor. At no time will the contractor be paid more than once for lime treatment of a section of roadway.

(a) Type B Mixing: After the 48-hour mellowing period, the lime treated mixture shall be kept moist and be manipulated with an in-place mixer until the pulverization requirements of Subsection 304.06 have been met.

(b) Type C Mixing: Following the 48-hour mellowing period, the lime treated mixture shall be thoroughly manipulated with an in-place mixer to the satisfaction of the engineer. The mixture shall meet the pulverization requirements of Subsection 304.06 prior to subsequent stabilization or treatment with portland cement.

(c) Types D and E: Mixing shall be accomplished with an in-place mixer unless the engineer approves other equipment.

304.06 PULVERIZATION. For Types B and C treatment, the pulverized mixture, when tested in accordance with DOTD TR 431, shall meet the gradation requirements in Table 304-1 below.

Table 304-1
Gradation Requirements for Types B & C Lime Treatment

U. S. Sieve, Inches (mm)	Percent Passing By Weight (Mass)
3/4 (19.0)	95
No. 4 (4.75)	50

Pulverization requirements for Type B and C treatments shall be met prior to final compaction and finishing.

304.07 COMPACTING AND FINISHING.

(a) Type B: After meeting the pulverization requirement, the mixture shall be uniformly compacted to at least 95.0 percent of maximum dry density. The maximum dry density will be determined in accordance with DOTD TR 415 or TR 418 and in-place density in accordance with DOTD TR 401. Compaction and finishing operations shall be completed within 6 hours after meeting pulverization requirements. One density test will be taken per 1,000 linear feet (300 lin m) per roadway or 2,000 linear feet (600 lin m) per shoulder constructed separately in accordance with DOTD TR 401. At places inaccessible to rollers, such as edges adjacent to curb and gutter sections, the mixture shall be compacted using devices that will obtain uniform compaction to required density without damage to adjacent structures. Any section not meeting the required density shall be reconstructed in accordance with these specifications at no direct pay. Reconstruction shall include the addition of the specified amount of lime.

The final finish shall meet grade and cross-slope requirements and shall have a smooth, uniform, closely knit surface, free from ridges, waves, loose material or laitance.

(b) Type C: Type C lime conditioned materials shall be shaped and uniformly compacted to the required sections. The contractor shall make reasonable efforts to conform to the compaction requirements of (a) above. When conditions, such as a yielding subgrade, make this impractical or detrimental, the contractor shall establish an optimum rolling pattern.

(c) Type D: Type D lime treated materials shall be uniformly compacted and finished to the satisfaction of the engineer. The contractor shall make reasonable efforts to conform to the compaction requirements of (a) above. When conditions, such as a yielding subgrade, make this impractical or detrimental, the contractor shall establish an optimum rolling pattern.

(d) Type E: Type E lime treated materials shall be compacted and finished in accordance with the normal embankment construction procedures of Section 203.

304.08 QUALITY CONTROL. Construction methods shall prevent contamination, segregation, soft spots, wet spots, laminations and other deficiencies. The contractor shall be responsible for taking such tests as necessary to adequately control the work.

(a) Type B Lime Treatment: The contractor shall control the grade, cross-slope, lime spread, mixing, pulverization, thickness, width,

density and curing to construct a completed course that is uniform and conforms to the acceptance requirements.

(b) Type C Lime Treatment: The contractor shall control the lime spread, mixing and pulverization to construct a completed course that is uniform and conforms to the acceptance requirements.

(c) Type D Lime Treatment: The contractor shall control the lime spread and mixing to construct a completed course that is uniform and conforms to the acceptance requirements.

(d) Type E Lime Treatment: The contractor shall control the lime spread, mixing and density to construct a completed layer that is uniform and conforms to the acceptance requirements.

304.09 PROTECTION AND CURING (TYPE B TREATMENT).

After finishing operations have been completed, the material shall be protected against rapid drying for 72 hours by applying an asphalt curing membrane complying with Section 506. The application shall be placed immediately following smooth rolling and shall be adequately maintained during the 72-hour curing period.

304.10 MAINTENANCE.

(a) Type B Lime Treatment: Maintenance of Type B Lime Treatment will be in accordance with Subsection 303.09.

(b) Types C, D and E Treatments: These treatments shall be maintained by the contractor to prevent damage to the lime treated layer as directed.

304.11 DIMENSIONAL TOLERANCES (TYPE B TREATMENT).

(a) General: Thickness and width of completed lime treated courses will be checked for acceptance in accordance with DOTD TR 602.

Areas not meeting tolerances specified herein will be delineated and shall be corrected to plan dimensions by scarifying, adding lime, remixing, and recompacting deficient areas at no direct pay.

(b) Thickness Requirements: Underthickness shall not exceed 3/4 inch (20 mm) and overthickness shall not exceed 1 inch (25 mm).

(c) Width Requirements: Roadway base course width shall not vary from plan width in excess of +6 inches (+150 mm). Shoulder base course width shall not vary from plan width in excess of +3 inches (+75 mm). No tolerances are provided for under widths of shoulder or roadway bases. When the base course for roadway and shoulders are constructed at the same time, the 6-inch (150 mm) width tolerance will be applied. Base

course width deficiencies in excess of foregoing tolerances shall be corrected at the contractor's expense.

304.12 MEASUREMENT.

(a) Lime: Lime will be measured by the ton (Mg). When lime is furnished in bags, the number of bags used and the weight (mass) per bag will be used for measurement. When lime is furnished in bulk, the contractor shall furnish certified weights (mass) for each transport load.

(b) Treatment: The quantities of Type B, C and D lime treatment for payment will be the design areas as specified on the plans and adjustments thereto. Design quantities are based on the horizontal dimensions of the completed lime treatment shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if design errors are proven, or if design changes are necessary.

No measurement for payment will be made for Type E lime treatment other than as specified.

(c) Water and asphalt curing materials will not be measured for payment.

304.13 PAYMENT.

(a) Lime: Payment for lime will be made at the contract unit price per ton (Mg). If quicklime is used in a slurry, payment will be made at the unit price for hydrated lime after converting the quicklime to the equivalent weight (mass) of hydrated lime by multiplying the weight (mass) of quicklime by 1.32 then multiplying that product by the purity of the lime.

(b) Treatment: Payment for Types B, C and D lime treatment will be made at the contract unit prices per square yard (sq m). Type B lime treatment will be adjusted as specified in Section 1002 for specification deviations of asphalt materials. The Materials and Testing Section will provide the payment adjustment percentage for properties of asphalt materials. Payment for Type E Treatment will be at the contract unit price per ton (Mg) of lime used.

Payment will be made under:

Item No.	Pay Item	Pay Unit
304-01	Lime	Ton (Mg)
304-02	Lime Treatment (Type B) ___in (mm) Thick	Square Yard (Sq m)
304-03	Lime Treatment (Type C) ___in (mm) Thick	Square Yard (Sq m)
304-04	Lime Treatment (Type D) ___in (mm) Thick	Square Yard (Sq m)
304-05	Lime Treatment (Type E)	Ton (Mg)

Table 304-2
Types of Lime Treatment

B	Base or Subbase	1. One application of lime 2. Initial mixing 3. 48-hour mellowing or aging period 4. Pulverization[1] 5. Density control 6. Minimum thickness and width 7. 72-hour cure with asphalt curing membrane
C	Conditioning for Cement Treatment or Stabilization	1. One application of lime 2. Initial mixing 3. 48-hour mellowing or aging period 4. Pulverization[1] 5. Compact to engineer's satisfaction 6. No cure required
D	Working Table (Under Embankment)	1. One application of lime 2. Mixing[2] 3. Compact to engineer's satisfaction 4. No cure required
E	Conditioning and Drying (Subgrades Under a Base Course)	1. One application of lime per embankment lift 2. Mixing[2] 3. Embankment construction requirements including density 4. No cure required

[1]In-place mixer shall be required.
[2]In-place mixer shall be required unless the engineer approves other equipment.

Section 305
Subgrade Layer

305.01 DESCRIPTION. This work consists of treating subgrade soil materials with portland cement, portland-pozzolan cement, or a combination of portland cement and lime, or constructing a subgrade layer of stone, crushed slag, recycled portland cement concrete, blended calcium sulfate, or asphaltic concrete in accordance with plan details or as directed. When traffic is required to be placed on the completed, unsurfaced subgrade layer, or when the subgrade layer is below natural ground, blended calcium sulfate will not be an allowable alternate. When not specified, the subgrade layer may be composed of any of the types of materials listed above, at the option of the contractor. The same subgrade layer shall be used throughout the project unless otherwise approved by the project engineer. The plans may limit the types of subgrade layer allowed.

These specifications set forth the minimum requirements for construction of the subgrade layer; however, the contractor shall construct a subgrade layer that will provide adequate support for his construction equipment and processes.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

In order to meet air quality standards, the contractor may be required to use central plant mixing of cement or cement and lime treated mixtures in dust sensitive areas at no direct pay. The Department will identify the dust sensitive areas in the plans.

305.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Geotextile Fabric	203.11 & 1019
Asphaltic Concrete	502
Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Emulsified Asphalt	1002
Stone	1003.01 & 1003.10
Recycled Portland Cement Concrete	1003.01 & 1003.10
Crushed Slag	1003.03(d)

Blended Calcium Sulfate	1003.01 & 1003.10
Water	1018.01
Lime	1018.03

Blended calcium sulfate shall be sampled in accordance with the requirements for stone in Section 302 of the Materials Sampling Manual.

Asphaltic concrete shall meet the requirements of Section 502 base course.

305.03 EQUIPMENT. Equipment necessary to produce a finished product meeting specification requirements shall be furnished and maintained by the contractor. The equipment will be approved prior to use.

305.04 CONSTRUCTION REQUIREMENTS.

(a) Treated Subgrade Layer: Materials to be treated shall be existing materials or materials placed under other pay items.

(1) Subgrade Soils: Subgrade soils to be treated shall be not more than 79 percent sand or 69 percent silt, when tested in accordance with DOTD TR 407, and shall have a Plasticity Index (PI) not exceeding 35 when tested in accordance with DOTD TR 428. Blending to adjust the percents sand or silt will not be allowed for subgrade layers for Class I base course. Blending or treating to reduce PI will not be allowed.

(2) Treatment: Treatment of subgrade soils consists of mixing with portland cement or a combination of portland cement and lime conditioning, and compacting, finishing, and curing. In-place treatment with portland cement shall be in accordance with Section 303. When central plant mixing is used, it shall conform to Section 301. Treatment with lime shall be in accordance with Section 304 for Type C treatment. The minimum quantities of portland cement and lime shall be in accordance with the following:

P.I.	Lime or Cement (Percent by volume)
0-15	9 % cement
16-25	6 % lime and 9 % cement
26-35	9 % lime and 9 % cement

The engineer has the option of increasing or decreasing the percentages of cement and lime based on field conditions. The contract unit price for pay

item 305-01, Subgrade Layer, will be adjusted for the actual percentages of cement and lime required.

(3) Pulverization: After treatment the pulverized mixture shall conform to the gradation requirements in Table 305-1 below when tested in accordance with DOTD TR 431.

Table 305-1
Gradation Requirements for Treated Subgrade Layer

U. S. Sieve, Inches (mm)	Percent Passing By Weight (Mass)
3/4 (19.0)	95
No. 4 (4.75)	50

(b) Aggregate Subgrade Layer: Unless otherwise specified, the contractor has the option of furnishing stone, crushed slag, or recycled portland cement concrete. The aggregate subgrade layer shall be placed, compacted, finished, and protected in accordance with Section 302.

If an aggregate subgrade layer is used, a Class D geotextile fabric will be required to separate the aggregate subgrade layer from untreated soil.

(c) Asphaltic Concrete Subgrade Layer: Asphaltic concrete shall be constructed in accordance with Section 502.

(d) Blended Calcium Sulfate: Calcium sulfate shall be blended with an approved aggregate prior to placement. The blended calcium sulfate material shall be uniformly mixed and sampled from dedicated stockpiles.

Water shall be added or other suitable means taken to prevent dust during the transporting and placing of dry blended calcium sulfate.

Blended calcium sulfate shall be placed, spread, and compacted to produce layers not exceeding 12 inches (300 mm) compacted thickness. Each layer shall be placed for the full width, brought to optimum moisture content, and compacted to at least 95 percent of maximum dry density before the next layer is placed. Optimum moisture and maximum density shall be determined in accordance with DOTD TR 415 or TR 418 Method G modified to include a maximum drying temperature of 140°F (60°C). A forced draft type oven capable of maintaining the temperature shall be provided by the contractor for field moisture content determination for density control.

Blended calcium sulfate shall not be placed within 10 feet (3.0 m) of metal pipe.

Protection and curing of blended calcium sulfate shall be in accordance with Subsection 301.12(b).

305.05 MEASUREMENT. The quantities of subgrade layer for payment will be the design areas as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions of the completed subgrade layer shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary.

DOTD TR 602 measurements for width and thickness will not be made, but the width and thickness will be checked by the engineer during construction.

When aggregate, blended calcium sulfate, asphaltic concrete, or central mixing is used, the removal of existing soil materials from the subgrade will not be measured for payment.

Geotextile fabric used beneath the subgrade layer will not be measured for payment.

305.06 PAYMENT. Payment for subgrade layer will be made at the contract unit price which includes cement, water, stone, recycled portland cement concrete, crushed slag, blended calcium sulfate, asphaltic concrete, and asphalt curing membrane or prime coat, subject to the payment adjustment provisions of Section 1002 for specification deviations of asphalt materials and Subsection 303.11(a) for density deficiencies of cement treated materials. Adjustments in pay for increase or decrease in the percent cement ordered by the engineer will be in accordance with Subsection 303.13. The Materials and Testing Section will provide the payment adjustment percentage for properties of asphalt materials.

Payment for geotextile fabric will be included in the contract unit price for subgrade layer.

Payment will be made under:

Item No.	Pay Item	Pay Unit
305-01	Subgrade Layer ____in (mm) Thick	Square Yard (Sq m)

Section 306
Scarifying and Compacting Roadbed

306.01 DESCRIPTION. This work consists of scarifying, shaping and compacting an existing roadbed to form a subbase or base course in accordance with these specifications, and in conformity with the lines, grades, depth and cross section shown on the plans or established.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application for Quality Assurance Specifications for Embankment and Base Course."

306.02 CONSTRUCTION REQUIREMENTS. Existing materials shall be scarified for the full width of roadbed and a minimum depth of 6 inches (150 mm), shaped to the required section, and uniformly compacted to at least 95 percent of maximum dry density for subbase, and 100 percent for base, as determined in accordance with DOTD TR 401 and TR 415 or TR 418. Any damage to the scarified roadbed prior to compaction shall be corrected at no direct pay. The scarified, shaped and compacted roadbed shall have a smooth, uniform, closely knit surface, free from ridges, waves, depressions or loose material. Scarifying of the roadbed shall not be performed in excess of 1 mile (1.5 km) in advance of compacting the roadbed. The recompacted roadbed shall be primed in accordance with Section 505.

306.03 MAINTENANCE OF COMPACTED ROADBED. The contractor shall protect the compacted roadbed from damage due to either public traffic or construction operations and shall maintain the roadbed in satisfactory condition at all times, including the asphalt prime coat. Any damage shall be immediately repaired by the contractor at no direct pay.

306.04 MEASUREMENT. The quantities of scarifying and compacting roadbed for payment will be the design lengths or areas as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions of the roadbed shown on the plans. Design quantities will be adjusted when the engineer makes changes to adjust to field conditions, if plan errors are proven, or when design changes are necessary.

306.05 PAYMENT. Payment for scarifying and compacting roadbed will be at the contract unit price, which includes asphalt prime coat.

Payment adjustments will be applied for specification deviations of asphalt materials in accordance with Section 1002. The Materials and Testing Section will provide the payment adjustment percentage for properties of asphalt materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
306-01	Scarifying and Compacting Roadbed ___in (mm) Thick	Mile (km)
306-02	Scarifying and Compacting Roadbed ___in (mm) Thick	Square Yard (Sq m)

Section 307
Permeable Bases

307.01 DESCRIPTION. This work consists of constructing a permeable asphalt base or permeable concrete base on a prepared subbase in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical sections shown on the plans or as directed.

When a permeable base is included in the contract, the contractor shall have the option to furnish either a permeable asphalt base or a permeable concrete base unless otherwise specified. The same type of base shall be used throughout the project unless otherwise specified on the plans or approved in writing.

The permeable asphalt base shall consist of a mixture of aggregate, polymer modified asphalt cement and approved anti-strip additive. The permeable concrete base shall consist of a mixture of aggregate, portland cement, admixtures and water.

307.02 MATERIALS. Materials shall comply with the following requirements.

(a) Aggregates: The aggregates for both the permeable asphalt base and the permeable concrete base shall be 100 percent crushed stone conforming to the requirements of Subsection 1003.06 and Table 307-1 below.

Table 307-1
Gradation Requirements for Permeable Base Aggregates

Sieve Size, Inches (mm)	Percent Passing By Weight (Mass)
1 (25)	100
3/4 (19.0)	90 - 100
3/8 (9.5)	20 - 55
No. 4 (4.75)	0 - 10
No. 8 (2.36)	0 - 5

(b) Asphalt: The asphalt for asphalt treated permeable base shall be an approved polymer modified asphalt cement, PG 76-22m complying with Section 1002. The percentage of asphalt cement shall be 2.0 percent to 4.0 percent by weight (mass) of the total mixture. Asphalt cement content and mixing process shall be such that all aggregates are visibly coated. The

mixture shall retain 90 percent coating when tested in accordance with DOTD TR 317.

A job mix formula shall be submitted and approved in accordance with Section 502.

(c) Anti-Strip Additive: Anti-Strip additive for the permeable asphalt base shall be an approved product listed on the QPL 57.

The anti-strip additive shall be added at the minimum rate of 0.5 percent by weight (mass) of asphalt and shall be thoroughly mixed with the asphalt cement at the plant. Additional anti-strip additive may be added up to 1.2 percent by weight (mass).

The proposed job mix formula shall indicate a single anti-strip additive rate which is 0.1 percent greater than the percentage which will yield a minimum of 90 percent coating when tested in accordance with DOTD TR 317. The approved range shall be 0.2 percent by weight (mass) of asphalt, with the lower limit being the quantity determined in accordance with DOTD TR 317 and the maximum limit not to exceed 1.2 percent by weight (mass) of asphalt.

(d) Permeable Portland Cement Concrete: Cement for permeable concrete base shall be a Type I portland cement complying with Section 1001.

Permeable concrete base shall have a minimum cement content of 235 pounds of portland cement per cubic yard (140 kg/cu m) of concrete. The water cement ratio of the mixture shall be not more than 0.37.

(e) Admixtures: Admixtures for the permeable concrete base shall comply with Subsection 1011.02. The rate shall be as indicated in the QPL 58.

307.03 CONSTRUCTION.

(a) Permeable Asphalt Base: The permeable asphalt base shall be placed in accordance with Section 502. Compaction shall be with one to three passes of a 5 to 10 ton (4.5 to 9 Mg) smooth steel-wheel roller conforming to Section 503.

Permeable asphalt base shall be placed at a temperature between 200°F to 260°F (90°C to 125°C) when measured in the hopper of the paving machine. Compaction shall begin when the temperature of the permeable asphalt base has cooled to approximately 160°F (70°C) and shall be completed before the temperature falls below 100°F (35°C).

(b) Permeable Concrete Base: The permeable concrete base shall be placed by slip forming in accordance with Section 601 or by an asphaltic concrete paver in accordance with Section 503. Compaction shall

be performed by using vibrating screeds or plates as directed. No construction joints will be required.

Immediately after concrete placement, the permeable concrete base shall be cured by covering the entire surface and exposed edges with white pigmented curing compound in accordance with Subsection 601.10.

307.04 PROTECTION. The contractor shall protect the permeable asphalt base and permeable concrete base from severe weather conditions and contamination by dust, dirt, mud or other fine grained material. The base shall be protected by an approved method from the time of placement until placement of the following pavement layer. No traffic will be permitted on the permeable asphalt base or permeable concrete base. Equipment required to place the pavement will be allowed provided that it enters and exits as near as possible to the paving operation. Any damage to the permeable bases caused by the contractor's equipment shall be repaired by the contractor at no direct pay.

Any portion of the permeable bases which become contaminated to the extent that drainage is reduced or inhibited shall be removed and replaced at no direct pay.

The permeable bases shall be covered with the pavement within 15 working days after placement.

307.05 TOLERANCES. The finished surface of permeable asphalt base and permeable concrete base shall be uniform and shall not vary at any point more than 0.05 foot (15 mm) above or below the established grade. The cross-slope shall not vary by more than ±0.003 ft/ft (±3 mm/m).

Permeable asphalt base or permeable concrete base with a surface higher than 0.05 foot (15 mm) above the established grade shall be removed and replaced with permeable base which complies with these specifications, or when permitted, the high spots may be removed to within specified tolerance by any method that does not produce contaminating fines nor damage the base to remain in place. Grinding will not be permitted.

Permeable base with a surface lower than 0.05 foot (15 mm) below the established grade shall be removed and replaced with permeable base which complies with these specifications. When permitted, low areas not exceeding 1 inch (25 mm) shall be filled with pavement at the time and in the same operation in which the pavement is placed at no direct pay.

307.06 TESTING. Before placing surfacing, the contractor shall core the permeable bases at the locations determined by the engineer in accordance with DOTD TR 602. All cores taken by the contractor shall be given to the engineer for verification of base thickness.

307.07 MEASUREMENT. Permeable asphalt base and permeable concrete base will be measured by the square yard (sq m) from the design quantities shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary. Design areas of permeable base are based on the horizontal dimensions shown on the plans, the length being along the centerline of the base.

307.08 PAYMENT. Payment for permeable asphalt base and permeable concrete base will be made at the contract unit price per square yard (sq m), which shall include all materials, tools, incidentals and the performance of work necessary to complete these items.

Payment will be made under:

Item No.	Pay Item	Pay Unit
307-01	Permeable Base ____in (mm) Thick	Square Yard (Sq m)

Section 308
In-Place Cement Treated Base Course

308.01 DESCRIPTION. This work consists of scarifying, pulverizing, blending, shaping and treating roadbed material with portland cement, portland-pozzolan cement, or portland blast-furnace slag cement in accordance with the lines, grades, thickness and sections established or shown on the plans.

Cement treatment is primarily used for recycling existing roadbed materials typically 12 inches (300 mm) thick, unless specified otherwise. When specified, the contractor shall furnish and place materials under different pay items to be treated in accordance with this section or stabilized in accordance with Section 303.

With approval, concrete complying with Section 901 or asphaltic concrete complying with Section 502 may be used in lieu of the specified base course material in areas that are inaccessible for mixing and compacting in turnouts and crossovers, and in other isolated or irregular areas. The concrete shall be placed, consolidated, finished, and cured as directed in accordance with Section 706. The contractor shall remove and satisfactorily dispose of existing materials as required to accommodate placement of the portland cement concrete or asphaltic concrete at no direct pay. Excess material shall be disposed of in accordance with Subsection 202.02.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Embankment and Base Course."

308.02 MATERIALS. Materials shall comply with the following Sections or Subsections:

Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Portland Blast-Furnace Slag Cement	1001.04
Emulsified Asphalt	1002
Water	1018.01

Portland cement shall be Type I or II. Portland-pozzolan cement shall be Type IP. Portland blast-furnace slag cement shall be Type IS. The quantity of cement used shall be supported by proof of delivery.

Portland blast-furnace slag cement shall contain a maximum of 50 percent ground granulated blast-furnace slag by weight. Pre-blending of Types I or II portland cement and ground granulated blast-furnace slag will be allowed if blended at an approved blending facility and mixed thoroughly to insure a uniform blend. The ground granulated blast-furnace slag used in pre-blending shall be from a source listed in QPL 70 and shall meet the requirements of Subsection 1018.27.

Soils or soil-aggregate combinations furnished by the contractor for treatment in accordance with this section shall comply with the requirements of Subsection 302.02(a), except that if an A-4 or A-6 Soil Group material is used, it shall meet the durability requirements of DOTD TR 432, Method D.

308.03 EQUIPMENT. Equipment necessary to produce a finished base course shall be in accordance with Subsection 303.03.

308.04 PREPARATION OF ROADBED. Unless otherwise designated in the plans, roadbed preparation shall be in accordance with Subsection 303.04.

308.05 CEMENT TREATMENT. For portland cement, the roadbed material shall be treated with a rate of cement by volume as shown on the plans. For portland-pozzolan cement and portland blast-furnace slag cement, the rate of blended cement will be determined prior to mixing using TR 432, Method B or C, whichever is applicable, using 150 psi (1050 kPa) as the design compressive strength criteria. In addition, the durability of base courses utilizing portland-pozzolan cement or portland blast-furnace slag cement shall be determined in accordance with DOTD TR 432, Method D, utilizing the rate of cement determined from Method B or C.

The laboratory testing specified above for portland-pozzolan cement and portland blast-furnace slag cement shall be performed at the contractor's expense at a laboratory approved by the Materials Engineer Administrator. Sufficient material shall be obtained at the time of sampling to provide the District laboratory with approximately 200 pounds (90 kg) of the base material to be treated for verification testing. Approximately 10

pounds (5 kg) of the cementitious material to be used shall also be provided to the District laboratory. Materials for verification testing shall be provided at no cost to the Department. Verification testing will consist of molding and curing of three specimens at the percentage of cementitious material to be used determined by the contractor's laboratory to meet the minimum strength and durability criteria as specified above. The specimens shall be cured and tested according to TR 432, using the Method that required the higher percent cement. If the verification testing results do not produce an average compressive strength of 150 psi (1050 kPa), or meet the durability requirements of TR 432, Method D, the contractor shall halt construction of the base until such time as a new mix design can be developed and verified.

The method of spread shall be such that the amount of cement used can be readily determined when tested in accordance with DOTD TR 436. Cement shall be uniformly spread and mixed with the material. Pulverization, in accordance with Subsection 303.04, shall be maintained throughout the treatment process. A minimum of two passes with the mixer (stabilizer) will be required. The mixture shall be shaped to the required section.

Water shall be added as needed by means of the mixer and shall be uniformly incorporated in the mixture in amounts required to attain optimum moisture for the mixture. During the mixing process, water shall be added only through the spray bar of the in-place mixer which is adjusted to provide uniform coverage across the completed width of the roadway for the full depth of the base. Wet streaks or spots will not be allowed.

Optimum moisture of the mixture will be determined in accordance with DOTD TR 415 or TR 418. The percentage of moisture determined in accordance with DOTD TR 403 in the mixture by dry weight shall not vary from optimum moisture by more than ±2 percent at the time of compaction.

308.06 COMPACTING AND FINISHING. Unless otherwise designated on the plans, compaction and finishing of cement treated base course shall be accordance with Subsection 303.06.

308.07 QUALITY CONTROL. The contractor shall control the preparation of roadbed, selection and placement of materials, cement spread, mixing, compaction, moisture content, density, thickness, width, surface finish, grade and cross slope so that the completed base course is uniform and conforms to plan dimensions and other acceptance requirements as provided herein. The contractor shall control his operations

so that contamination, segregation, soft spots, wet spots, laminations and other deficiencies are prevented. The contractor shall be responsible for taking such tests as necessary to adequately control the work.

308.08 PROTECTION AND CURING. Upon completion of final finishing, the cement treated base shall be immediately protected against rapid drying by applying an asphalt curing membrane in accordance with Section 506. Asphalt curing membrane shall be placed on the same day as treatment. Complete coverage of curing membrane shall be maintained from initial application until the placement of the next course. When traffic, including construction equipment, is allowed on the base course, at least the first lift of surfacing shall be placed within 30 calendar days unless otherwise directed.

308.09 MAINTENANCE. The contractor shall protect the completed base course from damage due to either public traffic or the contractor's operations, and shall satisfactorily maintain the completed base course including asphalt curing membrane in accordance with Section 303.

308.10 WEATHER LIMITATIONS. Mixing will not be permitted when the base course material is frozen, when raining, when the ambient air temperature is below 35°F (2°C), or the temperature forecasted by the U.S. Weather Service is to be 25°F (-3°C) or less within the 24 hour period following placement.

308.11 ACCEPTANCE REQUIREMENTS. Cement spread rate will be tested in accordance with DOTD TR 436.

The moisture content of the cement treated mixtures will be tested for compliance with optimum moisture content in accordance with DOTD TR 403 at placement at least twice per day.

The pulverization of the prepared roadbed will be tested in accordance with DOTD TR 431, and shall be at least 60 percent passing the No. 4 (4.75 mm) sieve.

The completed base course will be checked for determining acceptance in increments of 1,000 linear feet (300 lin m) per roadway or 2,000 linear feet (600 lin m) per shoulder constructed separately.

(a) Density Requirements: Upon completion of compaction operations, in-place density will be determined in accordance with DOTD TR 401.

The density requirement as based on DOTD TR 415 or TR 418 will be 95.0 percent of maximum density.

When the density test value for the section is below 95.0 percent, a payment adjustment will be applied in accordance with Table 308-1 below.

Table 308-1
Density Acceptance and Payment Schedule

Density Test Value	Percent of Contract Unit Price
95.0 & Above	100
93.0 to 94.9	90
90.0 to 92.9	75
Below 90.0	50 or Remove[1]

[1]At the option of the Department after investigation.

(b) Thickness Requirements: The thickness of the completed base course will be determined in accordance with DOTD TR 602.

The completed base course shall not vary from plan thickness in excess of the tolerances in Table 308-2 as follows. Base course thickness deficiencies in excess of these tolerances shall be corrected as specified herein at no direct pay.

Table 308-2
Base Course Thickness Tolerance

Underthickness, Inches (mm)	Overthickness, Inches (mm)
3/4 (20)	1 1/2 (40)

Any failing area will be isolated for purposes of correction. Base course thickness deficiencies in excess of the foregoing tolerances shall be corrected as follows.

When no grade adjustments are permitted, thickness deficiencies shall be corrected by retreatment with cement or removing and replacing the full depth of base course in deficient areas with one of the following materials:

(1) Cement treated base course.
(2) Asphaltic concrete complying with Section 502.
(3) Concrete complying with Section 901.

When grade adjustments are permitted, the contractor shall have the option of correcting deficiencies by furnishing and placing a supplemental layer of asphaltic concrete complying with Section 502 for the full width of base course in lieu of removing and replacing deficient base course. When approved, corrections may be made by retreatment of the existing material

in accordance with this section. Thickness of the supplemental layer of asphaltic concrete shall be in accordance with Table 308-3 as follows.

Table 308-3
Supplemental Asphaltic Concrete Layer Thickness

Underthickness, Inches (mm)	Overthickness, Inches (mm)	Minimum Thickness of Supplemental Asphaltic Concrete[1], Inches (mm)
1 to 1 1/2 (30 to 40)	1 3/4 to 2 (45 to 50)	1 1/4 (35)
1 3/4 to 2 (45 to 50)	2 1/4 to 2 1/2 (60 to 65)	1 1/2 (40)
2 1/4 to 2 1/2 (60 to 65)	2 3/4 to 3 (70 to 80)	2 (50)
Over 2 1/2 (Over 65)	Over 3 (Over 80)	Remove and Replace[2]

[1]May be placed with subsequent lift of asphaltic concrete.
[2]At the option of the Department after investigation

(c) Width Requirements: The width of the completed base course will be determined in accordance with DOTD TR 602. Roadway base course width shall not vary from plan width in excess of +6 inches (+150 mm). Shoulder base course width shall not vary from plan width in excess of +3 inches (+75 mm). No tolerances are provided for underwidths of shoulder or roadway bases. When the base course for roadway and shoulders are constructed at the same time, the 6-inch (150 mm) width tolerance will be applied. Base course width deficiencies in excess of foregoing tolerances shall be corrected as follows at the contractor's expense.

(1) Overwidth: When no grade adjustments are permitted, the full depth and width of base course in isolated areas having overwidths in excess of the foregoing tolerances shall be retreated full width with cement or removed and replaced to the plan width with asphaltic concrete complying with Section 502 or concrete complying with Section 901.

In lieu of removing and replacing overwidth base course, areas of the deficient base course will be allowed to remain in place at a payment adjustment of 90 percent of the contract unit price for the entire lot.

When grade adjustments are permitted, the contractor shall correct base course width deficiencies by removing and replacing as specified above, or by furnishing and placing a 1 1/4 inch (35 mm) thick supplemental layer of asphaltic concrete complying with Section 502 for the full width of the roadway.

(2) Underwidth: Underwidths of base course in excess of the foregoing tolerances shall be corrected to plan width by retreating the full width with cement or by furnishing and placing additional materials;

however, the width and thickness of the widening materials shall be not less than 12 inches (300 mm). Materials used for widening the deficient base course shall be the same as specified for overwidth correction in Heading (c) (1) above.

(d) Grade and Cross-slope: The finished grade shall be within ±1/2 inch (±15 mm) of the established grade. The cross-slope shall not vary by more than ±0.003 ft/ft (±3 mm/m).

(e) Correction of Deficiencies: The contractor shall correct deficiencies in surface finish, grade, contamination, segregation, soft spots, wet spots, laminations and other deficiencies at no direct pay. Deficiencies shall be corrected by removing and replacing or as directed.

308.12 MEASUREMENT. The quantity of in-place cement treated base course for payment will be the design areas as specified in the plans and adjustments thereto. The design quantity is based on the horizontal dimensions of the completed base course shown on the plans. The design quantity will be adjusted if the engineer makes changes to adjust to field conditions, if design errors are proven, or if design changes are necessary.

Removal of existing patches will be measured by the square yard (sq m). This measurement will be determined and documented jointly by the contractor and project engineer. If no item is included in the contract, measurement will be in accordance with Subsection 109.04.

308.13 PAYMENT. Payment for in-place cement treated base course will be made at the contract unit prices, adjusted as specified in Subsection 308.11 which include furnishing cement, water, asphalt curing membrane, labor and equipment, and performing necessary roadbed preparation. Payment for removing all existing asphaltic concrete surfacing will be made under Section 509 except for the bottom 1 inch (25 mm). No direct payment will be made for removal and disposal of the remaining [bottom 1 inch (25 mm)] of asphaltic surfacing or maintaining the areas in safe condition for traffic.

If the actual required percent of cement differs from that required by the contract documents, payment will be increased or decreased based on the difference in required quantity of cement at the price of cement shown on paid invoices (total of all charges). The contractor shall provide copies of paid invoices for this determination. If the contract documents do not specify a percent cement, 6 percent cement will be used for bid purposes.

Removal of existing patches will be paid at the contract unit price or if no item is provided, in accordance with Subsection 109.04. However, no

payment will be made unless the contractor identifies the patches and participates in the measurement and documentation.

Payment adjustments will be applied for specification deviations of asphalt materials in accordance with Section 1002 based on the invoice price per gallon (L). The Materials and Testing Section will provide the payment adjustment percentage for properties of asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
308-01	In-Place Cement Treated Base Course ___ in (mm) Thick	Square Yard (Sq m)
308-02	Removal of Existing Patches	Square Yard (Sq m)

PART IV -- SURFACE COURSES

Section No. **Page No.**

Section 401
Aggregate Surface Course

401.01 DESCRIPTION. This work consists of furnishing and constructing aggregate surface courses for shoulders, drives or other facilities in accordance with these specifications, and in conformity with the lines, grades, thicknesses and typical sections shown on the plans or established.

401.02 MATERIALS. The contractor has the option of furnishing any one of the following types of aggregate surface course materials complying with the following Subsections.

Stone	1003.01 & 1003.04(a)
Sand-Clay-Gravel (Lime Treated)	1003.01 & 1003.04(b)
Recycled Portland Cement Concrete	1003.01 & 1003.04(c)
Reclaimed Asphaltic Pavement	1003.01 & 1003.04(d)
Crushed Slag	1003.01 & 1003.04(e)
Water	1018.01
Lime	1018.03

Aggregate surface course materials shall be a uniform blend, sampled in dedicated stockpiles and approved prior to placement.

Unless otherwise approved in writing, the same type material shall be used throughout the project.

401.03 EQUIPMENT. Equipment necessary to produce a finished product meeting specification requirements shall be furnished and maintained by the contractor. Equipment will be approved prior to use.

401.04 SHOULDER CONSTRUCTION.

(a) General: The subgrade shall be approved before aggregate surface course is placed. Material removed from shoulders shall be uniformly spread adjacent to the shoulder material.

(b) Existing Shoulders: On existing shoulders, where only aggregate surface course is to be placed, vegetation shall be removed and the shoulders shaped and satisfactorily compacted prior to placing aggregate surfacing. For reconstructed shoulders, the top layer under the

subgrade shall be a usable soil complying with Subsection 203.06 and shall be compacted to a minimum of 95.0 percent of maximum dry density. Maximum dry density will be determined in accordance with DOTD TR 415 or DOTD TR 418 and percent in-place density in accordance with DOTD TR 401.

(c) New Shoulders: For new shoulders, the top layer under the subgrade shall be a usable soil complying with Subsection 203.06 and shall be compacted to a minimum of 95.0 percent of maximum dry density. Maximum dry density will be determined in accordance with DOTD TR 415 or DOTD TR 418 and percent in-place density in accordance with DOTD TR 401.

401.05 PLACING MATERIALS. The material shall be placed directly on the prepared and approved subgrade from hauling vehicles or spreading equipment. No surface course shall be placed on damaged subgrade until repairs conforming to Subsection 401.04 have been completed and approved.

Aggregate surfacing materials shall not be placed or spread on adjacent portland cement concrete or asphaltic concrete pavements. Aggregate surfacing operations shall be conducted so that pavement surfaces, edges, and joints are not damaged.

401.06 MIXING. Sand-clay-gravel shall be uniformly mixed with 6 percent lime by volume, except that for central mixing, 5 percent lime will be used. The sand-clay-gravel shall be sampled and approved prior to treatment with lime.

Adequate moisture shall be added to control compaction.

401.07 SHAPING AND COMPACTING AGGREGATE SURFACE COURSE.

(a) General: The material shall be shaped by suitable means and compacted. Shaping and compacting shall continue until the surface conforms to the required sections and is free from ruts and waves.

(b) Aggregate Surfacing: Aggregate surfacing shall be compacted to the satisfaction of the engineer by approved methods. After initial compaction, the surface shall be wetted as necessary and rolled with a pneumatic-tire or steel-wheel roller to a tight, uniform surface.

(c) Reclaimed Asphaltic Pavement: Reclaimed asphaltic material shall be placed to required thickness, shaped to the required

section, and compacted with at least three passes by an approved pneumatic-tire roller to a tight, uniform surface.

(d) Lime Treated Materials: Finishing and compacting of lime treated materials shall be completed within 72 hours after initial mixing with lime.

401.08 DIMENSIONAL TOLERANCES. When net section measurement is specified, the thickness and width of completed aggregate surface course will be checked for acceptance in accordance with DOTD TR 602. Areas with thickness and width deficiencies in excess of the following tolerances shall be corrected to plan dimensions by furnishing, placing, reworking, shaping, and compacting additional materials as required at no direct pay.

(a) Thickness: Underthickness shall not exceed 3/4 inch (20 mm). Overthickness may be waived at no additional cost to the Department.

(b) Width: Underwidth on shoulders shall not exceed 3 inches (75 mm). Overwidth may be waived at no additional cost to the Department.

When vehicular measurement is used, no DOTD TR 602 measurements will be made. The engineer will take measurements to ensure the work's conformance to plan dimensions.

401.09 MEASUREMENT.

(a) Net Section: The quantities of aggregate surface course for payment will be the design volumes as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions and the compacted thickness of the completed aggregate surface course shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary.

(b) Adjusted Vehicular Measurement: Surface course material will be measured by the cubic yard (cu m) in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

Materials delivered by volume will be measured by the cubic yard (cu m) in hauling vehicles and divided by the following factors to determine the pay volume:

Table 401-1
Adjusted Vehicular Measurement (Materials Delivered by Volume)

Material	Factor
Stone or Crushed Slag	1.30
Lime Treated Sand-Clay-Gravel	1.30
Recycled Portland Cement Concrete	1.30
Reclaimed Asphaltic Pavement	1.50

Materials delivered by weight (mass) will be measured by the ton (2,000 pounds) [Mg (1,000 kg)] in hauling vehicles and divided by the following factors to determine the pay volume:

Table 401-2
Adjusted Vehicular Measurement (Materials Delivered by Weight (Mass))

Material	Tons to Cubic Yards, Factor	Megagrams to Cubic Meters, Factor
Limestone	1.95	2.34
Sandstone	1.82	2.15
Porous Limestone	1.76	2.08
Lime Treated Sand-Clay-Gravel	1.89	2.21
Recycled Portland Cement Concrete	1.82	2.15
Reclaimed Asphaltic Pavement	1.80	2.10

401.10 PAYMENT. Payment for aggregate surface course will be made at the contract unit price per cubic yard (cu m), which includes preparation of existing shoulders, furnishing and placing and compacting required aggregate materials, water and lime.

Payment will be made under:

Item No.	Pay Item	Pay Unit
401-01	Aggregate Surface Course (Net Section)	Cubic Yard (Cu m)
401-02	Aggregate Surface Course (Adjusted Vehicular Measurement)	Cubic Yard (Cu m)

Section 402
Traffic Maintenance Aggregate

402.01 DESCRIPTION. This work consists of furnishing and constructing aggregate surfacing for maintenance of traffic as directed and in accordance with the following requirements.

402.02 MATERIALS. Aggregate for maintenance of traffic shall be stone, wash gravel, recycled portland cement concrete, or reclaimed asphaltic pavement (RAP) satisfactory to the engineer.

402.03 EQUIPMENT. Equipment, necessary to produce a finished product meeting specification requirements shall be furnished and maintained by the contractor.

402.04 CONSTRUCTION REQUIREMENTS. The contractor shall satisfactorily place, shape, compact and maintain areas requiring traffic maintenance aggregate. When directed, the aggregate material shall be reused at adjacent locations when the material can be reasonably shifted by blading at no direct pay. When directed, material shall be loaded, hauled and re-used and paid at 50 percent of the contract unit price. Unless otherwise allowed by the project engineer, aggregate surfacing no longer necessary for maintenance of traffic shall be removed and disposed of in accordance with Section 202.

402.05 MEASUREMENT. Traffic maintenance aggregate will be measured by the cubic yard (cu m) in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01. No adjustment factor will be used.

402.06 PAYMENT. Payment for traffic maintenance aggregate maintained and subsequently removed (when required) will be made at the contract unit price under:

Item No.	Pay Item	Pay Unit
402-01	Traffic Maintenance Aggregate (Vehicular Measurement)	Cubic Yard (Cu m)

Section 403
Aggregate Roadway Surfacing

403.01 DESCRIPTION. This work consists of furnishing and constructing aggregate roadway surfacing in accordance with plan details and the following requirements.

403.02 MATERIALS. Aggregate surfacing material shall be gravel conforming to Subsection 1003.08(c)(1) or stone or recycled portland cement concrete conforming to Subsection 1003.04.

403.03 EQUIPMENT. Equipment, necessary to produce a finished product meeting specification requirements shall be furnished and maintained by the contractor.

403.04 CONSTRUCTION REQUIREMENTS. The subgrade shall be prepared as provided in Section 203 and shall be approved before surfacing material is placed. After placement of aggregate surfacing, the aggregate shall be blended with the top two inches (50 mm) of the subgrade materials by blade mixing or other approved methods.

Surface course material shall be satisfactorily shaped and compacted. Shaping and compacting shall continue until the surface conforms to the required section and is free from ruts and waves.

403.05 MEASUREMENT. Aggregate surfacing will be measured by the cubic yard (cu m) in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

403.06 PAYMENT. Payment will be made at the contract unit price under:

Item No.	Pay Item	Pay Unit
403-01	Aggregate Roadway Surfacing (Vehicular Measurement)	Cubic Yard (Cu m)

PART V -- ASPHALTIC PAVEMENTS

Section No. **Page No.**

Section 501 (Reserved)

Section 502
Superpave Asphaltic Concrete Mixtures

502.01 DESCRIPTION.

(a) General: These specifications are applicable to Superpave asphaltic concrete wearing, binder and base course mixtures of the plant mix type.

This work consists of furnishing and constructing one or more courses of asphaltic concrete mixture applied hot in conformance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown on the plans or established. The mixture shall consist of aggregates and asphalt with additives combined in proportions which meet the requirements of this section. Equipment and processes shall conform to Section 503.

(b) Quality Assurance: Quality assurance requirements and design procedures shall be as specified herein elsewhere and in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures" which is hereby made a part of this contract by reference.

It is the intent of these specifications that the mixtures produced and placed meet the requirements for 100 percent payment. Work shall meet the requirements of this section and be subject to acceptance by the Department.

The contractor shall be responsible for and shall exercise quality control over materials and their assembly, design, processing, production, hauling, laydown and associated equipment. Quality control is defined as the constant monitoring of equipment, materials and processes to ensure that mixtures produced and placed are uniform, within control limits, and meet specification requirements. When these specifications are not being met and satisfactory control adjustments are not being made, operations shall be discontinued until proper adjustments and uniform operations are established. Control shall be accomplished by a program independent of the Department's testing and shall ensure that the requirements of the job mix are being achieved and that necessary adjustments provide the specified results.

The quality of mixtures will be evaluated during two phases, mixture produced at the plant, and mixture hauled, placed and compacted. Quality of both phases will be evaluated continuously as stated herein elsewhere.

Plant quality control testing shall be conducted continuously throughout production independent of delivery points. Project site quality control testing shall be conducted on each project for the mix placed on that project.

When the plant is in operation, the contractor shall have a Certified Asphaltic Concrete Plant Technician at the plant or jobsite who is capable of designing asphaltic concrete mixes, conducting any test or analysis necessary to put the plant into operation and producing a mixture meeting specifications. Daily plant operations shall not begin unless the Certified Asphaltic Concrete Plant Technician is at the plant. The Asphaltic Concrete Plant Technician certification will be awarded by the Department upon satisfactory completion of the Department's requirements.

(c) Mixture Substitutions: Changes in design level will not be allowed on the roadway. Substitutions will be allowed for mixes without requiring a change order as follows. Wearing course [0.75 inch (19 mm)] may be substituted for binder course but not substituted for base course. Binder course [1 inch (25 mm)] may be substituted for base course. Wearing Course, 0.5 inch (12.5 mm) may be substituted for Incidental Paving, Level A. Shoulders may be any mixture type shown in Table 502-5 regardless of design level.

When any substitution is made, all specification requirements for the mixture used shall apply with the following exceptions. When wearing course is substituted for binder course, RAP will be allowed in accordance with binder course requirements in Table 502-5. The lift thickness placed shall be as specified in Subsection 502.08 and Table 502-5 for the mix type used.

502.02 MATERIALS. All materials must be sampled in accordance with the Materials Sampling Manual and shall be tested in accordance with the test procedures in Table 502-1. The contractor shall keep accurate records, including proof of deliveries of materials for use in asphaltic concrete mixtures. Copies of these records shall be furnished to the engineer upon request. Materials shall comply with the following Subsections:

Asphalt	1002
Silicone and Anti-Strip Additives	1002.02
Aggregates	1003.01 & 1003.06
Reclaimed Asphaltic Pavement (RAP)	1003.01 & 1003.06
Hydrated Lime	1018.03(a)
Mix Release Agent	1018.25

Table 502-1
Test Procedures for Superpave Asphaltic Concrete

Description	Test Method
Specific Gravity and Density of Compressed Asphaltic Mixtures	DOTD TR 304
Theoretical Maximum Specific Gravity, G_{mm}	DOTD TR 327
Asphalt Cement Content, P_b	DOTD TR 323
Mechanical Analysis of Extracted Aggregate	DOTD TR 309
Moisture Content of Loose HMA	DOTD TR 319
Degree of Particle Coating (plant requirement)	DOTD TR 328
Moisture Sensitivity (Lottman) (Tensile Strength Ratio)	DOTD TR 322
Bulk Specific Gravity and Absorption	AASHTO T 84, T 85
Coarse Aggregate Angularity, % Crushed (Double Faced)	DOTD TR 306
Fine Aggregate Angularity	DOTD TR 121
Flat and Elongated Particles	ASTM D 4791
Sand Equivalent	DOTD TR 120
Mixture Conditioning (Aging) of HMA Mixtures	AASHTO R 30
Superpave Volumetric Mix Design	AASHTO M 323
Preparing Gyratory Samples	AASHTO T 312
Asphalt Cement Draindown	ASTM D 6390
Longitudinal Profile Using Automated Profilers	DOTD TR 644
Thickness and Width of Base and Subbase	DOTD TR 602

(a) Asphalt Cement: The asphalt cement grades used shall be as specified in Table 502-2 using the design traffic load levels shown on the plans.

If the asphalt cement does not comply with the requirements of Section 1002, mix production shall cease until proper asphalt material is supplied.

Table 502-2
Superpave Asphalt Cement Usage

Current Traffic Load Level	Mixture Type	Grade of Asphalt Cement
Level 1	Wearing Course	PG 70-22m
	Binder Course	PG 70-22m
	Base Course	PG 64-22
Level 2	Wearing Course	PG 76-22m
	Binder Course	PG 76-22m
Level A	Incidental Paving	PG 70-22m

Base course mixtures containing 20 to 30 percent RAP shall use PG 58-28 asphalt cement.

When mixtures are used for bike paths, curbs, detour roads, driveways, guardrail widening, islands, joint repair, leveling, parking lots, patching, or widening, PG 64-22 asphalt cement may be used in lieu of the modified asphalts. Unless otherwise noted on the plans, PG 64-22 asphalt cement may also be used on shoulders in lieu of the modified asphalts.

PG 76-22m asphalt cement may be substituted for PG 70-22m or PG 64-22 asphalt cements at no increase in price. PG 70-22m asphalt cement may be substituted for PG 64-22 at no increase in price. When average daily traffic (ADT) is less than 2500, PG 70-22m Alternate asphalt cement may be substituted for PG 70-22m asphalt cement for Level 1 and Level A mixes at no increase in price.

(b) Additives:

(1) Silicone: Silicone additives, when needed, shall be dispersed into the asphalt cement by methods and in concentrations given in QPL 22.

(2) Anti-Strip (AS): An anti-strip additive shall be added at the minimum rate of 0.5 percent by weight (mass) of asphalt cement and thoroughly mixed in-line with the asphalt cement at the plant. Additional anti-strip shall be added up to 1.2 percent by weight (mass) of asphalt in accordance with Subsection 502.03.

When the amount of anti-strip additive is not in accordance with the approved job mix formula, production shall be discontinued until satisfactory adjustments are made.

(3) Hydrated Lime: Hydrated lime additive may be incorporated into all asphaltic concrete mixtures at the rate specified in the approved job mix formula. The minimum rate shall not be less than 1.5 percent by weight (mass) of the total mixture. Hydrated lime additive shall be added to and thoroughly mixed with aggregates in conformance with Subsection 503.05(c). Hydrated lime may be added as a mineral filler in accordance with Heading (c)(3).

(c) Aggregates: Aggregates shall meet the requirements of Table 502-5 and Section 1003.

(1) Friction Ratings: Friction ratings for aggregates shall be determined in accordance with Subsection 1003.06. The friction ratings and allowable usage of aggregates shall be as shown in Table 502-3. Friction rating requirements shall apply only to the final lift of the travel lane wearing course. Bike paths, curbs, driveways, guardrail widening, islands, joint repair, leveling, parking lots, patching, shoulders, widening and incidental paving uses, and roadway binder and base courses may use

any combination of Friction Rating I, II, III, and IV aggregates, in combination with the allowable RAP percentages.

Table 502-3
Aggregate Friction Rating

Friction Rating	Allowable Usage
I	All mixtures
II	All mixtures
III	All mixtures, except travel lane wearing courses with plan ADT greater than 7000[1]
IV	All mixtures, except travel lane wearing courses[2]

(2) Reclaimed Asphaltic Pavement (RAP): Reclaimed asphaltic pavement shall be stockpiled separate from other materials at the plant and will be subject to approval prior to use. Such stockpiles shall be uniform and free of soil, debris, foreign matter and other contaminants. Reclaimed materials that cannot be broken down during mixing or that adversely affect paving operations shall be screened or crushed to pass a 2 inch (50 mm) sieve prior to use.

(3) Mineral Filler: Mineral filler complying with the requirements of Subsection 1003.06(a)(6) may be used in all mixtures.

(4) Natural Sand: Natural sand shall meet the requirements of Table 502-5 and Subsection 1003.06(a)(3).

502.03 DESIGN OF ASPHALTIC MIXTURES, JOB MIX FORMULA (JMF). The contractor shall design the mixtures for optimum asphalt content and comply with requirements of the Superpave Mix Design for the level of mixture in Table 502-5 in accordance with AASHTO M 323. The job mix formula shall include the recommended formula, extracted gradation, and supporting design data. The recommended formula shall be submitted for approval to the District Laboratory Engineer on a properly completed Superpave Asphaltic Concrete Job Mix Formula form with all supporting design data. No mixture shall be produced until the proposed job mix formula has been approved.

The contractor's proposed job mix formula shall indicate a single anti-strip additive rate which is 0.1 percent greater than the percentage which will yield a minimum Tensile Strength Ratio (TSR) of 80 percent up to a

maximum of 1.2 percent anti-strip additive when tested in accordance with DOTD TR 322.

The job mix formula shall indicate a single rate of hydrated lime additive, when used. The job mix formula rate of hydrated lime additive shall not be less than 1.5 percent by weight (mass) of total mixture.

The job mix formula shall indicate the optimum mixing temperature. The job mix formula limits for mix temperature will be ±25°F (±14°C) from the optimum mixing temperature.

The job mix formula is to be inside the control points as detailed in Table 502-4. Blending of aggregates, i.e., gravel and stone, will be allowed provided the final composite mixture and final product meets or exceeds all specifications requirements.

The plant shall be operated to produce, on a continuing basis, a mixture uniformly conforming to the approved job mix formula. When this is not the case, the contractor shall make satisfactory adjustments or cease operations. The District Laboratory Engineer may permit the contractor to submit a new Asphaltic Concrete Job Mix Formula form for approval. The contractor shall submit a new job mix formula whenever a plant begins initial operations for the Department in a specific location or whenever a plant experiences a change in materials or source of materials. A new job mix formula will also be required whenever there are significant changes in equipment, such as the introduction of a new crusher, drum mixer, burner, etc.

When reclaimed asphaltic pavement (RAP) is used in a roadway mix, the quantity of RAP shall be designated in the job mix formula and meet the requirements of Table 502-5. The engineer may require the contractor to reduce the percentage of RAP to meet acceptance requirements.

When the contractor changes a source of RAP, the new mix design shall be submitted, validated and approved if the type of aggregate changes (e.g. gravel to limestone) or the source change causes a change in acceptance tolerances. If the contractor determines that the source change will not cause a change in acceptance tolerances, the contractor may elect to integrate the new RAP source into the existing approved mix design provided the contractor submits a revised job mix formula cover sheet which shows the new source of RAP and other changes. A new validation will not be required. If subsequent acceptance tests indicate that the mix is out of tolerance, a new design will be required and appropriate payment adjustments will apply.

502.04 JOB MIX FORMULA VALIDATION. The first day's production or a maximum of 2000 tons (2000 Mg) of mix shall be used to validate a new JMF. The contractor and the Department, using the stratified random sampling approach, shall jointly take five (5) samples, one per validation sublot, during the validation lot. The contractor may elect to exclude test results representing the first 250 tons (250 Mg) from the validation analysis in order to make slight adjustments to the mix. The remaining validation lot, up to 1750 tons (1750 Mg), shall be divided into five (5) equal validation sublots and tested for validation analysis. If excluded from validation, the 250 tons (250 Mg) will be paid in accordance with Table 502-9.

Minimum testing shall include one theoretical maximum specific gravity (G_{mm}), one gyratory specimen compacted to N_{design}, one gyratory specimen compacted to N_{max}, and one oven extraction. As approved by the district laboratory engineer, the contractor and the Department shall jointly analyze the test results for the following parameters:

(1) Extracted Gradation
(2) Percent Extracted Asphalt Cement
(3) Percent Crushed Aggregate, (from cold feed blends)
(4) Theoretical Maximum Specific Gravity (G_{mm}) (aged for one hour)

The following parameters apply to samples aged for one hour in an oven at gyratory compaction temperature and compacted to N_{design}.

(5) Bulk Specific Gravity (G_{mb}) at N_{design}
(6) Percent G_{mm} at $N_{initial}$
(7) Percent Air Voids, VMA and VFA

The following parameters apply to samples aged for one hour in an oven at gyratory compaction temperature and compacted to N_{max}

(8) Bulk Specific Gravity (G_{mb}) at N_{max} measured and estimated
(9) Percent G_{mm} at N_{max} and Corrected percent G_{mm} at N_{design}
(10) Slope of the Gyratory Compaction Curve

The mean, standard deviation, Quality Index and percent within limits (PWL) of the test results shall be calculated in accordance with Subsection 502.13, Quality Level Analysis. The test data will be used to validate the JMF.

A JMF is considered validated if the following parameters are 90 percent within limits of the JMF and meet the specifications requirements.

(1) Extracted Gradations for the No. 8 and No. 200 (2.36 mm and 75 μm) sieves

(2) Theoretical Maximum Specific Gravity (G_{mm})

(3) Percent G_{mm} at $N_{initial}$

(4) Percent Air Voids at N_{design}

Additionally, the average of all validation tests for the other parameters shall be within the specifications limits.

Should the JMF validate on all but one parameter, the contractor may make adjustments and repeat the validation testing using the next day's production or a maximum of 2000 tons (2000 Mg). Should the JMF fail to validate on more than one parameter, the JMF will be considered non-valid, and the contractor will be required to submit a new JMF for approval. Upon validation of the JMF, the validation averages will be used for JMF target values. Payment for validation lots will be in accordance with acceptance pay parameters, except that five cores shall be obtained to determine density pay. After validating the JMF for mix properties, the contractor, witnessed by the Department, shall sample the next day's production and perform validation testing at the plant for DOTD TR 322 and AASHTO T 312 specimens. When the validation results are less than 80 percent, no further production for that job mix formula or any proposed job mix formula substituted for that mix type will be accepted on any DOTD project having DOTD TR 322 requirements until a passing plant-produced Tensile Strength Ratio (TSR) value is verified by the Department. A previously validated and approved JMF may be produced in lieu of the disapproved JMF.

Validation is not required for mixture designs used solely for bike paths, crossovers, curbs, driveways, guardrail widening, islands, joint repair, leveling, parking lots, patching, shoulders, turnouts, widening, and miscellaneous handwork, but the mixture must meet specifications requirements.

502.05 PLANT QUALITY CONTROL. For quality control purposes, the contractor shall obtain a minimum of two (2) samples of mixture from each sublot using a stratified random sampling approach. Test results for theoretical maximum specific gravity (G_{mm}) and measured bulk specific gravity (G_{mb}) at N_{max} and percent G_{mm} at $N_{initial}$, on samples of each sublot shall be reported. Control charts may be requested by the engineer if mixture problems develop. Quality control gyratory samples may be aged or unaged at the contractor’s option, but the method chosen shall be used consistently throughout the project. If aged samples are used, report the

measured G_{mb} at N_{max}. If unaged samples are used, report the estimated G_{mb} at N_{max}. One loose mix sample shall be taken from each sublot after placement of the mix in the truck. The mix shall be tested by the contractor at the plant for aggregate gradation, asphalt content and percent crushed aggregate. The mix shall be tested in accordance with DOTD TR 309, TR 323 and TR 306. The lot average and standard deviation shall be determined for aggregate gradation and asphalt content. The percent within limits (PWL) shall be determined on the Nos. 8 and 200 (2.36 mm and 75 μm) sieves and for G_{mm}. Corrective action shall be taken if these parameters fall below 90 PWL. For each lot, the contractor shall report all quality control data to the DOTD Certified Plant Technician. The full range of gradation mix tolerances will be allowed even if they fall outside the control points. The District Laboratory Engineer may require re-validation of the mix when the average of the Quality Control data indicates non-compliance with the specified limits or tolerances.

The moisture content of the final mixture shall be minimized and uniformly controlled to ensure that placement and density requirements are met. The percent moisture in loose mix shall be reported once per lot and shall not exceed 0.3 percent by weight (mass) when tested in accordance with DOTD TR 319.

502.06 PLANT ACCEPTANCE. All Department inspection procedures, including sampling and testing, form the basis for acceptance of the asphaltic concrete. Sampling and testing shall be accomplished following a stratified sampling plan in accordance with the Materials Sampling Manual and specified test procedures. Times and locations shall be established by the engineer.

The Department will take samples or perform tests as outlined in these specifications, to ensure that the asphaltic concrete conforms to Department standards, which include job mix limits, typical sections, material properties, and surface deviations. Plant acceptance tests will be performed for VFA and air voids in the specimen compacted to N_{design} to determine the acceptability of the asphaltic concrete at the plant unless directed otherwise by the engineer. If the average VFA for 5 samples is outside the specifications limits, satisfactory adjustments must be made or production shall be discontinued. The plant acceptance tests for air voids shall be subject to payment adjustments and sampling and testing in accordance with the requirements specified herein.

Testing for percent air voids will be conducted by the Department. Test results of mixture specimens compacted to N_{design} shall comply with Table

502-5 when tested in accordance with AASHTO T 312 and DOTD TR 304. One sample will be taken from each of five (5) sublots. The data will be used to determine if the lot is outside acceptance limits shown in Table 502-5. If the lot is outside the acceptance limits, an adjustment in unit price for the lot will be made in accordance with Tables 502-7 or 502-9.

Acceptance testing for air voids will be conducted on the total lot quantity.

502.07 ROADWAY OPERATIONS.

(a) Weather Limitations: Asphaltic concrete mixtures shall not be applied on a wet surface or when the ambient temperature is below 50°F (10°C) for wearing courses and 40°F (5°C) for base and binder courses, except that material in transit, or a maximum of 50 tons (45 Mg) in a surge bin or silo used as a surge bin at the time plant operation is discontinued may be placed; however, mixture placed shall perform satisfactorily and meet specification requirements. Inclement weather will be sufficient reason to terminate or not begin production.

When base course materials are placed in plan thicknesses of 2 3/4 inches (70 mm) or greater, these temperature limitations shall not apply provided all other specification requirements are met. When a wearing course is substituted for a binder course mixture the temperature limitation for binder course shall apply.

(b) Surface Preparation: The surface to be covered shall be approved prior to placing mixtures. The contractor shall maintain the surface until it is covered.

(1) Cleaning: The surface to be covered shall be swept clean of dust, dirt, caked clay, caked material, vegetation, and loose material by revolving brooms or other mechanical sweepers supplemented with hand equipment as directed. When mixtures are to be placed on portland cement concrete pavement or overlaid portland cement concrete, the contractor shall remove excess joint filler from the surface by an approved burning method. The contractor shall remove any existing raised pavement markers prior to asphaltic concrete overlay operations.

When brooming does not adequately clean the surface, the contractor shall wash the surface with water in addition to brooming to clean the surface.

When liquid asphalt is exposed to traffic for more than 1 calendar day, becomes contaminated, or degrades due to inclement weather, the liquid asphalt shall be reapplied at the initial recommended rate at no direct pay.

(2) Applying Liquid Asphalt Materials:

a. Existing Pavement Surfaces: Before constructing each course, an approved asphalt tack coat shall be applied in accordance with Section 504. The contractor shall protect the tack coat and spot patch as required.

b. Raw Aggregate Base Course and Raw Embankment Surfaces: The contractor shall apply an approved asphalt prime coat to unprimed surfaces, or protect in-place prime coat and spot patch as required with asphalt prime coat, in accordance with Section 505.

c. Cement and Lime Stabilized or Treated Embankment and Base Course Surfaces: The contractor shall apply an approved asphalt curing membrane when none is in place, or protect the in-place curing membrane and spot patch, as required, with asphalt material in accordance with Section 506.

d. Other Surfaces: Contact surfaces of curbs, gutters, manholes, edges of longitudinal and transverse joints, and other structures shall be covered with a uniform coating of an approved asphalt tack coat complying with Section 504 before placing asphaltic mixtures.

(c) Joint Construction:

(1) Longitudinal Joints: Longitudinal joints shall be constructed by setting the screed to allow approximately 25 percent fluff and also overlapping the paver approximately 2 inches (50 mm) onto the adjacent pass. Prior to rolling, the overlapped mix shall be pushed back to the uncompacted side, without scattering loose material over the uncompacted mat, to form a vertical edge above the joint. The vertical edge shall then be compacted by rolling to form a smooth, sealed joint. Longitudinal joints in one layer shall offset those in the layer below by a minimum of 3 inches (75 mm); however, the joint in the top layer shall be offset 3 inches (75 mm) to 6 inches (150 mm) from the centerline of pavement when the roadway comprises two lanes of width, or offset 3 inches (75 mm) to 6 inches (150 mm) from lane lines when the roadway is more than two lanes. The narrow strip shall be constructed first.

Where adjacent paving strips are to be placed, the longitudinal edge joint of the existing strip shall be tacked.

(2) Transverse Joints: Transverse joints shall be butt joints formed by cutting back on the previously placed mixture to expose the full depth of the lift. An approved 10 foot (3.0 m) static straightedge shall be used to identify the location at which the previously placed mixture is to be cut back to maintain no greater than a 1/8 inch (3 mm) deviation in grade. The cut face of the previously placed mat shall be lightly tacked before fresh material is placed. The screed shall rest on shims that are

approximately 25 percent of plan thickness placed on the compacted mat. Transverse joints shall be formed by an adequate crew. Transverse joints shall be checked by the engineer for surface tolerance using a stringline extended from a point 10 feet (3 m) before the joint to a point approximately 40 feet (12 m) beyond the joint. Any deviation in grade from the stringline in excess of 3/16 inch (5 mm) for roadway wearing courses and 1/4 inch (6 mm) for other courses shall be immediately corrected prior to the paving operation continuing beyond 100 feet (30 m) of the transverse joint. Additionally, the transverse joint shall meet the surface tolerance requirements of Table 502-4. The contractor shall make necessary corrections to the joint before continuing placement operations.

Transverse joints in succeeding lifts shall be offset at least 3 feet (1.0 m).

502.08 HAULING, PAVING AND FINISHING. Mixtures shall be transported from the plant and delivered to the paver at a temperature no cooler than 25°F (14°C) below the lower limit of the approved job mix formula. The temperature of the mix going through the paver shall not be cooler than 250°F (120°C).

No loads shall be sent out so late in the day that completion of spreading and compaction of the mixture cannot be completed during daylight, unless artificial lighting has been approved.

When segregation occurs, haul trucks shall be loaded with a minimum of three drops of mix, the last of which shall be in the middle.

Each course of asphaltic mixture shall be placed in accordance with the specified lift thickness. When no lift thickness is specified, or when substitute mixtures are utilized as specified in Subsection 502.01(c), mixtures shall be placed in accordance with Table 502-5

With the engineer's approval, motor patrols may be used to fill isolated depressions in the initial layer, provided this construction does not result in unsatisfactory subsequent lifts.

(a) Coordination of Production: The contractor shall coordinate and manage plant production, transportation of mix and placement operations to achieve a high quality pavement and shall have sufficient hauling vehicles to ensure continuous plant and roadway operations. The engineer will order a halt to operations when sufficient hauling vehicles are not available.

On final wearing course construction under traffic with pavement layers of 2 inches (50 mm) compacted thickness or less, the contractor will be permitted to pave one travel lane for a full day. The contractor shall pave

the adjacent travel lane the next work day. When the adjacent travel lane is not paved the next calendar day and the longitudinal joint is exposed to traffic for more than 3 calendar days, and it has been determined that the subsequent roadway edge is not true to line and grade as previously constructed, the entire length of exposed longitudinal joint shall be cut back to plan thickness to a vertical edge and heavily tacked. When pavement layers are greater than 2 inches (50 mm) compacted thickness, the contractor shall place approximately 1/2 of each day's production in one lane and the remainder in the adjacent lane.

Pavement shall be protected from traffic until it has sufficiently hardened to the extent the surface is not damaged.

(b) Paving Operations: When placing the final two lifts of asphaltic concrete on the roadway travel lanes, a material transfer vehicle (MTV), as described in Subsection 503.15, will be required to deliver mixtures from the hauling equipment to the paving equipment, and to prevent segregation of the asphaltic concrete hot mix. The MTV is required regardless of ADT. All mixtures shall flow through the paver hopper. Mixtures dropped in front of the paver shall be either lifted into the hopper or rejected and cast aside. Delivery of material to the paver shall be at a uniform rate and in an amount within the capacity of paving and compacting equipment. The paver speed and number of trucks shall be adjusted to have one truck waiting in addition to the one at the paver in order to maintain continuous paving operations. The height of material in front of the screed shall remain uniform.

During mixture transfer, the paver shall not be jarred or moved out of alignment. The level of mix in the paver hopper shall not drop so low as to expose the hopper feed slats.

Pavers shall be designed and operated to place mixtures to required line, grade and surface tolerance without resorting to hand finishing.

Longitudinal joints and edges shall be constructed along lines established. Stringlines or other forms of longitudinal control shall be placed by the contractor for the paver to follow. The paver shall be positioned and operated to closely follow the established line. Irregularities in alignment shall be corrected by trimming or filling directly behind the paver.

After each load of material has been placed, the texture of the unrolled surface shall be checked to determine its uniformity. The adjustment of screed, tamping bars, feed screws, hopper feed, etc., shall be checked frequently and adjusted as required to assure uniform spreading of the mix to proper line and grade and adequate compaction. When segregation of

materials or other deficiencies occur, paving operations shall be suspended until the cause is determined and corrected.

Surface irregularities shall be corrected directly behind the paver. Excess material forming high spots shall be removed. Indented areas shall be filled and finished smooth. Hand placement in accordance with Heading (c) for surface repair will be permitted. Material shall not be cast over the surface.

When a screed control device malfunctions during binder or wearing course operations, paving operations shall be immediately discontinued and shall not be resumed until the screed malfunction has been remedied. Material in transit may be placed. Material placed shall perform satisfactorily and meet specification requirements. Any cost overrun resulting from placing material without the automatic screed control device shall be borne by the contractor.

When paving and finishing operations are interrupted so that the mixture remaining in trucks, paver, paver hopper or on the pavement cools to such extent that it cannot be placed, finished or compacted to the same degree of smoothness and with the same texture and density as the uncooled mixture, the cooled mixture shall be removed and replaced at no direct pay.

When additional mix is required to increase superelevation in curves, the use of automatic slope control will be optional with the contractor.

The traveling reference plane method of construction will be required for airport runways unless designated otherwise on the plans. Unless the erected stringline is required or directed, the 30-foot (minimum) traveling reference plane method of construction shall be used for roadway travel lanes. The following requirements shall apply for mechanical pavers:

(1) Traveling Reference Plane: The traveling reference plane method shall be approved before use. After the initial paving strip of each lift is finished and compacted, adjacent paving strips shall be placed to the grade of the initial paving strip using the traveling reference plane or shoe device to control grade and a slope control device to control cross slope.

On multilane pavements, the initial paving strip and the sequence of lane construction will be subject to approval.

When both outside edges of the paving strip being placed are flush with previously placed material, the slope control device shall not be used. A grade sensor is required for each side of the paver.

In superelevated curves, the cross slope shall be changed from that specified for tangents to that specified for superelevation in gradual increments while the paver is in motion so a smooth transition in grade is

obtained. This change in cross slope shall be accomplished within the transition distance specified.

This is the minimum acceptable method and the contractor must meet or exceed current surface tolerance specifications.

(2) Erected Stringline: The erected stringline method shall be used as directed by the engineer. This method may be used on the first lift of asphalt when the underlying new or reconstructed bases do not have grade control requirements. Pavers for roadway travel lanes shall be equipped with automatic screed and slope control devices when used with an erected stringline.

An erected stringline shall consist of a piano wire or approved equal stretched between stakes set at no greater than 25 foot (7.5 m) intervals tensioned between supports so that there is less than 1/8 inch (3 mm) variance between supports when the sensor is in place. The stringline elevation will be verified by the Department using standard surveying practices.

If required, the initial paving strip of the first lift shall be constructed using an erected stringline referenced to established grade. When permitted, mixtures required to level isolated depressions may be placed without automatic screed control. Subsequent lifts may be constructed by use of the traveling reference plane, provided surface and grade tolerances are met on the previous lift.

Only one grade sensor and the slope control device are necessary for roadways with a normal crown on tangent alignment. Superelevated curves will require the use of two grade sensors and two erected stringlines to obtain proper grade and slope; however, when the automatic screed control device is equipped with a dial or other device which can be conveniently used to change the cross slope in small increments, superelevated curves may be constructed using this device and one erected stringline.

After the initial paving strip of the first lift is finished and compacted, adjacent paving strips shall be laid using an approved traveling reference plane.

(3) Without Automatic Screed Control: When permitted, pavers without automatic screed control may be used for pavement patching, pavement widening, paved drives and turnouts.

(c) Hand Placement: When the use of mechanical finishing equipment is not practical, the mix may be placed and finished by hand to the satisfaction of the engineer. No casting will be allowed including casting the mixture from the truck to the grade. During paving operations

material shall be thoroughly loosened and uniformly distributed. Material that has formed into lumps and does not break down readily will be rejected. The surface shall be checked before rolling and irregularities corrected.

502.09 COMPACTION.

(a) General: After placement, mixtures shall be uniformly compacted, by rolling while still hot, to at least the density specified in Table 502-4. If continuous roller operation is discontinued, rollers shall be removed to cooler areas of the mat, where they will not leave surface indentations. The use of steel wheel rollers which result in excessive crushing of aggregate will not be permitted.

The rolling pattern established by the contractor shall be conducted by experienced operators in consistent sequences and by uniform methods that will obtain specified density and smoothness. Individual roller passes shall uniformly overlap preceding passes to ensure complete coverage of the paving area. The speed and operation of rollers shall not displace, tear or crack the mat. Nonvibrating steel wheel rollers shall be operated with drive wheels toward the paver. Any operations causing displacement, tearing or cracking of the mat shall be immediately corrected.

Equipment which leaves tracks or indented areas which cannot be corrected in normal operations or fails to produce a satisfactory surface shall not be used. Operation of equipment resulting in accumulation of material and subsequent shedding of accumulated material into the mixture or onto the mat will not be permitted.

To prevent adhesion of mixture, wheels of steel wheel rollers shall be kept properly moistened, but excess water will not be permitted.

Pneumatic tire rollers shall be operated so that tires will retain adequate heat to prevent mix from adhering to tires. The pneumatic tire roller shall be operated at a contact pressure which will result in a uniform, tightly knit surface. The pneumatic tire roller shall be kept approximately 6 inches (150 mm) from unsupported edges of the paving strip; however, when an adjacent paving strip is down, the roller shall overlap the adjacent paving strip approximately 6 inches (150 mm).

Vibratory rollers may be used provided they do not impair the stability of the pavement structure or underlying layers. Vibratory rollers shall not be used on the first lift of asphaltic concrete placed over the asphalt treated drainage blanket. When mix is placed on newly constructed cement or lime stabilized or treated layers, vibratory rollers shall not be used for at least 7 days after such stabilization or treatment.

It is the responsibility of the contractor to determine the number, size, and type of rollers to sufficiently compact the mixture to the specified density and surface smoothness. The rolling equipment shall be capable of maintaining the pace of the paver and shall conform to Subsection 503.17.

The surface of mixtures after compaction shall be smooth and true to cross slope and grade within the tolerances specified. Mixtures that become loose, broken, contaminated or otherwise defective shall be removed and replaced with fresh hot mixture compacted to conform with the surrounding mixture.

Excessive rippling of the mat surface will not be accepted. Ripples are small bumps in the pavement surface which usually appear in groups in a frequent and regular manner. There shall be no more than 12 ripples or peaks in any 100-foot (30 m) section. Rippling indicates a problem with the paving operation or mix that requires immediate corrective action by the contractor; otherwise operations shall cease. Unacceptable areas shall be corrected at no direct pay. A profilograph trace may be required to define these areas.

(b) Rolling: After rolling, newly finished pavements shall have a uniform, tightly knit surface free of cracks, tears, roller marks or other deficiencies. Deficiencies shall be corrected at no direct pay and the contractor shall adjust operations to correct the problem. This may require the contractor to adjust the mix or furnish additional or different equipment.

(c) Hand Compaction: Along forms, curbs, headers, walls and at other places inaccessible to rollers, mixture shall be uniformly compacted to the satisfaction of the engineer with approved hand tampers or mechanical tampers, conforming to Subsection 503.18.

502.10 ROADWAY QUALITY CONTROL.

(a) Density: The contractor shall constantly monitor equipment, materials, and processes to ensure that density requirements are met.

(b) Surface Tolerance: The contractor shall constantly monitor equipment, materials, and processes to ensure that surface tolerance requirements are met. The contractor shall test the pavement during the first work day following placement, but in no case any later than 7 calendar days.

Surface tolerance testing will be required on wearing and binder courses for roadway travel lanes. It will be required on the wearing course only for shoulders, parking areas and airport runways and taxiways. For surface

tolerance purposes, the wearing course is defined as the final lift placed. The binder course is defined as the last lift placed prior to the final lift.

Other lifts on which additional asphaltic concrete is to be placed shall be finished so that succeeding courses will meet the requirements of this subsection. Base courses on which portland cement concrete pavement is to be placed shall be finished so that the portland cement concrete pavement will meet the requirements of Section 601.

(1) Equipment: The contractor shall furnish an approved 10 foot (3.0 m) metal static straightedge for quality control and acceptance testing for transverse, cross slope and grade

The contractor shall also furnish a DOTD certified inertial profiler, for quality control and acceptance, to measure both wheelpaths simultaneously with laser or infrared height sensing equipment. Inertial profilers shall be capable of testing the finished surface in the longitudinal direction for conformance to the surface tolerance requirements listed in this subsection. Longitudinal surface profile shall be measured in inches per mile (mm per km) in accordance with DOTD TR 644 and reported as the International Roughness Index (IRI).

The Department will evaluate and verify the accuracy of the inertial profiler annually using static and dynamic tests in accordance with DOTD TR 644. Approved profilers will have a DOTD decal indicating the date of profiler verification and profiler system parameter settings. These settings shall be verified by the inspector before the first day of binder course paving and randomly thereafter.

For each project, a Department representative will observe the daily set up procedure and pre-operation tests, which shall be performed by the contractor in accordance with the manufacturer's procedures and DOTD TR 644. A copy of the manufacturer's setup procedure, pre-operation procedures, and operating procedure for measuring surface tolerance shall be available at all times during measurement.

(2) Transverse, Cross Slope and Grade:

a. Transverse: The contractor shall monitor and test the roadway for conformance to the requirements of Table 502-4. For turnouts, crossovers, detour roads, parking areas, and roadway or shoulder sections less than 500 feet (150 mm) in length, the wearing course shall be tested and the surface deviations shall not exceed 1/2 inch (15 mm). Areas with surface deviations in excess of specification limits shall be isolated and corrected by the contractor in accordance with Heading (4). The contractor shall control the transverse surface finish.

b. Cross Slope: When the plans require the section to be constructed to a specified cross slope, the contractor shall take measurements at selected locations, using a stringline, slope board or other comparable method. The contractor shall control the cross slope so that the values shown in Table 502-4 are not exceeded for each lane constructed. The contractor shall make corrections in accordance with Heading (4) of this subsection.

c. Grade: When the plans require the pavement to be constructed to a grade, the contractor shall perform tests for conformance at selected locations, using a stringline or other comparable method. The contractor shall control grade variations so that the tolerances shown in Table 502-4 are not exceeded. Grade tolerances shall apply to only one longitudinal line, such as the centerline or outside edge of pavement. The contractor shall make corrections in accordance with Heading (4) of this subsection.

(3) Longitudinal: The contractor shall report an average IRI number in inches per mile (mm per km) and shall measure and report the average IRI value for each wheelpath on every 0.05-mile (0.08 km) segment of highway. Isolated rough areas will not be allowed. Any 0.05-mile (0.08 km) individual wheelpath segment measurement of the binder and wearing courses shall meet the requirements of Table 502-8B. The contractor shall make corrections in accordance with Heading (4) of this subsection.

(4) Correction of Deficient Areas: The contractor shall correct areas not meeting Table 502-8B requirements for individual wheelpath measurements in a 0.05-mile (0.08 km) segment.

a. Deficiencies in Wearing Course: The contractor shall correct deficiencies in the final wearing course by diamond grinding and applying a light tack coat, removing and replacing, or furnishing and placing a supplemental layer of wearing course mixture at least 1 1/2 inches (40 mm) compacted thickness for the full width of the roadway meeting specification requirements at no direct pay. If the supplemental layer does not meet specification requirements to the satisfaction of the engineer, the contractor shall remove and replace or correct it by other methods approved by the engineer.

b. Deficiencies in Binder Courses: The contractor shall correct deficiencies in binder course, transverse, cross slope, and grade measurements to meet specification requirements at no direct pay. Corrections shall be made before subsequent courses are constructed.

c. Deficiencies in Shoulder Transverse, Cross Slope and Grade: The contractor shall correct deficiencies in these areas by grinding at the project engineer's direction.

502.11 ROADWAY ACCEPTANCE. Acceptance testing for pavement density, surface tolerance and dimensional tolerances will be conducted on that portion of the lot placed on each contract.

Hot mix exhibiting deficiencies before placement such as segregation, contamination, lumps, nonuniform coating, excessive temperature variations or other deficiencies, apparent on visual inspection, shall not be placed.

Hot mix exhibiting deficiencies, such as segregation, contamination, alignment deviations, variations in surface texture and appearance or other deficiencies, apparent on visual inspection, will not be accepted and shall be satisfactorily corrected and/or replaced at no direct pay. Poor construction practices such as handwork, improper truck exchanges, improper joint construction, or other deficiencies, apparent on visual inspection, will not be accepted.

(a) Density: Acceptance testing for pavement density will be conducted by the Department. Three pavement samples for each mix use shall be obtained from each sublot within 24 hours after placement. When this falls on a day the contractor is not working, sampling shall be done within 3 calendar days. Sampling shall be performed using the random number tables shown in DOTD S605. If there are different mix uses within the same sublot, i.e. shoulder and roadway, then an additional core may be taken to ensure that there is at least one core per mix use. The density requirement for each lot will be as shown in Table 502-4 determined in accordance with DOTD TR 304. Payment will be made in accordance with Table 502-7B using the total number of cores for the lot in accordance with Subsection 502.13. Payment for small quantity lots will be made in accordance with Table 502-9.

When the sampling location determined by random sampling falls within areas that are to be replaced or within 1 foot (0.3 m) of the unsupported pavement edge, another random sampling location will be used.

Samples shall be cores approximately 4 inches (100 mm) or 6 inches (150 mm) in diameter taken by an approved core drill. The contractor shall furnish samples cut from the completed work. The removed pavement shall be replaced with hot or cold mixture and refinished during the work day coring is performed. No additional compensation will be allowed for

furnishing test samples and replacing the areas with new pavement. Samples shall be taken by the contractor in the presence of the engineer's representative from areas selected by the Department in accordance with this subsection. Cores less than 1 3/8 inches (35 mm) thick shall not be used as pavement samples for payment determination.

Cores shall be transported to the plant in approved transport containers. Transportation containers will be sealed, signed, and dated by the inspector using an approved method. The individually wrapped core will also be sealed, signed, and dated by the inspector using an approved method. Any evidence of tampering with the core wrappings, sticker, or of opening the container or friction top can will result in the cores being rejected. Additional pavement samples will be required.

(b) Surface Tolerance: The contractor shall measure the top two lifts of the roadway travel lanes. Final acceptance will be based on the last measurement taken on the final wearing course of the travel lanes. Measurement of the center two lanes will be required for airports. The contractor shall test the pavement during the first work day following placement, but in no case any later than 7 calendar days.

(1) Equipment: For longitudinal surface tolerance testing, equipment and daily set-up and pre-operation procedures shall be in accordance with Subsection 502.10(b)(1). For transverse, cross slope and grade testing, the contractor shall furnish a 10-foot metal static straightedge for Department use.

(2) Transverse, Cross Slope and Grade: The Department will test the surface of the binder and wearing courses at selected locations for conformance to the surface tolerance requirements of Subsection 502.10(b)(2) and Table 502-4, which shall not be exceeded. The contractor shall make corrections as directed in accordance with Subsection 502.10(b)(4).

(3) Longitudinal Surface Tolerance:

a. Acceptance: The contractor shall report an average IRI number in inches per mile (mm per km) and shall measure and report the average IRI value for each wheelpath on every 0.05-mile (0.08 km) segment of highway. The IRI values for the inside and outside wheelpaths shall be averaged and reported as the segment average and the mean of each segment average shall be reported as the sublot average. The individual wheelpath IRI values shall conform to the requirements of Table 502-8B. The average sublot values shall conform to the requirements listed in Tables 502-8A. A DOTD inspector will be present for the final test run

and will immediately receive a copy of the IRI results via USB flash drive. The contractor shall provide the engineer a copy of the IRI report. Acceptance of each sublot will be in accordance with Tables 502-8A and 502-8B, based on the IRI profile report. The Department may elect to perform and utilize independent ride quality test results for acceptance at any time.

b. Exceptions and Exclusions:

1. Excluded Areas: The Department will review the profile report obtained for each binder and wearing course on a sublot basis. In special cases or extenuating circumstances, the engineer may isolate or exclude sections of the profile. These special cases or extenuating circumstances may be curb and gutter sections that require the adjustment of cross-slope in order to maintain adequate drainage, manholes, catch basins, valve and junction boxes, street intersections, or other structures located in the roadway which cause abrupt deviations in the profile. This specification exclusion will not be used to simply isolate sections of road that are in poor condition when the project is let.

2. Secondary Areas: Ramps less than 1500 feet (460 m), tapers, shoulders and medians, or sections of pavement surfaces as directed by the engineer such as 300 feet (90 m) from bridge ends, will not be included in the ride quality index for payment purposes, but shall have a maximum IRI average of 110 or less in a sublot.

502.12 DIMENSIONAL REQUIREMENTS. Mixtures that are specified for payment on a cubic yard (cu m) or square yard (sq m) basis shall conform to the following dimensional requirements. Overthickness and overwidth will be accepted at no direct pay.

(a) Thickness: Thickness of mixtures will be determined in accordance with DOTD TR 602. Underthickness shall not exceed 1/4 inch (6 mm).

When grade adjustments are permitted for all mixtures except the final wearing course, areas with underthickness in excess of 1/4 inch (6 mm) shall be corrected to plan thickness at no direct pay by furnishing and placing additional mixture in accordance with Subsection 502.10(b)(4)b. For the final wearing course, areas with underthickness in excess of 1/4 inch (6 mm) shall be corrected to plan thickness at no direct pay by furnishing and placing a supplemental layer of wearing course mixture meeting specification requirements in accordance with Subsection 502.10(b)(4)a over the entire area for the full width of the roadway when grade adjustments are permitted.

When grade adjustments do not permit, the deficient underthickness area shall be removed and replaced at no direct pay.

(b) Width: The width of completed courses will be determined in accordance with DOTD TR 602. Underwidths shall be corrected by furnishing and placing additional mixture to a minimum width of 1 foot (0.3 m) and plan thickness at no direct pay.

502.13 QUALITY LEVEL ANALYSIS. The Quality Level Analysis is a statistical quality control/quality acceptance (QC/QA) method for validating Job Mix Formulas (JMF), contractors quality control, project acceptance and payment for all Superpave asphaltic concrete.

The mean $\left(\overline{X}\right)$ is the average of a set of numbers. To determine the mean add the numbers (X_i) in the set and divide by the number of numbers (n) in the set.

$$\text{Mean} = \overline{X} = \frac{X_1 + X_2 + X_3 + \ldots + X_n}{n} = \frac{\sum_{i=1}^{n} X_i}{n}$$

The standard deviation of a set of numbers measures the spread of the numbers in the set or the deviation from the mean. Calculate the standard deviation according to the following formula:

$$\text{Standard Deviation} = s = \sqrt{\frac{(X_1 - \overline{X})^2 + (X_2 - \overline{X})^2 + \ldots + (X_i - \overline{X})^2}{n - 1}}$$

$$= \sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n - 1}}$$

A Quality Index is calculated using both the upper and lower specification limits (if applicable). The Quality Index calculated using the upper or higher specification limit is called the Upper Quality Index (Q_U). The Quality Index calculated using the lower specification limit is called the Lower Quality Index (Q_L).

To determine each Quality Index, the specification limits are added or subtracted from the mean of the test results and the result is divided by the standard deviation as shown below.

$$\text{UpperQualityIndex} = Q_U = \frac{USL - \overline{X}}{s} \qquad \text{LowerQualityIndex} = Q_L = \frac{\overline{X} - LSL}{s}$$

Where: USL = upper specification limit
LSL = lower specification limit

Table 502-6 is used to convert the Quality Index into the PWL value. A PWL is calculated for each Quality Index (upper and lower) and combined for a total PWL calculated in accordance with the formula:

$$PWL = PWL_L + PWL_U - 100$$

where: PWL_L = lower percent within limits
PWL_U = upper percent within limits

In using Table 502-6, the appropriate columns corresponding to the number of test results must be used.

If a specification requirement does not have both an upper and lower limit only one Quality Index and PWL, upper or lower as appropriate, is calculated and the other PWL is equal to 100 in the total PWL calculation.

502.14 LOT SIZES. A lot is a segment of continuous production of asphaltic concrete mixture from the same job mix formula produced for the Department at an individual plant. A standard lot size is 5,000 tons (5000 Mg). A standard sublot size is 1,000 tons (1000 Mg). Additional adjustments may be made to the standard lot or sublot size as specified in this subsection. The final sublot, at the end of a project lot, may be increased up to 150 percent to accommodate hauling unit capacity.

With good historical performance, and when agreed upon by the engineer and contractor, the lot size may be increased up to 10,000 tons, with corresponding sublot size up to 2000 tons (2000 Mg). Twenty-four hour per day plant production usually necessitates such an increase.

The engineer or contractor may decrease the size of an individual lot for any of the following conditions:

(1) The interval between continuous production exceeds 7 calendar days.

(2) A new job mix formula is accepted.

(3) The final lot is less than 5,000 tons (5000 Mg).

(4) The total project quantity is less than 5000 tons (5000 Mg).

(5) A payment adjustment will be applied to the portion of the lot already produced, provided adjustments have been made to bring the asphaltic concrete into compliance with specifications.

For lots with 3000 tons or greater, PWL calculations will be required in accordance with Table 502-6 and Table 502-7.

Lots with less than 3000 tons (3000 Mg) of mix are paid as Small Quantity Lots. Only standard 1000 ton (1000 Mg) sublots will be allowed when determining pay for Small Quantity Lots. Each 1000 ton (1000 Mg) sublot, or less, as applicable, will be paid individually in accordance with Table 502-9.

Any mixtures used for bike paths, crossovers, curbs, driveways, guardrail widening, islands, joint repair, leveling, parking lots, shoulders, turnouts, patching, widening, and miscellaneous handwork will be paid as a Small Quantity Lot, and separately in 1000 ton sublots, or portions thereof, in accordance with this subsection and Table 502-9.

Pavement density and surface tolerance requirements will not be applied for short irregular sections, such as curbs, driveways, guardrail widening, islands, joint repair, leveling, and turnouts; however, hot mix shall be placed to provide a neat, uniform appearance and shall be compacted by satisfactory methods.

For projects, or separate locations within a project, requiring less than 250 tons (250 Mg), the job mix formula, materials, and plant and paving operations shall be satisfactory to the engineer. Sampling and testing requirements may be modified by the engineer and the payment adjustment for deviations waived.

502.15 MEASUREMENT. Asphalt tack coat, prime coat or curing membrane will not be measured for payment.

(a) Weight Measurement: Asphaltic concrete will be measured by the ton of 2,000 pounds (megagrams) from printed weights as provided in Section 503. Stamped printer tickets will be issued for each truckload of material delivered. Material lost, wasted, rejected or applied contrary to specifications will not be measured for payment.

Estimated quantities of asphaltic concrete shown on the plans are based on 110 lb/sq yd/inch (2.35 kg/sq m/mm) thickness. The measured quantity

of asphaltic mixtures will be multiplied by the following adjustment factor to obtain the pay quantity.

Theoretical Maximum Specific Gravity, (G_{mm}) (DOTD TR 327)	Adjustment Factor
2.340 - 2.360	1.02
2.361 - 2.399	1.01
2.400 - 2.540	1.00
2.541 - 2.570	0.99
2.571 - 2.590	0.98

The adjustment factor for mixtures with theoretical maximum specific gravities less than 2.340 or more than 2.590 will be determined by the following formulas:

Theoretical maximum specific gravity less than 2.340:

$$F = \frac{2.400}{S}$$

Theoretical maximum specific gravity more than 2.590:

$$F = \frac{2.540}{S}$$

where,

F = quantity adjustment factor

S = theoretical maximum specific gravity of mixture from approved job mix formula

(b) Volume or Area Measurement: The quantities for payment will be the design quantities specified in the plans and adjustments thereto. Design quantities will be adjusted when the engineer makes changes to adjust to field conditions or when design changes are necessary. Design quantities are based on the horizontal dimensions and compacted thickness of the completed course shown on the plans.

(c) Surface Tolerance Incentive Measurement: At the completion of construction of the wearing course travel lanes, the contractor, in the presence of a DOTD representative, shall measure a continuous profile from the start station to the end station of the construction project for the purpose of determining qualification for

incentive pay under Subsection 502.16(e). Bridges and 300 feet (90 m) on each end of the bridge will be excluded from measurements for surface tolerance incentive pay.

502.16 PAYMENT.

(a) General: Payment for asphaltic concrete will include furnishing all required materials, producing the mixtures, preparing the surfaces on which the mixtures are placed, hauling the mixtures to the work site, and placing and compacting the mixtures.

Payment for asphaltic concrete will be made at the contract unit price on a lot basis as defined in Subsection 502.14. When the mix does not meet requirements in the areas listed in this subsection, the Payment Adjustment Schedule shown in Tables 502-7, 502-8 or 502-9 will be applied. Production of mix that is not eligible for 100 percent payment will not be allowed on a continuous basis. When test results demonstrate that payment adjustments are necessary, satisfactory adjustments shall be made, or production shall be discontinued.

(b) Wearing Course Mixes: For wearing course travel lanes, adjustments in contract price for plant and roadway deficiencies or incentives will be based on the average of the percent payments for plant air voids, roadway density, and surface tolerance. For all other wearing course applications, payment adjustment will be based on the average of the percent payments for plant air voids and roadway density.

(c) Base, Binder and Shoulder Mixes: For base and binder courses for travel lanes and all shoulder mixes, adjustments in contract price for plant and roadway deficiencies or incentives will be based on the average of the percent payments for plant air voids and roadway density.

Final adjustments in unit price will be as described in Tables 502-7 and 502-9.

(d) Erected Stringline: When the use of an erected stringline is not specified, but directed by the engineer, an additional payment of $500 per contract plus $0.25 per linear foot ($0.75 per lin m) will be made for mixtures placed by the erected stringline method. When the use of an erected stringline is specified, no additional payment will be made.

(e) Longitudinal Surface Tolerance Incentive Pay: For Category A projects and in accordance with Table 502-8A, a surface tolerance incentive payment equal to 5 percent of the contract unit price for the theoretical travel lane quantity of the wearing course item will be paid if the contractor achieves a project average IRI of 45 or less as measured at the completion of the project. No lot of wearing course on the project shall

be less than 100 percent for surface tolerance. Only Category A projects are eligible for incentive pay. Any grinding except within 300 feet (90 m) of a bridge end will cause the roadway to be ineligible for surface tolerance incentive pay.

Payment will be made under:

Item No.	Pay Item	Pay Unit
502-01	Superpave Asphaltic Concrete	Ton (Mg)
502-02	Superpave Asphaltic Concrete	Cubic Yard (Cu m)
502-03	Superpave Asphaltic Concrete, (in (mm) Thick)	Square Yard (Sq m)

Table 502-4
Superpave Requirements

A. REQUIREMENTS FOR EXTRACTED ASPHALT CEMENT AND AGGREGATE GRADATION					
U.S. (Metric) Sieve % Passing	1/2 inch (12.5 mm) Nominal	3/4 inch (19 mm) Nominal	1 inch (25 mm) Nominal	1.5 inch (37.5 mm) Nominal	Mix Tolerance[1]
2 inch (50 mm)	---	---	---	100	±4
1 1/2 inch (37.5 mm)	---	---	100	90-100	±4
1 inch (25 mm)	---	100	90-100	89 Max.	±4
3/4 inch (19 mm)	100	90-100	89 Max	---	±4
1/2 inch (12.5 mm)	90-100	89 Max	---	---	±4
3/8 inch (9.5 mm)	89 Max.	---	---	---	±4
No. 4 (4.75 mm)	---	---	---	---	±4
No. 8 (2.36 mm)	34-58	29-49	23-45	19-41	±3
No. 16 (1.18 mm)	---	---	---	---	±2
No. 30 (600 µm)	---	---	---	---	±2
No. 50 (300 µm)	---	---	---	---	±2
No 100 (150 µm)	---	---	---	---	±2
No. 200 (75 µm)	4.0-10.0	3.0-8.0	2.0-7.0	1.0-6.0	±0.7
Extracted Asphalt, %	---	---	---	---	±0.2
Mix Temperature	---	---	---	---	±25°F (±14°C)

B. PAVEMENT REQUIREMENTS				
Density, Min. % of Theoretical Maximum Specific Gravity, DOTD TR 327				
Travel Lane Wearing, Binder and Base Courses	92.0			
Shoulders, Bike Paths, and Parking Lots	89.0			
Patching, Widening and Crossovers	91.0			
Surface Tolerance Variation, inches (mm)[2]		Transverse[3]	Cross Slope[3]	Grade[4]
Roadway Travel Lane Wearing Courses		1/8 (3)	3/8 (10)	1/2 (15)
Binder Courses		1/4 (6)	1/2 (15)	1/2 (15)
Shoulder Wearing Course		3/16 (5)	3/4 (20)	3/4 (20)

[1]Job Mix Formula based on validated mix design.
[2]For longitudinal surface tolerance requirements, see Subsection 502.10(d).
[3]Based on 10 feet (3.0 mm).
[4]Applicable only when grade is specified.

Table 502-5
Superpave General Criteria

Nominal Max., Size Agg.	0.5 inch (12.5 mm)			0.75 inch (19 mm)			1.0 inch (25 mm)			1.5 inch (37.5 mm)
Type of Mix	Incidental Paving[1]	Wearing Course		Wearing Course	Binder Course		Binder Course		Base Course	Base Course
Level[2]	A	1	2	2	1	2	1	2	1	1
Asphalt Binder	Table 502-2									
Friction Rating[2]	Table 502-3									
Coarse Agg. Angularity, + No. 4 (4.75 mm)	55	75	95	95	75	95	75	95	75	75
Fine Agg. Angularity, Min. % - No. 4 (4.75 mm)	40	40	45	45	40	45	40	45	40	40
Flat and Elongated Particles, % Max. (5:1) + No. 4 (4.75 mm)	10									
Sand Equivalent, Min. % (Fine Agg.), - No. 4 (4.75 mm)	40	40	45	45	40	45	40	45	40	40
Natural Sand Max. % of New Agg.	N/A	15	15	15	15	15	15	15	15	25
RAP, Max. % of Mix[3]	20	15	15	15	20	20	20	20	30	30
	Compacted Mix Volumetrics [4]									
VMA, Min. %	13	13	13	12	12	12	11	11	11	10
Air Voids, %[5]	2.5-4.5									
VFA, %[5]	68-78									
$N_{initial}$ 90% max.[6] (Gyrations)	7	7	8	8	7	8	7	8	7	7
N_{design} 96.5±1 % (Gyrations)	75	75	100	100	75	100	75	100	75	75
N_{max} 98 % max. (Gyrations)	115	115	160	160	115	160	115	160	115	115
Moisture Sensitivity, TSR Min.	80									
Dust/Effective Asphalt Ratio, %	0.6 – 1.6									
Lift Thickness, inch (mm)	2.0- (50-)	1.5–2.0 (45-50)		2.0–3.0 (50-75)			2.5–4.0 (65-100)		2.5+ (65+)	4.0+ (100+)

[1]May be used for airports, bike paths, crossovers, curbs, driveways, guardrail widening, islands, joint repair, leveling, parking lots, shoulders, turnouts, and other incidental items approved by the engineer. (May also be used for mixtures specified as Marshall Type 3.)
[2]Mixtures designated as Level 1F and 2F shall meet the requirements for Level 1 and 2, respectively. Additionally, Level 1F and 2F shall meet the friction rating requirements in Table 502-3 for travel lane wearing courses with ADT > 7000.
[3]Maximum 20 % Rap will be allowed in all shoulder wearing course mixtures. RAP will not be allowed for airports.
[4]Air voids, VMA, VFA, % G_{mm} @ $N_{initial}$, and % G_{mm} @ N_{design} are determined on samples compacted to N_{design}; The parameter of % G_{mm} @ N_{max} is determined on a sample compacted to N_{max}.
[5]Air voids design target is 3.5%, VFA target is 73%.
[6]For Level 1 mixtures, $N_{initial}$ shall be 91.0 % max. For Level A mixes, $N_{initial}$ shall be 92.0 % max.

Table 502-6
Quality Index Values for Estimating Percent Within Limits

PWL	n = 3	n = 4	n = 5 - 6	n = 7 - 9	n = 10 - 12	n = 13 - 15
99	1.16	1.47	1.68	1.89	2.04	2.14
98	1.15	1.44	1.61	1.77	1.86	1.93
97	1.15	1.41	1.55	1.67	1.74	1.80
96	1.15	1.38	1.49	1.59	1.64	1.69
95	1.14	1.35	1.45	1.52	1.56	1.59
94	1.13	1.32	1.40	1.46	1.49	1.51
93	1.12	1.29	1.36	1.40	1.43	1.44
92	1.11	1.26	1.31	1.35	1.37	1.38
91	1.10	1.23	1.27	1.30	1.32	1.32
90	1.09	1.20	1.23	1.25	1.26	1.27
89	1.08	1.17	1.20	1.21	1.21	1.22
88	1.07	1.14	1.16	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.13	1.13
86	1.05	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.05	1.04	1.04
84	1.02	1.02	1.02	1.01	1.00	1.00
83	1.00	0.99	0.98	0.97	0.96	0.96
82	0.98	0.96	0.95	0.94	0.93	0.92
81	0.96	0.93	0.92	0.90	0.89	0.89
80	0.94	0.90	0.88	0.87	0.85	0.85
79	0.92	0.87	0.85	0.83	0.82	0.82
78	0.89	0.84	0.82	0.80	0.79	0.78
77	0.87	0.81	0.79	0.77	0.76	0.75
76	0.84	0.78	0.76	0.74	0.72	0.72
75	0.82	0.75	0.73	0.71	0.69	0.69
74	0.79	0.72	0.70	0.67	0.66	0.66
73	0.77	0.69	0.67	0.64	0.63	0.62
72	0.74	0.66	0.64	0.61	0.60	0.59
71	0.71	0.63	0.60	0.58	0.57	0.56
70	0.68	0.60	0.58	0.55	0.54	0.54
69	0.65	0.57	0.55	0.53	0.51	0.51
68	0.62	0.54	0.52	0.50	0.48	0.48
67	0.59	0.51	0.49	0.47	0.46	0.45
66	0.56	0.48	0.46	0.44	0.43	0.42
65	0.53	0.45	0.43	0.41	0.40	0.40
64	0.49	0.42	0.40	0.38	0.37	0.37
63	0.46	0.39	0.37	0.35	0.35	0.34
62	0.43	0.36	0.34	0.33	0.32	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29
60	0.36	0.30	0.28	0.27	0.26	0.26
59	0.32	0.27	0.25	0.24	0.24	0.23
58	0.29	0.24	0.23	0.21	0.21	0.21
57	0.25	0.21	0.20	0.19	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.15
55	0.18	0.15	0.14	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05
51	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00

Note 1: For negative values of Q_u or Q_L. PWL_U or PWL_L is equal to 100 minus the tabular PWL_U or PWL_L.
Note 2: If the value of Q_U or Q_L does not correspond exactly to a value in the table, use the next higher value.

Table 502-7
Payment Adjustments for Superpave

Payment adjustments will be based on specification limits.

A) PLANT ACCEPTANCE

Air Voids: The percent within limits (PWL) will be calculated for air voids for each lot and reported to the nearest whole number. Payment for plant acceptance will be in accordance with Table 502-7A.

Table 502-7A
Payment Adjustment Schedule for Plant Acceptance

Air Voids PWL	Percent Payment
100	103
88-99	100
71-87	98
51-70	90
21-50	80
≤20	50 or Remove[1]

[1]At the option of the Department after investigation.

B) ROADWAY DENSITY

The percent within limits (PWL) will be calculated for pavement density for each lot and reported to the nearest whole number. Payment for roadway density will be in accordance with Table 502-7B.

Table 502-7B
Payment Adjustment Schedule for Roadway Density

Roadway Density PWL	Percent Payment
98-100	105
89-97	100
79-88	98
61-78	90
31-60	80
≤30	50 or Remove[1]

[1]At the option of the Department after investigation.

C) SURFACE TOLERANCE (Final Wearing Course Travel Lanes Only)

Payment adjustments for surface tolerance for the final wearing course travel lanes will be based on the International Roughness Index (IRI) in accordance with Table 502-8A and Subsections 502.15 and 502.16. Percent payments will be determined for each sublot and averaged to determine payment for the lot.

TOTAL PAYMENT

The percent payment for the wearing course travel lanes will be the average of the percent payments for plant acceptance, roadway density, and surface tolerance for each lot. Incentive payment for surface tolerance will be in accordance with Subsection 502.16(e) and paid separately.

The percent payment for all other mix types will be the average percent payments for plant acceptance and roadway density for each lot.

All calculations for percent payment will be rounded to the nearest one (1) percent.

Table 502-8A
Payment Adjustment Schedules for Longitudinal Surface Tolerance, Maximum International Roughness Index, inches per mile (mm per km)

Percent of Contract Unit Price (by Sublot)[1]	103%[2]	100%	90%	80%	50% or Remove[3]
Category A All Interstates, Multi-Lift New Construction and Overlays of More than two Lifts	<55 (<870)	<65 (<1030)	65-75 (1030-1180)	NA	>75 (>1180)
Category B One or Two Lift Overlays Over Cold Planed Surfaces, and Two-Lift Overlays Over Existing Surfaces[4]	<65 (<1030)	<75 (<1180)	75-89 (1180-1400)	NA	>89 (>1400)
Category C Single-Lift Overlays Over Existing Surfaces[4]	<75 (<1180)	<85 (<1340)	85-95 (1340-1500)	>95-110 (>1500-1740)	>110 (>1740)
Longitudinal Surface Tolerance Incentive Pay, Final Completion, Average of All Travel Lanes[5]	≤45 (≤710)				

[1]Or portion of sublot placed on the project.
[2]Maximum payment for sublots with exception areas, exclusions or grinding is 100 percent, unless the excluded area is a bridge end.
[3]At the option of the engineer.
[4] Existing surfaces include reconstructed bases without profile grade control.
[5]Only Category A projects are eligible for incentive. However, any grinding except within 300 feet (90 m) of a bridge end will cause the roadway to be ineligible for surface tolerance incentive pay.
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Table 502-8B
Individual Wheelpath Deficient Area Limits
Maximum International Roughness Index, inches per mile (mm per km)

Any 0.05 Mile (0.08 km) Segment	Wearing Course	Binder Course
Category A	89 (1400)	130 (2050)
Category B	99 (1560)	150 (2370)
Category C	110 (1740)	N/A

Table 502-9
Payment Adjustment Schedule for Small Quantities of Superpave[1]

Parameter[2]	Percent of Contract Unit Price/Sublot		
	100	95	50 or Remove[3]
% Air Voids	2.5-4.5	1.5-2.4 or 4.6-5.5	<1.5 or >5.5
Average Roadway Density, % G_{mm}	≥ Lower limit	-0.1 to -0.9 below lower limit	-1.0 below Lower limit

[1]See Subsection 502.14.
[2]For plant acceptance, use one sample for percent air voids to determine pay. For roadway acceptance, use the average of three cores to determine density and pay. Determine surface tolerance in accordance with Table 502-8A. The total percent payment for small quantities of Superpave mixtures will be the average of the percent payments for plant acceptance (air voids), roadway acceptance (density) and surface tolerance.
[3]At the option of the engineer.

Section 503
Asphaltic Concrete Equipment and Processes

503.01 DESCRIPTION. This section specifies requirements for certification of plant and paving equipment. It includes methods and equipment for handling and storing materials, producing asphaltic concrete, and transporting and placing asphaltic concrete at the job site.

The Department's publication entitled "Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures" is hereby made a part of this specification by reference.

503.02 PLANT EQUIPMENT.

(a) General: Asphaltic concrete shall be mixed at a central mixing plant by either the batch, or continuous drum mixing process. Aggregates, additives and asphalt cement shall be proportioned in accordance with the approved Job Mix Formula. When the automatic adjustments or other critical control and shutoff devices are not functioning, the plant shall not operate. The plant shall operate with clean, easily accessible, and accurate thermometers, scales and meters, which shall be immediately repaired, replaced, or recalibrated when faulty operation is detected.

The system shall provide positive weight (mass) control of cold aggregates fed by a belt scale or other device interlocked with the asphalt measuring system to maintain required proportions of combined aggregates and asphalt. Aggregates shall be heated, dried and mixed with asphalt to produce a homogeneous mixture in which all aggregate particles are uniformly coated. Approved methods shall be provided to discard the first and last output of the plant after each interruption. Special requirements pertaining to batch plants shall be in accordance with Subsection 503.11.

Rates of production of every material used on a DOTD project shall be digitally displayed and the quantities totalized.

(b) Certification and Calibrations: Plants furnishing asphaltic concrete mixtures in accordance with Sections 502 and 508 shall be certified at least every two years in accordance with current Departmental procedures. All plant components and processes are subject to inspection and approval by the District Laboratory Engineer. The meters, scales, and measuring devices shall be tested, inspected and certified every 90 calendar days, and more often when directed, by a qualified independent scale

service or the Weights and Measures Division, Louisiana Department of Agriculture and Forestry.

The contractor shall have a plant site laboratory conforming to Section 722 as a part of the plant facilities. The plant lab shall be equipped with a "land-based" telephone and made available for DOTD use. The plant site laboratory shall be located in close proximity to the plant operations, so that plant operations may be observed. All laboratory equipment shall be calibrated and verified by the procedures in AASHTO R18 and the appropriate test methods and by the frequency directed in AASHTO R18. Traceable standards and accreditation are not required. Documentation for the calibrations and verifications shall be available upon request by DOTD personnel.

503.03 AGGREGATES.

(a) Stockpiles: Aggregates shall be stored at the plant site so that no intermixing, segregation, or contamination will occur. Stockpiles shall be well drained.

Blending and proportioning of aggregates shall be done from cold feed bins and not in stockpiles or on the ground at the plant site or the source. Gradation and other properties of aggregate in stockpiles shall be such that when the aggregates are combined in proper proportions, the resulting combined gradation will meet the requirements of the approved job mix formula.

(b) Cold Feed: Cold aggregate bins shall be of sufficient size to store the amount of aggregates required for continuous plant operation. Partitions between bins shall extend a minimum of 1 foot (300 mm) above the top of bins and be sufficient to prevent intermixing of aggregate sizes. The unit shall include a feeder mounted under the bins with each bin compartment having an accurately controlled individual gate to form an orifice for measuring the material drawn from it. The orifice shall be rectangular, with one dimension adjustable by positive mechanized adjustment with locking system. Indicators shall be provided on each gate to show the gate opening in inches (mm) or a predetermined setting to match the calibration curves.

Calibration of the cold feed system shall be based on the weight (mass) of bin material. Material shall be fed from a bin through the individual orifice and bypassed to a container to be weighed, or over the calibrated weigh bridge. Material from each bin shall be calibrated separately. Calibration shall be performed at three different production rates with

records kept on file. The calibration process shall be part of the contractor's quality control.

An automatic plant shutoff shall be provided to operate when any aggregate bin becomes empty or flow is interrupted. The contractor shall provide belt scales for conveyor systems when the drum-mixer process is used, calibrated in accordance with Subsection 503.02(b).

The plant shall have an accurate mechanical means for uniformly feeding aggregate into the dryer. Feeders shall be capable of uniformly delivering the maximum number of required aggregate sizes in their proper proportion. When more than one cold bin feeder is used, each shall operate as a separate unit. The individual controls shall be integrated with a master control for all materials.

(c) Moisture: The contractor's Certified Asphaltic Concrete Plant Technician shall measure the moisture content of the cold feed aggregates daily in accordance with DOTD TR 319 when starting the plant. Adequately scheduled tests during plant operations and adjustments to the plant shall be made to correct for moisture in the aggregate. The schedule for moisture content testing will be subject to approval.

Provisions shall be made for introducing the latest moisture content of the cold feed aggregates into the belt weighing system, thereby correcting the conversion of wet aggregate weight (mass) to dry aggregate weight (mass). Dry weight (mass) of the aggregate flow shall be displayed digitally in appropriate units.

(d) Screens: The plant shall have a scalping system on the fine sand cold bin, the RAP bin and other bins as necessary, to ensure removal of objectionable material.

For continuous drum mix plants, and when a belt scale is used, an additional vibrating scalping screen will be required between the aggregate cold feed discharge and belt scale. Other processes will require a vibrating scalping screen between the cold feed discharge and mixing process. The screens shall be sized to remove all oversize aggregate and other objectionable material.

(e) Reclaimed Asphaltic Pavement (RAP): If used, a separate cold feed system, shall be provided for reclaimed asphaltic pavement (RAP). This system shall include a scalping screen, bin, feeder belt and weigh bridge which is fully integrated with the cold feed system and asphalt cement supply system. This system shall be calibrated in accordance with Subsections 503.02(b) and 503.03(b). RAP must be added to the dryer in a location, in accordance with the manufacturer’s recommendation, that does not expose the material to direct flame.

503.04 ASPHALT CEMENT.

(a) Working Tank: The asphalt cement working tank shall be capable of uniformly heating the material by approved methods, under positive control, to the required temperature as recommended by the supplier. The asphalt circulating system shall be of adequate size to ensure proper and continuous circulation (except while asphalt is being measured). New tanks shall be equipped with paddle-type mixers or agitators which keep the material in motion and minimize prolonged exposure to the heating source. Proper mixing temperature of asphalt shall be maintained. Pipelines and fittings shall be heated or insulated. A sampling spigot shall be provided in each tank or the supply line. Strainers or screens must be placed between the working tank and mixing unit to filter undesirable material. A thermometer graduated in 5°F (2°C) increments and having an accuracy of ±5°F (±2°C) shall be fixed in the asphalt feed line at an approved location near the discharge valve at the mixer unit to indicate the temperature of asphalt from storage.

(b) Measurement: Asphalt cement shall be measured either by weight (mass) or volume. All scales and meters shall be accurate to 0.5 percent and be calibrated and verified in accordance with Subsection 503.02(b). The rate of flow of asphalt cement shall also be digitally displayed and the quantity used totalized.

(1) Weight Measurement: Scales shall read to the nearest pound (kg).

(2) Volume Measurement: Measurement by volume shall be by means of a positive displacement pump and shall be recorded in digital form to the nearest gallon (L). Provisions shall be made to periodically check by weight (mass) the quantity of asphalt cement delivered. The rate of asphalt cement delivery and the total quantity delivered shall be continuously displayed in digital form corrected to 60°F (15°C). The quantity of asphalt cement delivered shall be corrected to the approved job mix temperature. Measurement shall be continuous and accurate to 1.0 percent of the required measurement.

503.05 ADDITIVES. The rate of flow of anti-strip, shall be digitally displayed and the quantity used totalized. When used, the rate of flow of mineral filler, lime and/or fibers shall also be digitally displayed and the quantity used totalized. All meters shall be accurate to 0.5 percent.

(a) Anti-strip: The anti-strip additive storage tank shall be a recirculating tank provided with uniform heat and an indicating thermometer at an approved location near the tank discharge point. A

thermometer graduated in 5°F (2°C) increments and having an accuracy of ±5°F (±2°C) shall be placed at an approved point near the anti-stripping tank discharge point before the meter. Anti-strip additive shall be dispensed directly into the asphalt feed line at a location between the asphalt control valve and the end of the asphalt discharge line. The anti-strip delivery system shall ensure that the proper amount of material is delivered continuously and in correct proportion to the asphalt cement. This system may be a paddle-type no-flow indicator, which triggers a light or alarm in the control room and an alarm in the plant lab when the anti-strip material is not flowing. Other similar systems may be allowed with approval by the District Laboratory Engineer. In either system, if the anti-strip flow is not restored within 15 minutes, production shall be discontinued until the system is repaired. The equipment shall include a positive displacement accumulating meter which accumulates and displays materials used, and reads to the nearest 0.25 gallon (L). Additionally, a measuring dip stick and a chart correlating tank quantity with height of anti-strip liquid shall be provided.

(b) Mineral Filler: Mineral filler shall be proportioned separately from a hopper equipped with an adjustable feed which can be accurately and conveniently calibrated and which shall be interlocked with the aggregate and asphalt feeds. The feeder shall accurately proportion the mineral filler and provide a constant flow of material. For batch plants, the mineral filler shall be batched into the mix along with the aggregates. For continuous drum mixer plants, the mineral filler shall be introduced to the mix at an approved location sufficiently in advance of the addition of the asphalt to allow proper drying time.

For mineral filler, a separate bin and feeder in accordance with Subsection 503.03(b) shall be furnished with its drive interlocked with the aggregate feeders. Mineral filler shall be introduced directly into the drum near the asphalt discharge.

(c) Hydrated Lime: When hydrated lime additive is mixed with aggregate on the belt feed, the hydrated lime additive equipment shall be interlocked and synchronized with cold feed controls to operate concurrently with the cold feed operation. A positive signal system that will automatically shut the plant down when a malfunction causes an improper supply of additive or water shall be installed. The plant shall not operate unless the entire additive system is functioning properly. The hydrated lime additive system shall consist of the following equipment.

(1) A separate bulk storage bin with a vane feeder or other approved feeding system which can be readily calibrated. The system shall

provide a means for easy sampling of additive and verification of the quantity dispensed by weight (mass). The feeder system shall continuously record the total amount of additive dispensed.

(2) An approved spray bar or other approved system capable of spraying the composited aggregate with potable water before the addition of hydrated lime additive when the moisture content of the composited aggregate falls below 3 percent. An alternate system for spraying coarse aggregate stockpiles may be allowed when approved. The approved equipment and methods shall consistently maintain the aggregates in a uniform, surface wet condition. The moisture content of the aggregate-lime additive mixture following spraying and mixing shall be introduced into the automatic moisture controls of the plant.

(3) An approved pugmill or other approved mixing device to uniformly coat the composited aggregates with the hydrated lime additive shall be located between the point at which the additive is placed on the composited aggregate and the dryer.

The hydrated lime additive shall be dispensed directly onto the composited aggregate between the cold feed and the dryer. When cold feed control is used, the additive shall be introduced after the composited aggregate has passed through the vibrating scalping screen. The additive shall be uniformly blended with the composited aggregate before entry into the dryer. The process and equipment used for mixing the lime additive and aggregate shall be approved and shall provide that no less than the required amount of additive is continuously blended with the aggregate. When a belt scale is used on the composited aggregate feed belt, it shall be positioned to record the combined weight (mass) of the blended aggregate and hydrated lime additive.

(d) Fibers: A separate feed system shall be used to accurately proportion the required quantity of mineral fibers into the mixture in such a manner that uniform distribution is obtained. The proportioning device shall be interlocked with the aggregate feed or weigh system to maintain the correct proportions for all rates of production. The fiber proportion shall be controlled to within plus or minus 10 percent of the amount of fibers required. Flow indicators or sensing devices shall be provided for the fiber system, interlocked with plant controls so that the mixture production will be interrupted if introduction of the fiber fails. For drum plants, the fiber shall be added in such a manner that it will not become entrained in the exhaust system of the dryer or plant.

503.06 DRYER. The plant shall include one or more dryers, with automatic burner controls, that continuously agitate aggregates during heating and drying. The equipment shall be capable of heating and drying aggregates in the necessary quantities to supply the mixing unit continuously at its operating capacity and at a specified temperature and acceptable moisture content. Aggregates shall be heated and dried to produce a mixture meeting specification requirements without burner fuel contamination. Slope of dryers shall be in accordance with approved recommendations of the dryer manufacturer.

503.07 SECONDARY DUST COLLECTOR. When a dust collection system returns fines to the mixture, the fines shall be returned at a uniform and regulated rate and at an approved location. In the drum-mix process, baghouse fines shall be added near the asphalt cement discharge. Baghouse fines shall be dispensed into the aggregate mixture by an approved feed control device from a collector box, surge bin or filler silo. This provision does not apply to primary collectors.

503.08 MIXER. The mixer unit shall produce a uniform blend at the specified production rate, with rapid and complete asphalt coating of aggregate. As a minimum, 95 percent of the coarse aggregate particles retained on the No. 4 (4.75 mm) sieve shall be completely coated when tested in accordance with DOTD TR 328.

The aggregate, asphalt cement and the mixture shall be processed at the temperature specified in the approved job mix formula. The temperature of the mixture at discharge from the mixer shall be within ±25°F (±14°C) of the optimum mixing temperature in the job mix formula. When the mixing, coating, placing or density requirements are not being met, the engineer may require that the job mix temperature be changed or that the foregoing temperature range be restricted.

503.09 STORAGE AND LOADING ASPHALTIC CONCRETE MIXTURE.

(a) Mix Conveyors: The mix shall be transported directly from plant to silos or bins by means of an enclosed continuous type conveyor system designed to prevent spillage and match the production rate of the plant. The mixture from the silo or surge bin shall remain within ±15°F (±8°C) of plant discharge temperature.

The plant shall be equipped with an approved recording thermometer graduated in maximum 10°F (5°C) increments and having an accuracy of

±5°F (±2°C) and a sensitivity which will provide an indication of temperature change at a rate of at least 10°F (5°C) per minute. It shall be placed at the dryer discharge chute or approved location to register automatically the temperature of, the asphaltic concrete mixture at discharge.

(b) Storage Silos and Surge Bins: For drum mix plants storage silos or surge bins shall be used for storing asphaltic concrete mixtures and approved by the engineer.

Use of silos or bins shall conform to the limitations on retention time, type of mixture, heater operation, bin atmosphere, bin level or other characteristics set forth in these specifications and other requirements stated in granting approval of these facilities. An indicator device which is activated when material in the bin drops below the top of the sloped portion shall be affixed to each bin and be visible to the loading operator. Mixtures shall be maintained above this level during production, except for extended periods when the plant is not in operation. If extra storage time is anticipated, 0.1 percent asphalt cement may be added to the mix.

When the mixture is placed into a silo or bins through a surge device, an automatic warning system shall be provided to audibly warn the operator of a gate malfunction. Silo or bin unloading gates shall be either clam shell gates operating under gravity feed or other approved gates that will not cause segregation or be detrimental to the mix.

(1) Silos: If heated, the storage silo heating system shall be capable of uniformly maintaining mix temperature without localized heating.

Without prior approval, maximum allowable storage time for asphaltic concrete mixtures is 18 hours. The Department may grant permission to exceed the storage time, provided test results and other data indicate that the additional storage time is not detrimental to the mix.

(2) Unheated Surge Bins: Storage time for surge bins depends on the temperature of the stored mix. The mix temperature, when discharged from the surge bin, must not be lower than 25°F (±14°C) below the optimum mixing temperature in the job mix formula.

(c) Loading and Sampling: Haul trucks shall conform with Subsection 503.13.

The sampling platform shall be a sturdy, secured metal platform with protective rails, at least 15 square feet in area, and set at the proper height to easily obtain a sample.

The plant shall be equipped with an approved pressurized system capable of spraying a uniform coating of an approved asphalt mix release

agent into the haul unit bed prior to loading. Diesel is not allowed as a mix release agent.

503.10 SCALES AND METERS.

(a) Scales: Scales and meters shall be accurate to ±0.5 percent of the indicated load. They shall be designed, constructed and installed so that operations do not affect their accuracy. Calibrations are required in accordance with Subsection 503.02(b). All asphaltic concrete mixtures shall be measured by weigh hoppers or truck platform scales to determine weight (mass) for pay.

(b) Weigh Hoppers: Weigh hoppers weigh the mixture or individual material components. Hoppers for weighing a mixture from a storage or surge bin shall not leak or cause segregation. Weigh hoppers shall be suspended from calibrated springless dial scales or load cell scales. The weigh hopper shall be equipped with an approved automatic printer system that will print the certified tare weight (mass) of the truck, each batch weight (mass) and total weight (mass) of mixture loaded into the truck

(c) Platform Scales: Truck-platform scales shall be of sufficient length to weigh the entire unit transporting the mix. Scales shall be equipped with an approved automatic printer system that will print the tare weight (mass) as well as the total weight (mass) of the unit and the mix. The truck must be weighed empty to determine tare weight prior to mixture loading.

(d) Printers: In the event of a breakdown of the printing mechanism, the contractor may be permitted to operate during the 48-hour period immediately following the breakdown provided an accurate weight (mass) of mixture can be determined and recorded, and repeated breakdowns do not occur.

503.11 BATCH PLANTS.

(a) Screens: Batch plant screens, if used, shall proportion and screen aggregates to the required sizes. The normal capacity of the screens shall exceed the full capacity of the mixer or dryer. The screens shall be exposed for inspection as directed.

(b) Hot Bins: Hot aggregate shall be stored in bins. Storage shall be accomplished to minimize segregation and loss of temperature of aggregates. Bin sizes shall be adequate for continuous operation of the plant at rated capacity. Bins shall be arranged to ensure separate and adequate storage of appropriate fractions of aggregate. Adequate dry

storage shall be provided with an overflow pipe or chute to prevent contamination of materials. Each size of aggregate shall be stored in separate bins when screens are used. For screenless operation, aggregate shall be stored in one or more bins with adequate provisions to prevent segregation.

The temperature of the heated aggregates shall be measured at an approved location and continuously recorded. The thermometer shall be graduated in maximum 10°F (5°C) increments with an accuracy of ±5°F (±2°C) and a sensitivity to temperature change at a minimum rate of at least 10°F (5°C) per minute.

When plant operation is interrupted and the temperature of material in hot storage cools to 25°F (14°C) or more below the specified mixing temperature, or when a plant changes type of mix and the change requires a change of materials, bins shall be pulled and the material discarded.

Fiber, if used in a batch plant, must be added to the aggregate in the weigh hopper or as approved and directed by the engineer. Also, for batch plants, the dry mixing time shall be increased by 8 to 12 seconds, or as directed by the engineer, from the time the aggregate is completely emptied into the pugmill.

(c) Mixer Unit: Batch plants shall have an approved pugmill and spray bar. Prior to adding asphalt cement, the combined aggregate shall be thoroughly mixed dry, after which the proper amount of asphalt cement shall be sprayed over aggregates and mixed to produce a homogeneous mixture in which all aggregate particles are uniformly coated. Mixing times shall be in accordance with the approved job mix formula. The mixer shall have an approved timing device to prevent entrance of additional material during mixing. The device shall also lock the asphalt cement bucket throughout the dry mixing period. The pugmill shall not be operated above the rated capacity. The discharge gates shall be locked to ensure proper mixing.

(d) Weigh Hoppers: In batch plants, asphalt cement and aggregate hoppers shall be of sufficient size to weigh the total batch in one operation.

To determine percent asphalt cement for the mix, the contractor shall provide an approved printer system which will print separately the weight (mass) of aggregates and asphalt cement. These weights (masses) shall be used for calculating the percent asphalt cement in the mixture. When a mixture is loaded directly into the haul truck, these weights (masses) shall be used for the purpose of determining pay weights (masses) for the mix. Printing equipment shall also print zero weight (mass) for each batch and total weight (mass) of mixture loaded in trucks.

In the event of a breakdown of the printing mechanism, the contractor may be permitted to operate during the 48-hour period immediately following the breakdown, provided an accurate weight (mass) of mixture can be determined and recorded, and provided repeated breakdowns do not occur.

503.12 PAVING EQUIPMENT. All primary roadway equipment, including asphalt distributors, pavers, rollers and hauling equipment, must be certified at least every two years in accordance with current DOTD policies.

503.13 HAUL TRUCKS. Equipment for transporting asphaltic mixtures shall have tight, clean, smooth metal beds or approved equal, sprayed daily or as often as directed with an approved asphalt mix release agent.

Each vehicle shall have a cover of canvas or other suitable material large enough to completely cover the top and extend over the sides of the bed to protect the mixture from the weather or loss of heat due to excessive haul time. The cover shall have sufficient tie-downs to hold the cover to the bed during hauling. The covers shall be used as directed.

The hauling unit shall discharge the mixture in a continuous manner so the spreader apron of the paver or MTV will not be overloaded. If the hauling unit or paver is causing surface tolerance penalties or excessive bumps, its use shall be discontinued.

Bottom dump equipment producing windrows will not be allowed.

When size, speed and condition of trucks interfere with orderly paving operations, changes in equipment and/or operations shall be made. Load restrictions shall be in accordance with Subsection 105.14.

503.14 DISTRIBUTORS. The asphalt cement distributor shall meet the requirements of 507.03(a) or the following:

The asphalt distributor shall be equipped with a suitable spray bar and nozzles designed to distribute material within the specified temperature range and shall be equipped with thermometers to indicate temperature of material in the tank. The distributor shall be designed to maintain a constant uniform pressure on asphalt material as it passes through nozzles and to apply asphalt material at the required rate. The distributor shall be equipped with a valve system that controls the flow of asphalt materials, a pump tachometer or pressure gauge that registers pump output, a bitumeter

and odometer that indicates both the speed of the distributor in feet (m) per minute and total distance traveled, and measuring devices, as necessary.

Charts shall be provided for an accurate, rapid determination and control of the amount of asphalt materials being applied per square yard (sq m) of surface under operating conditions. The bitumeter shall be calibrated to ensure accurate spraying operations and shall be kept clean of asphalt buildup. The distributor shall be equipped with a hand-held spray attachment for applying asphalt materials to areas inaccessible with the spray bar.

503.15 MATERIAL TRANSFER VEHICLE (MTV). When placing the final two lifts of asphaltic concrete on the roadway travel lanes, an approved material transfer vehicle (MTV) will be required to deliver mixtures from the hauling equipment to the paving equipment, and to prevent segregation of the asphaltic concrete hot-mix. The MTV is required regardless of average daily traffic (ADT). The MTV shall perform additional mixing of the asphaltic concrete mixtures and then deposit the mixture in the paving equipment hopper to reduce segregation and facilitate continuous production. As a minimum, the MTV shall have a high capacity truck unloading system which will receive mixtures from the hauling equipment; a storage bin in the MTV to continuously mix the mixture prior to discharge to a conveyor system; a discharge conveyor, with the ability to swivel, deliver the mixture to a paving equipment hopper while allowing the MTV to operate from an adjacent lane; and a paver insert hopper with a minimum capacity of 18 tons (18 Mg) which can be inserted into conventional paving equipment hoppers. Other pavers approved by the Department may be used without an insert.

If the weight of the MTV is determined by the engineer to cause settlement or movement in the base or sub-base, the use of the MTV shall be discontinued for this section.

When a malfunction occurs in the MTV during lay-down operations, work may continue for the balance of that day on any course other than the final wearing course. When an MTV malfunctions during final wearing course paving operations, plant operations shall be immediately discontinued and shall not resume until the MTV malfunctions have been remedied. Wearing course materials in transit may be placed. This procedure in no way alleviates the contractor from meeting contract specifications.

Due to the weight of the loaded MTV, the following restrictions shall apply at bridge crossings:

(a) The MTV shall abide by posted weight limits.

(b) The MTV shall be as near empty as possible prior to crossing a bridge.

(c) The MTV shall be moved across a bridge without any other vehicles being on the bridge.

(d) The MTV shall be moved on a bridge only within the limits of the travel lanes and shall not be moved on the shoulders of the bridge.

(e) The MTV shall move at a speed no greater than 5 miles per hour without acceleration or deceleration when crossing a bridge.

503.16 PAVERS. Pavers shall be equipped with automatic screed and slope control devices for use with an approved traveling reference plane or erected stringline, as directed.

Pavers shall be capable of placing mixtures within specified tolerances. A screed or strike-off assembly shall be used to distribute the mixture over the entire paving strip. The width of the paving strip will be approved. Assemblies, including extensions, shall place mixtures that are uniform in appearance and quality. The assembly shall be adjustable to provide the required cross section. The assembly shall be equipped with a heater and a vibrator.

In hilly terrain, when mix is discharged directly into the paver hopper, a positive connection shall be provided between paver and hauling unit. When the hauling unit discharges directly into the paver hopper, the paver shall be capable of pushing the hauling unit.

Pavers shall be equipped with hoppers adequately designed and maintained to prevent spillage. Pavers shall also be equipped with augers to place the mix evenly in front of the screed, including extensions. Pavers shall be equipped with a quick and efficient steering device and shall be capable of traveling both forward and in reverse. Pavers shall be capable of spreading mixes to required thickness without segregation or tearing.

For shoulder construction or other incidental applications, modified pavers or widening machines may be used when permitted.

A screed extension shall consist of a screed plate or plates, which meet all requirements for the screed set forth in these specifications. Screed extensions used during roadway paving operations shall be heated. The bottom surface of the screed extension shall be in the same plane as the bottom surface of the screed plate. Auger assembly extensions shall be used when screed extensions in excess of 1 foot (300 mm) on a side are to be continuously used in the pavement operation. Such auger extensions shall extend to within 1 foot (300 mm) of the end of the screed. With

approval, the use of an auger extension with screed extensions in excess of 1 foot (300 mm) on one side may be waived for transitions, taper sections and similar short sections. The engineer may waive the requirement for auger extensions when hydraulically extended screeds, which trail the main screed assembly, are used, provided required density and surface texture are obtained.

A strike-off assembly or boxed extension shall not be used for paving within the traveled way, except when approved for short irregular sections or non-typical sections.

Pavers shall be equipped with automatic screed and adjustable slope control devices capable of placing the mixture to grade within the tolerances specified, and distributing the mixture over the entire lane width and such partial lane widths as may be approved. Pavers shall be equipped with two grade sensors when required.

Pavers shall be equipped to work from an erected stringline, shoe device or an approved traveling reference plane that will accurately reflect, the average grade of the surface on which it is to be operated and which will result in a finished surface conforming to grade and surface requirements.

503.17 COMPACTION EQUIPMENT.

(a) General: Compaction equipment shall be self-propelled and be capable of reversing without backlash. It is the contractor's responsibility to provide the number, type and size of rollers sufficient to compact the mixture to the specified density and surface smoothness. The contractor shall establish, and modify as necessary, the number, type, size and rolling pattern on the first day of production. Poorly performing compaction equipment will not be allowed and shall be replaced with suitable equipment or supplemented as necessary.

(b) Steel Wheel Rollers: Steel wheel rollers may be either vibratory or nonvibratory. Wheels shall be true to round and equipped with suitable scrapers and watering devices. Vibratory rollers shall be designed for asphaltic concrete compaction and shall have separate controls for frequency, amplitude and propulsion.

(c) Pneumatic Tire Rollers: All tires shall be treadless, shall be the same size and ply rating, and shall be inflated to a uniform pressure not varying more than ±5 psi (±35 kPa) between tires. Wheels shall not wobble and shall be aligned so that gaps between tires on one axle are covered by tires of the other axle. Tires shall be equipped with scrapers to prevent adhesion of mixture. The engineer may require additional cleaning and water apparatus on tires if material adhesion is detrimental to the mat.

503.18 MISCELLANEOUS EQUIPMENT AND HAND TOOLS. Power revolving brooms or power blowers shall be provided and maintained in a satisfactory working condition.

In areas that are inaccessible to conventional rollers, satisfactory mechanical compaction equipment, or hot hand tampers, shall be used. Tamping tools may be used for compacting edges.

503.19 MEASUREMENT. Asphaltic concrete mixtures shall be measured for payment in accordance with appropriate subsections. Scales and meters for measuring asphalt materials and mixture shall conform to the requirements in this subsection.

Section 504
Asphalt Tack Coat

504.01 DESCRIPTION. This work consists of preparing and treating existing asphaltic or portland cement concrete pavement surfaces with asphalt material in accordance with these specifications and in conformity with the lines shown on the plans or established.

504.02 ASPHALT MATERIALS. Tack coat shall be an undiluted modified asphalt emulsion Grade CRS-2P, CSS-1, SS-1, SS-1P, or SS-1L complying with Section 1002.

504.03 WEATHER LIMITATIONS. Asphalt tack coat shall not be applied on a wet surface or when the ambient air temperature is below 40°F (5°C).

504.04 EQUIPMENT. The contractor shall provide equipment for applying asphalt material and preparation of the surface to be tacked. Equipment shall conform to Subsections 503.14 and 503.18. A hand-held pressure nozzle may be used for tack coat application in lieu of the spray bar/tachometer combination for irregular sections or short sections of 1500 feet (450 m) or less.

504.05 SURFACE PREPARATION. The surface shall be cleaned by sweeping or other approved methods. Edges of existing pavements which will form joints with new pavement shall be satisfactorily cleaned before tack coat is applied.

504.06 APPLICATION. Asphalt shall be uniformly applied to a clean dry surface with no bare areas, streaks or puddles with an asphalt distributor at a rate in accordance with Table 504-1. These rates may be raised or reduced as directed.

Table 504-1
Asphalt Tack Coats

Existing Surface	Rate; Gal/Sq yd (L/Sq m)[1]
Bleeding Surface Treatment	0.02 (0.09)
Dry Surface Treatment	0.03 (0.14)
New Hot Mix	0.03 (0.14)
Old Hot Mix	0.07 (0.32)
Portland Cement Concrete	0.07 (0.32)
Friction Course	0.05 (0.23)
Cold Planed Surface[2]	0.08 (0.36)

[1]Rates are minimum rates of undiluted asphalt emulsion.
[2]Minimum of two applications.

The minimum application temperature of the modified asphalt emulsions and emulsified asphalt Grade CRS-2P is 160°F (71°C) and Grades CSS-1, SS-1, SS-1L and SS-1P is 70°F (21°C).

Tack coat shall be applied in such manner as to cause the least inconvenience to traffic. The contractor will be permitted to apply the tack coat one calendar day prior to the mixture laydown; however, when tack coat has been damaged by traffic pick-up or contaminated by dirt, dust or mud, the surface shall be cleaned and retacked prior to the mixture laydown at no direct pay. Tacked surfaces exposed to traffic for more than 24 hours or damaged due to inclement weather shall be retacked at no direct pay.

504.07 MEASUREMENT AND PAYMENT. Asphalt tack coat will not be measured for payment; however, payment under the contract will be subject to the payment adjustment provisions of Section 1002 for specification deviations of the asphalt materials. The Materials and Testing Section will provide the payment adjustment percentage for asphalt materials.

Section 505
Asphalt Prime Coat

505.01 DESCRIPTION. This work consists of preparing and treating a surface with asphalt material in conformance with these specifications and in conformity with lines shown on the plans or established.

505.02 ASPHALTIC MATERIALS. Prime coat shall be cutback asphalt Grade MC-30, MC-70, or AEP Emulsified Asphalt complying with Section 1002.

505.03 WEATHER LIMITATIONS. Asphalt materials shall not be applied on a wet surface or when ambient air temperature is less than 35°F (2°C) in the shade.

505.04 EQUIPMENT. The contractor shall provide the necessary equipment for proper construction of the work. Equipment shall be approved before construction begins and shall be maintained in satisfactory working condition. Equipment shall conform to Subsection 503.14.

505.05 SURFACE PREPARATION. The surface to be coated shall be shaped to required grade and section, shall be free from ruts, corrugations, segregated material or other irregularities, and shall be compacted to required density. Delays in priming may necessitate reprocessing or reshaping to provide a smooth, compacted surface.

505.06 APPLICATION. Prime coat shall extend 6 inches (150 mm) beyond the width of surfacing shown on the plans. The prime coat shall not be applied until the surface has been satisfactorily prepared and is dry.

Prime coat shall be applied at the rates and temperatures shown in Table 505-1. Quantities of prime coat shall not vary from that shown in Table 505-1.

Table 505-1
Prime Coats

Asphalt Grade	Application Rate Gal/Sq Yd (L/Sq m)		Application Temperature °F (°C)	
	Min.	Max.	Min.	Max
MC-30	0.25 (1.15)	0.30 (1.35)	60 (15)	120 (50)
MC-70	0.25 (1.15)	0.30 (1.35)	100 (40)	180 (80)
AEP	0.25 (1.15)	0.30 (1.35)	60 (15)	120 (50)

505.07 PROTECTION. After prime coat has been applied it shall cure for a minimum of 24 hours before the surfacing is placed. The contractor shall keep traffic off the surface until the prime coat has properly cured, unless otherwise permitted.

If traffic is permitted, the contractor may be required to spread approved granular material, as directed, over the prime coat at no direct pay.

The prime coat shall be maintained intact. When required, the primed surface shall be thoroughly cleaned prior to the placement of surfacing.

Where the prime coat has failed, the failed area shall be cleaned and be recoated with prime coat at no direct pay. When the prime coat is generally unsatisfactory, the contractor shall reprime the unsatisfactory surface at no direct pay.

505.08 MEASUREMENT AND PAYMENT. Asphalt prime coat will not be measured for payment; however, payment under the contract will be subject to the payment adjustment provisions of Section 1002 for specification deviations of the asphalt materials. The Materials and Testing Section will provide the payment adjustment percentage for asphalt materials. Payment for surface preparation will be made under other items.

Section 506
Asphalt Curing Membrane

506.01 DESCRIPTION. This work consists of the application and maintenance of an asphalt curing membrane to the surface of cement or lime treated or stabilized materials in compliance with these specifications or as directed.

506.02 MATERIALS. Asphalt for curing membrane shall be an emulsified asphalt or an emulsified petroleum resin (EPR-1) complying with Section 1002. Water shall comply with Subsection 1018.01.

506.03 WEATHER LIMITATIONS. Asphalt curing membrane shall not be applied when the temperature is below 35°F (2°C), unless otherwise permitted.

506.04 EQUIPMENT. The contractor shall provide and maintain the necessary equipment for proper construction of this work. The equipment shall be approved before construction begins.

506.05 SURFACE PREPARATION. The surface to which curing membrane is to be applied shall be free from ruts, corrugations, loose material or other irregularities.

506.06 APPLICATION. The asphalt curing membrane shall be applied immediately upon completion of final finishing of the final lift of the surface. The emulsified asphalt curing membrane shall be uniformly applied at a minimum rate of 0.10 gallon per square yard (0.45 L/sq m) of undiluted emulsified asphalt. The EPR-1 curing membrane shall be uniformly applied at a minimum rate of 0.20 gallon per square yard (0.90 L/sq m) of undiluted resin. The undiluted emulsified petroleum resin shall consist of 5 parts water and 1 part resin concentrate. Any additional applications required shall be placed by the contractor at no direct pay. When emulsified asphalt is diluted with water and applied in multiple passes of the distributor, the total amount of asphalt material applied shall be increased so that the residual amount of asphalt material equals a minimum of 0.10 gallon per square yard (0.45 L/sq m). Extraneous material which has collected on the base shall be removed before additional

application of asphalt curing membrane. The surface shall be maintained and repaired before additional applications.

506.07 PROTECTION. After the curing membrane has been applied, the contractor shall keep public and construction traffic off the surface until the curing membrane has properly cured, unless otherwise directed. The curing membrane shall be maintained by the contractor at no direct pay until the surfacing has been placed. When traffic is permitted, additional curing membrane shall be applied at intervals to protect and cure the surface at no direct pay.

506.08 MEASUREMENT AND PAYMENT. Asphalt curing membrane will not be measured for payment; however, payment under the contract will be subject to the payment adjustment provisions of Section 1002 for specification deviations of the asphalt materials. The Materials and Testing Section will provide the payment adjustment percentage for asphalt materials. Water will not be measured for payment.

Section 507
Asphaltic Surface Treatment

507.01 DESCRIPTION. This work consists of furnishing properly distributed asphalt material followed by a uniform application of aggregate for building a riding surface, improving the surface friction of a roadway, sealing cracks in the roadway, reducing the rate of oxidation of a surface mixture, or as an interlayer to delay or reduce the occurrence of reflective cracking.

Asphaltic Surface Treatment (AST), sometimes referred to as "chip seal", shall consist of a specified emulsion applied "cold" or modified asphalt material applied "hot", at the temperature range specified in Table 507-1 for emulsions or Table 507-2 for hot applications, respectively. If not designated on the plans, the contractor shall have the option of providing either a hot or cold application. The application rates of asphalt material and aggregates will vary with aggregate size and existing roadway conditions but, for bid purposes only, shall meet the requirements of Table 507-1 or Table 507-2. The engineer will approve the actual application rates.

507.02 MATERIALS. The asphalt material shall comply with Section 1002. Aggregates shall comply with Subsection 1003.05. Allowed aggregates shall be as shown herein or as designated on the plans. Aggregates shall be from approved sources as shown in QPL 2.

Aggregates, except for limestone and interlayer aggregates, for hot application shall be precoated with a paving grade asphalt cement or a cationic emulsion in accordance with Section 1002. The residual asphalt content shall be a minimum of 1.0 percent by weight (mass) of the aggregate for high absorption aggregates and 0.5 percent minimum by weight (mass) for low absorption aggregates as defined in DOTD TR 300. The precoat applicator shall certify the quantities of precoat used in the process. The uncoated and precoated aggregate shall flow freely through the spreader as verified by DOTD by spread rate measurements. The gradation requirements apply to the aggregate after precoating for hot application. A gradation certification report shall be submitted with each aggregate shipment. If an emulsion is used for precoating, the stockpiled precoated aggregate shall be cured prior to use.

Hot asphalt shall be smooth and homogeneous and shall comply with the specifications for PAC-15 as shown in Table 1002-11.

Samples of asphalt material will be taken by the contractor in the presence of the engineer's representative. The engineer's representative will immediately take possession of the samples.

507.03 EQUIPMENT. The contractor shall provide and maintain the necessary equipment for proper construction. The equipment shall be approved, and calibrated before construction begins.

Storage tanks, piping, booster tanks, distributors and all other equipment used in delivering, storing or handling asphaltic materials shall be kept clean and in good operating condition.

Equipment shall consist of the following:

(a) Power Asphalt Distributor: The asphalt distributor shall be computer operated and capable of maintaining the allowable variation from any specified rate within ±0.02 gallons per square yard (±0.09 L/sq m). The distributor shall be equipped with a height adjustable spray bar with spray nozzles recommended by the nozzle manufacturer which yield uniform double coverage as a minimum. The end nozzle over the roadway edge shall provide a sharp line of asphalt material parallel to the direction of travel. For hot applications, the distributor shall maintain constant circulation throughout the spreader bar to prevent blockage in the nozzles.

Means shall be provided, under operating conditions, for an accurate and rapid determination of the control and amount of asphalt materials being applied per square yard (sq m) of surface. The distributor shall be equipped with thermometers to indicate the temperature of the material in the tank. The distributor shall be equipped with a hand-held spray attachment for applying asphalt materials to areas inaccessible with the spray bar.

Prior to use, the asphalt distributor shall have been calibrated in accordance with ASTM D 2995 within the previous 12 months. The contractor shall provide the ASTM calibration and shall furnish the engineer an accurate and satisfactory calibration record prior to beginning the work. The engineer may at any time require verification of calibration accuracy of the asphalt distributor in accordance with ASTM D 2995.

(b) Pneumatic-tire Rollers: A minimum of two self-propelled rollers, weighing at least 12 tons (11 Mg) each shall be used. Tires shall be smooth tread, of the same size and ply rating, and shall be inflated to a minimum uniform tire pressure of 60 psi (400 kPa), unless damage occurs. The engineer may require a reduction in roller pressure to prevent damage

to the aggregate or underlying base course. Wheels shall not wobble and shall be aligned so that gaps between tires on one axle are covered by tires of the other axle. Tires shall be equipped with scrapers to prevent adhesion of material. The engineer may require cleaning apparatus on the tires if material adhesion causes imperfections in the surface treatment.

(c) Power Broom or Blower: A power revolving broom or power blower shall be used to clean the surface of dust, dirt, mud, and loose or excess material.

(d) Aggregate Spreader: A self-propelled, pneumatic tire power spreader designed, equipped and operated to spread aggregate uniformly at the designated rate within the limits of the desired roadway width shall be used. The aggregate spreader shall be capable of maintaining an allowable variation from the specified rate within ±0.5 pounds per square yard (±0.3 kg per sq m) or ±0.25 pounds per square yard (±0.14 kg per sq m) for expanded clay.

The aggregate spreader shall be calibrated in accordance with ASTM D 5624.

(e) Vacuum-Sweeper: A vacuum-sweeper will be required when there is a dusting problem, as determined by the project engineer.

507.04 WEATHER LIMITATIONS. Asphaltic surface treatments shall not be applied on a wet surface nor when the air temperature or pavement surface temperature in the shade is less than 60°F (15°C). Interlayers may be placed during any month of the year. Cold applied emulsions shall be placed within the months of April through October. Hot applied modified asphalt material shall be placed within the months of May through September.

507.05 PREPARATION OF EXISTING SURFACE. Potholes and surface depressions will be repaired by the Department prior to the asphaltic surface treatment work unless specified otherwise in the plans.

Immediately prior to application of the asphalt material, existing pavements shall be cleaned over the full width to be treated. Raised pavement markers shall be removed before application of asphaltic surface treatment, unless specified otherwise in the plans.

The pavement shall then be swept with a power broom or blower to remove all loose material. Areas not reached by the power broom or blower shall be cleaned by hand brooming.

If a prime coat or curing membrane is present prior to asphaltic surface treatment operations, it shall be satisfactorily cured and maintained in

accordance with Sections 505 and 506 prior to application of asphaltic surface treatment.

The pavement shall be considered excessively moist when it is visibly wet or when a one (1) square foot piece of polyethylene film condenses moisture after being tightly placed on the pavement surface for 15 minutes.

The surface shall be approved by the engineer prior to application of asphaltic surface treatment.

507.06 APPLICATION. After the existing surface has been approved, asphalt material and aggregates shall be applied in the amounts determined by the contractor and approved by the engineer, and by the sequence specified herein.

Application temperatures and sequence of application and spreading for asphaltic surfacing shall be as given in Table 507-1 or 507-2. The quantities of material given in Table 507-1 or 507-2 may be adjusted by the engineer as field conditions warrant. The type and condition of the surface being covered will affect the required application rate of asphalt material. The quantities to be used shall be as recommended by the contractor and approved by the engineer and shall be established during the first asphalt and aggregate application.

Before the asphaltic surface treatment operation begins the contractor shall calibrate and set the flow rates of his distributor and spray bar along with the aggregate spreader at a remote location offsite in a manner acceptable to the engineer. Aggregate spread rates may be adjusted by the engineer. It should be noted that after the aggregate spreader passes, the aggregate should never cover 100 percent of the roadway surface. The asphalt coated surface should be visible between the aggregates. Aggregate trucks must be struck off at the loading area for proper material yield measurements.

The aggregate spreader shall follow immediately behind the asphalt distributor. The roller shall make the initial pass immediately following the aggregate spreader before the emulsion breaks.

(a) Asphalt Material: The quantities in Tables 507-1 and 507-2 are for bid purposes only and shall be adjusted as recommended by the contractor and approved by the engineer as field conditions warrant. In general, the rate of asphalt is increased if the road is absorbent, badly cracked, or coarse, and is decreased if the road is smooth and flushed with asphalt. Guidelines for adjusting the rate of asphalt emulsion in gallons per square yards (L per sq m) are as follows:

Black, flushed asphalt, -0.1 to -0.06 (-0.4 to -0.27)

Smooth, non-porous, 0.00 (0.00)

Absorbent, porous, oxidized, 0.03 to 0.09 (0.14 to 0.40)

If asphalt cement is used, multiply these factors by 0.67.

The length of spread of asphalt material shall not exceed that which can be covered by aggregate within approximately one minute.

The rate of asphalt material placed shall be applied uniformly for the full width of treatment unless otherwise directed by the engineer. If the contractor is unable to keep the application of asphalt material consistently within ±0.02 gallons per square yard (±0.09 L per sq m), construction shall be stopped and the distributor shall be recalibrated to the satisfaction of the engineer.

The height of the spray bar and the angle of the nozzles shall be adjusted so that individual spray fans do not interfere with each other and uniform double or triple coverage is achieved. A minimum of 100 gallons (380 L) of asphalt material shall be maintained in the distributor during operation.

One of the special spray nozzles at the ends of the spray bar shall be adjusted and maintained to provide a sharp edge for the asphalt material on the edge of the roadway surface being covered. When the application is less in width than the length of the spray bar, these special nozzles shall be moved to provide the specified edge lines.

When any nozzles become blocked during application of asphalt material, the flow of material shall be immediately stopped and the nozzles cleaned. When the engineer directs that application be made over less than the full width of the roadway at a time, there shall be a slight longitudinal overlapping of adjacent treatments. The distributor shall be operated along a marked edge to keep the surface treatment in proper alignment.

To secure uniform distribution at the transverse junction of two treatments, the distributor shall be promptly stopped before the flow decreases. Building paper or other suitable material shall be placed over the end of the previous application. The joining application shall start on the building paper. Building paper so used shall be removed and disposed of satisfactorily. Burning of building paper will not be permitted within the right-of-way.

During application of asphalt material, adjacent pavements, structures, and trees shall not be splattered with asphalt material. The distributor shall not be cleaned or discharged into ditches, borrow pits, on shoulders or along the right-of-way.

Excess asphalt material at the junction between distributor loads shall be removed and satisfactorily corrected. Areas of the surface to be treated

which are not covered with asphaltic material directly from the distributor shall be covered by means of a hand-held spray attachment equipped with nozzles.

(b) Aggregates: The quantities in Tables 507-1 and 507-2 are for bid purposes only and shall be adjusted by the engineer as field conditions warrant. Aggregate spreading operations shall begin immediately after the application of the asphalt materials. All aggregates for hot applications shall be placed in a surface dry condition. Aggregate material shall be applied within approximately one minute after application of the asphalt material.

Aggregate shall be uniformly spread over the full width of asphaltic material with one pass of the spreading equipment with the application being sharply defined at edges. Equipment shall not be driven on uncovered asphalt material. When necessary to obtain uniform coverage, the surface shall be hand broomed.

Hand spreading will be permitted in conjunction with self-propelled spreaders over areas inaccessible to spreaders. Asphalt material shall be covered with the appropriate rate of aggregate before rolling is allowed.

(c) Multiple Applications: When multiple applications are to be placed, a minimum of 48 hours shall elapse between the application of each successive treatment of emulsions. Successive hot applications can be placed without delay.

(d) Interlayers: An interlayer shall be Type E as specified herein and may be placed on raw or stabilized base, on a milled surface, between lifts of asphalt, or over existing portland cement concrete pavement which will be overlaid with asphalt. The liquid application rate shall correspond to the proper aggregate size given in Table 507-1 or 507-2 as adjusted by the engineer to meet existing conditions. Asphaltic concrete shall not be placed on an emulsion surface treatment for a minimum of five days after application. Hot applied interlayers may be overlaid immediately.

507.07 ROLLING AND BROOMING AGGREGATE MATERIAL. Immediately after spreading the aggregate material, the surface shall be rolled using a minimum of two pneumatic tire rollers. The first pass shall be made within approximately one minute. Rolling shall proceed in a longitudinal direction, beginning at the outer edges of the application. Each pass shall overlap the previous pass by 1/2 the roller width. A minimum of three (3) passes shall be made over a single point. All rolling shall be completed within 1/2 hour after aggregate material has been spread. Deficiencies or damage in the aggregate material detected during

rolling shall be immediately corrected and rerolled as directed. Rolling aggregate material shall be continued until uniform coverage has been obtained. The remaining applications shall be rolled as specified for the first application. A steel wheel roller will not be allowed.

The surface shall be lightly broomed or blown to remove loose material. All loose material shall be completely removed from all roadway surfaces, including paved shoulders. If the engineer determines the amount of loose material is excessive, it shall be picked up and removed from the project instead of broomed onto the adjacent slopes.

507.08 PROTECTION. Traffic shall not be allowed on the surface until the aggregate has been placed, rolled, and, if necessary, lightly broomed or blown. Each treatment shall be lightly broomed or blown beginning the next morning, and will continue up to final acceptance of the project if necessary, to remove loose aggregate.

Maintenance of the surface shall include the distribution of aggregate material over the surface to absorb any free asphalt, covering any area deficient with aggregate material, and additional rolling as directed at no direct pay. Maintenance shall be conducted not to displace imbedded material.

When lightweight aggregate is used, a vacuum sweeper without the sweeper engaged will be required to remove loose aggregate when a dusting problem occurs. Loose aggregate material will not be permitted on the surface and will be promptly removed.

Table 507-1
Asphaltic Surface Treatment (AST) Requirements
(Emulsion)

TYPE AST	Course No.	TYPE A[1]		TYPE B[1]		TYPE C[1]	TYPE D			TYPE E[2] (Interlayer)
Agg. Friction Rating		I, II		I, II, III		I, II, III	I, II, III, IV			I, II, III, IV
Asphalt Emulsion		CRS-2P		CRS-2P		CRS-2P	CRS-2P			CRS-2P
Application Temp. Minimum		160°F (70°C)		160°F (70°C)		160°F (70°C)	160°F (70°C)			160°F (70°C)
Maximum		175°F (80°C)		175°F (80°C)		175°F (80°C)	175°F (80°C)			175°F (80°C)
Number of Applications		2	1	2	1	1	3	2	1	2
Asphalt Emulsion[3] Application Rates Per Course	1	0.39 (1.77)	0.41 (1.86)	0.39 (1.77)	0.31 (1.40)	0.41 (1.86)	0.46 (2.08)	0.39 (1.77)	0.31 (1.40)	0.39 (1.77)
	2	0.29 (1.31)	---	0.29 (1.31)	---	---	0.36 (1.63)	0.29 (1.31)	---	0.29 (1.31)
	3	---	---	---	---	---	0.26 (1.18)	---	---	---
Aggregate[4] Application Rates Per Course	1	S2-0.0111 (S2-0.010)	S2-0.0111 (S2-0.010)	S2-0.0111 (S2-0.010)	S3-0.0075 (S3-0.007)	S2-0.0111 (S2-0.010)	S1-0.0200 (S1-0.018)	S2-0.0111 (S2-0.010)	S3-0.0075 (S3-0.007)	S2-0.0111 (S2-0.010)
	2	S3-0.0075 (S3-0.007)	---	S3-0.0075 (S3-0.007)	---	---	S2-0.0111 (S2-0.010)	S3-0.0075 (S3-0.007)	---	S3-0.0075 (S3-0.007)
	3	---	---	---	---	---	S3-0.0075 (S3-0.007)	---	---	---

[1]Only lightweight aggregate, crushed slag or crushed stone shall be used for Types A, B or C Asphaltic Surface Treatment.
[2]Lightweight aggregate will not be allowed.
[3]Application rates are in gallons of asphalt emulsion per square yard (liters of asphalt emulsion per sq m) of AST.
[4]Size aggregate and application rates. For example, S2 is Size 2 aggregate and 0.0111 is the application rate in cubic yards of aggregate per square yard (0.010 cu m of aggregate per sq m) of AST.

Table 507-2
Asphaltic Surface Treatment (AST) Requirements
(Hot Application)

TYPE AST	Course No.	TYPE A[1]		TYPE B[1]		TYPE C[1]	TYPE D			TYPE E[2] (Interlayer)
Agg. Friction Rating		I, II		I, II, III		I, II, III	I, II, III, IV			I, II, III, IV
Asphalt Cement[3]		PAC-15		PAC-15		PAC-15	PAC-15			PAC-15
Application Temp.										
Minimum		300°F (149°C)		300°F (149°C)		300°F (149°C)	300°F (149°C)			300°F (149°C)
Maximum		360°F (182°C)		360°F (182°C)		360°F (182°C)	360°F (182°C)			360°F (182°C)
Number of Applications		2	1	2	1	1	3	2	1	2
Asphalt Cement[4] Application Rates Per Course	1	0.30 (1.36)	0.31 (1.40)	0.30 (1.36)	0.24 (1.09)	0.31 (1.40)	0.36 (1.63)	0.30 (1.36)	0.24 (1.09)	0.30 (1.36)
	2	0.23 (1.04)	---	0.23 (1.04)	---	---	0.28 (1.27)	0.23 (1.04)	---	0.23 (1.04)
	3	---	---	---	---	---	0.20 (0.91)	---	---	---
Aggregate[5] Application Rates Per Course	1	S2-0.0111 (S2-0.010)	S2-0.0111 (S2-0.010)	S2-0.0111 (S2-0.010)	S3-0.0075 (S3-0.007)	S2-0.0111 (S2-0.010)	S1-0.0200 (S1-0.018)	S2-0.0111 (S2-0.010)	S3-0.0075 (S3-0.007)	S2-0.0111 (S2-0.0010)
	2	S3-0.0075 (S3-0.007)	---	S3-0.0075 (S3-0.007)	---	---	S2-0.0111 (S2-0.010)	S3-0.0075 (S3-0.007)	---	S3-0.0075 (S3-0.007)
	3	---	---	---	---	---	S3-0.0075 (S3-0.007)	---	---	---

[1]Only lightweight aggregate, crushed slag or crushed stone shall be used for Types A, B or C Asphaltic Surface Treatment.
[2]Lightweight aggregate will not be allowed.
[3]See Table 1002-11.
[4]Application rates are in gallons of asphalt cement per square yard (liters of asphalt cement per sq m) of AST.
[5]Size aggregate and application rates. For example, S2 is Size 2 aggregate and 0.0111 is the application rate in cubic yards of aggregate per square yard (0.010 cu m of aggregate per sq m) of AST.

507.09 MEASUREMENT. The quantities of asphalt material and aggregate incorporated in the completed and accepted asphaltic surface treatment will be measured separately. Design quantities are based on horizontal dimensions. Design quantities will be adjusted when the engineer makes changes to adjust to field conditions. Each size aggregate will be measured by the square yard (sq m) per application. Asphalt material will be measured in the distributor by the gallon (L) at application temperatures.

507.10 PAYMENT. Payment for placement and maintenance of asphalt materials and aggregates will be made at the contract unit prices, subject to the payment adjustment provisions of Section 1002 for specification deviations of asphalt materials. The Materials and Testing Section will provide the payment adjustment percentage for asphalt materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
507-01	Asphalt Material (type)	Gallon (L)
507-02	Aggregate (size)	Square Yard (Sq m)

Section 508
Stone Matrix Asphalt

508.01 DESCRIPTION. This work consists of furnishing and constructing Stone Matrix Asphalt (SMA) which is a plant mixed asphalt concrete wearing course for high traffic applications. This mixture is a rut resistant hot mix design with stone on stone contact. The mixture shall be composed of a PG 76-22m asphalt cement and a gap graded coarse aggregate structure. Mineral filler and/or fibers shall be used to control draindown. This work shall be in accordance with these specifications, plan details, and as directed. All requirements of Section 502 apply to Stone Matrix Asphalt, except as modified herein. All plant and paving equipment and processes must meet the requirements of Section 503.

Mixture used for shoulder may be Stone Matrix Asphalt or any mixture type shown in Table 502-5.

508.02 MATERIALS.

(a) Asphalt Cement: Asphalt cement shall be PG 76-22m as listed on QPL 41 and complying with Section 1002.

(b) Aggregate: Aggregates shall be in accordance with Subsection 1003.06(b) and Table 508-1.

(c) Additives: Additives shall meet the requirements of Subsection 502.02(b) except mineral filler and/or fibers will be required.

(1) Anti-Strip: An approved anti-strip additive as listed in QPL 57 shall be added.

(2) Mineral Filler: Mineral filler shall comply with Subsection 1003.06(a)(6).

(3) Fibers: A cellulose or mineral fiber, meeting the requirements of Subsection 1002.02(d), shall be used to prevent draindown or to serve as a filler. Fibers shall be added at a minimum rate of 0.1 percent by weight (mass) of mixture and at a rate sufficient to prevent draindown.

508.03 JOB MIX FORMULA (JMF). The contractor shall submit a job mix formula to the District Lab Engineer at least 10 days prior to construction. One laboratory specimen at optimum design shall be cut in half and submitted to the District Lab Engineer for visual examination. A "stone-on-stone" structure will be required for the coarse aggregate (as retained on the No.4 (4.75 mm) Sieve). The Job Mix Formula shall meet

the requirements of Table 508-1. Moisture susceptibility shall be determined in accordance with DOTD TR 322. An anti-strip additive shall be included in accordance with Subsections 502.02(b)(2) and 502.03.

The contractor shall utilize a Superpave gyratory compactor in design of SMA in accordance with AASHTO M 323 with the following modifications. Seventy-five (75), (N_{design} = N_{max}), revolutions of the gyratory compactor will be required. Percent G_{mm} at N_{design} shall be not more than 89 percent at 9 revolutions and not more than 96.5 percent at 75 revolutions. The mixture shall exhibit a minimum of 16.0 percent VMA in design and shall maintain a minimum average of 16.0 percent VMA for each lot during production.

A maximum 0.3 percent draindown of asphalt cement by weight (mass) will be allowed and shall be calculated in accordance with ASTM D 6390.

508.04 VALIDATION. Production of the job mix formula will be allowed pending validation on a plant produced mixture. Validation will be on the first 1000 ton (Mg) sublot and will include the QC and QA results on mixture gradation, percent asphalt cement, volumetrics, asphalt draindown, percent anti-strip additive, and moisture susceptibility testing. One random sample from each third of the validation sublot shall be taken. The average of test results shall meet specification requirements for final job mix formula approval. If the mix fails to validate, one additional attempt may be allowed by the Laboratory Engineer before requiring redesign of the mixture.

508.05 QUALITY CONTROL. Percent asphalt cement, gradation, G_{mm}, and volumetrics shall be measured in accordance with Section 502. Lot sizes for both QC and acceptance will be determined in accordance with Subsection 502.14, except that all travel lane SMA, regardless of the quantity produced, will be paid in accordance with these specifications, not as a Small Quantity Lot. A lot size shall be 5000 tons (5000 Mg) and a sublot size shall be 1000 tons (1000 Mg). The minimum sampling and testing frequency shall be once per sublot. Aggregate gradations shall be controlled to the tolerances shown in Table 508-1.

If the average quality control tests for the lot for gradation, percent air voids, and VMA are not within specification requirements, corrections shall be made or operations ceased. Surface tolerance shall be monitored and controlled in accordance with Subsection 502.10(b).

508.06 ACCEPTANCE TESTING. Acceptance tests shall be performed at the plant unless otherwise directed by the engineer. The Department will take samples for both plant and roadway acceptance tests in accordance with Section 502. The plant acceptance tests will be taken at random at a rate of once per 1000 tons (1000 Mg) sublot. Lot sizes are in accordance with Subsection 508.05. Plant acceptance tests will include percent anti-strip, air voids, VMA and gradation [No. 4 and No. 200 (4.75 mm and 75 μm) sieves]. Roadway acceptance tests will include pavement density and surface tolerance. All acceptance test results will be in accordance with the approved job mix formula and the tolerances specified in Table 508-1. Acceptance tests will be subject to payment adjustments in accordance with Table 508-2.

(a) Theoretical Maximum Specific Gravity (G_{mm}): Theoretical maximum specific gravities (G_{mm}) in accordance with DOTD TR 327 will be determined by Department personnel at the plant on each sample taken and reported for each sublot

(b) Plant Volumetrics: Percent G_{mm} at $N_{initial}$, percent air voids at N_{design}, and percent VMA will be determined on the compacted briquette maintaining 2.5-4.5 percent air voids at N_{design}.

(c) Asphalt Draindown: A minimum of one asphalt draindown test will be made per lot. A maximum 0.3 percent draindown of asphalt cement by weight (mass) will be allowed in accordance with ASTM D 6390.

(d) Roadway Density: The percent roadway density will be determined for each sublot by taking 3 roadway cores per sublot and comparing the bulk specific gravity of the 3 roadway cores to the average G_{mm} for each sublot. The average percent G_{mm} for the sublot will be determined.

(e) Surface Tolerance: Surface tolerance will be measured in accordance with Subsection 502.11(b).

508.07 ACCEPTANCE FOR PAY. Payment based on acceptance tests will be made in accordance with Table 508-2. Acceptance will be based on Plant Acceptance Tests and Roadway Acceptance Tests as follows:

(a) Plant Acceptance Tests:

(1) Percent Air Voids: The percent deviations from the job mix formula tolerances for each sublot will be calculated and then the percent deviations of the sublots will be averaged for the lot.

(2) Percent VMA: The percent deviations below the minimum limit for each sublot will be calculated and then the percent deviations of the sublots will be averaged for the lot.

(3) Percent Passing the No. 4 (4.75 mm) Sieve: The percent deviations from the job mix formula tolerances for each sublot will be calculated and then the percent deviations of the sublots will be averaged for the lot.

(4) Percent Passing the No. 200 (75 µm) Sieve: The percent deviations from the job mix formula tolerances for each sublot will be calculated and then the percent deviations of the sublots will be averaged for the lot.

(5) Percent Payment for Plant Acceptance: The average of the percent payments for items (1) through (4) will be the percent payment for the plant.

(b) Roadway Acceptance Tests:

(1) Roadway Density: The average sublot percent density will be used to determine the sublot percent deviation from the JMF. The sublot deviation will be used to determine percent payment for the sublot. The percent payment for roadway density for each lot will be the average of the percent payments for each sublot.

(2) Surface Tolerance: The percent payment reported for surface tolerance will be for the entire lot in accordance with Section 502.

(3) Percent Payment for Roadway Acceptance: The percent payment for the roadway will be the average of the above percents payment for roadway density and surface tolerance.

(c) Total Percent Payment for Lot: The percent payment for the lot of SMA used on the project will be the lowest value of the percent payment for plant acceptance and the percent payment for roadway acceptance. All calculations for percent payment will be rounded to the nearest one (1) percent.

508.08 CONSTRUCTION REQUIREMENTS. Existing paving markings shall be removed before placing SMA. The SMA mix shall not be produced above a plant discharge temperature of 350°F (177°C). The SMA mix shall not be accepted at the entry of the material transfer vehicle (MTV) at less than 300°F (149°C). The paving operation shall be conducted in such a manner that the forward speed of the paver is kept continuous and does not exceed 25 feet (7.6 m) per minute or as directed.

The SMA mix shall be rolled immediately after placement. Two breakdown rollers capable of rolling across the width of the mat in one pass are recommended. Rolling shall be accomplished with steel wheel rollers weighing a minimum of 10 tons (89 kN). Pneumatic rollers shall not be used. Vibratory rollers shall be limited to high frequency and low

amplitude and used only as necessary to achieve density. The mastic shall not be allowed to migrate to the surface. Rolling shall continue until all roller marks are eliminated and minimum density is obtained, but not after the mat has cooled to 220°F (104°C), or lower. Traffic will not be allowed on the newly compacted surface until the mat has cooled to 140°F (60°C), or lower.

508.09 MEASUREMENT. SMA will be measured by the ton (Mg) in accordance with Subsection 502.15(a) and as amended herein.

508.10 PAYMENT. The SMA will be paid for by the ton (Mg) in place which will include all surface preparation, materials, equipment, production, haul, roadway operations, compaction, quality control, and incidentals. Payment will be made at an adjusted contract unit price per lot in accordance with Table 508-2.

Payment will be made under:

Item No.	Pay Item	Pay Unit
508-01	Asphalt Concrete (SMA) Wearing Course	Ton (Mg)

Table 508-1
Stone Matrix Asphalt (SMA) Mix Properties

A. MIXTURE REQUIREMENTS					
GRADATION			VOLUMETRICS		
US Sieve (Metric Sieve)	Percent Passing	JMF Tolerance, %	Properties	Requirements	Tolerance
3/4 inch (19 mm)	100	±4	% G_{mm} @ $N_{initial}$ (9 revolutions)	89 maximum	
1/2 inch (12.5 mm)	90 - 100	±4	Air Voids, % (75 revolutions)	3.5	±1.0
3/8 inch (9.5 mm)	75 Max.	±4			
No.4 (4.75 mm)	24 - 34	±4	VMA, %	16.0 minimum	
No.8 (2.36 mm)	16 - 28	±4	VFA, %	For Info. Only	
No. 30 (600 µm)	12 - 25	±3	G_{mb} (Control Only)	Per JMF	±0.022
No. 50 (300 µm)	11 - 22	±3	G_{mm} (Control Only)	Per JMF	±0.020
No. 200 (75 µm)	7 - 13	±1			
Extracted % AC	6.0 min.	±0.4			

B. PAVEMENT DENSITY REQUIREMENTS	
Density, Min. % of Theoretical Maximum Specific Gravity, DOTD TR 327	
Travel Lane	94.0
Shoulders	89.0

C. SURFACE TOLERANCE REQUIREMENTS
Surface Tolerance Variation - Refer to Section 502

Table 508-2
Payment Adjustment Schedules

Values shall be based on average of sublots unless otherwise noted:	Percent of Contract Unit Price Per Lot			
	100	95	80	50 or Remove[1]
A. Asphalt Properties, % (Reference Table 1002-1)	---	---	---	---
B. Plant Acceptance:				
Anti-Strip Additive, % Below JMF per Sublot	---	0.2 or More Below	---	---
% Air Voids, Average Sublot % Deviation from JMF Limits/Lot	0.0 - 0.1	0.2 - 0.3	0.4 - 0.5	0.6 and Greater
% VMA, Average Sublot % Deviation from JMF Below the Minimum Limit/Lot	0.0 - 0.2	0.3 - 0.5	0.6 - 0.8	0.9 and Greater
Aggregate Gradation, Average Sublot % Deviation from JMF Limits/Lot				
No. 4 (4.75 mm)	0.0 - 1.0	1.1 - 2.0	2.1 - 3.0	3.1 and Greater
No. 200 (75 µm)	0.0 - 0.5	0.6 - 1.0	1.1 - 2.0	2.1 and Greater
C. Roadway Acceptance:				
Roadway Density, Average Individual Sublot % Deviation from Minimum	0.0	0.1 - 1.0	1.1 - 2.5	2.6 and Greater
Surface Tolerance, in inches/mile (mm/km)	Per Section 502			

[1] At the option of the engineer.

Section 509
Cold Planing Asphaltic Pavement

509.01 DESCRIPTION. This work consists of removing asphaltic concrete surfacing in accordance with these specifications and in conformity with the average depth, width, grade, cross-slope and typical sections shown on the plans or established.

509.02 EQUIPMENT. Equipment for cold planing asphaltic surfacing shall be an approved, self-propelled planing machine or grinder. Equipment shall have sufficient power, traction and stability to remove the thickness of asphaltic concrete necessary to provide profile grade and cross slope uniformly across the surface. Cold planing equipment shall be capable of working from an erected stringline, shoe device or approved traveling reference plane that will accurately reflect, the average grade of the surface on which it is to be operated and shall have an automatic system for controlling cross slope at a given rate. Adequate loading equipment shall be provided to immediately remove materials cut from the surface and discharge the cuttings into a truck or on the shoulder as specified or directed. Adequate personnel shall be provided to ensure that the millings are removed from the surface daily. The drum shall be round and true with sufficient number of teeth to yield a uniform and fine textured surface. The machine shall be equipped with means to control dust created by the cutting action and shall have a system providing for uniformly varying the depth of cut while the machine is in motion.

509.03 CONSTRUCTION REQUIREMENTS.

(a) General: The maximum forward speed of the planing machine shall be 40 feet (12.0 m) per minute. The engineer may approve forward speeds greater than 40 feet (12.0 m) per minute provided the planed surface is uniform and fine textured and conforms to the surface tolerance requirements for a binder course. This speed may be reduced as directed to provide a planed surface of uniform and fine texture with the specified grade and cross slope. If ridges are excessive, the engineer may require additional milling, replacement of teeth, or other corrective action. The maximum depth of cold planing shall be 2 inches (50 mm) per pass when traffic is being maintained.

The traveling reference plane will be used on the first pass of the cold planing machine. The shoe device may be used on adjacent passes. This is the minimum acceptable method and the contractor must meet or exceed current surface tolerance specifications.

When the entire roadway width has not been planed to a flush surface by the end of a work period resulting in a vertical or near vertical longitudinal face exceeding 2 inches (50 mm) in height, this longitudinal face shall be sloped as directed. The contractor shall place smooth transitions at transverse joints prior to restoring to traffic by milling or by using an asphaltic concrete mix. RAP shall not be used. Transitions shall be a minimum length of one linear foot per 1/4 inch (0.3 m per 0.6 mm) of cold planed depth. Provisions shall be made at drives and turnouts to maintain local traffic.

Asphaltic concrete next to structures or in small irregular areas that cannot be removed by the planing machine shall be removed by other acceptable methods.

Pavement surfaces resulting from planing operations shall be of uniform texture, grade and cross-slope and free from loose material. Planed surfaces not meeting these requirements shall be replaned at no direct pay. No uneven, undulating surfaces will be accepted. The contractor shall provide drainage of planed areas where needed by cutting through the shoulder to the ditch on the same day that adjacent cold planing is performed.

The cold planing operation shall not precede the subsequent paving operation by more than 15 calendar days. This time may be extended by the engineer if extensive joint repairs, patching or shoulder stabilization is required.

In accordance with Section 713, temporary pavement markings shall be in place prior to opening the roadway to traffic.

The DOTD encourages reclamation and recycling of all materials obtained within the project limits. All reclaimed asphaltic pavement (RAP) material to be retained by the DOTD for its recycling program, or by other government entities, shall be hauled by the contractor to the storage facility indicated on the plans and stockpiled as directed. The contractor may also be required to retain a specified percentage or quantity of the RAP generated by the project. When so specified, the bidder shall indicate in his bid the value of the retained material that he used in calculating his bid.

Millings containing lightweight aggregate shall not be used as RAP in asphaltic concrete mixtures.

Required joint repairs shall be made after planing. Pavement patching shall be completed before planing, unless additional areas requiring patching

are exposed by the cold planing. Pavement patching and joint repair shall be in accordance with Section 510.

(b) The surface tolerance requirements of the cold planed surface for single lift overlays shall meet the requirements for binder course in Section 502.

509.04 MEASUREMENT. Measurement of cold planing will be made by the square yard (sq m) of asphaltic concrete surfacing satisfactorily removed. No additional measurement will be made for multiple passes required to achieve total cold planing depth indicated in the plans. Measurement of contractor retained RAP will be by the cubic yard (cu m), theoretical in-place plan quantity, and will be credited to the Department by treating it as a negative quantity in the Schedule of Pay Items.

509.05 PAYMENT. Payment for cold planing of asphaltic pavement will be made at the contract unit price per square yard (sq m), which includes the costs for removing, hauling and stockpiling of RAP material. The value of the RAP material retained by the contractor will be credited to the Department at the contract unit price for the retained material.

Drainage cuts placed through the shoulders and transitions at transverse joints will be at no additional pay.

Payment for temporary pavement markings will be included under appropriate pay items.

Payment will be made under:

Item No.	Pay Item	Pay Unit
509-01	Cold Planing Asphaltic Pavement	Square Yard (Sq m)
509-02	Contractor Retained Reclaimed Asphaltic Pavement	Cubic Yard (Cu m)

Section 510
Asphaltic Concrete Pavement Patching, Widening and Joint Repair

510.01 DESCRIPTION. This work consists of patching, widening and joint repair of existing asphaltic concrete pavements in accordance with these specifications and in conformity with the lines, grades and typical sections shown on the plans or as directed. Asphaltic concrete shall be used for patching, widening, and joint repair.

510.02 MATERIALS. Asphaltic concrete for patching and widening may be any type mixtures listed in Section 502, except that 1/2 inch (12.5 mm) nominal maximum size mixtures shall not be used. Asphaltic concrete for joint repair shall be Superpave Asphaltic Concrete (Level A) complying with Section 502. Asphalt tack coat shall comply with Section 504.

510.03 EQUIPMENT. Equipment furnished shall meet the specification requirements for the types of material used.

510.04 GENERAL CONSTRUCTION REQUIREMENTS. The contractor shall remove existing surfacing and base materials and perform all required excavation for patching and widening. When through traffic is maintained, the contractor shall complete the replacement of pavement, place the widening material, or fill and compact open areas or trenches at the end of each day's operations.

Excavation and compaction of the subgrade shall be in accordance with the plans or as directed. The subgrade shall be compacted uniformly.

Existing surfacing and excess excavation shall be disposed of beyond the right-of-way in accordance with Section 202.

For joint repair, contact surfaces of existing pavement shall be cleaned and a thin, uniform asphalt tack coat applied prior to placing asphaltic mixture in the joint.

Patching and widening with asphaltic concrete shall conform to Section 502, except that priming of the subgrade will not be required. Contact surfaces of pavement shall be cleaned and a uniform coat of asphalt tack coat applied before placement of asphaltic concrete. Patches shall not be overlayed for a minimum of 5 calendar days.

Spreading, finishing and compaction of asphaltic concrete shall leave the surface smooth and level with, or slightly above, the edge of existing pavement. To provide lateral support, the contractor will be permitted to construct temporary berms of excavated material against the outside edge of widening strips prior to rolling.

510.05 MEASUREMENT.

(a) Patching: Patching of pavement will be measured by the square yard (sq m) of existing pavement designated to be removed and replaced. Removal of existing surfacing and base course, tack coat, and required excavation will not be measured for payment.

(b) Widening: The quantities of widening for payment will be the design areas as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. Design quantities are based on the horizontal dimensions shown on the plans. Required excavation, removal of existing pavement and base course, asphaltic tack coat and disposal of removed material will not be measured for payment. No measurement for payment will be made for widening placed outside the dimensions shown on the plans or established by the engineer.

(c) Joint Repair: Joint repair will be measured by the ton (Mg) of asphaltic concrete used to fill the joint. Measurement will be made in accordance with Subsection 502.15.

510.06 PAYMENT.

(a) Patching: Payment for pavement patching will be made at the contract unit prices per square yard (sq m), subject to the following provisions:

Payment adjustments for deficiencies in asphaltic concrete and asphalt materials will be applied to 1/2 the contract unit price for pavement patching.

When the engineer orders additional thickness of patching in excess of plan thickness, payment for the additional thickness will be made as follows. The value per inch (mm) thickness will be determined by dividing the contract unit price per square yard (sq m) by the plan thickness. Thickness of patches will be measured from the surface that exists at the time of patching. Payment for the additional thickness will be made at 50 percent of the value per inch (mm) thus determined.

When the engineer approves of an underthickness of patching less than plan thickness, a deduction in payment will be made. This deduction per inch (mm) of underthickness will be made at 50 percent of the value per inch (mm). The value per inch (mm) will be calculated by dividing the contract unit price per square yard (sq m) by the plan thickness.

Any patching that develops or is required between the time of initial patching operations and the placement of the first lift of asphaltic concrete will be paid for at the contract unit price. Any patching required due to base failure after placement of the first lift of asphaltic concrete will be paid for at twice the contract unit price.

Asphaltic concrete will be subject to the payment adjustment provisions of Section 502.

(b) Widening: Payment for pavement widening will be made at the contract unit prices per square yard (sq m). Overwidths will be accepted at no additional pay. Underwidth shall be corrected by furnishing and placing additional asphaltic concrete to a minimum width of 1 foot (0.3 m) and plan thickness at no direct pay.

(c) Joint Repair: Payment for pavement joint repair will be made at the contract unit price per ton (Mg), subject to the following provisions:

Asphaltic concrete for joint repair will be subject to the payment adjustment provisions of Section 502 except for surface tolerance and density; however, payment adjustments will be applied to 1/3 the contract unit price for joint repair. The Materials and Testing Section will provide the payment adjustment percentage for properties of asphalt material.

Payment will be made under:

Item No.	Pay Item	Pay Unit
510-01	Pavement Patching	Square Yard (Sq m)
510-02	Pavement Widening	Square Yard (Sq m)
510-03	Pavement Joint Repair	Ton (Mg)

PART VI -- RIGID PAVEMENT

Section No. **Page No.**

Section 601
Portland Cement Concrete Pavement

601.01 DESCRIPTION. This work consists of constructing portland cement concrete pavement, on a prepared subgrade or base course in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the engineer.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Portland Cement Concrete Pavement and Structures" which is hereby made a part of the contract by reference.

601.02 MATERIALS. Materials shall comply with the following Sections or Subsections.

Portland Cement Concrete	901
Aggregates	1003
Joint Materials	1005
Tie Bars	1009.03
Dowel Bars	1009.04
Curing Materials	1011.01
Epoxy Systems	1017
Hydrated Lime	1018.03
Water	1018.01
Non-Shrink Grout	1018.26
Geotextile Fabric	1019

The contractor shall furnish either Type B or D concrete. The same type of concrete shall be used throughout the project, unless otherwise authorized in writing.

601.03 EQUIPMENT. Paving and miscellaneous equipment shall comply with the requirements of the appropriate subsection. The contractor shall submit, at least 7 days prior to paving, a list of his proposed equipment and tools necessary for handling materials and performing the work. All equipment shall be at the job site at least 24 hours prior to the start of

operations to be examined for approval. Equipment shall be so designed and operated as to assure placing and spreading of concrete without segregation.

(a) Vibrators: Vibrators for full width vibration of concrete slabs shall be internal type with either immersed tube or multiple spuds. They may be attached to the spreader or finishing machine or mounted on a separate carriage. Spacing of vibrators shall not exceed 18 inches (450 mm) when pavement is placed using the slip form method, and the vibrator spacing shall not exceed 24 inches (600 mm) when conventional forms are used. The first vibrator shall be approximately 12 inches (300 mm) from the edge of the slab. The attached vibrators shall be capable of being raised to prevent contact with joints, dowel bars, subgrade, forms or other features extending into the pavement. Frequency of submerged internal vibrators, both tube and spud vibrators, shall be 7,000 to 10,000 impulses per minute. This frequency also applies to internal vibrators used adjacent to forms. Vibrators mounted on any machine or carriage shall be interlocked with the forward travel mechanism so that they automatically start and stop vibrating when the machine starts and stops. Hand held vibrators shall be an approved type and design, capable of transmitting vibrations to concrete at frequencies of at least 4,500 impulses per minute.

(b) Sawing Equipment: When joints are sawed in accordance with Subsection 601.09, the contractor shall provide adequate equipment to complete the sawing to required dimensions, and in a timely manner to prevent cracking. The contractor shall have back-up equipment at the jobsite to continue sawing operations if the primary sawing equipment malfunctions.

(c) Forms:

(1) General: Forms shall have a depth not less than the specified edge thickness of pavement and a base width at least 0.8 of the depth, except as otherwise approved.

Forms shall be provided with adequate devices for secure setting. Flange braces shall extend outward on the base at least 2/3 the height of forms. Forms with battered top surfaces and bent, twisted or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved.

Materials used for keyway forms will be subject to approval. Top face of forms shall not vary from a true plane more than 1/8 inch in 10 feet (3 mm in 3.0 m) and the upstanding leg shall not vary more than 3/8 inch (10 mm) from the vertical. Forms shall contain provisions for locking ends of abutting sections together tightly.

(2) Straight Forms: Straight forms shall be made of metal at least 7/32 inch (6 mm) thick and shall be furnished in sections at least 10 feet (3.0 m) long.

(3) Flexible or Curved Forms: Flexible or curved forms of proper radius shall be used on curves of 150-feet (45 m) radius or less and shall be an approved design. On curves with a radius greater than 150 feet (45 m), straight forms of shorter lengths will be permitted.

(4) Built-up Forms: When approved, built-up forms may be used; however, the build-up shall not exceed 2 inches (50 mm). No limitation will be made on the use of built-up forms or amount of build-up where the total area of pavement of a specified thickness is less than 2,000 square yards (2000 sq m).

(d) Screeds: Wooden or metal screeds used for hand finishing or mechanical Clary type screeds shall be at least two feet (0.6 m) longer than the slab width. Screed widths for slip form pavers and mechanical pavers that ride on forms equipped with pan type screeds shall be the full width of the slab. The type of screed to be used shall be approved by the engineer and be sufficiently rigid to retain its shape in order to finish the concrete to the required crown and elevation.

(e) Floats: Machine floats shall be composed of cutting and smoothing floats suspended from, and guided by, a rigid frame constantly in contact with side forms. Long handled floats shall have blades at least 5 feet (1.5 m) long and 6 inches (150 mm) wide.

(f) Straightedge: Straightedges shall be approved minimum 10-foot (3.0 m) metal static straightedges with handles approximately 3 feet (0.9 m) longer than the lane width.

(g) Carpet Drag: Carpet drags shall consist of approved artificial turf. The artificial turf shall be made of molded polyethylene with synthetic turf blades approximately 0.85 inch (22 mm) long containing approximately 7200 individual blades per square foot (78,000 individual blades per sq m). The artificial turf carpet shall be full pavement width and of sufficient size that during the finishing operation approximately 2 feet (0.6 m) of carpet parallel to the pavement centerline will be in contact with the pavement surface for the full pavement width. For pavement 16 feet (5 m) or more in width, the artificial turf shall be mounted on a bridge that travels on the forms. If necessary for maintaining intimate contact with the pavement surface, the carpet may be weighted.

(h) Burlap Drag: The burlap drag shall consist of a seamless strip of damp burlap that shall produce a uniform gritty surface texture after dragging it longitudinally along the full width of the pavement. For pavement widths

16 feet (5 m) or more, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap at least 4 feet (1.2 m) wide is in contact with the full width of pavement surface. The drag shall consist of not less than two layers of burlap with the bottom layer approximately 6 inches (150 mm) wider than the upper layer.

(i) Tine Texturing Device: The tine texturing device shall have metal tines that produce randomly spaced grooves uniform in appearance and transverse to the pavement centerline. Tine dimensions and spacing requirements shall be in accordance with Subsection 601.08(h). The pavement shall have a continuously textured surface.

601.04 PREPARATION AND MAINTENANCE OF SUBGRADE OR BASE. The surface on which the concrete is to be placed shall be prepared and maintained in accordance with plan details and in such a manner that the pavement depth, grade and surface finish requirements will be met. Additional preparation needed for the support of construction equipment will be at no direct pay.

The subgrade or base course shall be cleaned of loose material and maintained in a satisfactory condition, and any deficient areas shall be corrected at no direct pay.

The subgrade or base course shall be graded to proper cross section. High areas shall be trimmed to grade. Areas below grade may be filled with concrete during paving. Failures, soft spots, or other damaged areas in bases and subgrade shall be repaired prior to concrete placement in accordance with Subsection 301.14. The finished grade shall be maintained in a smooth and compacted condition until pavement is placed. No concrete shall be placed until the subgrade or base course has been approved.

The contractor shall apply an approved mixture to the asphaltic concrete base course to prevent heat buildup in the base and bonding between the concrete pavement and base. If the contractor elects to use a whitewash mixture, approved mixtures will consist of hydrated lime and water or a wax based white pigmented curing compound. The type of whitewash mixture used and application rate needed to prevent heat buildup or bonding will be the responsibility of the contractor. Other types of mixtures proposed by the contractor will be subject to Department approval.

601.05 PLACING FORMS.

(a) Base Support: The foundation under forms shall be firm and true to grade so that the form will be firmly in contact for its whole length or firmly shimmed at the required grade.

(b) Form Setting:

(1) General: Form sections shall be tightly locked and free from movement in any direction. No settlement or springing of forms under the finishing machine will be acceptable except as allowed by the project engineer. Face and top of forms shall be cleaned and oiled prior to placing concrete. A pin shall be placed at each side of every form joint. Pins shall be of sufficient length to provide adequate anchorage.

(2) Stabilized (or treated), Permeable Bases, and Asphaltic Concrete Base Courses: On asphaltic concrete base courses, or cement or lime stabilized or treated base courses, each 10-foot (3.0 m) section of forms shall be staked into place with at least two pins installed in full size drilled holes.

(3) Other Types of Base Courses or Subgrade: On other types of bases or subgrades, at least three pins will be required in each 10-foot (3.0 m) section. After forms have been set to correct grade and alignment, the base or subgrade shall be thoroughly tamped, mechanically or by hand, at both inside and outside edges of forms.

(c) Grade and Alignment: Alignment and grade of forms shall be checked and corrections made by the contractor prior to placing concrete. When any form has been disturbed or the grade or alignment has become unstable, the form shall be reset and rechecked. Form sections shall not deviate from required alignment by more than 3/8 inch (10 mm).

601.06 PLACING CONCRETE. The subgrade or base shall be uniformly moist when concrete is placed. When directed, the subgrade or base shall be sprinkled to dampen the surface, but the method of sprinkling shall not form mud or pools of water. Concrete shall be deposited on the base or subgrade in such manner as to require as little rehandling as possible. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels or other approved tools. Workers shall not walk in freshly mixed concrete with tools, boots or shoes coated with dirt or foreign substances.

When concrete is to be placed adjacent to previously constructed pavement, and equipment (except for saws) will be operated on the previously constructed pavement, the previously constructed pavement shall have attained an age of 10 days or a compressive strength of 3,000 psi (20.7 MPa) when tested in accordance with DOTD TR 230. The contractor shall protect the finish from damage. Hot and cold weather limitations of Subsection 901.11 shall apply.

When only light strike-off and finishing equipment is carried on existing pavement, paving of adjoining pavement will be permitted after 1 day, exclusive of days when temperature is below 40°F (5°C).

Concrete shall be placed as near to joints as possible without disturbing them.

601.07 TEST SPECIMENS. The contractor shall furnish concrete for casting test specimens as required at no direct pay. Test specimens will be made and cured in accordance with DOTD TR 226.

601.08 STRIKE-OFF, CONSOLIDATION AND FINISHING.

The normal sequence of operations is: strike-off and consolidation, screeding, floating and removal of laitance, straight edging, surface finishing, and tine texturing. The finishing machine used shall be designed for concrete paving and meet the approval of the engineer. The finishing machine shall be mechanically powered and shall be capable of spreading, consolidating, screeding and finishing the concrete to the required pavement elevation and cross section. Mechanical Clary type lane screeds will be allowed when approved by the engineer for projects with concrete pavement lane lengths of 1500 feet (450 m) or less, continuous paving lengths less than 600 feet (180 m), pavement gaps, intersections, or when side clearance is restricted. The finished pavement shall meet the surface tolerance required in Subsection 601.11 regardless of the type of finishing equipment used.

(a) Strike-off: Concrete shall be struck off to the specified cross section and to an elevation such that when concrete is properly consolidated and finished, the pavement surface shall be at the established elevation.

(b) Consolidation: Concrete shall be consolidated for full width and depth of the slab. Vibrators shall not be operated longer than 15 seconds in one location. If satisfactory density of concrete is not obtained, the contractor shall use methods which will produce pavement in compliance with the specifications.

(c) Consolidation and Finishing at Joint Forming Devices:

(1) Concrete adjacent to joints shall be compacted without voids or segregation against joint material, also under and around load transfer devices, joint assembly units and other features extending into pavement. Concrete shall be thoroughly consolidated, using internal vibrators or other acceptable methods, for its full width along the faces of forms and along the full length and on both sides of joint assemblies. When hand-held vibrators are used, care shall be taken to avoid excessive vibration.

(2) After concrete has been placed and vibrated adjacent to joints, the finishing operations shall be brought forward, operating in a manner to avoid damage or misalignment of joints.

(d) Screeding: Concrete, as soon as placed, shall be struck off and screeded with an approved screed.

The screed shall be moved forward on forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which work is progressing and so manipulated that neither end is raised from side forms during the striking off process. This shall be repeated until the surface is of uniform texture, true to grade and cross section and free from porous areas. The screed shall be controlled to maintain a uniform roll of concrete ahead of the screed.

(e) Floating: Floating to provide the final smooth surface will be required using an approved machine float. When necessary, following machine floating, long handled floats may be used to smooth and fill open-textured pavement areas. Long handled floats shall not be used to float the entire pavement surface in lieu of machine floating. When strike-off and consolidation are done by hand and the pavement crown will not permit use of the machine float, the surface shall be floated transversely with the long handled float. The crown shall not be worked out of the pavement.

(f) Straightedging: Excess water and laitance shall be removed from the pavement surface with a steel straightedge. The plastic concrete surface shall be tested for trueness with a straightedge. The straightedge shall be furnished and used by the contractor and shall be held in contact with the surface in successive positions parallel to pavement centerline. The whole area shall be checked from one side of the slab to the other. Advance along the surface shall be in successive stages of not more than 1/2 the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, and refinished. High areas shall be cut down and refinished. Attention shall be given to ensure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is free from deviations from the straightedge and the slab conforms to required grade and cross section.

(g) Surface Finishing: In general, addition of water to the surface of concrete to assist in surface finishing operations will not be permitted. If application of water to the surface is permitted, it shall be applied as a fog spray by approved equipment.

During final surface finishing operations, areas that are improperly finished shall be refloated and refinished as required.

Surface finishing shall be with an approved carpet or burlap drag in accordance with Subsection 601.03(g) or 601.03(h). The drag used shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1/16 inch (2 mm) deep. The adjacent concrete shoulder will require the same finish as the pavement. The drag used shall be kept free of hardened concrete. Drags that cannot be cleaned, or show wear or produce unsatisfactory results shall be replaced.

(h) Tine Texturing: The metal tine texturing device shall be operated by approved mechanical means when texturing main roadway travel lanes. When approved, manual methods may be used for tine texturing of ramps, crossovers, turnouts, split slab construction or other pavement sections. Tine texturing will not be required on parking areas, drives, or other areas as designated by the engineer. Tines shall be steel flat wire, 4 to 5 inches (100 to 125 mm) in length, randomly spaced, with a minimum spacing of 3/8 inch (10 mm) and a maximum spacing of 1 1/2 inch (40 mm). No more than 50 percent of the spaces shall exceed 1 inch (25 mm). The width of tines shall be 1/8 ± 1/64 inch (3.0 ± 0.5 mm). The depth of groove produced in the concrete shall be 3/16 inch (5 mm) maximum and 1/8 inch (3 mm) minimum, measured in accordance with DOTD TR 229. Pavement, which does not meet the above requirements, shall be corrected by regrooving.

The adjacent concrete shoulder will require the same finish as the travel lane. Tine texture on the shoulders will be visually inspected.

(i) Edging at Forms and Joints: Before tine texturing and before concrete has reached its initial set, the edges on each side of pavement and each side of transverse expansion joints, Type EJ modified joints, and longitudinal construction joints which are not sawed shall be worked with an approved tool and rounded to the radius specified. A well-defined, continuous radius shall be produced and a smooth, dense mortar finish shall be obtained. A work bridge shall be used to perform the working of joints. The pavement surface shall not be disturbed by tilting the tool during use.

Tool marks on the slab adjacent to joints shall be eliminated by brooming the surface, but the rounding of the slab shall not be disturbed. Concrete on top of joint filler shall be removed. Joints shall be tested with a straightedge before concrete has reached initial set and corrections made as necessary.

(j) Hand Finishing: Hand finishing methods will not be permitted except under the following conditions:

(1) In case of breakdown of mechanical equipment, hand finishing may be used to finish concrete already deposited on the grade when the breakdown occurs.

(2) Pavement widths not exceeding 15 feet (4.5 m) or areas of irregular dimensions where operation of mechanical equipment is impractical may be hand finished.

(k) Finish for Concrete to be Overlaid: If concrete pavement is to be overlaid with asphaltic concrete, tine texturing will not be required; and the pavement shall be satisfactorily finished to required lines, grades and typical section. Machine or hand finishing methods may be used. The final surface finish shall be equivalent to that normally achieved with a wood float.

601.09 JOINTS.

(a) Longitudinal Joint (Type LJ): The longitudinal joint shall be constructed such that the transverse joint is continuous across the slab. Deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports. Tie bars shall not be coated with asphalt or other material or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, steel side forms or other approved methods shall be used. Only Grade 40 (Grade 300) tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before concrete of the adjacent lane is placed. Instead of bending tie bars, approved mechanical butt splicing devices complying with Subsection 806.07 may be used.

Tie bars that break or show evidence of fracture upon straightening shall be replaced when directed by using an approved adhesive anchor system listed in the QPL 52 or by epoxying with a Type I, Grade C epoxy resin system. When epoxy is used, holes for tie bars shall be drilled approximately 1/8 inch (3 mm) larger than the diameter of the bar to be anchored. Holes shall be clean and moisture free. Adhesive anchor systems shall be used in accordance with the manufacturer's recommendations.

The Type I, Grade C epoxy resin system shall be mixed in accordance with the manufacturer's recommendations with no fillers or extenders added. The maximum quantity of epoxy, which may be mixed, is that quantity that can be applied within the manufacturer's designated time limit depending upon ambient temperature or other job conditions. The surface of the steel tie bar shall be coated with epoxy. Epoxy shall be injected into the hole using a caulking gun or other approved method to completely fill the hole. Epoxy injected shall be sufficient to fill the void between the bar and hole as evidenced by epoxy squeeze-out when the bar is inserted. Precautions shall be taken to prevent bars from being disturbed until epoxy has sufficiently cured. Epoxy shall not be applied when ambient temperature is below 40°F (5°C).

When shoulder and roadway pavement slabs are placed separately, a longitudinal joint will be required between the slabs; however, when shoulder and roadway pavements are placed monolithically, and the total width of roadway and shoulder does not exceed 15 feet (4.5 m), no longitudinal joint will be required between the shoulder and roadway pavements. Ramps which exceed 15 feet (4.5 m) in width shall have a longitudinal joint at the centerline.

The contractor shall repair or replace any cracking, chipping, spalling, or tearing of the concrete at no direct pay by approved methods to the satisfaction of the engineer.

The longitudinal joint (Type LJ) shall be formed by sawing. The sawing operation shall begin as soon as the concrete has reached sufficient strength to support the sawing machine and tearing and raveling of the concrete does not occur. The sawing operation shall be completed in a timely manner such that cracking does not occur.

The initial joint width shall be a minimum of 1/8 inch (3 mm); joint depth shall be as specified in the plans. The joint sealant reservoir shall be sawed to a minimum width and depth shown on the plans. The joint sealant shall conform to Subsection 1005.02(a) or (c).

After each joint is sawed, the saw cut and adjacent concrete surfaces shall be cleaned of materials removed during sawing.

No equipment, other than the sawing machine, will be permitted on the pavement during sawing operations. Sufficient back-up equipment shall be provided at the jobsite to continue sawing operations in case of a breakdown of the primary sawing equipment.

During paving operations, joint locations shall be clearly marked by approved methods. When sawing operations are not providing proper crack control, the contractor shall modify sawing operations as required to provide proper crack control.

(b) Transverse Expansion Joints (Type EJ): Concrete disturbed during expansion joint installation shall be replaced with fresh concrete and vibrated with a surface vibrator. The sealer shall be a preformed elastomeric compression seal complying with Subsection 1005.03 or a two component rapid cure silicone complying with Subsection 1005.02(d). The expansion joint filler shall be one of the following types.

(1) Wood Filler: If wood filler conforming to Subsection 1005.01(b) is used to form the joint, the joint shall be sealed as specified. When wood filler is used, it shall be thoroughly saturated with water before installation. No board less than 6 feet (1.8 m) long shall be used.

Dowel Bars shall provide bracing adequate to hold the wood filler in a vertical position.

Wood fillers that are damaged shall not be used. Finished joints shall not deviate more than 1/4 inch (6 mm) in horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted within the expansion space. Field modification of wood filler will not be allowed.

(2) 1 1/2 Inch (38 mm) Type EJ Modified: When a slip form paving method is used the contractor will be allowed to construct the transverse expansion joint with a 1 1/2 inch (38 mm) wide sawed joint over a bolster block. The bolster block shall be constructed from Class A Concrete or one of the pavement types complying with Section 901. One layer of tar paper equivalent to a minimum of 30 pounds per 100 square feet (15 kg per 9.0 sq m) shall be placed between the bolster block and the pavement. If the contractor elects to use the EJ modified joint, all the expansion joints shall be constructed using this method.

(c) Transverse Contraction Joints (Type TCJ): Transverse contraction joints shall consist of planes of weakness created in the cross section of the pavement. The joints shall include load transfer devices. Joints for pavement with a design speed greater than 45 mph (70 km/h) shall be constructed by sawing as specified in Heading (1) below. Joints for pavement with a design speed of 45 mph (70 km/h) or less may be constructed by any of the following methods.

(1) Joints shall be constructed by sawing after the concrete has reached sufficient strength to support sawing equipment. During paving operations, joint locations shall be clearly marked by approved methods. Joints may be either sawed to required joint width and depth at one time, or may be initially sawed to a width of approximately 1/8 inch (3 mm) and to the required joint depth and subsequently widened by sawing to required joint width. Sawing shall be to the specified depth for the full width of roadway or lane. When the transverse contraction joint cannot be sawed to the edge of the pavement due to forms, an insert shall be placed in the 6 inches (150 mm) adjacent to the forms. Initial sawing shall be done as soon as the concrete has hardened sufficiently that tearing of the concrete will not occur, and shall be completed in a timely manner such that cracking does not occur.

The joint sealant reservoir shall be sawed to the minimum width and depth shown on the plans.

After each joint is sawed, the saw cut and adjacent concrete surfaces shall be cleaned of materials removed during sawing.

No equipment other than the sawing machine and testing equipment will be permitted on the pavement during sawing operations. Sufficient back-up equipment shall be provided at the jobsite to continue sawing operations in case of a break-down of the primary sawing equipment.

If sawing operations are not providing proper crack control the contractor shall modify sawing operations, equipment, timing and/or concrete mix as required to provide proper crack control.

The contractor shall repair any cracking, chipping, spalling or tearing of the concrete at no direct pay by approved methods to the satisfaction of the engineer.

(2) Install an approved removable joint device to form a joint to the required width and depth. A vertical plane shall be established prior to installing the removable device in the fresh concrete with a T-iron. The blade of the T-iron shall have a thickness of 1/4 to 3/8 inch (6 mm to 10 mm) and a depth 1/4 inch (6 mm) greater than the depth of the insert. This device shall be vibrated in place and raised 1/2 inch to 3/4 inch (15 mm to 20 mm) while concrete is workable, with all laitance removed along side of insert. The insert shall remain in place at least 12 hours. These devices may be reused provided they are cleaned of foreign materials and are undamaged in removal.

(3) Install a combination joint former/sealer device as specified in Subsection 1005.04 to form a joint in fresh concrete to ensure proper bond and alignment. A vertical plane shall be established prior to installing the seal insert device in the fresh concrete with a T-iron. The blade of the T-iron shall have a thickness of 1/4 to 3/8 inch (6 mm to 10 mm) and a depth 1/4 inch (6 mm) greater than the depth of the insert. The insert shall be vibrated in place until the concrete is properly consolidated against both sides of the seal. The top cap of the insert shall be flush with the top surface of the pavement at the completion of all finishing operations.

(d) Transverse Construction Joints (Type CJ): Transverse construction joints shall be constructed when there is an interruption of more than 1/2 hour in concreting operations. No transverse joint shall be constructed within 10 feet (3.0 m) of an expansion or contraction joint. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet (3.0 m) long, concrete back to the preceding joint shall be removed and disposed of as directed. Hand vibrators shall be used to ensure proper consolidation of concrete adjacent to transverse construction joints. Joints shall include dowel bars.

(e) Longitudinal Construction Joint (Type LCJ): Longitudinal construction joints shall be constructed when adjacent lanes are constructed separately. Hand vibrators shall be used to ensure proper consolidation of

concrete adjacent to longitudinal construction joints. Joints shall include tie bars. A heavy coat of curing compound shall be applied to the adjacent face of the concrete before constructing the adjacent slab. Tie bars shall be protected from being coated with curing compound.

(f) Longitudinal Butt Joint (Type LBJ): Longitudinal butt joints shall be constructed when adding one or more additional lanes of pavement. Deformed tie bars of the specified length, size, spacing and material shall be placed perpendicular to longitudinal butt joints. Tie bars shall not be coated with asphalt or other material or enclosed in tubes or sleeves.

Tie bars shall be installed in holes drilled in the existing pavement using an approved adhesive anchor system listed in the QPL 52, or by using a Type I, Grade C epoxy resin system, as listed in QPL 32, or an approved cementitious grout anchor system, as listed in QPL 40. Holes shall be clean and moisture free.

Adhesive anchor systems shall be used in accordance with the manufacturer's recommendations. When epoxy is used, tie bars shall be placed in the existing pavement in holes drilled approximately 1/8 inch (3 mm) larger than the diameter of the tie bar to be anchored. When an approved cementitious grout anchor system is used, the bars shall be placed in the existing pavement in holes drilled approximately 1/2 inch (15 mm) larger than the diameter of the tie bar to be anchored.

The epoxy shall be mixed in accordance with the manufacturer's recommendations with no fillers or extenders added. The maximum quantity of epoxy, which may be mixed, is that quantity that can be applied within the manufacturer's designated time limit dependent upon ambient temperature or other job conditions. The surface of the tie bar shall be coated with epoxy. Epoxy shall be injected into the hole using a caulking gun or other approved method to fill the hole with epoxy. Epoxy injected shall be sufficient to fill the void between the bar and hole as evidenced by epoxy squeeze-out when the bar is inserted. Precautions shall be taken to prevent the tie bar from being disturbed until epoxy has sufficiently cured. Epoxy shall not be applied when the ambient temperature is below 40°F (5°C).

(g) Transverse Butt Joint (Type BJ): Transverse butt joints shall be constructed when extending existing pavement. Smooth dowel bars of the specified length, size, coating, spacing and material shall be placed perpendicular to transverse butt joints.

Dowel bars shall be installed in the existing pavement by drilling holes approximately 1/8-inch (3 mm) larger than the diameter of the bar. The bar shall be installed using an approved Type I, Grade C epoxy resin system. Holes shall be clean and moisture free.

The epoxy shall be mixed in accordance with the manufacturer's recommendations with no fillers or extenders added. The maximum quantity of epoxy, which may be mixed, is that quantity that can be applied within the manufacturer's designated time limit depending upon ambient temperature or other job conditions. The embedded surface of the dowel bar shall be coated with epoxy. Epoxy shall be injected into the hole using a caulking gun or other approved method to fill the hole with epoxy. Epoxy injected shall be sufficient to fill the void between the bar and hole as evidenced by epoxy squeeze-out when the bar is inserted. A grout retention ring shall be placed over the dowel bar against the slab face to prevent epoxy from flowing out of the hole. The grout retention ring shall be left in place. Precautions shall be taken to prevent bars from being disturbed until epoxy has sufficiently cured. Epoxy shall not be applied when the ambient temperature is below 40°F (5°C).

Transverse butt joints shall be formed by using a removable joint forming device after the concrete has been placed or by sawing in accordance with Heading (a)(1).

(h) Transverse Expansion Joints-Modified (Type EJ-Modified): Transverse expansion joints-modified shall consist of a 4-inch (100 mm) wide joint sawed over the bolster block. The bolster block shall be constructed from Class A concrete or one of the pavement types conforming to Section 901. One layer of tar paper equivalent to a minimum of 30 pounds per 100 square feet (15 kg per 9.0 sq m) shall be placed between the bolster block and the pavement. Joint material shall comply with Subsection 1005.06.

(i) Dowel Bars: Dowel bars shall have a uniformly round cross section and shall be saw-cut, smooth and free of burrs, projections and deformations. Dowel bars shall be plastic coated in accordance with Subsection 1009.04.

Dowel bars may be placed by an approved mechanical device equipped with suitable means to control proper depth and alignment of the dowel bars. Dowel bars shall be positioned parallel to the pavement centerline and surface; and shall be firmly held in position by the mechanical device until concrete has been thoroughly consolidated around the bars.

Dowel bars placed in approved dowel assemblies shall have an approved expansion tube furnished with each bar used in expansion joints. The sleeve shall fit the dowel bar tightly and the closed end shall be watertight. The location of dowel bar placement for concrete shoulders shall conform to the plans.

Dowel bars with slightly damaged coatings may be used with the approval of the engineer provided the bars are lightly oiled or greased prior to placement.

(j) Asphaltic Concrete Overlaid Pavement: When new concrete pavement is to be overlaid with asphaltic concrete, joints shall be sawed or formed and sealed.

(k) Cracking: The intent of the specifications is for the contractor to construct concrete pavement free of longitudinal, transverse, and diagonal cracks. The contractor shall be responsible for repairing all longitudinal, transverse, and diagonal cracking that may occur. The contractor shall make immediate adjustments in his paving operations in order to prevent any additional cracking from occurring. Adjustments or modifications may include, but are not limited to, modifying sawing operations, applying bond breakers to base courses, lubricating dowel bars, reducing joint spacing, changing the cement-fly ash percentage, changing the cement-blast furnace slag percentage, changing the ratio of fine to coarse aggregates, changing aggregate gradation, and shortening or suspending paving operations when temperature changes occur. The cost of repairing all cracking and any adjustments in the contractor's paving operations, or concrete mixes to prevent cracking will be at no direct pay.

Cracking will be repaired by the following methods:

1) All transverse cracks shall be repaired with a full depth pavement patch.

2) All diagonal cracks shall be repaired with a full depth pavement patch.

3) All longitudinal cracks relatively parallel and within 8 inches (200 mm) of the longitudinal joint shall be repaired. The longitudinally sawed joint adjacent to the longitudinal cracks shall be cleaned and epoxied. The crack shall be routed, cleaned, and sealed unless otherwise directed by the engineer.

4) All longitudinal cracks farther than 8 inches (200 mm) from the longitudinal joint shall be repaired by a full depth pavement patch.

5) Multiple cracks per slab shall be repaired by replacing the entire slab between transverse joints.

The full depth pavement patching shall be placed in accordance with the details shown on the plans. Cracks to be sealed shall be routed to a minimum depth of 3/4 inch (20 mm) and to a width of not less than 3/8 inches (10 mm) or more than 5/8 inch (16 mm). The engineer may elect not to route and seal if the cracks are tight.

The concrete used for full depth pavement patching repair shall be the same type used throughout the project. If approved by the engineer, concrete for full depth patching can be substituted with Type E concrete. Spalls in the existing pavement resulting from pavement removal in the patch area shall be repaired by extending the removal limits to include the spalled areas. Pavement removal required for spall repair shall be the full lane width. Holes for dowel bars and tie bars shall be drilled into vertical faces of the adjoining pavement. Tie bars shall be installed in accordance with Subsection 601.09(f), and dowel bars shall be installed in accordance with Subsection 601.09(g). The finished patch surface shall meet the surface finish requirements of Subsection 601.11 and shall be textured to match the texture of the adjoining pavement.

Concrete used for panel replacement repair shall be the same type used throughout the project. If approved by the engineer, Class A concrete can be substituted for concrete used for panel replacement pavement repair.

601.10 CURING AND PROTECTION. Immediately after completion of finishing operations and as soon as marring of concrete will not occur, the pavement surface shall be cured by covering with a white pigmented curing compound. Concrete shall not be left exposed for more than 1/2 hour prior to applying the curing compound. Curing shall be maintained continuously for 72 hours.

(a) Curing: All exposed pavement surfaces shall be uniformly sprayed with white pigmented curing compound immediately after completion of surface finishing and as soon as surface water evaporates. Curing compound shall not be applied during rainfall.

Curing compound shall be applied under pressure by mechanical sprayers at the rate recommended by the manufacturer, but in no case less than 1 gallon per 100 square feet (4 L per 10 sq m) of surface area. Spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At time of use, the compound shall be thoroughly mixed. During application, the compound shall be stirred continuously by mechanical methods. Hand spraying of irregular widths or shapes and on surfaces exposed by form removal will be permitted provided curing compound has been thoroughly agitated prior to placing in the sprayer. Curing compound shall not be applied to inside faces of joints to be sealed. In split slab construction, curing compound shall be applied in such manner as to prevent spraying exposed tie bars.

Should the film become damaged within the curing period, the damaged portions shall be immediately repaired with additional compound.

When slip forming, or when the side forms are removed before the end of the 72-hour curing period, the exposed sides of slabs shall be immediately protected by applying a curing compound equal to that provided for the surface.

(b) Rain Protection: Prior to beginning daily paving operations, the contractor shall have available at the jobsite sufficient polyethylene sheeting material to properly protect the last 1 hour's operation against the effects of rain. The pavement surface and sides shall be covered with polyethylene sheeting, when required. Units shall be lapped at least 18 inches (450 mm). Sheeting shall be placed and weighted down so that it will remain in contact with the surface. Sheeting shall be large enough to extend beyond pavement edges at least twice the pavement thickness.

(c) Cold Weather Protection: When concrete is being placed and the air temperature is expected to drop below 35°F (2°C), a sufficient supply of straw, hay, grass, approved curing paper or other approved blanketing material shall be provided along the work. When the temperature is expected to reach the freezing point during the day or night, the protective material shall be spread over the pavement to a sufficient depth to prevent freezing of concrete. Concrete damaged by frost action shall be removed and replaced at no direct pay.

601.11 SURFACE TOLERANCE REQUIREMENTS (LONGITUDINAL).

(a) General: The pavement travel lanes will be tested using an approved California Type 25-Foot (7.5 m) Profilograph over each wheel path of each lane except that the outside wheel path will not be tested on projects which are classified in Table 601-1 as Category III projects and which have catch basins and curb along the outside edge of the pavement. The resulting profile trace will be evaluated to determine the location of high points (bumps) in excess of specification limits and to determine the pavement's Average Profile Index. The Average Profile Index is defined as the arithmetical average of the Profile Indexes of the wheel paths for each test section or lot of the travel lanes.

Associated pavements (acceleration lanes, deceleration lanes, continuous turn lanes and ramps) will be tested using the profilograph over the centerline of each lane or ramp. The resulting profile trace will be evaluated to determine the location of high points (bumps) in excess of specification limits.

Shoulders, turnouts, parking areas, crossovers and the 25-foot (7.5 m) areas of new travel lanes in tie-in areas shall be tested with an approved 10 foot (3.0 m) metal static straightedge.

The operation of the profilograph, including evaluation of the profile trace, determination of the Profile Index for each wheel path in each travel lane, calculation of the Average Profile Index for each roadway and determination of high points (bumps) in excess of specification limits shall be in accordance with DOTD TR 641. The operation of the profilograph and evaluation of the profile trace shall be by trained, qualified personnel who have successfully completed the Department's training and evaluation program.

The Blanking Band Template for determining the Profile Index shall be 0.2 inch (5 mm). The Bump Template for determining high points (bumps) in excess of specification limits shall be 0.3 inch in 25 feet (7.5 mm in 7.5 m) or less for Category I or II in Table 601-1 or 0.4-inch in 25 feet (10.0 mm in 7.5 m) or less for Category III in Table 601-1. The pavement profile determination will terminate approximately 25 feet (7.5 m) from each bridge approach slab or existing pavement that is joined by new pavement constructed under these specifications. Obviously deficient areas, as determined by the engineer, shall be corrected before any profilograph testing is performed.

(b) Requirements: Surface finish testing will be conducted in the longitudinal direction. Deficiencies shall be isolated in both the longitudinal and transverse direction. All pavement travel lanes and associated pavements, regardless of design speeds or paving operations, with surface deviations represented by high points (bumps) in excess of 0.3 inch in 25 feet (7.5 mm in 7.5 m) or less for Category I or II or 0.4 inch in 25 feet (10.0 mm in 7.5 m) or less for Category III shall be corrected.

A report as required in DOTD TR 641 of each profile trace performed by the contractor shall be submitted to the engineer for review.

(1) Design Speed Greater than 45 MPH (70 km/h): For pavements with design speeds greater than 45 mph (70 km/h), the contractor shall furnish paving equipment and employ methods that produce a riding surface having an Average Profile Index of not more than 6.0 inches per mile (94.5 mm/km) per lot.

(2) Urban Areas Using Continuous Paving Operations: For urban areas using continuous paving operations with design speeds 45 mph (70 km/h) or less, the contractor shall furnish paving equipment and employ methods that produce a riding surface having an Average Profile Index of not more than 12.0 inches per mile per lot (189.0 mm/km/lot).

(3) Urban Areas Not Using Continuous Paving Operations: For urban areas not using continuous operations (such as: areas with catch basins, manholes, crossovers, driveways, curb and gutter sections, and split-slab construction) with design speeds 45 mph (70 km/h) or less, the contractor

shall furnish paving equipment and employ methods that produce a riding surface having an Average Profile Index of not more than 20.0 inches per mile (315 mm/km) per lot.

(4) Tie-in Areas, Shoulders, Turnouts, Parking Areas, and Crossovers: For pavement tie-in areas, shoulders, turnouts, parking areas, and crossovers, the contractor shall furnish equipment and employ methods that produce an acceptable riding surface. Pavement tie-in areas with surface deviations in excess of 1/4 inch in 10 feet (5 mm in 3.0 m) shall be corrected. Pavement shoulders, turnouts, parking areas, and crossovers with surface deviations in excess of 1/2 inch in 10 feet (15 mm in 3.0 m) shall be corrected.

(c) Equipment: The profilograph used for daily paving quality control and to identify surface areas requiring corrective actions shall consist of an approved California Type 25-foot (7.5 m) Profilograph furnished and operated by the contractor, calibrated and operated in accordance with DOTD TR 641.

The profilograph used for surface tolerance acceptance and to determine surface finish payment adjustments shall consist of an approved California Type 25-Foot (7.5 m) Profilograph furnished, calibrated and operated by the Department in accordance with DOTD TR 641.

The pavement profile is recorded by the profilograph at a scale of 1:1 vertically and 1:300 [1 inch equals 25 feet (25 mm equals 7.5 m)] longitudinally.

An approved 10-foot (3.0 m) metal static straightedge shall be furnished by the contractor for both quality control and acceptance surface tolerance testing of tie-in areas, shoulders, and turnouts, parking areas, and crossovers.

(d) Quality Control Surface Testing: The contractor shall perform quality control surface testing to ensure his paving and finishing operations are producing pavements meeting the requirements for all pavement types listed under the heading. The testing shall be performed using the equipment and at intervals listed under each pavement type.

(1) Pavement Travel Lanes: During the start up of initial paving operations, or after a shut down period, initial surface testing shall be performed by the contractor with a profilograph as soon as the concrete has cured sufficiently to allow testing. The purpose of this initial testing is to aid the contractor and the Department in evaluating the paving operations and equipment. The results from this testing shall be furnished to the engineer prior to proceeding with paving operations. If initial testing and evaluation indicates that the Average Profile Index exceeds the minimum requirements given in Table 601-1 for payment, paving operations shall be suspended until the contractor makes alterations to the paving and finishing operation in order to produce pavements within these limits. The contractor shall continue initial

surface testing and make changes to his paving operations until he has demonstrated that he can pour pavements within surface tolerance limits. After initial surface testing has demonstrated that paving operations and pavement smoothness are acceptable, the contractor shall proceed with regular paving operations and the contractor shall test each days paving with the profilograph no later than during the first work day following placement of the pavement. If the contractor fails to meet the minimum requirements given in Table 601-1 during regular paving operations, work shall be stopped and alterations to the paving and finishing operation shall be made by the contractor before paving operations can continue. The contractor shall also perform surface testing at the time interval specified for initial surface testing until the engineer is satisfied that the pavement is meeting minimum surface tolerance requirements.

Areas with high points (bumps) in excess of the requirements given in Heading (b), shall be isolated both longitudinally and transversely and corrected by the contractor for the full longitudinal and transverse extent of their occurrence in accordance with Heading (d)(5). Additional profiles as necessary shall be taken by the contractor to define the limits of all out of tolerance pavement requiring correction.

After correcting all individual deviations in excess of the requirements in Heading (b), additional corrective action shall be made by the contractor as necessary to reduce the Average Profile Index to the minimum requirements given in Table 601-1. Corrections shall be made in accordance with Heading (d)(5).

On those areas where corrective action is taken, the pavement shall be reprofiled as many times as necessary by the contractor to verify that corrections have produced an Average Profile Index that complies with the minimum requirements given in Table 601-1 and that the surface deviations in excess of the requirement given in Heading (b), have been corrected.

(2) Associated Pavement: During the start up of initial paving operations or after a shut down period, initial surface testing shall be performed by the contractor with a profilograph as soon as the concrete has cured sufficiently to allow testing. The purpose of this initial testing is to aid the contractor and the Department in evaluating the paving operations and equipment. The results from this testing shall be furnished to the engineer prior to proceeding with paving operations. If initial testing and evaluation indicates that there are excessive high points (bumps) in excess of the requirements given in Heading (b), the contractor shall stop and alter paving operations to reduce or eliminate the number of high points (bumps) in excess of specification limits. After initial surface testing has demonstrated that

paving operations and pavement smoothness are acceptable, the contractor shall proceed with regular paving operations, and the pavement shall be tested with a profilograph after paving operations for the associated pavement have been completed.

High points (bumps) having deviations in excess of the requirements given in Heading (b) shall be isolated and corrected by the contractor for the full longitudinal and transverse extent of their occurrence in accordance with Heading (d)(5). Verification of the required correction by reprofiling shall be conducted by the contractor.

(3) Shoulders, Turnouts, Parking Areas, and Crossovers: During the start up of initial paving operations, or after a shut down period, initial surface testing shall be performed by the contractor with an approved 10-foot (3.0 m) metal static straight edge as soon as the concrete has cured sufficiently to allow testing. The purpose of this initial testing is to aid the contractor and the Department in evaluating the paving operation and equipment. The results from this testing shall be furnished to the engineer prior to proceeding with paving operations. If initial testing and evaluation indicates surface deviations in excess of 1/2 inch in 10-foot (15 mm in 3.0 m), the contractor shall stop and alter paving operations to produce pavement with surface deviations of 1/2 inch or less in 10 feet (15 mm or less in 3.0 m). After initial surface testing has demonstrated that paving operations and pavement smoothness are acceptable, the contractor shall proceed with regular paving operations. The pavement shall be tested with a 10-foot (3.0 m) metal straight edge after paving operations for this pavement type have been completed.

Surface deviations in excess of 1/2 inch in 10 feet (15 mm in 3.0 m) shall be isolated and corrected by the contractor for the full longitudinal and transverse extent of their occurrence in accordance with Heading (d)(5).

(4) Tie-in Areas: Initial surface testing will not be required for tie-in areas, however, the contractor shall alter his paving operations if the surface tolerance at the tie-in is unacceptable to the engineer.

The surface of the 25-foot (7.5 m) areas of pavement in tie-in areas which are not tested with the profilograph shall be tested after completion in each wheel path for its entire length with a 10-foot (3.0 m) metal static straight edge. The joint between the new and existing pavement or approach slab shall also be tested with the straight edge placed longitudinally across the joint in each wheel path. Surface deviations in excess of 1/4 inch in 10 feet (6 mm in 3.0 m) shall be isolated and corrected by the contractor for the full longitudinal and transverse extent of their occurrence in accordance with Heading (d)(5).

(5) Corrections: Corrections shall be made using an approved profiling device or by removing and replacing the pavement as directed. The use of bush hammers or other impact devices will not be permitted. In cases where corrections are made using an approved profiling device the contractor shall reestablish transverse grooving by sawing to provide a uniform texture conforming to Subsection 601.08(h). Corrective work will be at no direct pay and shall be completed prior to determination of pavement or shoulder thickness.

(e) Acceptance Surface Testing:

(1) Travel Lanes: After corrective work and verification within a lot has been completed by the contractor in conformance with these specifications, each lot will be tested for surface tolerance acceptance. The acceptance testing for surface tolerance will be performed by the Department unless the contractor requests to do the testing. If the contractor elects to do the testing, all final quality control traces including any "reroll" quality control trace shall be run in the presence of a DOTD Authorized Profilograph Operator or Evaluator and the Department will take immediate possession of these traces for evaluation by the DOTD Authorized Evaluator. Use of the contractor's profilograph profile trace for acceptance shall be in accordance with TR 641, and testing shall be performed using the pavement lot limits determined by the Department. To determine surface tolerance payment adjustments, the Profile Index will be determined in each wheel path of each travel lane, the Average Profile Index will be calculated and any high points (bumps) in excess of specification limits will be identified. When high points (bumps) are found in excess of the requirements given in Heading (b), the contractor shall make corrections in accordance with Heading (d)(5). The entire lot, except for the exceptions at approach slabs and adjacent to existing pavement tie-ins, will be tested and evaluated.

(2) Associated Pavement: After corrective work and verification within a lot has been completed by the contractor in compliance with these specifications, each lot will be tested at the centerline of the pavement for surface tolerance acceptance. Ramps which have a centerline joint will be treated as having two lanes. The acceptance testing for surface tolerance will be performed by the Department unless the contractor requests to do the testing. Use of the contractors' profilograph profile trace for acceptance shall be in accordance with TR 641, and shall be performed using the pavement lot limits determined by the Department. High points (bumps) found in excess of the requirements given in Heading (b) shall be corrected by the contractor in accordance with Heading (d)(5). All associated pavement shall be tested

except for the exceptions at approach slabs and adjacent to existing pavement tie-ins.

(3) Shoulders, Turnouts, Parking Lots, and Crossovers: After corrective work has been completed, the surface of shoulders, turnouts and crossovers will be tested longitudinally by the engineer at one randomly selected location in each 300 linear feet (90 lin m) using the straightedge. Areas with surface deviations of 1/2 inch in 10 feet (15 mm in 3.0 m) will be isolated by the engineer and shall be corrected by the contractor at no direct pay to within 1/2 inch (15 mm) deviation in accordance with Heading (d)(5).

(4) Tie-in Areas: After corrective work has been completed, the surface of the 25-foot (7.5 m) area of new pavement adjacent to tie-ins with existing pavements or approach slabs which is not tested with the profilograph will be tested in each wheel path for its entire length with an approved 10-foot (3.0 m) metal static straightedge. The joint between the new and existing pavement or approach slab will also be tested with the straightedge placed longitudinally across the joint in each wheel path. Surface deviations in excess of 1/4-inch in 10 feet (5 mm in 3.0 m) will be isolated by the engineer and shall be corrected by the contractor in accordance with Heading (d)(5).

(5) Corrections: If the Department determines the Average Profile Index for pavement travel lanes does not conform to the specification requirements for 100 percent payment, given in Table 601-1, the contractor will be allowed to make corrections in accordance with Heading (d)(5) and the Department will reprofile for acceptance one additional time.

The engineer will review the profile trace on a per lot basis. Those areas out of specification which have been, in the opinion of the engineer, created by conditions beyond the control of the contractor may be isolated and excluded from the calculations of the average profile index. These exceptions may involve manholes and other structures located in the roadway, grade changes at intersections, and other specific conditions which cause abrupt deviations in the profile trace. High points (bumps) shall be corrected in accordance with Heading (d)(5).

601.12 REMOVING FORMS. Forms shall not be removed from freshly placed concrete until it has achieved final set. Forms shall be removed carefully to avoid damage to pavement. After forms are removed, sides of the slab shall be cured in accordance with Subsection 601.10. Minor honeycombed areas shall be filled with mortar composed of one part cement and two parts fine aggregate. Major honeycombed areas shall be removed and replaced. Any area or section so removed shall not be less than 10 feet (3.0 m) in length nor less than the full width of the lane involved. When it is

necessary to replace a section of pavement, any remaining portion of the slab adjacent to joints that is less than 10 feet (3.0 m) long shall also be replaced.

601.13 SEALING JOINTS.

(a) General Requirements: Each joint will be subject to approval for proper width, depth, alignment and preparation before sealing. Sealing of joints will be required when concrete is to be overlaid with asphaltic concrete.

Pavement may be opened to traffic prior to sealing provided the joint forming device or insert has not been removed or sawed. When the insert is removed or sawed, pavement may be opened to traffic provided joints are protected during the interval between sawing and sealing. Protection of joints shall be accomplished by placement of a backer material immediately after sawing or removal of insert. When poured or extruded sealants are used, the concrete shall be at least 7 days old prior to sealing joints. When opening sections to traffic and when poured or extruded sealants are used, joints in pavement gaps, tie-ins, and other areas approved by the engineer can be sealed after three days provided the concrete has attained a compressive strength of 3,000 psi (20.7 MPa).

Joints shall be thoroughly cleaned immediately prior to sealing. Poured or extruded sealants require joint faces to be sandblasted immediately prior to sealing. Sandblasting is not required for preformed elastomeric compression seal except when the joint insert is sawed.

Sealant shall be placed as soon as possible after curing of concrete. Traffic will not be permitted while sealing and until after sealant is cured. When a poured or extruded sealant in accordance with Subsection 1005.02 is used, the pavement shall be closed to traffic for at least one day after sealing. When elastomeric compression seal is used, the pavement may be opened to traffic immediately following completion of sealing.

Joints shall be free of spalls, fractures, breaks or voids. Areas requiring repairs shall be chipped back to sound concrete and repaired with an approved nonshrinking patching system in accordance with the manufacturer's recommendations.

Joint sealants shall be installed in accordance with the manufacturer's recommendations. Sealants shall comply with the following:

(1) Longitudinal joints (Type LJ) shall be sealed as specified in Subsection 601.09(a).

(2) Transverse expansion joints (Type EJ) shall be sealed as specified in Subsection 601.09(b).

(3) Transverse contraction (Type TCJ) and construction joints (Type CJ) shall be sealed with either silicone polymers complying with

Subsection 1005.02(c), preformed elastomeric joint sealer complying with Subsection 1005.03(a), or combination joint former/sealers complying with Subsection 1005.04.

(4) Longitudinal and transverse joints to be overlaid with asphaltic concrete with any sealant complying with Subsection 1005.02.

(5) Transverse expansion joints, (Type EJ Modified), 4 inches (100 mm) sealed with a preformed polyurethane foam sealant complying with Subsection 1005.06.

(6) Transverse butt joints (Type BJ) shall be sealed with either silicone polymer complying with Subsection 1005.02(c) or preformed elastomeric joint seal complying with Subsection 1005.03(a).

(7) Transverse expansion joints (Type EJ Modified), 1 1/2 inch (38 mm) shall be sealed with sealant complying with Subsection 1005.02(d) or 1005.03.

(8) Longitudinal joints in the asphaltic concrete shoulders adjacent to concrete pavement shall be sawed in accordance with plan details and sealed with a sealant complying with Subsection 1005.02(a).

Transverse shoulder and roadway joints shall be sealed with the same sealant.

(b) Poured Sealants and Preformed Joint Sealers: The following additional requirements apply to the installation of poured sealants and preformed joint sealants complying with Subsections 1005.02, 1005.03 and 1005.06.

(1) Hot Poured Rubberized Asphaltic Sealants:

a. Joint Preparation: Joints shall be formed or sawed in accordance with Subsection 601.09. Joints shall be thoroughly cleaned by sandblasting to effectively remove concrete curing membrane, laitance and other foreign matter from the joint. Sandblasting operations shall continue until the joint exhibits a uniformly etched surface. Upon completion of sandblasting, the joint and adjacent areas shall be dry and cleaned of dust and sand.

b. Application: Poured sealants and backer material complying with Subsections 1005.02(a) shall be installed in accordance with the following requirements.

The sealant shall not be installed until the joint has been approved. A backer material complying with Subsection 1005.02 shall be placed as shown on the plans. The joint shall be sealed without formation of entrapped air or voids. Air temperature at the time of installation shall be at least 50°F (10°C).

A mobile, heated, double-walled agitator-type kettle with suitable oil medium in the outer space for heat transfer capable of maintaining a sealant

temperature of 380°F to 410°F (195°C to 210°C) will be required. Kettles shall have easy access to facilitate cleaning. They shall be thoroughly cleaned of foreign substances or previously used compounds and shall be flushed daily with flushing oil. This equipment shall be provided with an automatic continuous temperature recording chart for constant kettle temperature surveillance. A direct connecting pressure-type extruding device with nozzles shaped for insertion into the joint shall be provided. Application equipment shall be so designed that sealant material may be recirculated in the inner kettle when not in use and shall be capable of filling the joint with sealant material free of voids or entrapped air. The applicator shall be subject to approval.

(2) Preformed Elastomeric Compression Seals: Preformed elastomeric compression seals shall comply with Subsection 1005.03. When the adhesive-lubricant material is to be pumped, a maximum of 30 percent dilution with a material recommended by the manufacturer will be allowed. The adhesive-lubricant shall be applied just prior to installation of the seal and shall be sufficient to completely cover the seal's sidewalls.

Seals shall be installed by machine on projects requiring 3,000 feet (900 m) or more of joint sealing. Stretching of the compression seal shall not exceed 5 percent. Prior to beginning installation, a length of seal equal to the pavement width shall be cut and installed so that stretching may be measured. Random checks for stretching shall be made as deemed necessary by the engineer. If the adhesive-lubricant has chemically set and maximum stretch limits are exceeded, the seal shall be removed and cleaned, the joint recleaned and the seal reinstalled. Field splicing will not be allowed.

(3) Silicone Sealant: The silicone sealant shall comply with Subsection 1005.02(c) or 1005.02 (d). The sandblasted joint faces shall be dry and dust free prior to sealant installation. The air temperature at the time of placement shall be at least 50°F (10°C) and rising. Backer material complying with Subsection 1005.02 shall be placed as shown in the plans. The joint faces shall be primed in accordance with the manufacturer's recommendations when a silicone sealant conforming to Subsection 1005.02(d) is used.

Non-sag material shall be forced against the joint walls by approved tooling methods that will ensure proper adhesion. No tooling is required when a self leveling material is used.

(4) Preformed Polyurethane Foam: Preformed polyurethane foam shall comply with Subsection 1005.06. Preformed polyurethane foam shall be installed using an approved, moisture insensitive lubricant-adhesive according to manufacturers' instructions.

601.14 PROTECTION OF PAVEMENT. The contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the contractor's employees and agents. This shall include flaggers to direct traffic, and erection and maintenance of warning signs, lights, pavement bridges or crossovers, etc., as necessary.

Any damage to pavement occurring prior to final acceptance shall be repaired or the pavement replaced at no direct pay.

601.15 SPLIT SLAB CONSTRUCTION. Split slab construction methods will only be permitted with the written approval of the DOTD Chief Construction Engineer when required for traffic maintenance, for short pavement sections or for turnouts, crossovers and other irregular sections.

There will be no additional payment for split slab construction. Longitudinal joints in pavement constructed by the split slab method shall comply with Subsection 601.09(a). Pavement constructed by this method shall in all other respects conform to these specifications. Split slabs placed with slip-form pavers shall conform to Subsection 601.16.

The use of split slab construction methods will not preclude the use of approved paving equipment as specified elsewhere herein.

601.16 SLIP FORM PAVING METHOD. The slip-form paving method may be used at the option of the contractor.

(a) Grade and Alignment: After the grade or base has been placed and compacted to required density, areas which will support the paving machine shall be cut to required elevation by means of a properly designed machine. The requirements of Subsection 601.04 shall apply for preparing and maintaining the grade during paving operations. The slip-form paver shall have the capability of maintaining correct alignment and grade. Edge lines shall not deviate from true alignment by more than 1/2 inch (15 mm) at any point.

(b) Placing Concrete: Concrete shall be placed with an approved slipform paver designed to spread, consolidate, screed and float-finish freshly placed concrete in one pass of the machine in such manner that a minimum of hand finishing will be necessary to provide a dense, homogeneous pavement in conformance with plans and specifications. The machine shall be equipped with vibrators conforming to Subsection 601.03(a). Concrete shall be vibrated for the full pavement width and depth. Sliding forms shall be rigidly held together laterally to prevent spreading of forms.

Concrete shall be of a uniform consistency exhibiting minimal bleed water and laitance. The slip-form paver shall be operated with as nearly a

continuous forward movement as possible. Mixing, delivering and placing concrete shall be coordinated to provide uniform progress. Concrete plants shall have sufficient mixing capacity to provide such continuous delivery of concrete to enable the paver to advance at a minimum rate of 1.5 feet (450 mm) per minute. If it is necessary to stop forward movement of the paver, the vibrator and tamping elements shall also be stopped immediately. If forward movement of the paver is delayed for a period of time, the engineer may direct fogging of the pavement. No tractive force shall be applied to the machine except that which is controlled from the machine.

(c) Finishing: Pavement finishing and texturing shall conform to Subsection 601.08. Surface tolerances shall be as specified in Subsection 601.11 with the following modifications. In addition to longitudinal testing, edges of slabs placed without conventional forms shall conform to the following tolerances when tested transversely with an approved 5-foot (1.5 m) metal static straightedge.

(1) Edges not along Longitudinal Joints: The following edge slump tolerance will only be allowed within a 6 inches (150 mm) width adjacent to the pavement edge. The surface within the 6 inches (150 mm) width adjacent to the edge shall not vary more than 1/2 inch (13 mm). The pavement edge shall be checked by the contractor with a 5 foot (1.5 m) straight edge while the concrete is still in a plastic state. Any edge slump settlement in excess of 1/2 inch (13 mm) shall be corrected before the concrete has hardened. If the 1/2-inch (13 mm) tolerance is not being met, conventional metal forms shall be placed at the slab edges. Top of the forms shall be set to required grade, and the forms shall be adequately supported to maintain required line and grade during concrete placement and finishing operations.

If edge slump deficiencies are not corrected by the method described above before the concrete has hardened, then the following method of correction shall apply. Areas that fail to meet the required edge slump tolerance shall be removed by full depth sawing of the pavement edge for a minimum width of 12 inches (300 mm) and repoured to the original lane width at proper grade. An approved Type II, Epoxy, Grade B or Grade C listed under QPL 32 shall be applied to the vertical faces, and tie bars shall be installed in the original slab in accordance with the plans, prior to repouring the pavement edge. The minimum length of removal for edge slump corrections shall be 10 feet (0.3 m).

(2) Edges at Longitudinal Joints: The following edge slump requirements will only be allowed within a 6-inch (150 mm) width adjacent to the pavement edge, and it will apply to all locations where additional concrete

work (additional lanes, shoulders, turnouts, ramps, widening, curb and gutters, etc.) is to be constructed immediately adjacent to the pavement being placed. The surface within the 6-inch (150 mm) width adjacent to the edge shall not vary more than 1/4 inch (6 mm). The pavement edge shall be checked by the contractor with a 5-foot (1.5 m) straight edge while the concrete is still in a plastic state. Any edge slump settlement in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. If the 1/4 inch (6 mm) tolerance is not being met, conventional metal forms shall be placed at the slab edges. Top of the forms shall be set to required grade, and the forms shall be adequately supported to maintain required line and grade during concrete placement and finishing operations.

If the edge slump deficiencies are not corrected by the method described above before the concrete has hardened, then the following method of correction shall apply. Areas that fail to meet the required edge slump tolerance shall be corrected by full depth removal of the pavement edge and replacing it as part of the adjacent concrete work. The pavement shall be removed by full depth sawing for a width necessary to bring the pavement within the required tolerance. The maximum width that may be removed and replaced with the adjacent concrete work is 12 inches (300 mm). If the pavement surface corrections require removing more than 12 inches (300 mm) of the pavement edge, full depth removal will be required for one-half of the lane width. The one-half lane pavement removal shall be replaced in accordance with the Departments' full depth concrete pavement patching details prior to placing the adjacent paving. All removals for edge slump corrections shall begin and end at a transverse joint.

(d) Curing: Curing shall be done in accordance with Subsection 601.10.

(e) Joints: Joints shall be constructed and sealed in accordance with Subsections 601.09 and 601.13.

(f) Rain Protection: The contractor shall have adequate materials available for protection of edges and surface of unhardened concrete from damage due to rain prior to each days paving. Such protective materials for pavement edges shall consist of standard metal forms or wood planks having a nominal thickness of 2 inches (50 mm) and a nominal width of not less than the pavement thickness. Protective materials for pavement surfaces shall comply with Subsection 601.10(b). When rain appears imminent, paving operations shall stop and all available personnel shall begin placing forms against pavement edges and covering the surface of the unhardened concrete with polyethylene sheeting.

(g) Cold Weather Protection: Cold weather protection shall comply with Subsection 601.10(c).

601.17 OPENING TO TRAFFIC. The pavement shall not be opened to any traffic, including vehicles of the contractor, until standard test specimens complying with Subsection 601.07 have attained a compressive strength of 3,000 psi (20.7 MPa) when tested in accordance with DOTD TR 230. If the compressive strength tests are not conducted, the pavement shall not be opened to traffic until 14 days after concrete has been placed. The pavement shall be cleaned and joints sealed in accordance with Subsection 601.13 prior to opening to traffic.

601.18 ACCEPTANCE REQUIREMENTS.

(a) General: Sampling and testing for acceptance will be conducted on each lot of pavement for thickness, compressive strength and surface tolerance. Any pavement that is obviously deficient shall be satisfactorily corrected or removed and replaced. Sampling and testing shall be accomplished following a stratified sampling plan in accordance with the Materials and Sampling Manual and specified test procedures. Times and locations will be established by the engineer.

A lot of portland cement concrete pavement or shoulders is an identifiable area of approximately 4000 square yards (4000 sq m) paid under the same item. The final area of pavement placed will be considered as a lot if it is at least 2000 square yards (2000 sq m); otherwise, it will be included in the previous lot. The engineer may redefine the lot limits when sequences of construction prevent timely sampling and testing on each lot for acceptance provided the same lot sizes are maintained.

(b) Thickness and Compressive Strength: Strength and thickness of pavements will be determined from hardened cores. Concrete core location, diameter, thickness and strength determinations will be made by the Department in accordance with DOTD TR 225. The contractor, in the presence of a DOTD District Laboratory representative, shall cut the cores and the DOTD representative shall take immediate possession of the cores. The contractor shall notify the District Laboratory Engineer at least five (5) days prior to the start of coring operations.

Each pavement lot will be divided into five (5) equal segments and one core will be obtained from each segment after surface tolerances have been met. Additional cores required by the Department to isolate thickness, strength or other pavement deficiencies, or recutting deficient cores will be done at no direct pay. All core holes in the pavement shall be patched by the contractor using an approved pavement or structural concrete mixture meeting the requirements of Section 901. The core holes are to be patched immediately after coring operations for each construction phase are completed. The surface

of the patch shall be finished to match the surrounding pavement. The cost of patching the core holes will be included in the bid price of the concrete coring.

(1) Thickness: The average thickness of the pavement lot shall not be less than the specified thickness by more than 0.10 inch (3 mm). Under thickness deficiencies in excess of 0.10 inch (3 mm) will be subject to the payment adjustments shown in Table 601-1. Over thickness will be waived at no direct pay.

In calculating average pavement thickness, individual measurements in excess of specified thickness by more than 0.25 inch (6 mm) will be considered as specified thickness plus 0.25 inch (6 mm).

Individual areas found deficient in thickness by more than 1 inch (25 mm) will be evaluated by the engineer, and if in the engineer's judgment the deficient areas warrant removal, they shall be removed and replaced with concrete of specified thickness. If the deficient area is allowed to remain in place, payment for the quantity of concrete represented by the deficiency will be made at 50 percent of the contract unit price. Payment for the remainder of the lot will be made in accordance with Table 601-1 based on the average thickness of the remaining lot segments.

(2) Compressive Strength: Average compressive strength for the lot shall not be less than 4,000 psi (27.6 MPa) or 3,600 psi (24.9 MPa) when air entrainment is used.

When the average strength for the lot is less than 4,000 psi (27.6 MPa), 3,600 psi (24.9 MPa) when air entrainment is used, the contract unit price will be adjusted in accordance with Table 601-1. When an individual core indicates compressive strength less than 3,000 psi (20.7 MPa), and if in the judgment of the engineer the concrete may be left in place, payment for the quantity of concrete represented by the deficient core will be made at 50 percent of the contract unit price. Payment for the remainder of the lot will be made in accordance with Table 601-1 based on the average compressive strength of the remaining segments. If removal is warranted, the entire deficient section shall be replaced with concrete of the specified quality.

The compressive strength of cores will be determined after a minimum of 28 days.

(3) Projects with less than 2,000 square yards (2,000 sq m): Projects with less than 2,000 square yards (2000 sq m) of pavement may be cored as required in Headings (1) and (2) above, or may be accepted on the basis of compressive strength cylinders and thickness measurements taken by the engineer.

(c) Surface Tolerance: The surface of each pavement lot will be tested longitudinally with an approved profilograph as described in Subsection

601.11. If sections of pavement do not meet the requirements for surface tolerance, an adjustment in unit price for the lot will be made in accordance with Table 601-1. There is no payment adjustment for associated pavements, tie-in areas, shoulders, turnouts, crossovers, and parking areas.

601.19 QUALITY CONTROL. The contractor shall be responsible for the production, transporting, placement, joint construction, surface finishing, maintenance and curing of all concrete pavement and shoulders constructed in accordance with these specifications. The contractor shall control the work to produce concrete pavement and shoulders that are uniform and conform to the plan dimensions and test requirements. The contractor shall perform whatever tests are necessary to ensure the concrete pavement and shoulders comply with these specifications. Construction methods shall be such that cracking does not occur.

601.20 MEASUREMENT. The quantities of portland cement concrete pavement for payment will be the design quantities specified in the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary. Design areas of pavement are based on the horizontal dimensions shown on the plans, the length being along the centerline of the pavement.

601.21 PAYMENT. Payment for portland cement concrete pavement will be on a lot basis at the contract unit price per square yard (sq m), which includes furnishing and placing all materials including tie bars, dowel bars and joint material. Concrete cores taken for thickness and strength acceptance will be paid at the contract unit price per each. There will be no adjustment in the unit price for coring when different pavement thicknesses are specified. If the pavement does not comply with acceptance requirements, payment will be made at an adjusted unit price in accordance with Table 601-1. When payment adjustments are made for more than one deficiency, they shall be cumulative.

Payment will be made under:

Item No.	Pay Item	Pay Unit
601-01	Portland Cement Concrete Pavement ___in. (mm) Thick	Square Yard (Sq m)
601-02	Portland Cement Concrete Pavement (Crossovers and Turnouts) ___in. (mm) Thick	Square Yard (Sq m)
601-03	Portland Cement Concrete Shoulder ___in. (mm) Thick	Square Yard (Sq m)
601-04	Portland Cement Concrete Pavement Coring	Each

Table 601-1E
Payment Adjustment Schedule

	Payment (Percent Of Contract Unit Price/Lot)[1]					
	100	98	95	80	50 or remove and replace[2]	Correct or remove and replace[2]
Deficiency in Average Thickness of 5 cores per lot, inches	0 to 0.10	-----	0.11 to 0.25	0.26 to 0.50	Over 0.50	-----
Average Compressive Strength, psi						
Without Air Entrainment	4000 & over	-----	3500 to 3999	3000 to 3499	Below 3000	-----
With Air Entrainment	3600 & over	-----	3150 to 3599	3000 to 3149	Below 3000	-----
Category I Average Profile Index (inches/mile/lot) for pavement travel lanes with design speed greater than 45 mph[3]	6.0 or less	6.1 to 7.0	7.1 to 8.0	-----	-----	over 8.0
Category II Average Profile Index (inches/mile/lot) for Urban Areas using continuous paving operations with design speeds 45 mph or less[3]	12.0 or less	12.1 to 13.0	13.1 to 14.0	-----	-----	over 14.0
Category III Average Profile Index (inches/mile/lot) for Urban Areas not using continuous paving operations with design speeds 45 mph or less[3]	20.0 or less	20.1 to 22.0	22.1 to 24.0	24.1 to 26.0	-----	over 26.0

[1]Payment adjustments shall be cumulative.
[2]At the option of the Department after investigation.
[3]As defined in Subsection 601.11 using an approved profilograph.

Table 601-1M
Payment Adjustment Schedule

	Payment (Percent of Contract Unit Price/Lot)[1]					
	100	98	95	80	50 or remove and replace[2]	Correct or remove and replace[2]
Deficiency In Average Thickness of 5 cores per lot, mm	0 to 3	-----	4 to 6	7 to 13	Over 13	-----
Average Compressive Strength, MPa						
Without Air Entrainment	27.6 & over	-----	24.1 to 27.5	20.7 to 24.0	Below 20.7	-----
With Air Entrainment	24.9 & over	-----	21.7 to 24.8	20.7 to 21.6	Below 20.7	-----
Category I Average Profile Index (mm/km)/lot for pavement travel lanes with design speed greater than 70 km/h[3]	94 or less	95 to 110	111 to 126	-----	-----	Over 126
Category II Average Profile Index (mm/km)/lot for Urban Areas using continuous paving operations with design speeds 70 km/h or less[3]	189 or less	190 to 205	206 to 221	-----	-----	Over 221
Category III Average Profile Index (mm/km)/lot for Urban Areas not using continuous paving operations with design speeds 70 km/h or less[3]	315 or less	316 to 347	348 to 378	379 to 410	-----	Over 410

[1]Payment adjustments shall be cumulative.
[2]At the option of the Department after investigation.
[3]As defined in Subsection 601.11 using an approved profilograph.

Section 602
Portland Cement Concrete Pavement Rehabilitation

602.01 DESCRIPTION. This work consists of the repair and rehabilitation of portland cement concrete pavements, which includes pavement grinding and texturing, retrofitting dowel bars, full and partial depth pavement patching, cleaning and resealing or filling of longitudinal and transverse joints, cleaning and sealing of cracks, and undersealing in accordance with these specifications, plan details, and as directed by the engineer.

Removed materials, including concrete pavement, shall be disposed of outside the project rights-of-way in accordance with Subsection 202.02.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Portland Cement Concrete Pavement and Structures".

602.02 MATERIALS. Materials for concrete pavement rehabilitation shall comply with the requirements of the appropriate subsection. Materials necessary for performing the work shall be approved by the engineer.

602.03 EQUIPMENT. Equipment for concrete pavement rehabilitation shall conform to the requirements of the appropriate subsection. Equipment and tools necessary for handling materials and performing the work will be approved by the engineer. The equipment shall be at the job site sufficiently ahead of the start of operations to be examined for approval.

602.04 CLEANING AND FILLING EXISTING LONGITUDINAL PAVEMENT JOINTS. This work consists of removing joint sealants in longitudinal joints, 2 inches (50 mm) and wider, in existing concrete pavement and filling the joints in accordance with plan details and the following requirements.

Joints and adjacent pavement surfaces shall be cleaned of existing sealants, incompressibles and debris to the satisfaction of the engineer in accordance with the plans. Joint faces shall then be cleaned by sandblasting or water blasting, and blown free of sand or water by compressed air just prior to filling. The air compressor shall be equipped with an approved oil and water trap. The joints shall be dry before filling. Prepared joints shall be filled within 24 hours. Joints that have become contaminated or dirty before filling

shall be recleaned as directed.

The joints shall be filled with an epoxy concrete consisting of a mixture of epoxy resin system and thoroughly dry fine aggregate. The epoxy resin system shall be Type I Grade A complying with Section 1017. The fine aggregate shall consist of packaged concrete or mortar sand complying with Section 1003 with the additional requirement that the sand, just prior to mixing, shall be in an oven dry condition. The mixture proportions of the epoxy concrete shall be one part epoxy resin system to approximately four parts fine aggregate, by dry volume. The final mix proportions shall be such that during placement the slump of the mixture will allow the material to fill all voids and be consolidated and finished. The dry aggregate shall be stored and proportioned so as to yield a uniformly combined material. The epoxy resin system and fine aggregate shall be mixed in equipment and by methods that produce a homogenous mixture.

Reinforcing steel shall be placed in the joint as shown on the plans. The reinforcing shall be cut at transverse joints. Transverse joints shall be established in the epoxy concrete by using inserts or sawing, and then sealed.

Existing transverse joints shall be protected from intrusion of epoxy concrete. If epoxy concrete gets into the transverse joints they shall be immediately cleaned of epoxy concrete to the satisfaction of the engineer.

The filled joint shall remain closed to traffic until, in the engineer's opinion, the epoxy concrete and joint sealant have satisfactorily cured.

602.05 CLEANING AND RESEALING EXISTING LONGITUDINAL AND TRANSVERSE PAVEMENT JOINTS. This work consists of removing joint sealants in longitudinal and transverse joints of existing concrete pavement and resealing the joints in accordance with plan details and the following requirements.

Joints and adjacent pavement surfaces shall be cleaned of existing sealants, incompressibles and debris in accordance with the plans to the satisfaction of the engineer. Joint faces shall be cleaned by sandblasting or water blasting, and blown free of sand or water by compressed air just prior to resealing. A minimum of one pass with the blasting nozzle held at an angle close to the surface [1-2 inches (25-50 mm)] shall be made along each reservoir face. The air blowing operation is to proceed in one direction (forward) to prevent recontamination of the joint. The air compressor shall be equipped with an approved oil and water trap. The joint shall be dry before resealing. Prepared joints shall be resealed within 24 hours. Joints, which have become contaminated or dirty before resealing, shall be recleaned as directed.

Resealing materials shall comply with Subsection 1005.02(a), and be

installed in accordance with plan details and the manufacturer's recommendations. Backer material shall be of the size shown on the plans complying with Subsection 1005.02(a).

Small crushed corners, not repaired by other methods, shall be sealed with hot poured sealant at the same time the joint is sealed to the satisfaction of the engineer at no direct pay.

The resealed joint shall remain closed to traffic until, in the engineer's opinion, the sealant has satisfactorily cured to tack free.

602.06 CLEANING AND SEALING CRACKS. This work consists of cleaning and sealing longitudinal, diagonal, and transverse cracks in accordance with plan details and the following requirements. The minimum width of crack to be sealed shall be 3/8-inch (10 mm) at the pavement surface. Cracks to be sealed shall be designated by the engineer.

Cracks shall be cleaned by sandblast or water blast. Cracks, less than 1/2 inch (13 mm) wide shall be routed to form a sealant reservoir approximately 1/2 inch (13 mm) wide by 1/2 inch (13 mm) deep and blown free of sand or water by compressed air just prior to sealing. A minimum of one pass with the blasting nozzle held at an angle close to the surface [1 - 2 inches (25 - 50 mm)] shall be made along each reservoir face. The air blowing operation is to proceed in one direction (forward) to prevent recontamination of the joint. The air compressor shall be equipped with an approved oil and water trap. The crack shall be dry before sealing. Prepared cracks shall be sealed within 24 hours. Cracks, which have become contaminated before sealing, shall be recleaned as directed. Cracks shall be sealed with a hot poured sealant complying with Subsection 1005.02(a), installed in accordance with the manufacturer's recommendations.

The sealed cracks shall remain closed to traffic until, in the engineer's opinion, the hot poured sealant has satisfactorily cured to tack free.

602.07 FULL DEPTH CORNER PATCHING OF JOINTED CONCRETE PAVEMENT. This work consists of full-depth removal and replacement of portland cement concrete pavement corner breaks at locations shown on the plans or as directed, in accordance with plan details and the following requirements.

Unsound concrete within the patch area shall be removed with approved pneumatic tools having a maximum weight of 30 pounds (14 kg). Any other method of removal shall be approved by the engineer. This approval is subject to the contractor demonstrating satisfactory performance without damage to the base course.

Before placing concrete, existing joints within or adjacent to patch areas shall be sawed to provide for the placement of fiberboard or other approved material in the joint. The fiberboard shall extend for the full thickness of the pavement.

Concrete surfaces within the patch area shall be cleaned of loose particles, dust and debris, and a bonding grout shall be applied to the existing concrete in the patch area with a stiff bristle brush just prior to placement of the new concrete. Grout shall consist of equal parts of portland cement and sand by weight (mass) with enough water to provide a stiff slurry. Grout shall be continuously agitated, and shall be used within 90 minutes.

Deteriorated base course in the patch area shall be removed and replaced with concrete as directed. Base course in the patch area damaged by the contractor shall be removed and replaced with concrete as directed at no direct pay. When base course is patched with concrete an approved bond breaker shall be placed between the base course and the pavement at no direct pay.

Approved wood or metal forms or fiberboard shall be placed for side forms adjacent to shoulders. A maximum 12 inches (300 mm) width of shoulder surfacing and base may be removed to facilitate forming; however, the contractor shall repair any damage to shoulder underdrain systems, and patch removed shoulder areas to the satisfaction of the engineer after form removal at no direct pay.

Concrete for pavement patching shall be Type E complying with Section 901. An approved set-accelerating admixture complying with Subsection 1011.02 may be used in the concrete mix at the dosage recommended by the admixture manufacturer for accelerated curing time. The set accelerator shall be added at the jobsite. The concrete shall be placed, consolidated, finished and cured as directed.

The patched surface shall conform to the existing surface and be textured to match the texture of adjoining pavement. If pavement is to be overlayed, the patched surface shall be drag finished only. The finished patched surface shall meet the surface finish requirements of Subsection 601.11 except that an approved minimum 10-foot (3.0 m) metal static straightedge shall be used.

After the concrete has been placed, transverse joints shall be sawed and sealed as shown on the plans with a sealant complying with Subsection 1005.02(a) in accordance with the manufacturer's recommendations. The longitudinal joint shall be reestablished to match the existing longitudinal joint. Backer material shall be of the size shown on the plans complying with Subsection 1005.02(a).

Patches shall remain closed to traffic a minimum of 72 hours or until standard test specimens conforming to Subsection 601.07 have attained a

compressive strength of 3000 psi (20.7 MPa) when tested in accordance with DOTD TR 230.

If patches are opened to traffic and reclosed for joint sawing and sealing, the patches shall remain closed to traffic until, in the engineer's opinion, the sealants have satisfactorily cured.

602.08 FULL DEPTH PATCHING OF JOINTED CONCRETE PAVEMENT. This work consists of full-depth removal and replacement of portland cement concrete pavement, with proper joints, at locations shown on the plans or as directed, in accordance with plan details and the following requirements.

The contractor shall coordinate activities to limit lane closures. If pavement has been removed and cannot be replaced during daylight hours the contractor shall temporarily backfill the areas with satisfactory aggregate and the lane shall remain closed to traffic.

Saw cuts shall be made with a concrete saw for the full depth of the pavement along the perimeter of the pavement to be removed as marked by the engineer. Spalls in the existing pavement resulting from pavement removal in the patch area shall be repaired by extending the removal limits to include spalled areas. Pavement removal for spall repair shall be made at the full patch width. Repair of the spalled areas shall be at the contractor's expense. Pavement in the patch area shall be removed by one of the following methods.

(1) The pavement may be reduced to appreciable sized pieces by making additional saw cuts or by using hand held jack hammers. The resulting pieces shall be removed by lifting lugs or other approved methods which will not damage the existing base course or the remaining edges.

(2) An approved resonant pavement breaking device may be used to reduce the pavement to pieces which can be removed without damaging the existing base course.

Any other method of removal shall be approved by the engineer. This approval will be subject to the contractor demonstrating satisfactory performance without damage to the base course.

Deteriorated base course in the patch area shall be removed and replaced with concrete as directed by the engineer. Base course in the patch area damaged by the contractor shall be removed and replaced with concrete as directed at no cost to the Department. When base course is patched with concrete an approved bond breaker shall be placed between the base course and the pavement at no direct pay.

Holes for dowel bars and tie bars shall be drilled into vertical faces of the

adjoining pavement, and bars shall be installed with an approved adhesive anchor system listed on QPL 32 or 52 as directed and shown on the plans. The free end of the dowel bar shall be lightly oiled or greased.

Approved wood or metal forms shall be placed for side forms adjacent to shoulders. A maximum 12 inches (300 mm) width of shoulder surfacing and base may be removed to facilitate forming; however, the contractor shall repair any damage to shoulder underdrain systems, and patch removed shoulder areas to the satisfaction of the engineer after form removal at no direct pay.

Concrete for pavement patching shall be Type E complying with Section 901. An approved set-accelerating admixture complying with Subsection 1011.02 may be used in the concrete mix at the dosage recommended by the admixture manufacturer for accelerated curing time. The set accelerator shall be added at the jobsite. The concrete shall be placed, consolidated, finished and cured as directed.

The patched surface shall conform to the existing surface and be textured to match the texture of adjoining pavement. If pavement is to be overlayed, the patch surface shall be drag finished only. The finished patched surface shall meet the surface finish requirements of Subsection 601.11 except an approved minimum 10-foot (3.0 m) metal static straightedge shall be used.

Patches shall remain closed to traffic a minimum of 72 hours or until standard test specimens conforming to Subsection 601.07 have attained a compressive strength of 3000 psi (20.7 MPa) when tested in accordance with DOTD TR 230.

Transverse joints shall be formed or sawed, then sealed with a sealant complying with Subsection 1005.02(a) in accordance with plan details and manufacturer's recommendations. Backer material shall be of the size shown on the plans complying with Subsection 1005.02(a).

In areas where a bond breaker is required in longitudinal joints, the bond breaker shall be a 6-mil (150 μm) (nominal) polyethylene sheet or approved equal. The bond breaker shall be placed the full thickness of the slab.

If patches are opened to traffic and reclosed for joint sawing and sealing, the patches shall remain closed to traffic until, in the engineer's opinion, the sealants have satisfactorily cured to tack free.

602.09 PARTIAL DEPTH PATCHING OF JOINTED CONCRETE PAVEMENT. This work consists of partial depth patching of concrete pavement in accordance with plan details and the following requirements.

(a) Patch Preparation: Saw cuts shall be made with a concrete saw along the perimeter of the pavement to be removed as marked by the engineer.

The saw cut shall be made to the depth of unsound concrete, as determined by the engineer, but shall not be less than 1 1/2 inches (40 mm) nor more than 4 inches (100 mm). If the depth of unsound concrete exceeds 4 inches (100 mm), a full-depth patch shall be placed and payment made under that pay item. Unsound concrete within the patch area shall be removed with approved pneumatic tools having a maximum weight (mass) of 30 pounds (14 kg).

Before placing repair material, transverse and longitudinal joints within or adjacent to patch areas shall be sawed to within 1/2 inch (13 mm) of load transfer or tie steel, and fiberboard or other approved material shall be placed in the joint. The fiberboard, or other approved material, shall be placed to the bottom of the saw cut.

Concrete surfaces within the patch area shall be cleaned of loose particles, oil, dust, traces of asphaltic concrete, joint material and other contaminants by sandblasting before patching. All sandblasting residue shall be removed prior to placement of the patching material.

(b) Patching Material: The contractor has the option of using either portland cement concrete or epoxy mortar for partial depth patching of concrete pavement.

(1) Portland Cement Concrete: Portland cement concrete for pavement patching shall be Type E complying with Section 901, except that a Grade F aggregate shall be used. An approved non-chloride type set-accelerating admixture complying with Subsection 1011.02 may be used in the concrete mix at the dosage recommended by the admixture manufacturer for maximum strength. The set accelerator shall be added at the job site.

Steel fibers complying with ASTM A-820, Type I or II shall be added to the mix. The nominal length of the fibers shall not be less than 1 inch (25 mm) nor greater than 1 1/2 inches (40 mm). The fiber shall be deformed and shall have an aspect ratio not less than 40 or greater than 60. The concrete shall contain 85 to 90 pounds per cubic yard (51 to 54 kg/cu m) of steel fibers**.** The fibers shall remain packaged until such time as they are included in the mix. Fibers with a nominal length greater than 1 inch (25 mm) shall be bonded together with water soluble glue. Fibers with a nominal length of 1 inch (25 mm) are not required to be bonded together. Glued fibers shall be the last material added to the mix and they shall be added at a rate not exceeding 132 lbs (60 kg) of fibers per minute. Additional mixing at the manufacturer's recommended mixing speed for at least l minute is required after addition of the fibers. Mixer capacity prior to the addition of the fibers shall not exceed 80 percent. Non-bonded fibers shall be blended with the aggregate in such a manner to prevent clumping of the fibers prior to addition of cement and water. Tightly bound or clumped steel fibers shall be broken up or prevented

from entering the mix. The fibers may be screened prior to placing onto the aggregate conveyor belt.

(2) Epoxy Mortar: The patching material shall be an epoxy mortar consisting of a mixture of epoxy resin system and thoroughly dry fine aggregate. The epoxy resin system shall be Type I Grade B complying with Section 1017. The epoxy resin system shall be light gray in color. The epoxy components shall be mixed in strict compliance with the manufacturer's mixing recommendations before the fine aggregate is added to the mixture. Epoxy mortar that has begun to generate appreciable heat shall be discarded. The fine aggregate shall consist of a packaged blasting sand. The sand, prior to mixing, shall be in an oven dry condition. The mixture proportions of the epoxy mortar shall be one part epoxy resin system to approximately three parts blasting sand, by dry volume. The final mix proportions shall be such that during placement the slump of the mixture will allow the material to fill all voids and be consolidated and finished. The dry aggregate shall be stored and proportioned so as to yield a uniformly combined material. The epoxy resin system and blasting sand shall be mixed in equipment and by methods that produce a homogenous mixture.

(c) Construction Requirements:

(1) Portland Cement Concrete: Concrete surfaces within the patch area shall be cleaned of loose particles, dust and debris, and a bonding grout shall be applied to the existing concrete in the patch area with a stiff bristle brush just before placement of the new concrete. Grout shall consist of equal parts of portland cement and sand by weight (mass) with enough water to provide a stiff slurry. Grout shall be continuously agitated, and shall be used within 90 minutes.

The concrete shall be placed, consolidated, finished and wet cured as directed.

The patch surface shall conform to the existing surface and be textured to match the texture of adjoining pavement. The finished patch surface shall meet the surface finish requirements of Subsection 601.11 except an approved 10-foot (3.0 m) metal static straightedge shall be used.

After the concrete has been placed, consolidated, and cured, transverse joints shall be sawed and sealed as shown on the plans with a sealant complying with Subsection 1005.02(a) in accordance with the manufacturer's recommendations. The longitudinal joint shall be reestablished to match the existing longitudinal joint. Backer material shall be of the size shown on the plans and shall comply with Subsection 1005.02(a). If patches are opened to traffic and re-closed for joint sawing and sealing, the patches shall remain closed to traffic until, in the engineer's opinion, the sealants have satisfactorily

cured to tack free.

Patches shall remain closed to traffic until standard test specimens conforming to Subsection 601.07 have attained a compressive strength of 3200 psi (22.0 MPa) when tested in accordance with DOTD TR 230.

(2) Epoxy Mortar: The surface of the repair areas shall be heavily primed with neat blended epoxy immediately before the epoxy mortar is placed. Priming shall include overlapping the surface of the area adjacent to the patch. The mixture shall be placed and tamped with sufficient effort to eliminate voids and to thoroughly compact the product. All patches shall be finished to the cross section of the existing pavement.

After the epoxy mortar has been placed, any transverse joints shall be sawed and sealed as shown on the plans with a sealant complying with Subsection 1005.02(a) in accordance with manufacturer's recommendations. Any longitudinal joint shall be reestablished to match the existing longitudinal joint. Backer material shall comply with Subsection 1005.02(a).

The patch surface shall conform to the existing surface and be textured to match the texture of adjoining pavement. The finished patch surface shall meet the surface finish requirements of Subsection 601.11 except an approved 10-foot (3.0 m) metal static straightedge shall be used.

Patches shall remain closed to traffic for at least 2 hours at air temperatures of over 60°F (16°C), and at least 4 hours at lower air temperatures unless otherwise approved by the engineer. If patches are opened to traffic and re-closed for joint sawing and sealing, the patches shall remain closed to traffic until, in the engineer's opinion, the sealants have satisfactorily cured to tack free.

602.10 PATCHING CONTINUOUSLY REINFORCED CONCRETE PAVEMENT.

This work consists of removing and replacing continuously reinforced portland cement concrete pavement at locations shown on the plans or as directed, in accordance with plan details and the following requirements.

Patching operations shall be conducted in one lane at a time. Patching operations shall not be performed in the adjacent lane until the previously patched lane has been reopened to traffic. Patches shall remain closed to traffic a minimum of 72 hours or until standard test specimens conforming to Subsection 601.07 have attained a compressive strength of 3,000 psi (20.7 MPa) when tested in accordance with DOTD TR 230.

When possible, pavement removal and replacement shall be completed during daylight hours. If pavement has been removed and cannot be replaced during daylight hours the patch area shall be temporarily backfilled with satisfactory aggregate and shall remain closed to traffic until the patch is

completed.

Prior to pavement removal, the patch area shall be outlined by saw cutting the pavement to a minimum depth of 1 1/2 inches (40 mm) and the pavement shall be cut full depth 18 inches (450 mm) from the edges of the patch as shown on the plans. Only one lane shall be full depth saw cut at a time. Pavement shall then be removed in such a manner that reinforcing bars projecting in the patch area are not bent or damaged. Hammers used for pavement removal in the 18-inch (450 mm) splice area shall not exceed 40 lbs (20 kg).

Deteriorated base course in the patch area shall be removed and replaced with concrete as directed. Base course in the patch area, damaged by the contractor, shall be removed and replaced with concrete as directed by the engineer at no direct pay. When base course is patched with concrete an approved bond breaker shall be placed between the base course and the pavement at no direct pay.

Deformed reinforcing steel shall be of the same size as the removed steel and shall be tied to projecting steel bars to provide at least 16 inches (400 mm) of lap. Grade 40 or 60 (Grade 300 or 420) may be used at the option of the contractor. Transverse steel shall be placed first on approved chairs, and longitudinal bars shall be placed on transverse bars and tied at bar intersections.

The contractor shall protect the existing shoulder surfacing, base course and underdrain system from damage during pavement removal operations, and shall place an approved 6-mil (150 μm) (nominal) polyethylene sheeting over exposed underdrain system areas before placement of concrete for the patch. Damaged shoulder surfacing, base course and underdrain system shall be satisfactorily repaired at no cost to the Department.

Concrete for pavement patching shall be Type E complying with Section 901. An approved non-chloride type set-accelerating admixture complying with Subsection 1011.02 may be used in the concrete mix at the dosage recommended by the admixture manufacturer for maximum strength. The set accelerator shall be added at the jobsite. Vertical surfaces of existing pavement in the patch areas shall be coated with a neat cement grout immediately prior to placement of new concrete. The concrete shall be placed, consolidated, finished and cured as directed.

The patch surface shall conform to the existing surface and be textured to match the texture of adjoining pavement. The finished patch surface shall meet the surface finish requirements of Subsection 601.11, except an approved 10-foot (3.0 m) metal static straightedge shall be used.

602.11 GRINDING. This work consists of grinding existing pavement roadway surfaces in accordance with plan details and the following requirements.

(a) General Requirements: Areas of the pavement surface as designated on the plans shall be ground to eliminate joint and crack faults and to provide a constant pavement cross slope within the designated grinding limits in each lane. Adjacent sides of transverse joints or cracks in excess of 1/8-inch (3 mm) difference in plane when checked with a 3-ft (1 m) straightedge, shall be reground until flush. Extra depth grinding will not be required to texture small low areas but the depth shall be sufficient to provide 98 percent texture coverage.

(b) Equipment: Grinding shall be accomplished by sawing with an industrial diamond abrasive which is impregnated in the saw blades. The saw blades shall be assembled in a cutting head mounted on a machine designed specifically for diamond grinding that will produce the required texture and smoothness level without damage to the concrete pavement or joint faces. The saw blades shall be 1/8-inch (3 mm) wide and there shall be a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width depending on the hardness of the aggregate. Grinding equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. Grinding equipment shall be capable of working in a closed lane, adjacent to an open traffic lane.

Each grinding machine shall weigh a minimum of 16 tons (14.5 Mg) and be powered with at least 300 horsepower (225 kw). Each machine shall be capable of cutting a path 3 to 4 ft (0.9 to 1.2 m) wide and within 12 inches (300 mm) of the face of the concrete curb. Sufficient equipment shall be furnished to complete the project in the working time specified.

Vacuuming equipment shall be provided for the removal of the slurry residue and excess water.

(c) Operations: The grinding operations shall produce a consistent cross slope without abrupt edges between passes of the grinding machine. When tested with a 12-foot (3.7 m) straightedge perpendicular to centerline, the variation shall not exceed 1/4 inch (6 mm). The slurry produced shall not be permitted to flow across active traffic lanes and shall be collected and disposed of before being blown by traffic or wind. When practical, slurry may be disposed of on the slope near the shoulder edge as the machine progresses down the roadway, unless otherwise directed.

Grinding shall follow removal of raised pavement markers, patching, and load transfer restoration, but should precede joint sealing, striping and replacement of raised pavement markers.

Grinding shall be performed in a longitudinal direction and shall begin and end at lines normal to the pavement centerline. The area ground shall not be left slick or polished but shall have a "corduroy-like", longitudinal line type texture. The entire travel way shall be ground as indicated on the plans or as directed by the project engineer.

Before grinding operations begin, the lane to be ground shall be profiled by the contractor with an approved profilograph and any designated test sections containing low areas of concern shall be brought to the attention of the project engineer by the contractor. These low sections will not be required to meet the specified Profile Index but the finished profile shall provide a 70 percent improvement over the "before-grinding" profile. The contractor shall utilize this "before-grinding" profile trace to select areas that may require multiple grinding passes.

(d) Final Surface: After the grinding is completed the pavement shall be tested with a profilograph for smoothness. Tangent sections and pavements with horizontal curves having a radius greater than 2000 ft (600 m) shall have a maximum Profile Index of 7 inches per mile (110 mm/km). Pavement with horizontal curves having a radius from 1000 to 2000 ft (300 to 600 m) shall have a maximum Profile Index of 9 inches per mile (145 mm/km).

The pavement texture, which is a function of blade width, blade spacing and cutting head alignment, shall be inspected after each new or rebuilt cutting head has ground 1000 ft (300 m). Grooves shall be approximately 1/8-inch (3 mm) wide. The fins between the grooves shall be approximately 1/10-inch (2.5 mm) thick and the typical height of the fins above the bottom of the grooves shall be approximately 1/16 inch (1.2 mm). Blade spacing shall be adjusted as necessary when the results fail to come within 25 percent of this criteria. If standing fins are not easily knocked off by foot, more blades with a closer spacing may be required. If, in the engineer's opinion, the fin height is not adequate to provide good skid resistance, blades shall be removed and a wider spacer used.

602.12 LONGITUDINAL SHOULDER JOINT. This work consists of constructing a longitudinal joint in designated asphaltic concrete shoulder surfacing adjacent to the portland cement concrete pavement in accordance with plan details and the following requirements as directed.

Joints shall be formed by sawing a slot approximately 1/2-inch (13 mm) wide and 1/2-inch (13 mm) deep in the asphaltic concrete shoulder adjacent to the portland cement concrete pavement. The slot shall be flushed with water immediately after sawing.

Just prior to placing joint sealant, the joint shall be blown free of sand and water with compressed air. The compressor shall be equipped with an approved oil and water trap. The joint shall be dry before sealing. Prepared joints shall be sealed within 24 hours. Joints which have become contaminated or dirty before sealing shall be recleaned as directed by the engineer. In areas where the shoulder has separated more than 1/2-inch (13 mm) from the pavement edge, backer material shall be placed in the joint prior to sealing.

Sealing materials shall be hot poured sealant complying with Subsection 1005.02(a) installed in accordance with the sealant manufacturer's recommendations. The sealed joint shall remain closed to traffic until, in the engineer's opinion, the sealant has satisfactorily cured to tack free.

602.13 REMOVAL OF EXISTING SHOULDER UNDERDRAIN SYSTEMS. This work consists of removing the existing shoulder underdrain system including outfall and backfilling the trench as required by the plan details and the following requirements.

The contractor shall remove the existing cap along the pavement edge and at the outfall locations, geotextile fabric, pipe, fittings, aggregate and other incidentals associated with the shoulder underdrain system to the satisfaction of the engineer. Particular attention shall be placed on removal of the geotextile fabric adjacent to the pavement edges to ensure all fabric is removed.

The contractor shall remove the concrete headwall and rodent screen. The outfall pipe shall be abandoned by plugging and backfilling to the satisfaction of the engineer.

The trench left after removal of the shoulder underdrain system shall be backfilled as required to accommodate installation of the new shoulder underdrain system. No more trench shall be opened than can be backfilled in the same day.

602.14 UNDERSEALING OR SLABJACKING PAVEMENT. This work consists of drilling holes in concrete pavement and pumping fly ash/cement slurry under the pavement to fill cavities (undersealing) or to raise the elevation of the pavement slabs (slabjacking).

(a) Materials:

(1) Portland Cement: Cement shall be Type I complying with Section 1001.

(2) Water: Water shall comply with Subsection 1018.01.

(3) Fly Ash: Fly ash shall comply with Subsection 1018.15.

(4) Powdered Ammonium Lignin Sulphonate: Powdered ammonium lignin sulphonate may be used as a fluidifier and water-reducing agent.

(b) Equipment. Equipment shall include the following.

(1) Air Compressors and Drills: Air compressors shall be equipped with air-lift pneumatic drills capable of drilling the required holes.

(2) Mixer: Mixer shall be a high speed (800 to 2000 rpm) colloidal mixer, or as approved, capable of thoroughly mixing slurry ingredients.

(3) Roller: The roller shall be a pneumatic-tire vehicle capable of exerting a single-axle load of 9 tons (8 Mg).

(c) Proportioning and Consistency:

(1) Proportioning: The slurry shall consist of one part portland cement and three parts fly ash by volume and water sufficient to meet the consistency requirements of Heading (2). When directed or approved, powdered ammonium lignin sulphonate shall be added at the rate of 0.5 to 1.5 percent by weight (mass) of cement.

(2) Consistency: The slurry shall be of such consistency that the efflux time from the flow cone, when tested in accordance with DOTD TR 633, is 12 to 18 seconds for undersealing, and 15 to 26 seconds for slabjacking.

(d) Construction Requirements:

(1) General: Holes of approximately 1 1/2 inches (40 mm) in diameter shall be drilled through pavement at locations specified on the plans or as directed. Drills shall be rotated to avoid cracking pavement and shall be held as nearly perpendicular as possible to pavement surfaces. Holes shall be cleaned with compressed air under pressure prior to undersealing. Holes which cannot be satisfactorily used shall be filled with slurry and new holes drilled. No more holes shall be drilled than can be used during a day's operations.

After holes are drilled, a pipe connected to the discharge hose of the pressure pump shall be lowered into the hole. Discharge end of the pipe shall not extend below the bottom of pavement.

When stooling of slurry occurs, additional holes shall be provided in the slab as directed. A more fluid slurry shall be pumped through these new holes to fill voids between stools.

When back pressure forces slurry out of the hole onto the slab after withdrawal of discharge pipe, the hole shall be temporarily plugged until the slurry has set. After completion of pumping in a hole, the discharge pipe or plug shall be removed and the hole filled with slurry.

Drainage structures shall be kept clean of slurry mixture. The contractor

shall monitor all drainage structures within the areas being pumped. When the pumping operation is forcing the slurry into a drainage structure, the contractor shall discontinue pumping operations and immediately clean the drainage structure of slurry mixture.

When directed, undersealed or slabjacked pavements shall be proof rolled with the specified roller; however, proof rolling shall not be conducted until at least 24 hours after completion of undersealing at no direct pay. When such proof rolling indicates that cavities exist beneath the slab, such cavities shall be filled as directed at no direct pay.

Pavement and shoulder surfaces shall be kept free of slurry mixture during undersealing operations.

Pumping operations shall be discontinued at least 1 hour before opening the pavement to traffic.

(2) Undersealing: Pumping of slurry into a hole shall continue until all voids beneath the pavement are filled. Lifting of the slab or slurry flowing out of an adjacent hole, through pavement joints or cracks, or out of the shoulder-pavement joint shall be sufficient evidence that all cavities are filled within range of the hole being pumped. Pumping pressures over 200 psi (1400 kPa) will not be permitted. When pressures cause pavement lifting, a lower pumping pressure shall be used. Lifting of the slab as a result of pumping shall not exceed 1/8 inch (3 mm). The contractor shall monitor the slab lifting by approved methods at all times during undersealing. Any pumping operation that causes voids to form under the pavement in the immediate area shall be terminated. The sequence of pumping from hole to hole shall be as directed.

(3) Slabjacking: Pumping operations for slabjacking shall be conducted in an approved manner and sequence. The contractor shall monitor the slab lifting at all times during pumping operations. Pumping shall continue until pavement slabs have been raised to the required grade within a tolerance of ±1/8 inch (±3 mm).

602.15 DOWEL BAR RETROFIT. This work consists of installing plastic coated 1 1/2 inch (38 mm) diameter by 18 inch (450 mm) long plain round dowel bars into slots cut across and through existing concrete pavement transverse joints. The existing portland cement concrete pavement shall be removed from the slots and the dowel bars shall be retrofitted across the pavement joints. The voids surrounding the dowel bars shall be filled with a concrete patching material. The transverse joints shall be sawed and sealed as required in the plans. All work shall conform to the plan details, and the following requirements.

The use of patented processes or devices for simultaneous cutting of slots for dowel bar retrofitting shall conform to Subsection 107.03.

(a) Materials: Dowel bars shall be in accordance with Subsection 1009.04.

The dowel bars shall have tight fitting nonmetallic end caps that allow for 1/4-inch (6 mm) bar movement at each end of the bar. The contractor shall submit an end cap sample to the project engineer for approval prior to installation.

Nonmetallic chair devices shall be used to support and hold the dowel bars in place. The chairs shall be in contact with the bottom and sides of the slot in order to maintain horizontal and vertical dowel bar alignments. The contractor shall submit a chair sample to the project engineer for approval prior to installation.

The foam core board filler material shall be 1/4-inch (6 mm) thick, constructed of closed cell foam and faced with poster board material on each side.

The caulk for sealing the existing transverse joint at the bottom and sides of the slot shall be a commercial grade of silicone caulk containing a minimum of 50 percent silicone.

A low shrinkage cementitious concrete patching material used to backfill the slots shall be selected from QPL 24 under Rapid Setting Patching Materials for Concrete and shall meet the following requirements when tested at the water content used at the project site.

(1) Compressive strength 3 hr., minimum 3,000 psi (20.7 MPa) - ASTM C 109

(2) Compressive strength 24 hr., minimum 5,000 psi (34.5 MPa) - ASTM C 109

(3) Shrinkage 4 days, 0.13 percent maximum - ASTM C 157

The contractor shall obtain and provide the manufacturer's technical specifications for approval of the patching product including all additives required to meet the minimum compressive strengths.

Curing compounds recommended by the patching material manufacturer shall be in accordance with Section 1011.

(b) Construction Requirements: The dowel bars shall be installed as follows:

Saw cut slots in the pavement shall be parallel to the centerline of the roadway and to a depth sufficient to place the center of the dowel bar at mid-depth in the pavement. Multiple saw cuts parallel to the centerline may be required to properly remove the material from the slot. The saw cuts for the slots at each transverse joint shall be made such that the dowel bars can be

positioned parallel to the roadway centerline and surface in accordance with plan details.

Jack hammers used to break loose concrete shall not be larger than the 30-pound (15 kg) class. If the 30-pound (15 kg) jack hammer damages the pavement, the project engineer will require the contractor to use a lighter weight hammer.

All exposed surfaces and cracks in the slot shall be sand blasted and cleaned prior to bar installation. Air compressors shall be equipped with approved oil and moisture traps.

The transverse contraction joint on the bottom and the sides of the slot shall be filled with silicone caulk. Caulking material at the bottom and sides of the slot that will result in breaking of the bond with the patching material shall be cleaned prior to patching.

The dowel bars shall be lightly oiled or greased prior to placement. The bar chairs shall provide a minimum of 1/2-inch (13 mm) clearance between the bottom of the dowel bar and the bottom of the slot. The dowel bars shall be centered over the transverse joint, placed in the middle of the slot to the depth shown on the plans, and shall be parallel to the roadway centerline and the roadway surface. The chairs shall hold the dowel bar securely in place during placement of the patching mix.

A 1/4-inch (6 mm) thick foam core board shall be placed at the middle of the dowel bar to maintain the transverse contraction joint. The existing joint sealant may need to be cut or removed to accommodate the foam core board. The foam core board shall fit tightly around the dowel bar and to the bottom and edges of the slot. The top of the foam core board shall be flush with the top surface of the concrete pavement. The foam core board shall remain in a vertical position and be tight to all edges during the placement of the patching material.

The contractor shall thoroughly moisten all surfaces on the sawed slot immediately prior to filling with patch compound unless the patching material manufacturer recommends the slot surface to be dry. Care shall be taken to prevent standing water in the slot. All excess water shall be removed with compressed air.

The contractor shall fill the slot (with the installed dowel bar, chairs, foam core board, and silicone in place) with an approved patching material. The patching material shall be mixed in accordance with the manufacturer's recommendations and with mixing equipment approved by the engineer. The patching material shall be vibrated with a small hand held vibrator capable of thoroughly consolidating the patching compound into the slot and around the dowel bar. The top surface of the filled slot shall be trowel finished and

cured. The patched areas shall be cured as directed by the patching material manufacturer.

The contractor shall provide six 2-inch (50 mm) cube molds in accordance with ASTM C 192 for sampling and testing the patching material once for each 4 hours of production or a minimum of once per day. Test specimens shall be made in accordance with ASTM C 192. If the compressive strengths are not being met, production shall cease and the contractor shall take corrective measures to the satisfaction of the engineer.

The patching material shall be allowed to cure for a minimum of four hours before placing any vehicle loads on the repair or as directed.

The transverse joints shall be sawed, then sealed with a sealant complying with Subsection 1005.02(c) in accordance with plan details and the manufacturer's recommendations. Backer material shall be of the size shown on the plan details and shall be selected from QPL 42.

All dowel bars not functioning or damaged shall be repaired or replaced at no cost to the Department.

602.16 MEASUREMENT. Measurement of portland cement concrete pavement rehabilitation will be as follows:

(a) Cleaning and Filling Existing Longitudinal Pavement Joints will be measured by the linear foot (lin m).

(b) Cleaning and Resealing Existing Longitudinal and Transverse Pavement Joints will be measured by the linear foot (lin m).

(c) Cleaning and Sealing Cracks will be measured by the linear foot (lin m) along the centerline of the crack at the pavement surface.

(d) Full Depth Corner Patching of Jointed Concrete Pavement will be measured by the square yard (sq m).

(e) Full Depth Patching of Jointed Concrete Pavement will be measured by the square yard (sq m).

(f) Partial Depth Patching of Jointed Concrete Pavement will be measured by the square yard (sq m).

(g) Patching of Continuously Reinforced Concrete Pavement will be measured by the square yard (sq m).

(h) Grinding will be measured by the square yard (sq m). Additional passes of the grinder will be considered to be incidental. The quantity of pavement grinding to be paid for will be determined by multiplying the width of the ground area by the horizontal length ground. Only the final ground area will be measured for payment on pavement areas that require multiple grinding passes.

(i) Longitudinal Shoulder Joints will be measured by the linear foot (lin m).

(j) Removal of Existing Shoulder Underdrain Systems will be measured by the linear foot (lin m) along the pavement edge.

(k) Undersealing Pavement or Slabjacking Pavement will be measured by the ton (Mg) of portland cement used in the slurry. Holes for undersealing or slabjacking will be measured per each. Fly ash, admixtures, and water will not be measured for payment.

(l) Dowel Bar Retrofit will be measured per each dowel bar installed and accepted.

602.17 PAYMENT. Payment for portland cement concrete pavement rehabilitation will be as follows:

(a) Cleaning and Filling Existing Longitudinal Pavement Joints: Payment for cleaning and filling longitudinal pavement joints will be made at the contract unit price per linear foot (lin m) which includes furnishing all materials and performing the work as specified under Subsection 602.04.

(b) Cleaning and Resealing Existing Longitudinal and Transverse Pavement Joints: Payment for cleaning and resealing existing longitudinal and transverse pavement joints will be made at the contract unit price per linear foot (lin m) which includes furnishing all materials and performing the work as specified under Subsection 602.05.

(c) Cleaning and Sealing Cracks: Payment for cleaning and sealing cracks will be made at the contract unit price per linear foot (lin m) which includes furnishing all materials and performing the work as specified under Subsection 602.06.

(d) Full Depth Corner Patching of Jointed Concrete Pavement: Acceptance and payment for full depth corner patching of jointed concrete pavement will be made on a lot basis at the contract unit price per square yard (sq m), adjusted in accordance with the following provisions. A lot will be a completed section or an identifiable pour completed in one day. Two random batches will be sampled for each lot with three cylinders molded for each batch. The six specimens per lot will be tested for compressive strength in 28 to 31 days. In the event of sudden cessation of operations, a minimum of three cylinders will represent a lot. Acceptance and payment for each lot will be based on the compressive strengths of Table 601-1.

Payment for full depth corner patching of jointed concrete pavement per square yard (sq m) includes furnishing all materials and performing the work as specified in Subsection 602.07.

Payment for deteriorated base course removed as directed and replaced with concrete will be made in accordance with Section 601.

(e) Full Depth Patching of Jointed Concrete Pavement: Acceptance and payment for full depth patching of jointed concrete pavement will be made on a lot basis at the contract unit price per square yard (sq m), adjusted in accordance with the following provisions. A lot will be an identifiable pour as described in Heading (d) of this subsection. Acceptance and payment for each lot will be based on the compressive strengths of Table 601-1.

Payment for full depth patching of jointed concrete pavement per square yard (sq m) includes furnishing all materials and performing the work as specified in Subsection 602.08.

Payment for deteriorated base course removed as directed and replaced with concrete will be made in accordance with Section 601.

(f) Partial Depth Patching of Jointed Concrete Pavement: Payment for partial depth patching of jointed concrete pavement will be made by the contract unit price per square yard (sq m) which includes furnishing all materials and performing the work as specified in Subsection 602.09.

When portland cement concrete is used for patching material in partial depth patches, the concrete will be accepted on a lot basis at the contract unit price per square yard (sq m). Acceptance and payment for each lot will be based on the compressive strengths of Table 601-1.

(g) Patching Continuously Reinforced Concrete Pavement: Payment for continuously reinforced concrete pavement will be made on a lot basis at the contract unit price per square yard (sq m), adjusted in accordance with the following provisions. A lot will be an identifiable pour as described in Heading (d) of this subsection. Acceptance and payment for each lot will be based on the compressive strengths of Table 601-1.

Payment for patching continuous reinforced concrete pavement per square yard (sq m) includes furnishing all materials and performing the work as specified in Subsection 602.10.

Payment for deteriorated base course removed as directed and replaced with concrete will be made in accordance with Section 601.

(h) Grinding Concrete Pavement and Joints: Payment for grinding concrete pavement and joints will be paid for at the contract unit price per square yard (sq m) which will include furnishing all labor, materials, tools, equipment, and incidentals involved in grinding the pavement, and disposing of the slurry residue.

(i) Longitudinal Shoulder Joint: Payment for longitudinal shoulder joint will be made at the contract unit price per linear foot (lin m) which

includes furnishing all materials and performing the work as specified in Subsection 602.12.

(j) Removal of Existing Shoulder Underdrain Systems: Payment for removal of existing shoulder underdrain systems will be made at the contract unit price per linear foot (lin m) which includes plugging and backfilling of outfalls, furnishing all materials and performing the work as specified in Subsection 602.13.

(k) Undersealing and Slabjacking Pavement: Payment for undersealing pavement and slabjacking pavement will be made at the contract unit price per ton (Mg) of portland cement. Holes for undersealing pavement and slabjacking pavement will be made at the contract unit price per each. Payment under these contract items include furnishing all materials and performing the work as specified in Subsection 602.14.

(l) Dowel Bar Retrofit: Payment for dowel bar retrofits will be made at the contract unit price per each, which includes furnishing all materials and performing the work as specified in Subsection 602.15.

Payment will be made under:

Item No.	Pay Item	Pay Unit
602-01	Cleaning and Filling Existing Longitudinal Pavement Joints	Linear Foot (Lin m)
602-02	Cleaning and Resealing Existing Longitudinal and Transverse Pavement Joints	Linear Foot (Lin m)
602-03	Cleaning and Sealing Cracks	Linear Foot (Lin m)
602-04	Full Depth Corner Patching of Jointed Concrete Pavement	Square Yard (Sq m)
602-05	Full Depth Patching of Jointed Concrete Pavement	Square Yard (Sq m)
602-06	Partial Depth Patching of Jointed Concrete Pavement	Square Yard (Sq m)
602-07	Patching Continuously Reinforced Concrete Pavement	Square Yard (Sq m)
602-08	Grinding Concrete Pavement	Square Yard (Sq m)
602-09	Grinding Isolated Joints	Square Yard (Sq m)
602-10	Longitudinal Shoulder Joints	Linear Foot (Lin m)
602-11	Removal of Existing Shoulder Underdrain Systems	Linear Foot (Lin m)
602-12	Undersealing Pavement	Ton (Mg)
602-13	Slabjacking Pavement	Ton (Mg)
602-14	Holes	Each
602-15	Dowel Bar Retrofit	Each

PART VII -- INCIDENTAL CONSTRUCTION

Section No. **Page No.**

Section No. **Page No.**

Section 701
Culverts and Storm Drains

701.01 DESCRIPTION. This work consists of furnishing, installing, and cleaning pipe, pipe arch, storm drains and sewers, also referred to as culverts or conduit, in accordance with these specifications and in conformity with lines and grades shown on the plans or established.

701.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Usable Soil	203.06(a)
Selected Soil	203.06(b)
Plastic Soil Blanket	203.10
Flowable Fill	710
Mortar	702.02
Portland Cement Concrete	901
Stone	1003.03(b)
Recycled Portland Cement Concrete	1003.03(c)
Granular Material	1003.07
Bedding Material	1003.08
Concrete Sewer Pipe	1006.02
Reinforced Concrete Pipe	1006.03
Reinforced Concrete Pipe Arch	1006.04
Gasket Materials	1006.06
Plastic Pipe	1006.07
Split Plastic Coupling Bands	1006.07(d)(4)
Plastic Yard Drain Pipe	1006.09
Bituminous Coated Corrugated Steel Pipe and Pipe Arch	1007.02
Structural Plate for Pipe, Pipe Arch and Arch	1007.04
Corrugated Aluminum Pipe and Pipe Arch	1007.05
Coupling Bands	1007.09
Reinforcing Steel	1009
Geotextile Fabric	1019

(a) Side Drain Pipe or Side Drain Pipe Arch: When the item for Side Drain Pipe or Side Drain Pipe Arch is included in the contract, the contractor has the option of furnishing reinforced concrete pipe or reinforced concrete pipe arch, corrugated metal pipe or corrugated metal pipe arch, or plastic pipe, unless otherwise specified.

(b) Cross Drain Pipe or Cross Drain Pipe Arch: When the item for Cross Drain Pipe or Cross Drain Pipe Arch is included in the contract, the contractor has the option of furnishing reinforced concrete pipe or reinforced concrete pipe arch, corrugated metal pipe or corrugated metal pipe arch, or plastic pipe, unless otherwise specified.

(c) Storm Drain Pipe or Storm Drain Pipe Arch: When the item for Storm Drain Pipe or Storm Drain Pipe Arch is included in the contract, the contractor has the option of furnishing reinforced concrete pipe or reinforced concrete pipe arch, or plastic pipe, unless otherwise specified.

(d) Yard Drain Pipe: When the item for Yard Drain Pipe is included in the contract, the contractor has the option of furnishing concrete sewer pipe, plastic yard drain pipe or plastic pipe in accordance with Section 1006 unless otherwise specified.

(e) Material Type Abbreviations:

(1) Reinforced Concrete Pipe:

RCP	Reinforced Concrete Pipe
RCPA	Reinforced Concrete Pipe Arch

(2) Corrugated Metal Pipe:

CAP	Corrugated Aluminum Pipe
CAPA	Corrugated Aluminum Pipe Arch
CMP	Corrugated Metal Pipe
CMPA	Corrugated Metal Pipe Arch
CSP	Corrugated Steel Pipe
CSPA	Corrugated Steel Pipe Arch
BCCSP	Bituminous Coated Corrugated Steel Pipe
BCCSPA	Bituminous Coated Corrugated Steel Pipe Arch

(3) Plastic Pipe:

PP	Plastic Pipe
PVCP	Polyvinyl Chloride Pipe
RPVCP	Ribbed Polyvinyl Chloride Pipe
CPEPDW	Corrugated Polyethylene Pipe Double Wall

(f) Joint Type Abbreviations:

T1	Type 1 Joint
T2	Type 2 Joint
T3	Type 3 Joint

(g) Quality Assurance for Pipe: Manufacturing plants will be periodically inspected for compliance with specified manufacturing methods, and material samples will be randomly obtained for laboratory testing for verification of manufacturing lots. Materials approved at the manufacturing plant will be subject to visual acceptance inspections at the jobsite or point of delivery.

701.03 EXCAVATION. The bottom of the trench shall be excavated to a minimum width of 18 inches (450 mm) on each side for all pipe. Surplus material or excavated material that does not conform to the requirements of Subsection 203.06(a) shall be satisfactorily disposed of in accordance with Subsection 202.02.

701.04 FORMING PIPE BED. When rock is encountered, it shall be removed below grade and replaced with material complying with Subsection 203.06. This replacement material shall be compacted to at least the density of the surrounding soil. The compacted earth cushion shall have a thickness under the pipe of at least 1/2 inch per foot (40 mm/m) of fill height over the top of the pipe with a minimum thickness of 8 inches (200 mm).

When pipe is not laid in a trench, a uniformly firm bed shall be made as specified for the bottom of a trench.

When bedding material is specified, additional excavation shall be performed below established grade and bedding material placed.

When a suitable foundation cannot be obtained, unstable soil below established grade shall be removed and replaced with granular material or bedding material constructed in accordance with Section 726. When stone or recycled portland cement concrete is used as backfill, unstable soil below established grade shall be removed and replaced with bedding material constructed in accordance with Section 726.

701.05 LAYING PIPE. Pipe laying shall begin at the downstream end of the line. The pipe shall be in contact with the foundation throughout its length. Bell or groove ends of pipe and outside circumferential laps of riveted metal pipe shall be placed facing upstream. Riveted seam metal pipe shall be placed with longitudinal laps at sides. Pipes in each continuous line shall have the same wall thickness. Metal pipes provided with lifting lugs shall be handled only by these lugs.

After pipe has been laid and before backfill is placed, the engineer will inspect the pipe for alignment, grade, integrity of joints, and coating damage.

701.06 JOINING PIPE.

(a) Joint Usage:

(1) Type 1 (T1) joints shall be used for side drains under drives and similar installations.

(2) Type 2 (T2) joints shall be used for cross drains under roadways, including turnouts.

(3) Type 3 (T3) joints shall be used for closed storm drain systems, flumes and siphons.

(b) Concrete Pipe: Concrete pipe may be either bell and spigot, or tongue and groove. The method of joining pipe sections shall be such that ends are fully entered and inner surfaces are flush and even.

An approved mechanical pipe puller shall be used for joining pipes over 36 inches (900 mm) in diameter. For pipe 36 inches (900 mm) or less in diameter, any approved method for joining pipe may be used which does not damage the pipe.

Joints shall comply with Subsection 1006.05, and shall be sealed with gasket material installed in accordance with the manufacturer's recommendations.

Types 2 and 3 joints shall be wrapped with geotextile fabric for a minimum of 12 inches (300 mm) on each side of joint for pipe 36 inches (900 mm) or less in diameter and a minimum of 18 inches (450 mm) on each side of the joint for pipe greater than 36 inches (900 mm) in diameter. Ends of the fabric shall be lapped at least 10 inches (250 mm). The edges and ends of fabric shall be suitably secured for the entire circumference of the pipe.

(c) Metal Pipe: Metal pipe shall be firmly joined by coupling bands. Bands shall be centered over the joint.

For Type 1 joints, approved gasket material shall be placed in one corrugation recess on each side of the joint at the coupling band and on each band connection in such manner to prevent leakage.

When Type 2 or 3 joints are specified, joining of metal pipe sections shall conform to the following provisions:

(1) General: Band joints shall be sealed with gasket material. Gasket material shall be placed in accordance with the plan details. The joint shall be wrapped with geotextile fabric for a minimum of 12 inches (300 mm) on each side of the connecting band for pipe diameters 36 inches (900 mm) or less and a minimum of 18 inches (450 mm) on each side of the connecting band for pipe diameters greater than 36 inches (900 mm). Ends of fabric shall be lapped at least 10 inches (250 mm). The edges and ends of fabric shall be suitably secured for the entire circumference of the pipe.

(2) Circular Section: Connecting bands shall be of an approved design and shall be installed in accordance with plan details.

(3) Arch Section: Connecting bands shall be a minimum of 12 inches (300 mm) wide for pipe arch less than 36 inches (900 mm) round equivalent diameter, and a minimum of 21 inches (525 mm) wide for 36 inches (900 mm) round equivalent diameter pipe arch and greater. Bands shall be connected at the ends by approved angle or strap connections. Connecting bands used for 36 inches (900 mm) round equivalent diameter pipe arch and above shall be 2-piece bands.

(d) Plastic Pipe: Joints for plastic pipe shall be either bell and spigot or split coupling bands.

Types 2 and 3 joints shall be wrapped with geotextile fabric for a minimum of 12 inches (300 mm) on each side of the joint for pipes 36 inches (900 mm) or less in diameter and for a minimum of 18 inches (450 mm) on each side of the joint for pipes greater than 36 inches (900 mm) in diameter. The ends of the fabric shall be lapped at least 10 inches (250 mm). The edges and ends of the fabric shall be suitably secured for the entire circumference of the pipe.

(1) Bell and Spigot Type Joint System: The method of joining pipe sections shall be such that ends are fully entered and inner surfaces are reasonably flush and even.

An approved mechanical pipe puller shall be used for joining pipes over 36 inches (900 mm) in diameter. For pipe 36 inches (900 mm) or less in diameter, any approved method for joining pipe may be used which does not damage the pipe.

Joints shall be approved and shall be sealed with a gasket system utilizing gasket material complying with Subsection 1006.06(a).

(2) Split Coupling Type Joint System: Split coupling bands shall comply with all dimensional and material requirements of Subsection 1006.07. The bands shall be centered over the joint. The split coupling band shall be secured to the pipe with a minimum of five stainless steel or other approved corrosion resistant bands.

Joints shall be approved and shall be sealed with gasket material. Gasket material shall be placed in the first two corrugation recesses on each side of the pipe connections. Gasket material shall also be placed on each band connection to prevent leakage. When flexible plastic gasket material is used it shall be a minimum of 1/2 inch (13 mm) in size. The bands shall be tightened to create overlap of the band and shall adequately compress the gasket material.

(e) Connections: Approved connections shall be used when joining new pipes to existing pipes. When concrete collars are required in order to

extend the ends of existing pipes that have been damaged or to join different types or sizes of pipes, the concrete collars shall be constructed in accordance with plan details, the applicable requirements of Section 901, and as directed.

701.07 RELAYING PIPE. If specified or directed, existing pipes shall be removed and suitable sections relaid as specified for new pipes.

701.08 BACKFILLING.

(a) General: Prior to backfilling, pipes found to be damaged or out of alignment or grade shall be removed and reinstalled, or replaced.

Type A backfill material shall be stone, recycled portland cement concrete, or flowable fill.

Type B backfill material shall be stone, recycled portland cement concrete, flowable fill, selected soils, or granular material.

When Type A backfill material is used, geotextile fabric shall be placed in accordance with plan details prior to placing backfill material. Care shall be taken to prevent damage to geotextile fabric during placement of backfill material.

Adjacent rolls of fabric shall be overlapped or sewn. When rolls are overlapped, the overlap shall be a minimum of 18 inches (450 mm), including the ends of the rolls. The top layer of the fabric shall be parallel with adjacent rolls and in the direction of backfill materials placement. When rolls are sewn, the contractor shall join adjacent rolls by sewing with polyester, or Kevlar thread. Field sewing shall employ the "J" seam or "Butterfly" seam with the two pieces of geotextile fabric mated together, turned in order to sew through 4 layers of fabric and sewn with 2 rows of Type 401, two-threaded locking chain stitch. Factory seams other than specified shall be submitted to the Materials and Testing Section for approval.

Damaged fabric shall be either removed and replaced with new fabric or covered with a second layer of fabric extending 2 feet (0.6 m) in each direction from the damaged area.

(b) Backfill Applications:

(1) Paved Areas: Cross drains and side drains in paved areas subject to traffic loads such as roadway travel lanes, shoulders, and turnouts shall be backfilled with Type A material. Type B backfill material shall be used in all other paved areas including driveways, detour roads and similar installations. Selected soils will not be allowed as backfill material. Placement and compaction shall be as specified in Heading (c) below.

(2) Nonpaved Areas: Pipe backfill material, except for plastic pipe, shall be Type B backfill material placed by approved methods and compacted

to the density of surrounding soil. Plastic pipe shall be backfilled with granular material or Type A backfill Material.

(c) Placement and Compaction: When corrugated metal pipe is used, the backfill material shall be tested and shall have a resistivity greater than 1500 ohm-cm and a pH greater than 5 when tested in accordance with DOTD TR 429 and DOTD TR 430 respectively.

If the top of pipe is even with or below the top of the trench, backfill material shall be brought up evenly on both sides of pipe for its full length to an elevation of 12 inches (300 mm) above the top of pipe [or to subgrade if less than 12 inches (300 mm)] or to natural ground elevation, whichever is greater.

When the top of the pipe is above the top of the trench, backfill material shall be brought up evenly on both sides of pipe for its full length to 12 inches (300 mm) above the top of pipe or to subgrade if less than 12 inches (300 mm). Material in the trench and above the top of the trench for a distance on each side of the pipe equal to the horizontal outside diameter for corrugated metal or plastic pipe and 18 inches (450 mm) for concrete pipe, and to 12 inches (300 mm) above the top of pipe or to subgrade if less than 12 inches (300 mm) shall be backfill material.

The embankment shall be constructed to a minimum of 24 inches (600 mm) over the pipe before heavy construction equipment is allowed to cross the installation. Where practical, installations with less than 24 inches (600 mm) of cover over the top of the pipe shall be constructed after heavy hauling is completed over the pipe location. After completion of hauling operations, the contractor shall remove excess cover material. Pipe damaged by hauling and backfilling operations shall be removed and reinstalled, or replaced, at no direct pay.

(1) Backfill Methods:

a. General: Compaction by flooding will not be allowed.

b. Selected Soils: Backfill shall be placed at or near optimum moisture content determined in accordance with DOTD TR 415 or TR 418 in layers not exceeding 8 inches (200 mm) compacted thickness. Backfill material shall be thoroughly compacted under the haunches of the pipe. Each layer shall be compacted by approved methods to at least 95 percent of maximum dry density prior to placement of a subsequent layer.

c. Granular Material: Backfill shall be placed at or near optimum moisture content determined in accordance with DOTD TR 415 or TR 418. Backfill material shall be thoroughly compacted under the haunches of the pipe and then compacted in layers not exceeding 12 inches (300 mm) compacted thickness. Each layer shall be compacted by approved methods to

at least 95 percent of maximum dry density prior to placement of a subsequent layer. Exposed slopes at the pipe ends shall be covered by at least 12 inches (300 mm) compacted thickness of plastic soil blanket.

d. Flowable Fill: Flowable fill shall be in accordance with Section 710.

e. Stone or Recycled Portland Cement Concrete: Backfill shall be placed at or near optimum moisture content determined in accordance with DOTD TR 415 or TR 418. Backfill material shall be thoroughly compacted under the pipe haunches and then compacted in layers not exceeding 8 inches (200 mm) compacted thickness. With approval of the engineer, layer thickness may be increased to 12 inches (300 mm) with verification of satisfactory installation and performance. Each layer shall be compacted by approved methods to at least 95 percent of maximum dry density prior to placement of a subsequent layer. The contractor shall control placement operations so as not to damage protective coatings on metal pipes. The contractor shall repair damaged coatings at no additional pay.

(2) Density Requirements: Maximum dry density will be determined in accordance with DOTD TR 415 or TR 418 and in-place density determined in accordance with DOTD TR 401.

701.09 INSPECTION OF PIPES. After completion of embankment and prior to roadway surfacing, the engineer shall inspect pipes for proper alignment and integrity of joints. Any misaligned pipe or defective joints shall be corrected by the contractor at no direct pay.

(a) Plastic Pipe: Installed plastic pipe shall be tested to ensure that vertical deflections do not exceed 5.0 percent. Maximum allowable deflections shall be governed by the mandrel requirements stated herein.

Deflection tests shall be performed no sooner than 30 calendar days after installation and compaction of backfill. The pipe shall be cleaned and inspected for offsets and obstructions prior to testing.

For pipe 36 inches (900 mm) and less in diameter, a mandrel shall be pulled through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. The mandrel shall be approved by the engineer prior to use. Use of an unapproved mandrel or a mandrel altered or modified after approval will invalidate the test. If the mandrel fails to pass, the pipe is overdeflected.

Unless otherwise permitted, overdeflected pipe shall be uncovered and, if not damaged, reinstalled. Damaged pipe shall not be reinstalled, but shall be removed and replaced with new pipe. Any pipe subjected to any method or

process other than removal, which attempts, even successfully, to reduce or cure any overdeflection, shall be removed and replaced with new pipe.

The mandrel shall be a rigid, nonadjustable, odd-numbered legged (minimum 9 legs) mandrel having a length not less than its nominal diameter or 24 inches (600 mm), whichever is less. The minimum diameter at any point shall be 5.0 percent less than the base inside diameter of the pipe being tested. The mandrel shall be fabricated of steel, aluminum or other approved material fitted with pulling rings at each end. The nominal pipe size and outside diameter of the mandrel shall be stamped or engraved on some segment other than a runner. A suitable carrying case shall be furnished.

For pipe larger than 36 inches (900 mm) in diameter, deflection shall be determined by a method approved by the engineer. If a mandrel is selected, the minimum diameter, length, and other requirements shall conform to the above requirements.

Mandrel testing shall be conducted by the contractor in the presence of the engineer. Mandrel testing shall be at no direct pay.

(b) Metal Pipe: If the inside diameter of metal pipe or rise dimension of metal pipe arch deflects more than 5.0 percent from original dimensions, they shall be removed and reinstalled, unless they do not rebound or are damaged. Pipe or pipe arch which are damaged or do not rebound shall be removed and replaced at no direct pay. Measurement of deflection will be made by the engineer away from rerolled ends.

701.10 CLEANING PIPES.

(a) Existing Pipes: Pipes designated to be cleaned shall be cleaned of soil, debris and other materials to the invert of the pipe. Designated pipes shall be cleaned by approved methods that will not damage the pipes. Any damage caused by the contractor's operations shall be satisfactorily repaired at no direct pay.

Removed soil, debris and other materials shall be disposed of in accordance with Subsection 202.02 or as otherwise approved in writing.

(b) Contractor Installed Pipes: Prior to final acceptance, pipes shall be cleaned of all debris and soil to the invert of the pipe at no direct pay.

Removed soil, debris and other materials shall be disposed of in accordance with Subsection 202.02 or as otherwise approved in writing.

701.11 STUBBING AND PLUGGING PIPES. When it is required that pipes be plugged, such plugs shall be constructed of Class R concrete complying with Section 901. Thickness of plug and method of construction shall be as directed.

When new pipes are to be stubbed into new or existing pipes or other structures, the connection shall be made with approved mortar complying with Subsection 702.02.

701.12 MEASUREMENT. Pipe, both new and relaid, will be measured in linear feet (lin m) as follows unless stated otherwise.

(a) Pipe not confined by fixed structures will be measured by the number of joints at the nominal length of each joint.

(b) Pipe confined by fixed structures will be measured along the pipe between the termini of pipe in structure walls.

(c) Pipe confined by a fixed structure on one end and unconfined at the other end will be measured along the pipe from the terminus of pipe in the structure wall to the unconfined end of pipe.

(d) Fabricating of pipe tees, elbows and other fittings will be measured per each fitting. The length of pipe in such fittings will be included in the pay length measurement of pipes of which they form a part.

(e) Excavation required for installation of pipes will not be measured for payment, except as otherwise specified in Subsection 203.14.

(f) Furnishing and placing backfill material for pipes will not be measured for payment. Backfill material needed to complete backfill above natural ground and around pipes that extend above natural ground will be measured and payment will be made under applicable earthwork items. When specified, flowable fill will be measured and paid for in accordance with Section 710.

(g) Plugging and stubbing of pipes will not be measured for payment.

(h) Cleaning existing pipes will be measured by the length of pipe cleaned and accepted.

(i) Concrete collars will be measured per each.

701.13 PAYMENT.

(a) Payment for pipe will be made at the contract unit price per linear foot (lin m) of the types and sizes specified.

When plastic pipe is specified on the plans or elected to be used by the contractor, payment will be made at the contract unit price per linear foot (lin m) of the types and sizes specified in accordance with the payment schedule of Table 701-1.

Table 701-1
Payment Schedule for Plastic Pipe

Percent Payment	Stage of Completeness
75	After placement and backfill has been completed
25	After the pipe has met vertical deflection requirements in accordance with Subsection 701.09(a)

(b) Payment for fabricating pipe tees, elbows and other fittings will be made at the contract unit price per each fitting.

(c) When unstable conditions are encountered, the additional excavation will not be measured for payment; however, the additional materials furnished and placed for the pipe foundation will be measured and paid for as follows:

(1) Granular Materials: Payment will be made under the embankment item. The net section volume of the materials will be multiplied by 3 to determine the pay volume. When the contract does not include a pay item for embankment, payment will be made in accordance with Subsection 104.02.

(2) Bedding Material: Measurement and payment will be made in accordance with Section 726. When the contract does not include a pay item for bedding material, payment will be made in accordance with Subsection 104.02.

(d) Payment for cleaning existing pipes will be made at the contract unit price per linear foot (lin m).

(e) Payment for concrete collars will be made at the contract unit price per each.

Payment will be made under:

Item No.	Pay Item	Pay Unit
701-01	Cross Drain Pipe (Size & Type)	Linear Foot (Lin m)
701-02	Cross Drain Pipe Arch (Size & Type)	Linear Foot (Lin m)
701-03	Storm Drain Pipe (Size & Type)	Linear Foot (Lin m)
701-04	Storm Drain Pipe Arch (Size & Type)	Linear Foot (Lin m)
701-05	Side Drain Pipe (Size)	Linear Foot (Lin m)
701-06	Side Drain Pipe Arch (Size)	Linear Foot (Lin m)
701-07	Yard Drain Pipe (Size)	Linear Foot (Lin m)
701-08	Relaying Pipe	Linear Foot (Lin m)
701-09	Fabricating Pipe Fittings	Each
701-10	Reinforced Concrete Pipe (Extension)	Linear Foot (Lin m)
701-11	Reinforced Concrete Pipe Arch (Extension)	Linear Foot (Lin m)
701-12	Corrugated Metal Pipe (Extension)	Linear Foot (Lin m)
701-13	Corrugated Metal Pipe Arch (Extension)	Linear Foot (Lin m)
701-14	Cleaning Existing Pipes	Linear Foot (Lin m)
701-15	Concrete Collar	Each
701-16	Plastic Pipe (Extension)	Linear Foot (Lin m)

Section 702
Manholes, Junction Boxes, Catch Basins, and End Treatments

702.01 DESCRIPTION. This work consists of the construction, installation, and adjustment of manholes, junction boxes, catch basins, culvert end treatments and safety ends in accordance with these specifications, and in conformity with lines and grades shown on the plans or established.

702.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Cast-in-Place Concrete (Class M)	901
Portland Cement	1001.01
Mortar Sand	1003.02(a)
Sewer Brick	1004.01
Asphaltic Varnish	1008.03
Reinforcing Steel	1009.01
Precast Reinforced Concrete Drainage Units	1016
Frames, Grates and Covers for Manholes, Catch Basins and Junction Boxes	1018.04
Geotextile Fabric	1019

The contractor may furnish structures of either cast-in-place concrete or precast concrete units.

Mortar shall consist of one part portland cement, two parts mortar sand, and water as required for proper consistency. Mortar shall be used within 30 minutes after mixing.

702.03 QUALITY ASSURANCE. Manufacturing plants will be inspected periodically for compliance with specified manufacturing methods. Material samples will be randomly obtained for laboratory testing for verification of manufacturing lots.

Materials will be subject to inspection at any time during the work.

702.04 CONSTRUCTION REQUIREMENTS. All cast-in-place structures shall be constructed in dry or dewatered areas, unless otherwise directed. Logs, stumps and other undesirable material shall be removed.

(a) Manholes, Junction Boxes, and Catch Basins: Concrete construction shall conform to Section 805. Joints shall be full mortar joints not more than 1/2 inch (13 mm) wide. When specified, outside faces of structures shall be plastered with 1/2 inch (13 mm) thick cement-sand mortar. Exposed surfaces of concrete and masonry shall be cured in accordance with Subsection 805.10 for at least 48 hours.

Precast concrete units shall be cast with the specified number and size of pipe openings required for the drainage system; however, if additional pipe is required during construction for which no openings have been provided, the contractor may make such openings provided any damaged units are replaced or satisfactorily repaired. Precast units shall be set to established grade within ±1/2 inch (±13 mm). Joints for sectional precast units shall be sealed with flexible plastic gasket material complying with Subsection 1006.06(b) installed as to form a watertight seal. The joints of precast units shall be wrapped with geotextile fabric a minimum of 18 inches (450 mm) on each side of the joint. Ends of the fabric shall be lapped at least 10 inches (250 mm). The edges and ends of the cloth shall be suitably secured.

Metal frames shall be set in a full mortar bed. Conduit sections shall be flush on the inside of structure wall and project outside sufficiently for proper connection with the next conduit section. Masonry shall fit neatly and tightly around conduit.

When grade adjustments of existing structures are specified, frames, covers and gratings shall be removed and walls reconstructed as required. Cleaned frames shall be reset at required elevation. Metal parts shall be thoroughly cleaned and placed in good repair. In lieu of adjusting structures, the contractor may adjust structures by means of approved metal adjustment rings.

New structures shall be cleaned of silt, debris or other foreign matter, and nongalvanized metal parts of new or adjusted structures shall be coated with asphaltic varnish meeting the requirements of Subsection 1008.03 or a jet black metal work paint satisfactory to the engineer.

The structure shall be backfilled in accordance with Subsection 701.08(c)(1).

Excavated material not satisfactory for backfill and surplus material shall be disposed of in accordance with Subsection 202.02.

(b) Culvert End Treatments: Culvert end treatments to control erosion at the ends of cross drains and side drains shall be constructed in accordance with these specifications, the plans, and as directed. Designs other than those shown on the plans shall be submitted for approval.

(1) Concrete Toe Wall Placement: Cast-in-place toe walls shall conform to Subsection 805.03 and plan details.

(2) Geotextile Fabric Placement: Geotextile fabric shall be placed in accordance with Subsection 712.03.

(3) Sacked Concrete (Wet-Batched) Placement:

a. Revetment: Wet-batched sacked concrete revetments shall conform to the requirements of Section 712. Placement of sacked concrete shall begin at the toe of the revetment and progress to the end of the pipe. The compressive strength shall comply with the requirements of Section 901 for Class R concrete.

b. Toewall: Sacks shall be stacked as indicated on the plans.

(4) Sacked Concrete (Dry-Batched) Placement:

a. Revetment: Dry-batched sacked concrete revetments shall conform to the requirements of Section 712. Placement shall begin at the toe of the revetment and progress to the end of the pipe. The supplier of the dry batched revetment shall submit a certificate of compliance with each shipment showing the proportions of cement and sand (or other approved aggregates used). The contents of the package shall be mixed with water by the contractor as required to produce a slump of 2 to 5 inches (50 to 125 mm). The compressive strength shall comply with the requirements of Section 901 for Class R concrete.

b. Toewall: Sacks shall be stacked as indicated on the plans.

(5) Stone Placement: Stone revetment shall conform to the requirements of Section 712.

(c) Culvert Safety Ends: Safety ends shall be furnished and installed on cross drains and side drains in accordance with these specifications, the plans and as directed. Designs other than those given on the plans shall be submitted for approval.

(1) Reinforcing steel shall be fabricated and placed in accordance with Section 806.

(2) Cast-in-place or precast concrete shall comply with Section 805.

(3) Pipe runners shall be bolted in place as shown on the plans. Bolts shall either be cast into the plastic concrete or placed in approximately 1-inch (25 mm) diameter holes and epoxied in place using an approved anchor system listed in QPL 32 or 52 as directed.

702.05 MEASUREMENT. New and adjusted junction boxes, manholes, catch basins, culvert end treatments and safety ends will be measured per each.

Excavation and backfill required for installation of these units will not be measured for payment.

702.06 PAYMENT. Payment for new and adjusted junction boxes, manholes, catch basins, culvert end treatments and safety ends will be made at the contract unit price per each which shall include all materials, tools, equipment, labor and incidentals necessary to complete the work.

The concrete in cast-in-place manholes, junction boxes, catch basins, and culvert end treatments and safety ends will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-6 and Note 1 therein. Acceptance for each precast concrete manhole, junction box, and catch basin lot will be in accordance with the requirements of Standard Plan PC-01. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment will be made under:

Item No.	Pay Item	Pay Unit
702-01	Junction Boxes	Each
702-02	Manholes	Each
702-03	Catch Basins	Each
702-04	Adjusting _____	Each
702-05	Cross Drain End Treatment (Type)	Each
702-06	Side Drain End Treatment (Type)	Each
702-07	Cross Drain Safety End (Type)	Each
702-08	Side Drain Safety End (Type)	Each

Section 703
Underdrain Systems

703.01 DESCRIPTION. This work consists of constructing pipe underdrain systems in accordance with these specifications and in conformity with lines and grades shown on the plans or established.

703.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Asphaltic Concrete	502
Portland Cement Concrete (Class M)	901
Aggregate Backfill (Size 3)(Crushed or Uncrushed)	1003.05
Granular Material (Backfill)	1003.07
Perforated and Nonperforated Underdrain Plastic Pipe	1006.08
Perforated Bituminous Coated Corrugated Steel Pipe	1007.03
Perforated Corrugated Aluminum Pipe	1007.06
Reinforcing Steel	1009.01
Precast Concrete Headwalls	1016.03
Hardware Cloth Screen	1018.21
Geotextile Fabric	1019.01
Geocomposite Drains	1019.02

When an item for "Shoulder Outlet Underdrains" is included in the contract, plastic pipe shall be furnished.

When an item for "Perforated Pipe Underdrains" is included in the contract, the contractor will be permitted to furnish any of the perforated plastic pipe types, unless otherwise specified.

When an item for "Nonperforated Pipe Underdrains" is included in the contract, the contractor will be permitted to furnish any of the nonperforated plastic pipe types, unless otherwise specified.

At the Department's discretion, plants will be inspected periodically for compliance with specified manufacturing methods. Material samples will be obtained for laboratory testing for acceptance of manufacturing lots.

703.03 CONSTRUCTION REQUIREMENTS.

(a) Plastic Pipe Shoulder Underdrains: Installation of plastic pipe underdrains, aggregate backfill and replacement of shoulder base and

surfacing shall follow immediately behind trenching operations. When traffic is permitted on the roadway, operations shall be conducted so that no trench will be open at the end of the day. Operations shall be performed in such a manner that existing pavement, shoulder surfacing and base course outside the limits of underdrain trenches are not damaged.

(1) Trenching: When existing surfaced shoulders are not to be overlaid with asphaltic concrete under the contract, existing shoulder surfacing shall be cut full depth along the edges of the proposed trench prior to beginning trenching operations. Excess excavated materials may be spread on embankment slopes when permitted. The contractor shall dispose of removed materials considered unacceptable for spreading on slopes in accordance with Subsection 202.02.

(2) Geotextile Fabric: Completed trenches for perforated plastic pipe shall be lined with geotextile fabric. Adjoining sheets of fabric shall be spliced by lapping a minimum of 18 inches (450 mm) and satisfactorily securing; or by use of sewn or heat-bonded splices. A sufficient width of fabric shall be placed in the trench to permit the cloth to lap over the top of the trench for the full width of trench. Care shall be taken during placement of geotextile fabric, pipe and backfill to avoid damaging geotextile fabric. The contractor shall satisfactorily repair or replace any damaged geotextile fabric at no direct pay.

(3) Plastic Pipe Installation: Plastic pipe underdrain shall be placed in the trench immediately adjacent to the pavement or shoulder edge as shown on the plans. Fittings and materials necessary to make splices of the plastic pipe underdrain and to make connections of the plastic pipe underdrain to the nonperforated outlet pipe shall be from the same manufacturer as the pipe. Fittings shall be designed to prevent soil or aggregate intrusion into the underdrain or outlet piping. When the underdrain is terminated without an outlet, a fitting or other approved method shall be provided to prevent soil or aggregate intrusion into the end of the underdrain.

(4) Aggregate Backfill: After pipe installation, the trench shall be backfilled in a manner that will not displace or damage the pipe. Aggregate backfill for perforated pipe shall be uniformly compacted with approved vibratory equipment to the satisfaction of the engineer, after which geotextile fabric shall be lapped over the full width of the trench and secured by an approved method. Aggregate backfill shall be placed in lifts no greater than 10 inches (250 mm) uncompacted thickness. The backfilled and compacted trench shall be left in a condition ready to receive surfacing.

(5) Replacement of Base Course and Surfacing: Asphaltic concrete shall be used for replacement of removed shoulder base course and

surfacing as shown on the plans and shall be constructed in accordance with Section 510.

(b) Shoulder Outlet Underdrain: Installation of the nonperforated plastic pipe, backfill, and replacement of shoulder base and surfacing shall follow immediately behind trenching operations. When traffic is permitted on the roadway, operations shall be conducted so that no trench will be open at the end of the day. Operations shall be performed in such a manner that the existing pavement, shoulder surfacing and base course outside the limits of the trenches are not damaged.

(1) Trenching: When existing surfaced shoulders are not to be overlaid with asphaltic concrete under the contract, existing shoulder surfacing shall be cut full depth along the edges of the proposed trench prior to beginning trenching operations. Excess excavated materials may be spread on embankment slopes when permitted. The contractor shall dispose of removed materials considered unacceptable for spreading on slopes outside the right-of-way in accordance with Section 202.02.

(2) Nonperforated Plastic Pipe Installation: Nonperforated plastic pipe shall be placed in the trench and connected to plastic pipe in accordance with manufacturer's recommendations. The pipe shall comply with the requirements of Subsection 1006.08(b).

(3) Backfill: After pipe installation, the trench shall be backfilled in a manner that will not displace or damage the pipe. Backfill material shall be excavated trench material that meets the requirements for granular material. When additional material is required, the contractor shall provide granular material at no direct pay. The backfill material shall be placed in lifts no greater than 6 inches (150 mm) of uncompacted material. Backfill material shall be uniformly compacted by approved methods to the satisfaction of the engineer. The backfilled and compacted trench shall be left in a condition ready to receive surfacing.

(4) Replacement of Base Course and Surfacing: Asphaltic concrete shall be used for replacement of removed shoulder base course and surfacing as shown on the plans and shall be constructed in accordance with Section 510.

(5) Headwalls: Portland cement concrete headwalls for non-perforated pipe shall be cast-in-place or precast constructed in accordance with Section 702. Each outlet pipe shall be furnished with a rodent screen as shown on the plans.

(c) Perforated or Nonperforated Pipe Underdrain: Perforated or nonperforated pipe underdrain shall be used as shown on the plans to drain

wet areas. Installation of the underdrains and backfill shall follow immediately behind trenching operations.

(1) Trenching: Trenches shall be excavated to the specified dimensions and grade or as directed. When specified, a minimum 3 inches (75 mm) bedding layer of specified material shall be placed and compacted in the bottom of the trench for its full width and length. The contractor shall dispose of excess excavated material in accordance with Subsection 202.02.

(2) Underdrain Pipe: Underdrain pipe shall be embedded firmly in the bedding material and shall be joined securely with appropriate coupling fittings or bands. When specified, perforated pipe shall be wrapped with geotextile fabric in accordance with plan details or as directed. Upgrade ends of pipe shall be capped to prevent soil intrusion.

(3) Backfill: Specified backfill shall be placed as shown on the plans or as directed.

(d) Geocomposite Wall Drains: Geocomposite wall drains shall be placed against the structure as shown on the plans before structural backfilling. The drains shall be placed such that drainage of the backfill is accomplished without soil intrusion into the drainage product core or outlet piping. The backfill shall be placed and compacted in accordance with Section 802 in a manner that will not displace or damage the geocomposite wall drain.

Fittings and material necessary to make splices and to make connections of the drainage product core to outlet piping shall be from the same manufacturer. When the sides of the product are terminated, the fabric shall be folded under to prevent soil intrusion into the end of the drainage product. The fabric shall overlap a minimum of 6 inches (150 mm) at all seams.

703.04 MEASUREMENT.

(a) Shoulder Underdrains:

(1) Shoulder Underdrains: Shoulder underdrains will be measured by the linear foot (lin m) along the pavement or shoulder edge. Required excavation, geotextile fabric, restoration of shoulder base course and surfacing, and disposal of excavated materials will not be measured for payment.

(2) Shoulder Outlet Underdrains: Shoulder outlet underdrains will be measured per each outlet underdrain installation. Required excavation, plastic pipe and fittings, backfill, replacement of shoulder base course and surfacing, concrete headwalls, rodent screens, and disposal of excavated materials will not be measured for payment.

(b) Perforated or Nonperforated Pipe Underdrains: Perforated and nonperforated pipe underdrains will be measured by the linear foot (lin m) of underdrain pipe. Required excavation, bedding, backfill and geotextile fabric will not be measured for payment.

(c) Geocomposite Wall Drains: Geocomposite wall drains will be measured by the square yard (sq m) of geocomposite wall drain.

703.05 PAYMENT. Payment for underdrains will be made at the contract unit prices. Pay adjustments for portland cement concrete of Section 901 will not apply.

Payment will be made under:

Item No.	Pay Item	Pay Unit
703-01	Shoulder Underdrains	Linear Foot (Lin m)
703-02	Shoulder Outlet Underdrains	Each
703-03	Perforated Pipe Underdrains	Linear Foot (Lin m)
703-04	Nonperforated Pipe Underdrains	Linear Foot (Lin m)
703-05	Geocomposite Wall Drains	Square Yard (Sq m)

Section 704
Guard Rail

704.01 DESCRIPTION. This work consists of furnishing and constructing beam type highway guard rail in accordance with these specifications, plan details, the manufacturer's recommended procedures and other requirements as directed by the engineer.

704.02 MATERIALS. Materials shall comply with the following Section and Subsections.

Cast-in-Place Concrete (Class M)	901
Reinforcing Steel	1009
Metal Beam Guard Rail	1010.08
Posts and Spacer Blocks	1010.09
Hardware	1010.10
Wire Rope and Fittings	1010.11

Welding shall comply with Section 815.

704.03 GENERAL CONSTRUCTION REQUIREMENTS.

(a) Posts: Posts shall be aligned and set plumb. When driving of posts is permitted, the manner of driving shall not damage posts. Post holes shall be backfilled with acceptable material placed and compacted as directed. When posts are to be placed within existing surfaced areas, surface material shall be replaced in kind or with Class M concrete.

(b) Rail Elements: Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond nuts. Holes for special details may be field drilled or punched when approved. Damaged galvanized surfaces and drilled holes shall be repaired in accordance with Subsection 811.12.

(c) Anchor Blocks: Reinforced concrete blocks for anchoring guard rail to existing bridge ends shall meet the requirements of Sections 805 and 806. Concrete shall be Class M complying with Section 901. Required removal of portions of existing bridge railings and drilling of holes into existing railings shall be performed in such manner that will not damage the railings that are to remain. The contractor shall satisfactorily repair damage

to the existing bridge due to operations at no additional cost to the Department. Removed materials shall be disposed of in accordance with Subsection 202.02.

(d) Guard Rail End Treatments: All guard rail end treatments must have been successfully crash tested and shall comply with the crash test requirements of the National Cooperative Highway Research Program (NCHRP) Report 350. End treatment systems not in compliance with this requirement will not be allowed on any federal or state funded projects.

The Bridge Design Engineer has pre-approved a list of end treatment systems for selection by the contractor. The contractor shall provide the project engineer with a copy of the most recent working drawing/shop drawing of the selected guard rail end treatment system prior to installation. The drawings shall provide the details of all components of the guard rail end treatment system and shall state that all details are in compliance with the NCHRP Report 350 requirements as approved by the FHWA.

The contractor may select any end treatment, which meets the above criteria, but shall not use a combination of such end treatments on the same project. The contractor shall submit to the Bridge Design Section the system name, the manufacturer of the end treatment system, and the necessary documentation to substantiate that the end treatment is in compliance with the NCHRP 350 requirement.

The contractor shall install all components of the guard rail end treatment system such as posts, blocks, and hardware in accordance with the drawings and the manufacturer's recommendations. Under no circumstances shall any component of the guard rail end treatment system be modified without written approval.

All end treatments shall be furnished with a retroreflective sheeting at the terminal end as shown in the plans.

When necessary, the guard rail length may be adjusted to provide the same "length of need" as specified in the plans. This adjustment shall be made at no additional cost to the Department.

704.04 MEASUREMENT. Quantities of guard rail, anchor sections, end treatments, and transitions for payment will be the design quantities as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

Design quantities of single faced guard rail are based on plan length along the face of rail between end posts, exclusive of openings, and plan length of end sections. Design quantities of double faced guard rail are based on plan

length between end posts along centerline of posts, exclusive of openings, and plan length of end sections. Design quantities of trailing end and breakaway cable terminal (BCT) anchor sections are based on plan length along the face of rail.

Guard rail anchor blocks and end treatments will be measured per each unit furnished and installed.

704.05 PAYMENT. Payment for guard rail, anchor sections, anchor blocks, end treatments, and transitions will be made at the contract unit prices which include drilling of holes in existing concrete for reinforcing steel dowels, concrete and reinforcing steel. Payment adjustments for portland cement concrete of Section 901 will not apply.

Payment will be made under:

Item No.	Pay Item	Pay Unit
704-01	Guard Rail	Linear Foot (Lin m)
704-02	Guard Rail (Double Faced)	Linear Foot (Lin m)
704-03	Blocked Out Guard Rail	Linear Foot (Lin m)
704-04	Blocked Out Guard Rail (Double Faced)	Linear Foot (Lin m)
704-05	Guard Rail Anchor Sections (BCT)	Linear Foot (Lin m)
704-06	Guard Rail Anchor Sections (Trailing End)	Linear Foot (Lin m)
704-07	Guard Rail Bridge Attachments	Linear Foot (Lin m)
704-08	Guard Rail Transitions	Linear Foot (Lin m)
704-09	Guard Rail Anchor Sections (Turndown)	Linear Foot (Lin m)
704-10	Guard Rail Anchor Blocks	Each
704-11	Guard Rail End Treatment (Type)	Each

Section 705
Fences

705.01 DESCRIPTION. This work consists of constructing fences and gates in accordance with these specifications and in conformity with lines and grades shown on the plans or established by the engineer.

705.02 MATERIALS. Materials shall comply with the following Section and Subsections:

Portland Cement Concrete (Class R)	901
Barbed Wire	1010.01
Woven Wire	1010.02
Posts and Braces for Field and Line Type Fence	1010.03
Staples and Nails	1010.04
Metal Fasteners for Steel Posts	1010.05
Gates for Field and Line Type Fence	1010.06
Chain Link Fence, Gates and Appurtenances	1010.07
Timber Preservatives	1014.03
Ground Rod Assemblies	1018.05

The same type chain link fencing shall be used throughout the project. The same type, shape and treatment of posts shall be used throughout a section of fence.

705.03 GENERAL CONSTRUCTION REQUIREMENTS. Clearing and grubbing for fence installation shall conform to Section 201.

The contractor's operations shall be confined to the area adjacent to right-of-way lines and within the right-of-way.

Where breaks in a run of fencing are required, and at intersections with existing fences, appropriate adjustment in post spacing shall be made for the type closure indicated.

Wood posts shall be placed with small end up. When posts, braces or anchors are to be embedded in concrete, the contractor shall install temporary braces as required to hold posts in proper position until concrete has set sufficiently to hold posts. No material shall be installed on posts or strain placed on bracing set in concrete for 72 hours after concrete has been placed.

Tops of posts shall be set to required grade and alignment. Cutting of wood post tops will be allowed only when approved. Cut ends shall be treated with 2 applications of the same type preservative used for post treatment. Wire shall be stretched taut.

Ground rods shall be installed along each segment of new or rebuilt fence, regardless of type fence post used, at maximum 500-foot (150 m) intervals. Ground rods and connections shall conform to plan details.

705.04 REBUILT FENCE. When specified, the contractor shall take down, move back and rebuild existing fence. Fence shall be rebuilt in the same manner as specified for new fence. Rebuilt ornamental fence, picket fence or other special type fence shall be equal in all respects to existing fence.

705.05 GATES. Gates of a different design from that shown on the plans may be furnished with prior approval. Gates shall be of rigid construction, and after erection shall not show sag or warp.

705.06 CHAIN LINK FENCE AND GATES.

(a) Concrete Post Anchorage: Posts shall be anchored in Class R concrete footings. Portable mixing of concrete in accordance with Subsection 901.10(g) will be permitted for small quantities of concrete.

Tops of footings shall extend slightly above ground and shall be steel troweled to a smooth finish sloped to drain away from posts. Posts, braces and other units shall be centered in footings.

Concrete operations shall be in accordance with Section 901. The contractor shall consolidate concrete by tamping or vibrating. Excess excavation from footings shall be disposed of satisfactorily.

(b) Fence Erection: Pull posts shall be placed not more than 200 feet (60 m) apart in straight runs and at each vertical angle greater than 20 degrees. Corner posts shall be placed at each horizontal angle greater than 20 degrees. Corner and pull posts shall have a horizontal brace and tie rod on each side of posts. The horizontal brace and tie rod shall be connected to adjacent line posts.

Posts shall be permanently positioned, anchorages firmly set, and top rail or tension wires satisfactorily secured to posts before fabric is placed. Ends of fabric shall be secured by stretcher bars threaded through loops of fabric and secured to posts by clamps with bolts and nuts.

Fabric shall be placed by securing one end and applying sufficient tension to remove all slack before making attachments elsewhere. Degree of

tensioning shall be commensurate with air temperatures at time of installation to prevent undue sagging or tensioning of fabric due to changing temperatures. Fabric shall be fastened to line posts at approximately equal spaces and to top rail (or top tension wire) and bottom tension wire with tie wires or bands as specified.

(c) Gate Erection: Gate installation shall include gate frames, stretcher bars, filler fabric, latches, stops, locking device, padlocks, hinges, gate posts with braces, tie rods, turnbuckles, caps and other fittings as specified or required for complete installation.

Clamps for attaching hardware shall be tightened. Bottom of gates shall clear the ground at least 3 inches (75 mm) at all points in its swing. The contractor shall grade the area if necessary to meet this requirement. Stops with latches or other approved means for holding the gate open shall be provided, placed to prevent damage to gate or fence by overswing. Unless otherwise directed, stops shall be provided at the centerline of fence to arrest the swing of a closed gate.

(d) Repair of Protective Coatings: After completion of fence and gate installation, any damaged protective coatings shall be satisfactorily repaired in accordance with Subsection 811.12.

705.07 MEASUREMENT.

(a) New Fence and Gates: New fence will be measured by the linear foot (lin m) between outside of end posts for each continuous run of fence, exclusive of gates. Gates for new fence will be measured per each for single swinging gates, and per double gate for double swinging gates.

(b) Rebuilt Fence: Rebuilt fence will be measured by the linear foot (lin m) between outside of end posts for each continuous run of fence, including gates.

(c) Intersecting Fences: Sections of new fence required for connections of existing intersecting fences to new or rebuilt fence will be included in the measurement of the new or rebuilt fence.

(d) Ground Rod: Ground rod placement will not be measured for payment.

705.08 PAYMENT.

Payment for fence and gates will be made at the contract unit prices. Payment adjustments for portland cement concrete of Section 901 will not apply.

Payment will be made under:

Item No.	Pay Item	Pay Unit
705-01	Barbed Wire Fence	Linear Foot (Lin m)
705-02	Combination Mesh and Barbed Wire Fence	Linear Foot (Lin m)
705-03	Single Swinging Walk Gates	Each
705-04	Single Swinging Driveway Gates	Each
705-05	Double Swinging Driveway Gates	Double Gate
705-06	Chain Link Fence (__-Foot (m) Height)	Linear Foot (Lin m)
705-07	__-Foot (m) Single Gates for Chain Link Fence (__-Foot (m) Height)	Each
705-08	__-Foot (m) Double Gates for Chain Link Fence (__-Foot (m) Height)	Double Gate
705-09	Rebuilt Fence	Linear Foot (Lin m)

Section 706
Concrete Walks, Drives and Incidental Paving

706.01 DESCRIPTION. This work consists of furnishing and constructing portland cement concrete walks, handicapped curb ramps, drives and incidental paving slabs in accordance with these specifications and in conformity with lines, grades and dimensions shown on the plans or established.

706.02 MATERIALS. Materials shall comply with the following Section or Subsections.

Portland Cement Concrete (Class M)	901
Joint Filler	1005.01(c)
Reinforcing Steel	1009.01
Curing Materials	1011.01

706.03 CONSTRUCTION REQUIREMENTS.

(a) Excavation: Excavation shall be made to required depth and width. The top of the subgrade shall be shaped and compacted to a firm, even surface conforming to the section shown on the plans. Unsuitable material shall be removed and disposed of in accordance with Subsection 202.02 and replaced with approved material at no direct pay.

(b) Forms: Forms shall be of wood or metal and shall extend the full depth of concrete. Forms shall be straight, clean and of sufficient strength to resist the pressure of concrete. Bracing of forms shall be such that forms remain in horizontal and vertical alignment until their removal.

Concrete may be placed by slip-form methods. Slip-formed concrete shall be placed with an approved machine designed to spread, vibrate, consolidate and finish concrete in one pass of the machine in such manner that minimum hand finishing is necessary. Sliding forms shall be rigidly held together to prevent spreading of forms. After the passing of the side forms there shall be no noticeable slumping of concrete.

(c) Subgrade: The subgrade shall be thoroughly moistened immediately prior to placing concrete.

(d) Placing and Finishing: Concrete shall be placed on the subgrade, struck off to required thickness and tamped sufficiently to bring the mortar to the surface. The surface shall be finished with a wood float or steel trowel

followed by brushing to a slightly rough finish. Joints and edges shall be rounded with an edging tool having a 1/4-inch (6 mm) radius.

(e) Joints:

(1) Expansion Joints: Expansion joints shall be filled with 1/2 inch (13 mm) thick preformed expansion joint filler. Expansion joints shall be installed at maximum 100-foot (30 m) intervals, and between intersecting paving and any fixed structure such as a building, bridge or curbing. Expansion joint material shall extend for the full width and depth of paving.

(2) Weakened Plane: Weakened planes shall be formed by a jointing tool or other acceptable means. Weakened planes shall extend into concrete for at least 1/4 of the depth and shall be approximately 1/8 inch (3 mm) wide.

a. Walks: Spacing of weakened planes for walks shall be equal to the width of walk.

b. Drives: A longitudinal weakened plane shall be formed along the centerline of drives more than 16 feet (5 m) wide, and transverse weakened planes shall be formed at not more than 16-foot (5 m) intervals.

c. Incidental Paving: Weakened planes for incidental paving shall be formed at intervals not exceeding 30 times the thickness of the concrete in length or width. Incidental paving poured adjacent to jointed concrete shall be jointed to match existing joints, with intermediate joints formed as necessary not to exceed the maximum joint spacing.

(3) Construction Joints: Construction joints shall be formed around manholes, utility poles, etc., extending into paving and 1/4 inch (6 mm) thick preformed expansion joint filler shall be installed in these joints.

(4) Tie-ins: Tie-ins of existing concrete shall be made by full depth sawing at no direct pay.

(f) Curing: Concrete shall be cured in accordance with Subsection 601.10.

(g) Detectable Warning Surface for Handicap Ramps: Handicapped curb ramps installed shall be equipped with a detectable surface warning system consisting of raised truncated domes as a transition between the sidewalk and the street as required by the Americans with Disabilities Act, 28 CFR Part 36, ADA Standards for Accessible Design. These standards are further described in the Americans with Disabilities Act Accessibility Guidelines (ADAAG), Section 4.29.2.

Detectable warnings (truncated domes) shall be installed on the ramp surface over the full width of the ramp throat for a distance of 24 inches (600 mm) in the direction of travel from the back of the curb. Truncated domes

shall be laid out on a square or triangular grid in order to allow enough space for wheelchairs to roll between the domes.

Light reflectance of the truncated domes and the underlying surface must meet the 70 percent contrast requirement of ADAAG.

706.04 MEASUREMENT. Quantities of concrete walks, drives and incidental paving slabs for payment will be the design quantities as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if design errors are proven or if design changes are made. Design areas are based on the horizontal dimensions shown on the plans. Excavation, backfill, reinforcing steel and joint materials will not be measured for payment.

Handicapped curb ramps included in the construction of a concrete walk, including the detectable surface warning system, will not be measured for payment.

706.05 PAYMENT. Payment for concrete walks, drives and incidental paving will be made on a lot basis at the contract unit price per square yard (sq m), adjusted in accordance with the following provisions. Payment for each lot will be made in accordance with Table 901-6. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment will be made under:

Item No.	Pay Item	Pay Unit
706-01	Concrete Walk (__inch (mm) Thick)	Square Yard (Sq m)
706-02	Concrete Drive (__inch (mm) Thick)	Square Yard (Sq m)
706-03	Incidental Concrete Paving (__inch (mm) Thick)	Square Yard (Sq m)

Section 707
Curbs and Gutters

707.01 DESCRIPTION. This work consists of furnishing and constructing curbs and gutters in accordance with these specifications and in conformity with lines, grades, dimensions and typical sections shown on the plans or established.

707.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Usable Soil	203.06(a)
Asphaltic Concrete	502
Portland Cement Concrete (Class M)	901
Asphalt Cement	1002
Aggregates	1003
Joint Fillers	1005.01
Joint Sealant	1005.02
Joint Seals	1005.03
Curing Materials	1011.01
Form Release Agent	1018.24

(a) Concrete Curbs and Gutters: When slip-formed methods are used, concrete shall have not more than a 1 1/2 inch (40 mm) slump.

(b) Asphaltic Curbs: Mixtures for these curbs shall be Superpave Asphaltic Concrete (Level A) in accordance with Section 502.

707.03 SUBGRADE. The subgrade shall be shaped and compacted to a firm, even surface. When possible, the subgrade shall be shaped and compacted at the same time and in the same manner as the subgrade for the pavement. Unsuitable material shall be removed and replaced with approved material at no direct pay.

707.04 CONCRETE FORMS. Forms for combination curb and gutter shall conform to Subsections 601.03(c) and 601.05. Forms for other curbs or gutters shall be wood or metal, straight, and of sufficient strength to resist pressure of the concrete without deforming. Forms shall be cleaned and coated with form release agent before concrete is placed against them. Forms

which have become excessively worn, bent or broken shall not be used. An approved mechanical curb forming machine conforming to Subsection 707.06(c) may be used without forms.

707.05 CONCRETE JOINTS. Joints shall be formed in integral curbing to correspond with transverse joints in the pavement slab. Joints shall extend under and through the curb and shall be finished and filled with the specified filler.

Other types of curbing shall be provided with 1/4 inch (6 mm) joints at maximum intervals of 20 feet (6 m) formed by using steel plates 1/4 inch (6 mm) thick, cut to section and set vertically in forms until concrete has set sufficiently to permit removal of plates.

707.06 PLACING CONCRETE.

(a) Integral Types: After concrete pavement has been struck off, curb forms shall be clamped or otherwise securely fastened in place on the slab form. Concrete for curbing shall be placed and thoroughly tamped within 30 minutes after pavement has been finished. Concrete shall be spaded or vibrated sufficiently to eliminate voids and shall be tamped to bring mortar to the surface. The concrete shall be finished smooth and even with a wooden float. Edges shall be rounded with an approved finishing tool to the specified radius. Care shall be taken to secure monolithic construction.

Integral type curb may be placed after completion of pavement, provided reinforcing steel is placed in the pavement of the size, type and spacing shown on the plans at no direct pay.

(b) Non-Integral Types: Concrete shall be placed on the prepared subgrade, struck off and consolidated to required thickness. Concrete shall be spaded or vibrated sufficiently to eliminate voids and shall be tamped to bring mortar to the surface, after which it shall be finished smooth and even with a wooden float. Edges shall be rounded to the specified radius.

(c) Slip-formed Concrete: Slip-formed concrete shall have uniform consistency and shall be placed with an approved extrusion machine designed to spread, consolidate and finish concrete in one pass of the machine such that minimum hand finishing is necessary. Sliding forms shall be rigidly held together to prevent spreading of forms. After the passing of the forms there shall be no noticeable slumping of concrete. Finished concrete shall be free from voids. Any additional finishing required shall be performed immediately after placement.

(d) Tolerances: Grade of combination curb and gutter shall not exceed the theoretical grade and shall not be more than 1/2 inch (13 mm) low.

707.07 FINISHING. Forms shall be removed within 24 hours after concrete has been placed. Honeycombed areas and other minor defects shall be filled with mortar composed of portland cement and sand complying with Subsection 702.02. Plastering will not be permitted on faces of curb or gutter. Rejected curb or gutter shall be removed and replaced. The top and face of curb or gutter shall be finished prior to initial set with a wood float, brush, and water.

707.08 ASPHALTIC CURB. Asphaltic curb shall be placed by an approved extruding machine. Prior to placing curb, the contractor shall apply asphaltic tack coat complying with Section 504.

707.09 CURING CONCRETE CURB OR GUTTERS. After finishing, curb or gutter shall be cured in accordance with Subsection 601.10.

707.10 BACKFILLING. After curb or gutter has set sufficiently, the contractor shall backfill adjacent to curb or gutter with usable soil compacted to the density of surrounding soil.

707.11 MEASUREMENT. Quantities of curbs and/or gutters for payment will be the design lengths as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if design errors are proven, or if design changes are made. Excavation, backfill, joint materials, asphaltic tack coat and steel tie bars will not be measured for payment. When combination curb and gutter is specified, gutters required at catch basins will be included in design quantities for combination curb and gutter.

707.12 PAYMENT. Payment for curbs and/or gutters will be made at the contract unit price per linear foot (lin m), subject to the following provisions:

(a) Asphaltic Mixtures: Asphaltic curbs will be subject to the payment adjustment provisions for air voids under of Section 502. Asphalt cement shall comply with the requirements of Section 1002. The Materials and Testing Section will provide the payment adjustment percentage for properties of asphalt cement.

(b) Portland Cement Concrete: The concrete in the curbs and/or gutters will be identified by lots and shall be subject to pay adjustments per linear foot (lin m) in accordance with Table 901-6. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment will be made under:

Item No.	Pay Item	Pay Unit
707-01	Concrete Curb	Linear Foot (Lin m)
707-02	Concrete Gutter	Linear Foot (Lin m)
707-03	Combination Concrete Curb and Gutter	Linear Foot (Lin m)
707-04	Asphaltic Curb	Linear Foot (Lin m)

Section 708
Right-of-Way Monuments

708.01 DESCRIPTION. This work consists of installing contractor furnished right-of-way monuments and right-of-way monument witness posts at various locations in accordance with these specifications, the project right-of-way map, the plan details or as directed.

708.02 MATERIALS.

(a) Right-of-Way Monuments: Right-of-way monuments shall be the type shown on the plans or an approved equal. Substitutions must be approved by the Location and Survey Section Administrator, Baton Rouge, LA.

The steel stakes shall be 3/4 inch x 3/4 inch x 2 feet (19 mm x 19 mm x 0.6 m) with stainless steel identification caps, also furnished by the contractor.

(b) Right-of-Way Monument Witness Posts: Witness posts shall be standard orange color, 6 feet (1.8 m) in length as shown on the plans or an approved equal. Substitutions must be approved by the Location and Survey Section Administrator, Baton Rouge, Louisiana. The standard DOTD decal logo as shown on the plans shall be attached to each post by the supplier.

708.03 GENERAL CONSTRUCTION REQUIREMENTS. Right-of-way monuments shall be positioned and set by, or under the responsible charge of a Louisiana licensed professional land surveyor. A reproducible final plat reflecting the surveyor's location of the monuments in accordance with the right-of-way map shall be prepared on standard size Department plan sheet(s) and submitted to the project engineer for forwarding to the Location and Survey Section Administrator, Baton Rouge, Louisiana. The contractor shall record the final plat in the appropriate parish courthouse(s) and a copy of the filing receipt(s) shall be furnished to the project engineer. A copy of the final plat shall also be furnished to the appropriate parish engineer(s) and Planning Commission(s) if applicable.

708.04 MEASUREMENT. Right-of-way monuments will be measured per each. Right-of-way monument witness posts will be measured per each.

708.05 PAYMENT. Payment for right-of-way monuments and right-of-way monument witness posts will be made at the contract unit price per each.

Payment will be made under:

Item No.	Pay Item	Pay Unit
708-01	Right-of-Way Monument	Each
708-02	Right-of-Way Monument Witness Post	Each

Section 709
Steel Cattle Guards

709.01 DESCRIPTION. This work consists of constructing, furnishing and installing welded steel cattle guards at the locations shown on the plans and conforming to plan details and these specifications.

Cattle guards of types different from those shown on the plans may be furnished with prior approval.

709.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Concrete (Class M)	901
Steel Pipe (Wingwalls)	1007.12
Reinforcing Steel	1009.01
Bolts, Nuts and Washers	1010.10
Treated Timber	1014

Steel shall be at least the minimum size specified and fabricated in accordance with Section 815. Pipe wings shall be 2-inch (50 mm) diameter standard strength steel pipe. Steel shall be painted in accordance with Section 811. Galvanized pipe will not require painting. Damaged galvanized steel shall be repaired in accordance with Subsection 811.12.

709.03 CONSTRUCTION REQUIREMENTS. Excavation shall extend a minimum of 12 inches (300 mm) outside neat lines of concrete walls or footings. Backfill shall be deposited in layers not exceeding 6 inches (150 mm) compacted thickness and each layer shall be compacted to the density of adjacent soil with mechanical tampers. When the cattle guard is placed in the roadway, the compaction requirements shall conform to Subsection 203.07.

Concrete and reinforcing steel shall be placed in accordance with Sections 805 and 806.

709.04 MEASUREMENT. Steel cattle guards will be measured as a unit. Excavation, backfill, concrete and reinforcing steel will not be measured for payment.

709.05 PAYMENT. Payment for steel cattle guards will be made at the

contract unit price per each. The concrete placed in cattle guards will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-6 and Note 1 therein. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment will be made under:

Item No.	Pay Item	Pay Unit
709-01	Steel Cattle Guard	Each

Section 710
Flowable Fill

710.01 DESCRIPTION. This work consists of furnishing, placing, and consolidating a controlled low strength flowable fill as an alternative to compacted soil. Applications for this material include, but are not limited to, general backfilling of drainage structures, entrenchments across pavements, encasements, beddings, void filling and other uses as shown on the plans or as approved by the engineer. The flowable fill shall be a cementitious mixture of portland cement, fly ash (depending on application and mix design), fine aggregate, water, entrained air, and appropriate admixtures for the particular application.

710.02 MATERIALS. Materials shall comply with the following Sections and Subsections.

Portland Cement	1001.01
Fine Aggregate	1003.02
Admixtures	1011.02
Water	1018.01
Fly Ash	1018.15

Flowable fill shall be designed and proportioned in accordance with Table 710-1. Trial batching will be required for excavatable and non-excavatable mixes to ensure appropriate job mix consistency and adherence to Table 710-1 properties.

Table 710-1
Flowable Fill Mix Design[1]

Material	Excavatable	Non-Excavatable
Portland Cement	75-100 lb/cu yd (45-60 kg/cu m)	75-150 lb/cu yd (45-90 kg/cu m)
Fly Ash	0-150 lb/cu yd (0-90 kg/cu m)	150-600 lb/cu yd (90-355 kg/cu m)
Water[2]	-	-
Air[3]	10-35%	5-20%
Concrete Sand	Proportioned to yield 1 cu yd (1 cu m)	Proportioned to yield 1 cu yd (1 cu m)
Unit Weight (wet)[3]	90-110 lb/cu ft (1440-1760 kg/cu m)	100-125 lb/cu ft (1600-2000 kg/cu m)
28-Day Compressive Strength[3]	Maximum 100 psi (0.7 MPa)	Minimum 125 psi (0.9 MPa)

[1]Mix designs shall yield 1.0 cubic yard (1.0 cu m) absolute volume.
[2]Mix designs shall produce a consistency that will result in a flowable self-leveling product at the time of placement and conform to the requirements of Subsection 710.02.
[3]The requirements for percent air, compressive strength and unit weight are for laboratory designs only and are not intended for jobsite acceptance requirements.

710.03 CONSTRUCTION REQUIREMENTS. Before placement, temporary enddams or soil berms shall be provided as directed by the engineer to confine the flowable fill. Flowable fill shall be placed to the lines and grades shown on the plans or as directed. Where flotation or misalignment may occur due to hydrostatic pressure, the contractor shall assure correct alignment and placement of the encased structure by using straps, soil anchors, or other approved means of restraint. Flowable fill shall be protected from freezing for 36 hours after placement. Flowable fill shall be placed by chute, pumping or other methods approved by the engineer. Due to flowable fill's liquid condition, hydrostatic pressure on adjacent structures shall be taken into account on deep fills where multiple lifts may be required. While in a liquid state, flowable fill in deep excavations is in a quick condition and shall be protected until hardening occurs. Flowable fill will not require field sampling or testing other than the approved trial batch mix design, unless otherwise directed by the project engineer.

710.04 MEASUREMENT. Flowable fill will be measured by the cubic yard (cu m) by batch tickets as adjusted by the project engineer.

710.05 PAYMENT. Payment for flowable fill will be made at the contract unit price per cubic yard (cu m).

Payment will be made under:

Item No.	Pay Item	Pay Unit
710-01	Flowable Fill	Cubic Yard (Cu m)

Section 711
Riprap

711.01 DESCRIPTION. This work consists of furnishing and placing riprap in accordance with these specifications and in conformity to lines, grades and thickness shown on the plans or as directed.

711.02 MATERIALS. Stone riprap shall be from an approved source listed in QPL 2. Stone riprap shall not disintegrate upon exposure to the elements or be easily broken from handling, and shall be reasonably free from earth and other foreign materials. When tested in accordance with AASHTO T 85, the solid weight of stone shall be at least 155 pounds per cubic foot (2490 kg/cu m) (based on bulk specific gravity). The least dimension of any individual stone shall be at least 1/3 its maximum dimension. Each shipment of stone shall be reasonably well graded within the specified limits.

Recycled concrete may be used as riprap unless otherwise indicated in Heading (a), provided its solid weight is at least 155 pounds per cubic foot (2490 kg/cu m) (based on bulk specific gravity) and it is free of protruding reinforcement.

Stockpiles of recycled concrete shall be source approved prior to use and kept separate from other materials. Stockpiles shall be uniform and free of soil, debris, excessive amounts of asphaltic materials, and foreign matter. Once a stockpile has been approved as an acceptable source of material, no material shall be added without prior approval.

Control of gradation will be by visual inspection at the source, project site or both.

Any difference of opinion between the engineer and contractor will be resolved by checking the gradation of two random truckloads (or equivalent size samples). Equipment, labor and sorting site shall be furnished by the contractor at no direct pay.

(a) Riprap: Riprap shall be reasonably well graded and shall comply with Table 711-1.

Table 711-1
Riprap

Riprap Class [1]	Stone Size lb (kg)	Spherical Diameter, ft (mm) [2]	Percent of Stone Smaller Than
2 lb (1 kg)	10 (4.5) 4 (2) 2 (1) 0.75 (0.30)	0.51 (155) 0.38 (115) 0.30 (90) 0.22 (65)	100 40-100 15-50 0-15
10 lb (5 kg)	50 (23) 20 (9) 10 (5) 5 (2.5)	0.88 (270) 0.65 (200) 0.51 (155) 0.41 (125)	100 50-100 15-50 0-15
30 lb (15 kg)	140 (64) 60 (27) 30 (15) 10 (4.5)	1.24 (375) 0.94 (285) 0.74 (225) 0.51 (155)	100 42-100 15-50 0-15
55 lb (25 kg) [3]	275 (125) 110 (50) 55 (25) 20 (9)	1.50 (460) 1.11 (335) 0.88 (270) 0.63 (190)	100 42-100 15-50 0-15
130 lb (60 kg) [3]	650 (295) 260 (120) 130 (60) 40 (18)	2.00 (610) 1.46 (450) 1.17 (360) 0.79 (240)	100 45-100 15-50 0-15
250 lb (115 kg) [3]	1250 (570) 500 (225) 250 (115) 80 (35)	2.50 (760) 1.83 (560) 1.46 (445) 1.00 (300)	100 45-100 15-50 0-15
440 lb (200 kg) [3]	2200 (1000) 900 (410) 440 (200) 130 (60)	3.00 (915) 2.23 (680) 1.76 (535) 1.17 (360)	100 40-100 14-50 0-15
1000 lb (455 kg) [3]	5000 (2270) 2000 (910) 1000 (455) 300 (135)	4.00 (1205) 2.91 (885) 2.31 (705) 1.55 (470)	100 45-100 10-50 0-15

[1]The stone size used to define the Riprap Class is the minimum median stone size for the stone class. The minimum thickness of a riprap layer shall be no less than the spherical diameter of the maximum stone size in the Riprap Class.
[2]Spherical diameters of riprap classes up to 30 lb (15 kg) are based on a solid weight of 140 lb/cu ft (2240 kg/cu m). Spherical diameters of riprap classes above 30 lb (15 kg) are based on a solid weight of 155 lb/cu ft (2480 kg/cu m).
[3]Recycled portland cement concrete may not be used in these riprap classes.

(b) Geotextile Fabric: Geotextile Fabric shall comply with Section 1019.01.

711.03 CONSTRUCTION REQUIREMENTS.

(a) Riprap: Areas on which riprap is to be placed shall be graded to the required section. Riprap shall be placed on the prepared slope or area in a manner which will produce a reasonably well-graded mass of stone with a minimum practicable percentage of voids. The entire mass of stone will be placed to be in conformance with the lines, grades, and thickness at one operation and to avoid displacing underlying material. Placing of riprap in layers, or dumping into chutes, or by similar methods likely to cause segregation, will not be permitted.

When placement in water currents is required, the contractor shall make drift checks and place riprap in such manner as to compensate for drift. The contractor shall furnish necessary facilities and personnel for checking riprap depth and distribution.

(b) Filter Stone: When specified, filter stone shall be placed on the prepared slope or area before placement of riprap. When filter stone is placed under water, free dumping will not be permitted. Underwater placement shall be by controlled methods using bottom dump buckets or wire rope baskets lowered through the water to the point of placement. If placement in strong water currents is required, placement of riprap will follow soon after placement of filter stone. Unless shown otherwise on the plans or directed, filter stone shall be Riprap Class 10 lb (5 kg) or less.

(c) Geotextile Fabric: When specified, geotextile fabric shall be placed on the prepared slope or area in accordance with Subsection 203.11(c) before placement of riprap. Care shall be taken not to damage the geotextile fabric when placing riprap. Placing riprap by rolling riprap down slope, or dropping riprap from extreme heights, or by similar methods likely to damage geotextile fabric, will not be permitted. Damaged geotextile fabric shall be repaired in accordance with Subsection 203.11(c) or replaced as directed.

711.04 MEASUREMENT.

Riprap and filter stone may be measured on either a square yard (sq m), cubic yard (cu m), or weight (mass) basis as specified.

When measured on a square yard (sq m) basis, the quantity measured will be that actually placed to the limiting dimensions shown on the plans or as directed by the engineer.

When measured on a cubic yard (cu m) basis, measurement will be made in vehicles at the point of delivery on the project in accordance with Subsection 109.01.

When measured on a weight (mass) basis the pay unit will be per ton (2000 pounds) [Mg (1000 kg)]. When riprap is delivered by vehicles or railroad cars, measurement will be based on certified weight (mass) tickets furnished by the contractor. When riprap is delivered by barge, measurement will be made by calculation from barge displacement, based on water weighing 62.4 pounds per cubic foot (1000 kg/cu m).

Geotextile fabric will be measured by the square yard (sq m) of covered area in place.

No measurement will be made for excavation or backfilling.

711.05 PAYMENT. Payment for riprap and geotextile fabric will be made at the contract unit prices. Filter stone will be paid for as riprap.

Payment will be made under:

Item No.	Pay Item	Pay Unit
711-01	Riprap (class & thickness)	Square Yard (Sq m)
711-02	Riprap (class)	Cubic Yard (Cu m)
711-03	Riprap (class)	Ton (Mg)
711-04	Geotextile Fabric	Square Yard (Sq m)

Section 712
Revetments

712.01 DESCRIPTION. This work consists of furnishing and constructing revetments for protection of embankment slopes, stream channels, culvert end treatments and other areas. Revetments shall be constructed in accordance with these specifications and in conformity with the details shown on the plans or as directed.

When an item for Flexible Revetments is included in the contract, the contractor has the option of furnishing revetments of either stone, recycled portland cement concrete, wet-batched sacked concrete or dry-batched prepackaged sacked concrete.

When an item for Stone Revetment is included in the contract, the contractor has the option of furnishing revetments of either stone or recycled portland cement concrete.

When an item for Sacked Concrete Revetment is included in the contract, the contractor has the option of furnishing revetments of either wet-batched sacked concrete or dry-batched prepackaged sacked concrete.

The same type revetment shall be used at each location. Revetment, except for cast-in-place revetment, shall be placed on geotextile fabric.

712.02 MATERIALS.

(a) Concrete: Concrete for cast-in-place revetment shall be Class R complying with Section 901.

(b) Geotextile Fabric: Geotextile fabric shall comply with Subsection 1019.01.

(c) Wet-Batched Sacked Concrete: Sacks shall comply with Subsection 1018.20. Concrete shall be Class R concrete complying with Section 901. Concrete shall be wet-batched prior to placement in sacks, and sacked concrete shall be immediately placed in the revetment after batching. Mixing water for concrete shall be added as required to produce a slump of 4 inches to 6 inches (100 mm to 150 mm).

(d) Stone and Recycled Portland Cement Concrete: Stone and recycled portland cement concrete shall comply with Section 711 Riprap Class 30 lb (15 kg).

(e) Dry-Batched Prepackaged Sacked Concrete: Prepackaged concrete shall be an approved product listed in QPL 48 and shall consist of one part cement and a maximum of 5 parts sand by weight (mass) or other

approved mix with the same cement content, and shall be dry mixed until uniform in color.

(1) Cement: Cement shall be in accordance with Subsection 901.08(a).

(2) Aggregate: Aggregates shall comply with the gradation requirements of Subsection 1003.02.

(3) Sacks: Sacks shall comply with Subsection 1018.20 and shall be capable of holding the concrete mixture without leakage during handling.

(4) Water: Water shall be from an approved source in accordance with Subsection 1018.01.

(f) Usable Soil: Usable soil shall be in accordance with Subsection 203.06.

712.03 CONSTRUCTION REQUIREMENTS. Revetments shall be constructed in dry or dewatered areas, unless otherwise directed. Logs, stumps and other undesirable material shall be removed from areas on which revetments are to be placed. Usable soil shall be used to bring areas to grade and shall be compacted to the density of surrounding ground to the engineer's satisfaction before final grading. The revetment areas shall be graded to required sections.

(a) Geotextile Fabric Placement: Ends of geotextile fabric shall be buried for anchorage as shown on the plans. Adjacent strips of geotextile fabric shall be lapped at least 18 inches (450 mm). The laps shall be pinned at maximum 5-foot (1.5 m) intervals. Geotextile fabric shall not be damaged during revetment placement. Damaged fabric shall be repaired in accordance with Subsection 203.11(c) or replaced at no direct pay.

(b) Concrete Cast-in-Place Revetment: Before placement, preformed 1/4 inch (6 mm) thick expansion joint filler complying with Subsection 1005.01(a) shall be placed around piles, columns, etc.

Placement of concrete revetment for slope protection shall commence at the toe of revetment and progress upslope. Revetment for stream channels and other relatively level areas shall be placed as directed.

After placement, the revetment surface shall be cured in accordance with Subsection 601.10.

(c) Wet-Batched Sacked Concrete Placement: Sacks shall be uniformly filled to approximately 3/4 cubic foot (0.02 cu m). The open end shall be folded under the bag during placement. Sacks of wet-batched concrete shall be placed in one layer in contact with adjacent sacks and tamped into position by approved methods. Placement of sacked concrete shall begin at the revetment toe and progress upslope. Sacked concrete

revetment for stream channels and other relatively level areas shall be placed as directed.

(d) Dry-Batched Prepackaged Concrete Placement: Sacks shall be uniformly filled to approximately 3/4 cubic foot (0.02 cu m) and the ends shall be sealed by tying, stitching or other approved methods. The filled sacks shall be tightly packed against each other. Placement shall begin at the revetment toe and progress upslope with staggered joints. At the end of each day's operations and upon completion at a location, the sacks and contents shall be saturated with water as required to produce a slump of 2 to 5 inches (50 to 125 mm). The compressive strength shall comply with Section 901 for Class R concrete. The quantity of water required shall be as directed at no direct pay.

(e) Stone Placement: Toe and end walls shall be constructed by placing stone in the trench lined with geotextile fabric. Placement of stone shall begin at the bottom of the slope in a layer having the specified average thickness. Stone shall be placed by approved methods. A tolerance of 2 inches (50 mm) above or below the specified thickness will be allowed. Openings between stones exposing more than 4 square inches (2500 sq mm) of geotextile fabric will not be permitted.

712.04 MEASUREMENT. Revetments will be measured by the square yard (sq m) of surface area to be revetted as shown on the plans and as directed. Site preparation, geotextile fabric, and expansion joint filler will not be measured for payment.

712.05 PAYMENT. Payment for revetments will be made at the contract unit price which includes furnishing and installing all materials as shown on the plan details and in accordance with this section. Payment for concrete cast-in-place, wet-batched sacked concrete, and dry-batched prepackaged sacked concrete revetment will be made on a lot basis at the contract unit price per square yard (sq m), adjusted in accordance with the following provisions. Payment for each lot will be made in accordance with Table 901-6. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment will be made under:

Item No.	Pay Item	Pay Unit
712-01	Concrete Cast-in-Place Revetment	Square Yard (Sq m)
712-02	Sacked Concrete Revetment	Square Yard (Sq m)
712-03	Stone Revetment	Square Yard (Sq m)
712-04	Flexible Revetment	Square Yard (Sq m)

Section 713
Temporary Traffic Control

713.01 DESCRIPTION. This work consists of furnishing, installing, maintaining, and removing temporary construction barricades, precast concrete barriers, lights, signals, pavement markings and signs; providing flaggers; and complying with all other requirements regarding the protection of the work, workers and safety of the public. Unless otherwise noted in the plans or special provisions this work also includes traffic control management in compliance with the contract documents and the Manual on Uniform Traffic Control Devices (MUTCD), including the installation, inspection, maintenance, and removal of all traffic control devices on the project. Signs, barricades, barriers, channelizing devices, pavement markings, etc., shall comply with plan details, the MUTCD and these specifications.

Signs, barricades, barriers, channelizing devices, pavement markings and arrangements thereof, as shown on the plans, are minimum requirements. Appropriate signs for special conditions shall be furnished and installed as directed. Requirements for proper signs, barricades, barriers, channelizing devices, or other safety precautions promulgated by the contractor's insurers are not negated by these specifications. These specifications shall not be construed to relieve the contractor of responsibilities for the safety of the public, for liability in connection therewith, or compliance with State and local laws or ordinances.

The contractor shall assign one or more authorized Traffic Control Supervisors (TCS) to provide traffic control management for the project. If more than one TCS is assigned, then a weekly schedule identifying who will be in charge of providing traffic control management on a daily basis shall be submitted to the engineer. The TCS shall have a set of all contract documents relating to traffic control or traffic staging and a current copy of the MUTCD and a current copy of Louisiana Work Zone Traffic Control Details readily available at all times.

If the contractor utilizes a subcontractor to provide traffic control management, the subcontractor’s TCS shall meet all the requirements set forth herein.

The contractor may assign one or more Traffic Control Technicians (TCT) to assist the TCS in inspection and maintenance of Traffic Control Devices.

713.02 MATERIALS. Materials for temporary signs, barricades, barriers and related devices shall comply with the following Sections and Subsections:

Portland Cement Concrete	901
Reinforcing Steel	1009
Backing Material	1015.04(b)
Reflective Sheeting	1015.05
Temporary Pavement Markings	1015.08
Raised Pavement Markers & Adhesive	1015.09
Thermoplastic Pavement Markings	1015.10
Traffic Paint	1015.12
Barricade Warning Lights	1018.12

(a) Temporary Pavement Markings: Temporary pavement markings shall be a minimum of 4 inches (100 mm) wide.

(b) Reflective Sheeting: Reflective sheeting requirements for temporary signs, barricades, channelizing devices, drums and cones shall comply with the following:

(1) Temporary Signs and Barricades: On the mainline of freeways and expressways, the initial advanced warning construction sign shall be fabricated using ASTM D 4956 Type X (Fluorescent Orange) reflective sheeting. Reflective sheeting for all other temporary signs and barricades shall comply with the requirements of ASTM D 4956, Type III.

(2) Vertical Panels: Reflective sheeting for vertical panels used to channelize or divide traffic shall meet the requirements of ASTM D 4956, Type III.

(3) Drums: Reflective sheeting for drums shall be a minimum of 6 inches (150 mm) wide and shall meet the requirements of ASTM D 4956, Type III, and the Supplementary Requirement S2 for Reboundable Sheeting as specified in Subsection 1015.05.

(4) Cone Collars: Reflective sheeting for traffic cone collars shall meet the requirements of ASTM D 4956, Type VI.

713.03 FABRICATION. Fabrication of temporary signs, barricades and related devices shall conform to Subsection 729.04. Fabrication of precast concrete barriers shall conform to Section 805.

713.04 TEMPORARY SIGNS AND BARRICADES.

(a) General: Temporary signs, barricades and related devices will be required when the contractor's work is in progress on portions of the work covered by the Notice to Proceed or when operations are suspended. During such times that temporary signs, barricades and related devices are not in place, appropriate existing regulatory signs shall be maintained by the contractor.

Construction work shall not begin until signs, barricades and other traffic control devices have been erected and approved.

When signs to be furnished and erected by the contractor are in place and approved, the contractor's Traffic Control Supervisor (TCS) shall remove or cover any standard signs that are in conflict with temporary signs.

When placing signs, the contractor shall coordinate with the engineer in removing Departmental signs, so that appropriate signs are in place at all times.

Signing shall remain in place and be maintained by the contractor, supplemented by additional signs as required, throughout the period of work. When previously used signs are to be erected on a project, the engineer will inspect and approve these signs before erection. The engineer will require any sign with reduced reflectivity or excessive color fading to be removed from the work zone. In case of a dispute over a rejected used sign, the Department at its discretion, may take such measurements or review reflectivity and color data obtained by the contractor to determine if the sign meets minimum standards for new materials. Signs that do not meet the minimum standards for new materials shall be replaced by the contractor at no direct pay.

Rejected signs will be marked "NOT FOR USE ON STATE PROJECTS" on the back of the sign.

Signs placed by the contractor shall be removed according to the Traffic Control Plan. It will be the responsibility of the Department to see that all permanent highway signs are in place upon completion and acceptance of the project.

On projects where the surface course is constructed with asphaltic concrete or portland cement concrete, permanent striping and raised pavement markers (when required) shall be completed prior to removal of barricades.

Signs, barricades and related devices furnished and placed by the contractor shall, upon removal, remain the contractor's property.

(b) Advance Warning Area: When specified, advance warning arrow panels for temporary traffic control shall be provided at locations shown on the plans or as directed. Panels shall be one of the specified types

complying with the Department's MUTCD. If no type is specified, Type C panels shall be furnished.

(c) Construction Zone: In areas of the construction zone all traffic control devices used shall be in accordance with Temporary Traffic Control Standard Detail TC-00.

713.05 TEMPORARY PRECAST CONCRETE BARRIERS. Barrier units will be furnished by the contractor unless specified otherwise. Each barrier unit shall be 15-feet (4.6 m) in length.

When the barrier units are furnished by the Department the units will be furnished at no cost to the contractor. The contractor shall load the barrier units at the location specified, deliver the units to the construction site and place them as required.

The contractor shall relocate barrier units as required during construction.

Connecting pins and plastic reflectors shall be furnished by the contractor at no additional cost to the Department. Reflectors shall have 7.0 square inches (4,500 sq mm) minimum reflective area, and be installed a maximum of 15 feet (4.6 m) apart (each side) in accordance with the manufacturer's recommendations. Damaged pins or reflectors shall be replaced as directed by the engineer.

After completion of the work, barrier units shall become the property of the Department and shall be removed and transported by the contractor to the location specified and unloaded as directed. All costs of loading, transporting and unloading the barrier units shall be included in the price bid on this item.

Barrier units damaged shall be satisfactorily repaired or replaced at no direct pay.

713.06 PAVEMENT MARKINGS. Color, width and type of temporary pavement markings shall be in accordance with Table 713-1 and the MUTCD. Temporary pavement markings shall be in place at the end of each day's operation.

Temporary striping tape shall be applied by approved methods to the satisfaction of the engineer. Thermoplastic Pavement Markings shall be applied in accordance with Subsection 732.03. Painted Traffic Striping shall be applied in accordance with Section 737.

Table 713-1
Temporary Pavement Markings[1,2]

		Two-lane Highways	Undivided Multilane Highways	Divided Multilane Highways
SHORT TERM	ADT<1500; or ADT>1500 and time<3 days	Lane lines 4-foot (1.2 m) tape on 40-foot (12 m) centers; with "Do Not Pass" and "Pass With Care" signs as required		
	ADT>1500; Time>3 days and<2 weeks	Lane lines 4-foot (1.2 m) tape on 40-foot (12 m) centers with no passing zone markings		
	All ADT's with time <2 weeks		Lane lines 4-foot (1.2 m) tape on 40-foot (12 m) centers; double yellow centerline	Lane lines 4-foot (1.2 m) tape on 40-foot (12 m) centers
	All ADT's with time >2 weeks	Standard lane lines, no-passing zone markings, legends and symbols and when pavement width is 22 feet (6.7 m) or greater, edge lines	Standard lane lines, centerlines, edge lines, and legends and symbols	Standard lane lines, centerlines, edge lines, and legends and symbols.

[1]No-passing zones shall be delineated as indicated whenever a project is open to traffic.
[2]On all Asphaltic Surface Treatments that are open to traffic and used as a final wearing course or as an interlayer, temporary pavement markings (tabs) on 20-foot (6 m) centers shall be used, in lieu of the 4-foot (1.2 m) tape, on 40-foot (12 m) centers.

(a) Short-term Pavement Markings: Short-term pavement markings will be required on any pavement surface under traffic.

Centerlines on two-lane highways and lane lines on multilane highways shall be temporary striping tape a minimum of 4 feet (1.2 m) long on a maximum of 40-foot (12 m) centers. When short-term pavement markings require no-passing zone markings or double yellow centerlines on undivided multilane highways, they shall be any of the temporary pavement markings listed in Subsection 713.02.

Removal of short-term pavement markings will only be required on the final surface.

(b) Long-term Pavement Markings: Long-term pavement markings will be required on any surface which is not covered by an additional surface

in 2 weeks or less. Long-term pavement markings shall include, but are not limited to, standard lane and centerline markings (i.e., 10-foot (3 m) stripes on a maximum of 40-foot (12 m) centers), edgelines, no passing zone markings on 2-lane highways, stop bars, and legend and symbol markings as shown on the permanent pavement marking details. Layout work for exact location of markings will only be required on the final surface.

These markings shall consist of any of the pavement markings listed in Subsection 713.02.

Long-term markings do not include the installation of raised pavement markings.

(c) Final Surface: On the final surface (portland cement concrete pavement or asphaltic concrete pavement), temporary markings shall be placed with sufficient accuracy to avoid conflict with permanent striping where possible. Temporary pavement markings on the final surface shall be any of the pavement markings listed in Subsection 713.02.

Placing permanent markings over traffic paint will be acceptable on final surfaces provided the temporary markings have been placed in the final configuration (proper final layout) and the painted lines are not flaking or showing signs of deterioration.

The removal of temporary pavement markings, if required, shall be in accordance with the requirements for the type of permanent marking being used. There shall be no objectionable staining of pavement surface as a result of the removal procedure.

(d) Temporary Reflectorized Raised Pavement Markings: When required, temporary reflectorized raised pavement markings shall be installed in accordance with Section 731.

(e) Pavement Markings for Asphaltic Surface Treatment: The type of markings shall be in accordance with Table 713-1. Short-term temporary pavement markings shall be in place at the end of each day's operation. Long-term temporary pavement markings shall be in place as soon as practical after expiration of the 4 day maintenance period following the asphaltic surface treatment operation. On the final wearing course, permanent markings shall be placed two weeks following completion of the long-term temporary pavement markings.

When used on the final wearing course, painted traffic striping shall be in accordance with Section 737.

Centerlines on two-lane highways and lane lines on multilane highways shall be temporary raised markers in accordance with Subsection 1015.08(c). "No-passing zone" markings shall be any of the temporary pavement markings listed in Subsection 713.02.

The temporary raised pavement markers shall be installed in accordance with the manufacturers' recommendations or as directed by the engineer. The temporary raised markers shall be flexible reflective tabs placed at 20-foot (6 m) intervals on the centerline of the roadway. The markers shall be installed so that the reflective faces of the markers are perpendicular to a line parallel to the roadway centerline.

If directed by the engineer, the temporary raised pavement markers shall be removed after permanent striping has been accomplished. Damage to the pavement surface shall be repaired at no direct pay.

713.07 PORTABLE WORK ZONE TRAFFIC CONTROL DEVICES.

All Category I, II, and III portable work zone traffic control devices, as described below, shall be crashworthy as determined by evaluations through the National Cooperative Highway Research Program (NCHRP) 350 for Test Level 3 (TL-3).

(a) Category I Devices: Category I devices are low-mass, single-piece traffic cones, tubular markers, single-piece drums and flexible delineators and are, by definition, considered crashworthy devices meeting NCHRP Report 350 TL-3 criteria. Drum and light combinations with Type A or C warning lights and fastener hardware consisting of vandal resistant 1/2 inch (13 mm) diameter cadmium plated steel bolts and nuts used with 1 1/2 inch (38 mm) diameter by 3/4 inch (19 mm) cup washers are included as Category I devices. In lieu of testing for crashworthiness, acceptance of Category I devices for compliance with NCHRP 350 will be allowed based on self-certification by the supplier. The supplier shall certify that the product is crashworthy in accordance with the evaluation criteria of NCHRP 350. This certification may be a one-page affidavit signed by the supplier, with supporting documentation kept on file to be furnished if requested.

(b) Category II Devices: Category II devices include other low mass traffic control devices such as portable barricades either with or without lights and or signs, portable sign stands, portable vertical panel assemblies, and drums with lights not meeting the drum and light combination requirements for Category I. Individual crash testing is required for Category II devices. FHWA letters of approval shall serve as verification that these devices comply with the crash testing requirements of NCHRP Report 350 TL-3. The contractor shall provide the engineer a listing of all the Category II devices to be used on the project prior to installation including a reference to the FHWA Work Zone letter number for each device. The contractor shall also certify that each device has been crash tested and meets the NCHRP 350 requirements.

(c) Category III Devices: Category III devices include massive devices such as concrete barriers, water filled barriers and portable attenuators. Individual crash testing is required for Category III devices. FHWA letters of approval shall serve as verification that these devices comply with the crash testing requirements of NCHRP Report 350 TL-3. The contractor shall provide the engineer a listing of all the Category III devices to be used on the project prior to installation including a reference to the FHWA Work Zone letter number for each device. The contractor shall also certify that each device has been crash tested and meets the NCHRP 350 requirements.

713.08 TRAFFIC CONTROL MANAGEMENT.

(a) Authorization: Prior to commencing work requiring traffic control management, the contractor shall submit to the engineer proof of the Traffic Control Supervisor's (TCS) and Traffic Control Technician's (TCT) current authorizations.

The Department will accept the TCS authorization of other approved agencies or firms only if all of the following minimum TCS requirements are met:

(1) Successful completion of a work zone traffic control supervisor course approved by the Department.

(2) Passing a written examination on the work zone traffic control supervisor course.

(3) A minimum of one year full-time field experience, verified by the agency or firm, in work zone traffic control. This experience may be verified by the Department at its discretion.

The Department will accept the TCT authorization of other approved agencies or firms only if all of the following minimum requirements are met.

(1) Successful completion of a work zone traffic control technician course approved by the Department.

(2) Passing a written examination on the work zone traffic control technician course.

(b) Traffic Control Supervisor (TCS) Duties: The TCS's responsibility shall be traffic control management, and the TCS shall be available to the engineer to address traffic control management issues as needed. The following is a listing of the TCS's primary duties:

(1) The TCS shall personally provide traffic control management and supervision services at the project site. The TCS may have other assigned duties, but shall be readily available at all times to perform TCS duties as required in the contract. A minimum of one TCT shall be required on site

during working hours.

(2) The TCS shall be responsible for observing and evaluating both the day and night time performance of all traffic control devices installed on the project, in accordance with the Traffic Control Plan (TCP), to ensure that the devices are performing effectively as planned for both safety and traffic operations. This shall be done upon the initial installation of the devices and when any modifications and/or changes are made, in addition to the inspection of traffic control required in Heading (e).

(3) The TCS shall be responsible for revisions requested by the contractor to the traffic control plan established in the contract and shall submit the new traffic control plan in accordance with Heading (c).

(4) The TCS shall be responsible for the training of flagging personnel. This training will ensure that all flagging done on the project is in compliance with the MUTCD Part VI and Louisiana Work Zone Traffic Control Details.

(5) The TCS shall coordinate all traffic control operations for the duration of the contract, including those of subcontractors, utility companies, and suppliers, to ensure that all traffic control is in place and fully operational prior to the commencement of any work. The Department recognizes that the contractor does not have direct control over the traffic control operations of the utility companies. The coordination provided by the TCS when dealing with utility companies is specifically for the purpose of coordinating concurrent utility traffic control with any other construction traffic control to avoid conflicts.

(6) The TCS shall coordinate, in writing, all project activities with the appropriate law enforcement, fire control agencies, and other appropriate public agencies as determined at the pre-construction conference by the engineer. The TCS shall also invite the above agencies to the pre-construction conference.

(7) The TCS shall prepare and submit statements concerning road closures, delays, and other project activities to the news media on a weekly basis or more often as needed. News releases shall be submitted to the engineer for review and approval prior to the contractor's submittal to the news media.

(8) The TCS shall be responsible for notifying the engineer, or designee, immediately of all vehicular accidents and/or incidents related to the project traffic control. The time and date of notification shall be documented in the traffic control diary. The TCS shall also monitor and document queues that occur as necessary.

(9) The TCS assigned to the project shall attend the pre-construction

conference and all project meetings.

(10) The TCS shall be responsible for the maintenance, cleanliness, replacement and removal of traffic control devices of the existing traffic control plan during working and non-working hours.

(c) Traffic Control Plan Revisions: Requests for revision in the traffic control plan must be made in writing to the engineer a minimum of 14 calendar days in advance of the needed revision. If the requested revision falls within the scope of the existing contract drawings, the engineer may approve the revision. If the engineer determines that the requested revision is outside the scope of the contract drawings, the contractor will be required to submit a change order. The change order drawings shall conform to the following:

(1) Letter size original contract drawings --The change order drawings shall be submitted on high quality white 8 1/2 x 11 inch letter size paper. The drawings may be hand drafted or computer drafted and arranged in landscape format on the page. The text and drawings must be legible after reproduction on standard reproduction equipment. Left, bottom and right hand margins shall be at least 1/2 inch and the top margin shall be 1 inch.

(2) Full size original contract drawings -- The change order drawings shall be submitted on high-quality, 4-mil, double-matte film using a plotting or reproduction process that fuses the graphics to ensure durability. Repeated handling and friction due to stacking of plans shall not smear, flake or rub off the graphics. Improper plotter settings and plotter wear may cause inconsistent durability of the drawings. The contractor shall test samples of the submitted drawings for durability. Advance samples of matte films may be submitted for approval; however, the contract plans will be tested separately. Failures will result in rejection of the submittal. Drawing sizes shall be in accordance with Subsection 801.03(a).

Lettering on change order drawings shall be of adequate size to facilitate a 50 percent reduction of plans. Additions or changes shall be made with a permanent type of waterproof ink made for this purpose. If revised cross sections are required, the cross-sections shall be plotted on standard plate cross-section sheets. The ground line, centerline elevation, and station numbers, as a minimum, shall be drawn in ink; the remaining information may be in pencil.

Regardless of size, all change order drawings and documents required shall be identified with the DOTD project title and project number. All plans and calculations shall be signed and sealed by a professional civil engineer currently registered to practice in Louisiana.

All plans submitted by the contractor shall conform to these specifications

and standards. The DOTD Chief Engineer may reject any plans not conforming to these standards.

Revisions to the TCP that are determined to be outside the scope of the original contract drawings must be approved by the DOTD District Traffic Engineering Division prior to implementation of the requested revision. In some cases on high traffic routes or high priority projects, the revisions must be approved by the HQ Traffic Operations Engineer.

(d) Traffic Control Diary: The TCS shall maintain a project traffic control diary in a bound book. The contractor shall obtain a sufficient number of the diaries from the Louisiana Associated General Contractors (LAGC). The TCS shall keep the traffic control diary current on a daily basis, and shall sign each daily entry. Entries shall be made in ink in a standard format furnished by the engineer, and there shall be no erasures or white-outs. Incorrect entries shall be struck out and then replaced with the correct entry. Photographs and videotapes may be used to supplement the written text.

The traffic control diary shall be available at all times for inspection by the engineer; and the diary shall be reviewed with the engineer on a weekly basis and a copy submitted to the engineer on a monthly basis. Failure to submit the monthly copy of the diary to the engineer shall result in the withholding of the next partial payment until the past due copies of the diary are submitted. The traffic control diary shall become the property of the Department at the completion of the project.

(e) Inspection of Traffic Control: The TCS shall be responsible for the inspection of all traffic control devices every calendar day that traffic control devices are in use. This inspection may be delegated to the TCT. The "Quality Guidelines for Work Zone Traffic Control Devices" standard by the American Traffic Safety Services Association (ATSSA) shall be used to evaluate the condition of the traffic control devices to determine if acceptable for use. The TCS shall provide for the immediate repair, cleaning, or replacement of any traffic control devices not functioning as required to ensure the safety of the motorist and construction personnel and/or not meeting the ATSSA standard.

Inspection of the traffic control devices shall be conducted by the TCS at the beginning and end of each workday, and as scheduled or directed by the engineer during the workday. The traffic control devices shall be inspected by the TCS on weekends, holidays, or other non-work days at least once per day. Traffic control devices shall be inspected by the TCS at least once a week during nighttime periods and the same night after any modifications or changes have been made in the traffic control devices.

(f) Failure to Comply: The engineer may suspend all or part of the

contractor's operation(s) for failure to comply with the approved "Traffic Control Plan" or failure to correct unsafe traffic conditions within a reasonable period of time after such notification is given to the contractor in writing.

In the event that the contractor does not take appropriate action to bring the deficient traffic control into compliance with the approved traffic control plan or to correct the unsafe traffic conditions, the Department may proceed with the corrective action using its own forces, and such costs will be deducted from payments owed to the contractor.

If the contractor's operations are suspended, the normal assessment of contract time will not cease for the period required to correct these unsafe conditions and traffic control deficiencies. The contractor shall not be relieved of the responsibility to provide traffic control safety to the traveling public when a project is under full or partial project suspension. When a project is under suspension due to the contractor's failure to comply with this section, or when the contract is under stipulated damages, the contractor shall continue to provide traffic control management and no additional measurement or payment will be made. If suspensions or partial suspensions are requested by the contractor, the additional traffic control management costs will be at the contractor's expense.

(g) Engineer Modifications: The provisions included in the plans and specifications for handling and controlling traffic during construction may be changed by the engineer, with the approval of the DOTD District Traffic Operations Engineer, due to actual field conditions encountered. Such changes will be made by written instruction to the contractor and shall be considered an amendment to the plans and specifications as of the date of change.

713.09 MEASUREMENT.

(a) Temporary Signs and Barricades: When the contract does not include a pay item for "Temporary Signs and Barricades," the providing of temporary construction signs, barricades and related devices will not be measured for payment. When a pay item for "Temporary Signs and Barricades" is included in the contract, the furnishing, erecting, maintaining and subsequent removing of temporary construction signs, barricades and related devices will be measured on a lump sum basis.

Advance warning arrow panels will not be measured for separate payment, but will be included in the contract lump sum price for Temporary Signs and Barricades.

(b) Temporary Pavement Markings: When the contract does not include an item for "Temporary Pavement Markings," provision of these markings will not be measured for payment.

When the contract includes an item for "Temporary Pavement Markings", these markings acceptably furnished, placed, maintained and subsequently removed will be measured by the linear foot (lin m), or by the mile (km) as specified.

When measurement is made by the linear foot (lin m) of striping, measurement will be made for the material placed. Gaps will be excluded.

When measurement is made by the mile (km) of single strip per roadway per application, no deduction will be made for the standard design gaps in broken line striping; however, deductions will be made for the length of other gaps or omitted sections.

Temporary pavement legends and symbols will be measured per each legend or symbol.

Temporary reflectorized raised pavement markers will be measured by counting the number of markers furnished, placed and accepted. Removal of raised pavement markers will not be measured for payment.

(c) Temporary Precast Concrete Barriers: When the contract does not include a pay item for Temporary Precast Concrete Barriers, the provision of these barriers will not be measured for payment. When the contract includes a pay item for Temporary Precast Concrete Barriers, the barriers will be measured per each unit installed, which includes construction, delivery, placement and removal from the job site one time. Further movements of barriers for subsequent construction phases will be measured per movement of each barrier.

(d) Traffic Control Management: Traffic control management will not be measured for payment.

713.10 PAYMENT. Payment for temporary construction signs, barricades and related devices will be at the contract lump sum price in accordance with the payment schedule of Table 713-2.

Table 713-2
Payment Schedule
Temporary Signs, Barricades and Related Devices

Percent of Total Contract Amount Earned	Allowable Percent of Lump Sum Price for Temporary Signs and Barricades
Initial Erection	40
25	60
50	80
75	95
100	100

Payment for temporary pavement markings will be made at the respective contract unit prices. Payment for temporary precast concrete barriers will be made at the contract unit price per each. The concrete in temporary precast barriers furnished by the contractor will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-5 and Note 1 therein. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment for movement of temporary concrete barriers will be made per movement of each barrier.

Payment will be made under:

Item No.	Pay Item	Pay Unit
713-01	Temporary Signs and Barricades	Lump Sum
713-02	Temporary Pavement Markings (__inch (__mm) Width)	Linear Foot (Lin m)
713-03	Temporary Pavement Markings (Broken Line)(__inch (__mm) Width) (__foot (__m) Length)	Mile (km)
713-04	Temporary Pavement Markings (Solid Line) (__inch (__mm) Width)	Mile (km)
713-05	Temporary Pavement Legends and Symbols (Type)	Each
713-06	Temporary Reflectorized Raised Pavement Markers	Each
713-07	Temporary Precast Concrete Barrier (Contractor Furnished)	Each
713-08	Temporary Precast Concrete Barrier (Department Furnished)	Each
713-09	Temporary Portable Barrier (Type)	Each
713-10	Temporary Precast Concrete Barrier Movement	Each

Section 714
Sodding

714.01 DESCRIPTION. This work consists of furnishing, hauling, planting, rolling, watering and maintaining live grass sod at locations shown on the plans or as directed.

714.02 MATERIALS. Approved sod shall be either field grown grass or nursery grown grass delivered in rolls or slabs.

Field grown grass sod shall be Bermuda grass, carpet grass, or other approved grass native to the sodded area.

Nursery grown grass sod shall be Centipede, Tiffway Bermuda, Nomow Bermuda, Common Bermuda or St. Augustine grass.

Fertilizer shall comply with Subsection 1018.16 and agricultural lime shall comply with Subsection 1018.17.

Sod shall be free from noxious weeds or other vegetation.

Water may be obtained from any source. Brackish, chemically contaminated, or oily water shall not be used.

714.03 GENERAL CONSTRUCTION REQUIREMENTS. Sod shall be cut with approved sod cutters. The designated area shall be mowed when necessary. Sod shall be cut to a minimum soil depth of 1 1/2 inches (40 mm) for field grown grass and 1 inch (25 mm) for nursery grown grass, and to a uniform width and in convenient lengths for handling. Soil shall be retained on roots of sod during excavating, hauling and planting. Only common Bermuda sod shall be used within 30 feet (9 m) of the outer edges of paved shoulders.

Sod cut more than 48 hours before placing shall not be used unless authorized. Sod taken from areas that may produce inferior growth will not be accepted.

Watering required in connection with digging, storing or hauling sod will be at no direct pay.

714.04 HANDLING SOD. Slab sod shall be placed flat, grass side up on pallets containing no more than 50 square yards (42 sq m) of slab sod and hauled, covered, to the planting site with soil intact. Pallets shall be off-loaded and placed as close as practical to the planting site. Rolls of sod shall contain no more than 225 square feet (21 sq m) per roll and shall be covered

and hauled to the planting site with soil intact. Rolls shall be off-loaded and placed as close as practical to the planting site.

714.05 PLANTING. Areas to receive sod shall be pulverized to a depth of at least 3 inches (75 mm), graded and cleared of weeds, grass, stones and other debris. If an item for agricultural lime is included in the contract, liming shall be done when the area is being pulverized. When an item for fertilizer is included in the contract, approximately 90 percent shall be broadcast over the area to receive sod, and the remaining 10 percent shall be broadcast over sod after placing and rolling. Upon delivery to the planting site, sod shall be transferred onto the surface soil. Areas to be sodded shall be watered as directed. Sod shall be placed with no space between edges. Slab and roll edges shall be staggered to avoid a continuous seam along the line of flow. Along the edges of such staggered areas, the offsets of individual strips shall not exceed 6 inches (150 mm). Slab edges which do not fit closely shall be pulled together by hand without stretching or tearing and pegged when necessary. When directed, sod surface will be top dressed with sand to smooth-out uneven spots.

714.06 ROLLING. Sod shall be rolled after planting with smooth drum steel wheel rollers or cultipackers. Where rolling is impractical, sod shall be tamped by approved hand methods.

714.07 WATERING. Water shall be the responsibility of the contractor unless otherwise noted. The contractor shall keep all sodded areas thoroughly watered for 30 calendar days after installation. Watering required by the engineer after 30 calendar days will be at no direct pay. Water shall not contain elements toxic to the plant life. Watering shall be started immediately after completing each day of installing sod. Water shall be applied at least 3 times per week to supplement rainfall, at a rate sufficient to ensure moist soil conditions to a minimum depth of 2 inches (50 mm). Watering trucks shall not be driven over newly installed turf areas.

714.08 PERIOD OF ESTABLISHMENT - SODDING. The sod establishment period to obtain a healthy stand of grass plants shall begin on the first day that sod is placed under the contract and shall end 60 calendar days after the last day of the sodding operation. A written calendar time period shall be furnished for the sod establishment period. When there is more than one sod establishment period, the boundaries of the sodded area covered for each period shall be described. The sod establishment period

shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

If an application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted to the engineer for approval by the District Roadside Development Coordinator. The contractor will be responsible for the application of any EPA approved chemicals.

714.09 SATISFACTORY STAND OF GRASS PLANTS: Grass plants shall be evaluated for species and health. All sod must be moist and growing at the time of acceptance. A satisfactory stand of grass plants from the sodding operation shall be living sod, uniform in color and leaf texture. Bare spots shall be a maximum of 2 inches (50 mm) square. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.

Unsatisfactory areas of sod shall be repaired or reinstalled, and eroded areas shall be repaired. If, at the end of the establishment period, the growth or stand of the sod is unacceptable, the sod will be rejected.

714.10 MEASUREMENT. Sodding: Sodding will be measured by the square yard (sq m) along the surface of completed sodding.

714.11 PAYMENT. Payment for sodding will be made at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
714-01	Sodding	Square Yard (Sq m)

Section 715
Topsoil

715.01 DESCRIPTION. This work consists of furnishing and placing topsoil on areas designated on the plans or as directed.

The contractor shall obtain the services of an established soil testing entity to coordinate soil sampling, perform testing and analyses, and prepare recommendations for materials and procedures to be used during the preplanting phase. When practicable, soil testing shall be performed early enough to permit agricultural lime or other additives (if required) to be applied sufficiently in advance of planting so that the soil pH adjustment will occur before planting. Samples shall be tested and analyzed to determine pH and fertility conditions. The test results and recommendations shall be used to determine the quantities of agricultural lime and fertilizer required for preplanting applications. A copy of the test report with recommendations shall be furnished to the engineer. Testing will be at no direct pay. Agricultural lime recommendations shall consider probable time of application.

715.02 MATERIALS.

(a) Topsoil: When available, the topsoil shall be the existing surface soil stripped and stockpiled. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by soil tests. Soil tests shall be provided prior to delivery of topsoil to the site. The tests shall determine the quantities and type of soil amendments required to meet local growing conditions for the seed species specified.

Delivered topsoil, existing soil in smooth graded areas, and stockpiled topsoil shall be tested for particle size, pH, organic content, textural class, chemical composition and soluble salts. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over 1 1/2 inches diameter. Topsoil shall be free from viable plants and plant parts. Topsoil shall also be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. Topsoil shall have a minimum PI of 4, a maximum PI of 12, a pH of 5.5-8.0, a minimum organic content of 2 percent, and shall be capable of supporting adequate vegetation.

(b) Soil Amendments. Soil amendments to be blended with the topsoil shall be delivered to the site either in the original, unopened

containers bearing the manufacturer's chemical analysis, or in bulk. A chemical analysis shall be provided for bulk deliveries.

Existing topsoil meeting the above requirements within construction limits may be used in accordance with Subsection 106.02. If agricultural lime or organic matter is added to a soil to bring topsoil into conformance with these specifications, it shall be at no direct pay.

715.03 CONSTRUCTION REQUIREMENTS. Areas to receive topsoil shall be scarified as directed. Topsoil shall be uniformly spread over the areas to a depth of 6 inches (150 mm) and rolled to a uniform surface with a cultipacker or other suitable equipment.

715.04 MEASUREMENT. Topsoil will be measured by the cubic yard (cu m) in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01, which includes testing and the test report.

Preparation of the areas to receive topsoil will not be measured for payment. Agricultural lime treatment of areas to receive topsoil will be measured in accordance with Subsection 718.04.

715.05 PAYMENT. Payment for topsoil will be made at the contract unit price, which includes testing and test reports.

Payment will be made under:

Item No.	Pay Item	Pay Unit
715-01	Topsoil	Cubic Yard (Cu m)

Section 716
Vegetative and Fiber Mulch

716.01 DESCRIPTION. This work consists of furnishing and placing an approved vegetative or fiber mulch with a tacking agent on seeded areas to promote seed germination and growth, while temporarily protecting the soil from erosion.

716.02 MATERIALS. Mulching materials and tacking agents shall comply with Subsection 1018.19. The contractor shall notify the engineer at least 7 calendar days in advance of commencing operations so that the mulch can be inspected and approved prior to use.

Vegetative and fiber mulch shall be delivered in bales or bags of uniform size. Storage of mulching materials shall be in accordance with Subsection 106.09. Mulch stockpiles shall be protected from the weather.

716.03 GENERAL CONSTRUCTION REQUIREMENTS. Mulching shall follow seeding operations within 48 hours. Mulch shall not be sprayed on structures. All stains resulting from the mulch or the tacking agent shall be removed, and the surface left in acceptable condition. During windy conditions the contractor shall make adjustments in operations to ensure uniform spreading.

Damage to seeded areas shall be repaired and re-seeded at no direct pay.

(a) Tacked Vegetative Mulch: Vegetative mulch shall be distributed uniformly over the seeded area by blowing it simultaneously with an approved tacking agent. Jet nozzles in the muzzle of the blower shall be spaced to provide a uniform coating of the mulch as it is blown through the nozzles.

The tacked vegetative mulch shall be loose enough to allow air to circulate, but compact enough to partially shade the ground and reduce the impact of rainfall on the soil surface. Mulching shall begin at the top of the slopes and extend downward. Blower pipe extensions shall be used where slopes cannot be reached by the blower.

(b) Fiber Mulch: The application equipment shall have a built in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix the fiber mulch, water and any tacking agent that is part of the fiber mulch system. The fibers shall be kept in uniform suspension throughout the mixing and distribution cycles. The slurry distribution lines

shall be large enough to prevent stoppage. Hydraulic spray nozzles in the discharge line shall provide uniform distribution of the slurry.

716.04 SPREADING RATES.

(a) Tacked Vegetative Mulch: Vegetative mulch shall be applied at a rate of 1 1/2 to 2 tons of mulch per acre (3.4 to 4.5 Mg/ha) simultaneously with the tacking agent. Final application rates for the tacking agent shall be in accordance with the application rate shown in QPL 72 for the particular type of vegetative mulch being used.

(b) Fiber Mulch: Fiber mulch shall be applied as a slurry at a rate of 1 to 1 1/2 tons per acre (2.3 to 3.4 Mg/ha) based on dry weight (mass) of the fibers. The application rate of the tacking agent, if not pre-blended with the fibers by the manufacturer, shall be in accordance with the application rate shown in QPL 72 for the particular type of fiber being used.

716.05 MANUAL SPREADING. In order to prevent defacing structures, mulch shall be manually spread around structures. When manual spreading is performed, mulch shall be placed in a shredded condition, after which the tacking agent shall be sprayed over the mulch at the specified rate.

716.06 MEASUREMENT. Vegetative mulch and fiber mulch products will be measured for payment by the ton (kg) of mulch material used. The weight (mass) of vegetative mulch to be used in determining spread rates of mulch and tacking agents will be the product of the number of bales or bags used and the average weight (mass) per bale or bag as determined on scales provided by the contractor which have been certified by a qualified independent scale service or the Weights and Measures Division, Louisiana Department of Agriculture and Forestry.

Quantities of tacking agents used with vegetative mulch will be measured by the pound (kg) and be determined by marked container count.

Tacking agents used with fiber mulch are considered part of the system and shall be included in the unit cost for the system.

716.07 PAYMENT. Payment for vegetative mulch and fiber mulch products will be made at the contract unit prices per ton (kg) and includes all materials including tacking agents, labor, equipment and other incidentals necessary to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
716-01	Mulch	Ton (kg)

Section 717
Seeding

717.01 DESCRIPTION. This work consists of preparing seed beds and furnishing and sowing grass seed on the areas designated on the plans or as directed. Unless otherwise specified, seed shall be applied either mechanically in a dry condition under this section or with hydro-seeding equipment in accordance with Section 739.

The contractor shall obtain the services of an established soil testing entity to coordinate soil sampling, perform testing and analyses, and prepare recommendations for materials and procedures to be used during the preplanting phase of new turf establishment. When practicable, soil testing shall be performed early enough to permit agricultural lime or other additives (if required) to be applied sufficiently in advance of planting so that the soil pH adjustment will occur before planting. Samples shall be tested and analyzed to determine pH and fertility conditions. The test results and recommendations shall be used to determine the quantities of agricultural lime and fertilizer required for preplanting applications. A copy of the test report with recommendations shall be furnished to the engineer. Testing will be at no direct pay. Agricultural lime recommendations shall consider probable time of application.

717.02 MATERIALS. Materials for seeding shall comply with the following Sections and Subsections:

Topsoil	715
Fertilizer	1018.16
Agricultural Lime	1018.17
Seed	1018.18

Water may be obtained from any source, except that brackish, chemically contaminated, or oily water shall not be used.

717.03 SOIL AREAS. Seed shall be selected on the basis of five general soil areas as follows:

(1) Alluvial soils of Mississippi and Red River bottoms.

(2) Mississippi terraces and loessial hill soils.

(3) Coastal plain soils (rolling, hilly and flatwoods areas in central, northern and eastern part of the State).

(4) Coastal prairie soils.

(5) Ouachita River bottom.

717.04 PREPARATION OF SEED BED. Seed beds shall be prepared by disking, harrowing or other approved methods. Soil on slopes of 3-horizontal-to-1-vertical and flatter shall be tilled to a minimum of 4 inches (100 mm) depth. On slopes between 3-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, the soil shall be tilled to a minimum of 2 inches (50 mm) depth by scarifying with heavy rakes, or other methods. Rototillers may be used where soil conditions and length of slope permit. On slopes 1-horizontal-to-1-vertical and steeper, no tillage is required. Drainage patterns shall be maintained as indicated on the plans. Areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of surface erosion or grade deficiencies shall conform to topsoil requirements. The pH adjuster, fertilizer, and soil conditioner may be applied during this procedure. The prepared surface shall be a maximum 1 inch (25 mm) below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove debris.

(a) Lawn Area Debris: Debris and stones over a maximum of 5/8-inch (15 mm) in any dimension shall be removed from surfaces designated on the plans as lawn areas or as directed by the engineer.

(b) Field Area Debris: Debris and stones over a maximum of 3-inches (75 mm) in any dimension shall be removed from the surface.

(c) Protection: Prepared surface areas shall be protected from compaction or damage by vehicular or pedestrian traffic and surface erosion.

717.05 PERMANENT SEEDING. Seed shall be planted within the dates shown in Table 717-l, unless otherwise permitted in writing.

717.06 TEMPORARY SEEDING. During construction, temporary seeding shall be placed as directed. Temporary seeding may be any of the types given in Table 717-1. Annual rye grass is the only acceptable grass for winter cover.

The contractor will be allowed to apply seed by use of a hydro-seeder in accordance with Section 739.

717.07 WATERING. When deemed necessary due to dry conditions, seeded areas shall be periodically watered until final acceptance at no direct pay.

717.08 SEED ESTABLISHMENT PERIOD. Turf will be considered to be established and completed when the areas to be turfed have produced Bermuda grass stems or runners which overlap adjacent Bermuda grass growth over a minimum of 85 percent of the entire area as determined by the engineer by random sampling on a square yard (sq m) basis and when the areas to be turfed have no spots greater than 4 square feet (0.4 sq m) that are void of Bermuda grass.

Acceptance of the entire turfed area will be based on the engineer's visual inspection and determination of the required coverage. Acceptance will be based on coverage by Bermuda grass only. Dying or dead turf and eroded areas will not be accepted. Partial areas will not be accepted unless determined by the engineer to be in the best interest of the Department.

717.09 MEASUREMENT. Seeding will be measured by the pound (kg).

717.10 PAYMENT. Payment for temporary and permanent seeding will be made at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
717-01	Seeding	Pound (kg)

Table 717-1
Seeding

Type	Seed Mixtures[1]	Pounds/ Acre	Kilogram/ Hectare	Soil Area[2]	Planting Dates	Establishment Period[7]
A	Hulled Bermuda	30	34	1,2,3,4,5	Mar.-Sep.	Mar.-Dec.
B	Hulled Bermuda Crimson Clover[3]	20 25	22 28	1,2,3,5	Feb.-Mar.	Feb.-Jun.
C	Kentucky 31 Fescue Unhulled Bermuda	25 20	28 22	1,2,3,4,5	Sep.-Feb.	Sep.-May
D	Unhulled Bermuda Crimson Clover[3]	20 40	22 45	1,2,3,4,5	Sep.-Feb.	Sep.-May.
E	Pensacola Bahia[4]	25	28	1,2,3,5	Mar.-Sep.	Mar.-Dec.
F	Ball Clover Unhulled Bermuda	25 20	28 22	1,2,3,4,5	Feb.-Mar.	Feb.-Jun.
G	Vetch (Common) Unhulled Bermuda	40 20	45 22	1,2,3,4,5	Sep.-Oct.	Sep.-Jan.
H[6]	Lespedeza Browntop Millet Hulled Bermuda Pensacola Bahia	6 20 15 50	7 22 17 56	1,2,3,4,5	Mar.-Jul.	Mar.-Oct.
I	Annual Rye	30	34	1,2,3,4,5	Sep.-Jan.[5]	Sep.-Apr.

[1]Only Hulled Bermuda or Unhulled Bermuda shall be planted in rest areas.
[2]See Subsection 717.03.
[3]Inoculated prior to planting with proper bacterial culture.
[4]Type E shall be used only upon the approval of the Roadside Development Specialist.
[5]Annual Rye grass shall not be planted before September 20. Annual Rye grass may be planted as late as January 15 if climatic conditions and soil temperatures will allow germination.
[6]This planting mixture is to be used in the Kisatchie National Forest areas only.
[7]The seed establishment period shall begin on the first day of seeding work under the contract and shall continue through the remaining life of the contract and end 3 months after the last day of the seeding operation. The contractor shall provide a written calendar time period for the seed establishment period. When there is more than one seed establishment period, the boundaries of each seeded area covered by each period shall be described. The seed establishment period may be modified for inclement weather, shut down periods, or for separate completion dates of areas as approved by the engineer.

Section 718
Fertilizer and Agricultural Lime

718.01 DESCRIPTION. This work consists of furnishing and applying commercial fertilizer and agricultural lime on the areas designated on the plans or as directed.

718.02 MATERIALS.

(a) Fertilizer: Fertilizer shall be an approved brand complying with requirements of the Louisiana Department of Agriculture and Forestry. Fertilizer shall be either 8-8-8, 12-12-12, 13-13-13 or 16-16-16, and shall comply with Subsection 1018.16. Fertilizer shall be delivered in sack or bulk.

Fertilizer tablets shall be an approved brand containing nitrogen fixing and phosphorus solubilizing bacteria, slow-release nitrogen, natural organic nutrients, and humic acid complying with the requirements of Subsection 1018.16. The fertilizer tablets shall be delivered in sealed waterproof containers.

(b) Agricultural Lime: Agricultural lime shall comply with Subsection 1018.17 and shall be delivered either in sacks or bulk.

718.03 APPLICATION.

(a) Commercial Fertilizer: Fertilizer shall be uniformly broadcast over areas to be fertilized by either hand or machine methods. The rate of fertilizer application shall be as shown in Table 718-1.

Table 718-1
Fertilizer Application Rates

Type Fertilizer	Pounds Per Acre	Kilogram Per Hectare
8-8-8	1000	1120
12-12-12	667	748
13-13-13	615	689
16-16-16	500	560

Other balanced fertilizer may be used at the proportional rate. Fertilizer applied after surface dressing shall be thoroughly incorporated into the soil

by light disking, harrowing, or rototilling. Fertilizer shall be applied before final disking, harrowing, or rototilling during surface dressing. When the surface is dressed by hand, the fertilizer may be applied before final raking and leveling.

(b) Agricultural Lime: Agricultural lime shall be spread uniformly at a minimum rate of 2 tons per acre (4.5 Mg/ha**)** with a spreader. Lime shall be applied prior to seeding, topsoil placement and slab sodding and may be applied in conjunction with fertilizer. After application, the areas shall be disked, harrowed, or rototilled to incorporate lime or lime-fertilizer into the top 3 inches to 6 inches (75 mm to 150 mm) of soil.

(c) Hydro-seeding: If hydro-seeding methods are used, the contractor will be permitted to include fertilizer and lime in the seeding slurry. When specified by the manufacturer, water soluble or liquid fertilizer will be allowed for hydro-seeding product applications.

718.04 MEASUREMENT.

(a) Fertilizer: Fertilizer will be measured by the pound (kg). The estimated quantity shown in the plans is based on Type 8-8-8 fertilizer. If other types of fertilizer are used, the measured quantities will be multiplied by the factors of Table 718-2 to determine pay quantities.

Table 718-2
Fertilizer Factors

Type	Factor
12-12-12	1.5
13-13-13	1.625
16-16-16	2.0

When other balanced fertilizers are used the factor will be determined by dividing the type of fertilizer by eight.

(b) Agricultural Lime: Agricultural lime will be measured by the ton (Mg).

718.05 PAYMENT. Payment for fertilizer and agricultural lime will be made at the contract unit prices under:

Item No.	Pay Item	Pay Unit
718-01	Fertilizer	Pound (kg)
718-02	Agricultural Lime	Ton (Mg)

Section 719
Landscaping

719.01 DESCRIPTION. This work consists of furnishing and planting various plant materials in accordance with the plans and these specifications.

719.02 LANDSCAPE CONTRACTOR REQUIREMENTS. The landscape contractor shall conduct his operations in accordance with Section 107, the requirements of the Louisiana Horticulture Law and Regulations, and this section.

719.03 MATERIALS. Materials for landscaping shall comply with the following Sections and Subsections, and the following requirements.

Mortar Sand	1003.02
Fertilizer	1018.16
Agricultural Lime	1018.17
Water Management Gel	1018.29
Mycorrhizal Inoculant	1018.30

Water may be obtained from any source, except that brackish, chemically contaminated, or oily water shall not be used.

Individual plant varieties, species, and size will be indicated on the plans.

(a) Pine Bark for Bed Preparation and Backfilling: The contractor shall furnish pulverized, well rotted, ground pine bark for use in preparing backfill soil and the soil in bed areas.

(b) Backfill Soil: Backfill soil shall be prepared as follows:

5 parts topsoil
3 parts pine bark for bed preparation and backfilling
1 part sand
1 part manure
Water Management Gel
Mycorrhizal Inoculant

Water Management Gel and Mycorrhizal Inoculant shall be added at the manufacturer's recommended rate for individual trees or plants at the time of planting.

All clods, stones, roots, gravel, and other debris shall be removed from the excavated soil. Backfill soil shall be mixed with excavated soil from individual planting holes at a rate of three parts backfill soil to one part excavated soil. This mixture shall then be used to backfill individual planting holes.

Fertilizer shall be added in accordance with Section 718 except as specified herein.

(c) Water Management Gel: Water management gel shall be in accordance with Subsection 1018.29.

(d) Mycorrhizal Inoculant: Mycorrhizal inoculant shall be in accordance with Subsection 1018.30.

(e) Topsoil: Topsoil, if called for on the plans, shall be furnished and placed at the specified rate in accordance with Section 715.

(f) Top Dressing Mulch: Top dressing mulch shall be pine bark, pine straw, redwood chips, hardwood mulch or cypress bark.

When pine bark mulch is specified, mulch shall consist of 1/2 inch (15 mm) minimum size chipped pine bark. Excessively "green" and/or decomposed pine bark will be rejected.

(g) Fertilizer Tablets: Fertilizer tablets shall be in accordance with Subsection 1018.16.

719.04 QUALITY AND EXTENT OF WORK. The engineer shall notify the Department's Landscape Architect before work begins to coordinate the planting. Work shall be done in accordance with accepted landscaping practices. Plant materials approved for planting shall be container grown or balled and burlap, loaded, moved, unloaded, planted, fertilized, pruned, watered and maintained as necessary to ensure their healthy growth.

719.05 PLANT MATERIALS. Plants will be subject to approval at the project site before planting. Trees and other plant materials shall be inspected by the Department's Landscape Architect, with the landscape contractor present. In the event that plant material is rejected, it shall be removed from the site, and the contractor shall locate acceptable plant material from other nursery sources at no direct pay.

(a) State and Federal Regulations: Plant material shall be free from injurious insect pests and plant diseases and subject to regulations of Federal and State Departments of Agriculture. Shipments of plants shall comply with nursery inspection and plant quarantine regulations of the states of origin and destination. The contractor shall obtain proper certificates for movement of nursery stock intrastate and interstate, and shall comply with all

other requirements before and during movement or shipment of plants. A copy of the Certificate of Inspection shall accompany each delivery.

(b) Plant Names: Scientific and common plant names shall comply with the current edition of "Hortus." Plants shall be true to name and legibly tagged. There shall be no substitutions for the types, species, quantities or sizes of materials specified without written permission, and then only when sufficient evidence has been presented that the specified plants cannot be obtained and that the substituted plants are equal to the plants specified.

(c) Grading Standards: Grading of plants shall comply with the latest edition of "American Standards for Nursery Stock," as published by the American Nursery and Landscape Association, unless otherwise specified.

(d) Plant List: A complete list of plants will be shown on the plans including botanical name, common name, quantity, height, caliper, etc. Sizes of stock shown are the minimum acceptable sizes.

(e) Quality and Source of Plants: Plants shall be nursery grown, well formed, and at least No. 1 Grade unless written permission is obtained to use selected native stock. This permission may be granted only if native stock is better suited or superior in quality to plants obtained from a nursery.

Plants and trees shall equal or exceed the measurements specified in the Plant List. They shall be measured before pruning, with branches in normal position. Dimensions for height and spread refer to the main body of the plant and not from branch tip to branch tip. The determining measurements for trees shall be caliper and/or height as described in the Plant List. Caliper of the trunk shall be taken 6 inches (150 mm) above the ground level for sizes up to and including 4-inch (100 mm) and 4-feet 6-inches (1350 mm) (Diameter Breast Height) above the ground level for larger sizes. Trees shall have a habit of growth which is normal for the species. Plants shall be healthy, vigorous, and free from insects, diseases and injuries.

The contractor shall not trim or cut leaders or main branches of trees.

(f) Balled and Burlapped Plants: Balled and burlapped plants shall be dug with firm, natural balls of soil of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Balls shall be firmly wrapped with burlap or similar material and bound with twine, cord or wire. Balled and Burlapped plants shall be watered prior to transportation and kept moist until planted.

(g) Container Grown Plants: Container grown stock which has become potbound or in which the top system is out of proportion (larger) to the size of the container will not be acceptable. The stock shall have a fibrous, cohesive root system. Container grown plants shall not be removed from the container until just before planting, and care shall be taken to

prevent root system damage. Container grown plants shall be watered prior to transportation and shall be kept moist until planted.

(h) Handling and Storage: The contractor shall protect plants from drying out by covering the root system with mulch, wood chips or suitable materials and watering the root system and foliage as necessary. Plants shall be protected from drying winds and sun as directed.

Plants shall be lifted from the bottom only, not by stems or trunks. Plants will be rejected if the soil is cracked or loosened.

(i) Delivery and Receipt of Plant Materials: The contractor shall notify the engineer at least 48 hours before delivery of plant materials to the project. Each shipment shall be accompanied by an invoice showing sizes and varieties in the shipment.

(j) Inspection: Plant materials shall be subject to inspection and approval at any time during the life of the contract. Plants having any of the following deficiencies will be rejected: excessive abrasions of bark, dried out root system, excessive dead wood, dried up wood, excessive sun scald injuries, undeveloped and weak top or roots, crooked or one-sided development of tops, no straight leaders on trees normally having them, broken or removed leaders, untrue types or sizes, not complying with Federal and State Laws or regulations bearing on inspection and certificates, excessively damaged balls of soil, balls of soil dug from loose soil which will not properly ball, dead plants and plants otherwise not complying with these specifications.

Rejected material shall be replaced with new plant material of the same kind at no direct pay.

719.06 CONSTRUCTION METHODS.

(a) Seasonal Operations: Unless otherwise authorized in writing, the planting season is between November 1 and April 15.

Work shall be suspended when the ambient temperature falls below 32°F (0°C), wind velocity is excessive, ground is frozen or too wet, or continuation of prevailing weather would likely cause unsatisfactory results. The contractor shall complete planting as early as practical in the planting season.

When the only landscape work on the project consists of shrub planting at dead end road installations, planting may be performed at any time during the year, provided the ambient air temperature is above 32°F (0°C) and weather and ground conditions are suitable for planting. Container grown plants will be required at dead end road installations.

(b) Pruning: If necessary, plant material shall be pruned on the project in accordance with the plan details.

Pruning shall be limited to the removal of injured twigs and branches. The normal shape of the plant shall be left intact unless otherwise directed by the Department's Landscape Architect. Selective pruning may be required on trees of special type or character at no direct pay.

(c) Soil Testing: The contractor shall obtain the services of an established soil testing entity to coordinate soil sampling, perform testing and analyses, and prepare recommendations for materials and procedures to be used during the preplanting phase. When practicable, soil testing shall be performed early enough to permit agricultural lime or other additives (if required) to be applied sufficiently in advance of planting so that the soil pH adjustment will occur before planting. Samples shall be tested and analyzed to determine pH and fertility conditions. The test results and recommendations shall be used to determine the quantities of agricultural lime and fertilizer required for preplanting applications. Agricultural lime recommendations shall consider probable time of application. A copy of the test report with recommendations shall be furnished to the engineer. Testing will be at no direct pay.

(d) Location of Plants: Plants shall be located in accordance with plans or as directed by the project engineer or landscape architect.

(e) Setting Individual Plants Not in Beds: The planting hole shall be dug twice the width of the root ball of the plant. The sides of the planting hole shall be straight and the bottom flat. A mound shall then be built in the center of the plant hole with excavated material for the plant to sit on. Plants shall be set plumb and at such level that, after settlement, a normal relationship of the crown of the plant with the ground surface will be established. Each plant shall be in the center of the planting hole. When plants are set, backfill soil shall be tamped under and around the base of each root mass to fill all voids. Plants shall be planted in backfill soil complying with Subsection 719.03(b) thoroughly settled by watering and tamping to minimize settling and leaning of plant material. Plants 6 feet (2 m) tall and taller, shall be staked in accordance with applicable nursery practices at no direct pay. The contractor shall be responsible for maintaining all plant material in a vertical position for the contract period. On balled and burlapped stock, any wire or cord shall be cut or removed from the root balls and stems. The top one-third of burlap shall be removed from the root ball.

Tree planting holes shall be loosened to a depth of 2 feet (0.6 m) below the bottom of the pit or to such depth that any hardpan has been broken and moisture is allowed to move freely. The contractor shall notify the engineer in writing of any problems before installing the trees.

When plants are grouped together in a plant bed or in a line less than 5 feet (1.5 m) apart, the area shall be loosened and lumps broken to a minimum depth of 6 inches (150 mm) prior to excavating planting holes.

After planting has been completed, a bowl shall be formed using excavated material around each plant as shown in the planting details. Bowls shall extend to the limits of the planting holes for trees and shrubs. No bowls are required in areas of bed preparation. Shrubs in lines or groups may share a common bowl around their perimeter.

(f) Fertilizer: The contractor shall furnish and place either granular or tablet commercial fertilizer at the specified rate in accordance with this section and Subsection 718.03(a). Fertilizer shall be mixed with backfill soil before backfilling. The recommended amount of fertilizer tablets shall be equally placed in the upper 2 inches (50 mm) of backfill soil 2 inches (50 mm) from the root ball or in accordance with the manufacturer's recommendations.

Fertilizer tablets shall be used in individual plant holes, separate from bed areas. After the tree or shrub has been placed, the manufacturer's prescribed amount and spacing of tablets for the specified plant size shall be applied.

(g) Agricultural Lime: The contractor shall furnish and place agricultural lime in accordance with Section 718 to adjust the soil pH.

(h) Backfilling: Care shall be taken in placing backfill under the sides and over the root mass. Backfill shall be placed to 3/4 the depth of the ball on the sides and watered uniformly on the sides of the root mass to allow settlement of the plant. Plants which settle or lean before or after watering, shall be straightened, raised or replanted.

Excavated material not used as backfill or for bowls shall be spread on areas of the project as directed or disposed of in accordance with Subsection 202.02.

(i) Water: The contractor shall furnish and apply water in sufficient quantities for proper irrigation of the plants at no direct pay.

(j) Bed Preparation: The contractor shall remove grass, weeds, sticks, roots, stones and other debris from the planting bed. The contractor shall treat the planting bed with an approved pre-emergence herbicide in accordance with the manufacturer's recommendations. The contractor shall rototill the planting bed to a minimum depth of 10 inches (250 mm) and add the materials of Table 719-1. Water management gel and mycorrhizal inoculant shall be mixed into the top 4 inches (100 mm) of soil at the rate recommended by the manufacturer prior to planting or seeding. It shall be broadcast by shaker, spreader, or hand, then raked or rototilled into the soil to produce a uniformly mixed layer.

Table 719-1
Bed Preparation Material

Material	Per 1000 Sq Ft	Per 100 Sq m
Mortar Sand	3 Cubic Yards	2.5 Cu m
Peat Moss	3 Cubic Yards	2.5 Cu m
Manure	3 Cubic Yards	2.5 Cu m
Pine Bark	7 Cubic Yards	6.0 Cu m
Fertilizer 8-8-8 (Or Other Balanced Equivalent At Proportional Rates)	25 Pounds	12 kg
Mycorrhizal Inoculant	per manufacturer	per manufacturer
Water Management Gel	per manufacturer	per manufacturer

The contractor shall create a trench for drainage purposes around the entire bed. All beds shall be built as "raised" beds. Beds shall be raked smooth and dirt lumps, stones, sticks, grass and other foreign matter shall be removed. Finish grades of bed trenches next to walks or buildings shall be 1 to 2 inches (25 to 50 mm) below finish grade of adjoining surfaces unless otherwise shown on the plans or as directed.

(k) Mulching: Mulch shall be placed uniformly to a minimum depth of 3 inches (75 mm) within the planting bowls and bed areas and watered. When plants are planted in rows or groups not more than 5 feet (1.5 m) apart, the entire area between the bowls shall be mulched. Avoid placing mulch directly around the trunks of trees and the stems of shrubs.

(l) Weeding: Weeds shall be removed from bed areas, the planting basin of each plant and groups of plants, including bowl walls. The contractor shall mow, for a radial distance of 5 feet (1.5 m), around plant materials not planted in beds. Use of selective herbicides will be permitted when approved by the District Roadside Development Coordinator. Contact-type herbicides shall be compatible with plants and the grass in the 10-foot (3 m) circle shall be cut to a satisfactory height. Weeding shall be performed as directed to maintain a neat appearance throughout the period of establishment and replacement.

719.07 PERIOD OF ESTABLISHMENT AND REPLACEMENT. Upon completion of planting and providing all plants are in place, living and conforming to these specifications, this portion of the contract will be given provisional acceptance.

(a) Period of Establishment: The contractor shall care for planted and mulched areas for a period of establishment, which shall be one full growing season, after provisional acceptance is made. A growing season shall begin April 16 and extend one full year until April 16 of the next year. The contractor can complete planting any time during the planting season specified in Subsection 719.06(a). If the contractor completes planting prior to April 16, the growing season shall begin at provisional acceptance and extend to April 16 of the following year. Any extension of the planting season past April 15 shall result in an extension of the period of establishment to October 31 of the following year. During this period of establishment, the contractor shall preserve plants in a healthy, growing condition. Such plant establishment work shall include cultivation, weeding, watering, pruning, controlling insects, pests and disease and other work determined necessary by the engineer to ensure healthy plant growth.

The contractor shall contact the engineer every week and outline activities which will be performed on the project. Failure to contact the engineer weekly and perform activities will result in a 1 percent reduction of the landscape contract amount, for each week of noncompliance before final payment. The contractor shall weed in the vicinity of plants, place mulch, and water the plants as required. During the period of establishment, the contractor shall maintain a neat and clean appearance of planting areas.

(b) Replacement: Plants that show signs of failure to grow at any time, or which are so injured or damaged as to render them unsuitable for the purpose intended, as determined by the engineer, shall be removed and replaced. Unless otherwise directed by the engineer, the contractor shall complete replacement of unsuitable plants within 15 calendar days after the engineer marks or otherwise indicates that the plants shall be replaced. Failure to comply in the time allotted will result in having the costs of these replacement plants deducted from the contract amount upon final payment, while the contractor shall remain liable for the original contract specifications.

Replacement planting shall comply with the spacing and size requirements specified for the plants being replaced. Replacement ground cover plants shall be the same species as specified for the ground cover being replaced. Other replacement plants shall be the same species as the plants being replaced unless the engineer, after consultation with the Department's Landscape Architect, approves the substitution of alternative species of plants in accordance with the provisions in this subsection.

Replacement plants shall be furnished and planted by the contractor at the contractor's expense.

(c) Semifinal Inspection: A semifinal inspection by the contractor and the engineer will be held 2 weeks prior to the end of the period of establishment to determine the acceptability of plants. Replacement planting, as required, shall be performed in accordance with Subsections 719.06(a) and 719.07(b).

Unsatisfactory plants shall be replaced in kind, quantity and size with live, healthy plants installed as originally specified. Substitute varieties of plants shall be used only when approved. These replacement plantings shall be made at no direct pay. Only these replacements made at this time will not require a period of establishment. However, all plants that must be replaced at the semifinal inspection will be replaced at the contractor's expense.

Upon completion of said replacements and prior to final acceptance of the project, the contractor shall weed around plants and remove discarded materials, rubbish and equipment from areas of the right-of-way affected by operations.

(d) Final Acceptance: Final inspection of plant material will be held approximately 2 weeks after replacement planting has been completed. Final acceptance will be made if all plants are in place, alive and are in conformance with plans and specifications.

Plants that are unsatisfactory at the time of final inspection of the project shall be replaced by the contractor in kind, quantity and size with live, healthy plants installed as originally specified. Substitute varieties of plants shall be used only when approved. These replacement plantings shall be made at no direct pay.

719.08 MEASUREMENT. Furnishing and planting the various types and sizes of plant materials will be measured per each. No measurement for payment will be made for plant hole preparation, backfill material, fertilizer tablets, water, plant maintenance or plant replacement of individual trees and shrubs either inside or outside of bed areas.

Bed preparation and top dressing mulch will be measured by the square yard (sq m).

When an item for "Landscaping" is included in the contract, the furnishing and planting of all required plant materials under the contract will be measured on a lump sum basis.

719.09 PAYMENT. Payment for furnishing and planting the various types and sizes of plant materials will be made at the contract unit price per each.

Payment for bed preparation and top dressing mulch will be made at the contract unit prices. Payment for mulch required for individual tree and

shrub planting will be included in the contract unit price for the plant and not as top dressing mulch. When an item for "Landscaping" is included in the contract, payment will be made at the contract lump sum price.

Partial payment during the period of establishment will be limited to 75 percent of the contract price upon provisional acceptance. Midway through the period of establishment, if the project engineer's records show that plants have been properly maintained and replacement plantings have been completed, 15 percent of the contract price for landscaping items will be paid, minus any reduction in accordance with Subsection 719.07(b). At the end of the full period of establishment, if the project engineer's records show that plants have been properly maintained and replacement plantings have been completed, the remaining 10 percent of the contract price for landscaping items will be paid, minus any reduction in accordance with Subsections 719.07(a) and (b). Payment for adjustment of pH will be made in accordance with Subsection 109.04.

Payment will be made under:

Item No.	Pay Item	Pay Unit
719-01	Plants (Type, Size)	Each
719-02	Top Dressing Mulch (__inch (__mm) Depth)	Square Yard (Sq m)
719-03	Bed Preparation (__inch (__mm) Depth)	Square Yard (Sq m)
719-04	Landscaping	Lump Sum

Section 720
Erosion Control Systems

720.01 DESCRIPTION. This work consists of furnishing and placing erosion control systems in accordance with plan requirements for use as soil retention blankets on slopes or as flexible channel liners in ditches.

720.02 MATERIALS.

(a) General: Erosion control systems shall comply with Subsection 1018.23. The manufacturer's installation plan and hardware (staples, stakes, etc.) are considered part of the system and shall be the same as that used during the evaluation for source approval.

The type of erosion control system to be used shall be shown on the plans. The contractor shall have the option of substituting a higher grade system for a lower grade system within the same application (slope protection or flexible channel liners) at no additional cost to the Department.

(b) Acceptance: Pretested lots of erosion control systems shall be accepted based on a Certificate of Delivery showing DOTD Lot Numbers and laboratory numbers representing the pretested material, including hardware. Erosion control systems that are not accompanied by a Certificate of Delivery shall be sampled in accordance with DOTD S 613 at the rate of 1/200 rolls for rolled type materials (or mats) or 1/200 bags for mulch systems per manufacture's lot. The sample size shall consist of not less than 3 square yards (sq m) of rolled (or mat) material or one 50 lb (20 kg) bag of mulch. Installation hardware, additives such as tackifiers, and any other component of the system not covered above shall be sampled at the rate of one item/type/size or one quart (L) per manufacturer's lot in accordance with DOTD S601. All samples shall be submitted to the Materials and Testing Section. A copy of the approved installation plan shall accompany each shipment to the project.

(c) Packaging: Materials shall be packaged in such a way as to maintain the quality of the product throughout handling. Each package shall be identified with the manufacturer's name, product name, and manufacturer's lot number. Each package that is represented by a Certificate of Delivery shall also be identified by the DOTD Lot Number corresponding to that shown on the Certificate of Delivery.

720.03 EQUIPMENT. Equipment necessary to satisfactorily perform the

work shall be furnished and maintained by the contractor. Equipment for hydraulically applying fiber mulch shall be equipped to eject the thoroughly wet mulch material at a uniform rate equal to the manufacturer's recommendations or as designated by the plans to provide the mulch coverage specified.

720.04 CONSTRUCTION REQUIREMENTS. Erosion control systems shall be installed in accordance with the approved installation plan, no later than 48 hours after completion of seeding or sodding operations. All staples shall be installed flush to the ground and shall penetrate all layers of overlapped or adjacent rows.

(a) Slope Protection: Slopes shall be constructed to the required grade, fertilized, and seeded prior to application of erosion control systems. At the time of coverage, the area to be covered shall be free of ruts, clods, stones, roots or other foreign matter that will prevent close contact of the blanket with the soil. Rolled products or mats with netting only on one side are to be placed with the netting exposed and the fibers in contact with the soil.

(b) Flexible Channel Liners: Channels shall be prepared in accordance with Heading (a). Flexible channel liners shall be placed beginning at the downstream end.

720.05 MAINTENANCE. The contractor shall maintain the areas on which erosion control systems have been placed until final acceptance of the project. This shall consist of the repair of damage by erosion, wind, fire or other cause. Such areas are to be repaired to reestablish the condition that existed prior to placing the erosion control systems and may include fertilizing, seeding, mulching or sodding as required at no direct pay.

720.06 MEASUREMENT. Erosion control systems, including hardware, will be measured by the square yard (sq m) of surface area covered.

720.07 PAYMENT. Payment for erosion control systems will be made at the contract unit price and includes all materials, labor, equipment and other incidentals necessary to complete the work. Required burial of ends and edges, overlaps and hardware will not be measured for payment.

Payment will be made under:

Item No.	Pay Item	Pay Unit
720-01	Erosion Control System (Type)	Square Yard (Sq m)

Section 721
Mowing, Trimming and Debris Collection

721.01 DESCRIPTION: This work consists of mowing grass and weeds, trimming overhanging branches, vegetation and trees, and collecting and removing trimmings and debris within the highway right-of-way or as directed.

721.02 EQUIPMENT: Rotary mowers will normally be utilized in the mowing of the right-of-way however, sickle bar mowers, side mounts, flail or boom mowers may be used to mow around bridges, culverts, sign posts, mailboxes, delineators, guard rails, wet areas and ditches, etc., as approved by the engineer. Other types of grass-cutting equipment may be used provided they have been approved by the engineer prior to use. All rotary mowers must be equipped with safety chains to prevent damage to property by flying debris from under the mower. Maximum cutting widths for rigid frame rotary mowers shall be 9 feet (2.7 m). Hand trimming will be required in some areas.

Mowers shall be shielded to prevent flying debris from the cutter blades in accordance with OSHA 29 CFR Part 1928.57. All vehicles and equipment used in performance of the work shall be equipped with amber flashing lights. Tractors shall be equipped with two fender mounted amber flashing lights, two red flags mounted on each side of the rollover protective structure (ROPS) cage, one plainly visible, rear mounted slow moving vehicle emblem, and working headlights.

All mowers shall be kept in good operating condition and shall be maintained to provide a clean sharp cut at all times. All equipment shall be inspected by the engineer for safety devices and suitability for the work prior to being placed in operation. All safety devices shall be properly maintained and functioning at all times.

721.03 GENERAL CONSTRUCTION REQUIREMENTS:

(a) Debris Collection: The contractor shall pick up and properly dispose of all trash and debris ahead of the mowing operation. The areas to be cleaned include all grassed areas, ditches, paved roadside shoulders, fences and under overhead bridges within the project limits. All trash which is uncovered by the mowing operations shall be picked up within 48 hours. Trash and debris picked up and piled or bagged on the roadside shall be

removed from the right-of-way by the end of the same work day. Bagged trash and debris shall not be piled on travel lanes or paved shoulders.

(b) Mowing Operations: The contractor shall have sufficient number and types of equipment best suited to perform the work. Mowers shall be adjusted for a cutting height of approximately 5 inches (125 mm). A follow vehicle equipped with warning lights will be required along with personnel and equipment to do the trimming. Trimming shall be done directly behind the mower.

(c) Mowable Areas: Mowable areas are defined as all of the grassed or vegetative areas of the right-of-way, extending from right-of-way line to right-of-way line or tree line to tree line or fence line to fence line as applicable including but not limited to banks of natural waterways, swale ditches, V-ditches, ditch bottoms and slopes. Areas under bridges and around guard rails, sign posts, delineators, culvert ends, trees, shrubs, plants, culvert head walls, bridge abutments, bridge or overpass columns and piling, and fences where the contractor is required to mow on both sides due to the presence of service roads, swale ditches, V-ditches and slopes or other facilities, etc. are mowable areas. These areas may not be accessible to standard mowing equipment and may require hand trimming or specialized mowing equipment such as boom or side mount mowers.

Mowable vegetation is defined as any trees, vegetation, brush, etc., which is 2 inches (50 mm) in diameter or less measured 5 inches (125 mm) above the ground.

(1) Divided and Undivided Highway and Frontage Roads: All mowable areas within the right-of-way shall be mowed. Any overhanging vegetation or trees, regardless of size, which may hinder or prohibit mowing to the tree line or right-of-way line shall be removed or cut back to the tree line or right-of-way line by the contractor at no direct pay. Trimmings must be removed from the right-of-way or chipped. Chips shall be dispersed in such manner as to not interfere with drainage.

(2) Right-of-Way Line: A strip approximately 7 feet (2.1 m) wide along the fence line or right-of way line is included as mowable area, if applicable and terrain permits. Any overhanging vegetation or fallen trees, regardless of size which may hinder or prohibit mowing of this strip shall be removed by the contractor at no direct pay.

(3) Natural Waterways or Canals Crossing the Right-of-Way: All vegetation (weeds, grasses, vines, and trees) on the waterway banks (slopes), canal bottoms, in the median, beneath the interstate bridges, and in the right of way to the tree line or right-of-way fence line shall be cut to within 5 inches (125 mm) of the ground by any means the contractor chooses

except that all non-mowable vegetation will be removed to ground level. Mowing of this area may require specialized equipment such as weed trimmers, boom or slope mowers. There will be no direct pay for this work as the area involved is included in the mowable acreage listed elsewhere.

(4) Catch Basins: The contractor shall perform the mowing operation in such manner to prevent the buildup of grass clippings on catch basins. If the mowing operation deposits grass clippings on catch basins, the contractor will be required to remove such from the entrance to the catch basin by hand or other methods acceptable to the engineer.

The contractor shall mow as close as practicable to all fixed objects exercising extreme care not to damage trees, plants, shrubs, delineators or other appurtenances which are part of the facility.

(d) Hand Trimming: Hand trimming will be required around fixed objects such as sign posts, delineators, culvert ends, trees, shrubs, plants, guard rails, culvert head walls, bridge abutments, bridge or overpass columns and piling, and fences where the contractor is required to mow on both sides due to the presence of service roads or other facilities, etc. as directed by the engineer. Trimming shall follow the mowing operation by no more than 24 hours.

(e) Use of Herbicides: The contractor may use herbicides around signs, guard rails, culvert ends, bridges revetments, ditches, laterals, fences, etc., to reduce the volume of hand trimming. General spraying of herbicides to control vegetation and spraying around shrubs, bushes and trees will not be allowed except as otherwise provided in these specifications. Vegetation treated with herbicides will be removed by hand or mechanical means to ground level after the manufacturer's suggested time period for the herbicide to affect the plant growth. Prior to the use of any herbicides, the contractor shall obtain the approval of the District's Roadside Development Coordinator for use, type and rate of application of any herbicide. The contractor must present evidence that his personnel applying herbicides have met all the requirements of the Department of Agriculture for training and certifications and shall keep on file for inspection all documentation and records required by law.

(f) Inaccessible Areas: Mowing will not be permitted when, in the opinion of the engineer, soil and weather conditions are such that the right-of-way will be damaged. However, the contractor will be required to provide specialized equipment such as boom or slope mowers to mow areas not accessible to standard mowing equipment. The contractor must use caution to assure that mud is not tracked onto the road surface.

The contractor shall skip the following areas when mowing:

1. Swamp areas or areas having ponded water.

2. Areas with large rocks or other obstructions that might damage the mowers.

3. Shoulder edge when shoulder material has been left in a windrow.

(g) Safety Requirements: The contractor shall conduct his operation in a manner such that the safety and convenience of the public shall be regarded as a prime importance. All equipment and traffic control devices shall be in accordance with the MUTCD and these specifications.

721.04 MEASUREMENT: Mowing will be measured by the acre (ha) and will include all labor, equipment, materials and incidentals required to complete the work. Trimming and debris collection will not be measured for payment.

721.05 PAYMENT: Payment for mowing will be made at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
721-01	Mowing	Acre (ha)

Section 722
Field Laboratories

722.01 DESCRIPTION. This work consists of furnishing laboratory buildings at the project sites for soils and aggregates testing.

These laboratories are to be provided exclusively for the use of Department personnel involved in the Department's Quality Assurance Program.

722.02 GENERAL REQUIREMENTS. Field laboratories shall be weather tight and constructed of wood, metal, masonry or other approved material for the purpose of housing the personnel, testing equipment, records and reports as necessary for the Quality Assurance Program.

Each laboratory shall have a minimum floor space of 160 square feet (15 sq m), or other approved size, that provides sufficient space with a minimum ceiling height of 7 feet (2.1 m). The laboratory shall have at least one outside door and have sufficient windows. The laboratory buildings shall have electric lighting and power outlets as directed. Fume hoods with electric exhaust fans of such size and location to ensure continuous removal of hazardous fumes and air borne particles during testing operations shall be provided. The building and contents shall be secured by suitable lock and catches. The engineer shall be afforded access to the laboratory at all times and shall be provided with a set of keys as necessary.

Laboratory buildings shall be constructed, furnished, maintained and located as approved. The contractor shall provide suitable desks, chairs and file cabinets for personnel using these facilities. Sturdy work benches shall be constructed along at least one wall, or as directed, to provide sufficient work area for the types of tests being conducted. Laboratory buildings shall be heated and air conditioned, and have approved sanitary facilities. A telephone shall be provided for Departmental use.

The laboratories may be used for successive phases of a project without additional compensation.

722.03 PROJECT SITE LABORATORY. Field laboratory buildings at the project site shall be movable types which can be placed near construction areas. The building shall be moved to various locations on the project as directed.

722.04 EQUIPPED PROJECT SITE LABORATORY. The contractor

shall furnish, install and maintain the following equipment in satisfactory condition, as needed, for soils and aggregates testing throughout the life of the project:

(1) An automatic soil compaction hammer capable of compacting both standard and modified proctors, with arrangement for both 12 inch and 18 inch (300 mm and 450 mm) drops and 4 inch and 6 inch (100 mm and 150 mm) molds and adjustable hammer weights from 5.5 to 10 pounds (2.5 kg to 4.5 kg). The specifications for the hammer shall be in accordance with TR 415, Field Moisture-Density Relationships., and TR 418, Moisture-Density Relationships as specified for each mold diameter. The equipment shall include two (2) molds of each size.

(2) A compaction block or pedestal composed of portland cement concrete shall be furnished for use with the automatic compaction hammer. The block shall weigh a minimum of 200 pounds (90 kg). The hammer shall be secured to the block.

(3) An electronic scale capable of measuring in both English and metric units having a capacity of 30 pounds (13.6 kg) or more with a sensitivity of 0.1 pounds (5 grams).

(4) An electronic scale capable of measuring in metric units having a capacity of 2 kilograms or more with a sensitivity of 0.1 grams.

(5) Two (2) electric or gas hot plates and drying pans. An open flame hot plate shall be equipped with suitable shield to disperse heat evenly and to prevent direct contact of the flame with the drying pan. The hot plates shall be of sufficient size to accommodate the drying pans.

The automatic soil compaction hammer and scales noted above shall be calibrated by an independent laboratory on an annual basis and shall be verified by the engineer.

722.05 MEASUREMENT.

Project site laboratories furnished, equipped, satisfactorily maintained, moved as directed, and subsequently removed from the project will be measured per each building.

722.06 PAYMENT. Payment for project site laboratories will be made at the contract unit price per each under:

Item No.	Pay Item	Pay Unit
722-01	Project Site Laboratory	Each
722-02	Project Site Laboratory, (Equipped)	Each

Section 723
Granular Material

723.01 DESCRIPTION. This work consists of furnishing and placing granular material in accordance with these specifications and in conformity with the lines, grades and typical sections shown on the plans or as directed.

723.02 MATERIALS. Granular material shall comply with Subsection 1003.07.

723.03 CONSTRUCTION REQUIREMENTS. Materials shall be placed, properly shaped and uniformly compacted by approved methods to a minimum of 95 percent of maximum dry density. Maximum dry density will be determined in accordance with DOTD TR 415 or TR 418 and in-place density will be determined in accordance with DOTD TR 401. Granular materials shall not be displaced during subsequent operations.

723.04 DIMENSIONAL TOLERANCES. When net section measurement is specified, the thickness and width of completed granular material courses will be checked for determining acceptance in accordance with DOTD TR 602. Areas with thickness and width deficiencies in excess of the following tolerances shall be corrected to plan dimensions by furnishing, placing, shaping and compacting additional materials as required at no direct pay.

(a) Thickness: Underthickness shall not exceed 3/4 inch (20 mm). Overthickness will be at no additional cost to the Department.

(b) Width: Underwidth shall not exceed 6 inches (150 mm). Overwidth will be at no additional cost to the Department.

723.05 MEASUREMENT.

(a) Net Section: The quantities of granular material for payment will be the design volumes as specified in the plans and adjustments thereto. Design quantities are based on the horizontal dimensions and the compacted thickness of the granular material shown on the plans. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary.

(b) Vehicular Measurement: Granular material will be measured by the cubic yard (cu m) in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

723.06 PAYMENT. Payment for granular material will be made at the contract unit price per cubic yard (cu m) under:

Item No.	Pay Item	Pay Unit
723-01	Granular Material (Net Section)	Cubic Yard (Cu m)
723-02	Granular Material (Vehicular Measurement)	Cubic Yard (Cu m)

Section 724 (Reserved)

Section 725
Temporary Detour Roads and Bridges

725.01 DESCRIPTION. This work consists of furnishing, constructing, maintaining and subsequently removing temporary detour roads and bridges.

Plan details and specified materials for temporary detour roads and bridges indicate minimum requirements. Other approved designs and materials may be used at the option of the contractor.

725.02 MATERIALS.

(a) Detour Roads: Materials for detour roads, except low profile runarounds, shall comply with applicable sections of these specifications.

Temporary culvert pipe shall be one of the types listed in Section 701. Temporary fencing shall be of a type acceptable to the engineer.

Temporary pavement markings shall comply with Subsection 1015.08.

(b) Detour Bridges: Timber shall be treated, either new or used. Defects which, in the opinion of the engineer, materially affect the strength of the timber, will not be permitted. Timber shall comply with the species, grade and stress rating requirements of Subsection 1014.01.

Unless otherwise specified, piles for substructures shall be treated timber, either new or used. Piles shall be reasonably straight, shall satisfactorily withstand driving and shall be satisfactory to the engineer.

When required by the plans, steel piles for substructures shall be of the size and type specified. Painting will not be required.

Substructures shall be precast concrete spans as called for in the plans, except that the contractor will be permitted to submit drawings and calculations, stamped by a licensed engineer, for an alternate superstructure and substructure. Concrete superstructure spans may be new or used and shall be satisfactory to the engineer.

725.03 CONSTRUCTION REQUIREMENTS.

(a) General: The contractor shall perform all necessary additional clearing and grubbing, and provide all necessary temporary fencing and culverts for detours. Construction signs, warning devices and pavement markings shall be in accordance with Section 713 and shall be placed for detours prior to being opened to traffic. The contractor shall maintain detours in a satisfactory condition.

(b) Detour Roads: The contractor shall furnish all embankment

material for detours and shall compact embankments by approved methods to the satisfaction of the engineer. When embankment is placed against slopes of existing embankments, the contractor shall remove from such slopes all grass, weeds, trash, brush and other objectionable material and shall plow slopes to form steps as directed.

Base and surfacing construction shall be performed in accordance with applicable sections of these specifications.

Temporary pavement markings complying with Section 713 shall be placed on detours surfaced with asphaltic concrete or portland cement concrete. These markings shall be in place at the time the detour is opened to traffic. Existing markings in tie-in areas shall be removed. Temporary pavement markings to effect tie-ins to existing striping shall be included in the cost of these markings.

(c) Low Profile Runaround: Low profile runaround type detour roads shall be surfaced with approved aggregate. Aggregate surfacing shall be placed to a minimum depth of 4 inches (100 mm) and a minimum width of 20 feet (6 m). Alignment and grade of runaround type detour roads shall be acceptable to the engineer. The contractor shall be responsible for drainage for low profile detours.

(d) Detour Bridging: Temporary bridge lengths shown on the plans are approximate, and the lengths to be constructed will be determined by the engineer. The contractor shall construct temporary bridges to allow passage of maximum legal loads. Temporary bridge construction shall be performed in accordance with applicable sections of these specifications. Guard rail shall be placed as shown on the plans or as directed.

725.04 REMOVAL OF DETOURS. Upon completion of permanent construction and diversion of traffic thereto, the contractor shall remove detour roads and bridging, temporary fencing, and culverts, eliminate construction scars and seed and fertilize to restore the area to its original condition. When not covered under other items, permanent fencing shall be replaced in kind as directed. Temporary markings on existing surfaces shall be removed in accordance with Section 713.

Temporary bridging shall be removed in accordance with Subsection 202.03. Removed temporary bridge materials, fencing and culverts shall remain the property of the contractor and shall be disposed of outside the right-of-way. Detour embankment, base and surfacing materials shall also be disposed of in accordance with Subsection 202.02 unless reuse of these materials on the project is permitted.

725.05 MEASUREMENT.

(a) Detour Roads: Temporary detour roads will be measured by the square yard (sq m) of completed detour road surfacing.

(b) Low Profile Runaround: Low profile runarounds will be measured per each runaround.

(c) Detour Bridging: Temporary detour bridging will be measured by the linear foot (lin m) along the centerline of completed bridging in accordance with the following:

(1) When constructed in accordance with the design shown on the plans, measurement will be made from beginning to end of bridging as shown on the plans.

(2) When constructed in accordance with an approved design other than as shown on the plans, measurement will not exceed the length required for the design shown on the plans.

(d) Incidentals: Additional clearing and grubbing, temporary fencing and culverts, will not be measured for payment.

When the contract includes items for "Temporary Pavement Markings", these markings will be paid for under the "Temporary Pavement Marking" items. When the contract does not include items for "Temporary Pavement Markings", these markings will be included in the items for "Temporary Detour Roads."

725.06 PAYMENT. Payment for temporary detour roads and bridging furnished, constructed, maintained and subsequently removed will be made at the contract unit prices under:

Item No.	Pay Item	Pay Unit
725-01	Temporary Detour Roads	Square Yard (Sq m)
725-02	Temporary Detour Bridging	Linear Foot (Lin m)
725-03	Low Profile Runaround	Each

Section 726
Bedding Material

726.01 DESCRIPTION. This work consists of furnishing and placing aggregate bedding material on geotextile fabric for drainage structures.

726.02 MATERIALS. Materials shall comply with the following Subsections:

Plastic Soil Blanket	203.10
Bedding Material	1003.01 & 1003.08
Geotextile Fabric	1019.01

Bedding materials shall be properly proportioned and mixed prior to being placed in the foundation.

726.03 PLACEMENT OF BEDDING. Geotextile fabric shall be placed in accordance with plan details prior to placing bedding material. Care shall be taken to prevent damage to geotextile fabric during placement of bedding material. Materials shall be placed, shaped and uniformly compacted to the satisfaction of the engineer.

Adjacent rolls of fabric will be overlapped or sewn. When rolls are overlapped, the overlap shall be a minimum of 18 inches (450 mm) , including the ends of the rolls. The top layer of the fabric shall be parallel with adjacent rolls and in the direction of bedding materials placement. When rolls are sewn, the contractor shall join adjacent rolls by sewing with polyester, or kevlar thread. Field sewing shall employ the "J" seam or "Butterfly" seam with the two pieces of geotextile fabric mated together, turned in order to sew through 4 layers of fabric and sewn with 2 rows of Type 401, two-threaded locking chain stitch. Factory seams other than specified may be submitted to the Materials and Testing Section for approval. When the ground is covered with water or supersaturated soil, sewing of the fabric will be required.

Damaged fabric shall be either removed and replaced with new fabric or covered with a second layer of fabric extending 2 feet (0.6 m) in each direction from the damaged area.

Excavation below the established grade of the structure for placement of bedding material shall be used or disposed of in accordance with Section 203.

A plastic soil blanket in accordance with Subsection 203.10 shall be placed

at structure ends when bedding material is exposed.

726.04 MEASUREMENT. Bedding material, including plastic soil material, completed and accepted, will be measured by the cubic yard (cu m) (net section). The length and width will be measured horizontally to the theoretical points established by the plans for bedding material. The depth will be as shown on the plans or established by the engineer.

Geotextile fabric will not be measured for payment.

Necessary excavation and disposal of excess excavated materials will not be measured for payment.

726.05 PAYMENT. Payment for bedding material will be made at the contract unit price under:

Item No.	Pay Item	Pay Unit
726-01	Bedding Material	Cubic Yard (Cu m)

Section 727
Mobilization

727.01 DESCRIPTION. This work consists of preparatory work and operations, including those necessary for movement of personnel, equipment, supplies and incidentals to the project site; the establishment of offices, buildings and other facilities necessary for work on the project; the cost of bonds and any required insurance; and other preconstruction expenses necessary for start of the work, excluding the cost of construction materials.

727.02 PAYMENT.

(a) When the contract does not include a pay item for mobilization, no direct payment will be made for mobilization.

(b) When the contract contains a pay item for mobilization, payment will be made at the contract lump sum price, subject to the following provisions:

Partial payments for mobilization will be made in accordance with the schedule of Table 727-1 up to a maximum of 10 percent of the original total contract amount, including this item. Payment of any remaining amount will be made upon completion of all work under the contract.

Table 727-1
Mobilization Payment Schedule

Percent of Total Contract Amount Earned	Allowable Percent of the Lump Sum Price for Mobilization
1st Partial Estimate	25
10	50
25	75
50	100

No payment adjustments will be made for this item due to changes in the work in accordance with Section 109.

Payment will be made under:

Item No.	Pay Item	Pay Unit
727-01	Mobilization	Lump Sum

Section 728
Jacked or Bored Pipe

728.01 DESCRIPTION. This work consists of furnishing and installing pipe in embankments at the locations shown on the plans by jacking or boring in accordance with these specifications.

728.02 MATERIALS. Pipe and joint materials shall comply with Subsection 701.02. Corrugated metal pipe to be jacked or bored shall have corrugated bands a minimum of 24 inches (600 mm) wide with four lines of approved gasket material. These bands shall be secured by a minimum of four galvanized steel rods and lugs in accordance with the plans.

728.03 CONSTRUCTION REQUIREMENTS. In general, pipes 30 inches (750 mm) diameter and greater shall be jacked, and pipes less than 30 inches (750 mm) diameter shall be bored.

The work shall begin at the outfall end of pipe when possible. When the grade at the jacking or boring end is below ground surface, suitable pits or trenches shall be excavated for conducting operations and placing joints of pipe. Adequate sheeting and bracing shall be provided to prevent earth caving.

For pipe with bell joints, if the outside diameter of pipe bell exceeds the outside diameter of pipe barrel by more than 1 inch (25 mm), pipe shall be either cased or pressure grouted its full length. The casing shall be an approved type and size, and shall be furnished and installed by the contractor in accordance with these specifications. Pressure grouting shall be performed with approved materials placed by approved methods.

The method used shall be such as not to weaken or damage the embankment. The contractor shall furnish the engineer for approval a plan showing the proposed procedure, including backstop or jacking frame arrangement, pipe guides, position of jacks and jacking head. Approval of this plan shall not relieve the contractor from responsibility to obtain the desired result.

(a) Jacking: Heavy duty jacks suitable for forcing pipe through the embankment shall be provided. Even pressure shall be applied to all jacks and shall be transmitted to the pipe end through a jacking head. The jacking head shall be designed so that pressure is uniformly applied around the ring of the pipe. Backstop or jacking frame shall be adequate to resist pressure of the

jacks under load. Pipe shall be set on guides properly fastened together to support the pipe in the proper direction at correct grade. Suitable cushioning material, such as plywood, shall be provided between sections of concrete pipe.

Material shall be excavated ahead of the pipe and shall be removed through the pipe. Excavation shall not extend more than 24 inches (600 mm) beyond the forward end of pipe. When the character of embankment material dictates, the distance shall be reduced to prevent the embankment from being damaged. Excavated material shall be disposed of in accordance with Subsection 202.02.

Excavation on the underside of pipe, for at least 1/3 the circumference of pipe, shall conform to the contour and grade of the pipe. A clearance of not more than 2 inches (50 mm) may be provided for the upper half of pipe, tapered to zero at the point where excavation conforms to contour of pipe.

A steel cutting edge may be used around the forward end of pipe, constructed so that it will transmit pressures uniformly around the ring of the pipe.

Jacking shall continue without interruption, to prevent pipe from becoming firmly set in the embankment.

Pipe shall not vary horizontally or vertically by more than 1/4 inch in 10 feet (0.6 mm in 3 m) from established line and grade. Any variation shall be regular, and no abrupt changes in direction will be permitted. Any pipe damaged or misaligned in jacking operations shall be removed and replaced by the contractor at no direct pay.

(b) Boring: Boring shall be done mechanically, using a pilot hole approximately 2 inches (50 mm) in diameter. The pilot hole shall extend through the embankment and shall be checked for line and grade before boring begins. Variations from line and grade shall not exceed those specified for jacking. The pilot hole shall serve as centerline of the larger diameter hole to be bored.

The use of water and other fluids with boring operations will be permitted only to lubricate cuttings. Jetting will not be permitted.

In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent high-grade, bentonite may be used to consolidate cuttings of the bit, seal walls of the hole, and furnish lubrication for subsequent removal of cuttings and installation of pipe.

Overcutting in excess of 1 inch (25 mm) shall be remedied by pressure grouting the entire length of the installation.

Pipe shall be joined as specified in Section 701.

728.04 MEASUREMENT. Quantities of jacked or bored pipe for payment will be the design lengths as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. Required excavation, sheeting, bracing, falsework, casing, joint materials and grouting will not be measured for payment.

728.05 PAYMENT. Payment for jacked or bored pipe will be made at the contract unit price per linear foot (lin m) under:

Item No.	Pay Item	Pay Unit
728-01	Jacked or Bored Pipe (Size, Type, Class or Thickness)	Linear Foot (Lin m)

Section 729
Traffic Signs and Devices

729.01 DESCRIPTION. This work consists of furnishing and installing traffic signs, dead end road installations, markers and delineators, with accessories, posts and overhead spans of specified materials, sizes, shapes, weights and designs.

In general, the work and materials shall comply with the MUTCD as modified by these specifications or as shown on the plans.

Signs shall be fabricated in an approved plant.

The term "legend" shall mean border strip, letters, numerals and symbols which convey the message on signs.

729.02 MATERIALS. Materials shall be new stock conforming to the following:

(a) Sign and Marker Sheeting: Sheeting material for sign panels, delineators, barricades and other markers shall comply with Section 1015. All permanent signs shall meet the requirements of ASTM D 4956, Type III, except as follows:

Reflective sheeting for the permanent signs of Table 729-1 shall meet the requirements of ASTM D 4956, Type IX.

Table 729-1
Permanent Signs for Use With Type IX Reflective Sheeting

Sign	MUTCD Number
Stop	R1-1
Yield	R1-2
4-Way	R1-3
All Way	R1-4
Do Not Enter	R5-1
Wrong Way	R5-1a
Chevrons	W1-8
No Passing Zone Pennants	W14-3
Type 3 Object Marker	OM-3 (Right & Left)
Type 2 Object Marker	-------
Guardrail End Decals	-------

(b) Ferrous Metal: Ferrous metals shall comply with Subsection

1015.02(a). Reinforcing steel shall comply with Section 1009. Ferrous metal, except reinforcing steel, shall be galvanized in accordance with Section 811.

(c) Aluminum: Aluminum alloys for structural members shall comply with Subsection 1015.02(b). Aluminum sign panels shall comply with Subsection 1015.04(a).

(d) Fittings: Structural bolts, nuts, washers and miscellaneous hardware shall comply with Subsection 1015.02.

(e) Guard Rail: Guard rail materials for dead end road installations shall comply with Section 1010.

(f) Timber: Treated piling and timber for barricades in dead end road installations shall comply with Section 1014.

(g) Concrete: Concrete shall be Class M complying with Section 901.

(h) Flexible Sign Posts: Flexible posts for small signs, markers and delineators shall comply with Subsection 1015.03.

(i) Silk Screen Paste: Silk screen paste shall be as recommended by the sheeting manufacturer.

(j) U-Channel Posts: U-channel posts shall comply with Subsection 1015.02(a)(3).

729.03 GENERAL REQUIREMENTS.

(a) Sign Face Fabrication: Signs of Types A, B, D and E, overhead signs and sign face overlay panels shall be fabricated in accordance with the MUTCD, the "Standard Highway Signs" booklet, and the signing detail sheets of the plans.

The contractor shall furnish shop drawings of sign faces for Types D and E, overhead signs and sign overlay panels and for any non-standard sign faces of Types A and B not provided by the Department. Approval of shop drawings shall be obtained before sign face fabrication is begun.

(b) Sign Mountings Fabrication: The contractor shall have the option of furnishing either steel or aluminum sign supports for both post mountings and overhead mountings and either rigid steel or flexible posts for small signs, markers and delineators. Before beginning work, the contractor shall notify the engineer in writing of signing materials he proposes to furnish. The same signing materials shall be used throughout the project.

Fabrication of sign mountings shall conform to Section 807. The contractor shall furnish fabrication and erection drawings of all sign mountings in accordance with Subsection 801.03 with the exception of standard roadside installations. Fabrication and erection drawings will be approved only after approval of sign face shop drawings. Neither fabrication of sign mountings nor construction of sign footings will be allowed before

drawings are approved and distributed.

An approved damper is required for each aluminum truss. Dampers shall be installed during truss fabrication and shall remain in place.

Structure mounted delineator and milepost assemblies shall be installed in accordance with plan details.

Welding shall comply with Section 815.

(c) Material Sampling and Certification: Material sampling and certification for sign faces, sign mountings and U-channel posts shall be in accordance with the Materials Sampling Manual.

729.04 FABRICATION OF SIGN PANELS AND MARKERS.

(a) General: The completed product shall have a surface free of cracks, blisters, blemishes, and wrinkles.

Metal fabrication including shearing, cutting and punching of holes shall be completed prior to surface treatment of metal and application of sheeting. Metal panels shall be cut to size and shape and shall be free of buckles, warps, dents, cockles, burrs and defects resulting from fabrication. Surface of sign panels shall be flat.

Splice plates joining sign panels shall not extend behind horizontal sills. Flat aluminum panels shall be a nominal 0.080 inch (2 mm) thick. Extruded aluminum panels shall be 12 inches (300 mm) wide and have a nominal face thickness of 0.125 inches (3 mm).

(b) Surface Treatment: Surface treatment shall be as specified herein or in accordance with approved recommendations of the reflective sheeting manufacturer.

(1) Degreasing:

a. Vapor Degreasing: Panels shall be immersed in a saturated vapor of organic solvent. Trademark printing shall be removed with lacquer thinner or a controlled alkaline cleaning system.

b. Alkaline Degreasing: Panels shall be immersed in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specifications. Immersion time shall depend upon amount of contaminants present and thickness of metal.

(2) Etching:

a. Acid Etch: The panels shall be etched in a 6 to 8 percent phosphoric acid solution at 100°F (38°C). The panels shall then be rinsed thoroughly with running cold water followed by hot water tank rinse.

b. Alkaline Etch: Etch precleaned aluminum surface in an alkaline etching material controlled by titration, using time, temperature and concentration specified by solution manufacturer. Rinse thoroughly. Remove

smut with an acidic, chromium compound solution specified by solution manufacturer and thoroughly rinse.

(3) Drying Panels: Panels shall be dried with a forced hot air drier. Panels shall be handled with clean canvas gloves or by other approved methods between cleaning and etching operations and sheeting application. Cleaned panels shall be protected from grease, oil or other contaminants prior to application of reflective sheeting.

(c) Sheeting Application: Application of reflective sheeting shall be in accordance with the approved written recommendations of the sheeting manufacturer. Sheeting shall be applied to sign faces in an orientation that will result in optimum retroreflectance, or as directed by the engineer.

Reflective sheeting shall be applied with no horizontal splices. Reflective sheeting applied directly to extruded panels shall have no more than two vertical splices per sign, with no more than one vertical splice per individual panel. When splices are used in this manner, only those that occur during, and as a part of , the manufacturing process will be allowed. Fabricated splices will not be allowed.

ASTM D 4956 Type IX reflective sheeting shall be applied with an orientation determined by the engineer to obtain the optimum entrance angle performance. Fabricated vertical splices in ASTM D 4956 Type IX reflective sheeting will be allowed only when the horizontal dimension of the sign face or attached shield is in excess of the maximum manufactured width of the sheeting. Fabricated vertical splices in ASTM D 4956 Type IX reflective sheeting will also be allowed when the specified orientation will create excessive sheeting waste.

Sign faces comprised of two or more pieces of reflective sheeting shall be carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance, both day and night. Alternate, successive width sections of either sheeting or panels shall be reversed and consecutive to ensure that corresponding edges of reflective sheeting lay adjacent on the finished sign. Reflective sheeting splices and sign edges shall be sealed in accordance with the manufacturer's recommendations. Legend shall be of the shape, size, dimension, and stroke specified in the MUTCD and sign face shop drawings.

Legend shall be applied by one of the following methods:

(1) Direct Applied: Legend shall be an adhesive coated reflective sheeting as specified in Subsection 1015.05. Legend shall be applied in such manner as to provide a wrinkle-free surface.

(2) Demountable: Legend shall be an adhesive coated reflective sheeting as specified in Subsection 1015.05, permanently adhered to a 0.032-

inch (0.8 mm) thick flat aluminum backing, except that route marker shields shall be 0.080-inch (2.0 mm) thick aluminum. Aluminum shall be treated in accordance with Heading (b). Legend shall be attached to sign face in such manner as to provide a smooth, flat surface. Sign fabrication rivets that prohibit such application shall be removed and replaced through legend, or legend may be raised by approved spacers. Legend shall show clean cut, uniform width of stroke and have essentially a plane surface.

(3) Screened: Legend shall be applied to sign faces by an approved screening process in accordance with the reflective sheeting manufacturer's recommendations. Screen pastes shall be compatible with reflective sheeting and shall not reduce reflectivity of sheeting less than the values shown in Subsection 1015.05(c). Completed screen surface shall be uniform in color, have sharp edges, be free of bubbles and blemishes, streaks or livered areas, and show good workmanship.

(4) Overlay Film: Legend shall be applied to the sign faces by an approved transparent electronic cuttable overlay film that is compatible with the reflective sheeting to which it is applied. Application shall be in accordance with the recommendations of the manufacturer(s) of both the film and the reflective sheeting. Areas covered by film shall have sharp edges, be free of bubbles and blemishes and show good workmanship. This material shall be in accordance with Subsection 1015.07(c). Direct or reversed application will be permitted.

(d) Screening Process: Screening of sign faces shall be in accordance with Subsection 1015.07(b). Screening shall be by direct or reverse silk screen methods accomplished in the manner specified by the sheeting manufacturer. Screening on sheeting may be accomplished either before or after application of sheeting to panels.

(e) Packaging: Before being packed, signs shall be allowed to stand for at least 12 hours after completion of screening. Signs shall be slipsheeted and packed in such manner as to ensure their arrival at their destination in an undamaged condition. Packaged signs shall not be permitted to become wet during storage or shipment.

729.05 CONSTRUCTION REQUIREMENTS. When removal of existing signs is required, the contractor's sign removal operations shall be coordinated as directed with new sign construction to provide for adequate signing to be in place at all times.

(a) Sign Location: Sign support locations will be as shown on the plans or as directed. Sign locations, after initial staking by the contractor, must be approved by the engineer. Sign locations which are obviously

improper because of topography, existing appurtenances or other conflicting conditions will be adjusted to the closest desirable location. The contractor shall then determine elevations for post length determinations at the established sign support location. The contractor shall be responsible for orientation, elevation, offset and leveling of signs.

(b) Sign Positioning:

(1) Overhead Signs: Signs shall be constructed so that the top edge of the sign face is tilted towards oncoming traffic 3 degrees (approximately 1:20) from vertical and at right angles to the road, unless otherwise directed.

(2) Road Edge Signs: Road edge signs shall be constructed with sign faces vertical. Sign faces located less than 30 feet (9 m) from the edge of travel lane shall be placed at a 93 degree angle from the center of the travel lane. Sign faces located 30 feet (9 m) or more from the edge of the travel lane shall be placed at an 87 degree angle from the center of the travel lane. Where the lanes divide or are on curves or grades, sign faces shall be oriented to be most effective both day and night and avoid specular reflection.

(3) Delineator, Object Marker and Milepost Assemblies: These assemblies shall be placed at least 24 inches (600 mm) beyond the outer edge of roadway shoulder, 24 inches (600 mm) beyond the face of curb, or in the line of guard rail.

(4) Vertical and Horizontal Clearances: Vertical and horizontal clearances shall be in accordance with the MUTCD and/or shall be as shown on the plans.

(c) Sign Overlay Panels: When specified, existing signs shall be completely overlaid with new sign panels placed over the existing sign face. No partially overlaid signs shall be allowed to remain exposed overnight. Only one overlay shall be placed on a sign. When an overlay is to be placed on an existing overlaid sign, the previous overlay shall be removed prior to placement of the new overlay. Overlay panels shall conform to Section 729.04. Raised legends shall be removed from the existing sign face prior to placing the overlay panel. The size of the overlay panel shall not exceed the size of existing sign panel by more than 3 inches (75 mm) on any side. Overlay panels shall be attached to the existing sign with rivets complying with Subsection 1015.02. Rivets shall be placed on 12-inch (300 mm) centers (maximum) along the perimeter of panel and at panel splices, and on 24-inch (600 mm) centers (maximum) both vertically and horizontally in interior portions of each panel. Rivets shall be centered horizontally on panels less than 24-inch (600 mm) wide. A 4 by 4-inch (100 mm by 100 mm) shim with a nominal 0.080-inch (2.0 mm) thick aluminum plate shall be placed between existing panel and overlay panel at interior rivet locations. Shims cut from

salvaged sign panels may be used. The existing sign panels shall be kept reasonably flat during installation of the overlay panels. Splice arrangement for overlay panels shall conform to the requirements for traffic sign blanks.

(d) Excavation and Backfill: The contractor shall perform excavation for sign installation to levels and dimensions shown on the plans, or as directed. Excavation and backfill shall be performed in accordance with Section 802.

(e) Footings: Foundation piles, concrete, reinforcing steel and anchor bolt assemblies shall comply with Sections 804, 805, 806 and 807.

Posts for ground mounted delineator, object marker and milepost assemblies may be driven; no footings will be required.

(f) Bolt Tensioning: Slip plates for breakaway sign posts shall be assembled in the shop with high strength bolts tightened at a minimum bolt tension in accordance with Subsection 807.21. After field installation, high strength bolts in the breakaway base connection shall be tightened to the specified minimum bolt tension. The bolt tension in both the slip plate connection and the breakaway base connection will be checked by the engineer. Bolt tensioning shall be corrected as required.

(g) Cleaning and Clearing: Prior to erection, sign faces shall be cleaned to allow adequate visibility of the sign. Any clearing or tree trimming required to provide for full sign visibility shall be in accordance with the plans or as directed. Trimming of trees of significant local interest shall be performed by a licensed arborist.

(h) U-Channel Posts: U-channel posts for ground mounted small signs, markers and delineators shall be driven vertically to a minimum depth of 3 feet (1 m) below natural ground using a suitable protective driving cap.

U-channel posts may be spliced where long lengths are required. The upper section shall overlap the lower section by at least 24 inches (600 mm). The bottom edge of the upper section of the splice shall be a minimum of 24 inches (600 mm) above the ground. The spliced sections shall be secured with at least four 5/16 inch (8 mm) diameter hex head bolts spaced equally along the splice.

Splicing of U-channel posts will not be allowed when break-away footings are required.

729.06 DEAD END ROAD INSTALLATIONS. Dead end road installations shall be of the specified type and located as shown on the plans. Timber barricade type installations shall be constructed in accordance with Section 812 and the following requirements. Timber piling shall be set in full depth holes and backfilled as directed or driven to required depth. Steel posts

for other type installations shall be driven with a suitable protective cap. Piles and posts shall be vertical. Guard rail shall be constructed in accordance with Section 704.

729.07 ACCEPTANCE OF SIGNS. After the installation of signs is complete, the engineer or an authorized representative shall perform a daytime and nighttime inspection of the signs, sign faces, mounts, installations, hardware and matters relating to the requirements of this section.

After this inspection the engineer and the Department's Sign Inspection Team shall inspect for color match and for conformance to applicable plans, standards and project specifications.

Color match, uniformity and spacing of legend, specular glare, and sign type and design will be inspected for conformance to plans and specifications. When specular reflection is apparent on any sign, its positioning shall be adjusted by the contractor to eliminate this condition. Signs shall be clean at the time of inspection. Reflective sheeting shall be free of cuts, scratches, breaks or other defects which might allow moisture to infiltrate and damage reflective cells. Nonstandard or otherwise unacceptable signs and traffic control devices shall be replaced or repaired as directed. The contractor will be required to correct damage that is discovered at the time of the sign inspection. When the damage was obviously caused by vandalism, the contractor will be paid for corrective work in accordance with Subsection 109.04.

In lieu of removing and replacing new sign faces that have been rejected, sign overlay panels complying with Subsection 729.05(c) may be used to correct the deficiencies at no direct pay.

729.08 MEASUREMENT.

(a) Sign Faces and Overlay Panels: Quantities for payment will be the design areas in square feet (sq m) of sign faces as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. Material used in blanks and backing incidental to the sign face will not be measured for payment. In determining the area of sign faces, no deductions are made for corner radii or mounting holes. The area of octagonal signs and Interstate shields is computed as the area of its smallest rectangle or square. The area of triangular signs is computed as the area of the triangle.

(b) Post Mountings: Post sign mountings, including breakaway supports, will be measured per each post.

(c) Overhead Mountings: Overhead sign mountings will be measured per each structure.

(d) Delineator, Object Marker and Milepost Assemblies: Delineator, object marker and milepost assemblies will be measured per each assembly.

(e) Dead End Road Installations: Dead end road installations will be measured per each installation.

(f) Footings: Concrete footings for overhead sign mountings will be measured per each footing. Footings and aprons for post sign mountings will not be measured for payment.

(g) U-Channel Posts: U-channel posts will be measured per each unit installed when not part of an assembly.

(h) Clearing or Tree Trimming: Any clearing or tree trimming required by this section which is not provided for elsewhere in the contract will be included in the contract unit price for signs.

729.09 PAYMENT.

(a) Sign Faces and Overlay Panels: Payment for sign faces and overlay panels will be made at the contract unit price per square foot (sq m), which includes furnishing, fabricating and constructing the signs and furnishing necessary attaching devices.

(b) Post Mountings: Payment for post sign mountings will be made at the contract unit price per each, which includes furnishing, fabricating and constructing the support complete, ready for affixing signs, and includes required excavation, concrete and reinforcement for footings and aprons, and the sign mounting. Payment for sign layout will be made in accordance with Section 740.

(c) Overhead Mountings: Payment for overhead sign mountings, including bridge fascia mountings, will be made at the contract unit price per each, which includes furnishing, fabricating and erecting the structure complete, ready for affixing signs, and the sign mounting.

(d) Delineator, Object Marker and Milepost Assemblies: Payment for delineator, object marker and milepost assemblies will be made at the contract unit prices per each, which includes posts.

(e) Dead End Road Installations: Payment for dead end road installations will be made at the contract unit price per each, which includes piling, posts, barricades, sign materials, reflectors, and any required guard rail.

(f) Footings: Payment for footings for overhead sign mountings will be made at the contract unit price per each, which includes excavation, piling, concrete, reinforcing steel, anchor bolt assemblies and backfill. The concrete

in footings will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-6 and Note 1 therein. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

(g) U-Channel Posts: Payment for U-channel posts will be made at the contract unit price per each which shall include all labor, equipment, tools, materials, and incidentals necessary to complete the work, including splicing of posts, and when required removing and remounting of existing signs, and mounting of new signs.

Payment will be made under:

Item No.	Pay Item	Pay Unit
729-01	Sign (Type A)	Square Foot (Sq m)
729-02	Sign (Type B)	Square Foot (Sq m)
729-03	Sign (Type C)	Square Foot (Sq m)
729-04	Sign (Type D)	Square Foot (Sq m)
729-05	Sign (Type E)	Square Foot (Sq m)
729-06	Sign (Overhead Mounted)	Square Foot (Sq m)
729-07	Sign (Overlay Panel)	Square Foot (Sq m)
729-08	Mounting (_____Size Post)	Each
729-09	Mounting (Overhead Truss) (Ground Mounted)	Each
729-10	Mounting (Overhead Truss) (Structure Mounted)	Each
729-11	Mounting (Overhead Cantilever) (Ground Mounted)	Each
729-12	Mounting (Overhead Cantilever) (Structure Mounted)	Each
729-13	Mounting (Bridge Fascia Mounted)	Each
729-14	Delineator Assembly (Ground Mounted)	Each
729-15	Delineator Assembly (Structure Mounted)	Each
729-16	Object Marker Assembly	Each
729-17	Milepost Assembly (Ground Mounted)	Each
729-18	Milepost Assembly (Structure Mounted)	Each
729-19	Dead End Road Installations (Type)	Each
729-20	Footings for Overhead Mounting (Type)	Each
729-21	U-Channel Post	Each

Section 730
Electrical Systems

730.01 DESCRIPTION. This work consists of furnishing all necessary equipment and materials, performing all necessary work and making any necessary modifications or fabrications required for a complete, operational and safe system in accordance with the plan details and these specifications. The work shall also include furnishing and installing electrical equipment and materials required for air conditioning equipment, motors, controls, pumps and other appliances. The plans and these specifications are supplemental to the applicable codes, manufacturer's instructions, and best prevailing construction trade practices.

730.02 EQUIPMENT AND MATERIALS. Equipment and materials shall be suitable for the intended use and shall be furnished with all necessary hardware and components.

References to a specific manufacturer's name and/or catalog number is intended to denote the quality of the equipment or material and not to specifically exclude other acceptable products. When specified model or catalog numbers are in conflict with descriptive specifications, plans or system compatibility, the descriptive specifications, plans, or system compatibility shall govern.

Except for those products designated as fabricated or those that are no longer produced, all specified products shall be manufactured by companies that are regularly engaged in the production of the specified products.

The products specified shall be specifically designed, tested and manufactured for the purpose for which they will be used. Modification of equipment for other than design purposes will be permitted only when no currently manufactured products meet the specifications.

All equipment and materials shall be new. Like equipment and materials shall be made by the same manufacturer.

The item descriptions and specifications do not necessarily include or define everything necessary for a complete and operational item. When required, the contractor shall provide any modifications, fabrications, extra hardware, and equipment necessary for the satisfactory installation and operation of the system to coordinate with other items or conditions at no direct pay.

Materials shall comply with the following Sections and Subsections:

Backfill	203.06(b) & 1003.07
Portland Cement Concrete (Classes M and S)	901
Reinforcing Steel	1009
Timber	1014
Anchor Bolts, Nuts and Washers	1015.02(c)(1)
Stainless Steel Hardware	1018.08(c)
Conduit	1018.09
Electrical Conductors	1018.10

730.03 CONTRACTOR REVIEW. The drawings are diagrammatic and do not show the exact location and size of equipment. The contractor shall coordinate the work to avoid interference and conflicts. The work shall comply with the applicable requirements of the latest National Electric Code, National Electrical Safety Code and U.L. Standards except where superseded by applicable laws. The contractor shall check mounting space, equipment dimensions, and installation requirements before ordering equipment. The contractor shall establish the electrical circuit requirements of all equipment to be served before ordering material. Where circuits are to serve specific appliances, equipment or feeders, the contractor shall verify the electrical requirements and the exact location of connection before installing the service to the equipment.

730.04 DRAWINGS AND EQUIPMENT SUBMITTALS. The contractor shall submit to the Bridge Design Engineer for checking shop drawings, working drawings and equipment brochures for all required equipment and materials. Nine prints of each checked drawing shall be submitted for final approval and distribution. Drawings submitted shall show construction details, dimensions, and ratings. Drawing format shall be in accordance with Subsection 801.03. Corrections and/or comments made on submittals are not intended to relieve the contractor from compliance with the contract documents. The review and approval of drawings and equipment submittals are to assure that the quality of the equipment and materials meet the requirements of the contract documents.

Approval of the brochures and drawings does not imply that the equipment described is complete, can be constructed or installed, will operate successfully, or will coordinate with existing or other equipment specified. The contractor shall remain responsible for confirming and correlating all quantities and dimensions; for selecting fabrication processes and construction

techniques; for coordination of the work; for performing the work in a safe and satisfactory manner; and for satisfactory installation and operation of equipment.

(a) Working Drawings: Before beginning construction, the contractor shall submit for approval a complete set of working drawings for the project. The intent of the working drawings is to provide the extra detail necessary to communicate the exact scope and details of construction. The drawings are also intended to resolve all potential conflicts between subcontractors, equipment compatibilities and equipment mountings. When the contract drawings are of sufficient detail, the contractor may request approval to use the contract drawings as working drawings. However, any errors on the working drawings are the responsibility of the contractor. The engineer may require the contractor to submit additional details to resolve conflicts or ambiguities which arise during construction.

(b) As-Built Drawings: Upon completion of the project, the contractor shall furnish one set of plans which reflect the final as-built condition of the electrical portion of the project. The drawings shall reflect the plan or field changes and shall include a complete equipment list showing each manufacturer's name and catalog or shop drawing number for each piece of equipment furnished. The drawings shall show the exact location of the underground wiring, light poles, junction boxes, under roadway crossings, service poles, controllers and conduits or cables. Complete schematic and wiring diagrams shall also be required. Light poles shall be located by station number. Underground equipment shall be located by dimensioning to fixed objects. Drawing sizes and format shall be in accordance with Subsection 801.03.

730.05 MAINTENANCE AND OPERATION INSTRUCTION BOOKLETS. Maintenance and operation instruction booklets shall comply with Subsection 801.03(e)(2).

730.06 SYSTEM TESTING. The contractor shall furnish all testing equipment and conduct the tests required by the plans and specifications. A copy of the test results shall be provided to the engineer.

(a) Performance Tests: Equipment shall be given a minimum two week performance test before final acceptance. The performance test shall allow for the normal operation of the equipment during the testing period. When the normal operation is insufficient to adequately test the equipment, artificial cycling or continuous "on" periods will be required. The contractor shall correct any defective equipment, materials and workmanship.

(b) Receptacle Tests: After completion of the electrical system, the contractor shall test each receptacle for proper polarity and continuity of the ground.

(c) Special Tests: The contractor shall conduct special tests when equipment or systems are suspected of improper operation, or when additional data is necessary to determine proper operation.

(d) Insulation Tests: The contractor shall conduct insulation resistance tests on all direct buried conductors and all other A.W.G. No. 10 and larger conductors. Tests shall be made after the conductors are installed and before connecting equipment that may be damaged by the tests. Readings below 50 megohms, when measured with a 1000 volt D.C. insulation tester, will be considered defective.

730.07 ELECTRICAL SERVICE. The contractor shall make arrangements with the power company for temporary and permanent electrical service and shall verify the exact location and points of attachment before installation.

(a) Temporary Service: Temporary electrical service, including power usage and installation shall be at no direct pay.

(b) Permanent Service: The Department will pay the power company for line extensions when the charges are not the result of contractor errors or failure to verify or coordinate with the power company.

(c) Power Usage: Power usage during construction and testing shall be at no direct pay.

730.08 MEASUREMENT.

(a) Trenching and Backfilling: Trenching and backfilling will be measured by the linear foot (lin m) of trench excavated and backfilled, which will include excavation, backfilling, and any required compaction.

(b) Conduit with Conductors: Conduit with conductors will be measured by the linear foot (lin m) of conduit which will include furnishing and installing conduit, conductors, clamps, fittings, flexible metal conduit, and miscellaneous hardware required for conduit installation.

(c) Conductors in Existing Conduit: Conductors will be measured by the linear foot (lin m) of conductors furnished and installed, which will include connectors, terminations and wire markers.

(d) Conduit: Conduit will be measured by the linear foot (lin m) of conduit which will include furnishing and installing conduit, clamps, fittings, flexible metal conduit, and miscellaneous hardware required for conduit installation.

(e) Jacked or Bored Casing: Jacked or bored casings will be measured by the linear foot (lin m) of casing furnished and installed, which will include the casing, duct markers, fittings, and required excavation and backfill.

(f) Light Pole: Light poles will be measured per each pole furnished and installed which will include the pole, decals, ownership plate, wiring and connections to circuit conductors, base assembly, grout and oxide-inhibiting compound. Measurement for ground mounted poles will also include the concrete foundation, concrete apron, underground junction boxes in apron, anchor bolts, reinforcing steel, conduits in foundation, ground rod, ground wires, ground clamp, excavation, backfill, and disposal of excess excavated material.

(g) Relocate Light Poles: Relocation of existing light poles will be measured per each pole, which will include disconnection of the wiring at the source; the removal or abandonment of underground wiring to the pole; the removal and storage of existing pole and luminaire; the complete removal and disposal of existing foundation and apron; the backfilling of existing foundation void; the re-installation of the existing pole and luminaire; the construction of a new foundation with apron; the installation of new ground rod, fused connectors, and pole wiring.

(h) Removal and Storage of Light Poles: Removal of existing light poles will be measured per each pole, which will include the disconnection of wiring at the source; the removal and transporting of the pole to the District compound; the furnishing of 6 inch by 6 inch (150 mm by 150 mm) creosote timbers, and the stacking of the standards as directed.

(i) Removal and Disposal of Light Pole Foundations: Removal of existing light pole foundations will be measured per each foundation, which will include the removal and disposal of the complete concrete foundation and apron; the backfilling to grade of all voids; and the removal or abandonment of underground wiring to the pole.

(j) High Mast Poles: High mast poles will be measured per each pole furnished and installed, which will include the pole, luminaire ring, lowering assembly, drive assembly, grounding, wiring, electrical connections, fuses, mounting hardware, and grout. Measurement for ground mounted poles will also include the concrete foundation, anchor bolts, reinforcing steel, conduit in foundation, ground rod, excavation, backfilling, disposal of excess excavated material, and all hardware and appurtenances required for a complete installation.

(k) Luminaire: Luminaires will be measured per each which will include the luminaire, ballast, lamp, fuse, lightning arrestor, mounting,

connections and hardware.

(l) Removal and Disposal of Luminaires: Removal and disposal of existing luminaires will be measured per each luminaire, which will include removal and the disposal of the luminaire and lamp.

(m) Electrical Service Points: Electrical service points will be measured per each which will include pole, controller assembly, footing, anchor bolts, ground rod, conduits in footing, rigid conduit and conductors on utility company pole connections, hardware, and all equipment as shown on the plans.

(n) Electrical System: Electrical system will be measured on a lump sum basis, which will include furnishing and installing all equipment and apparatus, and performing all work required for a complete and operational electrical system.

(o) Fabricated Light Pole Supports: Fabricated light pole supports will be measured per each, which will include fabrication and installation of the support, concrete anchors, anchor bolts and nuts, and grout.

(p) Underground Junction Box: Underground junction boxes will be measured per each box installed, and will include the box, cover, concrete pad, rigid steel conduits, ground rod bonding, splices, and any material and equipment required for a complete installation.

(q) Structure Junction Box: Structure junction boxes will be measured per each box installed, and will include the box, cover, mounting hardware, shims, terminal blocks, fittings, bonding, and any material and equipment required for a complete installation.

(r) Service Pole: Service poles will be measured per each, and will include the pole conduit and conductors on pole, fittings, conduit clamps, ground rod, hardware, and all equipment as shown on the plans.

(s) Removal and Disposal of Electrical Equipment: The removal of existing electrical equipment as indicated on the plans will be measured as a lump sum, which will include the disconnecting of wiring at the source, the removal of exposed conduit and wiring, and the removal of associated electrical equipment. Measurement for outside systems will include the removal of structure mounted conduit, wire clamps, junction boxes, and underpass luminaires; the removal of service poles and equipment; the removal of conduit risers and the demolition of underground manholes to 24 inches (600 mm) below grade; the removal of underground junction boxes; the back filling to grade of all voids; and the disposal of material and equipment declared not salvageable.

730.09 PAYMENT. Payment for electrical work will be made at the

contract unit prices. The concrete in foundations for light poles, high mast poles, and other electrical equipment will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-6 and Note 1 therein. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment will be made under:

Item No.	Pay Item	Pay Unit
730-01	Trenching and Backfilling	Linear Foot (Lin m)
730-02	Conduit with Conductors (Size and Type)	Linear Foot (Lin m)
730-03	Conductors in Existing Conduit (Size and Type)	Linear Foot (Lin m)
730-04	Jacked or Bored Casing (Size and Type)	Linear Foot (Lin m)
730-05	Light Pole (Size and Type)	Each
730-06	High Mast Pole (Size and Type)	Each
730-07	Luminaire (Size and Type)	Each
730-08	Electrical Service Point (Type)	Each
730-09	Electrical System	Lump Sum
730-10	Fabricated Light Pole Support	Each
730-11	Removal and Disposal of Electrical Equipment	Lump Sum
730-12	Removal and Storage of Light Poles	Each
730-13	Removal and Disposal of Light Pole Foundations	Each
730-14	Removal and Disposal of Luminaires	Each
730-15	Relocate Light Poles (Size and Type)	Each
730-16	Underground Junction Box (Size)	Each
730-17	Structure Junction Box (Size)	Each
730-18	Service Pole	Each

Section 731
Raised Pavement Markers

731.01 DESCRIPTION. This work consists of furnishing and placing raised pavement markers in accordance with plan details.

The contractor will be responsible for field layout and alignment of raised pavement markers. Existing pavement striping shall generally be used as a guide in determining raised marker locations. The Department will make every effort to replace obliterated striping prior to installation of raised pavement markers; however, if no striping exists at the time of raised marker installation, the contractor shall determine raised pavement marker locations in accordance with plan details or as directed.

731.02 MATERIALS.

(a) Markers: Markers shall comply with Subsection 1015.09. The same product shall be used throughout the project. Markers shall be the specified class, type, color, size and shape.

(b) Adhesive: Markers shall be placed with bituminous adhesive on asphaltic surfaces and epoxy adhesive on portland cement concrete surfaces.

(1) Epoxy Adhesive: Epoxy adhesive shall be Type V epoxy resin system complying with Subsection 1017.02. Epoxy components shall be mixed in equal parts by volume. Adhesive shall be mechanically mixed and dispensed, unless hand methods are permitted.

(2) Bituminous Adhesive: Bituminous Adhesive shall comply with Subsection 1015.09(c)(2).

731.03 CONSTRUCTION REQUIREMENTS.

(a) Weather Limitations: Markers shall not be applied when there is moisture on the surface.

(1) Epoxy Adhesive: When a normal set adhesive is used, application of markers will not be permitted at ambient air temperatures less than 50°F (10°C). When a rapid set adhesive is used, application of markers will be permitted at ambient air temperatures between 35°F (2°C) and 50°F (10°C), provided adhesive is adequately heated to obtain proper viscosity for mixing and application, and provided adhesive is identified as a rapid set type on container labels and Certificates of Delivery.

(2) Bituminous Adhesive: Markers shall be applied when the ambient air temperature is 50°F (10°C) or greater.

(b) Cleaning of Surfaces: Surfaces on which markers are to be applied shall be cleaned of all materials that may reduce the bond of adhesive. Surfaces shall be cleaned by blast cleaning or other approved methods which do not damage the surface; however, blast cleaning equipment shall be provided with positive cutoff controls. Surfaces shall be maintained in a clean dry condition until placement of markers.

(c) Application of Markers: Surfaces on which markers are to be placed shall be blown dry immediately prior to marker placement. Markers shall be applied to surfaces with adhesive in accordance with the manufacturer's recommendations.

(1) Epoxy Adhesive: Mixed adhesive shall have a uniformly grey color with no streaks of either black or white on the surface or within mixed adhesive. Voids in a cured undisturbed sample approximately 1/16 inch (2 mm) thick from the extrusion nozzle shall not exceed 4 percent by volume. Machine mixer and applicator shall be capable of accurately and uniformly proportioning the two components in a 1 to 1 ratio within 5 percent by volume of each component (i.e., within 47.5 to 52.5 percent for each component). Periodic checks of proportioning equipment shall be made to determine the actual ratio of components. This shall be done by placing containers in front of the mixing chamber and measuring the actual volume of each component. Equipment shall be arranged so it is possible to bypass the mixer to perform these periodic checks. Temperature of adhesive shall be maintained between 70°F (21°C) and 110°F (43°C) before mixing. The temperature shall be adjusted to prevent excessive flow of epoxy from the marker when installed. The area of the epoxy adhesive bed shall be equal to the bottom area of marker. Adhesive shall be applied in sufficient quantity to cause excess adhesive to be forced out around the perimeter of the marker. Voids in markers with an open grid pattern on bottom shall be filled with adhesive immediately prior to placement.

(2) Bituminous Adhesive: The adhesive shall be heated and melted in either thermostatically controlled double boiler type units utilizing heat transfer oil or thermostatically controlled electric heating pots. The melter/applicator unit shall be suited for both melting and pumping application through heated applicator hoses. The adhesive shall be heated to between 375°F and 425°F (190°C and 220°C) and applied directly to the pavement surface from the melter/applicator by either pumping or pouring. The area of the bituminous adhesive bed shall be a minimum of 6 inches (150 mm) in diameter. Markers shall be applied to the adhesive within 10 seconds. The marker shall be placed in the adhesive bed by applying downward pressure until the marker is firmly seated. Adhesive on exposed surfaces of

markers shall be immediately removed with soft rags moistened with mineral spirits or kerosene. Markers shall be protected against impact until the adhesive has hardened. The adhesive may be reheated and reused; however, the pot life at application temperatures shall not be exceeded.

731.04 MEASUREMENT. Raised pavement markers will be measured by counting the number of markers furnished, placed, and accepted.

731.05 PAYMENT. Payment for field layout and alignment of raised pavement markers will be in accordance with Section 740. Payment for raised pavement markers will be made at the contract unit prices per each under:

Item No.	Pay Item	Pay Unit
731-01	Nonreflectorized Raised Pavement Markers	Each
731-02	Reflectorized Raised Pavement Markers	Each

Section 732
Plastic Pavement Markings

732.01 DESCRIPTION. This work consists of furnishing and placing reflective pavement markings of hot applied thermoplastic or preformed (cold or hot applied) plastic at the locations shown on the plans or as directed. This work shall be in compliance with the MUTCD, plan details and these specifications. Plastic pavement markings include stripes, gore markings, lines, legends and symbols.

732.02 MATERIALS.

(a) Thermoplastic Markings: Thermoplastic marking material shall be a plastic compound reflectorized by internal and external application of glass beads, complying with Subsections 1015.10 and 1015.13. Width and color of markings shall be as specified.

Thermoplastic material shall be delivered in containers of sufficient strength to permit normal handling during shipment and transportation without loss of material. Approved heat-degradable containers that can be placed in heating kettles along with the plastic material will be permitted. Each container shall be clearly marked to indicate color of material, process batch number, name of manufacturer and date of manufacture.

(b) Preformed Plastic Markings: Preformed plastic markings shall comply with Subsection 1015.11.

(c) Surface Primer: A single component surface primer or two component epoxy primer sealer shall be provided by the contractor for the appropriate application in accordance with Subsection 732.03(e). The primer shall form a continuous film that dries rapidly and adheres to the pavement. The primer material shall not discolor or cause any noticeable change in the appearance of the pavement outside of the finished pavement marking. A sample of the primer shall be submitted with the recommended method of application to the engineer and to the manufacturer of the thermoplastic marking material. Written approval shall be obtained from the engineer and the manufacturer before applying the primer.

(d) Glass Beads: Glass beads used for drop-on application to molten plastic shall be shipped in moisture resistant sacks (containers). The sacks shall be strong enough to permit handling without damage. Sacks shall be sufficiently water-resistant so that beads will not become wet or caked in transit.

Glass beads for standard (flat) thermoplastic markings shall be in accordance with Subsection 1015.13.

732.03 CONSTRUCTION REQUIREMENTS FOR PLASTIC PAVEMENT MARKING MATERIAL.

(a) Equipment for Standard (Flat) Thermoplastic Marking Material: The application equipment shall consist of an extrusion die or a ribbon gun that simultaneously deposits and shapes lines at a thickness of 90 mils (2.3 mm) or greater on the pavement surface. Finished markings shall be continuous and uniform in shape, and have clear and sharp dimensions. Applicators shall be capable of producing various widths of traffic markings. Applicators shall produce sharply defined lines and provide means for cleanly cutting off stripe ends and applying broken lines. The ribbon extrusion die or shaping die shall not be more than 2 inches (50 mm) above the roadway surface during application. A spray application will only be allowed when applying 40 mil (1.0 mm) thermoplastic.

The application equipment shall provide continuous mixing and agitation of material. Thermoplastic conveying equipment components located between the main material reservoir and discharge mechanism shall be free from material accumulation and clogging. Parts of application equipment in contact with the material shall be easily accessible for cleaning and maintaining. Mixing and conveying equipment shall maintain material at the application temperature.

Glass beads shall be applied to the molten surface of completed stripes by either a single drop or a double drop application depending on the thickness of the thermoplastic striping as shown in Table 1015-13. The first (large) bead drop shall be applied by a gravity bead dispenser attached to the striping machine in such a manner that beads are dispensed simultaneously with the thermoplastic material at a controlled rate of flow on installed lines. The second (small) bead drop shall be applied immediately after the first bead drop by a gravity bead dispenser attached to the striping machine.

Applicators and kettles shall be equipped and arranged to comply with requirements of the National Board of Fire Underwriters. Applicators shall be maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. Applicator equipment shall consist of a motorized mobile unit capable of installing traffic stripes either left or right of the applicating unit so that only one lane of traffic will be occupied during installation.

(b) Weather Limitations: Application of markings will not be permitted when there is excessive pavement moisture or when the surface

temperature or ambient temperature is below 50°F (10°C). The pavement shall be considered excessively moist when it is visibly wet or when a 1 square foot (0.1 sq m) piece of polyethylene film condenses moisture after being placed on the pavement surface for 15 minutes.

(c) Cleaning of Surfaces: Surfaces on which markings are to be applied shall be cleaned of materials that may reduce adhesion of the thermoplastic marking materials to the pavement. Cleaning shall be done by blast cleaning or grinding. Surfaces shall be kept clean until placement of markings.

(d) Removal of Existing Markings: Existing thermoplastic markings that are not flaking or peeling will not require removal prior to placement of 40 mil (1.0 mm) thick thermoplastic. Existing thermoplastic markings, regardless of condition, shall be removed prior to placement of 90 mil (2.3 mm) thick or greater thermoplastic except on asphalt pavements.

When thermoplastic markings replace existing painted markings, the existing painted markings will not require removal prior to applying new thermoplastic markings, provided the existing painted markings are not flaking or peeling.

When preformed plastic markings (tape) replace any existing markings, the existing markings shall be removed prior to applying the preformed plastic markings.

Removal of markings shall be accomplished by methods that will not damage the pavement or bridge deck. Removal shall be to such extent that 75 percent of the pavement surface or bridge deck under the markings is exposed. After the markings are removed, compressed air or a power blower shall be used to blow clean the pavement surface of residue and debris resulting from the removal. At the end of each day's operations the engineer may direct that temporary pavement markings complying with Section 713 be used in areas where existing markings have been removed and new markings not placed. Temporary pavement markings shall be satisfactorily removed prior to resuming thermoplastic marking operations.

All markings made in error or not conforming to the traffic operation in use shall be removed by either an abrasion or burning process to the satisfaction of the engineer. Markings shall not be obliterated by painting with asphalt binder or other material.

(e) Application of Surface Primer: A single component surface primer will be required prior to placement of preformed plastic markings over an existing painted stripe, over old bleached asphalt, on portland cement concrete surfaces, or all surfaces when ambient temperatures are below 70°F (20°C) unless otherwise directed by the engineer. A two component epoxy

primer sealer will be required prior to placement of thermoplastic materials on portland cement concrete surfaces or all surfaces when ambient temperatures are below 70°F (20°C) unless otherwise directed by the engineer.

(f) Application of Markings: Material shall be installed in specified widths from 4 inches to 24 inches (100 mm to 600 mm). Finished lines shall have well defined edges and be free of waviness. Measurements shall be taken as an average through any 36-inch (900 mm) section of line. Longitudinal lines shall be offset approximately 2 inches (50 mm) from longitudinal joints. A tolerance of +1/2 inch and -1/8 inch (+13 mm and -3 mm) from the specified width will be allowed, provided the variation is gradual. Segments shall square off at each end without mist or drip. Transverse variations from the control device up to 1 inch (25 mm) will be allowed provided the variation does not increase or decrease at the rate of more than 1/2 inch in 25 feet (15 mm in 10.0 m). Lines not meeting these tolerances shall be removed and replaced at no direct pay.

(1) Thermoplastic Markings: Thickness of material, not including drop-on beads, shall be not less than 90 mils (2.3 mm) for lane lines, edge lines and gore markings and not less than 125 mils (3.2 mm) for crosswalks, stop lines, and word and symbol markings.

Thermoplastic material at 90 mil (2.3 mm) thickness or greater shall be applied by extrusion at 390°F to 450°F (200°C to 230°C). Thermoplastic material at 40 mil (1.0 mm) thickness shall be applied by spray at 410°F to 450°F (210°C to 230°C). Immediately after application of the markings, glass beads for a single drop application shall be applied at a minimum rate of 230 pounds per mile (65 kg/km) for a 4-inch (100 mm) solid line stripe. Glass beads for a double drop application shall be applied at a minimum rate of 211 pounds per mile (60 kg/km) for each drop on a 4-inch (100 mm) solid line. Material shall not scorch or discolor when kept at this temperature range for 4 hours.

(2) Preformed Plastic Markings: Plastic tape shall be applied by removing release paper and applying adequate pressure to ensure proper adhesion. Other preformed heat-applied material shall be applied in accordance with the manufacturers' recommendation. Material not adhering properly shall be satisfactorily corrected at no direct pay.

(g) Field Testing of Roadway Markings: The Department will field test the pavement markings in accordance with Subsections 1015.10 and 1015.11 and Table 732-1. Failure to meet these requirements will require the contractor to replace the portion of the material shown to be out of specifications as directed by the engineer.

(h) Corrective Work: Any line found to be defective shall be restriped

or replaced as directed by the engineer. The corrective work shall also be subject to these requirements. The contractor shall replace the pavement marking material at no cost to the Department.

(i) Guarantee: The contractor shall provide the Department with a guarantee stating that if the pavement marking fails to comply with the stated performance requirements, the contractor shall take the remedial action required. Replacement striping shall carry the unexpired guarantee of the striping it replaces.

732.04 MEASUREMENT.

(a) Plastic Pavement Striping: Plastic striping will be measured by the linear foot (lin m) or mile (km), as specified. When a bid item is not included for gore markings, the Department will measure the quantity by converting the actual length and width of line installed to an equivalent length of the normal width line on that section of roadway.

(1) Linear Foot (Lin m): Measurement will be made by the linear foot (lin m) of striping, exclusive of gaps.

(2) Mile (km): Measurement will be made by the mile (km) of single stripe. No deduction will be made for standard 30-foot (9 m) design gaps in broken-line striping; however, deductions will be made for the length of other gaps or omitted sections.

(b) Plastic Pavement Legends and Symbols: Plastic legends and symbols will be measured per each legend or symbol. Symbols shall include all letters, lines, bars or markings necessary to convey the message at each location.

(c) Removal of Existing Markings: Removal of existing pavement markings for undivided highways will be measured by the linear mile (km) of full roadway width including shoulders. For divided highways, the full roadway width including shoulders and ramps will be measured separately for each direction of travel. Removal of pavement markings will include removal of lane lines, edge lines, gore markings, legends, symbols, and raised pavement markers.

732.05 PAYMENT. Payment for the completed and accepted quantities of plastic pavement markings and removal of existing markings will be made at the contract unit prices under:

Payment will be made under:

Item No.	Pay Item	Pay Unit
732-01	Plastic Pavement Striping (__inch (__mm) Width)	Linear Foot (Lin m)
732-02	Plastic Pavement Striping (Solid Line) (__inch (__mm) Width)	Mile (km)
732-03	Plastic Pavement Striping (Broken Line) (__inch (__mm) Width)	Mile (km)
732-04	Plastic Pavement Legends and Symbols (Type)	Each
732-05	Removal of Existing Markings	Mile (km)

Table 732-1
Field Testing of Plastic Pavement Markings

Length of Roadway	Number of Random Test Segments	Length of Test Segments
Less than 1 mile (1.5 km)	3 segments per line type	250 feet (75 m)
1 mile (1.5 km) to 9 miles (14.5 km)	3 segments per line type	1000 feet (300 m)
Greater than 9 miles (15 km)	1 segment per every 3 miles (4.8 km) per line type	1000 feet (300 m)

Measurements

1. Test segments will be selected randomly by the engineer unless night reviews or other knowledge supersedes a random selection process.
2. Each line type will be measured separately.
3. Measurements will be taken on dry, clean roadways.
4. Data will be collected in direction of traffic flow.
5. A minimum of 10 readings will be taken in each test segment line type.
6. On broken lines (skip striping), no more than two readings will be taken per stripe, with readings 20 inches (0.5 m) from ends of marking.
7. For solid lines, the test segment will be divided into ten locations of 100 feet (30 m) each; readings will be spaced a minimum of 25 feet (7.5 m) and a maximum of 150 feet (45 m) apart.
8. The Department may take additional readings or test segments.
9. Acceptance will be based on the average of the readings for each test segment for each line type.
10. Failure of the average reading for any segment to meet the specified minimum values will require replacement.
11. Limits of replacement will be determined by the engineer.

Section 733
Concrete Roadway Barriers

733.01 DESCRIPTION. This work consists of furnishing and constructing concrete barriers for roadways. Barriers may be precast or cast-in-place concrete, at the contractor's option.

733.02 MATERIALS. Materials shall comply with the following Sections and Subsections.

Portland Cement Concrete	901
Joint Materials	1005
Reinforcing Steel	1009
Curing Materials	1011.01
Special Surface Finish Materials	1011.03

Cast-in-place concrete shall be Class M. Precast concrete shall be either Class A or Class P, except that the compressive strength requirements of Class P concrete shall be the same as specified for Class A concrete.

733.03 CONSTRUCTION REQUIREMENTS. Barriers shall be constructed in accordance with Sections 805 and 806 as modified herein. Exposed surfaces of barriers shall be given a Class 2A finish in accordance with Subsection 805.13(b).

The contractor shall perform necessary excavation and backfilling for barriers and shall dispose of excess excavated material in accordance with Subsection 202.02.

Slip-formed concrete shall be placed with an approved slip-form placing machine designed to spread, vibrate, consolidate and finish concrete in one pass of the machine in such manner that a minimum of hand finishing will be necessary to provide a dense, homogeneous unit. Sliding forms shall be rigidly held together to prevent spreading of forms. After passing there shall be no noticeable slumping of concrete. Concrete shall be held at a uniform consistency, having a slump of 1/2 inch to 1 1/2 inches (13 mm to 38 mm).

Expansion joints shall be formed in accordance with plan details and shall be located at the junction of the barrier with bridge railings, footings for sign supports and light standards, and other fixed structures. Vertical joints in barriers shall match joints in existing underlying concrete pavement. When

pavement joint spacing exceeds 20 feet (6 m), intermediate joints shall be placed as required, but shall not exceed a 20 foot (6 m) spacing. Vertical joints shall be formed to a minimum depth of 1 1/2 inches (38 mm) by an approved jointing tool or sawing the plastic concrete.

733.04 MEASUREMENT. Quantities of concrete barriers for payment will be the design lengths as specified on the plans and adjustments thereto. Design lengths will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

Design quantities are based on lengths of continuous sections of barrier, including joints but excluding other openings in the barrier. Required concrete, excavation, backfill, disposal of excess excavated material, reinforcement, joint materials and admixtures will not be measured for payment.

733.05 PAYMENT. Payment for concrete barriers for roadways will be made at the contract unit price per linear foot (lin m). The concrete in cast-in-place roadway barriers will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-6 and Note 1 therein. The concrete in precast roadway barriers will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-5 and Note 1 therein.

Payment will be made under:

Item No.	Pay Item	Pay Unit
733-01	Concrete Roadway Barrier (Type)	Linear Foot (Lin m)

Section 734
Rubblizing Portland Cement Concrete Pavement

734.01 DESCRIPTION. This work consists of rubblizing and compacting the existing reinforced or non-reinforced portland cement concrete pavement. The work shall be performed in accordance with the lines, grades, and typical sections shown in the plans and the following requirements.

734.02 EQUIPMENT. The existing pavement shall be rubblized with a self-contained, self-propelled, resonant frequency breaker capable of producing low amplitude 2000 pound (910 kg) force blows at a rate of not less than 44 cycles per second.

A steel wheel vibratory roller having a gross weight of not less than 10 tons (9 Mg), operated in the vibrating mode, shall be used to compact the rubblized pavement.

A pneumatic-tired roller as specified in Subsection 503.17(c) shall also be used to compact the rubblized pavement.

734.03 CONSTRUCTION REQUIREMENTS. A joint shall be saw cut full depth or load transfer devices shall be severed prior to rubblizing at an existing joint on ramps or roadway where rubblizing abuts concrete pavement which is to remain in place.

The existing concrete pavement shall be broken into pieces ranging from sand size to pieces generally 6 inches (150 mm), with no more than approximately 10 percent of the material larger than 6 inches (150 mm) and no individual pieces larger than 8 inches (200 mm). The majority of rubblized concrete material shall be pieces 1 to 3 inches (25 to 75 mm) in size.

The breaker shall be operated with a maximum amplitude of 1 inch (25 mm) to avoid disruption of base and prevent damage to underground structures.

At the beginning of the rubblizing operations, a 4 foot by 4 foot (1.2 m by 1.2 m) test pit shall be excavated in the middle of a lane at a location selected by the engineer to determine if the breaker is producing pieces of the specified sizes. Additional test pits may be required if directed by the engineer. The test pits shall be backfilled and compacted to the satisfaction of the engineer. The backfill material shall be base course aggregates as specified in Subsection 1003.03; backfilling with the rubblized material will not be

acceptable.

On projects that have a transition to a bridge or to an overpass, the test pit shall be made in the transition where the material will be totally removed. The transition where the test pit is to be located, shall be broken with the resonant breaker; the remainder of the transition shall be broken with any other equipment that the contractor elects to use.

Prior to rubblizing the pavement, the required shoulder drain system and outlets shall be completely installed and functioning. Care should be taken by the contractor not to damage the edge drain system.

Rubblizing shall begin at a free edge or previously broken edge and progress towards the opposite shoulder or longitudinal centerline of the road. In areas where the roadway must be overlaid one lane at a time, initial rubblizing will extend a minimum of 6 inches (150 mm) beyond the width of pavement to be overlaid.

Reinforcement in the rubblized pavement, if any, shall be debonded from the concrete and left in place. However, any reinforcement exposed at the surface during rubblizing or compacting operations shall be cut below the surface and removed.

The complete width of the rubblized pavement surface shall be compacted by vibratory steel-wheel and pneumatic-tired rollers in the following sequence as a minimum.

One pass with a vibratory steel-wheel roller

One pass with a pneumatic-tired roller

Two passes with a vibratory steel-wheel roller.

A pass shall be defined as forward and backward in the same path. The roller shall be operated at a speed not to exceed 4.5 feet per second (1.5 m/s).

Except at restricted crossover and ramp crossings, traffic will not be allowed on the rubblized pavement before the initial asphaltic concrete base and leveling courses, if required, are in place. Rubblized material dislodged by construction traffic shall be immediately removed from the roadway in front of the paver. In no instance shall more than 48 hours elapse between rubblizing the existing pavement and placing the initial pavement course. However, in the event of rain, this time limitation may be waived by the engineer to allow sufficient time for the rubblized pavement to dry to the satisfaction of the engineer. Crossover and ramp crossings shall be maintained in the same compacted state as other areas until the initial pavement course is placed.

The rubblizing operations shall not be performed until after any widening and/or shoulder work reaches the elevation of the existing pavement grade. Shoulders and widening can then be completed in conjunction with the

placement of pavement courses over the compacted rubblized pavement.

734.04 MEASUREMENT. Rubblizing portland cement concrete pavement will be measured by the square yard (sq m). The width will be the nominal width of the existing pavement, and the length will be measured along the centerline of each roadway or ramp.

734.05 PAYMENT. Payment for rubblizing portland cement concrete pavement will be made at the contract unit price per square yard (sq m) which includes furnishing all materials, labor, equipment and incidentals necessary to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
734-01	Rubblizing Portland Cement Concrete Pavement	Square Yard (Sq m)

Section 735
Mailboxes and Mailbox Supports

735.01 DESCRIPTION. This work consists of removing and replacing mailboxes, newspaper delivery tubes, and mailbox supports in accordance with these specifications, the plans and as directed.

Mailboxes are privately owned although placed on public right-of-way. Coordination with the mailbox owner and the United States Postal Service (USPS) shall ensure the owner receives mail deliveries.

The contractor shall notify the property owners on a form furnished by the Department, a minimum of 10 calendar days before removal, that the mailbox and supports will be removed for construction and will be replaced using approved materials in accordance with these specifications. The contractor shall also notify the property owners that salvageable material will be placed on the owner's property for the owner's disposal if the owner so desires. The contractor shall give the engineer documentation that all property owners have been notified in accordance with these specifications.

735.02 MATERIALS. Mailboxes shall be fabricated of light sheet metal or plastic complying with the requirements of the USPS. The replacement mailbox shall be the same size as the existing mailbox. Newspaper tubes shall be furnished by the property owner. Names and numbers on mailboxes will be the responsibility of the property owner.

Mailbox supports shall be galvanized and shall be metal posts with a strength no greater than a 2-inch (50 mm) diameter standard-strength steel pipe or 2-pound per foot (3 kg/m) flanged channels. Mailbox supports shall include an anti-twist device.

735.03 CONSTRUCTION REQUIREMENTS. Mailbox supports shall be installed a maximum of 24 inches (600 mm) in the ground and shall not be set in concrete.

Existing mailboxes shall be used unless the existing mailboxes are hazardous, damaged or cannot be used as determined by the engineer.

Support-to-box attachment shall be sufficient to prevent the box from separating from the support if the support is struck by an automobile or light truck. Newspaper tubes shall be mounted below the mailbox on the side of the mailbox support.

Disposal of materials by the contractor shall be in accordance with

Sub 202.02 at no direct pay.
Sampling and testing of materials will not be required.

735.04 MEASUREMENT. Mailboxes will be measured per each and will include furnishing new mailboxes. Mailbox supports will be measured per each and will include all materials, bolts, nuts, washers and other components, equipment, and labor necessary to remove and replace mailbox supports, install mailboxes, and install newspaper delivery tubes.

735.05 PAYMENT. Payment will be made at the contract unit price per each.

Payment will be made under:

Item No.	Pay Item	Pay Unit
735-01	Mailboxes	Each
735-02	Mailbox Supports (Single)	Each
735-03	Mailbox Supports (Double)	Each
735-04	Mailbox Supports (Multiple)	Each

Section 736
Traffic Signals

736.01 DESCRIPTION. This work consists of furnishing and installing necessary materials and equipment to complete new traffic signal systems or modify existing systems in accordance with plan details and these specifications.

Unless otherwise specified, all materials shall be new.

When existing systems are to be modified, the existing material shall be incorporated in the revised system, salvaged or abandoned, as specified.

Incidental parts which are not shown on the plans, specified herein or in the project specifications, and which are necessary to complete the traffic signal or other electrical systems or required for modifying existing systems, shall be furnished and installed as though such parts were shown on the plans or specified herein. All systems shall be complete and in operation to the satisfaction of the engineer at the time of final acceptance.

736.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Usable Soil	203.06
Portland Cement Concrete, Class M	901
Reinforcing Steel	1009
Precast Reinforced Concrete Junction Boxes and Manholes	1016
Manhole Frames and Covers	1018.04
Ground Rods	1018.05
Rigid Metal Electrical Conduit	1018.09
Electrical Conductors	1018.10
Traffic Signal Heads	1020.01
Traffic Detectors and Associated Equipment	1020.02
Traffic Signal Hardware and Equipment	1020.03
Pedestal Anchor Bolts	1020.03(c)
Support Cable	1020.03(d)
Guy Components	1020.03(e)
Traffic Signal Cable	1020.03(f)
Electrical Junction Boxes	1020.03(g)
Poles for Traffic Signal Systems	1020.04
Steel Standards and Mast Arms	1020.04(c)

Controllers shall comply with the supplemental specifications entitled "Traffic Signal Control System, Traffic Control Standards.

Traffic detectors and associated equipment shall be included in the Traffic Signal Control System, Traffic Control Standards, unless otherwise noted on the plans.

736.03 REGULATIONS AND CODE. Electrical equipment shall comply with the latest standards of the NEMA or the RMA, whichever is applicable. In addition to the requirements of these specifications, the plans, and the project specifications, material and work shall comply with the latest requirements of NFPA No. 70 National Electrical Code and ANSI C2 National Electrical Safety Code, the Standards of ASTM, ANSI, MUTCD, ITE and IMSA. The term code as referred to in this Section shall be the NFPA No. 70, National Electrical Code, and ANSI C2, National Electrical Safety Code. Discrepancies between codes or standards and these specifications, shall be resolved in accordance with Subsection 105.04.

736.04 GENERAL REQUIREMENTS. The contractor shall verify the location of existing utilities prior to construction. The contractor shall verify the practicality of the location, elevation, and orientation of foundations for poles and pedestals prior to ordering materials.

Traffic control equipment to be salvaged shall be protected during removal and delivery to the specified location. Equipment not to be salvaged shall become the property of the contractor and shall be disposed of in accordance with Subsection 202.02.

The contractor shall use the existing equipment or provide traffic signal equipment during the period of construction for continuous operation of the signal system at no direct pay. Traffic control operations and construction shall be in accordance with the plans or these specifications. Operational differences shall be submitted in writing and approved in advance by the Traffic Engineer.

The contractor shall provide police supervision of traffic at any time the traffic signal system is not in operation at no direct pay.

Minimum clearances for traffic signal supports and apparatus shall be in accordance with the MUTCD. Poles shall be located a minimum of 24 inches (600 mm) outside the shoulder or a minimum of 10 feet (3 m) outside the edge of the travelway whichever is greater.

The contractor shall provide drawings and equipment submittals in accordance with Subsection 730.04, except that the submittal shall be to the Traffic Services and Operations Engineer instead of the Bridge Design

Engineer. Shop drawings and submittals shall include cam breakout details and circuit identifications.

Upon completion of signal and controller work, each cabinet shall contain a plastic envelope with a completed copy of the Traffic Signal Inventory Form, LA. DOTD TSI-1 and a copy of the field wiring terminations pertaining to that intersection. The contractor shall submit to the District Traffic Engineer related documents including equipment manuals, traffic studies, copies of wiring diagrams, and manufacturer's certification letters, for each intersection prior to the new signals or signal modifications becoming operational.

736.05 ELECTRICAL SERVICE. The contractor shall verify the location of the power source and arrange for electrical service in accordance with Subsection 730.09. Existing power service shall be used unless a new power source is indicated on the plans. The traffic signal control equipment shall be in the same quadrant as the power source. If the power source is not in the same quadrant, the contractor shall submit a detailed drawing of proposed changes for approval.

At each power source, a 1-inch (25 mm) diameter conduit with conductors shall be attached to the service pole and terminated with a threaded service entrance fitting (weatherhead) at a height designated by the power company. The wires shall extend a minimum of 24 inches (600 mm) beyond the weatherhead.

736.06 FOUNDATIONS. Excavation for mast arm and strain pole foundations shall be drilled with an auger. Excavation for pedestal poles and controller foundations may be made with an approved auger or by hand. When a cave-in occurs during excavation, the contractor may continue excavating using casing or sleeving. Cave-ins shall be repaired before the foundation is placed. When subsurface obstructions are encountered, the contractor shall remove the obstructions or replace the excavated material and relocate the foundation, as directed, at no direct pay. Forms and ground which will be in contact with concrete shall be thoroughly moistened before placing concrete.

Foundations shall be cast monolithically. The exposed portions shall be formed to present a neat appearance. The bottom and sides of concrete foundations shall rest on firm undisturbed ground. Pole foundations shall be placed with the bored hole as the form. Backfill around a cast-in-place foundation will not be allowed.

Tops of foundations for poles and signal supports, except special

foundations, shall be finished at grade of curb top or sidewalk or as directed. Conduit ends and anchor bolts shall be placed in correct position and shall be held in place by a template.

Exposed surfaces of concrete shall receive a Class 1, Ordinary Surface Finish in accordance with Subsection 805.13 except when the edge of a concrete foundation is within 18 inches (450 mm) of a sidewalk, the sidewalk section shall be in accordance with Section 706.

The tops of mast arm foundations shall be level so the pole base will be in full contact and the pole will be vertical without the use of shims. Anchor bolts shall extend a minimum of 1/4 inch (6 mm) above the nut.

Conduits which terminate in anchor base type poles and pedestals shall extend approximately 3 inches (75 mm) above the foundation and shall be aligned toward the handhole opening.

An additional 2-inch (50 mm) diameter conduit stub-out shall be installed in foundations for future use. The foundation shall be marked as shown on the plans to indicate the location of the additional conduit and grounding conduit.

736.07 PEDESTAL POLES. The pedestal poles shall be installed plumb within 1 inch (25 mm) at the top. Pedestal poles not constructed within the 1 inch (25 mm) tolerance shall be removed and the foundation reconstructed at no direct pay. Shims will not be permitted on a new pedestal foundation. A total of 1/4 inch (6 mm) of shims will be permitted on existing foundations. When an existing pedestal pole cannot be shimmed within tolerance through no fault of the contractor, the existing foundation shall be replaced in accordance with Subsection 109.04.

736.08 MAST ARMS. After installation and loading, mast arm shaft shall be plumb within 1 inch (25 mm) at the top. The end of the mast arm shall be a minimum of 5 feet (1.5 m) above the top of the shaft. The end of the mast arm shall be a minimum of 21 feet (6.4 m) above the bottom of the transformer base. The mast arms shall be installed with compression grommet bushing (CGB) connectors in bosses utilized for cabling.

736.09 STRAIN POLES. Strain poles for the attachment of support cables shall be the anchor base type. Support cable shall be attached in accordance with Subsection 736.12. Poles shall be plumb within 6 inches (150 mm) at the top after support cable tensioning in accordance with the plans.

736.10 TIMBER POLES. Poles shall be set in holes drilled by an auger to a minimum depth of 6 feet (1.8 m). Auger diameter shall be approximately 4

inches (100 mm) greater than the pole butt diameter. The poles shall be embedded in the ground a minimum of 20 percent of the pole length. The poles shall be plumb within 6 inches (150 mm) at the top after support cable tensioning in accordance with the plans. Backfill material shall be provided and compacted as directed.

Holes for the attachment of support cables shall be fitted with 5/8-inch (16 mm) diameter thimble-eye through-bolts and 2 1/2 inch (65 mm) square curved washers.

Each pole shall have a continuous length of No. 8 AWG copper wire along the length of the pole. A minimum of 6 feet (1.8 m) of the copper wire shall be coiled and attached to the bottom of the pole forming a coil ground. The copper wire shall extend a minimum of 6 inches (150 mm) above the top of the pole. The wire shall be stapled with galvanized 1 1/2 inch (40 mm) staples at approximately 6-inch (150 mm) intervals beginning at the butt, then at approximate 12-inch (300 mm) intervals beginning at 12 feet (3.6 m) from the butt and continuing to the top of the pole.

Anchors shall be installed on new poles in accordance with the plans.

736.11 GUY WIRE ASSEMBLIES. Guy wire shall be attached to the pole with a 5/8-inch (16 mm) diameter angle thimble-eye bolt of appropriate length through a lift plate fastened to the pole by two 3/8-inch (9.5 mm) diameter lag screws. The opposite side of the pole shall have a 2 1/2 inch (65 mm) square curved washer, a square nut, and a thimble-eye nut for termination of support cable. An additional square nut shall be used as a locking nut against the thimble-eye nut.

Hardware shall be tightened against the pole. Excess bolt length shall be sawn to within 1/4 inch (6 mm) of the nut and the galvanized coating repaired in accordance with Subsection 811.12.

The guy assembly shall have strain insulator, thimble eye anchor rod, service sleeves, and screw-type anchors as shown on the plans. Installed anchors shall develop holding strength and be properly aligned to provide permanent stability to the installation.

Guy assemblies shall be installed and tensioned before erection of signals so that they will resist the major portion of the horizontal loading.

736.12 SUPPORT CABLE. Support cable with accessories shall be installed between two or more poles to provide support and attachment for traffic control equipment. Support cables shall be grounded. Accessories used with support cables shall include strain insulators and three-bolt clamps. Long strain insulators shall be used as needed for safety clearance and shall

require approval when not shown on the plans. Attachments of the support cable shall be made with standard thimble-type hardware.

736.13 VEHICLE AND PEDESTRIAN SIGNAL HEADS. Signals shall be vertical unless otherwise specified. Cable suspended heads shall be fitted with a universal hanger. Drop pipes will be allowed only when necessary to provide proper roadway clearance. Disconnect hangers shall be required for cable suspended heads.

Mast arm mounted signals shall be installed using an approved adjustable rigid bracket.

Each bulb in the signal head shall be connected to an individual wire from the controller. Lamp sockets shall be rotated to position the open portion of the lamp filament upward.

Each signal head shall be oriented to its lane or crosswalk and secured in place by a serrated or other locking device incorporated in signal housing and support hardware. Supporting brackets on trunnions shall be used at the top and bottom of the section assembly to rigidly support all faces. Openings not used for mounting purposes shall be closed with approved threaded weatherproof plugs.

A minimum of 8 feet (2.4 m) between signal heads is required, measured between imaginary lines centered on each signal head parallel to the approach. The signal head shall be aimed within 3 degrees of parallel to the approach lane to which it applies, or as directed.

Vehicular signal heads shall be covered with a sturdy opaque material until placed in service.

A 12-inch (300 mm) light emitting diode (LED) traffic signal lamp unit shall be provided as part of a new traffic signal head or as a retrofitted replacement into a new or existing signal housing.

Installation of a retrofitted replacement LED traffic signal lamp unit into a new or existing signal housing shall only require removal of the existing lens and incandescent lamp, fitting of the new unit securely in the housing door, and connecting the new unit to existing electrical wiring or terminal block by means of simple connectors. The LED retrofit will not require removal of the reflector. The existing wiring for the incandescent socket shall remain in place, but shall be disconnected from the terminal block, and neatly coiled adjacent to the terminal block with connectors taped with electrical tape to prevent accidental short circuits.

If proper orientation of the LED traffic signal lamp unit is required for optimum performance, prominent and permanent directional marking(s), such as an “UP arrow”, for correct indexing and orientation shall be clearly

displayed on the unit.

The contractor shall neatly inscribe the installation date on the back of each LED traffic signal lamp unit.

Each LED traffic signal lamp unit shall be provided with a complete and accurate installation wiring guide and the name, address, and telephone number for the representative, manufacturer, or distributor for warranty replacement.

Each LED traffic signal lamp unit shall be individually packaged and delivered securely bound on pallets. Each package shall be labeled with the manufacturer's name, individual serial number, manufactured date, model, and batch or lot number.

736.14 VEHICLE LOOP DETECTOR INSTALLATION. Slots shall be sawed in the pavement for installation of vehicle detector loop wire in the configuration, dimensions, and combinations as shown on the plans. An extension from the loop to the pavement edge shall be cut to permit wire routing to an adjacent pullbox or condulet through a 1/2-inch (13 mm) conduit.

Slots shall be cleaned of loose material. The engineer shall examine and approve the depth of each loop slot for conformance with the plans before the contractor places the loop wires in the slot. Wires shall be carefully placed in the slot. The number of turns of wire installed for each loop shall be as required. The wire shall be pushed carefully into the slots with a blunt tool to avoid damaging the insulation. No splices will be permitted in the loop installation except in the pull-box, conduit fittings or pole. Wires from the pavement to the controller box shall be installed inside a conduit as shown on the plans. Wire installed from the pavement edge to the splice shall be twisted uniformly at 2 to 5 turns per foot (7 to 16 turns/m). The loop ends shall be spliced to a lead-in cable. The lead-in cable shall be connected inside the controller cabinet. The wires shall be spliced using an approved connector and by soldering, then encapsulated with an approved electrically insulating waterproof epoxy as shown on the plans. The condulet shall not be filled with the approved insulating waterproof epoxy.

The slots shall be completely filled to within 1/8 inch (3 mm) of the pavement surface with an approved sealant.

736.15 PEDESTRIAN PUSHBUTTON. Pushbuttons shall be installed on poles or pedestals at locations where the signal head is visible from the pushbutton location. Push-buttons mounted on steel poles shall be serviced by wiring inside the poles. Wires shall be installed through a 3/4-inch (20 mm)

diameter hole in the pole and through the back of housing and shall be installed with a rubber grommet. Unused conduit attachment holes shall be plugged. The housing shall be attached to the pole using machine or selftapping screws.

Pushbuttons mounted on wood poles shall be wired through conduit. Pedestrian pushbutton signs shall be installed above the pushbutton.

736.16 ELECTRICAL. Wires in cabinets shall be neatly laced into cables with nylon lacing or plastic straps.

Conductors shall be installed in conduit except where the run is inside poles or suspended from support cable.

After completion of field wiring, the conduit entering cabinets, pole bases, or junction boxes shall be sealed with a removable sealing material compatible with the cable jacket, insulation and conduit material.

Support cable, metallic cable sheaths, conduit, transformer cases, metal poles and pedestals shall be made mechanically and electrically secure and grounded. Bonding and grounding jumpers shall be No. 6 AWG copper wire. Equipment on wood poles shall be grounded.

Cable from the circuit breaker at the service to the controller shall consist of a minimum of three No. 6 AWG THWN stranded copper wires.

Six feet (2 m) of spare signal, loop lead-in and communication cable shall be installed in each base-mounted cabinet. Field wiring shall be connected to terminals by one piece, screw-tightened lugs.

Aerial signal cable shall have a drip loop extending at least 6 inches (150 mm) below the entrance. The aerial signal cable and drip loop shall not chafe on the equipment.

Signal cable shall be installed between signal heads and controller cabinets. When specified, interconnect and/or communication cable shall be installed between controller cabinets of different intersections. Signal, interconnect, and/or communication cable may be lashed to support cable or installed in underground conduit as shown on the plans. Lashing material shall be stainless steel for interconnect and aluminum for signal cable.

736.17 CONDUIT INSTALLATION. Underground wiring shall be enclosed in conduit. Conduit connections shall use threaded couplers and shall be sealed with a waterproof sealant. Coupling of new conduit to existing conduit shall be with a three-piece coupling.

Threads shall be clean cut, straight and true, and of sufficient length to permit full-depth coupling. Excessive threads will not be permitted. Ends of conduit installed for future connections shall be threaded, reamed and capped.

Couplings shall be tightened until the conduit ends are together. Damaged coatings in exposed threads shall be repaired in accordance with Subsection 811.12. Exposed threaded ends of conduit shall be terminated with an insulated-throat, ground-type bushing.

Backfilling shall be with usable soil, placed and compacted to at least the density of the surrounding ground at no direct pay. After installation, conduits shall be tested for clearance with a 2 inch (50 mm) long mandrel having a diameter 1/4 inch (6 mm) smaller than the inside diameter of the conduit. Conduits not allowing passage of the mandrel will be rejected.

The contractor may install larger size conduit at no direct pay. No reducing couplings will be permitted in a conduit run.

Underground conduits shall be buried a minimum of 18 inches (450 mm) below the surface. Conduits for loop detectors shall be installed parallel to existing or proposed curbs and a maximum of 24 inches (600 mm) behind the back of curb or as directed. Conduit shall be jacked or bored under existing pavements and within the drip line of trees in accordance with Section 728.

736.18 CONTROL EQUIPMENT. Field wiring in controller cabinets and bases shall be neatly arranged, lashed into cables, routed to the appropriate terminal blocks, and permanently identified near the terminal.

Controller equipment programming shall be provided by the contractor. When the information supplied by the Department is insufficient for functional operation of the installed equipment, the contractor shall notify the engineer in writing of the problem identifying discrepancies, and proposing specific remedies or corrections. After programming, controller equipment operations shall be tested with the signals off, using the signal shutdown switch.

736.19 JUNCTION BOXES. Junction boxes, when shown on the plans, are required a minimum of every 150 feet (45 m) in a conduit run. Backfilling shall be with usable soil, shall conform to Subsection 701.08, and shall be placed and compacted to the density of the surrounding ground at no direct pay. All metal covers and conduits shall be bonded together.

Electrical conductors shall be installed clear of the metal frames and covers.

Pull box fittings shall be used on conduit longer than 180 feet (55 m). Pull box fittings shall be installed at a minimum spacing of 90 feet (27 m).

736.20 EQUIPMENT TESTING.

(a) Manufacturer's Tests: When design tests are specified herein, additional tests will not be required if documentation is provided indicating that such tests have been previously completed. Equipment shall be subject to factory demonstration tests and design approval tests at a location agreed upon by the contractor and the Department. The Department reserves the right to have its representative witness all factory demonstration tests and design approval tests.

Performance tests may be required on equipment not previously tested or approved. The Department will not be responsible for time lost or delays caused by sampling and testing prior to final approval of any item.

The contractor shall conduct special tests when equipment or systems are suspected of improper operation, or when additional data is necessary to determine proper operation or conformance with specifications.

A test shall be performed on the completely assembled equipment, cabinet, and control equipment by the manufacturer prior to shipment. Malfunctions or defects shall be corrected and the equipment retested. The complete log beginning with the first test, showing the results of the test shall be delivered with the equipment. The test shall require the operation of the equipment with each signal circuit connected to an incandescent load of a minimum of 600 watts. The equipment shall operate sequentially and continuously for a minimum of 48 hours as stated above in an environment having a minimum temperature of 140°F (60°C).

(b) Insulation Tests: Insulation tests shall be made between conductors and ground and between conductors. Tests shall be made after the conductors are installed and before connecting equipment that may be damaged by the tests. Readings below 50 megohms, when measured with a 1000 volt D.C. insulation tester, will be considered defective.

(c) Test Documentation: Documentation shall include a Certificate of Compliance, two sets of cabinet wiring drawings, and technical manuals for the control equipment. Cabinet drawings shall be DOTD standard blue line copies, with the manufacturer's name, equipment model number, project number, sheet number, date and revision block.

736.21 MEASUREMENT.

(a) Trenching and Backfilling: Trenching and backfilling will be measured by the linear foot (lin m) of excavated trench backfilled and accepted.

(b) Conduit with Conductors: Conduit with conductors will be measured by the linear foot (lin m) of conduit with conductors installed and

accepted. Measurement will include conduit, conductors, clamps, fittings, above ground junction boxes, and miscellaneous hardware required for a complete conduit installation.

(c) Jacked or Bored Conduit: Jacked or bored conduit will be measured by the linear foot (lin m) of conduit furnished and installed. Measurement will include the conduit, fittings, excavation, backfilling and duct markers.

(d) Signal Support: Signal supports will be measured per each signal or strain pole installed and accepted. Measurement will include the pole, mast arm, base assembly, guy wires and hardware, signal support cables and hardware, traffic signal cables inside pole, concrete foundation, reinforcing steel, conduits in foundation, ground rod, ground wires, ground clamp, hardware, drilled excavation, backfill, grout, electrical oxide-inhibiting compound and disposal of excess excavated material.

(e) Signal Heads: Signal heads will be measured per each head installed and/or retrofitted, and accepted. Measurement will include disconnect hangers, traffic signal wiring attached to overhead span, closure caps, mounting hardware, LED traffic signal lamp units, head programming, mounting connections and hardware.

(f) Signal Service: Signal service will be measured per each service assembly installed and accepted. Measurement will include pole, disconnect, ground rod, wire and conduit on service pole, conduit and conductors on utility company pole, and connections and hardware required.

(g) Traffic Signal System: Traffic signal systems will be measured on a lump sum basis, which will include furnishing and installing all equipment and apparatus, and performing work required for a complete system.

(h) Signal Controller: Signal controllers will be measured per each controller installed and accepted. Measurement will include all electronic control equipment specified, prewired cabinet, foundation, conduits in foundation, ground rod assembly, anchor bolts and hardware, connections, documentation, programming, and testing.

(i) Loop Detector: Detectors will be measured by the linear foot (lin m) of sawn slot. Measurement will include sawing, installed wire and sealing. Measurement will be made from the edge of the pavement and once around each loop perimeter.

(j) Underground Junction Box: Underground junction boxes will be measured per each box installed and accepted. Measurement will include the box, cover, excavation, backfill and any concrete patching required.

(k) Conduit: Conduit will be measured by the linear foot (lin m) point to point of conduit installed and accepted. Measurement will include conduit

(including conduit within junction boxes), clamps, fittings, above ground junction boxes, and all miscellaneous hardware required for a complete conduit installation.

(l) Conductors: Conductors will be measured by the linear foot (lin m) of conductor installed and accepted. Measurement will include conductor, clamps, connectors, and all miscellaneous hardware required for a complete conductor installation.

(m) Cable: Cable will be measured by the linear foot (lin m) of cable installed and accepted. Measurement will include cable, clamps, connectors, and all miscellaneous hardware required for a complete cable installation.

736.22 PAYMENT. Payment for traffic signal work will be made at the contract unit prices, which include all materials, tools, equipment, labor and incidentals necessary to complete the work.

The concrete in foundations for signal supports, signal controllers, and other signal equipment will be identified by lots and shall be subject to pay adjustments in accordance with Table 901-6 and Note 1 therein. Size, sampling, and testing of each concrete lot shall be in accordance with the Materials Sampling Manual.

Payment will be made under:

Item No.	Pay Item	Pay Unit
736-01	Trenching and Backfilling	Linear Foot (Lin m)
736-02	Conduit with Conductors (Size & Type)	Linear Foot (Lin m)
736-03	Jacked or Bored Conduit (Size & Type)	Linear Foot (Lin m)
736-04	Signal Support (Size & Type)	Each
736-05	Signal Heads (Type)	Each
736-06	Signal Service	Each
736-07	Traffic Signal System	Lump Sum
736-08	Signal Controller	Each
736-09	Loop Detector	Linear Foot (Lin m)
736-10	Underground Junction Box	Each
736-11	Conduit (Size & Type)	Linear Foot (Lin m)
736-12	Conductor (Size & Type)	Linear Foot (Lin m)
736-13	Cable (Size & Type)	Linear Foot (Lin m)

Section 737
Painted Traffic Striping

737.01 DESCRIPTION. This work consists of furnishing and applying reflective white or yellow paint for pavement striping in accordance with plan details, the MUTCD and these specifications.

737.02 MATERIALS. Traffic paint shall be either quick dry alkyd or waterbased traffic paint complying with Subsection 1015.12. Glass beads for drop-on application shall comply with Subsection 1015.13.

737.03 EQUIPMENT. Selection of proper equipment to produce satisfactory results within the following requirements shall be the responsibility of the contractor.

(a) Equipment shall permit traffic to pass safely within the limits of the roadway surface and shoulder while operating.

(b) Equipment shall be designed for placement of both solid and broken line stripes of the spacing shown on the plans with square, neat stripe ends.

(c) Equipment shall provide a method for cleaning the surface of dust immediately prior to placement of striping materials.

(d) Equipment shall provide a gravity bead dispenser for drop-on application of glass beads.

(e) The equipment shall provide accurate regulation of the application rate and shall have a tachometer or other approved device to ensure uniform paint application at the designated rate. The equipment shall be adjustable for applying one, two or three adjacent lines simultaneously at the specified spacing and be equipped with a device capable of following a control line. Operation of the unit shall be such that paint will not be spattered or blown on another stripe. The unit shall be designed to properly agitate the paint while in operation.

(f) The equipment may be equipped with a heat exchanger to heat the paint to reduce drying time.

(g) The operation shall include a trailing vehicle equipped with a flashing arrow board.

737.04 CONSTRUCTION. Yellow centerline striping shall be used to delineate traffic moving in opposite directions. White lane line striping, shall be used to delineate traffic moving in the same direction. These stripings shall

be broken lines and solid lines as required by Part 3 of the MUTCD. Edge lines shall be solid lines, the color of which shall be determined from Part 3 of the MUTCD.

Pavement striping shall be 4 inches (100 mm) in width on all routes. Striping widths for gore markings and turning lanes shall be 8 inches (200 mm) unless noted otherwise in the plans. All lines shall have clean edges with a width tolerance in accordance with Subsection 737.08. The project engineer may waive the tolerance when deviations are caused by undulation in the pavement surface.

Broken lines shall be constructed with a stripe-to-gap ratio of a 10-foot (3 m) paint stripe to a 30-foot (9m) gap. The length of the stripe shall be 10 feet (3 m) minimum and 10 1/2 feet (3.2 m) maximum. The stripe-gap cycle shall be 40 feet (12 m) minimum and 40 1/2 feet (12.3 m) maximum.

The contractor shall apply all striping on new pavement prior to opening to traffic, except when rain or other unavoidable occurrences prevent marking the pavement, in which case the pavement shall be marked as soon as conditions permit.

737.05 SURFACE PREPARATION. Surfaces to be striped shall be cleaned of materials that may reduce adhesion of paint to pavement. Surfaces shall be kept clean and dry at the time of application of paint.

737.06 WEATHER LIMITATIONS. No paint striping shall be done when the pavement surface is not thoroughly dried, when the air is foggy or misty, when the air or surface temperature is below 50°F (10°C), or when wind or other condition causes a film of dust to be deposited on the surface after cleaning and before striping can be done or causes displacement of striping material.

737.07 APPLICATION. The longitudinal joint or existing centerline stripe shall be used in determining the location of the centerline of new striping. In the absence of a longitudinal joint or existing stripe, the location of the centerline of new striping shall be located by the contractor with the approval of the engineer. Broken line individual intervals will not be marked. No striping material shall be applied over a guide stringline.

(a) Paint Preparation: Immediately before application, paints shall be agitated and mixed thoroughly to a uniform consistency, free from lumps or agglomerates. Paints shall be kept covered to retain volatiles. Paints shall not be thinned without approval.

Paint may be heated in heat exchangers to accelerate drying, to a

temperature between 110°F and 130°F (43°C and 54°C) for waterbased paint, and between 120°F and 150°F (49°C and 66°C) of solvent based paint.

(b) Application Rate: Paint shall be applied at the rate of 25 gallons per mile (59 L/km) at a thickness of 22 wet mils (560 wet µm) and 15 dry mils (380 dry µm) to produce a 4-inch (100 mm) wide solid line. Temporary paint shall be applied at a thickness of 15 wet mils (380 wet µm).

Glass beads, complying with Subsection 1015.13, shall be applied at the same time as the paint but in a separate operation at the rate of 10 pounds of beads per gallon of paint (1.2 kg/L).

737.08 TOLERANCES. A tolerance of +1/2 inch and -1/8 inch (+13 mm and -3 mm) from the specified width will be allowed, provided the variation is gradual. Segments of broken line may vary ±6 inches (150 mm) from the specified length provided it is not consistently short. Segments shall be squared off at each end without mist or drip. Longitudinal painted lines shall not deviate from established alignment by more than 1 inch (25 mm) provided the variation does not increase or decrease at the rate of more than 1/2 inch in 25 feet (15 mm in 10 m). Lines not meeting these tolerances shall be removed by abrasive blasting or grinding and replaced at no direct pay.

737.09 PROTECTION OF MARKINGS. Traffic shall be prevented from crossing a wet stripe. The contractor shall use flaggers or other methods to prevent traffic from crossing the wet stripe or adjust the operation. Stripes that have been marred or picked up by traffic before they have dried shall be repaired by the contractor at no direct pay. The pavement shall be cleaned outside the stripe at no direct pay.

The contractor is not required to maintain striping which has been accepted and opened to traffic.

737.10 PROTECTION OF TRAFFIC. The contractor shall furnish and place all necessary temporary warning and directional signs to direct and protect the traveling public during striping operations.

The pavement striping equipment shall move in the direction of normal traffic flow. The trailing vehicle shall be equipped with an approved flashing arrowboard for directing traffic to the appropriate side during striping operation, when required. Temporary signs, cones and equipment shall be removed from the roadway when striping equipment is not in operation.

Protective and traffic marking devices shall comply with Section 713.

The contractor shall be responsible for resolving all issues related to paint on private vehicles at no direct pay.

737.11 FIELD TESTING OF PAINTED TRAFFIC STRIPING: The Department will field test the pavement markings in accordance with Subsection 1015.12 and Table 737-1. Failure to meet these requirements will require the contractor to replace the portion of the material shown to be out of specifications as directed by the engineer.

737.12 CORRECTIVE WORK: Any line found to be defective shall be restriped or replaced as directed by the engineer. The corrective work shall also be subject to these requirements. The contractor shall replace the painted traffic striping material at no cost to the Department.

737.13 GUARANTEE: The contractor shall provide the Department with a guarantee stating that if the painted traffic striping fails to comply with the stated performance requirements, the contractor shall take the remedial action required. Replacement striping shall carry the unexpired guarantee of the striping it replaces.

737.14 MEASUREMENT. Painted Traffic Striping will be measured by the mile (km) or linear foot (lin m) as specified.

(a) Mile (km): Measurement will be by the mile (km) of single stripe per roadway. No deduction will be made for the standard 30-foot (9 m) design gaps in broken-line striping; however, deductions will be made for the length of other omitted sections.

(b) Linear Foot (Lin m): Measurement will be by the linear foot (lin m), exclusive of gaps.

737.15 PAYMENT. Payment for painted traffic striping will be made at the contract unit prices.

Payment will be made under:

Item No.	Pay Item	Pay Unit
737-01	Painted Traffic Striping (Solid Line)	Mile (km)
737-02	Painted Traffic Striping (Broken Line)	Mile (km)
737-03	Painted Traffic Striping (Solid Line)	Linear Foot (Lin m)

Table 737-1
Field Testing of Painted Traffic Striping

Length of Roadway	Number of Random Test Segments	Length of Test Segments
Less than 1 mile (1.5 km)	3 segments per line type	250 feet (75 m)
1 mile (1.5 km) to 9 miles (14.5 km)	3 segments per line type	1000 feet (300 m)
Greater than 9 miles (15 km)	1 segment per every 3 miles (4.8 km) per line type	1000 feet (300 m)

Measurements

1. Test segments will be selected randomly by the engineer unless night reviews or other knowledge supersedes a random selection process.
2. Each line type will be measured separately.
3. Measurements will be taken on dry, clean roadways.
4. Data will be collected in direction of traffic flow.
5. A minimum of 10 readings will be taken in each test segment line type.
6. On broken lines (skip striping), no more than two readings will be taken per stripe, with readings 20 inches (0.5 m) from ends of marking.
7. For solid lines, the test segment will be divided into ten locations of 100 feet (30 m) each; readings will be spaced a minimum of 25 feet (7.5 m) and a maximum of 150 feet (45 m) apart.
8. The Department may take additional readings or test segments.
9. Acceptance will be based on the average of the readings for each test segment for each line type.
10. Failure of the average reading for any segment to meet the specified minimum values will require replacement.
11. Limits of replacement will be determined by the engineer.

Section 738
Mulch Sodding

738.01 DESCRIPTION. This work shall consist of furnishing, hauling, spreading, fertilizing and liming (if required), rolling, watering and maintaining live bermuda grass roots and topsoil at locations shown on the plans or as directed.

738.02 MATERIALS. Mulch sod shall consist of a combination of grass roots and topsoil. Mulch sod shall be predominately bermuda grass or other approved grass roots reasonably free of weeds and debris.

Topsoil shall comply with Subsection 715.02.

Fertilizer and agricultural lime shall comply with Section 718.

Water may be obtained from any source except brackish, chemically contaminated, or oily water shall not be used.

738.03 EQUIPMENT. A single or double type soil roller or cultipacker weighing not less than 500 pounds (225 kg) and not more than 1500 pounds (680 kg) will be required.

Water wagons, tanks or sprinkling devices will be required.

738.04 CONSTRUCTION REQUIREMENTS.

(a) Digging: The source of mulch sod approved by the Roadside Development Specialist shall be mowed and raked when necessary. Mulch sod shall not be stockpiled for more than 48 hours.

Mulch sod shall be free of tree roots, tops, branches or other debris. Such foreign material shall be removed prior to the sod being stockpiled or delivered.

When agricultural lime is necessary to adjust the soil pH to between 5.5 and 8.0, it shall be done on sod field prior to stockpiling and delivery at no direct pay.

(b) Hauling: Mulch sod shall be loaded with suitable equipment, hauled and spread on the areas designated on the plans or as directed.

(c) Surface Preparation: Fertilizer shall be broadcast over the entire area to be mulch sodded before mulch sodding is placed and disked. When required, agricultural lime or other treatment to adjust pH to between 5.5 and 8.0 shall be applied to the area to be mulch sodded prior to scarifying. Areas to receive mulch sod shall be scarified and pulverized to a depth of

approximately 3 inches (75 mm) and dressed to grade at no direct pay.

(d) Spreading: The mulch sod shall be spread to a depth of approximately 6 inches (150 mm) in such a manner that a minimum amount of roots are exposed. Spike tooth harrows or drags shall not be used to spread mulch sod. The mulch sod shall be dressed to grade.

(e) Rolling: The mulch sod shall be rolled with a cultipacker or soil pulverizer as directed. Locations inaccessible to rolling equipment shall be hand tamped.

(f) Watering: Mulch sod shall be watered and kept moist as directed until satisfactory growth is established at no direct pay.

738.05 MEASUREMENT. Mulch sod will be measured by the cubic yard (cu m) in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

Fertilizer will be measured and paid for in accordance with Section 718. Agricultural lime, when specified, will be measured and paid for in accordance with Section 718.

738.06 PAYMENT. Payment for mulch sod will be made at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
738-01	Mulch Sodding	Cubic Yard (Cu m)

Section 739
Hydro-Seeding

739.01 DESCRIPTION. This work consists of preparing seed beds and sowing grass seed utilizing hydro-seeding equipment and methods in order to establish a turf grass cover to areas designated on the plans or as directed.

739.02 BED PREPARATION. Seed beds shall be prepared in accordance with Subsection 717.04.

739.03 HYDRO-SEEDING GENERAL. Hydro-seeding shall consist of mixing and applying seed, commercial fertilizer, water management gel, polyacrylamide tackifier, and mycorrhizal inoculum with paper or wood fiber and water. Seed and commercial fertilizer shall be uniformly spread over the area at the rates specified in Table 717-1 and Table 718-1. Paper or wood fiber shall be mixed and applied with the seed in accordance with the manufacturer's recommendations and as approved by the engineer. The contractor will be permitted to include fertilizer and lime in the seeding slurry for application during hydro-seeding operations.

The application rate for pellet-inoculated seed shall be determined using the seed mass exclusive of inoculant materials.

The materials and the quantities thereof to be mixed with water will be specified. The quantity of water shall be as needed for application.

Mixing of materials for application with hydro-seeding equipment shall be performed in a tank with a built-in continuous agitation system of sufficient operating capacity to produce a homogeneous mixture and a discharge system which will apply the mixture at a continuous and uniform rate. The tank shall have a minimum capacity of 962 gallons (3700 L). The engineer may authorize use of equipment of smaller capacity if it is demonstrated that the equipment is capable of performing all operations satisfactorily.

A dispersing agent may be added to the mixture provided the contractor furnishes evidence that the additive will not affect germination. Any material considered detrimental, as determined by the engineer, shall not be used.

Any mixture containing polyacrylamide tackifier shall not be applied during any rainy weather or when soil temperatures are below 41°F (5°C) or if the wind speed is above 20 miles per hour (32 km/h). Pedestrian traffic or equipment shall not be permitted to enter areas where hydro-seeding has been applied.

Prior to planting, the engineer will contact the Department's roadside development personnel to select the varieties of seed to be used.

739.04 MEASUREMENT. Quantities for hydro-seeding will be measured by the acre (ha).

739.05 PAYMENT. Payment for hydro-seeding will be made by the acre (ha) and shall include the seed, mulch, tackifier, lime, fertilizer, water and bed preparation as a system.

Payment will be made under:

Item No.	Pay Item	Pay Unit
739-01	Hydro-Seeding	Acre (ha)

Section 740
Construction Layout

740.01 DESCRIPTION. This section sets forth requirements for all construction layouts. The work consists of establishing lines and grades, taking all cross sections, and staking out the construction work in accordance with these specifications, plan details, and as directed. This work also includes but is not limited to, the layout of pavement striping and raised pavement markers, setting of line and grade for construction of superelevated curves or other applicable work items, and providing assistance in the coordination of utility relocation activities to ensure that the placement of relocated facilities will not conflict with required construction.

740.02 CONSTRUCTION REQUIREMENTS. The contractor shall establish all lines and grades and stake out all work on this project, including sufficient vertical and horizontal points for utility relocations for use by the Department and others.

The project survey control and horizontal alignment are based on the Louisiana State Plane Coordinate System (NAD-83--92), as determined by GPS observation. The construction plans and/or right-of-way map depicts the coordinates of sufficient survey control points to establish or re-establish horizontal control throughout the length of the project. The contractor shall employ such methods as approved by the project engineer for the location of the project alignment and other necessary survey control points in accordance with currently acceptable surveying standards and practices. When required, the Department will also provide one bench mark on or near the project for vertical control. The contractor shall verify the values of any intermediate bench marks shown on the plans, by checking against the bench mark established by the Department for vertical control.

The contractor shall employ qualified engineering and surveying personnel experienced in layout and construction of highways and bridges to correctly establish and keep complete and comprehensive notebook records (field books) of all lines and grades necessary from initial layout to final acceptance. The contractor shall provide sufficient qualified staff, of at least one employee, on site during utility relocation periods. The contractor shall provide any necessary survey work to ensure there are no utility conflicts with required construction. The contractor shall provide daily documentation of utility relocation activities for incorporation into the project diaries.

The contractor shall be liable for the accuracy of the initial layout and all subsequent alignment and elevations and shall, at no additional pay, rebuild, repair or make good any portion of the work found to be incorrectly positioned either horizontally or vertically at any time before final acceptance. The contractor shall notify the engineer immediately of any apparent errors in the plans. The contractor shall compute and provide template grades to the engineer. In order to obtain pipe order lengths, the appropriate grades shall be provided to the engineer two weeks in advance of the work.

Numbered notebooks for recording of all lines and grades will be provided by the Department and shall be properly indexed and cross referenced by the contractor before return to the engineer for submittal with the final estimate. Computer generated printouts will be allowed when approved.

Stationing for overlay projects shall be set using an approved measuring device that is accurate to 0.1 percent. Stakes shall be placed every 100 linear feet (50 lin m) and maintained by the contractor throughout construction.

Layout of striping, raised pavement markers, and signs shall be done by methods approved by the engineer prior to placement.

740.03 MEASUREMENT. Measurements for determination of pay quantities will be made by the Department. Construction layout and utility oversight and coordination will be measured per lump sum, which will include all labor, materials and incidentals required to complete the work.

No changes in the lump sum contract price will be made for minor additions or deletions to the scope of work.

740.04 PAYMENT. Payment for construction layout, and utility oversight and coordination will be made at the contract lump sum price in accordance with Table 740-1 and Table 740-2, respectively.

Table 740-1
Construction Layout Payment Schedule

Percent of Total Contract Amount Earned	Allowable Percent of Lump Sum Price for Construction Layout
Staffed	25
25	50
50	80
75	95
100	100

Table 740-2
Utility Oversight and Coordination Payment Schedule

Percent of Utility Relocation Complete	Allowable Percent of Lump Sum Price for Construction Layout
Staffed	25
25	50
50	65
75	80
100	85
Project Completion	100

Payment will be made under:

Item No.	Pay Item	Pay Unit
740-01	Construction Layout	Lump Sum
740-02	Utility Oversight and Coordination	Lump Sum

Section 741
Water Distribution Systems

(Supplemental Specification)
(Under Separate Cover)

Section 742
Sanitary Sewer Systems

(Supplemental Specification)
(Under Separate Cover)

Section 743
Airport Pavement Markings

(Supplemental Specification)
(Under Separate Cover)

PART VIII--STRUCTURES

Section 801
General Requirements for Structures

801.01 DESCRIPTION. This section sets forth general requirements for construction of bridges and other structures and includes preparation and submittal of shop drawings and other data.

The contractor will be allowed to construct a bridge using any combination of compatible superstructure and substructure details shown on the plans. A precast superstructure may be combined with the compatible cast-in-place bent caps and a precast or cast-in-place concrete barrier rail may be used with the precast slab.

Before beginning construction, the contractor shall notify the engineer in writing as to which alternates are to be used and any deviation will require approval of the engineer.

Any changes in the plans due to combining precast or cast-in-place superstructure with precast or cast-in-place substructure will be the responsibility of the contractor and shall be submitted to the engineer for approval.

Work within wetlands, navigable waters or adjacent areas shall comply with Subsection 107.09.

801.02 BORINGS. Soil borings and other soil investigations and soil analyses will be provided by the Department for development of subsurface information for bridge foundations. This data will be included in the plans for informational purposes. Bidders should make such additional investigations as they consider necessary to determine soil conditions.

If subsurface conditions differing materially from those indicated in the plans are encountered at the site, the contractor shall promptly notify the Engineer in writing of the specific differing conditions before the site is further disturbed and before additional work is performed.

801.03 SHOP DRAWINGS, WORKING DRAWINGS AND OTHER SUBMITTALS.

(a) General: The contractor shall submit shop drawings, working drawings and other submittals for approval. Two prints of required shop or working drawings shall be submitted to the Bridge Design Engineer for checking, one of which will be returned with either approval or required

revisions noted thereon. For final approval and distribution, nine prints of each checked drawing shall be submitted to the Bridge Design Engineer. Sheets shall be assembled in sets and placed in numerical order prior to submittal.

When specified, the contractor shall furnish the consulting engineers in lieu of the Bridge Design Engineer, shop and working drawings for checking, approval, and distribution. A copy of each transmittal letter shall be sent to the Bridge Design Engineer.

No work shall be started until final approval of shop and working drawings has been obtained. No direct payment will be made for required shop and working drawings and other submittals. Review and approval of these drawings and other required submittals will not relieve the contractor of responsibility under the contract.

A shop drawing submittal schedule shall be submitted to the Bridge Design Engineer prior to the preconstruction conference.

Changes on drawings shall be noted and dated to show that a revision has been made.

(1) Drawing Format: Tracings and subsequent reproductions shall have an outside measure of 22 by 34 inches (560 mm by 863 mm) with distance between margins measuring 21 by 31.5 inches (530 mm by 800 mm). Top, bottom and right margins shall be 1/2 inch (15 mm). Each sheet shall have a title block with the state project number, project name, parish, sheet number, date, and revision block. The title block location and format shall be consistent with the contract plan. If a fabrication plant is involved, the name of the fabricator's plant location will be included in the title block.

a. Original Tracings: Original tracings shall be ink drawings or plottings on polyester translucent matte film 0.004 inch (0.1 mm) thick and have matte surfaces on both sides.

b. Reproductions: Reproductions shall be a black image on opaque white bond paper. The minimum specification for the paper shall be a high quality 24 pound weight with a brightness of 95 percent. The image shall be a permanent type that will not smear or rub off due to normal handling and stacking, and will produce a satisfactory scanned image for archiving. Additions or changes shall be reflected on the final sheet.

(2) Structural Shop and Working Drawings: The control set of structural steel and prestress girder shop drawings will be obtained by the Bridge Design Section from the Construction Section for archiving. The original tracings or reproductions of original working drawings shall be

delivered to the Bridge Design Engineer upon completion of fabrication or erection.

(3) Other Structures: One set of the final approved shop and working drawings suitable for microfilming shall be delivered to the Bridge Design Engineer upon completion of fabrication or erection.

(b)Falsework: The contractor shall prepare plans for falsework and submit them to the engineer for review. This requirement shall also apply to falsework required for changes in an existing structure for maintenance of traffic. These plans shall be stamped by an engineer currently licensed to practice civil engineering in the State of Louisiana.

(c) Form Drawings: When requested, the contractor shall prepare and submit to the engineer for review, plans for a proposed forming system for cast-in-place concrete. The plans shall be sufficiently detailed to allow a complete evaluation of their adequacy. Plans for deck forms shall include details of the type screed to be used.

(d)Steel Fabrication and Erection: The type, size and procedures for submittal and approval of these drawings shall be as described in Heading (a) of this subsection.

(1) Shop Drawings: The contractor shall furnish shop drawings for steel work for approval. No fabrication shall be started prior to final approval of these plans; however, when the project has separate structures or has been divided into parts to facilitate construction in accordance with the approved construction schedule, fabrication may be started for a separate structure or a particular part when the final shop details applying thereto have been approved and distributed. These details must conform to the general drawings, stress sheets and specifications. No deviations from the approved shop plans will be allowed without written approval. The contractor shall be responsible for correctness of drawings and for shop fits and field connections, even though drawings have been approved.

If the structural steel on the project consists only of expansion dams and bearing assemblies, the contractor will not be required to furnish a final set of corrected drawings.

(2) Erection Drawings: Before starting steel erection, the contractor shall inform the engineer of the method of erection and equipment the contractor proposes to use, which shall be subject to review and approval. The contractor shall prepare and submit for review and approval a key erection diagram and detail erection drawings for the work, all with dimensions and erection marks to properly coordinate erection drawings with shop drawings.

The contractor shall also submit erection drawings for all continuous span steel units, trusses and other metalwork requiring field splices to the Bridge Design Engineer for review and approval. Drawings shall outline the erection procedure and equipment to be used. These plans shall be stamped by an engineer currently licensed to practice civil engineering in the State of Louisiana.

(3) Stay-in-Place Metal Panels: When stay-in-place metal panels are used, shop drawings will be required illustrating complete details and supports. They shall be accompanied by two sets of design calculations.

(4) Shipping Statements and Shop Bills: The contractor shall furnish the engineer one copy of shipping statements or notices as each shipment of structural steel is made to the project. Weights of individual members shall be shown on shipping statements.

If payment for structural steel is per pound, the contractor shall also furnish the Bridge Design Engineer with three copies of final shop bills for the structural steel, showing the name, piece-mark, and calculated weight for each member. These bills shall include a summary of the weights of structural steel for the project by grades. Shop bills are not required when lump sum payment is to be made.

(e) Movable Bridge Equipment:

(1) Shop Drawings and Erection Drawings: The contractor shall furnish complete detailed working drawings of the machinery houses, operating house, counterweight, including calculations, and machinery and traffic barrier parts and assembly layouts of items to be furnished. Weights of machinery parts shall be shown on shop drawings and may be estimated initially; however, the final shop drawings shall show the correct weights as determined by weighing the fabricated parts. For commercial parts, the manufacturer's weights or certified dimension sheets will be acceptable. Certified dimension sheets of motors, brakes, generators, gasoline engines, limit switches, traffic gates and other such equipment shall be submitted to the Bridge Design Engineer for approval as soon as possible after award of the contract so that the engineer and fabricator will have the information necessary to determine the details of associated parts. Certified dimension sheets shall show complete specifications for equipment furnished.

The contractor shall submit nine copies of certified dimension sheets and detailed manufacturer's description of each piece of equipment and apparatus to the Bridge Design Engineer, one of which will be returned approved or

with required revisions noted thereon. If revisions are required, the contractor shall submit nine corrected copies for final approval. The name of the project, project number and parish shall be shown on each sheet of every submittal, with indication of any changes noted on the drawings.

Drawings for counterweights shall show dimensions, method of construction and calculations.

A detailed list of commercial machinery and traffic barrier parts installed on the bridge shall be included in shop drawings. The list shall include item number as shown on drawings and the name, ratings, description, service manufacturer, type, model, catalog and serial number of each item.

The type, size and procedures for submittal and approval of shop and erection drawings shall be as described in Heading (a) of this subsection.

If any part of the work not requiring fabrication is so completely detailed that design drawings may serve as working drawings, the contractor will not be required to submit shop drawings for that part of the work, provided the contractor notifies the Bridge Design Engineer in writing that the work is to be performed as shown on design drawings. The contractor shall be responsible for any errors which may be on the plans, and will not be relieved of any responsibility placed upon the contractor by the contract. Shop drawings will be required for fabricated items.

(2) Maintenance and Operation Instruction Booklets: The contractor shall furnish the Bridge Design Engineer six bound copies of a booklet, 8 1/2 by 11 inches (216 by 279 mm) in size, containing descriptive leaflets and drawings covering items of the electrical equipment. This booklet shall include catalog numbers indicated, printed or typewritten statements prepared by the equipment manufacturer covering the proper method of adjusting, lubricating and otherwise maintaining each item, a concise statement of the necessary operating functions in proper sequence, a detailed description of the functions of each item in connection with the various operating steps, reduced copies of conduit and wiring diagrams and drawings of control desk and switchboard. The booklet shall designate each wire and item of equipment by the numbers and symbols used on the drawings.

The contractor shall also furnish the Bridge Design Engineer six bound copies of a similar booklet for mechanical and traffic barrier equipment which shall include lubricating charts showing locations of lubricating fittings and other points of lubrication, recommended types of lubricant, frequency of application and changing of lubricants and reduced prints of the machinery and traffic barrier shop drawings.

Each booklet shall contain the following:

a. Front Matter: Cover, instructions for normal operation, operation under emergency or adverse conditions, and shutdown; table of contents, list of illustrations; introduction; and safety precautions.

b. Theory of Operation: Theory of operation to the extent necessary for understanding by operation and maintenance personnel.

c. Maintenance Instructions: Cleaning, lubrication, troubleshooting, inspection, performance verification, disassembly, repair, replacement, and reassembly.

d. Parts Lists.

e. List of Special Tools: Name and size of nonstandard tools necessary for proper maintenance and adjustment of equipment, location requiring the special tools, and the proper adjustment.

f. Illustrations and diagrams.

g. Warning Notes: Cautions and warning notes indicating any condition or practice which could result in personal injury or loss of life.

(f) Precast-Prestressed Concrete Girder Spans: The contractor shall furnish complete fabrication and erection drawings. No girders shall be cast prior to approval of these drawings. When precast stay-in-place concrete panels are used, the below requirements will also apply to fabrication drawings. Precast panels shall comply with Subsection 805.14(k).

Fabrication drawings shall include complete details and dimensions of girders, details of proposed casting bed layout and stressing data. For pretensioned members, fabrication drawings should also include method of holding draped strands in place and method and schedule of release of hold-down and strands and appropriate debond strand data.

If details on the girder design drawings are adequate to serve as working drawings, the contractor is not required to submit working drawings. However, the contractor shall submit corrections to plan dimensions due to elastic shortening, shrinkage, girder slope and other causes. The use of design drawings shall not relieve this contractor of any contract responsibilities.

Erection drawings shall show the location of each girder in each span as well as identifying marks for each girder showing its span and location. The date of casting shall be shown on one end of each girder.

The type, size and procedures for submittal and approval of fabrication and erection drawings shall be as described in Heading (a) of this subsection.

(g)Illumination Systems: Detail drawings for lighting standards or high mast towers including all connections, bases, welds, anchor bolts,

handhole reinforcement, and erection procedures shall be furnished by the contractor for approval.

Electrical system components shall be in accordance with Section 730.

(h)Traffic Signs and Devices: Detail drawings for overhead or structure mounted signs and devices shall be furnished by the contractor for approval. Fabrication or construction shall not be started until drawings have been approved and distributed.

(1) Fabrication and Erection of Overhead and Structure-Mounted Sign Structures: The type, size and procedures for submittal and approval of these drawings shall be as described in Heading (a) of this subsection.

Detailed drawings for fabrication and erection of aluminum and steel parts for overhead or structure-mounted sign structures shall include details of all parts of the sign structure and mounting brackets.

Required dampers for aluminum overhead sign trusses shall be shown on the shop drawings.

Backing details to be used that are not covered by typical details and notes shown on the plans shall be submitted.

(2) Sign Face Details: Sign face details shall be submitted to the Traffic and Geometric Design Engineer for approval. Details shall be submitted on legal size sheets of acceptable quality for sign faces not completely detailed on the plans. Two prints of required sign face details shall be submitted for checking, one of which will be returned with either approval or required revisions noted thereon. Nine copies of prints shall then be submitted and, if approved, shall be distributed. Approval and distribution of these prints shall be required prior to submittal of drawings for fabrication and erection of the corresponding sign structures.

(i) Buildings: Detail drawings, brochures and samples for architectural and mechanical work shall be furnished by the contractor for approval by the Bridge Design Engineer in accordance with the following requirements.

The type, size and procedures for submittal and approval of shop and working drawings shall be as described in Heading (a) of this subsection. No fabrication or erection work shall begin until these drawings have been approved. Brochures and samples shall be furnished in accordance with the project specifications.

Maintenance and operation instruction booklets shall be furnished in accordance with the project specifications.

801.04 TEMPORARY BRIDGE WORKS. The design of all temporary bridge works or temporary bridge alternates shall be the responsibility of the contractor and will be complete and comprehensive, analyzing all geotechnical,
hydraulic, and structural engineering facets including all stage and load conditions of the temporary structures. Temporary bridge alternate designs shall be submitted to the Bridge Design Engineer for approval. Guidance on the design and construction of all temporary bridge works is contained in two AASHTO publications: "Guide Design Specifications for Bridge Temporary Works" and "Construction Handbook for Bridge Temporary Works". The latest edition of these specifications should be followed for design and construction of all temporary bridge works.

Design details, sketches, calculations, or plans submitted by the contractor shall bear the signature and seal of a professional civil engineer currently licensed to practice in the State of Louisiana.

All field welding of temporary works shall be done by certified welders.

Section 802
Structural Excavation and Backfill

802.01 DESCRIPTION. This work consists of removal of all materials necessary for construction of retaining walls and foundations. It shall include furnishing all necessary equipment, dewatering and the construction of all cribs, sheeting, cofferdams, caissons, etc. necessary for execution of the work. It shall also include subsequent removal of cofferdams and cribs, and placement and compaction of necessary backfill. It shall also include wasting of excess excavated material as approved by the Engineer, such that it will not affect the carrying capacity of the channel nor be unsightly.

802.02 GENERAL CONSTRUCTION REQUIREMENTS. Excavations for substructures shall be shored, sheeted, braced or protected by cofferdams where necessary. When footings can be placed in the dry without cribs or cofferdams, backforms may be omitted, with approval, and the excavation filled with concrete to the required elevation of the top of footing. Additional concrete required shall be placed at no direct pay.

Foundations for reinforced concrete box culverts shall be prepared in accordance with Subsection 701.04.

802.03 PRESERVATION OF CHANNEL. Unless otherwise directed, no excavation shall be made outside of caissons, cribs, cofferdams or sheeting. The natural stream bed adjacent to the structure shall not be disturbed. If excavation or dredging is made at the site of the structure before caissons, cribs or cofferdams are in place, the contractor shall, at no direct pay, after the foundation base is in place, backfill such excavation to the original ground surface or river bed with satisfactory material. Material deposited within the area of the stream shall be removed and the stream freed from obstruction.

802.04 DEPTH OF FOOTINGS. Elevations of the bottoms of footings as shown on the plans are approximate. The engineer may order, in writing, such changes in dimensions or elevation of footings as necessary to secure a satisfactory foundation.

802.05 PREPARATION OF FOUNDATIONS FOR FOOTINGS. Rock or other hard foundation material shall be cleaned of loose material and cut to a

firm level, stepped or roughened surface, as directed. Seams shall be cleaned and filled with concrete, mortar or grout to a suitable depth.

When concrete is to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation. Final removal of foundation material to grade shall not be made until just before concrete is placed.

802.06 COFFERDAMS AND CRIBS.

(a) General: Cofferdams and cribs for foundation construction shall be designed and constructed by the contractor in accordance with Subsection 801.04, be made as watertight as necessary for proper performance of the work and be carried to adequate depths and heights. Interior dimensions of cofferdams and cribs shall be such as to give sufficient clearance for construction of forms and inspection of their exteriors and to permit pumping outside of forms. Cofferdams or cribs which tilt or move laterally during sinking shall be righted, reset or enlarged to provide the necessary clearance at no direct pay.

When it is impractical to dewater the foundation before placing concrete, the engineer may require construction of a concrete foundation seal of such dimensions as necessary. The foundation shall be dewatered and the balance of concrete placed in the dry. When weighted cribs are used to partially overcome hydrostatic pressure acting against the bottom of the foundation seal, special anchorages such as dowels or keys shall be provided to transfer the weight of the crib to the foundation seal. During placing of a foundation seal, elevation of water inside the cofferdam shall be controlled to prevent flow through the seal. If the cofferdam is to remain in place, it shall be vented or ported at low water level.

When cofferdams are required for deep foundation construction the contractor shall be responsible for the complete design, fabrication, installation, maintenance and removal of the cofferdam system. The contractor shall submit a deep foundation installation plan which includes all design assumptions and computations. The proposed cofferdams and cribs shall be designed taking into consideration all aspects of global, external and structural stability during each stage of construction, and all unbalanced soil, water and construction loadings. The foundation plan, including the geotechnical design, shall be signed and sealed by a professional civil engineer currently licensed to practice in the State of Louisiana. Upon request, the contractor shall provide to the Department, a description of the engineers geotechnical experience.

(b) Protection of Concrete: Cofferdams or cribs shall be constructed so as to protect foundations from damage caused by a sudden stream rise.

(c) Drawings: Drawings for substructure work shall be furnished in accordance with Subsection 801.03. Drawings for cofferdams shall be stamped by an engineer currently licensed to practice civil engineering in the State of Louisiana and shall include two copies of design computations showing design water levels, soil and water pressures, and all other loads and factors included in the design.

(d)Removal: Cofferdams or cribs with all sheeting and bracing shall be removed after completion of the substructure. Care shall be taken not to damage concrete. No sheet piling used as forms shall be removed prior to 7 days after placement of concrete. Timber from cofferdams or cribs shall not be left embedded in substructure concrete.

802.07 DEWATERING. Excavations below the groundwater table will require ground water control to permit construction in the dry and maintain stability of the excavation base and sides. Controlling seepage may be accomplished by individual or a combination of methods such as sheeting, sumps, or well point systems. The contractor shall submit his method of dewatering in writing to the engineer for approval. Prior approval by the engineer shall not release the contractor from his responsibility to protect the work or to modify his dewatering operation to accomplish its intent regardless of prevailing conditions. All dewatering wells including well points shall be installed and properly abandoned by DOTD-licensed water well contractor, in accordance with the requirements of Louisiana Water Well Rules, Regulations and Standards, a copy of which may be obtained from DOTD's Water Resources Section. All dewatering operations shall be at no direct pay unless otherwise specified in the contract.

(a) Cofferdams and Cribs: Pumping from the interior of a foundation enclosure shall be done in such manner as to preclude the possibility of movement of water through fresh concrete. No pumping will be permitted during placement of concrete or for at least 24 hours thereafter unless done from a suitable sump separated from the concrete work by a watertight wall or other effective means.

Pumping to dewater a sealed cofferdam shall not begin until 72 hours after placement of concrete seal unless otherwise directed.

(b)Well Point System: When required by plans or the engineer, a well point system shall be designed, detailed, installed, maintained and removed by

the contractor. The well point system shall be installed around the perimeter of
the excavated area in a location such that other operations will not be impeded. The well point system shall be capable of continuously maintaining the piezometric level in the soil at least 5 feet (1.5 m) below the bottom of the excavated area.

Prior to installation, the contractor shall submit 5 copies of his design calculations and detail drawings of his well point system to the engineer; however, the contractor shall be solely responsible for the adequacy of the well point system.

The contractor shall install piezometers or other suitable means of monitoring within the excavated area as required by field conditions. The contractor shall make daily readings or measurements of the piezometer to verify that the well point system is operational. Excavation may begin when the piezometric level is 5 feet (1.5 m) below the proposed excavation bottom surface for at least four hours.

The well point system shall have a back-up system of pumps and power units. If failure of the well point system occurs, water shall be added to the excavation as rapidly as possible. The dewatering system shall be repaired at the contractor's expense.

(c) Removal: After having served their useful purpose, all temporary dewatering devices and/or temporary protective works shall be completely and satisfactorily removed so as to not interfere, in any way with the operation, usefulness and stability of the permanent structure.

802.08 EXCAVATION OF FOUNDATION. After each excavation is completed, the contractor shall notify the engineer. No concrete shall be placed until the engineer has approved the depth of excavation and character of foundation material.

802.09 BACKFILL. Backfill material shall be of acceptable quality, free from large or frozen lumps, wood or other foreign material.

(a) For backfilling cofferdams and cribs, all spaces excavated and not occupied by piers or other permanent work shall be backfilled with soil to the surface elevation of surrounding ground in such manner as to maintain approximately the same elevation on each side.

(b) Backfilling of Reinforced Concrete Box Culverts: Material and backfilling requirements for reinforced concrete box culverts and attached headwalls shall be in accordance with Subsection 701.08.

Adequate cover shall be provided over reinforced concrete box culverts before heavy construction equipment may cross the installation to prevent damage to the box culvert.

(c) Backfill material for footings shall be placed in horizontal lifts and compacted to the satisfaction of the engineer. The excavation shall be pumped as dry as possible before backfill material is placed.

(d) Backfill for structures other than in Headings (a), (b) and (c) above shall be placed in horizontal layers not exceeding 9 inches (225 mm) loose thickness and uniformly compacted by approved methods to the satisfaction of the engineer. Jetting of backfill behind abutments and wingwalls will not be permitted. The excavation shall be pumped as dry as possible before beginning backfilling.

(e) No backfill shall be placed against a concrete abutment, wing wall or reinforced concrete box culvert until concrete has been in place a minimum of 14 calendar days, or until test cylinders made in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230 have obtained a minimum compressive strength of 3,000 psi (20.7 MPa).

802.10 MEASUREMENT. The quantity of structural excavation for payment shall be the number of cubic yards (cu m), measured in its original position, of material acceptably excavated in conformity with the plans or as directed. No volume shall be included in the measurement outside of a volume bounded by vertical planes 18 inches (450 mm) outside of and parallel to neat lines of footings. The cross-sectional area measured shall not include water or other liquids but shall include mud, muck and other similar semi-solids. No measurement will be made of excavation required for construction of abutment bents or abutment footings. Measurements for intermediate bents or pier footings will be made on the basis of the depth taken from the elevation of the completed sections or natural ground line, whichever is lower, to the bottom of footing; however, no measurement will be made for material not excavated.

(a) Reinforced Concrete Box Culverts: Excavation and backfill required for box culvert construction will not be measured for payment, except as specified in Subsection 203.15.

(b)Cofferdams: When the contract does not contain an item for "Cofferdams", the cofferdams and cribs will not be measured for payment.

When an item for "Cofferdams" is included in the contract, the cofferdams will be measured on a lump sum basis.

(c) Well Point System: When the contract does not contain an item for "Well Point System", the contractor may use any approved method to control the seepage water as required within the specifications. The "Well Point System" will not be measured for payment.

When an item for "Well Point System" is included in the contract, the dewatering system will be measured on a lump sum basis.

802.11 PAYMENT. Payment for structural excavation will be made at the contract unit price per cubic yard (cu m), which includes constructing and removing cribs, sheeting and cofferdams, required excavation and backfill, and disposal of excess excavated material.

If the engineer orders foundations to be lower than the specified elevation, payment for the additional excavation required will be made in accordance with Table 802-1.

Table 802-1
Payment for Additional Excavation

Depth of Foundation Below Specified Elevation		Percent of Contract Unit Price for the Excavation Item
Feet	Meters	
0 to 2.0	0 to 0.5	100
2.1 to 4.0	0.51 to 1.0	125
4.1 to 6.0	1.01 to 2.0	150
6.1 to 8.0	2.01 to 2.5	175
8.1 to 10.0	2.51 to 3.0	200
Over 10.0	Over 3.0	Extra Work

When an item for "Cofferdams" is included in the contract, payment for cofferdams will be made at the contract lump sum price, which includes furnishing and installing all materials, backfilling, dewatering, maintenance, removal, and satisfactory clean-up of the areas.

When an item for "Well Point System" is included in the contract, payment for the dewatering system will be made at the contract lump sum price, which includes furnishing, installing, maintaining and removing all materials, equipment, tools, labor and incidentals necessary to satisfactorily control the seepage water.

Payment will be made under:

Item No.	Pay Item	Pay Unit
802-01	Structural Excavation	Cubic Yard (Cu m)
802-02	Structural Excavation for Intermediate Bents	Cubic Yard (Cu m)
802-03	Structural Excavation for Piers (Dry)	Cubic Yard (Cu m)
802-04	Structural Excavation for Piers (Wet)	Cubic Yard (Cu m)
802-05	Cofferdams	Lump Sum
802-06	Well Point System	Lump Sum

Section 803
Sheet Piles

803.01 DESCRIPTION. This work consists of furnishing and driving sheet piling of the specified type in accordance with the plan details and these specifications. Applications are as follows:

(a) Plan Sheeting:

(1) Permanent Sheeting: Where required by the plans, permanent sheeting shall be of the design shown in the contract plans. Sheeting shall be new and shall receive corrosion protection in accordance with Subsection 803.06.

(2) Temporary Sheeting: Where contract plans require sheeting to facilitate the sequence of construction and to support traffic carrying facilities, the contract plans will specify the required design parameters for sheeting. The contractor shall be responsible for the design and details of the sheeting. Temporary sheeting design and details shall be submitted to the Bridge Design Engineer for approval. Sheeting may be new or used and will not require corrosion protection. Typically, temporary sheeting should be removed when no longer required; however, when impractical to remove or when required in the plans, shall remain in the completed work.

(b)Construction Sheeting: Sheeting used at the contractor's option shall be in accordance with Section 802. The contractor shall be responsible for the design and details of the sheeting. Sheeting may be new or used, does not require corrosion protection, and shall be removed unless otherwise approved.

803.02 MATERIALS. Materials shall comply with the following Sections and Subsections.

Concrete	901
Coal Tar Epoxy-Polyamide Paint	1008.04
Reinforcing Steel	1009
Sheet Piles	1013.10
Timber and Preservatives	1014
Hardware	1018.08

(a) Concrete Sheet Piles: Concrete sheet piles shall be precast-prestressed piles fabricated in accordance with Subsection 805.14.

(b)Metal Sheet Piles:

(1) Steel Sheet Piles: Steel sheet piles shall be fabricated in accordance with Section 807.

(2) Aluminum Sheet Piles: Aluminum sheet piles shall have a depth of 2 1/2 inches (60 mm) to 6 inches (150 mm), a width of 1.00 foot (300 mm) to 1.67 feet (500 mm), and a nominal thickness of at least 0.125 inch (3 mm). Sheet piles shall have sand-tight interlocking joints.

(c) Timber Sheet Piles:

(1) General: Piles shall be provided with tongues and grooves of suitable proportions, either cut from the solid material or made by building up the piles with three planks fastened together. Piles shall be drift-sharpened at their lower ends to wedge adjacent piles tightly together during driving. Hardware shall be galvanized.

(2) Treated Timber: Treated timber shall be either Southern Pine or Douglas Fir complying with Section 812.

803.03 DRIVING SHEET PILES. Sheet piles shall be driven with hammers adequate to drive the piles to required depth in satisfactory condition. To maintain satisfactory alignment, sheet piles shall be driven in increments of penetration necessary to prevent distortion, twisting out of position or pulling apart at interlocks. If a vibratory hammer is used, the contractor will assume full responsibility for any damage to adjacent structures or for embankment settlement caused by his operation.

803.04 JETTING SHEET PILES. Use of jets will require written approval of the engineer. When approved, jetting will be at no direct pay.

803.05 CUTOFFS.

(a) Tops of sheet piling shall be cut off or driven to a straight line at the elevation indicated on the plans or as directed.

(b) If heads of sheet piles are appreciably distorted or otherwise damaged below cut-off level, damaged portions shall be removed and replaced at no direct pay.

(c) Tops of timber sheet piles after cut-off shall be treated in accordance with Subsection 812.06, except that galvanized metal coverings shall be bent down at least 3 inches (75 mm) on each side and nailed to the vertical surface of sheet piles with large-headed galvanized roofing nails.

(d) Sheet piles damaged during driving, or driven out of proper position or below cut-off elevation, shall be withdrawn and replaced with new piles at no direct pay.

803.06 PAINTING. Temporary and construction sheeting will not require painting unless otherwise specified. Before driving, surfaces of steel sheet piling shall be cleaned and painted from the top of the sheet pile to a point 10 feet (3 m) below the ground or mud line. Paint system to be a 2-coat coal tar epoxy-polyamide in accordance with Section 811.

803.07 MEASUREMENT. Quantities of permanent sheet pile wall for payment will be the design wall area as shown on the plans. Permanent sheet pile design quantities will be measured in square feet (sq m) and be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. Temporary sheeting will be measured on a lump sum basis. Construction sheeting will not be measured for payment.

803.08 PAYMENT. Sheeting for cofferdams will be paid in accordance with Section 802. Payment for permanent sheet pile wall and temporary sheeting will be made at the contract unit prices under:

Item No.	Pay Item	Pay Unit
803-01	Timber Sheet Pile Wall	Square Foot (Sq m)
803-02	Concrete Sheet Pile Wall	Square Foot (Sq m)
803-03	Steel Sheet Pile Wall	Square Foot (Sq m)
803-04	Aluminum Sheet Pile Wall	Square Foot (Sq m)
803-05	Temporary Sheeting	Lump Sum

Section 804
Driven Piles

804.01 DESCRIPTION. This work consists of furnishing and driving foundation piles of the type and dimensions designated on the plans to the required penetration, including cutting off or building up foundation piles when required.

804.02 MATERIALS. Materials shall comply with the following Sections and Subsections.

Precast Concrete Piles	805.14
Concrete	901
Coal Tar Epoxy-Polyamide Paint	1008.04
Reinforcing Steel	1009
Steel H Piles	1013.09
Steel Pipe Piles	1013.11
Timber Piles	1014

804.03 CAST-IN-PLACE CONCRETE PILES. Cast-in-place concrete piles shall be steel encased. Steel shells shall be of the specified diameter and type. Shells for cast-in-place concrete piles shall be of sufficient thickness and strength so that the shell will hold its original form and show no harmful distortion after it has been driven. It shall be the contractor's responsibility to determine the required shell wall thickness. The shell shall be filled with Class A concrete and placed in accordance with Section 805. The DOTD Chief Construction Engineer shall approve use of concrete other than Class A. When reinforcing steel is required, it shall comply with Section 806.

804.04 PILE LENGTHS. The contractor shall furnish piles in accordance with an itemized order list, which will be furnished by the engineer showing the number, size, length and location of all permanent piles. No permanent piles shall be fabricated prior to receipt of this order list. The lengths given in the order list will be based on the lengths that are assumed after cutoff to remain in the completed structure. At the contractor's expense, the pile lengths shall be increased to provide for fresh heading and for such additional length as may be necessary to suit the contractor's method of operation. When test piles or indicator piles are required, the pile lengths shown on the plans are for

estimating purposes only. The approved order list will not be furnished to the contractor until the test piles or until indicator piles have been driven, tested, and analyzed. The engineer may revise the order length when driving conditions deviate from the test pile or indicator pile results.

804.05 PILE DRIVING SYSTEM SUBMITTAL AND APPROVAL.

(a) Submittals: A description of the proposed pile driving system, which includes the pile driving equipment to be furnished by the contractor and the method of pile installation, shall be submitted in the form of a Pile Installation Plan for approval by the DOTD Chief Construction Engineer. The pile driving equipment and the pile installation method shall be such that piles will obtain the required penetration without damage. In no case shall the pile driving equipment be transported to the project site until approval is received in writing. As a prerequisite to such approval, the contractor shall submit the Pile Installation Plan at the preconstruction conference and/or no later than 30 calendar days prior to driving piles. The engineer will evaluate the Pile Installation Plan for conformance with the plans and specifications. Within 20 calendar days after receipt of the Pile installation Plan, the engineer will notify the contractor of any additional information required and/or changes that may be necessary in the opinion of the engineer to meet the plans and specification requirements. Any parts of the contractor's submittal that are unacceptable will be rejected and the contractor will resubmit changes agreed upon for reevaluation. The engineer will notify the contractor, within seven calendar days after receipt of proposed changes, of their acceptance or rejection. The time required for submission, review, and approval of a revised pile driving system shall not constitute the basis for a contract time extension by the contractor. All approvals given by the engineer shall be subject to trial and satisfactory performance in the field. The contractor shall use the approved pile driving system during pile driving operations. The contractor shall make any required changes, including supplying additional hammers, that may result from unsatisfactory field performance. Final acceptance will be given after necessary modifications are made. No changes in the driving system or installation method may be made after final approval without the written approval of the DOTD Chief Construction Engineer.

(b)Driven Pile Installation Plan: The pile installation plan shall provide detailed information pertaining to the pile driving equipment and the method of pile installation. The submittal should include the following information:

(1) Pile and Driving Equipment Data Form. The Department shall supply this standard form. The contractor shall complete the form with the proposed pile driving equipment for each unique pile driving system that will be used on the project. When a hammer cushion or pile cushion is composed of differing materials with varying properties the contractor shall provide a detailed description of the composite cushion. Composite cushion descriptions shall include material type, layout, and thickness of each cushion component.

(2) A list detailing the type and size of the proposed pile driving equipment, including hammer, leads, jetting equipment, compressors, and drilling equipment for preboring. Include hammer manufacturer's operating manual and compressor data sheets. If a mandrel is used to install piles, a complete description shall be provided including size and weight of components.

(3) Proposed pile driving methods that may be required to facilitate pile driving installation such as preboring or jetting.

(4) Methods to determine hammer energy in the field for determination of the pile bearing capacity. When pressure measuring equipment will be used to determine hammer energy, the submittal shall include hose length, hose diameter, equivalent energy charts, and calibrations.

(5) Detailed drawings of any proposed followers.

(6) Detailed drawings of templates.

(7) Required shop drawings for pile splices, shoring, sheet piling, cofferdams, etc.

(8) Pile driving sequence for each unique pile layout configuration.

(9) Details of proposed static load test system, equipment, and procedures in accordance with Subsection 804.11. The load test system details shall include information pertaining to ground excavations or casings, bearing plates, layout of reaction piles, reaction beams, deflection monitoring reference beam, etc. The load test equipment details shall include jack size, length of jack hose, and type of deflection monitoring instrumentation to be used. General load testing procedures should be provided concerning loading increments, sequence of loading, etc. If a load cell is required, calibration and load cell information shall be submitted.

(10) Proposed schedule for test pile and/or indicator pile program and production pile driving.

(11) Details of the access system for attaching instrumentation for dynamic monitoring.

(12) Other information shown in the plans or required by the engineer.

(c) Pile Driving Equipment Approval: Unless shown otherwise in the plans or directed by the engineer, the approval of the pile driving system shall be made by the Hammer Approval Method shown in Table 804-1. This approval shall be based on the contractor's proposed pile driving equipment and pile installation method.

If the Hammer Approval Method is used, the engineer will evaluate the contractor's proposed pile driving system in accordance with the requirements stated herein for the minimum hammer rated energy. The Wave Equation Hammer Approval Method may be substituted for the Hammer Approval Method if pile driving problems arise after approval with the Hammer Approval Method or when, in the opinion of the engineer, a more rigorous method of analysis is required to review the contractor's proposed pile driving system. The Hammer Approval Method shall not be used if the required end-of-driving pile capacity is greater than 300 tons (2650 kN).

(1) Hammer Approval Method: The Hammer Approval method is based on the required end-of-driving pile capacity, hammer type, and the minimum required hammer rated energy. Table 804-1 provides the minimum Manufacturer's Rated Hammer Energy that is required. The Manufacturer's Rated Hammer Energy shall be based on the theoretical potential energy of the ram at impact.

Table 804-1
Hammer Approval Method
Minimum Manufacturer's Rated Hammer Energy

End-Of-Driving Pile Capacity		Minimum Manufacturer's Rated Hammer Energy			
(tons)	(kilonewtons)	(ft-kip)		(kilojoules)	
		ECH*	Diesel	ECH*	Diesel
≤ 60	≤ 535	6	8	8	11
80	710	8	11	11	15
100	890	11	14	15	19
120	1070	13	17	18	23
140	1245	16	21	22	29
160	1425	20	24	27	33
180	1600	24	29	33	39
200	1780	29	34	39	46
220	1960	35	40	48	54
240	2135	43	47	58	64
260	2315	52	57	71	77
280	2490	59	67	80	91
300	2670	64	74	87	100

* ECH = External Combustion Hammers

(2) Wave Equation Hammer Approval Method: Approval of the contractor's pile driving equipment will be based on the wave equation analysis computer program (FHWA-WEAP87 or newer version) and as required elsewhere in this subsection. A wave equation analysis will be performed by the Department for each pile type and size required in the plans. Approval of the pile driving system does not relinquish the contractor's responsibility from driving the piles to the required pile tip elevation without damage.

The criteria the engineer will use to evaluate the pile driving equipment from the wave equation shall be the pile driving resistance. The required number of hammer blows at the required end-of-driving pile capacity shall be from 36 to 146 blows per foot (30 to 120 blows per 0.25 m). The pile driving resistance at any depth above the required pile tip elevation shall be achieved with a reasonable driving resistance of less than 300 blows per foot (250 blows per 0.25 m).

Additional criteria that the engineer will use for the pile driving equipment to be acceptable are the pile driving stresses that are indicated by the wave

equation analysis to be generated during pile driving. The pile driving stresses shall not exceed the allowable values as required in Subsection 804.08(g).

When the wave equation analysis shows that the contractor's proposed equipment or methods will result in either the inability to drive the pile with a reasonable driving resistance to the desired pile bearing capacity or will exceed the maximum allowable pile driving stresses, the contractor shall modify or replace the proposed methods or equipment at his expense until subsequent wave equation analyses indicates that the contractor's proposed pile driving equipment and driving methods meet the required criteria for acceptability stated herein.

804.06 PILE DRIVING EQUIPMENT.

(a) Hammers: Piles may be driven with either diesel hammers or external combustion hammers (ECH) such as hammers driven by steam, air, or hydraulic power. Non-impact hammers such as vibratory hammers shall not be used unless specified in the plans or permitted in writing by the engineer. Hammers shall be rated based on the theoretical potential energy of the ram at impact.

A variable energy hammer shall be used to drive precast concrete piles.

(1) Steam and Air Hammers: Steam and air hammers that are used to drive precast concrete piles shall be capable of providing at least two ram stroke lengths. The short ram stroke length shall be approximately half of the full stroke. Reductions in steam or air pressures to produce reduced hammer strokes will not be permitted. In lieu of a variable energy hammer, the contractor may propose in the Pile Installation Plan the use of multiple hammers of different rated energies to drive precast concrete piles.

The plant and equipment furnished for steam and air hammers shall have sufficient capacity to maintain the hammer at the volume and pressure specified by the manufacturer. The plant and equipment shall be equipped with accurate pressure gauges that are easily accessible for viewing by the engineer. The weight of the striking parts of air and steam hammers shall not be less than 1/3 the weight of drive head and pile being driven, and in no case shall the striking parts weigh less than 2,750 pounds (1250 kg).

(2) Open-End Diesel Hammers: Open-end diesel hammers used to drive precast concrete piles shall be capable of providing a selection of at least three fuel settings that will produce varying stroke lengths.

The contractor shall provide the engineer a chart from the hammer manufacturer equating stroke in feet (m) and blows per minute. The

contractor shall have available on-site an approved device to determine and display ram stroke in feet (m) of an open-end diesel hammer.

The device used to determine the hammer stroke shall be periodically verified as determined by the engineer by comparing the computed hammer stroke with the observed stroke on rams that have rings on the ram or by placing a temporary scale extending above the ram cylinder.

(3) Closed-End Diesel Hammers: Closed-end diesel hammers used to drive precast concrete piles shall be capable of providing a selection of at least three fuel settings that will produce varying stroke lengths.

Closed-end (double acting) diesel hammers shall be equipped with a bounce chamber pressure gauge mounted to be easily accessible by the engineer. The contractor shall provide the engineer a chart, calibrated to actual hammer performance, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used. The calibration between bounce chamber pressure and actual hammer performance should be performed within 30 calendar days prior to starting driving and at 90 calendar day intervals thereafter.

(4) Hydraulic Impact Hammers: The power plant and equipment furnished for hydraulic hammers shall have sufficient capacity to maintain the hammer at the volume and pressure specified by the manufacturer. The power plant and equipment shall be equipped with accurate pressure gauges that are easily accessible to the engineer. These hammers shall be equipped with sensors or other approved devices capable of monitoring and displaying hammer performance.

(5) Gravity Hammers: Gravity hammers, if permitted in the contract, shall only be used to drive timber piles. When gravity hammers are permitted, the ram shall weigh between 2,000 and 3,300 pounds (between 900 and 1500 kg) and the height of drop shall not exceed 10 feet (3 m). In no case shall the weight of gravity hammers be less than the combined weight of helmet and pile. All gravity hammers shall be equipped with hammer guides to ensure concentric impact on the helmet.

(b)Drive System Components and Accessories:

(1) Hammer Cushion: All impact pile driving equipment designed to be used with a hammer cushion shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving behavior. Hammer cushions shall be made of durable, manufactured materials, provided in accordance with the hammer manufacturer's guidelines. Wood, wire rope, and asbestos hammer cushions

shall not be used unless permitted by the engineer. A striker plate as recommended by the hammer manufacturer shall be placed on the hammer cushion to ensure uniform compression of the cushion material. The hammer cushion shall be inspected in the presence of the engineer when beginning pile driving at each structure and after every 100 hours of use during pile driving operations. The contractor shall replace the cushion when the hammer cushion begins to deteriorate or when the reduction in thickness exceeds 25 percent of the original thickness.

(2) Helmet: Piles driven with impact hammers require an adequate helmet or drive head to distribute the hammer blow to the pile head. The helmet shall be axially aligned with the hammer and the pile. The helmet shall be guided by the leads and not be free-swinging. The helmet shall fit around the pile head in such a manner as to prevent transfer of torsional forces during driving, while maintaining proper alignment of hammer and pile.

For special types of piles, appropriate helmets, mandrels, or other devices shall be provided in accordance with the manufacturer's recommendations.

(3) Pile Cushion: A pile cushion shall protect the heads of precast concrete piles. The pile cushion shall be made of plywood, hardwood, or a composite plywood and hardwood material. The minimum pile cushion thickness placed on the pile head prior to driving shall not be less than 4 inches (100 mm). The pile cushion dimensions shall match the cross sectional area of the pile top. A new pile cushion shall be provided for each pile driven unless otherwise permitted by the engineer. The pile cushion shall be replaced during pile driving when the cushion begins to deteriorate or burn. Pile bearing capacity shall not be determined using a new pile cushion until after the pile has been driven a minimum of 5 feet (1.5 m) or 100 blows.

When easy driving conditions exist throughout the entire depth of driving, the engineer may allow the pile cushion to be reused on several piles after guidelines for pile cushion replacement are developed from successful field performance. The objective shall be to maintain consistent energy delivery at the end-of-driving for proper determination of the pile bearing capacity without pile damage.

(4) Leads: Piles shall be supported in line and position with leads while being driven. Pile driver leads shall be constructed in a manner that affords freedom of movement of the hammer while maintaining alignment of the hammer and the pile to ensure concentric impact for each blow. Leads may be either fixed, semi-fixed or swinging types. Swinging leads shall be used in combination with a rigid template providing pile support meeting the approval of the engineer. The pile section being driven shall not extend above

the leads. The leads shall be of sufficient length to make the use of followers unnecessary and shall be so designed as to permit proper alignment of batter piles.

(5) Templates: A rigid template shall be used when swinging leads are used. When driving battered piles with swinging leads, the template shall be two tiered or equipped with cradles to hold the pile at the required batter, and the bottom of the leads shall be attached to the template. Template construction shall allow the pile to pass freely through the template without binding.

804.07 PREPARATION FOR INSTALLATION OF DRIVEN PILES.

(a) Site Preparation:

(1) Excavation: Piles shall not be driven until after the excavation is complete. Any material forced up between the piles shall be removed to the correct elevation before concrete for the foundation is placed.

(2) Abutment (End Bent) Fill: The full height of the embankment at bridge ends shall be constructed in accordance with Subsection 813.03 before driving affected piles. Piles to be driven through compacted embankment greater than 6 feet (2 m) shall be driven through prebored holes limited in depth to the height of the embankment.

(3) Cofferdams: Prior to driving any piles the contractor shall ensure the cofferdam is stable by monitoring the external stability of the ground outside of the cofferdam, wall inclination, and depth of excavation within the cofferdam. All excavation within the cofferdam shall be complete prior to driving piles. The depth of the excavation within the cofferdam shall be inspected for proper depth with a weighted line or other approved method.

(4) Cone Penetrometer Test (CPT) Probings: The Cone Penetrometer Test (CPT) probings may be taken at all test pile and indicator pile locations, and at the CPT locations shown in the plans for production piling. The probings will be taken by the Department.

Tip elevations for test piles, indicator piles, and permanent piles given in the plans are for estimating purposes only. The final location and pile tip elevations for the test piles and indicator piles will be determined by the engineer from CPT probings. The final pile order lengths will be determined from the test pile or indicator pile results and the CPT probings.

The contractor shall make arrangements with the Department to have the CPT probings taken at least 30 calendar days prior to driving test piles or indicator piles. When necessary, the contractor shall provide equipment to

assist in moving the Cone Penetrometer Test truck around the site. The site for the probings shall be level as directed.

The contractor shall provide Type I portland cement (approximately 1/2 bag per probe hole) for use in grouting the CPT probe holes.

Cone Penetrometer Test probing layout, supplying portland cement, and assistance will be at no direct pay.

(b)Piling Preparation:

(1) Transportation of Precast Concrete Piling: Precast concrete piles shall be supported adequately to prevent damage during transport.

(2) Collars: Collars, bands, or other approved devices to protect timber piles against splitting or brooming shall be provided when necessary, or as required by the engineer.

(3) Painting of Piling: When required by the plans or specifications, the foundation piling will be painted. The area of steel piles or the exterior surface of the steel shell of cast-in-place concrete piles, as specified in the plans shall be cleaned and painted from the top of the pile to a point 10 feet (3 m) below the ground or mudline. The paint system shall be a 2-coat coal tar epoxy-polyamide in accordance with Section 811.

(4) Supporting Holes for Piles: When approved, piles may be set in supporting holes, but in no case shall the depth of the holes be more than 10 feet (3 m) for piles up to 50 feet (15 m) long, or more than 20 percent of the designated penetration of the piles for piles over 50 feet (15 m) long. If additional support is required, templates or falsework above ground shall be furnished. After piles are driven, supporting holes shall be backfilled to finished ground or base of footing with granular-type material acceptable to the engineer and saturated with water.

(5) Splicing Piles:

a. Precast Concrete Piles: Precast concrete piles shall be furnished and driven in full lengths, unless otherwise specified in the plans or approved in writing by the engineer. There will be no direct payment for splicing.

b. Steel Piles: Steel piles shall be furnished and driven in full lengths unless splices are authorized. Splices shall be limited to two field splices per pile. Splicing of steel piles shall be made by welding with full penetration welds in accordance with Section 815.

c. Timber Piles: Timber piles shall be furnished and driven full length.

d. Cast-In-Place Concrete Pile Shells: Cast-in-place concrete pile shells may be field spliced, but sections that, in the opinion of the engineer, are too short shall not be used. Field splices of shell sections shall be made in accordance with the manufacturer's recommendations and to the satisfaction of the engineer. Welding shall comply with Section 815, except that the prequalification test for field welders will not be required unless directed.

(6) Pickup Straps: Pickup straps shall be cutoff and epoxy grouted prior to driving in coastal areas.

804.08 CONSTRUCTION REQUIREMENTS.

(a) Preboring: Preboring by augering, wet-rotary drilling, or other methods used to facilitate pile driving will not be permitted unless specified in the plans or required by the engineer. When the soil investigation or field trials indicate impenetrable material above the minimum pile tip elevation, preboring may be required to facilitate pile driving. The use of spuds to punch through impenetrable soil layers shall not be permitted without approval. The depth of the prebored hole shall be developed so as to minimize the pile skin friction disturbance and still be sufficient to permit pile installation to the required pile tip elevation. Preboring procedures shall be carried out in a manner that will not impair the capacity of the piles already in place or the safety of existing structures. The contractor shall develop the preboring depth limits based on the soil information obtained from soil boring logs or Cone Penetrometer Test probings and submit the limits to the engineer for approval. The maximum prebored depth shall be 3 feet (1 m) above pile tip elevation, unless otherwise directed. Prebored holes shall have a maximum diameter of 80 to percent of the pile diameter unless written approval to do otherwise is received from the engineer. The prebored hole diameter for tapered piles shall be determined by the engineer. Upon completion of the preboring, any voids around the pile shall be filled with granular-type material acceptable to the engineer and saturated with water. The contractor is responsible for any and all effects due to preboring.

(b)Jetting: Jetting will not be permitted unless allowed in the plans or required by the engineer. Jetting will not be allowed in footings, header banks, or where stability of embankments or other structures would be endangered unless approved in writing by the engineer. When the soil investigation or field trials indicate impenetrable material above the minimum pile tip elevation, jetting may be required to facilitate pile driving. The jet pipe penetration limit shall be developed to minimize the pile skin friction

disturbance and still be sufficient to permit pile installation to the required pile tip elevation. The contractor shall develop the jet pipe penetration limits based on soil information obtained from soil boring logs or Cone Penetrometer Test probings and shall submit the limits to the engineer for approval. The maximum jet penetration limit shall be 5 feet (1.5 m) above the required pile tip elevation. Extending the maximum jet penetration limit will require written approval by the engineer.

When water jets are permitted, the jetting procedures shall be carried out in a manner which will not impair the capacity of the piles already in place or the safety of existing structures or create a crater around the pile causing it to drift. The contractor shall be responsible for all damage to the site caused by unapproved or improper jetting operations. The number and size of jets and the volume and pressure of water at jet nozzles shall be sufficient to erode material adjacent to the pile but not disturb the soil bearing material within 5 feet (1.5 m) of the required pile tip penetration. The jetting plant shall have sufficient capacity to deliver at all times a pressure equivalent to at least 100 psi (700 kPa) at two 0.75 inches (19 mm) jet nozzles. One jet pipe will be allowed only when the contractor is pre-jetting a hole prior to placing and driving the pile or when driving is interrupted and the jet is placed inside a steel pipe pile or a voided concrete pile. A minimum of two jets will be required when piles are jetted and driven concurrently using external jets. When jetting and driving is required, the jets shall be above the advancing pile tip approximately 3 feet (1 m), or as approved by the engineer. Jetting operations shall cease when the jet penetration limit is reached, and the pile shall then be driven with the approved impact hammer to the final pile tip penetration. The pile bearing capacity shall be determined only from the results of driving after the jets have been withdrawn. The contractor shall control, treat if necessary, and dispose of all jet water in a manner satisfactory to the engineer. Upon completion of jetting a pile, any voids around the pile shall be filled with granular-type material acceptable to the engineer and saturated with water.

(c) Followers and Underwater Hammers: Followers or underwater hammers shall only be used when approved in writing by the engineer. When a follower or underwater hammer is permitted, the first pile in each pile group and every tenth pile driven thereafter shall be sufficiently long to permit being driven without a follower or underwater hammer, to verify that adequate pile capacity is being attained to develop the desired end-of-driving pile capacity for the pile group. The determination of the pile bearing capacity shall be

made in accordance with Subsection 804.10 using the driving results of the extended piles. No direct payment will be made for cut-off of these extended piles. The follower or underwater hammer and pile shall be held and maintained in equal and proper alignment during driving.

The follower shall be of such material and dimensions to permit the piles to be driven to the length determined necessary from the driving of the extended piles. The follower shall be provided with a socket or hood carefully fitted to the pile head to minimize energy losses and prevent pile damage.

(d)Cast-In-Place Concrete Pile Construction: After shells are driven to the required pile tip elevation and any required reinforcing steel is placed, shells shall be filled with concrete subsequent to their inspection and approval. The contractor shall provide suitable light for inspection of each shell after it has been driven to the required penetration. The shell shall be cleaned of debris and pumped dry before placing concrete. Reinforcing steel shall be securely fastened together to form a rigid cage. Care shall be taken to hold reinforcement in position during filling of piles. Concrete blocks or suitable devices may be used to prevent displacement of the reinforcement cage. Piles shall be filled with concrete to the cut-off elevation. Concrete in the shell shall be vibrated from the lower end of the reinforcing cage to the top of pile. When reinforcing steel is not required, concrete in the top 10 feet (3 m) of the shell shall be vibrated. Driving of additional piles within a radius of 10 feet (3 m) of the completed pile will not be permitted until concrete has been allowed to set for at least 36 hours.

(e) Location and Alignment Tolerance: Piles shall be driven at locations shown on the plans or as ordered in writing. In pile bents, the centroid of a pile at cut-off elevation shall not vary from plan location by more than 3 inches (75 mm) measured perpendicular to the bent, nor more than 6 inches (150 mm) measured along the centerline of the bent. For footing piles, the centroid of load of any pile at cut-off elevation shall be within a 6 inches (150 mm) radius of a circle having the plan location as its center. No pile shall be nearer than 3 inches (75 mm) from any edge of the cap. Any increases in size of cap to meet these edge distance requirements shall be at the contractor's expense. The final pile head at cut-off elevation shall be plus or minus 2 inches (50 mm) of the final grade shown in the plans. Piles shall be installed so that the axial alignment is within 2 percent of the specified alignment shown in the plans. For piles that cannot be inspected internally after installation, an alignment check shall be made before installing the last 5 feet (1.5 m) of pile, or after installation is completed provided the exposed portion of the pile is not less than 5 feet (1.5 m) in length. The engineer may

require that driving be stopped in order to check the pile alignment. Pulling laterally on piles to correct misalignment, or splicing a properly aligned section on a misaligned section shall not be permitted.

If the location and/or alignment tolerances specified herein are exceeded, the contractor shall provide the engineer with a sketch showing the actual versus theoretical positions of the piles. If corrective measures are necessary, the contractor shall bear all costs, including delays, associated with the corrective action.

(f) Installation Sequence: The contractor's approved pile driving sequence to drive individual piles in a footing shall be used unless otherwise directed by the engineer. The pile driving sequence for individual piles in a footing shall be in accordance with one of the following options:

(1) From the center of the pile group outward.

(2) By rows from the center of the pile group to the side.

(3) By rows from one side of the pile group to the other side.

(g)Pile Driving Stresses: The piles shall be driven in a manner as not to exceed the maximum allowable driving stresses.

For steel piles, the maximum compressive driving stresses shall not exceed 90 percent of the yield point of the pile material. For timber piles, the compressive driving stress shall not exceed 3600 psi (25 MPa). For precast prestressed concrete piles, the tensile and compressive driving stress in units of psi (MPa) from Table 804-2 shall not be exceeded.

Table 804-2
Maximum Allowable Driving Stresses

Tensile Driving Stress (Normal Environments):	
U.S. Units	Metric Units
$3\sqrt{f'_c} + f_{pe}$	$0.25\sqrt{f'_c} + f_{pe}$
Tensile Driving Stress (Corrosive Environments):	
U.S. Units	Metric Units
f_{pe}	f_{pe}
Compressive Driving Stress (All Environments):	
U.S. Units	Metric Units
$0.85\ f'_c - f_{pe}$	$0.85\ f'_c - f_{pe}$
f'_c = Concrete Compressive Strength, psi (MPa) f_{pe} = Effective Prestress, psi (MPa)	

The plans shall indicate if the allowable tensile driving stress of precast-prestressed concrete piles shall be computed for corrosive environments. Pile driving criteria may be provided by the Geotechnical Engineer to maintain pile driving stresses within the maximum allowable driving stresses.

(h)Extent of Driving: Driving shall be continued until the engineer determines satisfactory penetration and pile bearing capacity have been obtained. Approval from the engineer shall be required to terminate pile driving above the plan tip elevation or order list pile tip elevation. Piles shall be driven to the plan tip elevation or the order list pile tip elevation in accordance with these specifications, unless a minimum pile tip is specified in the plans. If the pile penetration requirements and pile bearing capacity are achieved within 5 feet (1.5 m) of the plan pile tip elevation or order list pile tip elevation, the engineer may consider the penetration and capacity requirements to be satisfied. The following requirements shall be used to evaluate satisfactory pile penetration and pile bearing capacity.

(1) Pile Driving Penetration Requirements: If refusal is encountered above the required plan pile tip elevation or order list pile tip elevation, the contractor may be required to obtain a larger hammer capable of achieving the required penetration, or to use pile installation techniques to facilitate pile driving such as preboring or jetting. Refusal conditions shall require that the approved hammer is operating at the maximum stroke or fuel setting required to achieve the hammer manufacturer's maximum rated energy. The hammer shall be in proper working order. If the hammer performance needs to be evaluated, the engineer may require dynamic monitoring of the pile driving operations. If the hammer performance indicates that the pile driving system's effective efficiency is not satisfactory, the contractor shall be required to adjust the pile driving system until satisfactory performance is observed. The cost of dynamic monitoring and/or delays due to unsatisfactory hammer performance shall be at the contractor's expense. Dynamic monitoring of hammers performing satisfactorily shall be paid for under the Item 804-17, Dynamic Monitoring.

(2) Pile Bearing Capacity Requirements: The pile bearing capacity shall be determined in accordance with Subsection 804.10.

If pile bearing capacity is less than the required end-of-driving pile capacity at cut-off elevation, the engineer has the option of either loading a permanent pile to determine its ultimate pile capacity, continuing to drive the pile until satisfactory resistance is obtained, or perform a pile restrike to check for increase in pile bearing capacity due to soil set-up. The loading procedure of permanent piles shall be in accordance with Subsection 804.11. The additional length of pile due to the additional driving shall be furnished in accordance with the construction methods in Subsection 804.08(k) for pile extensions. Pile restrikes shall be performed in accordance with Subsection 804.08(i).

If the potential exists for obtaining false pile bearing capacity results due to excess pore water pressure or if this condition was observed during field testing of test piles, indicator piles, or monitor piles, the pile bearing capacity shall be determined from pile restrikes as directed by the engineer.

(i) Pile Restrikes: Pile restrikes are to be conducted as required for test piles, indicator piles, and production piles or as directed by the engineer. Pile restrikes shall be conducted at no direct pay.

The piles to be restruck shall be driven initially to 1 foot (0.25 m) above the required pile tip elevation, or as directed by the engineer. All pile restrikes shall be performed with a warm hammer that has applied a minimum of 20 blows to another pile or dummy block immediately before being used to restrike the selected pile. For precast concrete piles, the original pile cushion used during initial driving shall be used. If the original pile cushion used to drive precast concrete piles is no longer in an acceptable condition, another similar used cushion shall be used. The maximum amount of pile penetration required for each pile restrike shall be 6 inches (150 mm) or a maximum of 50 hammer blows. If the required end-of-driving pile capacity is obtained during the restrike of permanent piles, the pile shall be driven to grade. Restrike blow counts shall be measured as the number of hammer blows per increment of 1 inch (25 mm).

(j) Heaved Piles: Elevations to check on pile heave after driving shall be made at the start of pile driving operations and shall continue until the engineer determines that such checking is no longer required. Elevations shall be taken immediately after the pile has been driven and again after piles within a radius of 15 feet (5 m) have been driven. If pile heave is observed, level readings referenced to a fixed datum shall be taken on all piles immediately after installation and periodically thereafter as adjacent piles are driven to determine the pile heave range. All end bearing piles that have been heaved more than 1/4 inch (6 mm) shall be redriven to the required resistance or penetration at no direct pay. Concrete shall not be placed in pile casings until all piles in a footing have been driven, or as directed by the engineer.

(k) Pile Extensions:

(1) Cast-In-Place Extension of Precast Concrete Piles: When permitted or shown on the plans, a precast pile may be extended a maximum of 5 feet (1.5 m) as shown on the plans. The plans show the length of reinforcing steel to be exposed and the additional size and number of reinforcing bars to be spliced where pile extensions are required. The final cut of the concrete shall be perpendicular to the axis of the pile. Concrete shall be as shown on the plans. Just prior to placing concrete, the top of the pile shall

be thoroughly wetted and covered with a thin coating of neat cement or other suitable bonding material.

(2) Steel Piles: When permitted or shown on the plans, a steel pile may be extended by splicing in accordance with Section 815.

(l) Pile Cut-Offs:

(1) Precast Concrete Piles: Cut-offs for precast concrete piles shall be made perpendicular to the axis of the pile at the elevation shown on the plans or as directed. Care shall be exercised to minimize spalling of concrete below the cut-off elevation.

(2) Steel Piles: Steel piles shall be cut off perpendicular to the axis of the pile and to the elevation shown on the plans or as directed. Cuts shall be made in clean straight lines and any irregularity due to cutting or burning shall be corrected by grinding or deposits of weld material prior to placing caps.

(3) Timber Piles: The tops of timber piling which support concrete footings or caps shall be sawed off perpendicular to their axes at the required elevation. When piles support timber caps they shall be sawed to a horizontal plane or to the slope specified, in such manner as to fit the cap. Shimming on tops of piles will not be permitted. Treatment of pile heads shall conform to Subsection 812.06.

(4) Cast-in-Place Concrete Piles: After pile shells are fully driven, inspected, and approved, they shall be cut off perpendicular to the axis of the pile at the required elevation.

804.09 UNSATISFACTORY PILES. The procedure used in driving piles shall not subject them to excessive abuse which produces cracking, crushing or spalling of concrete, splitting, splintering and brooming of timber, or deformation of steel. Manipulation of precast concrete piles to force them into proper position will not be permitted. Any pile found to be unacceptable due to internal defects, by improper driving, driven out of proper location, or driven below required elevation shall be corrected at no direct pay by one of the following methods approved by the engineer:

(a) The pile shall be withdrawn and replaced by a new and, if necessary, a longer pile. Additional pile length and/or load testing may be required with no additional compensation due to disturbance of the soil from jetting or other methods used during removal of the pile.

(b) A second pile shall be driven adjacent to the defective pile. This may require driving the replacement pile with a batter in order to place the pile head at the plan location.

(c) The pile shall be spliced or built up as otherwise provided herein or a sufficient portion of the footing extended to embed the pile.

(d) The cap or footing shall be redesigned at no direct pay and shall be approved by the engineer. The contractor will not be allowed additional compensation for increased quantities in a bent or footing due to driving additional piles to correct unsatisfactory piles.

(e) Cracks in concrete piles shall be corrected as follows:

(1) Transverse cracks in piles that show evidence of spalling and or piles with diagonal or longitudinal cracks will be rejected unless the pile has required penetration and resistance and can be cut off below the crack and built up, or it can be repaired by other methods approved by the engineer.

(2) Transverse cracks that show light dusting or powdering during driving shall be repaired by epoxy injection. Driving shall be stopped at the first sign of powdering and the crack shall be injected and cured in accordance with the epoxy manufacturer's recommendations before driving is resumed.

(3) Concrete piles with minor hairline surface cracks will not be cause for rejection or repair provided no change in the crack condition occurs during driving.

804.10 DETERMINATION OF PILE BEARING CAPACITY. The pile bearing capacity is the pile capacity obtained during the end-of-driving or pile restrike. The pile bearing capacity determination shall be made by use of the Dynamic Formula, the Wave Equation, or the Test Pile Loading Results as specified in the plans. If the method of pile capacity is not shown on the plans the Dynamic Formula shall be used.

(a) Dynamic Formula: The pile bearing capacity shall be determined by the engineer, based on the dynamic formula. Piles shall be driven with the approved pile driving equipment to the ordered length or other lengths necessary to obtain the required end-of-driving pile capacity. If the end of driving capacity is not shown on the plans the required pile bearing capacity shall be 3.5 times the pile design load.

English Dynamic Formula:

$$R = \frac{\left(1.75\sqrt{E_r}\,\log(10N_b)\right) - 100}{2}$$

R = *Pile Bearing Capacity (Tons)*

E_r = *Manufacturer's Rated Energy at the field observed ram stroke (foot – pounds)*

N_b = *Number of Hammer Blows/Inch*

Metric Dynamic Formula:

$$R = \left(7\sqrt{E_r}\,\log(10N_b)\right) - 550$$

R = *Pile Bearing Capacity (kiloNewton)*

E_r = *Manufacturer's Rated Energy at the field observed ram stroke (Joules)*

N_b = *Number of Hammer Blows/ 25 mm*

(b)Wave Equation: The pile bearing capacity shall be determined based on a wave equation analysis when required in the plans or directed by the engineer. Piles shall be driven with the approved pile driving equipment to the ordered length or other lengths necessary to obtain the required end-of-driving pile capacity. Approved methods to facilitate pile installation such as preboring, jetting, etc. shall be accounted for in the wave equation analysis.

804.11 FIELD TESTING PILES. When required, the contractor shall drive test piles, indicator piles, or monitor piles of the length, number, size and type specified at the location and penetration shown in the plans or as directed. These piles shall be driven using the approved pile driving system and the

same pile installation method as will be used on permanent piles. Permanent piles may require field testing as directed by the engineer.

(a) Ultimate Pile Capacity: The ultimate pile capacity is the pile capacity that has been determined from either a static or dynamic load test of a test pile, indicator pile, or permanent pile.

(b)Test Piles: Test piles are piles that are driven in advance of the permanent piles for purposes of determining the length of foundation piles by static load testing. Test piles should be long enough to be redriven, if necessary, to the plan tip elevation of the piles at the nearest bent or as directed by the engineer. Test pile length shall be sufficiently long to permit static load testing and dynamic monitoring with the Pile Driving Analyzer. If the test pile is different than the anticipated permanent pile, prior approval must be received from the Chief, Construction Division. All test piles and/or indicator piles shall be inspected by DOTD Fabrication Inspectors prior to delivery to the project.

(c) Indicator Piles: Indicator piles are piles that are driven in advance of the permanent piles for purposes of determining the length of foundation piles by dynamic load testing. The difference between this type of pile and a test pile is that a static load test is not anticipated to be necessary. Indicator piles should be long enough to be redriven, if necessary, to the plan tip elevation of the piles at the nearest bent or as directed by the engineer. Indicator piles will have dynamic monitoring using the Pile Driving Analyzer.

(d)Monitor Piles: Monitor Piles are permanent piles that are monitored during production pile driving for purposes of determining pile driving criteria by dynamic monitoring the pile driving installation. The Pile Driving Analyzer is used to evaluate the pile driving equipment and to monitor the pile driving stresses. This is usually accomplished by monitoring the first permanent pile of its type and size to be driven at each bridge structure or at a specified bent location. The monitor pile is paid for as a permanent pile.

(e) Pile Restrikes: Pile restrikes for test piles, indicator piles, or monitor piles shall be performed in accordance with the time intervals specified below unless otherwise shown in the plans. Test piles that only have static load tests shall have a 1-day restrike after the initial pile installation. Test piles with dynamic monitoring shall have a 1-day restrike after the initial pile installation and a restrike within 24 hours after the load test with the Pile Driving Analyzer monitoring the driving. Indicator piles shall have a 1-day restrike and a 14-day restrike with the Pile Driving Analyzer monitoring the driving.

(f) Test Site Preparation: When test piles and/or indicator piles are driven to determine the length of foundation piles or when a test pile is being driven on a stream bank where the most critical pile is in the middle of the stream, the test pile and/or indicator pile shall model the subsurface conditions of the permanent piles as directed. The contractor will be required to excavate the test pile location to the elevation of the bottom of the footing or stream and/or scour bottom and to keep this excavation open during driving and loading of test piles. In lieu of the above, the contractor will be permitted to drive the test pile within an approved metal casing. The casing shall extend and be excavated to the most critical elevation; be it the bottom of the footing, stream scour bottom, stream bottom, or elevation specified in the plans. The contractor shall provide any bracing or strengthening of the test pile required during loading or driving operations.

Cast-in-place concrete piles shall be filled with concrete in accordance with Subsection 804.08(d) and the concrete allowed to set for at least 48 hours and have attained a minimum concrete strength of 3400 psi (23.5 MPa) before commencing load testing.

(g)Static Load Test: Test piles will be loaded at least 14 calendar days after initial driving unless otherwise directed by the engineer. All test pile loading results should be reviewed by the engineer to determine the ultimate pile capacity.

(1) Loading Procedure: The load shall be applied in increments of 10 to 15 percent of the design load or as directed. Each load increment shall be held for an interval of 5 minutes. Gross settlement readings, loads, and other data shall be recorded by the engineer before and after the application of each load increment.

Test piles shall be loaded to failure or until 3 times the static load test pile capacity shown in the plans is reached. The test pile will be considered to have failed when continuous jacking is required to maintain the load and the pile is being driven into the ground. Unless otherwise directed, loading shall cease on a plunging pile when the gross settlement has reached 10 percent of the average pile diameter or diagonal dimension or as directed by the engineer. When the plunging load is reached, the loading system shall be allowed to equalize by taking readings at 5 minute increments until three consecutive readings indicate that the equilibrium load has been achieved.

The load shall be removed in decrements of approximately 25 percent of the maximum load placed on the test pile. Gross settlement and load readings shall be recorded 5 minutes after reaching each unloading load decrement. The

final recovery of the unloaded test pile shall be recorded until movement is essentially complete for a period up to 30 minutes.

(2) Load Testing System Approval: The load testing system shall be designed and constructed to allow vertical loads to be applied concentric with the longitudinal axis of the pile to be tested so that the load acting on the pile at any time may be accurately determined and controlled. To ensure concentric loading, a spherical bearing plate will be required to be mounted between the load frame and the pile head. The contractor shall submit for approval the proposed load testing system prepared and sealed by licensed civil engineer in the State of Louisiana. The plans shall include a detailed schematic of the load testing setup including steel bearing plates, load cell and bearing plates when required, hydraulic jack, reaction system, and reference system.

(3) Hydraulic Jack: The contractor shall furnish hydraulic jacks of adequate size to deliver the required load and shall be equipped with a single gauge which shows the total pressure being applied. When 2 or more hydraulic jacks are used, they shall be connected in parallel by a manifold or other device used to direct the flow of fluid to the jacks. The calibrated pressure gauge shall be accurate to within five percent of the true load placed on the test pile. The contractor shall have the entire hydraulic system calibrated for all stages of loading and unloading by an approved independent calibration service. The calibration method shall take into account the travel that the ram in the hydraulic jack will undergo. The certified laboratory report of the calibration tests shall be furnished to the Materials and Testing Section for approval. After the system is calibrated, no replacement parts will be permitted (except the pump) without recalibration of the system.

(4) Displacement Instrumentation: The contractor shall furnish instrumentation to monitor the gross displacement readings at the pile head during load testing. The instrumentation shall consist of two dial or electronic readout gauges capable of measuring displacement to a precision of ±0.001 inches (±0.025 mm), with a travel range of 3 inches (75 mm) or as directed. Smooth bearing surfaces perpendicular to the direction of the gauge-stem travel shall be provided for each gauge.

(5) Load Cell: When specified in the plans, the contractor shall furnish the load cell. The load cell and bearing plates shall be of sufficient size and capacity to measure the maximum load being applied. The contractor shall have the load cell recalibrated by an approved testing laboratory if it has not been calibrated within the six months preceding the load test.

(6) Reaction System: The reaction system shall be designed and constructed to resist the maximum anticipated test load.

a. Load Applied by Hydraulic Jack Acting Against Weighted Box or Platform: A test box or test platform resting on a suitable support shall be constructed over the test pile and loaded with earth, sand, concrete, metal or other suitable material with a total weight greater than the anticipated maximum test load. Supports for the weighted box or platform shall be located as far as practicable from the test pile but in no case less than a clear distance of 5 feet (1.5 m).

b. Load Applied to the Test Pile by Hydraulic Jack Acting Against Anchored Reaction Member: Reaction member anchorages shall be constructed with a minimum clear distance of three times the maximum diameter of the reaction anchorages or test pile (whichever has the greater diameter) but not less than 7 feet (2 m). If permanent piles are used for anchorages, permanent piles shall be reseated after completion of test pile load test. Precast concrete piles shall not be used as anchorages. A member or members of sufficient strength to act as a rigid reaction beam shall be attached to the upper ends of the anchorages. Chains or cables shall not be used to transfer the reaction load to the anchorages.

c. Combination Devices: Load applied to the test pile by hydraulic jacks acting against a combination of devices (a) and (b) as described above.

d. Other Systems: Other systems may be proposed by the contractor for approval by the engineer.

(7) Reference System: The contractor shall provide an independently supported reference beam. The reference beam shall consist of installing two wooden beams on each side of the test pile and braced internally to form a rigid frame. The frame will be supported at each end with sturdy timber stakes a minimum clear distance from the center of the test pile of three pile diameters or 8 feet (2.5 m) (whichever is longer). The reference beam supports shall be located as far as practical from reaction beam supports or anchorages. The reference beam supports shall be driven sufficiently deep to ensure that surface movement will not affect the lateral stability or vertical reference of the wooden frame.

(8) Shelter: When specified in the plans or directed by the engineer, the contractor shall supply a temporary tent or shelter sufficient to cover the pile, reference beams, and displacement monitoring gauges from direct sunlight and rain during the load test.

(9) Loading Permanent Piles: When the pile bearing capacity of a permanent pile in accordance with Subsection 804.10 is less than the test pile bearing capacity and will not correlate with the test pile data or is less than the required end-of-driving pile capacity shown in the plans, the engineer may direct the contractor to either drive permanent piles to a greater depth, restrike the pile after a specified waiting period, or load a permanent pile at the driven tip elevation. When loading a permanent pile is directed, the loading shall be conducted in accordance with the procedure given in Subsection 804.11(g) amended as follows. Permanent piles shall be loaded to failure or until a load equal to two times the design load plus any additional soil resistance required by the Engineer.

(10) Dynamic Load Test: This work consists of assisting the Department in obtaining dynamic measurements with the Department's Pile Driving Analyzer (PDA) of test piles, indicator piles, monitor piles, and permanent piles during initial pile driving and during pile restrikes. The cost of equipment mobilization or any delays due to dynamic monitoring shall be at no direct pay. When dynamic monitoring is specified, the piles shall be lengthened by a distance of 2.5 times the pile side dimension to allow access to the top of the pile at the end-of-driving. The dynamic monitoring shall be performed for the purpose of obtaining the ultimate pile capacity, pile driving stresses, pile integrity, and pile driving system efficiency.

a. Dynamic Monitoring Scheduling: The contractor shall give notice to the project engineer at least 14 calendar days before the scheduled date of driving piles to be monitored. The contractor shall allow a possible three calendar day delay for any scheduling conflicts of the Department's Pile Driving Analyzer personnel. The contractor shall confirm the driving date 3 working days prior to the scheduled driving date. The pile to be monitored and the contractor's pile driving equipment shall be on-site and at the location to be driven at least 24 hours prior to monitoring. The pile driving equipment shall be tested the day prior to dynamic monitoring to ensure that it is in proper working order. The project engineer will notify the Pavement and Geotechnical Services Section to confirm that the pile and all associated pile driving equipment are on site, have been inspected and assembled, and are ready for driving operations at least 24 hours prior to dynamic monitoring. The contractor shall allow for a possible 7 day delay when rescheduling is required due to contractor delay.

b. Pile Driving Monitoring: The contractor shall furnish equipment, materials, and labor necessary for attaching the dynamic monitoring instrumentation. The contractor shall make the piles available

prior to pile driving for drilling or tapping holes necessary to attach the instrumentation and take wave speed measurements. The contractor shall provide safe, stable, and OSHA approved access to the pile head for attaching the transducers after the pile is placed in the leads. A platform with a working area of not less than 16 square feet (1.5 sq m) shall be provided by the contractor and shall be equipped so that it may be raised to the top of the pile while the pile is located in the leads. Details of the access system for attaching instrumentation for dynamic monitoring shall be included in the pile installation plan. The expected delay for attaching the instruments to the pile will be approximately 1 hour. Occasionally, the pile driving may have to be temporarily interrupted for the transducers to be adjusted or replaced, or the monitoring results assessed. The contractor shall use reasonable care when working with the Pile Driving Analyzer instruments and accessories. The contractor shall be responsible for replacing any damaged equipment caused by the contractor.

During pile driving operations the Department will monitor with the pile driving analyzer the pile driving stresses induced by the contractor's hammer to ensure that the pile is not being damaged. When necessary, the contractor shall reduce the driving energy transmitted to the pile.

(11) Redriving Test Piles: When steel test piles or indicator piles fail to reach the required ultimate pile capacity, and redriving is required, steel bearing piles shall be extended by splicing if necessary, and redriven as directed. Precast concrete or cast-in-place concrete test piles or indicator piles shall not be extended and redriven. If directed, the contractor shall drive a new test pile to the designated depth at an approved location.

(12) Test Pile and Indicator Pile Removal: If test piles or indicator piles are not to be used as permanent piles, they shall be removed to a minimum of 3 feet (1 m) below natural ground or stream bed and disposed of as directed.

804.12 MEASUREMENT.

(a) Pilings: Piling will be measured by the linear foot (lin m) of pile below pile cut-off elevation. Redriving of permanent piles used as load test anchorages in accordance with Subsection 804.11(g)(6)b will not be measured for payment.

(b)Splices: Splices required to obtain order lengths will not be measured for payment.

(c) Pile Extensions: No measurement will be made for extensions necessitated by damage to the pile during driving.

(1) Precast Concrete Piles: Measurement of extensions on precast concrete piles will be made by the linear foot (lin m). The length of cut-back on the ordered length of pile will be added to the net length of extension to obtain the gross length of extension. The gross length of extension will be multiplied by four to determine the quantity for payment. No deduction will be made from the ordered length of pile driven due to cut-back for splicing.

(2) Steel Piles: Steel piles shall be measured to the linear foot (lin m). Measurement of extensions on steel piles will be made by the linear foot (lin m). The total number of linear feet (lin m) of piling driven will be determined by adding 2 feet (0.5 m) to the net length of piling for each authorized splice in place in the finished structure.

(3) Other Piles: Measurement of extensions on other types of piles will be made by the linear foot (lin m) for that portion of the pile added to the original length of pile driven, which includes any additional driving required.

(d)Cut-Offs: Cut-offs made as directed will be measured by the linear foot (lin m). Payment will not be made for cut-off of a pile unless the length of such cut-off is in excess of 1 foot (300 mm), nor will payment for cut-offs be made where they have been necessitated by crushing, brooming, splitting, or other damage resulting from driving. No payment will be made for required cut-offs of cast-in-place concrete pile shells. Such cut-offs will remain the property of the contractor.

(e) Test Piles and Indicator Piles: The number of test piles and indicator piles to be paid for will be the number of piles of each type furnished and driven as directed. Cut-offs of test piles and indicator piles will not be included in any pay length. Test piles or indicator piles pulled and reused as permanent piles will be measured as provided under Heading (a) of this subsection.

(f) Monitor Piles: Monitor piles will be measured under Heading (a) of this subsection. The field testing is paid for under the Dynamic Monitoring, Item 804-17.

(g)Loading Test Piles: The number of test pile load tests to be paid for will be the number of load tests ordered and completed.

(h)Loading Indicator Piles: The number of indicator pile load tests to be paid for will be the number of load tests ordered and completed.

(i) Redriving Test Piles: Redriving of test piles or indicator piles will be measured for each test pile or indicator pile for which redriving is required.

(j) Reloading Test Piles: The number of reload tests performed on test piles or indicator piles to be paid for will be the number of reload tests ordered and completed.

(k) Loading Permanent Piles: The number of load tests to be paid for will be the number of load tests made as directed.

(l) Dynamic Monitoring: The number of dynamic monitoring to be paid for will be the number of dynamic monitoring occurrences on test piles, indicator piles, monitor piles, and permanent piles ordered and completed. Dynamic monitoring occurrences that are necessary because of contractor error or required in accordance with Subsection 804.06(b)(3) shall not be measured for payment.

(m) Prebored Holes and Jetting: Pilot holes and jetting will not be measured for payment.

804.13 PAYMENT.

(a) Piling: Payment for piling will be made at the contract unit price per linear foot (lin m), which includes all bolting, wrapping or fastening timber fender piles, driving batter piles, concrete and reinforcing steel, jetting or pilot holes, and redriving permanent piles used for anchor piles.

(b)Pile Extensions: Payment for cast-in-place extensions will be made at the contract unit price per linear foot (lin m) for the type and size of pile extended.

(c) Cut-Offs: Payment for cut-offs will be made at the contract unit price per linear foot (lin m).

(d)Test Piles: Payment for test piles will be made at the contract unit price per each. Redriving of test piles will be paid for under Item 804-11.

(e) Indicator Piles: Payment for indicator piles will be made at the contract unit price per each. Redriving of indicator piles will be paid for under Item 804-11. If it is determined from the driving records and the dynamic monitoring that the indicator pile should be load tested, each load test will be paid for under Item 804-09.

(f) Loading Test Piles: Payment for loading test piles will be made at the contract unit price per each.

(g)Redriving Test Piles: Payment for redriving test piles or indicator piles will be made at the contract unit price per each.

(h)Reloading Test Piles: The number of reload tests to be paid for will be the number of reload tests ordered and completed.

(i) Loading Permanent Piles: The number of load tests to be paid for will be the number of load tests made as directed.

(j) Dynamic Monitoring: Payment for dynamic monitoring will be made at the unit price per each.

Payment will be made under:

Item No.	Pay Item	Pay Unit
804-01	Precast Concrete Piles (Size)	Linear Foot (Lin m)
804-02	Treated Timber Piles	Linear Foot (Lin m)
804-03	Steel Piles (Size)	Linear Foot (Lin m)
804-04	Cast-in-Place Concrete Piles (Size)	Linear Foot (Lin m)
804-05	Precast Concrete Test Piles	Each
804-06	Timber Test Piles	Each
804-07	Steel Test Piles	Each
804-08	Cast-in-Place Concrete Test Piles	Each
804-09	Loading Test Piles	Each
804-10	Reloading Test Piles	Each
804-11	Redriving Test Piles	Each
804-12	Loading Permanent Piles	Each
804-13	Precast Concrete Indicator Piles	Each
804-14	Timber Indicator Piles	Each
804-15	Steel Indicator Piles	Each
804-16	Cast-in-Place Concrete Indicator Piles	Each
804-17	Dynamic Monitoring	Each

Section 805
Structural Concrete

805.01 DESCRIPTION. This work consists of furnishing, placing, finishing and curing portland cement concrete in bridges, culverts and other structures.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance Specifications for Portland Cement Concrete Pavement and Structures" or "Application of Quality Assurance Specifications for Precast-Prestressed Concrete Plants."

Structural excavation and backfill shall conform to Section 802.

At the time of final acceptance, concrete box culverts constructed or extended by the contractor shall be cleaned of debris and soil to the culvert invert.

805.02 MATERIALS. Materials shall comply with the following Sections or Subsections:

Mortar	702.02
Steel Joints	807
Portland Cement Concrete	901
Joint Fillers	1005.01
Joint Sealants	1005.02-1005.06
Strip Seal Joints	1005.05
Waterstops	1005.07
Flexible Plastic Gasket Material	1006.06(b)
Reinforcing Steel	1009
Epoxy Coated Reinforcing Steel and Repair Material	1009.01(e)
Curing Materials	1011.01
Special Surface Finish for Concrete	1011.03
Metals	1013
Precast Box Culvert Units	1016
Epoxy Resin Systems	1017.02
Prefabricated Masonry Pads	1018.06
Elastomeric Bridge Bearing Pads	1018.14
Form Release Agents	1018.24
Geotextile Fabric	1019

Classes of concrete furnished shall be as follows:

Table 805-1
Classes and Uses of Concrete

Concrete Class	Use
A or A(M)	Concrete exposed to sea water, and all other concrete except as listed herein.
AA or AA(M)	Cast-in-place bridge superstructure
D	Pier footings
F	Dams and flood control structures
P or P(M)	Precast bridge members
P(X)	Precast-prestressed bridge girders
R	Nonreinforced sections
S	Underwater sections

805.03 HANDLING AND PLACING CONCRETE AND PRECAST UNITS.

(a) General: In preparation for placing concrete, all sawdust, chips and other debris shall be removed from the interior of forms. Struts, stays and braces serving to hold forms in correct shape and alignment shall be removed from the forms when concrete placing has reached an elevation rendering their use unnecessary.

Traffic shall not be permitted on bridge decks until concrete has been in place for 14 calendar days or has attained 3,500 psi (24.1 MPa) compressive strength. For concrete containing fly ash or ground granulated blast-furnace slag, the deck shall be closed to all traffic, including vehicles of the contractor, until the test specimens have attained a compressive strength of 3,500 psi (24.1 MPa).

Precast nonprestressed bridge unit shall be held at the plant a minimum of 10 calendar days after casting. After 10 calendar days, the units may be shipped, provided the required 28-day compressive strength has been attained.

Concrete shall be placed to avoid segregation of materials and displacement of reinforcement. The use of long troughs, chutes and pipes for conveying concrete from mixer to forms will be permitted only with written authorization. If these devices cause segregation, impede workability, or produce detrimental effects, their use shall be discontinued.

Open troughs and chutes shall be metal or metal-lined. Where steep slopes are required, chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement of concrete.

Chutes, troughs and pipes shall be kept free from coatings of hardened concrete by thoroughly flushing with water after each pour. Water for flushing shall not be discharged within the structure.

When placing operations involve dropping concrete more than 5 feet (1.5 m), it shall be deposited through a sheet metal or other approved tremie. After initial set of the concrete, forms and any reinforcing bar projection shall not be disturbed.

Concrete, during and immediately after depositing, shall be thoroughly consolidated. Consolidation shall be done by mechanical vibration subject to the following provisions.

(1) Vibration shall be internal unless authorization for other methods is obtained or as provided herein.

(2) Vibrators shall be of an approved type and design, capable of transmitting vibration to concrete at frequencies of at least 4,500 impulses per minute.

(3) Intensity of vibration shall be such as to visibly affect concrete over a radius of at least 18 inches (500 mm).

(4) The contractor shall provide a sufficient number of vibrators to properly consolidate each concrete batch immediately after it is placed.

(5) Vibrators shall be manipulated so as to thoroughly work concrete around reinforcement and imbedded fixtures and into corners and angles of forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. Vibrators shall be inserted and slowly withdrawn vertically from the concrete. Vibration shall be of sufficient duration and intensity to thoroughly compact concrete, but shall not cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which vibration is visibly effective.

(6) Vibration shall not be applied directly to or through reinforcement to sections or layers of concrete which have hardened to the degree that concrete ceases to be plastic under the vibration. It shall not be used to make concrete flow over distances so great as to cause segregation. Vibrators shall not be used to drag concrete in forms.

(7) Vibration shall be supplemented by such spading as necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations inaccessible to vibrators.

(8) These provisions for vibration shall apply to filler concrete for steel grid floor except that the vibrator shall be applied to the steel.

(9) These provisions for vibration shall also apply to precast concrete except that, if approved, the manufacturer's methods of vibration may be used.

Concrete shall be placed in horizontal layers not more than 15 inches (375 mm) thick unless otherwise permitted. When less than a complete layer is placed in one operation, it shall be terminated at a vertical bulkhead. Each layer shall be placed and consolidated before the preceding batch has taken initial set to prevent damage to green concrete and avoid surfaces of separation between batches. The top surface of concrete adjacent to forms shall be finished to a suitable grade strip.

When concrete placement is temporarily discontinued, the concrete, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete after becoming firm enough to retain its form.

Where a featheredge might be produced at a construction joint, as in the sloped top surface of a wingwall, an inset form shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than 6 inches (150 mm) in the succeeding layer. Placement of concrete shall not be discontinued within 18 inches (450 mm) of the top of any face, unless provision has been made for a coping less than 18 inches (450 mm) thick, in which case, the construction joint may be made at the underside of the coping.

Following concrete placement, accumulations of mortar splashed on reinforcement steel and forms shall be removed. Dried mortar chips and dust shall not be mixed in fresh concrete.

(b)Reinforced Concrete Box Culvert: The contractor may furnish structures of either cast-in-place concrete or precast concrete units; however, design and installation procedures for precast units will be subject to approval. For the cast-in-place option, the base slab or footings of a box culvert shall be placed and allowed to set before the remainder of the culvert is constructed.

Before concrete is placed in sidewalls, culvert footings shall be cleaned of shavings, sticks, sawdust and other debris and the surface carefully chipped or roughened in accordance with the method of bonding construction joints specified in Subsection 805.06.

For culverts 4 feet (1.2 m) or less in height, walls and top slab may be constructed monolithically. When this method of construction is used, necessary construction joints shall be vertical and perpendicular to the axis of the culvert.

In construction of box culverts more than 4 feet (1.2 m) in height, concrete in walls shall be placed and allowed to set in accordance with strength or curing time requirements of Subsection 805.11 before the top slab is placed.

If possible, each wingwall shall be constructed monolithically. Construction joints shall be horizontal and located so that no joint will be visible in the exposed face of the wingwall above the ground line.

Precast units shall be cast and placed as shown on the plans. Joints for sectional precast units shall comply with Subsection 1016.02. Joints shall be wrapped with an approved geotextile fabric for a minimum of 12 inches (300 mm) on each side of the joint. Ends of cloth shall be lapped at least 18 inches (450 mm), with the edges and ends suitably secured.

(c) Girders, Slabs and Columns: Concrete in girders shall be deposited uniformly for the full length of girder and brought up evenly in horizontal layers.

Concrete in girder haunches less than 3 feet (900 mm) high shall be placed at the same time as that in the girder web; the column or abutment tops shall be cut back to form seats for the haunches. Whenever a haunch or fillet has a vertical height of 3 feet (900 mm) or more, the abutment or columns, haunch and girder shall be placed in three stages: up to the lower side of haunch, to the lower side of girder, and to completion. For haunched continuous girders, the girder web (including haunch) shall be placed to the top of web. Where the size of pour is such that it cannot be made in a continuous operation, vertical construction joints shall be located within the area of contraflexure.

Concrete in slab spans shall be placed in one continuous operation for each span.

Concrete columns shall be placed in a continuous operation. Concrete shall be allowed to set at least 24 hours before caps are placed. When friction collars are used to support cap forms, concrete columns shall have been poured at least 7 days or shall have at least 3,000 psi (20.7 MPa) compressive strength before caps are placed. Compressive strength cylinders shall be made in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230.

No concrete shall be placed in the superstructure until column forms have been stripped sufficiently to determine the quality of concrete in the columns. The superstructure loads shall not be allowed on the bents until the concrete has attained at least 3,000 psi (20.7 MPa) compressive strength but not less than 7 curing days. Compressive strength cylinders shall be made in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230.

(d)Minimum Placement Rate for Bridge Decks: The contractor shall provide sufficient supervision, manpower, equipment, tools and materials
to assure proper production, placement and finish of concrete for each pour in accordance with minimum placement rates specified in Table 805-2 below. If the contractor fails to meet the minimum placement rate, the engineer may reject the pour; further placement of similar nature and size will not be permitted until corrective measures have been taken to assure that the minimum placement rate can be met.

Table 805-2
Concrete Placement Rates for Bridge Decks

Pour Size Cubic Yards (Cu m)	Minimum Placement Rate Cubic Yards (Cu m) Per Hour
0-50 (0-40)	20 (15)
51-75 (41-60)	25 (20)
76-125 (61-100)	30 (25)
Over 125 (Over 100)	40 (30)

Pour rates shown are intended for use on simple spans. For all spans, pours are to be completed in four hours. For continuous precast concrete girder spans, the pour rate is based on the volume of concrete in two adjacent spans divided by four hours.

(e) End-On-Construction: The use of end-on-construction will only be allowed for slab span bridges, either cast-in-place concrete or precast concrete, when the construction cannot be conducted from the ground or it is impractical to work from the water surface. The contractor shall make a written request to the Department for approval to use end-on-construction procedures. The contractor shall submit drawings and calculations with his request showing the construction loads to be placed on the structure. The drawings shall also show details of matting systems, crane size, outline dimensions, lifting loads, and extension distance from the crane. The calculations shall analyze the maximum construction loads, including structure dead loads, being applied to the structure. The drawings and calculations shall be stamped and signed by a professional civil engineer registered in the State of Louisiana.

No end-on-construction activity will be allowed on the structure until approved by the Department. Approval of end-on-construction procedures will not relieve the contractor from responsibility for repairing any damages to

the structure, at no cost to the Department, caused by his construction activities.

805.04 PUMPING. Pumping equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. Pipes carrying concrete to placing area shall be laid out with a minimum of bends and no unauthorized change in size. Where concrete is conveyed and placed by mechanically applied pressure, suitable equipment of adequate capacity shall be used.

A grout mortar, or concrete without coarse aggregate, shall be pumped through the equipment ahead of the regular concrete to provide lubrication to start pumping operations. This material shall not be used in placement. The lubrication process need not be repeated as long as pumping operations are continuous.

Operation of the pump shall be such as to provide a continuous stream of concrete without air pockets. When pumping is completed, concrete remaining in the pipes, if it is to be used, shall be ejected in such manner that there will be no contamination of concrete or separation of ingredients.

805.05 DEPOSITING CONCRETE UNDERWATER. Concrete shall not be deposited in water except on approval. The method of placing shall be approved by the engineer and conform to the following:

To prevent segregation, concrete shall be placed in its final position by means of a tremie and shall not be disturbed after being deposited. Concrete shall be placed in caissons, cofferdams or watertight forms.

For underwater parts of structures, concrete seals shall be placed in one continuous operation. The surface of the concrete shall be kept as nearly horizontal as possible; still water shall be maintained at the point of deposit.

A tremie shall consist of a tube at least 10 inches (250 mm) in diameter; if constructed in sections, the couplings shall be watertight. Tremies shall be supported so as to permit positioning anywhere over the top surface of the work and for rapid lowering when necessary to retard or stop the flow of concrete.

When concrete is dumped into the hopper, flow may have to be induced by slightly raising the discharge end of the tremie, but always keeping it in deposited concrete. Flow shall be continual until the work is completed. Aluminum tremies will not be permitted.

Dewatering may proceed when the concrete is sufficiently hard, but not for at least 72 hours after concrete placement is completed. Prior to constructing

succeeding portions of the structure, laitance or other unsatisfactory material shall be removed from the surface by scraping, chipping or other means which will not damage the concrete.

805.06 CONSTRUCTION JOINTS.

(a) General: Construction joints shall be made only where located on the plans or shown on the pouring schedule, unless otherwise approved. When not detailed on the plans, construction joints shall be placed as directed. Raised shear keys or reinforcing steel shall be used where necessary to transmit shear or bond sections together.

(b)Bonding: Forms shall be retightened before placing new concrete on or against hardened concrete.

(1) Neat Cement Slurry Joints: The surface of hardened concrete shall be roughened as required in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. It shall then be thoroughly cleaned of foreign matter and laitance, and saturated with water. All surfaces shall be thoroughly coated with a neat slurry to ensure that adequate mortar is placed at the juncture of the hardened and newly deposited concrete. New concrete shall be placed before the grout has attained its initial set. Placing of concrete shall be carried continuously from joint to joint. Edges of joints which are exposed to view shall be finished true to line and elevation.

(2) Epoxy Resin Joints: Vertical surfaces of bridge deck construction joints and other construction joints shall be coated prior to each succeeding pour with an approved Type II, Grade B or Grade C epoxy resin applied according to the manufacturer's recommendations. Surfaces of hardened concrete to which new concrete is to be bonded shall be cleaned of foreign material, loose or unsound concrete by sandblasting, hammers or wire brushes. Grease or oil shall be removed with a detergent wash such as trisodium phosphate, and the entire area washed with fresh water and brushed with a stiff brush. If a detergent is not required, dust and small particles not removed by other cleaning methods shall be removed by washing.

(3) Unless a joint type (1) or (2) above is specified in the plans or specifications, the surface of the hardened concrete shall be thoroughly cleaned of foreign matter and laitance, and saturated with water prior to pouring fresh concrete.

805.07 CONCRETE EXPOSED TO SALT WATER.

Concrete shall be thoroughly consolidated and stone pockets shall be avoided. No construction joints shall be formed between levels of extreme low water and extreme high water. Salt water shall not come in contact with concrete for at least 30 calendar days.

805.08 FALSEWORK. Detailed plans for falsework shall be furnished in accordance with Section 801.

Falsework shall be designed in accordance with Subsection 801.04.

Falsework which cannot be founded on a satisfactory footing shall be supported on piling spaced, driven and removed in an approved manner. Falsework shall be set to give the finished structure the specified camber.

805.09 FORMS.

(a) Construction: Forms shall be of wood, metal or other approved material, built mortartight and of sufficient rigidity to prevent distortion due to pressure of concrete and other loads incident to construction operations.

Forms shall be constructed and maintained to prevent warping and opening of joints due to shrinkage of lumber. Forms shall be substantial and unyielding and so designed that finished concrete will conform to proper dimensions and contours. Design of forms shall take into account the effect of vibration of concrete as it is placed.

(b)Form Surface: Forms for exposed surfaces shall not adhere to nor discolor concrete. Forms shall be made of either metal or dressed lumber of uniform thickness with or without approved form liner and shall be mortartight. Forms for reentrant angles shall be chamfered and forms shall be filleted at sharp corners. Forms for projections, such as girders or copings, shall be given a bevel or draft to ensure easy removal.

When possible, forms shall be daylighted at intervals not greater than 10 feet (3 m) vertically, the openings being sufficient to permit free access for inspecting, working and spading the concrete.

(c) Form Ties: Metal ties or anchorages within forms shall be constructed to permit their removal to a depth of at least 1/2 inch (13 mm) from the face without damage to concrete. If wire ties are permitted, upon removal of the forms, wire shall be cut back at least 1/4 inch (6 mm) inside from the face of the concrete with chisels or nippers. Fittings for metal ties shall be of such design that, upon their removal, cavities left will be of the smallest possible size. Cavities shall be filled with cement mortar and the surface left sound, smooth, even and uniform in color.

Fiberglass ties may be used and shall be ground flush with the concrete surface.

(d)Setting and Maintaining: Forms shall be set and maintained reasonably true to required line and grade until concrete is sufficiently hardened. When forms are deemed to be unsatisfactory, either before or during placing of concrete, the work shall be stopped until defects have been

corrected. Forms shall be so designed that portions where finishing is required may be removed without disturbing portions of forms to be removed later and, as far as practical, so that form marks will conform to general lines of the structure. For narrow walls and columns, where the bottom of the form is inaccessible, lower form boards shall be left loose so that they may be removed for cleaning out immediately before placing concrete.

(e) Re-Used Forms: Shape, strength, rigidity, mortar-tightness and surface smoothness of re-used forms shall be maintained. Warped or bulged lumber shall be resized before being reused. Unsatisfactory forms shall not be re-used.

(f) Surface Treatment: Forms shall be treated with an approved form release agent prior to placement of reinforcing steel. Release agents which will adhere to or discolor concrete shall not be used.

Prior to placing concrete, the interior of forms shall be cleaned of dirt, sawdust, shavings or other debris. Forms shall be inspected then saturated with water immediately prior to placing concrete.

(g)Steel Stay-in-Place Forms: Steel stay-in-place forms can only be used when approved by the DOTD Chief Construction Engineer. Steel stay-in-place forms shall conform to the requirements of Subsection 1013.25. The dead load deflection of steel stay-in-place forms shall not exceed L/240 or 3/8 inch (9 mm). Concrete admixtures or set accelerators containing chlorides will not be allowed in the concrete when placed against steel stay-in-place forms.

When allowed, the use of steel stay-in-place forms will require:

(1) Reinforcing chairs made for use with stay-in-place forms that will span the corrugations and properly support the reinforcing steel.

(2) Metal chairs in contact with the metal forms shall be hot-dipped galvanized, electroplated with zinc (GS Grade), epoxy coated, or made of stainless steel.

(3) Repair of any damage to galvanized surfaces on the metal pans or the visually exposed surfaces of the support angles with a cold galvanizing compound from QPL 23.

(4) Removal of any portion of the support angle leg that sticks up into the bottom of the deck by more than 1/2 inch (13 mm).

(5) Steel girders and stringers to be shielded to prevent weld splatter or arc strikes on them during the installation of the support angles.

(6) Contractor responsible for any additional temporary bracing requirement to prevent rotation of exterior girders.

805.10 CURING. Concrete in substructures for grade separation structures, superstructures of major structures, and railroad underpasses shall be cured with wet burlap or combined wet burlap and white polyethelene sheeting. Precast concrete shall be cured in accordance with Subsection 805.14(e).

A Type 1-D curing compound complying with Subsection 1011.01 may be used for curing concrete in minor drainage structures and bridge substructures and diaphragms when surfaces do not require a Class 2A finish. When membrane curing is used, exposed reinforcing steel and construction joint surfaces shall be covered or shielded to prevent coating with curing compound. Construction joint surfaces shall be wet cured by approved methods as soon as possible after concrete placement. Concrete surfaces in contact with forms shall be sealed immediately after completion of form removal and surface finishing. Membrane curing shall be applied as soon as surface moisture has evaporated. Method and application rate of curing compound shall be in accordance with the manufacturer's recommendations, but in no case shall the application rate be less than one gallon per 100 square feet (one liter per 2.5 sq m) surface area. The compound shall be applied in one or two applications. If the compound is applied in two increments, the second application shall follow the first application within 30 minutes. Satisfactory equipment shall be provided, with means to properly control and direct application of curing compound on concrete surfaces to result in uniform coverage.

If rain falls on newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged, a new coat of compound shall be applied to affected portions.

When curing with burlap, the exposed concrete immediately after finishing shall be covered with two thicknesses of wet burlap. Burlap shall be fixed so that it is in contact with the concrete at all times and shall be kept continuously wet for at least 5 curing days after concrete is placed, with curing days as defined in Subsection 805.11.

In bridge deck construction, exposed surface of decks shall be sprayed uniformly with a Type 2 curing compound immediately after final texturing as an interim curing measure in accordance with Subsection 601.10(a). Exposed reinforcing steel and joints shall be covered or shielded to prevent contact with curing compound. Moist curing methods stated herein shall then be used on the deck when concrete has set sufficiently to support burlap without marring the surface.

805.11 REMOVAL OF FALSEWORK AND FORMS. Except as otherwise specified herein, face form for barrier curbs or rails and side forms for caps requiring a Class 2A finish shall be removed not less than 1/2 nor more than 2 curing days after concrete is placed to permit finishing.

Forms for surfaces not requiring a Class 2A finish, and supporting forms and falsework for structure members such as bent caps, beams and slabs, shall be removed in accordance with one of the following methods. For concrete containing fly ash or ground granulated blast-furnace slag, only Method 1 shall be used.

Method 1: Forms and falsework may be removed as soon as concrete has attained a compressive strength, as determined by cylinder tests, indicated in Table 805-3:

Table 805-3
Removal of Forms and Falsework

Concrete Class	Compressive Strength, Psi (MPa)
A	3,000 (20.7)
A(M)	4,000 (27.6)
AA	3,500 (24.1)
AA(M)	4,000 (27.6)
D	2,500 (17.2)
F	3,200 (22.1)
P (nonprestressed)	3,000 (20.7)
P(M) (nonprestressed)	3,600 (24.9)
R	1,600 (11.0)

Test specimens will be made in accordance with DOTD TR 226 from the same concrete and cured under the same conditions as the portion of the structure involved. Specimens will be tested in accordance with DOTD TR 230.

Method 2: Forms and falsework may be removed when concrete has aged for the minimum number of curing days in Table 805-4:

Table 805-4
Forms and Falsework Removal Schedule

Forms	Curing Days
Under slabs, beams or pile caps with span lengths less than 10 feet (3.0 mm)	7 days
Under slabs, beams or pile caps with span lengths of 10 to 17 feet (3.0 to 5.0 m)	7 days plus 1 day for each foot (300 mm) of span over 10 feet (3 m)
Under slabs, beams or pile caps with span lengths over 17 feet (5.0 m)	14 days
Under portion of slabs that cantilever more than 1 foot (300 mm)	7 days
Walls, columns, side forms for beams, pile caps and slabs that cantilever less than 1 foot (300 mm)	1 day
Caissons	1 day
Precast nonprestressed bridge units (side forms)	1 day

The term "curing day" will be interpreted as a calendar day on which the temperature is above 50°F (10°C) or 55°F (13°C) if ground granulated blast furnace slag is used in concrete for at least 19 hours. Colder days may be counted if approved methods are used to maintain air temperature adjacent to concrete above 50°F (10°C) throughout the day.

During continued cold weather, when artificial heat is not provided, the engineer may permit removal of forms and falsework at the end of a period of calendar days equal to two times the number of curing days stated above.

The foregoing provisions for form and falsework removal shall apply only to forms or parts of forms so constructed as to permit removal without disturbing forms or falsework which are required to be left in place for a longer period on other portions of the structure.

Methods of form removal likely to cause overstressing of concrete shall not be used. Forms and their supports shall not be removed without approval. Supports shall be removed in such manner as to permit concrete to uniformly and gradually take stresses due to its own weight.

805.12 EXPANSION AND FIXED JOINTS, AND BEARINGS.

(a) Open Joints: Open joints shall be constructed by insertion and subsequent removal of a wood strip, metal plate or other approved material. Insertion and removal of the template shall be accomplished without chipping or breaking corners of concrete. Reinforcement shall not extend across an open joint.

(b)Filled Joints: Joints to be sealed with poured seals shall be formed and constructed similar to open joints. For joints with preformed filler, the filler shall be in correct position when concrete is placed.

(c) Joint Seals: Joints shall be sealed full width, including curbs and sidewalks. The concrete shall be at least seven days old prior to sealing. Liquid poured or silicone sealant may be used, however the same type sealant shall be used for the entire structure.

(1) Liquid Poured: Before application of the sealant, joint faces shall be sandblasted. Joints shall be thoroughly dry at the time of installation. Sealants shall be installed in accordance with the manufacturer's recommendations. The material's shelf life shall not be exceeded. The ambient air temperature at the time of application shall be at 70°F (20°C) or greater. Application shall be done by a machine with a powered mixing device with an accurate method of proportioning and mixing the components.

Primers, when required, shall be applied as directed by the manufacturer; however, it shall be applied the same day as installation and shall be tack free prior to installation of sealants.

Joints shall be backed with an approved backer material. Prior to cleaning the joint faces, the top of the joint filler shall be removed to a depth to allow for placement of the backer material, joint sealant, and sealant recess below the finished surface. The backer material shall be compressed into the joint such that it adheres tightly to the sides of the joint.

(2) Silicone Sealant: The silicone sealant shall comply with Subsections 1005.02(c) or (d). The joint faces shall be sandblasted prior to sealing, and the faces shall be dry and dust free at the time of installation. The silicone sealant shall be installed in accordance with the manufacturer's recommendations, and the air temperature at the time of placement shall be at least 50°F (10°C). The sealant material shall be tooled by approved methods to force the material against the joint walls.

Joints shall be backed with an approved backer material. Prior to cleaning the joint faces, the top of the joint filler shall be removed to a depth to allow for placement of the backer material, joint sealant, and sealant recess below the

finished surface. The backer material shall be compressed into the joint such that it adheres tightly to the sides of the joint.

(d)Strip Seal Joints: Joints shall be free of loose rust, and thoroughly clean and dry at the time of installation. Joint seal glands shall be installed in accordance with the manufacturer's recommendations.

Stretching of the seal gland shall be minimal. When installation procedures appear to cause stretching, random inspection will be made. Frequency and thoroughness of inspections shall be as directed. Maximum allowable stretch shall be 5 percent. When maximum limits are exceeded, and the adhesive lubricant has chemically set, the seal shall be completely removed and cleaned, the joint recleaned and reinstallation made at no direct pay.

The adhesive lubricant shall be applied just prior to installation of the gland and shall be sufficient to completely cover the contact surfaces of the steel extrusion and the seal glands. Installation shall be done in a manner that least disturbs the adhesive lubricant. Dilution of the adhesive lubricant will not be allowed.

The joint manufacturer shall submit shop drawings in accordance with Subsection 801.03 and shall supervise the installation and provide the necessary technical expertise.

Welding shall be in accordance with Section 815. Shop fabrication and fabrication inspection shall conform to Section 807.

Temporary restraints placed in joints shall be removed as soon as possible after placing concrete adjacent to the joint.

(e) Preformed Polyurethane Expansion Joint Filler: Joint fillers shall be installed as directed.

(f) Steel Joints: Plates, angles or other structural shapes shall be fabricated to conform to the plans and section of the concrete floor. The surface in the finished plane shall be true and free of warping. Positive methods shall be employed in placing joints to keep them in correct position during placing of concrete. The opening at expansion joints shall be designated on the plans at the prescribed temperature. The required clearance shall be accurate considering temperature effects and stage of construction at the time of installation.

Temporary restraints placed in joints shall be removed as soon as possible after placing concrete adjacent to the joint.

(g)Waterstops: Adequate waterstops of metal, rubber or plastic shall be placed as shown on the plans. Where joint movement is to be provided,

waterstops shall be of a type permitting such movement without damage. They shall be spliced, welded or soldered to form continuous watertight joints.

(h)Bearing Surfaces: Masonry surfaces on which bearings are to be set shall be finished to ensure uniform bearing at required grade and elevation.

(i) Elastomeric Bridge Bearing Pads: Bearings shall be specified by durometer hardness, size and configuration and, in the case of laminated bearings, by thickness of individual layers of elastomer and the size and position of special connection members required to be vulcanized with the bearing.

(j) Expansion Devices: Rockers or other expansion devices shall be accurately set considering temperature effects and stage of construction at the time of installation.

805.13 CONCRETE SURFACE FINISHES. Surface finishes shall be classified in accordance with Table 805-5 below.

Table 805-5
Concrete Surface Finishes

Class 1	Ordinary Surface Finish
Class 2A	Special Surface Finish
Class 4	Sandblast Finish
Class 6	Bridge Deck Finish
Class 7	Sidewalk Finish
Class 8	Precast Prestressed Concrete Finish

All concrete shall be given Class 1, Ordinary Surface Finish, in addition to any other type of finish specified.

Bridge deck surfaces shall be given a Class 6, Bridge Deck Finish.

(a) Class 1, Ordinary Surface Finish: Immediately following the removal of forms, fins and irregular projections shall be removed from all surfaces except from those which will not be exposed to view after construction or are not to be waterproofed. Cavities produced by form ties and other holes, honeycombed spots, broken corners or edges and other defects shall be cleaned and, after having been kept saturated with water, shall be pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the concrete being finished.

Mortar used in pointing shall be not more than 1 hour old. Water shall be added to a workable consistency. Concrete shall then be cured as specified under Subsection 805.10. Construction and expansion joints shall be free of

mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

Surfaces shall be true and uniform. Surfaces which cannot be satisfactorily repaired shall be coated as specified for Class 2A, Special Surface Finish.

Exposed surfaces not protected by forms shall be struck off with a straightedge and finished with a wood float to a true, even surface. Use of additional mortar to provide a grout finish will not be permitted.

(b)Class 2A, Special Surface Finish: The Class 2A Special Surface Finish will be used as required by the plans and additionally as follows: visually exposed faces of wingwalls, retaining walls, railings and parapets; outside faces of girders, slabs, brackets, curbs, headwalls, parapets, and vertical faces of caps and columns. Wingwalls shall be finished from the top to 1 foot (300 mm) below finish slope line on the exposed face and shall be finished on top for a depth of 1 foot (300 mm) below the top on backfill sides. When the Special Surface Finish is used, it shall be used throughout the structure.

Application of the Special Surface Finish shall not be started until other work which might mar the surface finish is complete and finishing operations can be carried out continuously on a structure.

The same materials and methods shall be used for all surfaces on the project given this Special Surface Finish.

(c) Class 4, Sandblasted Finish: After 28 curing days, the concrete surface shall be sandblasted with hard, sharp sand to produce an even fine grained surface in which mortar has been cut away, leaving aggregate exposed.

(d)Class 6, Bridge Deck Finish:

(1) Striking Off: After concrete is placed and consolidated according to Subsection 805.03, bridge decks or top slabs of structures serving as finished pavements shall be finished either by hand methods or approved mechanical machines. Continuous span units shall be struck off with approved mechanical equipment.

When hand methods are used, bridge decks shall be struck off with a screed parallel to the centerline of roadway, resting on bulkheads or screed strips cut or set to required roadway cross section. This screed shall be constructed to have sufficient strength to retain its shape, and the cutting edge shall be adjusted to conform to roadway profile. Screeds shall be of sufficient length to finish the full length of spans 30 feet (10.0 m) or less in length. These screeds shall be mechanically operated for finishing spans over 30 feet

(10.0 m) in length but may not be used to strike off spans in excess of 50 feet (15.0 m) without permission.

Spans over 30 feet (10.0 m) in length and continuous spans shall be placed with lengths of pours as shown on the plans. Screed strips or headers shall be accurately set to specified grades, checked and adjusted as necessary prior to final screeding operations. The screed shall be worked back and forth over the surface until proper profile and cross section are obtained.

Mechanical finishing machines shall be approved power driven machines, traveling on rails, equipped with transverse or longitudinal screeds and adjusted to conform to profile or cross section. Consolidation by vibratory action of the finishing machine will not be permitted. Screeds shall have sufficient strength to retain their shape after adjustment. The finishing machine shall go over each area of bridge deck as many times as required to obtain required profile and cross section. A slight excess of concrete shall be kept in front of the cutting edge of the screed. This excess of concrete shall be carried to the edge of the pour or form and shall be wasted.

Excess water, laitance or foreign materials brought to the surface during finishing operations shall not be reworked into the slab, but shall be removed immediately.

Addition of water to the surface of concrete to assist in finishing operations will be kept to an absolute minimum to facilitate finishing. It shall be applied as a fine spray by means of approved equipment.

(2) Straightedging: After striking off, the surface shall be checked by the contractor with an approved 10-foot (3.0 m) metal static straightedge operated parallel to the centerline of the bridge and shall show no deviation in excess of 1/8 inch (3 mm) from the testing edge of the straightedge. Deviations in excess of this requirement shall be corrected before final finishing. The checking operation shall progress by overlapping the straightedge at least 1/2 the length of the preceding pass. Major deviations shall be corrected by the strike-off, with the straightedge being used to correct minor deviations and as a checking device.

(3) Final Texturing: After surface irregularities have been removed and a satisfactorily smooth surface obtained, concrete shall be given a uniformly textured final surface finish by use of a metal tine texturing device.

Tines shall be approximately 0.025 inches by 0.126 inches (0.6 mm by 3.0 mm) steel flat wire, 4 inches to 5 inches (100 mm to 125 mm) in length, and randomly spaced with a minimum spacing of 3/8 inch (10 mm) and a maximum spacing of 1 1/2 inches (40 mm). No more than 50 percent of the spaces shall exceed 1 inch (25 mm). Groves produced in the concrete shall be

3/16 inch (5 mm) in depth, with a minimum depth of 1/8 inch (3 mm). Grooves shall be transverse to the centerline of roadway and shall extend to within 1 foot (300 mm) of the gutterline. A mechanical or manual operation may be used to propel metal tines, provided required texture is obtained.

Depth of final finish will be checked in accordance with DOTD TR 229. Texturing equipment other than that specified herein may be approved provided it produces an equivalent texture.

During final surface texturing operations, areas improperly finished shall be refloated and refinished as required.

(e) Class 7, Sidewalk Finish: After concrete has been placed, it shall be consolidated and the surface struck off by means of a strike board and floated with a wooden or cork float. An edging tool shall be used on edges and at expansion joints. The surface shall not vary more than 1/8 inch (3 mm) under a 10-foot (3.0 m) metal static straightedge. The surface shall have a granular or matte texture.

(f) Class 8, Precast-Prestressed Concrete Finish: Precast-prestressed bridge members shall be given Class 1, Ordinary Surface Finish at the plant as soon as possible after casting and prior to shipment by the manufacturer. The manufacturer of precast members will be required to adopt measures to reduce the number and size of trapped air cavities to a minimum; an excessive number of these cavities will be cause for rejection of the precast member.

After completion of the structure, construction damage shall be repaired so as to restore the Class 1, Ordinary Surface Finish. Exposed surfaces of precast-prestressed concrete piles shall be cleaned to produce a uniform color. Cleaning shall not be done in a manner to destroy the glazed surface of concrete resulting from the use of metal forms.

During pouring of decks, the contractor shall keep girders, pilings, and columns clean by washing and shall remove any materials that adhere to the surface and mar the girder finish.

805.14 PRESTRESSED CONCRETE.

(a) Supervision and Inspection: The contractor or fabricator shall provide a technician skilled in the prestress system to be used who shall supervise the work and provide assistance to the engineer as required.

Shop drawings as required under Subsection 801.03 shall be approved and in the possession of the plant inspector at least 2 days prior to beginning fabrication. Access to all parts of the plant engaged in fabrication of prestressed concrete bridge members shall be afforded the engineer while

prestressed members are being fabricated. Areas where inspection is required shall be kept free of debris.

The Department will inspect all prestressed concrete bridge members. The fabrication, construction and dimensional tolerances of prestressed members shall conform to the limits specified in the "Manual for Quality Control for Plants and Production of Precast-Prestressed Concrete Products (MNL-116-Latest Edition)" published by the Prestressed Concrete Institute, unless otherwise specified herein. Required finishing, repairs and curing shall be accomplished immediately after casting and before placing members in permanent storage.

The fabricator shall furnish the engineer an office with at least 140 square feet (13.0 sq m) of floor space to perform necessary work. Additional space deemed necessary by the engineer shall be provided. This office shall contain a desk, chair, file cabinet with lock, telephone, electric lights, power outlets, shelves and tables, in the quantity required by the engineer. This office shall also contain two separate telephone lines, one dedicated to the telephone and the other dedicated to a computer. Fabricator shall be responsible for paying all utility bills. The office shall be provided with adequate heating, ventilation, air conditioning, and convenient sanitary facilities with running water. This office shall be in good condition, located where there is not excessive noise and restricted to the Department's inspectors. Convenient and adequate reserved parking space shall be provided.

The fabricator shall furnish a concrete cylinder breaking machine of minimum 250,000 lb (1100 kN) capacity complying with ASTM C 39 along with all other necessary supplies and equipment. Suitable facilities for use of this machine shall also be furnished. This machine shall be calibrated by an approved laboratory or calibration service at the manufacturer's expense prior to initial use and at one year intervals thereafter. If, during use, the machine appears to be giving erratic results, recalibration will be required.

(b)General Equipment and Stressing Requirements: The fabricator shall provide all equipment necessary for construction and prestressing. Prestressing shall be done with approved equipment. If hydraulic jacks are used, they shall be equipped with accurate reading pressure gages.

In all methods of tensioning, the stress induced in tendons shall be measured both by jacking gages and elongations of reinforcement, and results shall check within specified limits. Means shall be provided for measuring elongation of reinforcement to the nearest 1/32 inch (mm).

Prior to use in fabrication of prestressed members under these specifications, all jacks to be used, with their gages, shall be calibrated by an approved independent calibration service at no direct pay. A certification shall be supplied to the Construction Section. During the work, if a jack or gage
appears to be giving erratic results or if gage pressure and elongations indicate materially differing stresses, recalibration will be required.

There may be a difference in indicated stress between jack pressure and elongation of about 5 percent. In such event, the error shall be so placed that the discrepancy shall be on the side of a slight overstress. In the event of an apparent discrepancy between gage pressure and elongation of as much as 10 percent, the operation shall be carefully checked and the source of error determined before proceeding.

The amount of stress to be given each stressing element shall be as shown on the plans.

Pretensioning of tendons shall be in prescribed stages to allow for stress equalization throughout the tendon.

(c) Concrete: Design of the concrete mix shall be the responsibility of the contractor subject to approval, but such approval shall not relieve the fabricator of responsibility for the product furnished.

Concrete shall be controlled, mixed and handled as specified in this section and Section 901.

Concrete shall not be deposited in forms until the engineer has inspected reinforcement, conduits, anchorages, cleanliness of forms and prestressing tendons and given approval.

Concrete shall be vibrated internally or externally or both, as ordered. Vibrating shall be done in such manner as to avoid displacement of reinforcing, conduits or tendons.

Tops of prestressed beams shall be rough floated. At the time of initial set, the top of beams shall be scrubbed transversely with a coarse wire brush to remove laitance and produce a roughened surface for future bonding.

(d)Forming for Girders: Prestressed members shall be cast in steel forms. Bolted form joints shall be so spaced that no exterior girder shall have more than two bolted joints or seams. Bolted joints or seams shall be sealed to minimize bleeding.

Prior to placement of concrete and reinforcing steel, forms shall be thoroughly cleaned and uniformly coated with an approved form release agent from QPL 29.

Outside surfaces of forms shall be maintained reasonably clean and free from concrete build-up.

Forms that have become heated shall be cooled by spraying with water immediately prior to placing concrete in each section.

Girder ends shall be coated with an approved protective coating to protect strand ends.

Prestressed members shall be finished in accordance with Subsection 805.13(f).

(e) Curing: To establish adequacy of curing methods and to determine whether concrete has attained the required compressive strength, seven test cylinders will be made and cured under the same condition as the members. Two cylinders will be tested at the end of 28 calendar days. The remaining five cylinders will be tested at any time requested by the contractor. However, no more than two cylinders will be tested in one day. If all five cylinders have been tested and concrete has not attained required strength, the members involved shall be held at the plant until the 28-day cylinders are tested. If each 28-day concrete cylinder has not attained required strength, all members involved will be subject to rejection. Acceptance will be made in accordance with the Department's manual entitled "Application of Quality Assurance Specifications for Precast-Prestressed Concrete Plants." Curing methods other than steam curing shall be in accordance to Subsection 805.10. Hot weather concrete limitations as stipulated in Subsection 901.11(b) shall not be applicable for steam curing; however, precautions such as cooling of forms will be required.

Steam curing shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. Initial application of steam shall be from 2 to 4 hours after final placement of concrete to allow initial set of concrete to take place. When retarders are used, the waiting period before application of steam shall be from 4 to 6 hours. Steam shall be at 100 percent relative humidity. Application of steam shall not be directly on concrete. During application of steam, ambient air temperature shall be increased at a rate not to exceed 40°F (5°C) per hour until a uniform temperature not exceeding 160°F (70°C) is reached. Steam curing shall continue at this temperature until concrete reaches release strength. At the contractor's option, the temperature may be decreased to not less than 100°F (40°C) after 6 hours and held at this temperature until the time of detensioning operations, provided no structural defects occur; if structural defects occur, the defective members will be rejected. At this time, steam curing may be discontinued.

Concrete shall remain covered for at least 2 hours after steam curing has ceased, at which time detensioning shall be accomplished. The 2-hour cool-down period may be waived if the fabricator demonstrates that there will be no adverse effect to members. One recording thermometer showing time-temperature relationship shall be furnished for each 200 feet (60 m) of bed.

(f) Transportation and Storage: Precast girders shall be transported in an upright position. Points of support and directions of reactions with respect to the girder shall be approximately the same during transportation and storage as when the girder is in its final position.

Care shall be taken during storage and handling of precast units to prevent damage. Units damaged by improper storing or handling shall be replaced by the contractor at no direct pay.

Members may be handled immediately after detensioning. If stressing is not done in a continuous operation, members shall not be handled before sufficiently stressed to sustain all forces and bending moments due to handling.

Prestressed members shall be held at the plant until concrete has attained the specified 28-day compressive strength.

Prestressed members, except for prestressed piling, may be installed at any time after completion of stressing and grouting, providing concrete has attained the specified minimum 28-day compressive strength.

Prestressed concrete piling shall be held at the plant for fourteen days after casting, provided the specified minimum 28-day compressive strength has been attained.

(g)Pretensioning Method: Prestressing strands shall be accurately held in position and stressed by approved jacks. A record shall be kept of the jacking force and tendon elongation produced. Several units may be cast in a continuous line and stressed at one time. Sufficient space shall be left between ends of members to permit access for cutting strands after concrete has attained required strength. No bond stress shall be transferred to concrete nor shall end anchors be released until concrete has attained specified release strength as shown by cylinders made in accordance with DOTD TR 226 and cured identically with members and tested in accordance with DOTD TR 230. Strands shall be cut or released in such order that lateral eccentricity of prestress will be a minimum in accordance with approved shop drawings. Sheathing used to debond prestress strands shall be constructed of polyethylene having sufficient rigidity to prevent bonding of the pre-stressing strand and concrete. The sheathing shall be split type sheathing having a

minimum thickness of 0.03 inch (0.75 mm) and shall be of sufficient width to maintain a 0.75 inch, ±1/16 inch (20 mm, ±2 mm) overlap after being placed on the strand. The joints between segments of sheathing shall be taped to prevent leakage of concrete into the sheathing.

Strands to be prestressed in a group shall be brought to a uniform initial tension prior to full pretensioning. This initial tension of 1,000 to 2,000 pounds (450 to 900 kg) shall be measured by a dynamometer or other approved
means so that its amount can be used as a check against elongation computed and measured.

After initial tensioning, the group shall be stressed until required elongation and jacking pressure are attained within the specified limits.

With cables stressed in accordance with plan requirements and the foregoing specifications and with all other reinforcing in place, the concrete shall be cast to required lengths. Strands shall not be spliced within the casting length of a girder.

(h)Post-tensioning Method: The post-tensioning method shall be in accordance with the latest edition of the AASHTO Standard Specifications for Highway Bridges and the AASHTO Guide Specifications for Design and Construction of Segmental Concrete Bridges, 1989.

(i) Grouting of Bonded Steel: Post-tensioning for prestressed members shall be of the bonded type in which the tensioned steel is installed in holes or flexible metal ducts cast in the concrete and bonded to surrounding concrete by filling the tubes or ducts with grout. The grout shall consist of portland cement and water and may contain an admixture when approved. Portland cement shall be Type I, II or III complying with Subsection 1001.01.

Cement used for grouting shall be fresh and shall not contain lumps or other indications of hydration. Water used in grout shall comply with Subsection 1018.01.

Admixtures, when used, shall impart the properties of low water content, good flowability, minimum bleed and expansion if desired. Their formulation shall contain no chemicals in quantities that may have a harmful effect on the prestressing steel or cement. Non-chloride admixtures complying with QPL No. 58, shall be used.

Aluminum powder of the proper fineness and quantity, or other approved gas evolving material, which is well dispersed through the other admixture may be used to obtain 5 to 10 percent unrestrained expansion of grout.

Prestressing reinforcement to be bonded shall be free of dirt, loose rust, grease or other deleterious substances. Before grouting, ducts shall be free of

water, dirt or other foreign substances. Ducts shall be blown out with compressed air until no water comes through the duct. For long members with draped strands, an open tap at the low point of the duct may be necessary. Grout cubes shall be molded and cured with the member and shall attain a compressive strength of at least 3,000 psi (20.7 MPa) prior to transfer of bond stress or end anchor release. Preparation and testing of grout cubes shall be in accordance with ASTM C 109.

(j) Prestressing Reinforcement: Prestressing reinforcement shall be high tensile strength steel wire, high tensile strength seven wire strand or high tensile strength alloy bars.

Ends of pretensioned strands not to be encased in end diaphragms shall be cut off flush with ends of beam and shall be coated with a suitable asphaltic material.

No more than 75 percent of the minimum ultimate tensile strength of the steel may be used when designing girders or piles with low relaxation strands. For this design the final compressive stress in the concrete shall be at least as great as that required for the design using normal stress relieved strands.

Strand for prestressing shall conform to Subsection 1009.05. The manufacturer shall submit to the engineer three copies of Certificates of Analysis of all required tests results and shall provide a typical load elongation curve for each size and grade of strand shipped. A 24-inch (600 mm) gage length shall be used to obtain the curves.

Load elongation curves shall show elongation in inches per inch (mm/mm), and inches per 10 feet (mm per 3 m), from 0 percent to 80 percent of the minimum ultimate tensile strength.

Mixing of low relaxation strands and normal stress relieved strands in girders and piles will not be permitted.

Any strand that has been stretched during stress relieving operations will be considered to be a low relaxation strand, even if it does not fully meet the requirements of low relaxation strands in Subsection 1009.05, and will not be allowed for use as a normal stress relieved strand nor will they be allowed to be used in the same member containing low relaxation strands meeting Subsection 1009.05.

(k) Precast-Prestressed Concrete Deck Forms: When specified, concrete decks for girder type bridges may be constructed as a composite utilizing concrete form panels conforming to the following requirements in lieu of conventional full depth cast-in-place construction.

(1) Design: If the contractor elects to use a different concrete panel than detailed in the plans, the contractor shall submit, for approval by the Bridge Design Engineer, detailed drawings of the alternate deck system and design computations for the composite slab and concrete panels complying with the latest AASHTO design specifications and requirements detailed herein.

a. Cover for reinforcing steel shall be as detailed on the plans.

b. Reinforcing steel shall be provided in the concrete panel transverse to the prestressing strands. Steel shall be deformed reinforcing steel with a minimum area of 0.22 square inch per foot (466 sq mm/m) of length.

c. Panels shall be fabricated with 3/8-inch (10 mm) diameter strands only, unless otherwise permitted by the Bridge Design Engineer. The minimum panel length parallel to strands shall be 60 inches (1.5 m).

d. Shear reinforcing steel of 0.40 square inch per 10 square feet (288 sq mm/sq m) of panel surface shall be provided. Top surface of the panel shall be left rough. At approximately the time of initial set, all laitance shall be removed with a coarse wire brush or metal tines at least 1/8 inch (3 mm) deep to ensure proper bond with the cast-in-place concrete.

e. Top of panels may be flat or of other geometric configuration. Panels shall be constructed to provide a minimum vertical clearance of 3/8 inch (10 mm) between the panel surface and longitudinal reinforcing steel in the cast-in-place portion of the deck slab.

f. The top reinforcing steel shall be as required on the panel details for all panel configurations.

g. The joint between adjacent panels shall be butted together and shall be sealed with grout, tape or other approved method prior to placing the cast-in-place portion of the slab.

h. Panels shall extend over girders 3 ±1/2 inches (75 ±10 mm). Panels shall be supported on girders with strips of fiberboard, mastic or felt material that provides a mortartight, uniform bearing. Bearing material shall have a width of 1/2 to 1 inch (15 to 25 mm) and maximum height of 1 1/2 inches (40 mm). The strips shall be placed in approximate 4-foot (1.2 m) lengths using an approved adhesive. Openings of 1/2 inch (15 mm) shall be left between adjacent strips placed longitudinally and parallel to edge of girder.

i. Panels shall not be supported transversely on diaphragms.

j. Panels used with steel girders longer than 100 feet (30 m) shall be supported with a saddle system resting on the top flange. No welding will be permitted on girder flanges. For short spans with small camber, panels may be placed on girder flanges with prior approval.

k. If panels are used with concrete girders, vertical stirrup reinforcing steel in the girders shall be changed from the plan details for cast-in-place decks to accommodate placement of the panels. The outer 3 inches (75 mm) of the top flange of girders shall be smoothed for seating the panels; the remaining area of the top girder flange shall be left rough.

l. For skewed spans, end panels may be sawed to fit the skew provided the short side of the panel is not less than 1/2 the length of the long side. From a line through the midpoint of the long side and short side of the end panel to the end of the panel, the effects of prestress shall be neglected and No. 4 (No. 13 M) deformed reinforcement shall be provided to carry required loads.

(2) Materials: Materials for use in the panels shall comply with Subsection 805.02 and the following requirements:

a. Concrete shall be Class P or P(M).

b. Prestressing steel shall be Grade 250 or 270 strand (Grade 1725 or 1860).

c. Deformed reinforcing steel shall be Grade 60 (Grade 420).

d. Welded deformed steel wire fabric shall comply with ASTM A 497.

e. Panels with elements less than 3 1/2 inches (90 mm) thick shall require Grade F aggregate. For all other panels, either Grade A or Grade F aggregate may be used.

f. Steel for continuous high (CHC) bar chairs shall comply with ASTM A 108, Grade 1008.

(3) Construction: Forms shall be installed in accordance with approved fabrication and erection plans. To ensure full bond between the precast panel and cast-in-place concrete, this interface shall be free of foreign material during cast-in-place concreting operations. After erection of panels and prior to pouring cast-in-place concrete, laitance or flakes shall be removed from the top surface of panels by water blasting. Water blasting shall be performed by experienced personnel with equipment providing a pressure of 2,500 to 3,000 psig (17 to 20.7 MPa) and a fan nozzle pressure of approximately 1,500 psig (10 MPa). Immediately prior to pouring cast-in-place concrete, panels shall be saturated with water.

Riser elevations may have to be adjusted to accommodate the actual camber and vertical curvature while maintaining the minimum cast-in-place slab depth at midspan. Controls for lines and grades above bent caps will be the responsibility of the contractor.

Panels shall be so placed as to obtain the minimum slab thickness shown in the plans within a tolerance of +3/8 inch (10 mm). The tolerance on the cast-in-place concrete cover for the top reinforcing steel will be +1/4 inch to -1/8 inch (+6 mm to 3 mm).

(4) Panel Tolerances: Tolerances for concrete form panels shall be in accordance with Table 805-6.

Table 805-6
Concrete Form Panel Tolerances

	Inches	Millimeters
Panel Depth (Thickness)	+1/4, 1/8	+6, 3
Panel Length (Parallel to strands)	±1	±25
Panel Width	+1/8, 1/2	+3, 13
Position of Strands (Vertical)	±1/8	±3
Position of Strands (Horizontal)	±1/2	±13

(5) Payment: Payment will be based on the plan quantities for full depth cast-in-place concrete construction, regardless of the deck construction method used.

805.15 PLACING ANCHOR BOLTS. Anchor bolts in piers, bents, abutments or pedestals shall be set in an approved non shrink grout listed in QPL 47 at the location and in the manner described herein.

Locations of anchor bolts to be built into the concrete shall be verified by the contractor prior to setting. Care shall be taken to ensure proper setting of bolts. Inaccuracies detrimental to the structure shall be corrected by approved means.

Anchor bolts not to be built into the concrete shall be set in preformed holes having a minimum diameter of 3 inches (75 mm) to allow for adjustment and deep enough to admit the anchor bolt. Holes may be formed by inserting oiled wooden plugs, metal sleeves or other approved devices into fresh concrete which are withdrawn after concrete has partially set. Such holes shall be adequately protected from ice formation while open. When erecting the members, the contractor shall set members and shoes in place,

then fill preformed holes sufficiently with grout so that when anchor bolts are placed to required depth, grout will completely fill holes.

If the contractor elects to set anchor bolts either at initial casting or by drilling, he shall verify the centerline-to-centerline spacing between anchor bolt holes of each member before setting the anchor bolts. If bolt holes are drilled, the diameter of drilled holes shall not be less than 1/2 inch (13 mm) larger than the bolt diameter.

Anchor bolts for cantilevered overhead signs and high mast light poles shall be constructed to ensure the proper performance of the double-nut anchor bolt system (baseplate sandwiched between top and bottom nuts). This requires that the bolts be set properly at initial casting, the system be constructed free of damage, and a preload be built into each anchor bolt by a specified tightening procedure. The following guidelines shall be followed:

(a) Inspection: The anchor bolts will be visually inspected for plan compliance (size and grade, bolt galvanizing, projection length, bolt pattern and orientation, etc.). The individual holes in the top template locations shall not be more than 1/8 inch (3 mm) misaligned from their corresponding baseplate holes. Individual bolts must not be out of plumb more than 1/8 inch per 3 feet (3 mm/m). Straightening of misaligned bolts by bending is strictly prohibited. The project engineer must approve any corrective action for misaligned bolts. Bolt and nut threads shall not be used in a damaged condition; anything more than minimal effort by one worker using only a spud wrench to turn off and then back on the nuts shall be brought to the engineer's attention and corrected to his satisfaction.

(b)Lubrication: After inspection of the anchor bolts is completed, their threads shall be cleaned of all foreign matter and then lubricated with beeswax. If erection is delayed more than 24 hours after being lubricated, this cleaning and lubricating must be repeated.

(c) Bolt Tightening Sequence: The pole shall be erected and bolts completely tightened with all cantilever elements removed. The bolts shall be tightened in the sequence specified at each step, which calls for tightening. For an eight-bolt pattern, the bolts shall be numbered 1 through 8 in a clockwise order viewed from above, beginning with bolt 1 on the side away from the heaviest cantilever element. The tightening sequence shall be 1,5,2,6,8,4,7,3. For a six-bolt pattern, the bolts shall be numbered 1 through 6 in a clockwise order viewed from above, beginning with bolt 1 on the side away from the heaviest cantilever element. The tightening sequence shall be 1,4,2,5,6,3.

(d)Tightening Procedures: The bottom nuts shall be installed on the anchor bolts, one on each bolt. The top template shall be leveled by adjusting the bottom nuts so the template rests on each nut and the distance between the top of the concrete shaft and the bottom face of the nut is approximately 1/2 inch (13 mm). Remove the template, lubricate the bearing surfaces of the bottom nuts and washers with beeswax, and erect and plumb the structure as to the satisfaction of the engineer. Adjust the bottom nuts so that each is bearing equally on its washer against the baseplate. With all cantilever elements removed and with the plumbed structure supported by crane, lubricate the bearing surfaces of the top nuts and washers and install the washers and top nuts and turn them onto the bolts so that each top nut is hand-tight against the washer. Using a wrench, turn the bottom nuts up in the specified sequence to a snug tight condition [snug tight is defined to be the condition where the nut is in firm contact with the baseplate, and it may be assumed that the full effort of a workman on a 12 inch (300 mm) wrench results in a snug condition].

Verify that the structure is still plumb and still supported by the crane. In the specified sequence, turn the top nuts down to the same snug tight condition.

(e) Preload is induced into the bolt by tightening the nuts and measuring the tightness by turn-of-nut method. Tighten each top nut in the specified sequence 30 degrees past snug tight (one-half of a hex nut "flat"). Repeat this process of tightening each top nut an additional 30 degrees down until each top nut has been tightened 60 degrees past snug tight.

805.16 SETTING BENCH MARKS. A bench mark bolt furnished and delivered by the contractor shall be set by the contractor without extra compensation on each bridge. The bench mark bolt shall be either hex head or square head 4 inch by 5/8 inch (100 mm by 15 mm) threaded galvanized bolt. It shall be located on the downstream side of the beginning of the bridge. The bolt shall be placed in the roadway surface near the expansion joint and 4 inch (100 mm) from the barrier rail. For bridges with sidewalks, the bolt will be set in the sidewalk 4 inch (100 mm) from the top of the curb. No permanent plates or markers other than those furnished or specified will be permitted on any structure.

805.17 MEASUREMENT.

(a) General: Quantities of structural concrete, precast prestressed girders and expansion joint seal for payment will be the design quantities as

specified on the plans and adjustments thereto. The design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

(b)Structural Concrete: Design volumes of structural concrete are computed from neat dimensions shown on the plans with the following modifications. Deductions are made for the volumes occupied by fillets, scorings and chamfers with cross sectional areas over 1 1/2 square inches (920 sq mm), expansion joints, and embedded structural steel, piling and cylindrical voids of voided slabs. Volumes deducted for embedded piling are based on 12 inches (300 mm) butt diameter timber piling and nominal butt dimensions for other types of piling. No deductions are made for volumes occupied by fillets, scorings and chamfers with cross sectional areas not over 1 1/2 square inches (920 sq mm), reinforcing steel, water piping, electrical conduit, weep holes, drain piping and armored joints.

(c) Precast-Prestressed Concrete Girders: Design quantities of precast-prestressed concrete girders are based on out-to-out lengths shown on the plans.

(d)Expansion Joint Seal and Strip Seal Joint: Design quantities of expansion joint seal and strip seal joint are based on lengths shown on the plans.

(e) Bridge Superstructure and Substructure: Bridge superstructure and substructure will be measured per span.

(f) Reinforced Concrete Box Culverts: Reinforced concrete box culverts of each size and type shall be measured by the linear foot (lin m) in place. The measurement shall be the flow line length, along the centerline, inside face of the headwalls. For multiple barrel structures, the measured length will be the sum of the lengths of all barrels measured as described above.

805.18 PAYMENT.

(a) Structural Concrete: Payment for structural concrete will be made at the contract unit price per cubic yard (cu m), adjusted in accordance with the following provisions.

Class A, A(M), AA, AA(M), D and S concrete will be accepted on a lot basis. A lot will be considered an identifiable pour not exceeding 200 cubic yards (150 cu m) of concrete. A pour of 200 to 400 cubic yards (150 to 300 cu m) will be divided into two lots as equal in size as possible while maintaining identifiability. A pour exceeding 400 cubic yards (300 cu m) will be represented by three lots.

Two random batches will be sampled for each lot, and three cylinders molded from each batch. The six cylinders per lot will be tested for compressive strength in 28 to 31 calendar days.

In the event of sudden cessation of operation, a minimum of three cylinders will constitute a lot.

Acceptance and payment for each lot will be made in accordance with Table 901-5.

Concrete that is classified as minor structure concrete will be accepted under these specifications and in accordance with Table 901-6.

Formwork, falsework, cofferdams, bracing, pumping, expansion joint fillers, steel punchings in counterweight concrete, excavation and backfill will not be measured for payment.

(b)Precast-Prestressed Girders: Payment for precast-prestressed girders will be made at the contract unit price per linear foot (lin m), which includes all reinforcing steel, masonry, anchor plates, plain or laminated elastomeric bearings, metal or other bearing plates and assemblies or other appurtenances indicated or necessary in the fabrication, handling and erection of the girders.

Tie-rods, nuts and washers will be considered as miscellaneous steel and paid for as provided in Section 807.

(c) Expansion Joint Seal and Strip Seal Joint: Payment for expansion joint seal and strip seal joint will be made at the contract unit price per linear foot (lin m).

(d)Bridge Superstructure and Substructure: Payment for bridge superstructure and substructure will be made at the contract unit price per span, which includes the entire superstructure (with railings) and that portion of the substructure above the bottom of caps.

Acceptance and payment for bridge superstructure and substructure will be made on a lot basis at the contract unit price per span, adjusted in accordance with the following provisions. A lot will be considered an identifiable pour as described in Heading (a) of this subsection. Acceptance and payment for each cast-in-place bridge superstructure and substructure lot will be in accordance with Table 901-5 and Note 1 therein.

(e) Reinforced Concrete Box Culverts: Payment for reinforced concrete box culverts will be made at the contract unit price per linear foot (lin m), which includes connections to existing structures, concrete, reinforcing steel, excavation, backfill, and all other items of material, labor, and equipment necessary to complete the work in accordance with the plans and specifications.

Acceptance and payment for reinforced concrete box culverts will be made on a lot basis at the contract unit price per linear foot (linear meter), adjusted in accordance with the following provisions. A lot will be considered an identifiable pour as described in Heading (a) of this subsection. Acceptance and payment for each cast-in-place reinforced concrete box culvert lot will be in accordance with Table 901-5 and Note 1 therein. Acceptance for each precast reinforced concrete box culvert will be in accordance with ASTM C 1433 (C 1433M).

Payment will be made under:

Item No.	Pay Item	Pay Unit
805-01	Class A Concrete	Cubic Yard (Cu m)
805-02	Class A(M) Concrete	Cubic Yard (Cu m)
805-03	Class AA Concrete	Cubic Yard (Cu m)
805-04	Class AA(M) Concrete	Cubic Yard (Cu m)
805-05	Class D Concrete	Cubic Yard (Cu m)
805-06	Class R Concrete	Cubic Yard (Cu m)
805-07	Class S Concrete	Cubic Yard (Cu m)
805-08	Precast-Prestressed Concrete Girders (Type)	Linear Foot (Lin m)
805-09	Expansion Joint Seal	Linear Foot (Lin m)
805-10	Bridge Superstructure and Substructure	Span
805-11	Strip Seal Joints	Linear Foot (Lin m)
805-12	Reinforced Concrete Box Culverts (Size)	Linear Foot (Lin m)
805-13	Class F Concrete	Cubic Yard (Cu m)

Section 806
Reinforcement

806.01 DESCRIPTION. This work consists of furnishing and placing reinforcing steel for reinforced portland cement concrete structures.

806.02 MATERIALS.

(a) Steel materials shall comply with Section 1009 Grade 60 (Grade 420).

(b) Epoxy coating material and patching material shall comply with Subsection 1009.01. Accessories such as tie wires and metal bar supports used in the fabrication and placement of epoxy coated reinforcing steel shall comply with Subsection 806.06 modified as follows.

(1) Tie Wires: Metal tie wires shall be fully coated with an acceptable epoxy, plastic or nylon material.

(2) Metal Bar Supports: Metal bar supports shall be coated with an acceptable epoxy or plastic material for a minimum distance of 2 inches (50 mm) from the point of contact with the epoxy coated reinforcing steel.

806.03 STEEL LISTS. Before placing reinforcing steel, two copies of a list of all reinforcing steel showing location, mark number, size and type bend shall be furnished to the engineer. The contractor shall be responsible for the accuracy of the lists and for furnishing and placing reinforcing steel in accordance with the details shown on the plans and as specified.

The contractor shall also furnish the engineer two copies of placing plans for all structures where reinforcing steel is involved, unless the plans contain sufficient detail for proper placement of reinforcing steel. Placing plans shall show the location, type and spacing of supports.

806.04 FABRICATION. Unless otherwise authorized, bent bar reinforcement shall be cold bent to the shapes shown on the plans in accordance with the following requirements:

(a) Bending: Stirrups and ties shall be bent around a pin having a diameter of at least four bar diameters for No. 5 (No. 16 M) or smaller bars, and at least five bar diameters for larger bars. All other bars, except as otherwise specified herein, shall be bent around a pin having a diameter as specified in Table 806-1:

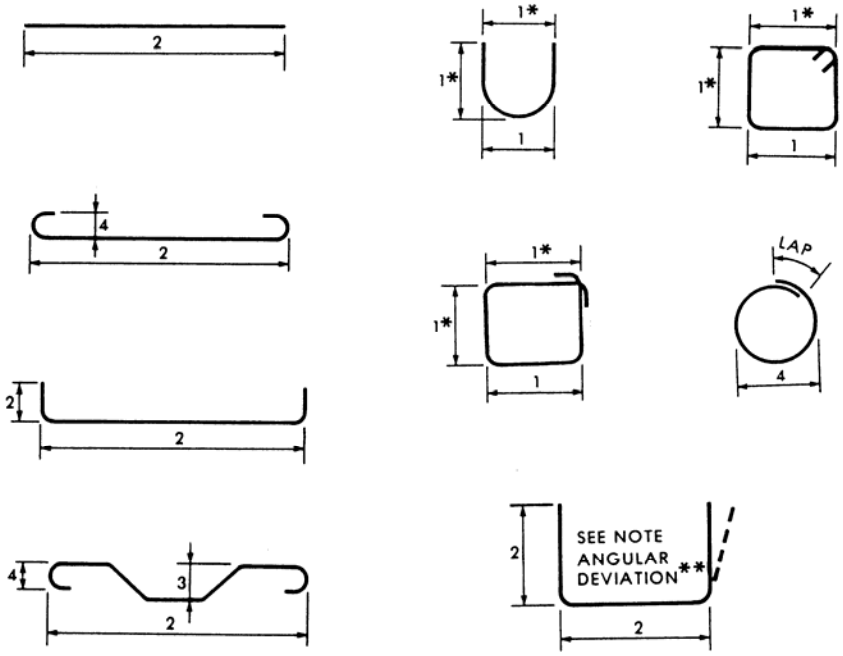
Table 806-1
Pins for Bar Bends

Bar Size	Minimum Pin Diameter
Nos. 3 through 8 (Nos. 10 M through 25 M)	6 bar diameters
Nos. 9, 10 and 11 (Nos. 29, 32 and 36 M)	8 bar diameters
Nos. 14 and 18 (Nos. 43 M and 57 M)	10 bar diameters

No rebending of bars will be allowed. Special fabrication will be required for bending Nos. 14 and 18 (Nos. 43 M and 57 M) bars more than 90 degrees.

(b)Tolerances: Bars shall be fabricated in accordance with the tolerances specified in Table 806-2. All dimensions given in Table 806-2 are out-to-out of bars.

Table 806-2
Fabrication Tolerances



Symbol	Tolerance, Inches (mm)
1	±1/2 (± 13)
2	± 1 (± 25)
3	+0, -1/2 (+0, -13)
4	± 1/2 (±13)

*Not to differ for opposite parallel dimension by more than 1/2 inch (13 mm).
**Angular Deviation-Maximum ± 2 1/2° or ± 1/2 inch/ft. (40 mm/m), but not less than 1/2 inch (13 mm).

(c) Shipping: Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the Manual of Standard Practice of the Concrete Reinforcement Steel Institute (CRSI). The tags shall be made of durable material and marked in a legible manner with waterproof markings. There shall be at least one tag per bundle attached by wire. The tags shall show size of reinforcing, number of pieces, and mark or length of bars.

(d)Handling and Coating Repairs: Epoxy coated reinforcing steel shall be handled in a manner to avoid damage to the coating. Bundling bands shall be padded. Bundles shall be lifted with multiple supports or strongbacks to prevent abrasion to the coating due to sag.

Patching material used by the applicator and the contractor shall be the same as the prequalified patching material. Repairs shall be made in accordance with the patching material manufacturer's recommendations.

Repairs to the coating will be required on all damaged areas larger than 1/4 inch square (40 sq mm). The total bar surface area covered by patching material shall not exceed 2 percent.

Ends of coated bars cut during field fabrication shall also be coated with the patching material before rusting appears; however, the coated ends are not to be included in the 2 percent maximum coverage of patching material. Hairline cracks without bond loss or other minor damage on fabrication bends need not be repaired.

806.05 PROTECTION OF MATERIAL. Reinforcing steel shall be stored above ground on platforms, skids or other supports and shall be protected from damage.

The various sizes, grades and lengths shall be plainly marked and tagged to facilitate inspection.

Epoxy coated steel bars shall be unloaded and stored on the project site in a manner to avoid damage or contamination. Bars shall be stored off the ground and covered such that formation of condensation and exposure to ultraviolet light is avoided.

806.06 PLACING AND FASTENING. Steel reinforcement shall be placed in the position shown on the plans and firmly held during placing and setting of concrete. When placed in the work, it shall be free from dirt, loose rust, loose scale, paint, oil, grease, form release agent, or other foreign material. Thin powdery rust and light rust need not be removed. Bars shall be tied with No. 14 or 16 gage (2.0 or 1.6 mm diameter) wire at all intersections, except

where spacing is less than 1 foot (300 mm) in each direction, alternate intersections shall be tied.

Distance of reinforcement from forms shall be maintained by metal chairs, ties, hangers or other approved supports. Precast mortar or concrete blocks may be used when approved by the engineer in applications where concrete is to be cast against soil. Metal chairs in contact with exterior surfaces of concrete shall be hot-dipped galvanized, electroplated with zinc (GS Grade), plastic-coated or stainless steel. Layers of bars shall be separated by approved devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks will not be permitted. Vertical stirrups shall pass around main tension members and shall be securely attached thereto. The minimum covering, measured from the surface of concrete to face of reinforcing bars, shall not be less than 2 inches (50 mm) except as follows: bottom of slab, 1 inch (25 mm); stirrups and ties in T-Beams, 1 1/2 inches (40 mm). Additional coverage as shown on the plans shall be provided for reinforcement in bottom of footings or where marine environments, corrosive, abrasive or other severe exposure conditions exist. Reinforcement shall be inspected and will be subject to approval before placing concrete.

During and after installation of epoxy coated bars, the contractor shall repair all significant cuts, nicks and abraded places in the coating on the bars with the epoxy repair material supplied by the epoxy resin manufacturer. Any damaged metallic accessories shall also be repaired with a suitable material. No more than 0.25 percent of the bar surface area may be left bare.

Damaged areas of the reinforcing steel and accessories shall be repaired before rusting occurs. Coated bars when incorporated into the work shall be free from dirt, paint, oil, grease, form release agent, or other foreign substances. Placing of concrete shall be performed in a timely manner with methods and equipment which will not damage the coated materials.

Since the epoxy coating is flammable, the coated bars shall not be exposed to fire or flame. Cutting coated bars by burning will not be permitted. Reinforcing steel to be partially embedded in concrete shall not be field bent unless specified on the plans or permitted by the engineer.

806.07 SPLICING. Reinforcement shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without written approval. Splices shall be staggered as far as possible. Unless otherwise specified, bars shall be lapped in accordance with the requirements of Table 806-3. Construction joints shall not be made

within the limits of lapped bars. In lapped splices, bars shall be placed in contact and wired together in such manner as to maintain the minimum clear distance to other bars and to the surface of concrete. Welding of reinforcement steel shall be done only if detailed on the plans or if authorized in writing. Welding shall comply with Section 815.

When permitted in the plans or specifications, reinforcing steel splices may be made by an approved mechanical butt splicing device listed in QPL 44 and used in accordance with the manufacturer's recommendations. The splice shall develop at least 125 percent of the specified yield strength of the reinforcing steel bars in tension.

Table 806-3
Lap Splice Length for Grade 60 (420) Steel

Bar No.	Lap Splice Length, inches (mm)
3 (10M)	18 (457)
4 (13M)	24 (610)
5 (16M)	30 (762)
6 (19M)	39 (990)
7 (22M)	53 (1346)
8 (25M)	69 (1753)
9 (29M)	88 (2235)
10 (32M)	111 (2819)
11 (36M)	137 (3480)

806.08 SUBSTITUTIONS. Substitutions of different size bars will be permitted with authorization of the engineer. Substituted steel shall have cross-sectional and surface areas equivalent to the design areas or larger.

Reinforcing bars may be substituted for the bars designated in the plans, on a one for one basis, as shown in Table 806-4.

Allowed substitutions will be made at no additional pay.

Table 806-4
Reinforcing Bar Size Substitutions

English No.	Metric No.
3	10M
4	13M
5	16M
6	19M
7	22M
8	25M
9	29M
10	32M
11	36M
14	43M
18	57M

806.09 MEASUREMENT. Quantities of reinforcement for payment will be the design weights as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary.

Design quantities are based on theoretical weights (mass) of nominal size plain round bars as shown in Table 806-5:

Table 806-5
Reinforcing Bar Weights (Mass)

Bar No.	Weight (Mass) Lb/Lin Ft (kg/lin m)
3 (10M)	0.376 (0.560)
4 (13M)	0.668 (0.994)
5 (16M)	1.043 (1.552)
6 (19M)	1.502 (2.235)
7 (22M)	2.044 (3.042)
8 (25M)	2.670 (3.973)
9 (29M)	3.400 (5.060)
10 (32M)	4.303 (6.404)
11 (36M)	5.313 (7.907)
14 (43M)	7.650 (11.380)
18 (57M)	13.600 (20.240)

Measurement and payment of structural shapes used as reinforcement will be made in accordance with Subsections 807.53 and 807.54.

The following will not be included in pay quantities:

(a) Reinforcement furnished for testing purposes.

(b) Additional reinforcement used for laps in splices other than those shown on the plans.

(c) Additional weight of reinforcement used at the contractor's request as substitutions for reinforcement shown in the plans.

(d) Spacers, clips, chairs and other material used in fastening reinforcement in place.

(e) Additional weight of epoxy coating or cleaning and epoxy coating repair.

806.10 PAYMENT. Payment for reinforcing steel will be made at the contract unit price under:

Item No.	Pay Item	Pay Unit
806-01	Deformed Reinforcing Steel	Pound (kg)
806-02	Deformed Reinforcing Steel (Epoxy Coated)	Pound (kg)

Section 807
Structural Metals

807.01 DESCRIPTION. This work consists of furnishing and placing structural metals for structures.

807.02 MATERIALS. Materials shall comply with Section 1013. When the type of structural steel to be used is not specified, steel complying with AASHTO M 270, Grade 36 (M 270M, Grade 250) shall be used.

807.03 DRAWINGS. Shop drawings and working drawings shall be furnished in accordance with Subsection 801.03.

807.04 MINIMUM SHOP REQUIREMENTS FOR FABRICATION OF STEEL STRUCTURES. The contractor (fabricator) shall provide sufficient lifting capacity, physical plant and equipment for the fabrication of structural steel. The cranes in each working area shall have a combined rated capacity equal to the lifting weight of the heaviest assembly fabricated for shipment unless alternate lifting and turning facilities are approved.

Lifting chains shall be provided with adequate softeners to prevent damage to the corners of material during lifting and turning. When hooks are used for lifting, they shall have sufficient width of jaw and throat to prevent damage to the flanges or to the web-to-flange welds.

Spreader beams, or multiple cranes, shall be provided for lifting plates and long slender members to prevent overstress and distortion from handling.

Shops shall have sufficient enclosed floor spaces to allow oxygen cutting, air carbon arc gouging, assembly and welding to be performed inside, except that shop assembly of field connections for trusses, girders and arches may be performed outside the shop buildings. The fabrication of major steel bridge components (includes all bridge structures other than unspliced rolled beam bridges) shall only be by fabrication shops having a current AISC Certification for Major Steel Bridges. Current AISC Certification for Simple Steel Bridges will be required for fabrication of highway sign structures, secondary members of bridges (such as cross frames), and unspliced rolled beam bridges. Structures that have fracture critical members shall require an AISC Fracture Critical Endorsement to the fabricator's Simple or Major Steel Bridge

Certification. The contractor will be required to provide the engineer with documentation of the certification prior to beginning fabrication.

The engineer may approve limited fabrication and welding outside the shop, provided the fabricator has made provisions to ensure that the quality of the work produced outside the shop buildings will not be adversely affected by weather or other conditions.

All cutting, fitting and welding shall be done in areas that are kept dry. Areas for automatic and semiautomatic welding shall be kept at a temperature not lower than 40°F (5°C) for at least 1 hour before work begins and at all times when work is being performed.

807.05 INSPECTION.

(a) The Department will inspect all structural metal including shop inspection of fabrication and assembly of structural steel, castings and other metal items. A schedule of fabrication for the metal items required for the project, including location of the shop and the dates inspection services will be required, shall be furnished to the Construction Section. This information shall be provided at least 10 days in advance of commencement of layout work on fabricated material.

The engineer will have the authority to reject materials and workmanship which does not conform to the requirements of the contract. The Department's Quality Assurance (QA) inspection of material and workmanship may be conducted before, during and after fabrication. Materials and workmanship which are "in the process" of being fabricated and which are found to contain defects or to have been subjected to damaging fabrication procedures shall be rejected while still in process. The inspector will have the right to perform at the expense of the Department, non-destructive tests of materials and workmanship. Department inspection at the mill and shop is a quality assurance function that may be exercised at the option of the engineer.

It shall be expressly understood that the Department's Quality Assurance will not relieve the contractor of responsibility to perform Quality Control to insure that the products conform to the requirements of the contract and shall not relieve the contractor of responsibility concerning unacceptable materials and workmanship and the responsibility to acceptably repair or replace the same.

The contractor shall furnish means and assistance for testing materials and workmanship. The engineer will have free and safe access at all times to any portion of shops where work is being done under these specifications.

The stamping of any material or finished member shall not preclude its subsequent rejection if found defective. Rejected material shall be promptly replaced.

The contractor or fabricator shall furnish the engineer an office with at least 140 square feet (13.0 sq m) of floor space to perform necessary work. Additional space, as deemed necessary by the engineer, shall be provided. This office shall contain desks, chairs, file cabinet with lock, telephone, electric lights, power outlets, shelves and tables, all in the quantity required by the engineer. The office shall be provided with adequate heating, ventilation and air conditioning and convenient sanitary facilities with running water. This office shall also contain two separate telephone lines, one dedicated to the telephone and the other dedicated to a computer. The contractor or fabricator shall be responsible for paying all utility bills. The office shall be in good repair, located where there is not excessive noise, and restricted to the Department's inspectors only. Convenient and adequate reserved parking space shall be provided.

Metal fabrication work requiring Departmental inspection shall be performed in a plant or shop within the continental United States.

(b)Qualifications: Qualifications of inspectors for Quality Assurance (QA) and Quality Control (QC) will be as specified in the latest edition of ANSI/AASHTO/AWS D1.5 (D1.5M), Section 6.1.3.

(c) Mill Inspection: Mill inspection of structural metals will be as deemed necessary by the engineer; however, five copies of Certificates of Analysis, a notarized Fabricator's Material Statement and a notarized Certificate of Compliance, properly identified as to the intended use, are required and shall be submitted to the Construction Section for approval and distribution.

(d)Obligations of the Contractor: The fabricator's QC Inspectors shall be a separate function of production and shall make the necessary visual inspections prior to assembly, during welding and after welding to insure that materials and workmanship meet the requirements of the contract. The contractor shall comply with all of the QA Inspector instructions to correct deficiencies in materials and workmanship as provided in the contract.

In the event that faulty welding, or its removal for rewelding, damages the base metal so that, in the judgment of the engineer, its retention is not in accordance with the intent of the contract, the contractor shall remove and replace the damaged base metal or shall compensate for the deficiency in an approved manner.

807.06 MARKING. Heat number markings shall be steel die stamped on main material. Round rods and bar shapes that are shipped, bundled and tagged with heat number from the mill, shall have this heat number transferred and steel die stamped to each piece as it arrives at the fabrication plant in the presence of the Department's inspector when these pieces are main members. Materials for other than main members may be identified by painting heat numbers. Main material used from stock shall show steel die stamped heat numbers along with test reports.

In the fabrication shop, the transferring of heat numbers shall be steel die stamp for all pieces of main material.

Steel die stamping shall be accomplished with low-stress steel stamps having a minimum face character radius of 0.010 inch (250 μm) and a maximum allowable impression depth of 0.010 inch (250 μm). Impressions shall be placed on the thickest member in transition joints. Impressions shall not be placed within 1 inch (25 mm) of plate edge.

In case of doubt as to the grade of metal being used, samples will be taken by the inspector for submittal to the Materials and Testing Section for tests to establish the grade.

A color code system in accordance with ASTM A 6 (A 6M) shall be used for all metal. This color shall be placed on material upon entering the shop and carried on all pieces to final fabrication.

Metals not included in ASTM A 6 (A 6M) shall have an individual color code established and on record for the engineer.

807.07 HANDLING AND STORING MATERIALS. Structural material, either plain or fabricated, shall be stored at the shop and project site above ground on platforms, skids or other supports. It shall be kept free from dirt, grease and other foreign matter and protected from corrosion.

Girders and beams shall be placed upright when stored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent damage from deflection.

807.08 STRAIGHTENING MATERIAL AND CURVING ROLLED BEAMS AND WELDED GIRDERS.

(a) Straightening Material: Rolled material, before being laid off or worked, shall be straight. If straightening is necessary, it shall be done by methods that will not damage the metal. Heat straightening of AASHTO M 270, Grade 100 (M 270M, Grade 690) and M 270, Grade 100W (M 270M, Grade 690W) steel shall be done only under rigidly controlled procedures,

each application subject to approval of the engineer. In no case shall the maximum temperature of the steel exceed 1125°F (610°C). Sharp kinks and bends will be cause for rejection of the material. If normalizing is used, straightening of steel plates shall be completed before normalizing operations begin for tension member material. Heat straightening of the material shall only be performed with approval.

(b)Curving Rolled Beams and Welded Girders:

(1) Materials: Steels that are manufactured to a specified yield point greater than 50,000 psi (345 MPa) shall not be heat curved. Heat curving will not be permitted for those portions of girders where span base line curvature is a 200-foot (60 m) radius or less.

(2) Type of Heating: Beams and girders may be curved by either continuous or V-type heating, as approved in accordance with the AASHTO Standard Specifications for Highway Bridges.

807.09 FINISH. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately and shall be ground to a neat finish.

807.10 BOLT HOLES.

(a) Holes for High Strength Bolts: Holes for bolts shall be either punched or drilled. Material forming parts of a member composed of not more than five plate thicknesses of metal may be punched 1/16 inch (2 mm) larger than the nominal diameter of bolts when the thickness of metal is not greater than 3/4 inch (20 mm) for structural carbon steel or 5/8 inch (15 mm) for alloy steel.

When there are more than five plate thicknesses or when any main material is thicker than 3/4 inch (20 mm) in structural carbon steel or 5/8 inch (15 mm) in alloy steel or when required under Subsection 807.13, holes shall either be drilled full size or subdrilled.

When required under Subsection 807.13, holes shall be either subpunched or subdrilled (subdrilled if thickness limitation governs) 3/16 inch (5 mm) smaller and, after assembling, reamed 1/16 inch (2 mm) larger or drilled full size to 1/16 inch (2 mm) larger than the nominal diameter of bolts.

(b)Oversize or Slotted Holes: When specified or approved, oversize, short-slotted, and long-slotted holes may be used with high strength bolts 5/8 inch (15 mm) and larger in diameter except as hereinafter restricted:

(1) Oversize holes shall be 3/16 inch (5 mm) larger than bolts 7/8 inch (22 mm) and less in diameter, 1/4 inch (6 mm) larger than bolts 1 inch (24

mm) in diameter, and 5/16 inch (8 mm) larger than bolts 1 1/8 inches (30 mm) or greater in diameter. They may be used in all plies of friction-type connections. Hardened washers shall be installed over exposed oversize holes.

(2) Short-slotted holes shall be 1/16 inch (2 mm) wider than the bolt diameter and have a length, which does not exceed the oversize diameter provisions of paragraph (1) above by more than 1/16 inch (2 mm). They may be used in all plies of friction-type or bearing-type connections. The slots may be used without regard to direction of loading in friction type connections, but shall be normal to the direction of the load in bearing-type connections. Hardened washers shall be installed over exposed short-slotted holes.

(3) Long slotted holes shall be 1/16 inch (2 mm) wider than the bolt diameter and have a length more than allowed in paragraph (2) above but not more than 2 1/2 times the bolt diameter.

In friction-type connections, long-slotted holes may be used without regard to direction of loading.

In bearing-type connections, the long diameter of the slot shall be normal to the direction of loading.

Long slotted holes may be used in only one of the connected parts of either a friction-type or bearing-type connection at an individual faying surface.

Structural plate washers or a continuous bar not less than 5/16 inch (8 mm) thick shall be used to cover long slots that are in the outer plies of joints. These washers or bars shall have a size sufficient to completely cover the slot after installation. If hardened washers are required, they shall be placed over the plate or bar.

(4) When enlarged or slotted holes are used, the distances between edges of adjacent holes or edges of holes and edges of members shall not be less than permitted with conventional size holes.

(c) Holes for Other Type Bolts: Holes for ribbed bolts, turned bolts or other approved bearing-type bolts shall be subpunched or subdrilled 3/16 inch (5 mm) smaller than the nominal diameter of bolt and reamed assembled or to a steel template or, after assembling, drilled from the solid.

807.11 PUNCHED HOLES. Diameter of the die shall not exceed diameter of the punch by more than 1/16 inch (2 mm). Holes that must be enlarged to admit bolts shall be reamed. Holes shall be clean-cut without torn or ragged edges. Poor matching of holes will be cause for rejection; any repair shall be subject to approval.

807.12 REAMED OR DRILLED HOLES. Reamed holes shall be cylindrical, perpendicular to the member and not more than 1/16 inch (2 mm) larger than the nominal diameter of bolts. Where practical, reamers and drills shall be directed by mechanical means. Drilled holes shall be 1/16 inch (2 mm) larger than the nominal diameter of bolt. All burrs shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done by approved methods. If required, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match-marked before disassembling.

807.13 PREPARATION OF FIELD CONNECTIONS.

(a) Subpunching and Reaming of Field Connections: Holes in field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames shall be subpunched (or subdrilled if required) according to Subsection 807.10 and subsequently reamed while assembled or to a steel template, as required by Subsection 807.17. Holes for floor beam and stringer field end connections shall be subpunched and reamed to a steel template or reamed while assembled. Reaming or drilling full size of field connection holes through a steel template shall be done after template has been located for position and angle and bolted in place. Templates used for reaming matching members, or opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be so accurately located that the parts or members are duplicates and require no match-marking.

For any connection, in lieu of subpunching and reaming or subdrilling and reaming, holes may be drilled full-size with all thicknesses of material assembled in proper position.

(b)Numerically-Controlled Drilled Field Connections:

(1) General: For any connection or splice designated in Subsection 807.13(a), in lieu of subsized holes and reaming while assembled, or drilling holes full-size while assembled, holes may be drilled full-size in unassembled pieces or connections including templates for use with matching subsized and reamed holes by means of suitable numerically-controlled drilling equipment subject to the following provisions.

If numerically-controlled drilling equipment is used, the engineer may require the contractor, by means of check assemblies, to demonstrate that this drilling procedure consistently produces holes and connections conforming to Subsections 807.15 and 807.17.

The contractor shall submit to the engineer for approval a detailed outline of the proposed procedures to accomplish the work from initial drilling through check assembly, including members that may be numerically-controlled drilled, sizes of holes, location of common index and other reference points, composition of check assemblies and other pertinent information.

(2) Holes: Holes drilled by numerically-controlled drilling equipment shall be drilled to appropriate size either through individual pieces or a combination of pieces held tightly together.

807.14 ACCURACY OF PUNCHED AND DRILLED HOLES. Holes punched full size, subpunched or subdrilled shall be so accurately punched that after assembling (before any reaming is done) a cylindrical pin 1/8 inch (3 mm) smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. Failure of a hole to pass a pin 3/16 inch (5 mm) smaller in diameter than the nominal size of punched holes will be cause for rejection.

807.15 ACCURACY OF REAMED AND DRILLED HOLES. When holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 inch (1 mm) between adjacent thickness of metal.

Steel templates shall have hardened steel bushings in holes accurately dimensioned from centerlines of connection as inscribed on the template. Centerlines shall be used in locating the template from milled or scribed ends of members.

807.16 FITTING FOR BOLTING. Contact surfaces of metal shall be prepared as specified in Subsection 807.21(e). Parts of a member shall be assembled, well pinned and firmly drawn together with bolts before drilling or reaming. Assembled pieces shall be taken apart, if necessary, for removal of burrs and shavings produced by reaming. The member shall be free from twists, bends and other deformation.

807.17 SHOP ASSEMBLING. Field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing, and then shall have their sub-size holes reamed to specified size while connections are assembled. Unless otherwise specified, assembly shall be Progressive Truss or Girder Assembly.

Check Assemblies with Numerically-Controlled Drilled Field Connections shall be in accordance with Heading (g) of this subsection.

Each assembly, including camber, alignment, accuracy of holes and fit of milled joints, shall be approved before a numerically-controlled drilled check assembly is dismantled.

A diagram shall be furnished to the engineer by the fabricator showing camber at each panel point of trusses or arch ribs, and the location of field splices and fractions of span length (1/4 points minimum, 1/10 points maximum) of continuous beam and girders or rigid frames.

(a) Full Truss or Girder Assembly: Full Truss or Girder Assembly consists of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder or rigid frame at one time.

(b)Progressive Truss or Girder Assembly: Progressive Girder Assembly shall consist of assembling initially for each arch rib, continuous beam line, or plate girder at least three contiguous shop sections. Progressive Truss Assembly shall consist of assembling initially for each truss, bent, tower face, or rigid frame, all members in at least three contiguous panels, but not less than the number of panels associated with three contiguous chord lengths. Successive assemblies shall consist of at least one section or panel of the previous assembly (repositioned if necessary and adequately pinned to assure accurate alignment) plus two or more sections or panels added at the advancing end. In the case of structures longer than 150 feet (45 m), each assembly shall not be less than 150 feet (45 m) long regardless of the length of individual continuous panels or sections. At the option of the fabricator, sequence of assembly may start from any location in the structure and proceed in one or both directions so long as the preceding requirements are satisfied.

Assemblies consisting of less than three shop sections or panels shall require approval of the engineer.

(c) Full Chord Assembly: Full Chord Assembly shall consist of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower, then reaming their field connection holes while the members are assembled and

reaming the web member connections to steel templates set at geometric (not cambered) angular relation to the chord line.

Field connection holes in web members shall be reamed to steel templates. At least one end of each web member shall be milled or scribed normal to the longitudinal axis of the member and the templates at both ends of the member shall be accurately located from one of the milled ends or scribed lines.

(d)Progressive Chord Assembly: Progressive Chord Assembly consists of assembling contiguous chord members in the manner specified for Full Chord Assembly and in the number and length specified for Progressive Truss or Girder Assembly.

(e) Special Girder Assembly: This procedure does not apply to continuous girders, but will be required for rolled beams or plate girders that are part of a simple supported span with a horizontal curve, skewed or superelevated, or any combination thereof.

Special girder assembly consists of assembling rolled beams or plate girders in pairs with all adjacent girders, including floor system, lateral bracing, cross frames, etc. These pairs of beams or girders shall be assembled on blocking, with the proper camber and their relative elevation, in such manner as to ensure proper fittings of all parts during field erection in accordance with any of the previously described methods.

(f) Special Complete Structure Assembly: Special Complete Structure Assembly consists of assembling the entire structure, including the floor system. This procedure is ordinarily needed only for complicated structures such as those having curved girders or extreme skew in combination with severe grade or camber.

(g)Check Assemblies with Numerically-Controlled Drilled Field Connections: A check assembly will be required for each major structural type of each project. It shall consist of at least three contiguous shop sections or, in a truss, all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices). Check assemblies shall be based on the proposed order of erection joints in bearings, special points such as portals of skewed trusses and similar considerations.

Use of either geometric angles (giving theoretically zero secondary stresses under dead-load conditions after erection) or cambered angles (giving theoretically zero secondary stresses under no-load conditions) shall be as specified.

The check assemblies shall preferably be the first such sections of each major structural type to be fabricated.

No match-marking and no shop assemblies other than the check assemblies will be required.

Shop drawings shall indicate clearly subpunched holes which are to be reamed assembled or reamed to a template in the shop and all groups of holes which are to be drilled full size with numerically-controlled drills.

If the check assembly fails to demonstrate that required accuracy is being obtained, further check assemblies may be required at no direct pay.

(h)Bearing Assembly: Bearing components shall be completely assembled in the shop and checked to assure accuracy of fit and shall be match-marked for shipping.

807.18 DRIFTING OF HOLES. Drifting done during assembly shall be only such as to bring parts into position and not sufficient to enlarge holes or distort metal. Holes that must be enlarged to admit bolts shall be reamed.

807.19 MATCH-MARKING. Connection parts assembled in the shop for reaming holes in field connections shall be match-marked with steel stencils. A diagram showing such marks shall be furnished to the engineer.

807.20 BOLTS AND BOLTED CONNECTIONS. All bolts shall comply with the requirements of this subsection, except for high strength bolts. Bolted connections fabricated with high strength bolts shall conform to Subsection 807.21.

(a) General: Bolts shall be unfinished, turned or ribbed bolts complying with ASTM A 307, Grade A. Bolts shall have single self-locking nuts or double nuts. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

(b)Turned Bolts: The surface of the body of turned bolts shall meet the ANSI B 46.1 roughness rating value of 125 μ inches (3.2 μm). Heads and nuts shall be hexagonal with standard dimensions for bolts of the specified nominal size or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt. Holes for turned bolts shall be carefully reamed with specified bolts furnished to provide for a light driving fit. Threads shall be entirely outside of holes. A washer shall be provided under the nut.

(c) Ribbed Bolts: The body of ribbed bolts shall be an approved form with continuous longitudinal ribs. The diameter of the body measured on a

circle through the points of the ribs shall be 5/64 inch (2 mm) greater than the nominal diameter of the specified bolt.

Ribbed bolts shall be furnished with round heads complying with ANSI B18.5. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. Hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If the bolt twists before drawing tight, the hole shall be carefully reamed and an oversized bolt used.

807.21 CONNECTIONS USING HIGH STRENGTH BOLTS.

(a) General: This specification covers the assembly of structural joints using ASTM A 325 (A 325M) or A 490 (A 490M) high strength steel bolts tightened to a high tension. Bolt holes shall be 1/16 inch (2 mm) larger than the nominal bolt size.

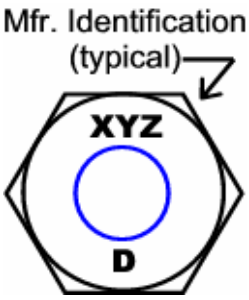
All fasteners within a connection shall be of the same type and all bolts within each connection shall be from the same manufacturer.

Construction shall conform to the specifications for welded structures of, carbon structural steel and high strength steel, except as otherwise provided herein.

(b) Lock-Pin and Collar Fasteners: When approved, lock-pin and collar fasteners complying with Subsection 1013.08(c) may be used.

(c) Bolts, Nuts and Washers: Bolts shall comply with ASTM A 325 (A 325M) Type 1 or Type 3, or ASTM A 490 (A 490M). Nuts shall comply with ASTM A 563 (A 563M), Grade DH or DH3 or ASTM A 194 (A 194M), Grade 2H. Washers shall comply with ASTM F 436 (F 436M). Marking of bolts, nuts and washers shall comply with Figure 1.

Figure 1

Type	A325 Assembly		A490 Assembly	
	Bolt	A563 Nut	Bolt	A563 Nut
1		 Grade Mark DH, (or 2H)*		 Grade Mark DH or DH3, (or 2H)*
3	 Note Mandatory Underline	 Grade Mark DH3	 Note Mandatory Underline	 Grade Mark DH3

*Grade 2H, plain finish, per ASTM A194 (A194 M).

Type 3 Bolts shall have the "A 325" ("A 325M") and "A 490" ("A 490M") underlined. Type 3 nuts shall have the manufacturers mark and the symbol DH3.

ASTM A 490 (A 490M) bolts shall have the heads marked "A 490" ("A 490M") and shall also identify the manufacturer.

Washers shall be marked by a symbol identifying the manufacturer. Additionally, Type 3 washers shall be identified by the symbol "3."

The minimum bolt length shall be determined by adding the appropriate length given in Table 807-1 to the grip (total thickness of all connected material, excluding washers).

Table 807-1E
Bolt Length

Bolt Diameter (inches)	Length to Add to Grip (inches)
1/2	11/16
5/8	7/8
3/4	1
7/8	1 1/8
1	1 1/4
1 1/8	1 1/2
1 1/4	1 5/8
1 3/8	1 3/4
1 1/2	1 7/8

Table 807-1M
Bolt Length

Bolt Diameter (mm)	Length to Add to Grip (mm)
M16	20
M20	25
M22	28
M24	30
M27	35
M30	40
M36	50

Nominal bolt and nut dimensions (for informational purposes only) for heavy hex structural bolts and nuts are shown in Table 807-2 and Figure 2.

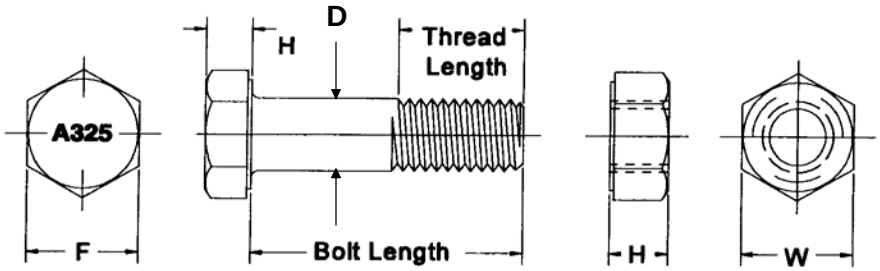
Table 807-2E
Bolt and Nut Dimensions

Heavy Hex Structural Bolts (Inches)				Heavy Hex Nuts (Inches)	
Nominal Bolt Diameter, D	Width Across Flats, F	Height, H	Thread Length	Width Across Flats, W	Height, H
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	1 7/64
1 1/4	2	25/32	2	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32

Table 807-2M
Bolt and Nut Dimensions

Heavy Hex Structural Bolts (mm)				Heavy Hex Nuts (mm)	
Nominal Bolt Diameter , D	Width Across Flats, F Min. - Max.	Height, H Min. - Max.	Thread Length For Bolt Lengths >100 mm	Width Across Flats, W Min. - Max.	Height, H Min. - Max.
M16	26.16 - 27.00	9.25 - 10.75	38	26.16 - 27.00	16.4 - 17.1
M20	33.00 - 34.00	11.60 - 13.40	43	33.00 - 34.00	19.4 - 20.7
M22	35.00 - 36.00	13.10 - 14.90	45	35.00 - 36.00	22.3 - 23.6
M24	40.00 - 41.00	14.10 - 15.90	48	40.00 - 41.00	22.9 - 24.2
M27	45.00 - 46.00	16.10 - 17.90	51	45.00 - 46.00	26.3 - 27.6
M30	49.00 - 50.00	17.65 - 19.75	56	49.00 - 50.00	29.1 - 30.7
M36	58.80 - 60.00	21.45 - 23.55	63	58.80 - 60.00	30.0 - 36.6

Figure 2



Nuts may be washer faced as shown in Figure 2 or doubled chamfered.

Add 5/32 inch (4 mm) for each hardened flat washer, and add 5/16 inch (8 mm) for each beveled washer. The minimum bolt length thus determined shall be increased to the nearest 1/4 inch (5 mm) for bolt lengths less than 4 inch (100 mm) and to the nearest 1/2 inch (10 mm) for bolt lengths equal to or greater than 4 inch (100 mm) to obtain the required bolt length, but in no case shall the bolt have less than two threads beyond the nut after final torque.

(d)Rotational Capacity Testing:

(1) Rotational-capacity tests are required and shall be performed on all black or galvanized (after galvanizing) bolt, nut, and washer assemblies by the manufacturer or distributor prior to shipping and by the contractor at the job site prior to installation. Washers are required as part of the test.

a. Except as modified herein, the rotational-capacity test shall be performed in accordance with the requirements of ASTM A 325 (A 325M).

b. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification.

c. A rotational-capacity lot number shall be assigned to each combination of lots tested.

d. The minimum frequency of testing shall be two assemblies per rotational-capacity lot.

e. The bolt, nut and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device.

f. The minimum rotation, from a snug tight condition (10 percent of the specified proof load), shall be:

240° (2/3 turn) for bolt lengths <4 diameters

360° (1 turn) for bolt lengths >4 diameters and <8 diameters

480° (1 1/3 turn) for bolt lengths >8 diameters

g. The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test are shown in Table 807-3.

Table 807-3E
Rotational Capacity Testing

	Bolt Diameter, inches								
	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Required Installation Tension (kips) Proof Load	12	19	28	39	51	56	71	85	103
Turn Test Tension (kips)	14	22	32	45	59	64	82	98	118

Table 807-3M
Rotational Capacity Testing

	Bolt Diameter, mm						
	M16	M20	M22	M24	M27	M30	M36
Required Installation Tension (kN) Proof Load	86	139	170	203	238	279	405
Turn Test Tension (kN)	99	160	196	234	274	321	466

h. After the required installation tension listed above has been exceeded, one reading of tension and torque shall be taken and recorded. The torque wrench used shall be a dial type and no multipliers will be allowed. The torque value shall conform to the following:

$$\text{Torque} < 0.25PD \ (0.34PD)$$

Where: Torque = measured torque (foot-pounds) (N·m)
P = measured bolt tension (pounds) (N)
D = bolt diameter (feet) (m)

i. Bolts that are too short to test in a Skidmore-Wilhelm Calibrator may be tested in a steel joint. The tension requirement of Heading (d)(1)g. need not apply. The maximum torque requirement of Heading (d)(1)h. shall be computed using a value of P equal to the turn test tension shown in the table in Heading (d)(1)g.

(2) Reporting: The results of all tests (including zinc coating thickness) required herein and in the appropriate specifications shall be recorded on the appropriate document. The location where tests are performed and date of tests shall be reported on the appropriate documents.

(3) Witnessing: The tests need not be witnessed by an inspection agency; however, the manufacturer or distributor that performs the tests shall certify that the results recorded are accurate.

(4) Documentation:

a. Mill Test Reports:

1. Mill Test Reports shall be furnished for all mill steel used in the manufacture of the bolts, nuts, or washers.

2. Mill Test Reports shall indicate the place where the material was melted and manufactured.

b. Manufacturer Certified Test Reports:

1. The manufacturer of the bolts, nuts, and washers shall furnish test reports for the item furnished.

2. Each Manufacturer Certified Test Report shall show the information required in accordance with Heading (d)(2).

3. The manufacturer performing the rotational-capacity test shall include the following on the Manufacturer Certified Test Reports.

(a) The lot number of each of the items tested.

(b) The rotational-capacity lot number.

(c) The results of the required tests.

(d) The pertinent information required in Heading (d)(2).

(e) A statement that Manufacturer Certified Test Reports for the items are in compliance with this specification and the appropriate ASTM specifications.

(f) The location where the bolt assembly components were manufactured.

c. Distributor Certified Test Reports:

1. The Distributor Certified Test Reports shall include Manufacturer Certified Test Reports above for the various bolt assembly components.

2. The rotational-capacity test may be performed by a distributor (in lieu of a manufacturer) and reported on the Distributor Certified Test Reports.

3. The Distributor Certified Test Reports shall show the results of the required tests.

4. The Distributor Certified Test Reports shall also show information required in Heading (d)(2).

5. The Distributor Certified Test Reports shall show the rotational-capacity lot number.

6. The Distributor Certified Test Reports shall certify that the Manufacturer Certified Test Reports are in compliance with this specification and the appropriate ASTM specifications.

(5) Shipping:

a. Bolts, nuts and washers (where required) from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked with the rotational-capacity lot number such that identification will be possible at any stage prior to installation.

b. The appropriate Mill Test Reports, Manufacturer Certified Test Reports, Distributor Certified Test Reports shall be supplied to the Construction Section.

(e) Bolted Parts: Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope of more than 1:20 with respect to a plane normal to bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or other compressible material. Holes may be punched, subpunched and reamed, or drilled, as required by the applicable specification, and shall be of a nominal diameter not more than 1/16 inch (2 mm) in excess of the nominal bolt diameter.

When assembled, joint surfaces, including those adjacent to the boltheads, nuts or washers, shall be cleaned and prepared in accordance with the following:

(1) When steel is to be painted, contact surfaces within joints shall be cleaned in accordance with Subsection 811.06(b) and painted in accordance with the paint manufacturers written recommendations with an approved inorganic zinc primer. The manufacturer shall provide certified independent test results indicating that the coating, when applied as recommended, shall produce a minimum Class B slip coefficient of 0.50 as specified in AASHTO R 31.

(2) When the plans specify the steel as unpainted AASHTO M 270, Grade 50W (M 270M, Grade 345W) , M 270, Grade HPS 50W (M 270M, Grade HPS 345W), M 270, Grade HPS 70W (M 270M, Grade HPS 485W), or M 270, Grade 100W (M 270M, Grade 690W), contact surfaces within joints shall be thoroughly cleaned by Commercial Blast Cleaning in accordance with

Subsection 811.06(c) or other approved methods that will remove all dirt, oil, grease, rust scale, loose mill scale, weld slag and other foreign matter, and shall remain unpainted.

(3) When galvanized steel is specified, after galvanizing and prior to assembly, contact surfaces within joints shall be scored by wire brushing or blasting. Wire brushing treatment shall be a light application of manual or power brushing that marks or scores the surface but removes relatively little of the zinc coating. Blasting treatment shall be a light brush-off treatment which will produce a dull gray appearance. Neither treatment shall be severe enough to produce a break or discontinuity in the zinc surface. When ASTM A 490 (A 490M) bolts are specified to connect galvanized parts, bolts shall be painted to prevent electrolytic action. ASTM A 490 (A 490M) bolts shall not be galvanized.

(4) When contact surfaces within the joint are to be coated with metallized zinc or aluminum, application shall be in accordance with AWS (C2.18), except that subsequent sealing treatments described in Section IV therein shall not be used.

(f) Installation: Bolts shall be installed with a hardened washer under nut or bolt head, whichever is the element turned in tightening. A flat washer may be used when the abutment surface adjacent to the bolt head or nut does not have a slope of more than 1:20 with respect to a plane normal to bolt axis. If an outer face of the bolted part has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for lack of parallelism.

ASTM A 490 (A 490M) bolts shall have two hardened washers. ASTM A 490 (A 490M) and ASTM A 325 (A 325M) bolts shall not be reused or retorqued. Retightening previously tightened bolts which have been loosened by tightening adjacent bolts shall not be considered as reuse or retorque.

Fasteners shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work shift shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the shift. Fasteners shall not be cleaned of lubricant that is present in as-delivered condition.

A direct tension indicator device in accordance with Heading (j) shall be at all job sites where high strength bolts are being installed and tightened. The tension measuring device shall be used to confirm the following:

(1) The conformance to the requirements of Table 807-4 of the complete fastener assembly, including lubrication if required, to be used in construction.

(2) Calibration of the wrenches, if applicable.

(3) The understanding and proper use by the bolting crew of the method to be used.

The frequency of testing, the number of tests to be performed and the test procedure shall be as specified in Headings (g) through (j) as applicable. A rotational-capacity test shall be conducted at the job site for each lot of bolt, nut, and washer assembly as specified elsewhere herein.

The job inspection torque wrench shall be used to verify that the tightening method used will provide the minimum bolt tension as specified in Table 807-4. The accuracy of the tension measuring device shall be confirmed through calibration by an approved testing agency at least annually.

Fasteners together with washers of size and quality specified shall be installed in properly aligned holes and tightened by the direct tension indicator device method described in Heading (j) to at least the minimum tension specified in Table 807-4 when all the fasteners are tight with the exception that the turn-of-nut tightening method may be used on shop installed bolts. Tightening may be done by turning the bolt while the nut is prevented from rotating when it is impractical to turn the nut. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

Table 807-4E
Bolt Tension

ASTM A 325 BOLTS		
Bolt Diameter (inches)	Minimum Bolt Tension (lb)[1]	Recommended Bolt Tension for Calibrated Wrenches (lb)[2]
1/2	12,050	12,500
5/8	19,200	20,000
3/4	28,400	30,000
7/8	39,250	41,000
1	51,500	54,000
1 1/8	56,450	59,000
1 1/4	71,700	75,000
1 3/8	85,450	89,500
1 1/2	104,000	109,000
ASTM A 490 BOLTS		
Bolt Diameter (inches)	Minimum Bolt Tension (lb)[1]	Recommended Bolt Tension for Calibrated Wrenches (lb)[2]
1/2	14,900	15,500
5/8	23,700	25,000
3/4	35,100	37,000
7/8	48,500	51,000
1	63,600	67,000
1 1/8	80,100	84,000
1 1/4	101,800	107,000
1 3/8	121,300	127,500
1 1/2	147,500	155,000

[1] Equal to 70 percent of specified minimum tensile strength of bolt.
[2] Approximately 5 percent in excess of the minimum bolt tension.

Table 807-4M
Bolt Tension

ASTM A 325M BOLTS		
Bolt Diameter (mm)	Minimum Bolt Tension (kN) [1]	Recommended Bolt Tension for Calibrated Wrenches (kN) [2]
M16	94.2	100
M20	147	160
M22	182	190
M24	212	220
M27	275	290
M30	337	360
M36	490	520
ASTM A 490M BOLTS		
Bolt Diameter (mm)	Minimum Bolt Tension (kN) [1]	Recommended Bolt Tension for Calibrated Wrenches (kN) [2]
M16	114	120
M20	179	190
M22	221	230
M24	257	270
M27	334	350
M30	408	430
M36	595	630

[1] Equal to 70 percent of specified minimum tensile strength of bolt.
[2] Approximately 5 percent in excess of the minimum bolt tension.

(g)Turn-of-Nut Tightening: When turn-of-nut tightening is used, hardened washers are required.

A representative sample of not less than three bolt and nut assemblies of each diameter, length and grade to be used in the work shall be checked at the start of work in a device capable of indicating bolt tension. The test shall demonstrate that the method for estimating the snug tight condition and controlling the turns from snug tight given in Table 807-5 to be used by the bolting crew develops a tension not less than 5 percent greater than the minimum tension in Table 807-4.

Bolts shall be installed in all holes of the connection and brought to a "snug tight" condition. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

Snug tightening shall progress systematically from the most rigid part of the connection to the free edges, and then the bolts of the connection shall be retightened in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully compacted. Following this initial operation all bolts in the connection shall be tightened further by the tightening operation, there shall be no rotation of the part not turned by the wrench. Tightening shall progress systematically from the most rigid part of the joint to its free edges.

(h)Calibrated Wrench Tightening:

(1) Calibrated wrench tightening may be used only when required by the plan or directed by the engineer. Calibration shall be on a daily basis and a hardened washer shall is used under the element turned in tightening. This specification does not recognize standard torques determined from tables or from formulas, which are assumed to relate torque to tension.

When calibrated wrenches are used for installation, they shall be set to provide a tension not less than 5 percent nor more than 25 percent in excess of the minimum tension specified in Table 807-4. The installation procedures shall be calibrated at least once each working day for each bolt diameter, length and grade using the following.

a. The length of air hose that will be used and the fastener assemblies that are being installed in the work. Calibration shall be accomplished in a device capable of indicating actual bolt tension by tightening three typical bolts of each diameter, length and grade from the bolt being installed and with a hardened washer from the washers being used in the work under the element turned in tightening.

b. The bolts, nuts and washers used for calibration one time may be used in the structure. Wrenches shall be recalibrated when significant differences are noted in the surface condition of the bolts threads, nuts or washers.

When calibrated wrenches are used to install and tension bolts in a connection, bolts shall be installed with hardened washers under the element turned in tightening bolts in all holes of the connection and brought to a snug tight condition. Following this initial tightening operation, the connection shall be tightened using the calibrated wrench. Tightening shall progress systematically from the most rigid part of the joint to its free edges. The wrench shall be returned to touch up previously tightened bolts which may have been relaxed as a result of the subsequent tightening of adjacent bolts until all bolts are tightened to the prescribed amount.

(2) Job Inspection Torque Wrench: A manual job inspection torque wrench will be calibrated in a device capable of indicating bolt tension. Five bolts of each diameter, length and type to be used will be installed in a tension indicating device and tensioned to 10 percent of the minimum required bolt tension (snug tight). Tightening shall then continue with the job inspection torque wrench to the minimum required bolt tension. The torque required to produce the minimum and recommended bolt tension specified in Table 807-4 shall be recorded. For each torque range, the low and the high values will be discarded and the remaining three values averaged. The average torque needed to provide the minimum bolt tension shall be the job inspection torque and the average torque needed to provide the recommended bolt tension shall be the maximum job torque.

(i) Installation of Alternate Design Bolts: When fasteners which incorporate a design feature intended to indirectly indicate the bolt tension or to automatically provide the tension required by Table 807-4 and which have been qualified under Heading (f) are to be installed, a representative sample of not less than three bolts of each diameter, length and grade shall be checked at the job site in a device capable of indicating bolt tension. The test assembly shall include flat hardened washers, if required in the actual connection, arranged as in the actual connections to be tensioned. The calibration test shall demonstrate that each bolt develops a tension not less than 5 percent greater than the minimum tension required by Table 807-4. The manufacturer's installation procedure as required by Heading (f) shall be followed for installation of bolts in the calibration device and in all connections.

When alternate design fasteners which are intended to control or indicate bolt tension of the fasteners are used, bolts shall be installed in all holes of the connection and initially tightened sufficiently to bring all plies of the joint into firm contact but without yielding or fracturing the control or indicator element of the fasteners. All fasteners shall then be further tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening prior to final twist-off of the control or indicator element of individual fasteners.

(j) Direct Tension Indicator Devices: When direct tension indicator devices are used, a representative sample of not less than three devices for each diameter and grade of fastener to be used in the work shall be assembled in a calibration device capable of indicating bolt tension. The test assembly

shall include flat hardened washers arranged as those in the actual connections to be tensioned. The calibration test shall demonstrate that the device indicates a tension not less than 5 percent greater than the minimum given in Table 807-4.

Manufacturer's installation procedure as required by Heading (f), if appropriate, shall be followed for installation of bolts in the calibration device and in all connections. Special attention shall be given to proper installation of flat hardened washers when direct tension indicator devices are used with bolts installed in oversize or slotted holes and when the load indicating devices are used under the turned element.

When bolts are installed using direct tension indicators meeting the requirements of ASTM F 959 (F 959M), bolts shall be installed in all holes of the connection and brought to snug tight condition. Snug tight is indicated by partial compression of the direc t tension indicator protrusions. All fasteners shall then be tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening prior to final tightening to deform the protrusion to the specified gap.

(k) Inspection: Before the installation of fasteners in the work, the engineer will check the marking, surface condition and storage of bolts, nuts and washers and the faying surfaces of joints for compliance with the requirements of these specifications.

The engineer shall observe calibration and/or testing procedures required in Headings (f) through (j), as applicable, to confirm that the selected procedure is properly used and that, when so used with the fastener assemblies supplied, the tensions specified in Table 807-4 are provided. He shall monitor the installation of fasteners in the work to assure that the selected procedure, as demonstrated in the initial testing to provide the specified tension, is routinely properly applied.

(1) Inspection of bolts installed by tightening method of Heading (j), Direct Tension Indicator (DTI) devices, shall be as follows:

The DTI washers of all bolts will be visually inspected to ensure that the washer protrusions are deformed to approximate final position.

A 0.005 inch (125 μm) Feeler gage will be used on 10 percent of the bolts in a connection, but not less than two bolts, to verify the washer gap conforms to the manufacturers recommendations. If all inspected bolts meet manufacturers requirements, the connection is accepted. If any of the inspected bolts fail to meet the manufacturers requirements, all bolts in the

connection will be checked with feeler gage and any bolts not sufficiently tightened shall be re-tightened and reinspected. Should inspection reveal excessive tightening, the contractor will be required to adjust the installation procedure to correct this situation. This will not be cause to replace bolts.

(2) Inspection of bolts installed by tightening methods of Headings (g), (h), and (i) shall be as follows:

One bolt from each connection shall be selected and the job inspection wrench shall be applied with sufficient torque to set the bolt or nut in motion. The torque shall be noted and the torque shall be greater than the job inspection torque, but less than the maximum job torque as determined during calibration.

Bolts will be inspected by applying the job inspection torque wrench to 10 percent of the bolts, but not less than two bolts, selected by the engineer at random in each connection. If no nut or bolt head is turned by application of the job inspection torque, the connection shall be accepted as properly tightened. If a nut or bolt head is turned by the application of less than the job inspection torque, this torque will be applied to all bolts in the connections, and all bolts whose nut or head is turned by less than the specified torque shall be tightened and reinspected; or the fabricator or contractor may retighten all bolts in the connection and resubmit the connection for inspection.

Table 807-5
Nut Rotation from Snug Tight Condition[1]

	Disposition of Outer Faces of Bolted Parts		
Bolt Length (Measured from underside of head to extreme end of point)	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters[2]	2/3 turn	5/6 turn	1 turn

[1]Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance is ±30 degrees; for bolts installed by 2/3 turn and more, the tolerance is ±45 degrees.
[2]When bolt lengths exceed 12 diameters, the required rotation must be determined by actual test in a suitable tension device simulating actual conditions.

The procedures for inspecting and testing lock-pin and collar fasteners and their installation for required preload tension shall be as approved. The contractor shall provide the personnel and required job inspection torque wrench for the engineer to perform the inspection specified herein. The job inspection torque wrench will be calibrated by the Materials and Testing Section.

807.22 PLATE CUT EDGES.

(a) Edge Planing: Sheared edges of plates more than 5/8 inch (15 mm) thick and carrying calculated stress shall be planed, milled, ground or thermal cut to a depth of 1/4 inch (6 mm). Reentrant corners shall be filleted to a minimum radius of 3/4 inch (20 mm) before cutting.

(b)Visual Inspection and Repair of Plate Cut Edges: Visual inspection and repair of plate cut edges shall be in accordance with Section 3.2.3 of the latest edition of ANSI/AASHTO/AWS D1.5 (D1.5M) Bridge Welding Code.

807.23 SHOP WELDING. Shop welding of metal structures shall comply with Section 815.

807.24 ORTHOTROPIC-DECK BRIDGES.

(a) Protection of Deck Plate After Sandblasting: If sandblasting to white metal, or an equivalent method, is used to prepare the deck plate to receive a wearing surface, a protective coating shall be applied to the plate immediately after cleaning.

(b)Dimensional Tolerance Limits: Dimensional tolerance limits for orthotropic-deck bridge members shall be applied to each completed but unloaded member and shall be as specified in latest AASHTO specifications except as otherwise provided herein. The deviation from detailed flatness, straightness or curvature at any point shall be the perpendicular distance from that point to a template edge having the detailed straightness of curvature and which is in contact with the element at two other points. The term "element" as used herein refers to individual panels, stiffeners, flanges or other pieces. The template edge may have any length not exceeding the greatest dimension of the element being examined and, for any panel, not exceeding 1.5 times the least dimension of the panel; it may be placed anywhere within the element. The deviation shall be measured between adjacent points of contact of the template edge with the element; the distance between these adjacent points of contact shall be used in formulas to establish the tolerance limits for the segment being measured when this distance is less than the applicable dimension of the element specified for the formula.

(1) Flatness of Panels: The term "panel" as used herein means a clear area of steel plate surface bounded by stiffeners, webs, flanges or plate edges and not further subdivided by any such elements. These provisions apply to all panels in the bridge; for plates stiffened on one side only, such as orthotropic-deck plates or flanges of box girders, this includes the total clear width on the side without stiffeners as well as the panels between stiffeners on the side with stiffeners.

The maximum deviation from detailed flatness of curvature of a panel shall not exceed the greater of:

$$3/16 \text{ inch or } D/144\sqrt{T} \qquad (5\text{mm or } D/28.6\sqrt{T})$$

where: D = least dimension in inches (mm) along boundary of panels, and
T = minimum thickness in inches (mm) of plate comprising the panel.

(2) Straightness of Longitudinal Stiffeners Subject to Calculated Compressive Stress, Including Orthotropic-Deck Ribs:

Maximum deviation from detailed straightness or curvature in any direction perpendicular to its length of a longitudinal stiffener subject to calculated compressive stress, including orthotropic-deck rib, shall not exceed:

$$L/480 \quad (L/12{,}192)$$

where: L = length of stiffener or rib between cross members, webs or flanges, in inches (mm).

(3) Straightness of Transverse Web Stiffeners and Other Stiffeners not Subject to Calculated Compressive Stress: Maximum deviation from detailed straightness or curvature in any direction perpendicular to its length of a transverse web stiffener or other stiffener not subject to calculated compressive stress shall not exceed:

$$L/240 \quad (L/6096)$$

where: L = length of stiffener or rib between cross members, webs or flanges in inches (mm).

807.25 FACING OF BEARING SURFACES. The surface of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall comply with the surface finish of Table 807-6 and ANSI B 46.1, Surface Roughness, Waviness and Lay, Part 1:

Table 807-6
Bearing Surface Finish

Surface	Surface Finish
Steel slabs	2,000 μ inches (50 μm)
Heavy Plates in contact in shoes to be welded	1,000 μ inches (25 μm)
Milled ends of compression members, stiffeners, and fillers	500 μ inches (12.5 μm)
Bridge rollers and rockers	250 μ inches (6.3 μm)
Pins and pin holes	125 μ inches (3.2 μm)
Sliding bearings	125 μ inches (3.2 μm)
All other surfaces	500 μ inches (12.5 μm)

807.26 ABUTTING JOINTS. Abutting joints in compression members, girder flanges and tension members, when specified, shall be faced and brought to an even bearing. When joints are not faced, the opening shall not exceed 1/4 inch (6 mm).

807.27 END CONNECTION ANGLES. Floor beams, stringers and girders having end connection angles shall be built to specified length (+0, -1/16 inch) (+0, -2 mm) between heels of connection angles. If continuity is required, end connections shall be faced. Thickness of connection angles shall not be less than 3/8 inch (10 mm) nor less than that shown on the plans after facing.

807.28 LACING BARS. Ends of lacing bars shall be neatly rounded.

807.29 FABRICATION OF MEMBERS. Steel plates for main members and splice plates for flanges and main tension members, not secondary members, shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and compressive stresses. Fabricated members shall be true to line and free from twists, bends and open joints.

807.30 BENT PLATES. Unwelded, cold-bent, load-carrying, rolled steel plates shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling, except that cold-bent ribs for orthotropic-deck bridges may be bent in the direction of rolling if permitted.

Bending shall be such that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal, are shown in Table 807-7.

Table 807-7
Steel Plate Bending Radius

Plate Thickness, t Inches (mm)	Minimum Bend Radius
Up to 1/2 (15)	2 t
Over 1/2 to 1 (15 to 25)	2 1/2 t
Over 1 to 1 1/2 (25 to 40)	3 t
Over 1 1/2 to 2 1/2 (40 to 65)	3 1/2 t
Over 2 1/2 to 4 (65 to 100)	4 t

Low alloy steel over 1/2 inch (15 mm) thick may require hot bending for small radii.

Allowance for springback of AASHTO M 270, Grade 100 (M 270M, Grade 690), and M 270, Grade 100W (M 270M, Grade 690W) steel should be about three times that for structural carbon steel. For brake press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

If shorter radii are essential, plates shall be bent hot at a temperature not greater than 1150°F (620°C), except for AASHTO M 270, Grade 100 (M 270M, Grade 690) , and M 270, Grade 100W (M 270M, Grade 690W) steel. If AASHTO M 270, Grade 100 (M 270M, Grade 690) , and M 270, Grade 100W (M 270M, Grade 690W) steel plates to be bent are heated to a temperature greater than 1125°F (610°C), they must be requenched and tempered in accordance with the producing mill's practice. Hot-bent plates shall conform to the requirements herein for cold-bent plates.

Before bending, corners of the plate shall be rounded to a radius of 1/16 inch (2 mm) throughout the portion of the plate at which bending is to occur.

807.31 FIT OF STIFFENERS. End stiffeners of girders and stiffeners intended as supports for concentrated loads shall have full bearing (either milled, ground or welded, as specified) on the flanges. Stiffeners not intended to support concentrated loads shall have a tight fit. As an alternate, stiffeners may be cut short, jammed to the tension flange and seal-welded to the compression flange. Fillers under stiffeners shall fit within 1/4 inch (6 mm) at each end. Welding transversely across tension flanges of beams or girders will not be permitted unless shown on the plans.

807.32 EYEBARS. Fabrication for eyebars shall comply with the latest AASHTO specifications.

807.33 STRESS RELIEVING. When specified, members such as bridge shoes, pedestals or other parts which are built up by welding sections of plate together shall be stress-relieved in accordance with AWS.

807.34 PINS AND ROLLERS. Pins and rollers shall be accurately turned to specified dimensions and shall be straight, smooth and free from flaws.

Pins and rollers more than 9 inches (230 mm) in diameter shall be forged and annealed. Pins and rollers 9 inches (230 mm) or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

In pins larger than 9 inches (230 mm) in diameter, a hole not less than 2 inches (50 mm) in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent damage by too rapid cooling and before being annealed.

807.35 BORING PIN HOLES. Pin holes shall be bored true to specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other. The final surface shall be produced by a finishing cut.

The distance outside-to-outside of end holes in tension members, and inside-to-inside of end holes in compression members shall not vary from that specified more than 1/32 inch (1 mm). Boring of holes in built-up members shall be done after connections are completed.

807.36 PIN CLEARANCES. Pin hole diameter shall not exceed pin diameter by more than 0.020 inch (0.5 mm) for pin diameters of 5 inches (125 mm) or less, and 0.03125 inch (0.80 mm) for larger pins.

807.37 SCREW THREADS. Threads for bolts and pins for structural steel construction shall comply with the Unified Standard Series UNC/ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that pin ends having a diameter of 1 3/8 inches (35 mm) or more shall have six threads per inch (per 25 mm).

807.38 PILOT AND DRIVING NUTS. Two pilot nuts and two driving nuts for each size pin shall be furnished.

807.39 CAMBER FOR ROLLED BEAMS IN SIMPLE SPAN. When specified, beams shall be cambered to conform to the vertical curve or level grade required after full dead load is applied. Camber shall approximate a simple curve from end to end of beam. The camber ordinate at midlength of the beam shall be equal to the dead load deflection of the beam plus the midordinate of the vertical curve, if the span is on a vertical curve. The camber ordinate may vary from the above by ±1/4 inch (±6 mm).

Beams may be cambered cold or may be heated. When heat is used, the tension flange shall be heated uniformly and progressively to not more than a red heat visible in ordinary shop light (1150°F) (620°C) while the beam is loaded to produce compression in the bottom flange. The contractor shall furnish pyrometers or temperature-indicating crayons for checking the desired temperatures. Heating and loading shall be done in such manner that the permanent camber remaining shall be within the limits specified above. After cambering, the beam shall be left to air cool and no quenching process shall be permitted.

807.40 STRAIGHTENING OF MEMBERS. Cooling with water will not be allowed without permission.

807.41 ARMORED JOINTS. Armored joint assemblies shall be paired and fitted before shipping. Plates, angles or other structural shapes shall be accurately shaped at the shop to conform to the specifications covering those items. Care shall be taken to ensure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during placing of concrete. The opening at expansion joints shall be that designated on the plans at normal temperatures, and care shall be taken to avoid impairment of the clearance.

807.42 SHEAR CONNECTORS. Shear connectors may be either 3/4 inch (19 mm) or 7/8 inch (22 mm) studs. Stud shear connectors shall comply with the requirements of Section 7, Stud Welding of the latest edition of ANSI/AASHTO/AWS/D1.5 (D1.5M) Bridge Welding Code.

807.43 MARKING AND SHIPPING. Unless otherwise specified, girders and beams shall be placed in the upright position for shipment. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.

The contractor shall furnish to the engineer as many copies of material orders, shipping statements and erection diagrams as directed. Weights of individual members shall be shown on the statements. Members weighing more than three tons (2500 kg) shall have weights marked thereon. Structural members shall be loaded in such manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

Pins, small parts and packages of bolts, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed 300 pounds (135 kg). A list and description of the contained materials shall be plainly marked on the outside of each shipping container.

807.44 PAINTING. Shop and field paints and their application shall comply with Section 811.

807.45 FALSEWORK. Falsework shall be designed in accordance with Subsection 801.04.

807.46 BEARINGS AND ANCHORAGES. Bearings shall be set level, in exact position, and shall have full and even bearing on the masonry. Bearings shall not be placed on masonry bearing areas which are irregular or improperly formed.

(a) Elastomeric Bearing Pads: If used, elastomeric bearing pads shall be set directly on the concrete masonry.

(b)Cast Iron or Steel or Rolled Steel Bearings: Cast iron or steel or rolled steel bearings shall be bedded on the masonry with a preformed fabric bearing pad.

(c) PTFE Sliding Plate Bridge Bearings: When polytetrafluorethylene (PTFE) sliding plate bridge bearings are specified on the plans, they shall comply with the following requirements.

Sliding plate bearings shall be fabricated by companies and shops normally engaged in production of bridge bearings similar to the types specified. Structural steel components shall comply with AASHTO M 270, Grade 36 or Grade 50 (M 270M, Grade 250 or 345). Fabrication and erection of bearings shall comply with Section 807 as amended herein.

Anchor bolts shall be grouted in preformed wells in the top of existing piers. Grout shall be an approved non-shrink, non-metallic type complying with Subsection 1018.26.

Sliding surfaces shall be stainless steel operating against a bearing surface of PTFE. Such bearing shall be structurally equal to those shown on the plans and shall be designed to accommodate all required movements and reactions.

(1) Construction Methods: Before fabrication of bearings, the contractor shall submit shop drawings for approval.

After fabrication and before bonding, stainless steel or PTFE back-up material shall be planed to a true plane. Bonding of PTFE sheets shall be performed at the factory of the bearing manufacturer under controlled conditions and in accordance with written instructions of the adhesive system manufacturer. Side of PTFE sheet to be bonded to metal shall be factory treated by an approved manufacturer by the sodium napthalene or sodium ammonia process.

After bonding operations, the PTFE surface shall be smooth, flat and free from bubbles. Filled PTFE surfaces shall then be polished. Fabric shall be capable of carrying unit loads of 10 ksi (70 MPa) without cold flow. PTFE fabric shall be bonded or mechanically attached to a rigid substrate.

The fabric-substrate bond shall be capable of withstanding a shear force equal to 10 percent of the perpendicular application loading without delamination in addition to the shear force developed as a result of the natural bearing frictions shear force. The test method shall comply with ASTM D 1002.

Welding to steel plate which has bonded PTFE surface will be permitted providing a welding procedure is established and approved which restricts temperature reached by bond area to less than 300°F (150°C) as determined by temperature indicating wax pencils or other suitable means.

The clad plate shall comply with ASTM A 264. In lieu of the clad plate the stainless steel plate may be continuously Tungsten Inert Gas Fillet Welded to the sole plate.

The back-up plate for the PTFE surface shall be factory vulcanized to the lower neoprene bearing element.

Where unfilled PTFE sheet is used, PTFE shall be recessed in backup plate by 1/2 the PTFE sheet thickness.

Bearings shall be assembled at the plant, marked for identification and delivered as a complete unit. Bearings shall have permanent match-marks to indicate the normal position of the bearing. During transportation and storage, bearings shall be covered with moisture proof and dust-proof covers, and shall be protected against damage.

The contractor shall furnish manufacturer's certification of steel, elastomeric pads, PTFE and other materials used in fabrication of bearings.

(2) Fabrication Inspection: Fabrication will be inspected by the Construction Section in accordance with Section 807.05 as amended herein.

Tests for coefficient of friction shall be performed by the manufacturer or in an approved laboratory. One completed bearing shall be tested from each group. Test methods and equipment shall be approved and shall include, but shall not be limited to, the following:

a. Tests shall be arranged so that the coefficient of friction of first movement of bearing can be determined.

b. Bearing surfaces shall be cleaned prior to testing and a silicon gel may be added to the surfaces. When silicon gel is used between the bearing surfaces during the test, silicon gel shall be applied to each bearing either before assembly at the fabrication plant or before erection in the field.

c. Tests shall be conducted at maximum working stress for the PTFE working surface with test load supplied continuously for 12 hours prior to measuring friction.

d. First movement static and dynamic coefficients of friction of test bearings shall be determined at a sliding speed of less than 1 inch (25 mm) per minute and shall not exceed 75 percent of the coefficient of friction specified in Table 807-8.

Table 807-8
Coefficient of Friction of Bearing

	Bearing Pressure[1]		
	500 psi (3.5MPa)	2000 psi (14MPa)	3500 psi (24MPa)
	Coefficient of Friction		
Unfilled PTFE, Fabric containing PTFE fibers, and PTFE-Perforated Metal Composite	0.08	0.06	0.04
Filled PTFE	0.12	0.10	0.08

[1]The actual bearing pressure shall be provided to the fabricator upon request.

e. Bearing specimens shall then be subjected to 100 movements of at least 1 inch (25 mm) of relative movement and if the test facility permits, full design movement at a speed of less than 1 foot (300 mm) per minute. Following this test, static and dynamic coefficients of friction shall be determined again and shall not exceed values measured in Heading (d) above. Bearing specimen shall show no appreciable sign of bond failure or other defects.

Bearings represented by test specimens passing above requirements will be approved subject to onsite inspection for visible defects.

807.47 STRAIGHTENING BENT MATERIAL AND CAMBERING.

(a) Straightening Bent Material: Straightening of plates, angles, other shapes and built-up members, when permitted, shall be done by methods that will not produce fracture or other damage. Distorted members shall be straightened by mechanical means or, if approved, by supervised application of a limited amount of localized heat, except that heat straightening of AASHTO M 270, Grade 100 (M 270M, Grade 690), and M 270, Grade 100W (M 270M, Grade 690W) steel shall be done only under rigidly controlled procedures, each application subject to approval of the engineer. In no case shall the maximum temperature of AASHTO M 270, Grade 100 (M 270M, Grade 690), and M 270, Grade 100W (M 270M, Grade 690W) steel exceed 1125°F (610°C), nor shall the temperature exceed 950°F (510°C) at weld

metal or within 6 inches (150 mm) of weld metal. Heat shall not be applied directly on weld metal. In all other steels, the temperature of the heated area shall not exceed 1150°F (620°C) (a dull red) as controlled by temperature indicating crayons, liquids or bi-metal thermometers.

Parts to be heat straightened shall be substantially free of stress from external forces, except stresses resulting from mechanical means used in the application of heat.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

(b) Cambering: Correction of errors in camber in welded beams and girders of AASHTO M 270, Grade 100 (M 270M, Grade 690), and M 270, Grade 100W (M 270M, Grade 690W) steel shall be done only under rigidly controlled procedures, each application subject to approval.

807.48 ASSEMBLING STEEL. Parts shall be accurately assembled and any match-marks shall be followed. Materials shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will damage or distort members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before members are assembled.

Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. Blocking shall be left in place until tension chord splices are fully riveted or bolted and all other truss connections pinned and bolted. Rivets or permanent bolts in splices of butt joints of compression members and rivets or permanent bolts in railings shall not be driven or tightened until the span has been swung.

Splices and field connections shall have at least 50 percent of the holes filled with bolts and pins (either erection or untorqued permanent bolts) and at least 10 percent of cylindrical erection pins for fit-up and alignment. Splices and connections carrying traffic during erection shall have 75 percent of the holes filled. Main member splices shall have all holes filled with bolts and cylindrical erection pins (half bolts and half pins) for fit-up and alignment.

Fit-up bolts shall be of the same nominal diameter as rivets or permanent bolts and cylindrical erection pins shall be 1/32 inch (1 mm) larger.

Permanent field bolting shall be performed in accordance with Subsection 807.21.

807.49 PIN CONNECTIONS. Pilot and driving nuts shall be used in driving pins. They shall be furnished by the contractor without charge. Pins

shall be so driven that the members will take full bearing on them. Pin nuts shall be tightened and the threads burred at the face of the nut.

807.50 FIELD WELDING. Field welding of steel structures, when authorized, shall comply with Section 815.

807.51 MISFITS. Correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of erection. However, any error in fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting of parts by moderate use of drift pins or reaming and slight chipping or cutting, shall be reported immediately to the inspector and approval of the method of correction obtained. The correction shall be made in the presence of the inspector. The contractor shall be responsible for the correction of all misfits, errors and damages and shall make the necessary corrections and replacement at no direct pay.

807.52 WEATHERING STEEL. When AASHTO M 270, Grade 50W (M 270M, Grade 345W), M 270, Grade HPS 50W (M 270M, Grade HPS 345W), M 270, Grade HPS 70W (M 270M, Grade HPS 485W), or M 270, Grade 100W (M 270M, Grade 690W) weathering steel is specified to be left unpainted, the following modifications in the requirements of this subsection shall apply.

(a) Materials: Steel to be completely embedded in concrete shall be either AASHTO M 270, Grade 36 or Grade 50W (M 270M, Grade 250 or 345W) steel. Anchor bolt assemblies and other steel partially embedded in concrete shall be AASHTO M 270, Grade 50W (M 270M, Grade 345W) steel.

(b)High Strength Bolts: High strength bolts shall be ASTM A 325, Type 3 (A 325M, Type 3).

(c) Stiffeners: To facilitate drainage adjacent to stiffeners, the lower end of transverse stiffeners shall be clipped at least 1 1/2 inches (40 mm), and longitudinal stiffeners shall be terminated at least 1 inch (25 mm) short of transverse stiffeners.

(d)Cleaning of Exposed Surfaces: Exposed surfaces of weathering steel to be left unpainted shall be cleaned of all grease, oil, paint or other soilage.

Outside surfaces of exterior girders and the bottom surface of the bottom flange of exterior girders shall be blast cleaned, either before or after erection, in accordance with Subsection 811.06(b). All other exposed surfaces of

weathering steel shall be blast cleaned in accordance with Subsection 811.06(c). Blast cleaned surfaces shall be kept free of grease, oil, markings, paint or other soilage; such soilage of blast cleaned surfaces shall be removed by approved methods. Concrete splatter shall be washed off immediately. The first 10 feet (3 m) of weathering steel girders adjacent to expansion joints shall
be painted with the standard zinc paint except that the top coat color shall match the color of the weathered steel.

(e) Restoration of Concrete Finish: All concrete surfaces requiring a Class 2A finish shall be restored to the required finish at the time of final acceptance.

807.53 MEASUREMENT.

(a) Weight Basis: Structural steel will be measured by the weight (mass) of metal in pounds (kg) remaining in the completed and accepted structures. The weight will be computed on the basis of theoretical net weight from the approved shop drawings. No allowance will be made for bolts, nuts, washers or welds and no deductions will be made for bolt holes, beam copings, cut flanges or edge preparation for welding. Deduction will be made for pin holes. Plates shall be estimated from the sizes billed and deductions made for cut corners. Shear connectors will not be measured for payment.

No measurement of structural steel of any class will be allowed for temporary work or for additional weight (mass) in members provided for erection purposes.

No allowance will be made in the pay quantity for any items not remaining in the finished structure, except as hereinafter provided.

No allowance will be made for shop or field paints, galvanizing or other coatings.

No allowance will be made for overrun on plates or rolled sections.

When full-size tests of built-up structural members and eyebars are required, any fullsize members tested to destruction will be measured if the test proves satisfactory. However, if the test proves unsatisfactory, the members represented by it will be rejected and no measurement or allowance will be made for such members.

AASHTO M 270, Grade 36 (M 270M, Grade 250) steel shall include all metal classified as such in the plans and specifications and such minor items as anchor materials including pins, rollers, metal railings, steel plates and shapes for expansion joints, ladders, checkered floor plates, bronze castings and plates, steel and iron castings (except cast iron drains in floors) ladders,

stairways, platforms, structural supports and brackets for machinery and power equipment including pit pumps, steel framework for counterweights, floor plates, keeper plates and their tap bolts, sheet metal covers for gears and drum switches and other parts, shim plates, bearing plates for approach spans, curb angles, anchor bolts including those for roadway gates, and bronze and cast iron for expansion plates.

AASHTO M 270, Grade 36 (M 270M, Grade 250), M 270, Grade 50 (M 270M, Grade 345), M 270, Grade 50W (M 270M, Grade 345W), M 270, Grade HPS 50W (M 270M, Grade HPS 345W), M 270, Grade HPS 70W (M 270M, Grade HPS 485W), M 270, Grade 100 (M 270M, Grade 690), or M 270, Grade 100W (M 270M, Grade 690W) steel shall include all steel classified as such in the plans or specifications.

Metal weights (masses) will be computed on the bases of Table 807-9:

Table 807-9
Metal Unit Weights (Mass)

Metal	Unit Wt (lb/cu ft.)	Unit Mass (kg/cu m)
Aluminum, cast or wrought	173.0	2770
Bronze, cast	536.0	8590
Copper-alloy	536.0	8590
Copper, sheet	558.0	8940
Iron, cast	445.0	7130
Iron, malleable	470.0	7530
Iron, wrought	487.0	7800
Lead, sheet	707.0	11320
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490.0	7850
Zinc	450.0	7210

(b)Lump Sum Basis: When payment is specified to be made by the lump sum, no weight (mass) measurement of metal will be made. Any estimate of the weight (mass) of structural metalwork shown on the plans is approximate and no guarantee is made that it is the correct weight (mass) of each grade of metal to be furnished. It is the contractor's responsibility to determine the correct weight (mass) of each grade of metal furnished. No adjustment in contract price will be made due to errors in the estimated weight (mass) shown on the plans. Shop bills will not be required.

807.54 PAYMENT.

(a) Weight (Mass) Basis: Payment for the various classifications of structural metals will be made at the respective contract unit prices per pound (kg).

(b)Lump Sum Basis: Payment for the completed and accepted items will be made at the contract lump sum price, which includes furnishing, fabricating, erecting, painting, galvanizing or other coating of all necessary materials; furnishing all required labor, plants, equipment, tools, staging, falsework, forms, power welding, bolts, all bearings described in Subsection 807.46 and other hardware; and the performance of all work necessary to complete the item.

When changes in the work are ordered by the engineer, which vary the weight (mass) of steel to be furnished, the lump sum payment will be adjusted as follows:

The value per pound (kg) of the increase or decrease in the weight (mass) of structural steel involved in the change will be determined by dividing the contract lump sum amount by the estimated weight (mass) shown on the plans. The adjusted contract lump sum payment will be the contract lump sum amount plus or minus the value of the steel involved in the change, and no additional compensation will be made on account of said change.

If a change in the grade of steel to be furnished is ordered by the engineer, resulting in additional cost to the contractor, compensation will be made in accordance with Subsection 109.04.

Payment will be made under:

Item No.	Pay Item	Pay Unit
807-01	Steel (AASHTO M 270, Grade 36) (M 270M, Grade 250)	Pound (kg)
807-02	Steel (AASHTO M 270, Grade 50) (M 270M, Grade 345)	Pound (kg)
807-03	Steel (AASHTO M 270, Grade 50W) (M 270M, Grade 345W)	Pound (kg)
807-04	Steel (AASHTO M 270, Grade HPS 50W) (M 270M, Grade HPS 345W)	Pound (kg)
807-05	Steel (AASHTO M 270, Grade HPS 70W) (M 270M, Grade HPS 485W)	Pound (kg)
807-06	Steel (AASHTO M 270, Grade 100) (M 270M, Grade 690)	Pound (kg)
807-07	Steel (AASHTO M 270, Grade 100W) (M 270M, Grade 690W)	Pound (kg)
807-08	Structural Metalwork	Lump Sum

Section 808
Steel Grid Flooring

808.01 DESCRIPTION. This work consists of furnishing and installing steel grid flooring of the open or concrete-filled type, as specified, in accordance with these specifications and in reasonably close conformity with the details shown on the plans.

Before fabrication or construction is undertaken, the contractor shall submit shop and assembly details in accordance with Subsection 801.03.

808.02 MATERIALS. Steel grid flooring shall comply with Subsection 1013.21.

Concrete in filled steel grid floors shall be Class A complying with Section 901, except Grade F coarse aggregate shall be used.

Paint shall comply with Section 811.

808.03 FABRICATION. Deviations from these specifications to conform to manufacturer's specifications will not be permitted without approval of the Bridge Design Engineer.

Upper edges of members forming the wearing surface of open type grid flooring shall be fabricated or treated to give maximum skid resistance.

808.04 NOTICE OF BEGINNING OF WORK. The contractor shall give the DOTD Chief Construction Engineer at least 10 days advance written notice of the beginning of work at the mill or shop so that inspection may be provided. No material shall be manufactured or work done in the shop before shop drawings have been approved and before the DOTD Chief Construction Engineer has been notified.

808.05 FACILITIES FOR INSPECTION. The contractor shall furnish facilities for inspection of material and workmanship in the mill and shop as described in Subsections 807.04 and 807.05.

808.06 STORAGE OF MATERIALS. Steel grid flooring shall be stored as specified in Subsection 807.07.

808.07 STRAIGHTENING MATERIAL. Steel grid flooring sections, before being installed, shall be straight, except for camber if specified. If straightening is necessary, it shall be done by methods that will not damage the metal.

808.08 ARRANGEMENT OF SECTIONS. Where main elements are normal to centerline of roadway, the units generally shall be of such length as to extend over the full width of roadway for roadways up to 40 feet (12 m), but in every case the units shall extend over at least three panels. Where joints are required, ends of main floor members shall be welded at joints over their full cross-sectional area or otherwise connected to provide continuity.

Where main elements are parallel to centerline of roadway, sections shall extend over at least three panels, and ends of abutting units shall be welded over their full cross-sectional area or otherwise connected to provide continuity.

808.09 PROVISION FOR CAMBER. Steel units so rigid that they will not readily follow the camber required shall be cambered in the shop. To provide a bearing surface parallel to the crown of the roadway, stringers shall be canted or provided with shop-welded beveled bearing bars. If beveled bars are used, they shall be placed along the centerline of stringer flange, in which case the design span length shall be governed by width of bearing bar instead of width of stringer flange.

Longitudinal stringers shall be mill-cambered or provided with bearing strips so that the complete floor, after deadload deflection, shall conform to the required longitudinal camber.

808.10 FIELD ASSEMBLY. Areas of considerable size shall be assembled before the floor is welded to its supports. Main elements shall be made continuous and sections shall be connected along their edges by welding. Connections will be subject to approval.

808.11 CONNECTION TO SUPPORTS. The floor shall be connected to its steel supports by welding. Before welding, the floor shall either be loaded to make a tight joint with full bearing or clamped down. Location, length and size of welds shall be subject to approval of the Bridge Design Engineer, but in no case shall they be less than the manufacturer's standards.

Ends of main steel members of the slab shall be securely fastened together at the sides of the roadway for the full length of span by steel plates or angles welded to ends of main members.

808.12 WELDING. Shop and field welding shall comply with Section 815. Field welding shall comply with the approved method and location as shown on the shop drawings.

808.13 PROTECTIVE COATING. Unless otherwise specified, the steel grid floor shall be hot dipped galvanized in accordance with Section 811.

808.14 CONCRETE FILLER. When specified, concrete filler shall be placed in the open grid.

Floor types with bottom flanges not in contact shall be provided with bottom forms of metal to retain the concrete filler.

Metal forms shall fit tightly on bottom flanges of floor members and be placed in short lengths so as to extend only about 1 inch (25 mm) onto the edge of each support, and in all cases forms shall provide for adequate bearing of the slab on the support.

Concrete shall be consolidated by vibrating the steel grid floor. The vibrating device and manner of operating it will be subject to approval.

808.15 MEASUREMENT. The quantity of steel grid flooring for payment will be the design area as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven or if design changes are necessary.

Concrete for filling steel grid flooring will not be measured for payment.

808.16 PAYMENT. Payment for steel grid flooring will be made at the contract price per square foot (sq m), which includes furnishing and fabricating all steel materials, including base plates, trim angles, trim plates, galvanizing or other coating (if required) and all welding and bolting, and any additional materials or fabrication in the floor system necessitated by the use of an approved alternate grid flooring type.

Payment will be made under:

Item No.	Pay Item	Pay Unit
808-01	Steel Grid Flooring	Square Foot (Sq m)

Section 809
Movable Bridges

809.01 DESCRIPTION. This work consists of furnishing, fabricating and erecting movable span bridges and all appurtenances required for their operation such as machinery, operating house, traffic barriers, and machinery houses.

The requirements for fixed span bridges, as given elsewhere in these specifications, shall apply to movable span bridges unless specified otherwise in this section.

809.02 GUARANTEES. Prior to final acceptance of the project, the contractor shall furnish warranties and guarantees as specified in Subsection 104.05.

809.03 BOND. The contractor will be required to furnish satisfactory bonding in accordance with Subsection 103.05.

809.04 DRAWINGS. Shop drawings, brochures and work drawings shall be furnished in accordance with Subsection 801.03.

809.05 MAINTENANCE AND OPERATION MANUALS. Maintenance and operation instruction manuals shall be furnished in accordance with Subsection 801.03(e)(2).

809.06 INSTRUCTION TO DEPARTMENTAL PERSONNEL. The contractor shall notify the engineer when the span, including the power plant, operating house, traffic barriers and machinery, is fully operational in order that the permanent bridge operators may be assigned for instruction. At this time the contractor shall furnish a person experienced in operation of the equipment for 5 working days of 8 hours each to instruct the Department's bridge operators in the complete and correct operation of the bridge and to provide complete instruction to the Department's electrical, mechanical and bridge maintenance personnel in proper operation, maintenance, lubrication and adjustment of equipment. Prior to beginning the instruction period the contractor shall prepare an instruction guide and submit it to the Bridge Design Engineer for approval. The guide shall describe the instructions to be given

the Department's operators and maintenance personnel. Items of instruction shall be listed and spaces provided for the project engineer to check off the item as it is completed. The completed guide shall be included in the maintenance manual. This 5-day period of instruction shall be prior to final inspection.

809.07 METALS. Structural and miscellaneous metals used in the manufacture of parts for movable bridges shall be as listed in Sections 1012 and 1013 and the current AASHTO Standard Specifications for Movable Highway Bridges.

809.08 WIRE ROPE, COUNTERWEIGHT ROPE, AND ATTACHMENTS. Wire rope and attachments shall comply with Subsections 1009.10 and 1009.11.

809.09 GENERAL FABRICATION AND ERECTION REQUIREMENTS. Except as otherwise provided herein, the fabrication and erection of structural parts shall conform to Section 807.

809.10 MANUFACTURE AND FABRICATION OF MACHINERY AND TRAFFIC BARRIERS.

(a) Shop Practice: The manufacture of machined parts shall be in accordance with ANSI standards for the various items. For surface finish requirements refer to ANSI B 46.1.

(b)Inspection: The contractor shall give the DOTD Chief Construction Engineer 10 days advance written notice before beginning the manufacture of any item, so that inspection may be provided. The contractor shall furnish facilities for inspection of material and workmanship as described in Subsections 807.04 and 807.05. Inspectors shall be allowed free access to plant facilities for adequate inspection of the work. This inspection shall be at the option of the Department and shall not relieve the contractor of any responsibility placed upon him by the contract.

(c) Fit Tolerances for Accurate Work: Fits for machinery parts shall be in accordance with ANSI Standards B4.1 for English measure (referred to hereafter as ABC measure: American, British, Canadian conference agreement) and B4.2 for metric (ISO) measure. Tables of Preferred Fits are provided in the referenced Standards that give allowances and tolerances for diameters up to 20 inches (500 mm). For larger sizes the preferred fits can be calculated from other data from within the standards. Allowances are based

upon the use of the hole as the nominal size and give the amounts by which the shaft should be less than or greater than the basic (ISO) or nominal (ABC) hole size. Fits classifications and recommended fits for typical mating parts are tabulated in Table 809-1.

(d)Description of Standard Fit Classifications (ISO): The classes of fits are arranged in three general groups: clearance fits, transition fits, and interference fits.

(1) Clearance fits:

a. H11/c11 *Loose running fits* are intended for wide commercial tolerances or allowances on external members.

b. H9/d9 *Free running fits* are not intended for use where accuracy is essential, but good for large temperature variations, high running speed, or heavy journal pressure.

c. H8/f7 *Close running fits* are intended for running on accurate machines and for accurate location at moderate speeds and journal pressures.

d. H7/g6 *Sliding fits* are not intended to run freely, but to move and turn freely and locate accurately.

e. H7/h6 *Locational clearance fits* are intended to provide snug fits for locating stationary parts; but can be freely assembled and disassembled.

(2) Transition fits:

a. H7/k6 *Locational transition fits* are intended for more accurate location, it is a compromise between clearance and interference.

b. H7/n6 *Locational transition fits* are intended for more accurate location where greater interference is permissible.

(3) Interference fits:

a. H7/p6 *Locational interference fits* are intended for parts requiring rigidity and alignment with prime accuracy of location but without special bore pressure requirements.

b. H7/s6 *Medium drive fits* are intended for ordinary steel parts or shrink fits on light sections, the tightest fits usable with cast iron.

c. H7/u6 *Force fits* are intended for parts which can be highly stressed or for shrink fits where the heavy pressing forces required are impractical.

(e) Description of Standard Fit Classifications (ABC): The classes of fits are arranged in three general groups: running and sliding fits, locational fits, and force fits.

(1) Running and Sliding Fits (RC): Running and sliding fits are intended to provide a similar running performance, with suitable lubrication allowance, throughout the range of sizes. The clearances for the first two classes, used chiefly as slide fits, increase more slowly with the diameter than for the other classes, so that accurate location is maintained even at the expense of free relative motion.

a. RC_1 *Close sliding fits* are intended for the accurate location of parts which must assemble without perceptible play.

b. RC_2 *Sliding fits* are intended for accurate location, but with greater maximum clearance than class RC_1. Parts made to this fit move and turn easily but are not intended to run freely, and in the larger sizes may seize with small temperature changes.

c. RC_3 *Precision running fits* are about the closest fits which can be expected to run freely, and are intended for precision work at slow speeds and light journal pressures, but are not suitable where appreciable temperature differences are likely to be encountered.

d. RC_4 *Close running fits* are intended chiefly for running fits on accurate machinery with moderate surface speeds and journal pressures, where accurate location and minimum play is desired.

e. RC_5 and RC_6 *Medium running fits* are intended for higher running speeds, or heavy journal pressures, or both.

f. RC_7 *Free running fits* are intended for use where accuracy is not essential, or where large temperature variations are likely to be encountered, or under both these conditions.

g. RC_8 and RC_9 *Loose running fits* are intended for use where wide commercial tolerances may be necessary, together with an allowance, on the external member.

(2) Locational Fits (LC, LT, and LN): Locational fits are fits intended to determine only the location of the mating parts; they may provide rigid or accurate location, as with interference fits, or provide some freedom of location, as with clearance fits. Accordingly, they are divided into three groups: clearance fits (LC), transition fits (LT), and interference fits (LN).

a. LC *Locational clearance fits* are intended for parts which are normally stationary, but which can be freely assembled or disassembled.

They range from snug fits for parts requiring accuracy of location, through
the medium clearance fits for parts such as spigots, to the looser fastener fits where freedom of assembly is of prime importance.

b. LT *Locational transition fits* are a compromise between clearance and interference fits, for application where accuracy of location is important, but either a small amount of clearance or interference is permissible.

c. LN *Locational interference fits* are used where accuracy of location is prime importance, and for parts requiring rigidity and alignment with no special requirements for bore pressure. Such fits are not intended for parts designed to transmit frictional loads from one part to another by virtue of the tightness of fit, as these conditions are covered by force fits.

(3) Force Fits (FN): Force or shrink fits constitute a special type of interference fit, normally characterized by maintenance of constant bore pressures throughout the range of sizes. The interference therefore varies almost directly with diameter, and the difference between its minimum and maximum value is small, to maintain the resulting pressures within reasonable limits.

a. FN_1 *Light drive fits* are those requiring light assembly pressures, and produce more of less permanent assemblies. They are suitable for thin sections or long fits, or in cast-iron external members.

b. FN_2 *Medium drive fits* are suitable for ordinary steel parts, or for shrink fits on light sections. They are about the tightest fits that can be used with high-grade cast-iron external members.

c. FN_3 *Heavy drive fits* are suitable for heavier steel parts or for shrink fits in medium sections.

d. FN_4 and FN_5 *Force fits* are suitable for parts which can be highly stressed, or for shrink fits where the heavy pressing forces required are impractical.

(f) Fits for Common Mating Parts: Recommended fits for common mating parts are shown in Table 809-1.

Table 809-1
Recommended Fits for Common Mating Parts

Part	Fit	
	ABC	ISO
Shaft Journals	RC4	H8/f7
Journal Bushing	RC4	H8/f7
Split Bushing in Base	LC2	H7/h6
Solid Bushing in Base (≤ 0.25 inch wall (6 mm wall))	LN2	H7/p6
Solid Bushing in Base (> 0.25 inch wall (6 mm wall))	FN2	H7/s6
Hubs on Shafts	FN2	H7/s6
Hubs on Main Trunnions (≤ 10 inches diam. (254 mm diam.))	FN4	H7/u6
Hubs on Main Trunnions (> 10 inches diam. (245 mm diam.))	FN2	H7/s6
Turned Bolts in Finished Holes	LC2	H7/h6
Sliding Bearings	RC4	H8/f7
Keys and Key Ways (top and bottom)	LC2	H7/h6
Keys and Key Ways (sides)	FN2	H7/s6

(g)Surface Finishes: Surface finishes shall be in accordance with ANSI Standard B46.1. Recommended surface finishes for common machinery parts are shown in Table 809-2.

Table 809-2
Recommended Surface Finishes for Common Machinery Parts

Part	Finish	
	ABC (μin.)	ISO (μm)
Machinery Base on Steel	250	6.3
Machinery Base on Masonry	500	12.5
Shaft Journals	8	0.2
Journal Bushing	16	0.4
Split Bushing in Base	125	3.2
Solid Bushing in Base	63	1.6
Hubs on Shafts (≤ 2 inches/50mm bore)	32	0.8
Hubs on Shafts (> 2 inches/50mm bore)	63	1.6
Hubs on Main Trunnions	63	1.6
Turned Bolts in Finished Holes	63	1.6
Sliding Bearings	32	0.8
Center Discs	32	0.8
Keys and Key Ways	63	1.6
Machinery Parts in Fixed Contact	125	3.2
Teeth of Open Spur Gears:		
Under 1 inch circular pitch (Under 25mm module)	32	0.8
1 inch circular pitch to 1.75 inches circular pitch (25mm module to 44mm module)	63	1.6
Over 1.75 inches circular pitch (Over 44mm module)	125	3.2

809.11 TRUNNIONS, SHAFTS AND JOURNALS. Trunnions and shafts shall be made with fillets where abrupt changes in section occur.

Journals of trunnions and shafts shall be polished to ANSI 8 μin.(0.2 μm) surface finish after being machined. Fillets shall be polished to ANSI 63 μin.(1.6 μm) surface finish in the direction of turning. For trunnions and shafts more than eight inches (200 mm) in diameter, a hole approximately 1/5 the diameter of shaft or trunnion shall be bored lengthwise through the center.

809.12 COUPLINGS. Faces of flange couplings shall be planed to an ANSI 125 μin. (3.2 μm) surface finish and holes bored in pairs.

809.13 HUBS. Hubs of wheels, pulleys, gears and couplings shall be bored true to center for a medium drive fit upon their shafts or axles. Ends of hubs shall be finished as required.

809.14 BUSHINGS. Bushings shall be bored to fit the matching shaft or journal to within the tolerances specified.

The bearing housing shall be bored to fit the outside of the bushing. Contact edges of oil grooves and bushings shall be rounded.

Babbitt metal, when required shall be poured in the bearing in such a way that the thickness of the bushing after boring will be uniform.

809.15 BEARING HOUSING. Rubbing and bearing surfaces shall have an ANSI 16 μin.(0.4 μm) surface finish and the joints between cap and base of bearings shall have an ANSI 125 μin.(3.2 μm) finish. Holes in cap and base shall be drilled. Holes in bearings, for bolts fastening them to their supports, shall be drilled or reamed to size for turned bolts as required in Subsection 809.21. Holes in the supports shall be reamed to fit after bearings have been adjusted. Bearings shall be finished on both ends. Trunnion bearings shall be bored parallel with the base.

809.16 GEAR TEETH. Gear teeth transmitting power for operation of the bridge shall be machine cut. The periphery and ends of teeth shall be turned. The pitch circle shall be scribed on the teeth. Rack teeth may be either cast or cut and finished.

Open gears shall be fabricated to AGMA 390.03 standard and AGMA Gear Quality Number 6 or 7.

809.17 BEVEL GEARS. Bevel gear teeth shall be cut by a planer having a rectilinear motion in lines through the apex of the cone. Rotating milling cutters shall not be used for making bevel gears.

Open bevel gears shall be fabricated to AGMA 390.03 and AGMA Gear Quality Number 6 or 7.

809.18 WORMS AND WORM WHEELS. Threads on worms shall be machine cut and worm wheel teeth shall fit the worm accurately with surface or line contact.

Open worms and worm wheels shall be fabricated to AGMA 390.03 and AGMA Gear Quality Number 6 or 7.

809.19 MAIN DRIVE SPEED REDUCERS. The speed reducer units shall be manufactured in accordance with the requirements of the American Gear Manufacturers Association (AGMA) and shall carry the AGMA symbol on the nameplate. Reducers shall be rated for the minimum acceptable service factor shown on the plans or as recommended by the reducer manufacturer.

Speed reducer bearings shall be anti-friction type with a B-10 life of 40,000 hours. Gear quality shall be Class 7 and backlash shall meet AGMA standards based on center distance.

Lubrication of gears shall be oil immersion type. Provisions shall be made for filling, draining, and ventilating the housing and a sight gauge shall be mounted on the unit in a position where the lubricant level can be observed. Oil tight shaft seals and/or stuffing boxes shall be provided.

Reducer units shall be filled to fill plug level with synthetic oil as recommended by the reducer manufacturer.

The gear housing shall completely enclose the gears and shall be oil tight, gasketed, and removable.

809.20 KEY AND KEYWAYS. Keys shall be planed and keyways machine cut. Finish of keys and keyways shall give the key a locational clearance fit on the top and bottom and medium drive fit on the sides. Tapered keys shall bear on the top, bottom and sides; parallel faced keys on side only.

809.21 CASTINGS. Castings shall be cleaned and fins and other irregularities removed. Contact surfaces of castings to be attached to structural steel or other castings shall have an ANSI 250 μin.(6.3 μm) finish. Unfinished edges of bases, ribs and similar parts shall be neatly cast with rounded corners. Inside angles shall have proper fillets. Bosses shall be finished to the correct plane. Surfaces of castings in contact with masonry shall have an ANSI 2000 μin.(50 μm) finish.

809.22 BOLT HOLES, MACHINE BOLTS AND TURNED BOLTS. Holes for unfinished bolts 1/2 inch (13 mm) diameter or larger, inclusive, shall be drilled or reamed not more than 1/16 inch (2 mm) larger in diameter than the bolt. Holes for unfinished bolts less than 1/2 inch (13 mm) diameter shall be drilled or reamed not more than 1/32 inch (1 mm) larger in diameter than the bolt. Diameter of the shank of turned bolts shall be of such size as to make a locational clearance fit for the holed parts.

809.23 BRAKES AND BRAKE LININGS. Brake shoes or bands shall be made so as to bear uniformly on the brake wheel. Brake linings shall be attached to the shoes by copper rivets or approved bonding and in such manner as to be easily accessible for replacement.

809.24 RACK AND TRACK. In swing bridges, track segments shall be finished on the top and at ends to an ANSI 250 μin.(6.3 μm) finish. The track centerline shall be scribed on the surface.

Tooth segments forming the rack shall be fitted accurately and installed to AGMA 390.03 and AGMA Gear Quality Number 6 or 7. Care shall be taken to have the pitch of teeth at joints accurate and continuous. Tips of rack teeth shall be machine finished to a true circle. The pitch line shall be scribed on teeth.

Backs of racks which bear on metal surfaces and surfaces in contact with them shall be finished to an ANSI 1000 μin.(25 μm) finish. Surfaces which bear on masonry shall have an ANSI 2000 μin.(50 μm) finish.

809.25 PIVOT BEARING SEATS. Seats shall be finished to ensure a horizontal position of the span.

809.26 PIVOT BEARINGS. Discs for pivot bearings shall be fitted accurately, finished to gage and ground accurately to final finish. The sliding contact surface of steel and phosphor-bronze discs shall be given an ANSI 8 μin.(0.2 μm) finish. Disc centers shall be assembled, fitted accurately and match-marked.

When specified, rolling element bearings shall be furnished for the pivot. Rolling bearings shall be accurately fitted to the pivot jacket and top. The rotating parts shall be shop assembled and the alignments confirmed. The bearing pivot base and pivot top shall be shipped to the site as an assembly.

809.27 BALANCE WHEELS. The periphery and faces of balance wheels shall be turned to an ANSI 250 μin.(6.3 μm) finish, corners shall be rounded and the centerline of the balance wheels shall be scribed on the periphery. Hubs shall be bored accurately and faced on both ends.

809.28 PLANING GIRDERS. In-built track girders and segmental girders of rolling bascule bridges, the edges of webs, side plates and angles shall be given an ANSI 250 μin.(6.3 μm) finish.

809.29 TREAD PLATES AND TRACK SEGMENTS. Contact surfaces of tread plates and track segments shall be given an ANSI 250 μin.(6.3 μm) finish.

809.30 OIL OR GREASE GROOVES IN TRUNNION BEARINGS. Oil or grease grooves in trunnion bearing surfaces shall be machine cut. After machining, small imperfections may be removed by filing and honing. Grooves shall be smooth, especially the rounded corners.

809.31 BORING AND ASSEMBLY OF TRUNNION BEARINGS. Trunnion bearings to be mounted on flexible supports shall be so bored that when the trunnion girder or support deflects under full dead load, the axes of trunnions will be coincident.

Trunnions shall be fitted to their bearings in the manufacturer's shop. If they are to be disassembled for shipment, they shall be match- marked for field erection.

809.32 SHEAVES. Grooves in sheaves shall be turned. The shape of grooves shall conform as closely as feasible to the rope section so that while ropes run freely in the grooves, the sides of grooves shall prevent wire ropes from flattening under static loads, as when supporting counterweights. Segmental sheaves shall be completely assembled and, if of welded construction, shall be stress relieved before grooves are turned. Variation from required diameter shall not exceed 0.01 inch (25 μm).

Sheaves shall have a force fit on shafts up to and including 10 inches (250 mm), and a medium drive fit on shafts over 10 inches (250 mm).

Both ends of hub shall be finished as specified.

809.33 HOLES FOR SHEAVE BEARINGS. In vertical lift bridges, holes in girders and columns for bolts connecting main sheave bearings to their supporting members shall be drilled from the solid through cast iron or steel templates on which the bearings were set and accurately aligned when holes in the bearings are bored. Bolt holes and bolts shall be the same diameter. Bolts shall be driven in place without damage to bolts, bearings, girders or columns.

809.34 SHOP ASSEMBLY OF MACHINERY. When specified, machinery parts shall be assembled in the shop on their structural supports. They shall be aligned, adjusted and fitted in their correct relative positions and holes in structural supports shall be drilled to correctly match the holes in machinery parts. Parts shall be match-marked before disassembling and shall be erected in the field in the same relative positions.

When specified, the complete center of swing spans, including rack and track segments, shall be assembled in the shop and aligned, fitted, drilled and the parts match-marked. When specified, the complete gear train shall be assembled in the shop and subjected to a specified time run.

When assembling in the shop is not required, holes in structural supports shall be left blank to be drilled in the field after machinery parts have been set to correct alignment and adjustment or subpunched or drilled 1/4 inch (6 mm) smaller and reamed to size after erection.

Hydraulic power units shall be shop assembled. When specified, hydraulic system components shall be shop assembled into modules. Power units and modules shall be shipped to the bridge site as assemblies after testing. Power units and modules shall be tested in the shop and certified test data submitted to the Bridge Design Engineer. No hydraulic assemblies shall be shipped to the site without test data approval. The contractor shall submit to the bridge design engineer a test plan for approval 2 weeks before the anticipated test date. This submittal shall also serve as notification of the test so that the department may provide an inspector. This inspection shall be at the option of the Department and does not relieve the contractor of any of responsibilities in the contract.

809.35 HYDRAULIC PIPING. Inside of the hydraulic piping shall be bright, clean and free from grease, drainage compounds, oxide, scale and carbon deposits. Any pipe which has been pickled to remove scale shall be treated to eliminate pickle brittleness. The inside of the pipe shall then be coated with clean oil and ends of the pipe sealed for protection against corrosion during shipment and storage. The corrosion preventive oil used shall be such that after extended storage periods, it can be readily removed with an alkaline cleaning solution. Welding of hydraulic pipe shall comply with Section 815.

Hydraulic fluid shall be as specified on the plans. Hydraulic fluid shall be filtered whenever added to the system either for tests, addition of make-up fluid, or original and final system filling. The degree of filtration shall be as specified on the plans.

809.36 PROTECTION OF MACHINERY, POWER PLANT AND TRAFFIC BARRIER PARTS DURING SHIPMENT. Finished rubbing and bearing surfaces of machinery and traffic barrier parts shall be given a protective coating before shipment. Bearing surfaces of trunnions, heavy

axles and shafts, in addition to the protective coating, shall be protected by wood lagging securely attached.

Bearing surfaces of other shafts, axles and similar parts shall be covered with burlap or other satisfactory protecting material. Small machinery and traffic barrier parts shall be boxed or crated.

Electrical equipment and apparatus shall be protected by boxes or crates. Electric motors not designed to be operated fully exposed to the weather shall be protected by waterproof coverings.

Hydraulic equipment fluid ports shall be securely sealed prior to shipment and shall remain sealed until final assembly of the hydraulic system. Seals shall not be removed until just before the connection of components.

Modular and power unit components shall be properly supported to prevent damage to flanged joints.

809.37 ERECTION.

(a) Position of Span During Erection: Movable bridges may be erected in either the open or closed position, as approved by navigation authorities and the engineer.

(b)Protection of Machinery, Operator House and Traffic Barrier Parts During Erection: Parts that are protected from weather in the completed structure or during shipment from the shop shall also be protected during unloading, field storage and erection. Care shall be exercised in protecting electrical parts. Wire ropes shall be stored above ground and free from conditions likely to produce corrosion of wires or decay of fiber cores. While being unwound or otherwise handled during installation, wire ropes shall not be kinked or bent to short radius curves nor dragged over stones, rough metal surfaces or other material likely to produce abrasions on exposed surfaces of the wires.

(c) General Requirements for Machinery and Traffic Barrier Erection: Alignment and adjustment of machinery, electrical equipment and traffic barriers shall be done by skilled mechanics. Trunnion bearings and important shaft bearings shall be set using piano wire or optical methods to determine their correct adjustment. Alignment of the gear train shall be in accordance with AGMA 390.03.

Shims shall be of sheet steel and brass shim stock. The contractor shall have a supply of shims varying in size and thickness with a minimum thickness of 0.003 inch (75 μm). Shims shall be used for aligning and adjusting machinery to its proper place prior to securing it rigidly in position

with bolts or other fastenings. Brass shim stock shall be used for final adjustment. All shims shall be sized to provide full bearing.

Flanges on hydraulic systems shall be welded so that there is no visible deviation from the normal to the pipe axis.

Bolted flange connections on hydraulic piping systems shall be evenly assembled by use of feeler gauges and torque wrenches to ensure equal bolt tightening.

Minor pockets and depressions formed as a result of erection and which may collect moisture or oil shall be drained provided that none of the parts drained are weakened by the drainage openings.

(d)Lubrication: Rotating and sliding parts shall be thoroughly lubricated during erection. All parts shall be properly lubricated before operating machinery is tested. Counterweight and operating ropes shall be given one coat of an approved lubricant.

(e) Camber, General Requirements: When movable bridges are being erected, care shall be taken to set camber blocking to the necessary heights, so that the span will be assembled to proper camber curves when structural parts are unstressed. When the camber blocking is struck and spans swung, all joints shall be 100 percent pinned and bolted so that no slippage will occur at connections.

(f) Camber for Swing Spans: When swing spans are erected on camber blocking, blocking shall be set to such elevation as to fulfill the requirements of the plans.

(g)Alignment of Bascule Leaves: Trusses or girders of a bascule span erected in an open position shall be held to correct alignment and position with struts, braces and guys. When required, punching of laterals shall be left blank until the bridge is lowered to permit adjustment of alignment to ensure correct closing and locking.

(h)Alignment and Trunnion Bearings: When full deflection of trunnion girders or bearing supports occur under full dead load, the axes of trunnions shall be coincident.

(i) Alignment of Vertical Lift Spans: Towers and guides shall be vertical when the dead load of the span and counterweight has been applied.

(j) Pressure Testing of Hydraulic Piping Systems: Hydraulic piping systems, after installation but before connection to power units and assemblies, shall be pressure tested in accordance with the plans.

(k) Testing and Adjusting of the Moving Span Operation: The contractor shall test and adjust the moving span operation according to the

procedures set forth on the plans. These tests shall not take place until the moving span is completely constructed and all installation and testing of the individual electrical and mechanical components have been completed.

The contractor shall provide qualified technicians familiar with the mechanical and electrical systems to be tested and fully capable of making the required adjustments. The contractor shall provide the necessary tools, equipment, and measuring devices needed to perform the systems testing and adjusting.

After final adjustments are completed service test of power operation of the span shall be made by moving the span through a number of complete open and close cycles. The number of cycles required will be determined by the engineer. These cycles of movement shall be executed in succession without intervals of rest between them. Defects in the operation of the span shall be corrected.

After completion of the final tests of hydraulic systems, the hydraulic fluid shall be removed, properly discarded, replaced with new fluid, in-line filter elements replaced and air bled from the entire system.

(l) Barriers: Vertical lifting barriers shall be balanced to provide a counterweight heavy condition throughout the entire travel.

(m) End Lifts for Hydraulic Swing Spans: The final grade of the approach slab shall not be set until the end lift mechanism has been tested and determined to be capable of lifting the moving span to the desired final grade elevation under the conditions set forth in the plans. Adjustments in the approach slab may be required if the mechanism proves incapable of working to the nominal elevation.

809.38 COUNTERWEIGHTS. Counterweights shall be sufficient to balance the moving span and its attachments in any position, except that on vertical lift bridges, balancing for the counterweight ropes may not be required.

Counterweights shall be made adjustable so that variations in the weight of the movable span may be easily provided by adding or taking off concrete or cast iron blocks in properly located pockets. Blocks weighing not over 100 pounds (45kg) each shall be used. They shall be provided with eye or ring bolts to facilitate handling. Space for 5 percent under and over the calculated weight (mass) shall be provided. Movable blocks shall be provided as specified. Pockets shall be provided with drain holes at least 6 inches (150 mm) in diameter. If counterweights of bascule and vertical lift bridges are located above the floor of approaches, the vertical clearance between

counterweights and the floor, curbs, sidewalks or handrails shall not be less than 2 1/2 feet (750 mm) when the bridge is fully open including any over travel. In calculating the minimum clearance, counterweight ropes shall be assumed to stretch 2 percent of their calculated length.

Concrete for counterweight and adjusting blocks shall be Class A, complying with Section 901 weighing approximately 145 pounds per cubic foot (2300kg/cu m). Steel punchings or bulk metal may be used. To increase the relative unit weight (mass) of the counterweight concrete to a maximum of 315 pounds/cubic foot (5000kg/cu m). Such a mixture shall not be used, unless retained in place by surrounding steel box or by walls of reinforced concrete.

The structural steel fabricator shall determine the weight (mass) and when it is necessary, location of the center of gravity of the moving span, including all parts attached thereto, and of the counterweights, including their frames. These determinations shall be based on weights (mass) computed from approved shop plans and shall include structural steel, machinery, flooring and everything attached to movable parts of the bridge. The adjustment pocket of counterweights is to be assumed 1/2 full when determining the size of counterweights. The contractor shall submit to the Bridge Design Engineer for approval, calculations for determining the weight (mass) of concrete for counterweights.

Determination of the proper mixture for counterweights to give the desired unit weight (mass) is especially important. A series of tests shall be made well in advance of the time that placing of concrete is to begin to determine the unit weight of concrete which can be obtained from the materials at hand. Test blocks containing at least 1 cubic foot (0.03 cu m) shall be made and a record kept showing the weight (mass) of the blocks when cast and when 1, 2, 3 and 7 days old and continuing until the weight stabilizes. The engineer shall be notified at least 3 days prior to casting of test blocks. The casting and weighing of blocks shall be done in the presence of the engineer. This record of test blocks shall be submitted for the engineer's approval before concreting is to begin. These tests shall be made by the contractor in time to have the information available for the fabricator by the time the latter is ready to detail counterweights.

The contractor shall furnish the engineer and fabricator with the unit weight (mass) of materials used in the deck. The determination of unit weights (mass) shall be made by actually weighing samples of these materials. If the floor is concrete, test blocks shall be made as outlined above to determine the unit weight (mass) of the deck slab as constructed.

The contractor shall be responsible for the correctness of the center of gravity calculations and for the detailed drawings of counterweights and construction of counterweights of correct unit weight (mass) so that the completed bridge will be in proper balance. The contractor shall be responsible for the balancing of the bridge and shall make necessary adjustments and alterations required to obtain proper balance.

809.39 POWER PLANT. The power plant shall comply with the requirements for Electrical Systems in Section 730.

809.40 OPERATING AND MACHINERY HOUSES. The operating house and machinery house shall be constructed in accordance with the plans. Necessary parts of fittings not shown or specified shall be furnished by the contractor at no direct pay.

809.41 MEASUREMENT.

(a) Movable Bridge Machinery: Movable bridge machinery will be measured on a lump sum basis, which includes all gears (including gears for operating limit switches), shafts, couplings, bearings, castings, wedges, wedge bases, latches, speed reducers, lubricating system, center pivots, racks and tracks for swing spans, bearing discs, balance wheels, trunnions and trunnion bearings, pins, sleeves, sheaves, wire ropes and their sockets and socket pins, bolts, screws, bolts and nuts connecting machinery parts to structural steel, castings which form an integral part of machinery, winding drums, tread plates and castings for segmental girders and track girders for rolling lift spans and their connecting bolts, pistons and cylinders, eccentrics, pinions, ring gears, racks, clutches, brakes other than electrical brakes, rollers, valves, locks, toggles, crank arms, cranks, axles, hooks, bearing liners, wrenches, springs, manually operated roadway traffic gates, mechanically operated position indicators and all other parts and fittings necessary for the satisfactory operation of the bridge which require machine shop work and which are not included in any other class, and all items classified as "Movable Bridge Machinery" on the plans.

(b)Traffic Barriers: Traffic barriers will be measured on a lump sum basis, which includes furnishing all materials and erecting the traffic barriers.

(c) Power Plant: The power plant will be measured on a lump sum basis in accordance with Electrical Systems in Section 730.

(d)Operating House: The operating house will be measured for payment on a lump sum basis, which includes all obviously necessary parts of

the house, including furniture and cabinets. If the house is supported on piling, the piling will be measured as provided in Section 804.

(e) Machinery Houses: Machinery houses will be measured for payment on a lump sum basis, which includes all obviously necessary parts of the houses.

(f) Counterweights: Class A concrete in counterweights will be measured by the cubic yard (cu m) in accordance with Subsection 805.17.

Deformed reinforcing steel or structural steel used in counterweights will be measured as provided in Subsections 806.09 and 807.53.

809.42 PAYMENT. Payment for machinery, traffic barriers, operating house and machinery houses will be made at the lump sum contract prices.

Payment for concrete, reinforcing steel or structural steel used in counterweights will be made as provided in Subsections 805.18, 806.10 and 807.54. Payment for power plant will be made as provided for Electrical System in Subsection 730.09.

Payment will be made under:

Item No.	Pay Item	Pay Unit
809-01	Movable Bridge Machinery	Lump Sum
809-02	Traffic Barriers	Lump Sum
809-03	Operating House	Lump Sum
809-04	Machinery Houses	Lump Sum

Section 810
Bridge Railings and Barriers

810.01 DESCRIPTION. This work consists of furnishing and constructing bridge railings and barriers.

810.02 MATERIALS. Materials shall comply with Section 1012.

810.03 CONSTRUCTION, FABRICATION, ERECTION AND PAINTING. All construction, fabrication, erection and painting shall conform to Sections 805, 806, 807 and 811 as modified herein.

After completing the deck pour, a minimum of 3 days shall elapse or concrete in the deck slab shall attain a minimum compressive strength of 1,600 psi (11 MPa) before placing of reinforcing steel and forms for concrete railings. The deck slab shall attain a minimum compressive strength of 3,500 psi (24.1 MPa) before pouring concrete railings. Compressive strength cylinders shall be made in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230. The use of curing compounds will not be permitted on concrete railings.

Slip-formed concrete will be permitted, subject to the following provisions. Sliding forms shall be rigidly held together to prevent spreading of forms, and after passing there shall be no noticeable slumping of concrete. Concrete shall be held at a uniform consistency, having a slump of 1/2 inch to 1 1/2 inches (13 mm to 40 mm). The contractor's proposed slip-form procedures and equipment shall be approved prior to beginning slip-form concrete placement, and the contractor will be required to make a dry run with the paving machine prior to placement. If the contractor elects to saw the intermediate open joints in the railing, the joint width may be reduced from 1/2 inch (13 mm) to 1/4 inch (6 mm). Joint widths at expansion joints shall match plan dimensions. Joint sawing shall begin as soon as the concrete has reached strength such that tearing and raveling of the concrete does not occur. If, in the opinion of the engineer, the slip-form operation fails to produce satisfactory results, the contractor shall immediately discontinue slip-form operations, shall replace or satisfactorily repair the unacceptable concrete, and shall complete the work using conventional forming methods.

810.04 LINE AND GRADE. Line and grade of the top of the railing or barrier shall be true to that shown on the plans and shall not follow any unevenness in the superstructure. Barrier, railing and curbs shall be normal to roadway cross slope and grade.

810.05 EXPANSION JOINTS. Expansion joints shall be so constructed as to permit freedom of movement. After the work is completed, loose or thin mortar likely to spall under movement shall be removed.

810.06 PLACING RAILING. Concrete barrier or railing shall not be placed until falsework for the span has been released, and the span is self-supporting. On continuous spans, railing or barriers shall not be placed until the deck of the continuous unit is completed.

810.07 METAL RAILING. Metal railing shall be adjusted prior to its being fixed in place to ensure proper matching at abutting joints and correct alignment and camber throughout its length. Holes for field connections shall be drilled with the railing in place on the structure at proper grade and alignment.

810.08 MEASUREMENT. Quantities of railings and barriers for payment will be the design lengths as specified on the plans and adjustments thereto. Design quantities for railing include all work constructed above the roadway curb, sidewalk or sidewalk curb. Design quantities of barriers include all work constructed above the roadway. Design quantities will be adjusted if the engineer makes change to adjust to field conditions, if plan errors are proven, or if design changes are made.

Reinforcing steel and hardware for railings and barriers will not be measured for payment.

810.09 PAYMENT. Payment for railing and barriers will be made at the contract unit price per linear foot (lin m), subject to the following provisions.

Payment for concrete railing will be made on a lot basis. A lot will be a completed unit or an identifiable pour that is completed in one day.

Payment for each lot will be subject to adjustments in accordance with Table 901-5 and Note 1.

Payment will be made under:

Item No.	Pay Item	Pay Unit
810-01	Concrete Railing (Type)	Linear Foot (Lin m)
810-02	Steel Railing	Linear Foot (Lin m)
810-03	Pipe Railing	Linear Foot (Lin m)
810-04	Steel and Concrete Railing	Linear Foot (Lin m)
810-05	Pipe and Concrete Railing	Linear Foot (Lin m)

Section 811
Painting and Protective Coatings

811.01 DESCRIPTION. This work consists of furnishing and applying paints and other protective coatings, including preparation of surfaces.

Unless otherwise specified, an approved Zinc Paint System shall be used for coating metal surfaces requiring painting.

The QPL paint system to be used must be shown on shop or working drawings.

Metal surfaces to be painted shall be cleaned in accordance with the Near-White Blast Cleaning Method described in Subsection 811.06(b).

811.02 SAFETY STANDARDS. The contractor shall comply with Federal, State and local laws, rules and regulations concerning construction safety and health standards and all requirements of Section 107. Appropriate respiratory protective devices shall be provided by the contractor and shall be used. Respiratory equipment, including hood type respirator with external air supply to hood, shall meet the approval of the U.S. Bureau of Mines.

811.03 MATERIALS. All paints shall be in accordance with the requirements of Section 1008.

(a) Three-Coat Waterborne Paint System (two primers and one topcoat): The Three-Coat Waterborne Paint System shall comply with Subsection 1008.02. The contractor has the option of using any system on the QPL; however, no modification or combining of systems will be permitted and the same system shall be used throughout the project.

(b) The Coal Tar Epoxy-Polyamide Paint System shall comply with Subsection 1008.04.

(c) Cold galvanizing repair compound shall comply with Subsection 1008.05.

(d) Corrosion Inhibiting Alkyd Paint shall comply with Subsection 1008.06.

(e) Zinc Paint Systems for New Steel and 100 Percent Bare Existing Steel: The zinc paint system shall be an approved system listed on QPL 78. Each system shall be tested in accordance with AASHTO R 31 and meet the requirements of Subsection 1008.07. The contractor has the option of

using any one of these systems; however, no modifications or combinations of the systems will be permitted and the same system shall be used throughout the project.

811.04 PAINTING METAL. All metal surfaces shall be painted unless painting would interfere with proper operation of movable metal parts.

When field welded connections are required, areas to be welded shall be masked before shop painting of members and painted after welding.

Control desks and switchboards shall be painted as described on the plans. Equipment mounted on control desks and switchboards shall not be painted.

When required, galvanized or metallized surfaces of sheet metal, electrical conduit, and water, air and gas pipes that are exposed and visible shall be painted. Other galvanized or metallized surfaces shall not be painted unless otherwise specified.

Metal surfaces to be encased in concrete shall be painted with a minimum of one prime coat. Painting of aluminum surfaces will not be required.

(a) Three-Coat Waterborne Paint System: The minimum dry film thickness of coatings shall be as follows:

1st Prime Coat	3.0 mils (75 μm)
2nd Prime Coat	3.0 mils (75 μm)
Topcoat	3.0 mils (75 μm)

Color contrast in the two prime coats shall be provided by the differences in the wet coating and the dried coating.

(b)Coal Tar Epoxy-Polyamide System: The minimum dry film thickness of coatings shall be as follows:

1st Coat	8.0 mils (200 μm)
Final Coat	8.0 mils (200 μm)

(c) Corrosion Inhibiting Alkyd Paint System: Corrosion Inhibiting Alkyd Paint shall be a non-polluting pigmented alkyd paint to be used in a three-coat paint system on properly prepared structural steel surfaces to be permanently exposed. The contractor has the option of using either System A or System B, however, whichever system is selected shall be used on the entire project. The primer and intermediate coats shall be tinted for color contrast.

The minimum dry film thickness of the coatings shall be as follows:

Prime Coat	- 2.0 mils (50 µm)	
Intermediate Coat	- 2.0 mils (50 µm)	
Aluminum Topcoat	- 2.0 mils (50 µm)	- AASHTO M69, Type I

(d) Zinc Paint Systems for New Steel and 100 Percent Bare Existing Steel: The specified dry film thickness of coatings shall be as published in QPL 78.

811.05 WEATHER LIMITATIONS. Paint shall be applied on thoroughly dry surfaces and during periods of favorable weather with the relative humidity being below 85 percent. Painting will not be permitted when any of the following conditions occur: the surface temperature is less than 5°F (3°C) above the dew point, the wind velocity is 15 mph (25 km/h) or higher, or the ambient air temperature is below 50°F (10°C) in the shade and away from artificial heat except as provided in this subsection for enclosures. Paint also shall not be applied unless the surface temperature of the metal is at least 45°F (7°C) and rising, and shall not exceed manufacturer's recommendations or be hot enough to cause the paint to blister and produce a porous paint film, whichever is less.

When fresh paint is damaged by the elements, it shall be replaced by the contractor at no direct pay.

Subject to approval in writing, the contractor may provide and maintain suitable enclosures to permit painting during inclement weather at no direct pay. Provisions shall be made to control atmospheric conditions inside the enclosure within limits suitable for painting throughout the painting operation. When painting operations inside an enclosure result in a humidity increase above 85 percent, airflow through the enclosure shall be suitable to maintain the relative humidity to below 85 percent throughout the painting operations.

811.06 CLEANING OF SURFACES.

(a) General: Metal surfaces to be painted shall be abrasive blast cleaned in accordance with Heading (b) and shall produce an anchor pattern from 1 to 3 mils (25 to 75 µm).

Surfaces that are to be galvanized may be either chemically cleaned by emersion (sequence of caustic cleaning, water rinse, acid pickling and water rinse) or a combination of blast and chemical cleaning.

When steel abrasive blasting is used, the abrasive mixture shall have a minimum of 25 percent by volume of approved grit material. Grit size shall be SAE G-25 with a minimum hardness of 45, Rockwell "C" Range.

Surfaces of a casting shall be blast cleaned before the casting is machined.

Weld spatter and other undesirable materials shall be removed and sharp edges ground smooth prior to blast cleaning. All abrasive blasting equipment shall be equipped with an oil/moisture trap with replaceable cartridges (filters) located between the air supply and the pressure pot.

(b)Near-White Blast Cleaning Method: This method prepares metal surfaces for painting or coating by the use of abrasives propelled through nozzles or by centrifugal wheels.

(1) Definition: The near-white cleaned surface is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides or slight and tight residues of paint or coating. At least 95 percent of each square inch (1000 sq mm) of surface area shall be free of visible residues and the remainder shall be limited to the light discoloration mentioned above.

(2) Procedures: Near-White Cleaning shall be in accordance with SSPC-SP 10 with the following modifications. Rate of blast cleaning may vary from one area to the next to achieve the desired pattern. The use of recycled steel abrasive blasting materials will be permissible, provided anchor pattern requirements are met and adhesion is not compromised. Blast cleaned surfaces shall be painted before rusting occurs, preferably within 8 hours after blasting. Blast cleaned surfaces shall be painted the same day or reblasted. Occurrence of rusting after cleaning shall be cause for recleaning by blasting or other cleaning methods as directed.

(3) Safety Precautions: Safety precautions shall be in accordance with SSPC-SP 10.

(c) Commercial Blast Cleaning Method: This method prepares metal surfaces for painting by the use of abrasives propelled through nozzles or propelled by centrifugal wheels.

(1) Definition: The commercial blast cleaned surface is defined as one from which all oil, grease, dirt, rust scale and foreign matter have been completely removed from the surface and all rust, mill scale and old paint have been completely removed except for slight shadows, streaks or discolorations caused by rust stain, mill scale oxides or slight, tight residues of

paint or coating that may remain; if the surface is pitted, slight residues of rust or paint may be found in the bottom of pits; at least 2/3 of each square inch (1000 sq mm) of surface area shall be free of visible residues and the remainder shall be limited to the light discoloration, slight staining or tight residues mentioned above.

(2) Procedures: Procedures for Commercial Blast Cleaning shall be in accordance with SSPC-SP 6. Blast cleaned surfaces shall be painted before rusting occurs. Blast cleaned surfaces shall be painted the same day or be reblasted.

(3) Safety Precautions: Safety precautions shall be in accordance with SSPC-SP 6.

(d)Compressed Air Cleaning: Prior to the application of paint, blast cleaned surfaces shall be cleaned of excess abrasive using compressed air that has been filtered by an approved oil/moisture trap.

811.07 PROTECTION OF THE PUBLIC AND WORK. The contractor shall protect the public and all parts of the work against disfigurement by spatters, splashes and smirches of paint materials and damage caused by surface preparation. The contractor shall be responsible for damage caused by the contractor's operations to vehicles, persons or property, including plants and animals. The contractor shall provide protective measures to prevent such damage.

Paint stains which result in an unsightly appearance shall be removed or obliterated by the contractor at no direct pay.

When traffic causes an objectionable amount of dust, the contractor shall alleviate the dust for the necessary distance on each side of the work and take other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before paint is applied.

811.08 APPLICATION. Primers and top coat shall be applied at the specified minimum film thickness. Where members are found low in film thickness for either primer or top coat, the entire member shall be recoated. The contractor shall exercise the necessary controls to eliminate laps, sags, over spray patterns and other undesirable characteristics.

Measurement of dry film thickness shall be made in accordance with SSPC-PA 2.

(a) Three-Coat Waterborne Paint System: Primer and topcoat paint shall be applied with airless or conventional spray equipment. The spray

equipment shall apply paint in a fine, even spray. If thinning of paint is allowed, it shall be done in accordance with the paint manufacturer's recommendations but in no case shall exceed 10 percent. An approved oil/moisture trap shall be placed between air supply and pressure pot, and regulators and gages shall be provided for both air supply and pressure pot. Fluid pressure shall be regulated to deliver a uniform and wet coat of material from the spray gun.

On surfaces inaccessible to spray equipment, paint shall be applied with brush or approved daubers to ensure coverage.

(1) Primer: Primer for new steel shall be applied after fabrication and the two prime coats shall be applied at the shop.

Each primer coat shall be cured at least 24 hours before the next coat of primer or topcoat is applied. The curing times shall be the cumulative time that the ambient air temperature is 50°F (10°C) or above.

Before application of subsequent coats of paint, all surfaces shall be cleaned of any dirt, dry spray, overspray, or other residue. A 72 hour curing time will be required for steel painted at the shop before it can be handled for shipment.

(2) Field Spot Painting: Damaged areas or other surfaces to be field primed or painted shall be blast cleaned in accordance with Subsection 811.06(b) or power tool cleaned to bare metal in accordance with SSPC SP11 and painted with the approved primer and/or topcoat to a minimum dry film thickness of 6.0 mils (150 μm) for primer and 3.0 mils (75 μm) for topcoat. Primer shall be allowed to cure 24 hours prior to application of topcoat.

(3) Topcoat: Unless otherwise specified, topcoat paint for new steel shall be applied after field erection, field spot painting and cleaning of primer surfacing.

Dust film, dry spray, overspray or other residue shall be removed prior to painting. The use of sand paper for cleaning is acceptable, provided the minimum dry film thickness of primer remains.

(b) Coal Tar Epoxy-Polyamide System: Coal tar epoxy-polyamide paint shall be applied in accordance with the paint manufacturer's recommendations. Recoat time shall be in accordance with manufacturer's recommendations, but in all cases, the application of the second coat shall be within 24 hours unless cold temperatures have affected the cure of the first coat.

(c) Zinc Paint Systems for New Steel and 100 Percent Bare Existing Steel: Each coat of paint shall be applied with airless or conventional spray equipment. The spray equipment shall apply paint in a

fine, even spray. If thinning of paint is allowed, it shall be done in accordance with the paint manufacturer's recommendations, but in no case shall exceed 10 percent. An approved oil/moisture trap shall be placed between air supply and
pressure pot. Fluid pressure shall be regulated to deliver a uniform and wet coat of material from the spray gun.

On surfaces inaccessible to spray equipment, paint shall be applied with brush or approved daubers to ensure coverage.

(1) Primer (Shop Primer): Primer for new steel shall be applied after fabrication with one coat of the inorganic zinc paint applied at the shop. The dry-to-handle curing time shall be based on the temperature and relative humidity requirements of the manufacturer's product data sheet curing schedule. A 72 hour curing time will be required for steel painted at the shop before it can be shipped.

(2) Field Painting: Primer for existing steel and damaged areas of newly erected steel with a shop primer coat of inorganic zinc paint shall be applied after the steel is blast cleaned in accordance with Subsection 811.06(b) or power tool cleaned to bare metal in accordance with SSPC SP11 with an approved organic zinc paint system listed on QPL 78. Each coat of paint shall be applied in accordance with the dry film thickness requirements listed on QPL 78 and allowed to cure in accordance with temperature and relative humidity requirements of the manufacturer's product data sheet curing schedule.

(3) Intermediate Coat and Topcoat: Unless otherwise specified, intermediate coat and topcoat paint for new steel shall be applied after field erection, field spot painting and cleaning of primer surfacing. Dust film, dry spray, overspray or other residue shall be removed prior to painting. The use of sand paper for cleaning is acceptable, provided the minimum dry film thickness of primer remains.

811.09 SHOP PAINTING.

(a) Surfaces to be Painted: When fabrication and cleaning are completed, surfaces not painted during assembly shall be painted with one coat of the specified paint before damage occurs to the cleaned surface from weather or other exposure. Shop and field contact surfaces shall be prepared as specified in Subsection 807.21(e). Where paint would be detrimental to field welding operations, the surface shall not be shop painted within a suitable distance from edges to be welded or spliced.

(b)Erection Marks: Erection marks shall be painted on surfaces with a compatible paint of contrasting color.

(c) Loading: Material shall not be loaded for shipment until paint is dry and cured in accordance with Subsection 811.08(a)(1).

(d)Inaccessible Surfaces: Surfaces not to be in contact, but which will be inaccessible after assembly or erection, shall receive the complete paint system prior to assembly or erection.

(e) Machine Finished Surfaces: With the exception of abutting chord and column splices, rocker shoes and bases, and column and truss shoe bases, machine finished surfaces shall be coated with an approved protective coating as soon as practical after being accepted and before removal from the shop. Surfaces of iron and steel castings which are machine finished for the purpose of removing scales, fins, blisters or other surface deformations shall be painted with the specified paint system.

(f) Pins and Pin Holes: Pins and pin holes shall be given a coat of an approved protective coating. The protective coating shall be removed and replaced with a graphite coating prior to erection.

811.10 FIELD PAINTING. As soon as surfaces have been cleaned to the satisfaction of the engineer, heads of field rivets and bolts and any surfaces from which the shop coats of paint have been worn off or have otherwise become defective shall be covered with two coats of the same paint used in the shop in accordance with Subsection 811.08(a)(1). When the paint applied for touching up rivet or bolt heads and abraded surfaces has dried, the field coat may be applied. No coat shall be applied until the previous coat has dried throughout the full thickness of paint film.

The field coat of paint shall not be applied to the steel work below the highway floor level until the concrete roadway slab and concrete barrier railings have been completed and metalwork cleaned. If concreting operations have damaged the paint, the surface shall be cleaned and spot primed as directed.

During pouring of decks and concrete barrier railings, the contractor shall keep steel members clean by washing and shall remove any materials that adhere to the surface and mar the finish of the steel members.

When weathering steel is used for structural members such as bridge girders, the ends of the members shall be painted for a distance of 1.5 times the member depth. The paint color shall match the oxidized color of the weathered steel after two years of weathering. Brown pigment, federal color

#30045, shall be added to the topcoat of the paint system being applied to the ends of the member.

811.11 PAINTING LUMBER AND TIMBER. Lumber and timber requiring painting shall be satisfactorily cleaned and painted with three coats of
the specified paint. If not specified, the paint to be used will be selected by the engineer. Treated timber to be painted shall be processed in accordance with Subsection 1014.04(c).

All applicable requirements of this section shall apply to the painting of lumber and timber.

811.12 GALVANIZING. The following criteria shall be properly controlled and shall meet standards that are satisfactory for the galvanizing process.

1. Defects arising from fabrication
2. Thickness and uniformity of coating
3. Adherence of coating
4. Appearance
5. Embrittlement

Handling, stacking, transporting and erecting galvanized parts shall be done in such manner as to protect the coating and its appearance.

Galvanized parts shall be assembled with nonabrasive equipment.

Drip holes shall be satisfactorily plugged.

Galvanizing of products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips, 1/8 inch (3 mm) thick and heavier, shall comply with ASTM A 123. Galvanizing shall be performed after fabrication into the largest practical sections. Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, bending, welding and riveting. Components of bolted assemblies shall be galvanized separately before assembly. When it is necessary to straighten sections after galvanizing, such work shall be performed without damage to the zinc coating.

Galvanizing of iron and steel hardware shall comply with ASTM A 123 and A 153 or shall be accomplished by an approved mechanical galvanizing method complying with ASTM B 695 that provides the same thickness of coating. Galvanizing shall be performed after fabrication of hardware.

Components of bolted assemblies shall be galvanized separately before assembly.

Galvanized surfaces that are abraded or damaged after application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing loose and cracked coating, after which the cleaned areas shall be repaired by application of an approved cold galvanizing repair compound. Zinc coating by the metallizing process may be allowed when approved.

The galvanizer shall utilize all of the options available to prevent "white rust" from occurring. However, should "white rust" occur and in the opinion of the engineer it is excessive or unsightly it shall be cause for rejection. Should rejection of the product occur, the galvanizer or contractor shall have prior approval before taking any corrective action.

811.13 METALLIZING OF METAL PARTS AND SURFACES. When specified, metallizing shall be performed in accordance with AWS C 2.2 and thickness of the sprayed zinc coat shall be a minimum of 5 mils (125 μm). The method of applying the zinc coating shall be approved prior to application.

811.14 MEASUREMENT AND PAYMENT. No measurement or payment will be made for painting or any protective coating.

Section 812
Treated Timber

812.01 DESCRIPTION. This work consists of furnishing lumber of the sizes and grade specified and of furnishing timber of the stress-grade, sizes and dimensions for the different uses specified, treated, and of preparing, framing, assembling and erecting the same, including painting where specified, and all hardware. Unless otherwise specified, all timber shall be treated.

812.02 MATERIALS. Materials shall comply with the following Subsections:

Castings	1013.05(a), 1013.06(a)
Structural Timber and Lumber	1014.01
Preservatives	1014.03
Treatment	1014.04
Connectors	1018.07
Hardware and Structural Shapes	1018.08
Roofing Pitch	1018.13

812.03 SPECIES OF WOOD.

(a) Permanent Structures: Timber and lumber used in permanent bridges, bridge fenders and bulkheads may be either Douglas Fir or Southern Yellow Pine, provided the same species is used throughout each structure, except in bridge structures as hereinafter provided.

Caps and stringers for bridges may be either fir or pine; however, all caps and stringers furnished for any structure shall be the same species.

(b)Temporary Structures: Temporary bridges shall conform to Section 725. All other temporary structures may be any satisfactory species and grade of timber.

812.04 STORAGE OF MATERIAL. Lumber and timber stored on the site shall be kept in orderly stacks. Material shall be openstacked on supports above ground, and shall be so stacked and stripped as to permit free circulation of air between tiers and courses. When directed, protection from the weather by suitable covering will be required.

812.05 TIMBER.

(a) Workmanship: Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them.

(b)Surfacing: Lumber and timber, except bulkhead planks and sway bracing, shall be S4S.

(c) Handling: Treated timber shall be handled with rope slings, without dropping or breaking of outer fibers, bruising, or penetrating the surface with tools.

(d)Framing and Boring: Cutting, framing and boring of treated timber shall be done before treatment insofar as practical. When treated timber is to be placed in water infested by marine borers, untreated cuts, borings or other joint framings below highwater elevation shall be avoided.

(e) Installation of Timber Connectors: The split ring and the shear plate shall be installed in precut grooves of dimensions as specified or as recommended by the manufacturer. The toothed ring and the spike grid shall be forced into contact surfaces of the timbers joined by means of pressure equipment. Connectors of this type at a joint shall be embedded simultaneously and uniformly. Fabrication of structures using connectors shall be done prior to treatment.

Timber, after fabrication, shall be stored in a manner, which will prevent changes in dimensions of members before assembly.

Dimensions of materials and details not specified shall be subject to approval.

(f) Cuts and Abrasions: Cuts and abrasions in creosoted piles or timbers, after having been carefully trimmed, shall be covered with two applications of creosote complying with Subsection 1014.03(e) and covered with hot roofing pitch.

Cuts and abrasions in timber treated with other preservatives shall be repaired with the same preservative.

(g)Bolt Holes: Holes bored in pressure-treated material shall be filled with preservative. Unused bore holes and spike holes shall be poured full of preservatives and plugged with tight-fitting treated plugs.

(h)Temporary Attachment: When, with the approval of the engineer, forms or temporary braces are attached to treated timber with nails or spikes, holes shall be filled by driving galvanized nails or spikes flush with the surface or plugged as required for bolt holes.

812.06 TREATMENT OF PILE HEADS.

(a) General: After cutting, pile heads shall be treated to prevent decay. Pile heads to be encased in concrete will not require treatment.

Immediately after making final cut-off on treated timber foundation piles, the cut area shall be given two liberal applications of preservative followed by a heavy application of hot roofing pitch or other approved sealer. Heads of treated timber piles in bents or where the cut-off is exposed shall be protected by one of the following methods, as specified. If not specified, galvanized metal coverings shall be used.

(b)Galvanized Metal Coverings: The sawed surface shall be thoroughly brush coated with two applications of creosote oil, after which there shall be placed two layers of heavy canvas size 20 by 20 inches (500 mm by 500 mm) saturated with hot roofing pitch, followed by a 24 by 24 inches, 28 gage (600 mm by 600 mm, 0.5 mm thick) galvanized metal cover. The cover shall be bent down over the pile approximately 45 degrees.

(c) Fabric Covering: Heads of treated piles shall be covered with alternate layers of hot pitch and loosely woven fabric complying with ASTM D 173, using four applications of pitch and three layers of fabric. The cover shall measure at least 6 inches (150 mm) more in dimension than the diameter of the pile and shall be neatly folded down over the pile and secured by large headed galvanized nails or by binding with at least seven complete turns of galvanized wire securely held in place by large-headed galvanized nails and staples. Edges of fabric projecting below the wire wrapping shall be trimmed to present a workmanlike appearance.

812.07 HOLES FOR BOLTS, DOWELS, RODS AND LAG SCREWS.

Holes for drift bolts and dowels shall be bored perpendicular to the face of the timber and shall be 1/16 inch (2 mm) less in diameter than bolt or dowel. For square drift bolts or dowels, the diameter of the bored hole shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored the same diameter as the bolt.

Holes for rods shall be bored 1/16 inch (2 mm) greater in diameter than the rod.

Holes for lag screws shall be bored not larger than the body of the screw at the base of the thread.

812.08 BOLTS AND WASHERS. A washer of the size and type specified shall be used under bolt heads and nuts which would otherwise come in

contact with wood. Stacked washers will not be permitted. Bolts shall not project
more than 1 inch (25 mm) beyond the nut on work securely tightened. Long bolts shall be saw-cut or clipped, ground smooth and repaired as specified in Subsection 811.12.

Nuts of bolts shall be locked after they have been tightened.

812.09 COUNTERSINKING. Countersinking shall be done when smooth faces are required. Horizontal recesses formed for countersinking shall be painted with creosote complying with Subsection 1014.03(e) and, after bolt or screw is in place, filled with hot roofing pitch.

812.10 FRAMING. Lumber and timber shall be accurately cut and framed to a close fit in such manner that joints will have even bearing over the contact surfaces. No shimming will be permitted in making joints nor will open joints be accepted. Mating pieces shall be tightly bound or clamped in position prior to drilling bolt holes.

812.11 PILE BENTS. Piles shall be driven in accordance with Section 804.

812.12 CAPS. Timber caps shall be placed, with ends aligned, in a manner to secure uniform bearing over tops of supporting posts or piles. Caps shall be secured by drift-bolts of at least 3/4 inch (20 mm) diameter extending at least 9 inches (230 mm) into posts or piles. Drift-bolts shall be approximately in center of the post or pile.

812.13 BRACING. Ends of bracing shall be bolted through pile, post or cap with a bolt of at least 5/8 inch (16 mm) diameter. Intermediate intersections shall be bolted or spiked with wire or boat spikes. Spikes shall be used in addition to bolts.

812.14 STRINGERS. Stringers shall be sized at bearings and placed in position so that knots near edges will be in top portions of stringers.

Outside stringers may have butt joints with ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of floor beam or cap at each end. When stringers are two panels in length, joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails in each end. Cross-bridging members shall have full bearing at each end against sides of stringers. Cross-bridging shall be placed at the center of each span.

812.15 PLANK FLOORS. Single plank floors shall consist of a single thickness of plank supported by stringers or joists. Planks shall be laid heart side down, with 1/4 inch (6 mm) openings between them for seasoned material and with tight joints for unseasoned material. Each plank shall be securely spiked to each joist. Planks shall be graded as to thickness and so laid that no two adjacent planks vary in thickness by more than 1/16 inch (2 mm).

Two-ply timber floors shall consist of two layers of flooring supported on stringers or joists. The lower course shall be pressure-treated with creosote oil. The top course may be laid either diagonal or parallel to the centerline of roadway, as specified, and each floor piece shall be securely fastened to the lower course. Joints shall be staggered at least 3 feet (1 m). If the top course is placed parallel to the roadway centerline, care shall be taken to securely fasten ends of flooring. At each end of the bridge, these members shall be beveled.

812.16 LAMINATED OR STRIP FLOORS. Strips shall be placed on edge at right angles to the roadway centerline. Each strip shall be spiked to the preceding strip at each end and at approximately 18-inch (450 mm) intervals, with the spikes driven alternately near the top and bottom edges. Spikes shall be of sufficient length to pass through two strips and at least halfway through the third strip.

If timber supports are used, every other strip shall be toe-nailed to every other support. When specified, strips shall be securely attached to steel supports with approved galvanized metal clips. Care shall be taken to have each strip vertical and tight against the preceding one and bearing evenly on supports.

812.17 WHEEL GUARDS AND RAILING. Wheel guards and railing shall be framed in accordance with the plans and erected true to line and grade. Wheel guards shall be laid in sections at least 12 feet (3.6 m) long.

812.18 PAINTING AND PROTECTIVE COVERINGS. Parts of structures to be painted will be as specified. Metal parts not galvanized shall be painted in accordance with Section 811.

When timber decks are provided, top flanges of stringers and floor beams shall be protected by a covering composed of a heavy layer of hot roofing pitch and one thickness of 2-ply tar paper wide enough to project 3 inches (75 mm) beyond edges of members. These edges shall be bent down approximately 45 degrees.

812.19 MEASUREMENT. Quantities of timber for payment will be the design quantities and adjustments thereto. The design quantities are based on the number of thousand board feet (cu m) of timber in the completed work. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are necessary. Hardware will not be measured for payment. Metal parts not classified on the plans as hardware will be measured and paid for in accordance with Section 807.

812.20 PAYMENT. Payment for timber will be made at the contract unit price per thousand board feet (cu m).

Payment will be made under:

Item No.	Pay Item	Pay Unit
812-01	Treated Timber	MFBM (Cu m)

Section 813
Concrete Approach Slabs

813.01 DESCRIPTION. This work consists of furnishing and constructing concrete approach slabs for bridges and other structures in accordance with the details, locations and dimensions shown on the plans.

813.02 MATERIALS. Materials shall comply with the following Sections and Subsections:

Portland Cement Concrete	901
Bedding Material	1003.08
Joint Materials	1005
Plastic Underdrain Pipe	1006.08
Deformed Reinforcing Steel	1009.01
Polyethylene Film	1011.01(d)
Timber Piling	1014
Hardware Cloth	1018.21
Geotextile Fabric	1019.01

Bedding material shall be either stone, or recycled portland cement concrete in accordance with Subsection 1003.08(a).

Geotextile fabric shall comply with Section 1019, Classes B, C, or D. The fabric shall be resistant to chemical, biological and insect attack.

813.03 EMBANKMENT. The entire embankment affecting the construction of the abutment shall be constructed to grade in accordance with Section 203 before building the end bent or bridge abutment. A surcharge shall be constructed in areas where designated fill heights will result in settlement. The plans will indicate the amount of surcharge and length of time to remain in place. The surcharge will be removed prior to driving piles for end bent.

Geotextile fabric shall be placed as a separation layer between the embankment and the bedding material beneath the approach slab in accordance with Subsection 203.11. No equipment will be allowed on the fabric unless there is at least 6 inches (150 mm) of cover.

When specified, the approach slab subgrade shall be placed on a layer of bedding material in accordance with plan details. Bedding material shall be

placed and compacted as directed and covered with approved polyethylene film of at least 6-mil (150 μm) nominal thickness.

813.04 DRAINAGE SYSTEMS. Drainage systems shall be constructed in accordance with Section 703.

813.05 REINFORCING STEEL. Reinforcing steel shall comply with Section 806.

813.06 BEARING PILES. When shown in the plans, the approach slab shall be supported on bearing piles in accordance with Section 804.

813.07 CONCRETE. Concrete for all approach slabs shall be Class AA. Concrete for bolster blocks under approach slabs shall be either Class A, Class AA or one of the concrete pavement types. The slabs shall be constructed in accordance with Section 805.

Portland cement concrete headwalls for perforated pipe shall comply with Section 901, Class M concrete constructed in accordance with plan details.

Curing shall conform to Subsection 805.10. Surface tolerances shall conform to Subsection 805.13(d)(2).

813.08 ROADWAY FINISH. The roadway shall be given a metal tine texture finish. Surface finishing operations shall be performed in accordance with Subsection 805.13(d)(3). Approach slabs which require an asphaltic concrete overlay shall be finished in accordance with Subsection 805.13(d)(1) and a tine finish will not be used.

813.09 MEASUREMENT. Quantities of concrete approach slabs for payment will be the design areas as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made. Design quantities are based on horizontal dimensions shown on the plans. Required reinforcing steel, bearing piles, joint materials, bedding materials, surcharge material, geotextile fabric, polyethylene film, plastic underdrain pipe, rodent screen, and headwalls, will not be measured for payment.

813.10 PAYMENT. Payment for concrete approach slabs will be made at the contract unit price per square yard (sq m) subject to the following provisions:

Acceptance and payment for concrete approach slabs will be made on a lot basis. A lot will be considered as a complete approach slab or an identifiable pour that is completed in one day. Two random batches will be sampled for each lot, and three cylinders molded for each batch. The six cylinders per lot will be tested for compressive strength in 28 to 31 days. In the event of sudden cessation of operations, a minimum of three cylinders will constitute a lot. Acceptance and payment for each lot will be made in accordance with Table 901-5 and Note 1.

Payment will be made under:

Item No.	Pay Item	Pay Unit
813-01	Concrete Approach Slabs	Square Yard (Sq m)
813-02	Concrete Approach Slabs (Pile Supported)	Square Yard (Sq m)

Section 814
Drilled Shaft Foundations

814.01 DESCRIPTION. This work consists of furnishing and constructing foundations of reinforced concrete shafts in drilled excavations in accordance with the plans and these specifications or as directed.

814.02 MATERIALS. Materials shall comply with the following Sections and Subsections. Concrete shall be Class S with water reducing and set retarding admixtures.

Portland Cement Concrete	901
Granular Material	1003.07
Reinforcing Steel	1009
Admixtures	1011.02

814.03 SUBMITTAL REQUIREMENTS. The contractor shall submit the drilled shaft contractor qualifications and the Drilled Shaft Installation plan for approval by the DOTD Chief Construction Engineer. The contractor's (drilled shaft contractor) qualifications shall meet or exceed the experience requirements described in Subsection 814.04. The proposed drilled shaft equipment and the drilled shaft installation method shall be such that drilled shafts shall be excavated through whatever materials are encountered, to the dimensions and elevations shown in the plans or otherwise required by the specifications and special provisions. In no case shall the drilling equipment be transported to the project site until approval is received in writing. Approval by the engineer of the contractor qualifications and installation plan will not relieve the contractor of responsibility to satisfactorily install shafts.

(a) Contractor Qualifications: The contractor shall submit the drilled shaft contractor's qualifications, as specified herein, prior to or in conjunction with, the Drilled Shaft Installation Plan submittal. Within 20 calendar days after receipt of the contractor's qualification submittal, the engineer shall approve or reject the drilled shaft contractor's qualifications. The contractor shall resubmit any changes in the drilled shaft contractor's qualifications for approval.

(b)Drilled Shaft Installation Plan: The contractor shall submit the Drilled Shaft Installation Plan no later than 30 calendar days prior to

commencing the drilled shaft construction. Within 20 calendar days after receipt of the drilled shaft installation plan the engineer will notify the contractor of any additional information required and/or changes that may be necessary to meet the plans, specifications and special provisions requirements. Any parts of the contractor's Drilled Shaft Installation Plan that are unacceptable shall be rejected and the contractor shall resubmit changes agreed upon for reevaluation. The engineer will notify the contractor within 10 calendar days after receipt of proposed changes to the Drilled Shaft Installation Plan of their acceptance or rejection. The contractor shall use the approved drilled shaft construction method during drilling operations. The contractor shall make any required changes that may result from unsatisfactory field performance. No changes in the drilling method may be made after final approval without the written approval of the DOTD Chief Construction Engineer.

814.04 EXPERIENCE REQUIREMENTS. The contractor shall have a minimum of three years experience in constructing drilled shaft foundations of similar size as required by the project within the past five years and shall submit descriptions of that experience. The descriptions of the drilled shaft projects shall contain names and telephone numbers of owners' representatives who can verify the contractor's participation on those projects.

The contractor's on-site drilled shaft superintendent(s) shall each have a minimum of two years experience in the construction of drilled shaft foundations and the drill operators shall have a minimum of one year experience. The contractor shall submit the name and experience records of the drill operator(s) and drilled shaft superintendent(s) in charge of the drilled shaft construction operations.

814.05 DRILLED SHAFT INSTALLATION PLAN. The engineer will evaluate the drilled shaft installation plan for conformance with the plans, specifications, and special provisions. The drilled shaft installation plan shall provide detailed drilled shaft installation information including the following:

1. List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, concrete coring equipment, soil sampling equipment, slurry pumps, tremie, concrete pumps, casing, etc.

2. Details of the safety plan developed for this project.

3. Details of the overall construction operation sequence and the proposed sequence of shaft construction.

4. Details of planned shaft excavation methods and final shaft dimensions.

5. Details of proposed excavation and concrete placement contingency plans including a list of equipment or materials required.

6. Details of the slurry type, mixing method, sampling and testing method, circulating and desanding method, and disposal method, when the slurry method of construction is to be used.

7. Details of equipment and proposed methods to clean the drilled shaft excavation.

8. Details of reinforcement positioning including support and centering methods.

9. Details of concrete placement methods, curing, and protection. Details shall include concrete placement operational procedures for free fall, tremie, or pumping as appropriate.

10. Details of Crosshole Sonic Logging testing including proposed testing schedule, when required.

11. Other information shown in the plans or special provisions.

No changes shall be made to the drilled shaft installation plan without approval from the engineer.

814.06 PROTECTION OF EXISTING STRUCTURES AND UTILITIES. The contractor shall control his operations to prevent damage to existing structures and utilities. Preventative measures shall include, but are not limited to, selecting construction methods and procedures that will prevent caving of the drilled shaft excavation, and controlling the vibrations from construction activities.

814.07 SAFETY REQUIREMENTS. The contractor shall take whatever measures are necessary to insure the safety of all persons including the general public in accordance with Section 107. The following safety topics are presented as representative of issues that the contractor must address. This list is not intended to be all-inclusive and does not relieve the contractor of conforming to other regulations, laws, requirements, or other measures reasonably required for safe excavating operations.

(a) Excavation Equipment: Any required equipment within an excavation shall be operated by air or electricity. The use of gasoline-driven engines or diesel engines within an excavation shall not be permitted.

(b) Lighting: All lighting shall be electric and precautions shall be taken to prevent potential short circuits of electric current within ground water.

(c) Explosive or Noxious Gases: The contractor shall take precautions to assure that no explosive or noxious gases are present. Fresh air shall be supplied into the excavation whenever any personnel are present in the excavation.

(d)Excavation Entry: A safety harness or chair lift, with separate safety line, and two-way radio communication shall be used for any entry into the excavation.

(e) Open Excavations: No open excavations shall be left unattended. During non-working hours, excavations shall be protected by the use of solid, safe covers that are firmly fastened in place.

(f) Completed Drilled Shafts: When the elevation at the top of the completed drilled shafts is below the ground elevation, and steel reinforcement remains exposed, the contractor shall seal the opening at the ground surface to prevent injury.

814.08 EXCAVATION METHODS. The contractor's methods and equipment shall be suitable to perform the excavations required for the shafts. The contractor shall provide equipment capable of constructing shafts to a depth equal to the deepest shaft shown in the plans plus 16 feet (5 m).

Drilled shafts shall generally be constructed by the dry method, wet method, temporary casing method, or permanent casing method as necessary to produce sound, durable concrete foundation shafts free of defects. The permanent casing method shall be used only when required by the plans or authorized by the engineer. When the plans describe a particular method of construction, this method shall be used except when otherwise permitted by the engineer. When the plans do not describe a particular method, the contractor shall propose a method on the basis of its suitability to the site conditions and submit it for approval with his drilled shaft installation plan submittal.

The contractor shall set a suitable temporary surface casing. The minimum surface casing length shall be the length required to prevent caving of the surface soils and to aid in maintaining shaft position and alignment. Predrilling with slurry and/or overreaming to the outside diameter of the casing may be required to install the surface casing at some sites.

The bridge end embankments shall be completed prior to excavating drilled shafts for the end bents.

(a) Dry Construction Method: The dry construction method shall be used only at sites where the ground water table and soil conditions make it feasible to construct the shaft.

The dry construction method consists of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation, and placing the shaft concrete in a relatively dry excavation.

The dry construction method shall be used only when shaft excavations, as demonstrated in a trial shaft or test drilled shaft, have 12 inches (300 mm) or less of seepage water accumulated over a one hour period without pumping, the sides and bottom remain stable without detrimental caving, sloughing, or swelling for a four hour period, and the loose material and water can be satisfactorily removed prior to inspection and prior to placing concrete.

(b)Wet Construction Method: The wet construction method consists of drilling the shaft excavation below the water table, keeping the shaft filled with a slurry, desanding and cleaning the slurry, and cleaning the final excavation by means of a clean out bucket, air lift, submersible pump or other approved device. The shaft concrete shall be placed with a tremie or concrete pump beginning at the shaft bottom to displace the slurry as the shaft excavation is concreted.

Where drilled shafts are located in open water, the shafts shall be constructed by the wet method using exterior casings extending from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing of the concrete. The exterior casing shall be installed in a manner that will produce a positive seal at the bottom of the casing so there is no intrusion or extrusion of slurry, water or other materials into or out of the shaft excavation.

(c) Temporary Casing Construction Method: The temporary casing method consists of advancing the hole through caving material by the wet method described above. When a cohesive soil formation is reached, a casing shall be placed in the hole and sealed to prevent seepage. Drilling may proceed as with the dry method to the projected depth. Temporary casings shall extend sufficiently above the grade of the finished drilled shaft to provide for excess concrete to be placed for the anticipated subsidence of concrete due to casing removal. The placement of the concrete shall proceed as with the dry method except that the casing shall be withdrawn when the concrete is placed. In the event that, seepage conditions prevent the use of the dry method, excavation shall be completed using wet methods.

Where drilling is through materials having a tendency to cave, the drilling shall be advanced by drilling in a slurry. In the event that a caving layer or layers are encountered that cannot be controlled by slurry, the contractor shall

install temporary casing through such caving layer or layers. Overreaming to the outside diameter of the casing may be required. The contractor shall take whatever steps are required to prevent caving during shaft excavation including installation of deeper casings. If the contractor elects to remove a casing and replace it with a longer casing through caving soils, he shall adequately stabilize the excavation with slurry or backfill the excavation. Soil previously excavated or soil from the site may be used if the excavation is backfilled.

Before the casing is withdrawn, the level of fresh concrete shall be such that the fluid trapped behind the casing is displaced upward. As the casing is withdrawn, care shall be exercised to maintain the level of concrete within the casing so that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete.

The casing method may be used, when approved by the engineer, to construct drilled shafts through weak caving soils that do not contribute significant shaft shear resistance. In this case, a temporary casing is placed through the weak caving soils before excavation begins. Excavation is conducted using the dry or wet construction method as appropriate. The temporary casing shall be removed during the concreting operations unless approved otherwise by the engineer.

(d)Permanent Casing Construction Method: The permanent casing method shall be used when required in the plans. In this method, a casing is placed to the prescribed depth before excavation begins. If full penetration cannot be attained, the engineer may direct the excavation through the casing and the casing advanced again until reaching the desired penetration. In some cases, overreaming to the outside diameter of the casing may be required before placing the casing.

The casing is cut off at the prescribed elevation upon reaching the proper construction sequence and the remainder of the casing is left in place.

814.09 EXCAVATION PROCEDURES AND CONDITIONS.

(a) Soil Sampling: The plans generally indicate the expected depths, the top of the shaft elevations, and the estimated bottom of shaft elevations between which the drilled shaft shall be constructed as a minimum. Drilled shaft excavations may be extended deeper when the engineer determines that the material encountered while drilling the shaft excavation is unsuitable and/or is not the same as the material anticipated in the design of the drilled shaft.

The contractor shall take soil samples, when shown in the plans or directed by the engineer, to determine the character of the material directly below the drilled shaft excavation. The soil sampling method shall be capable of obtaining representative material samples encountered at the bottom of the drilled shaft excavation. Sampling tools such as core barrels, split spoon sampler, or undisturbed sample tubes and sampling procedures shall be approved by the engineer. The soil samples shall be taken to a maximum depth of 5 feet (1.5 m) below the bottom of the drilled shaft excavation. The engineer will inspect the samples and determine the depth of required excavation.

(b)Excavation Log: The contractor shall maintain a drilling log during shaft excavation and during sampling operations. The log shall contain information such as the description of and approximate top and bottom elevations of each stratum encountered, depth of penetration, drilling time in each of the various strata, material description, and remarks. Two copies of the drilling log, signed by a designated representative of the contractor, shall be furnished to the engineer.

(c) Excavated Material: Excavated materials which are removed during drilled shaft construction and are not used elsewhere on the project shall be disposed of by the contractor in accordance with Subsection 202.02.

(d)Excavation Contingencies: The contractor shall have readily available all equipment and materials necessary for mitigating situations that may occur during drilled shaft excavation, such as caving or sloughing of the excavation sides, slurry problems, such as loss of slurry through permeable media, excessive seepage, unsuitable bearing material, etc. Contingency solutions may consist of a change in excavation method, slurry additives, sampling tools, etc. Contingency methods shall be submitted with the installation plan for approval.

(e) Overreaming: When excavation time limits described in Subsection 814.13(d) are exceeded, sidewall overreaming shall be required when the sidewall of the hole is determined to have either softened due to excavation methods, swollen due to delays in concreting, or degraded because of slurry cake buildup. Depending on the condition of the sidewall, the drilled shaft diameter shall be overreamed by increasing the diameter of the drilled shaft between 1 to 6 inches (25 to 150 mm). The extent of sidewall overreaming shall be as directed by the engineer. Overreaming may be accomplished with a grooving tool, overreaming bucket or other approved equipment. The contractor shall bear all costs associated with both sidewall overreaming and additional shaft concrete placement.

(f) Adjacent Drilled Shaft Construction: Adjacent shafts within 3 shaft diameters (center to center) shall not be excavated or casings placed until 48 hours have elapsed from the completion of the pour of the previous drilled shaft. Production drilled shaft construction may continue on other shafts.

(g)Lost Tools: Drilling tools that are lost in the excavation shall be promptly removed by the contractor. All costs due to lost tool removal shall be borne by the contractor including but not limited to costs associated with the repair of hole degradation due to removal operations or time limits being exceeded during the period the excavation remains open.

814.10 PERMANENT CASING. Permanent casing type, size, and length, shall be as specified in the plans. Casing shall be steel, smooth, clean and watertight and shall be free of accumulations of hardened concrete both inside and outside. It shall be of ample strength to withstand both handling and driving stresses during installation.

(a) Casing Placement: The casing shall be continuous between top and bottom elevations prescribed in the plans. After installation is complete, the permanent casing shall be cut off at the prescribed elevation and the shaft completed by installing necessary reinforcing steel and concrete in the casing.

(b)Casing Coating: When casing coating is specified in the plans or required by the engineer, the exterior surfaces of permanent casings shall be painted with a cold tar epoxy-polyamide paint as described in the plans and in accordance with Section 811. The exterior surfaces shall be coated prior to the installation of the casings. After the installation of the casings, all damage to the coated surfaces of the casing exposed to the air shall be repaired by a reapplication of the coating system.

814.11 TEMPORARY CASING. Temporary casings shall be made of steel of ample strength to withstand handling and driving stresses, and the pressure of concrete and of the surrounding earth. The casing shall be smooth, watertight, and clean and free of accumulations of hardened concrete. The inside diameter of casings shall not be less than the specified shaft size. No extra compensation will be allowed for concrete required to fill an oversized casing or excavation.

(a) Casing Removal: Temporary casing removal may occur gradually as concrete is placed. Movement of the casing by rotating, exerting downward pressure and tapping it to facilitate extraction, or extraction with a vibratory hammer, will be permitted. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft. Temporary casings shall be

removed while the concrete remains workable. When conditions warrant, the casing may be pulled in partial stages. A sufficient head of concrete shall be maintained above the bottom of the casing to overcome the hydrostatic pressure of water outside the casing. At all times the elevation of the concrete in the casing shall be maintained high enough to displace the drilling slurry between the outside of the casing and the edge of the hole as the casing is removed. Casings that, in the opinion of the engineer, will not adversely affect the shaft capacity may be left in place when approved by the engineer.

(b)Bound and Fouled Casings: Shafts constructed with temporary casings that become bound or fouled during shaft construction and cannot be practically removed, shall be considered defective. The contractor shall be responsible for correcting the defective shaft, with modifications required to compensate for loss of frictional capacity in the cased zone.

If upward movement of the concrete and/or reinforcing steel occurs at any time during the pulling operation, the following criteria shall govern:

1. If the upward movement is 1 inch (25 mm) or less, the casing may continue to be pulled provided no further movement occurs. If directed by the engineer, the concrete shall be vibrated or rodded in the upper 5 feet (1.5 m), to reconsolidate the concrete after the casing is withdrawn. Vibration or rodding shall not be used to attempt to break the casing loose for extraction.

2. If the upward movement is greater than 1 inch (25 mm), the drilled shaft shall be considered defective and the contractor shall be responsible for correcting the defective drilled shaft. Subject to the approval of the engineer, one of the following corrective options may be used.

a. The casing may be left in place as a permanent sleeve and the concrete vibrated or rodded to reconsolidate the concrete. The contractor shall obtain concrete core samples and/or conduct approved nondestructive testing. If the concrete core sampling or nondestructive testing are not conclusive, the engineer may require the contractor to perform a load test or other tests to determine the adequacy and acceptability of the drilled shaft. The contractor shall be responsible for modifications required to compensate for loss of frictional capacity in the cased zone when the temporary casing is abandoned in the shaft. All such modifications including leaving the casing in place, and all testing shall be at no additional cost to the Department.

b. All drilled shaft materials shall be removed and the shaft redrilled.

(c) Removable Casings: Use of removable casings or special casing systems shall be subject to written approval from the engineer. These casings shall be removed in a manner that will not damage the exposed drilled shaft

concrete after hardening. These casings can be removed when the concrete has attained sufficient strength provided the following criteria are met.

1. Curing of the concrete is continued for the full curing period in accordance with the specifications.

2. Shaft concrete is not exposed to salt water or moving water for seven days or until reaching a compressive strength of at least 2500 psi (17.3 MPa).

814.12 SLURRY. When slurry is employed in the drilling process as in the wet construction method, mineral slurry or polymer slurry may be used in accordance with these specifications. The contractor shall provide a list of construction projects, within the past three years, where the proposed slurry has been used to construct drilled shafts in comparable site conditions as those anticipated for the required drilled shafts. The project list shall contain names and telephone numbers of owner's representatives who can verify the field performance of the proposed slurry.

All equipment in contact with the water or slurry during mixing or transporting to the excavation, such as mixing tanks, pumps, and water lines, shall be free of fresh concrete residue.

(a) Polymer Slurry:

(1) Approval Process: Polymer slurries and additives may be used when approved in writing by the DOTD Chief Construction Engineer. The request for approval of a polymer slurry shall be included with the drilled shaft installation plan. The following information shall be furnished with the submittal:

a. The manufacturer's specifications for polymer slurry and any additives.

b. Recommended instructions for proper slurry mixing

As a prerequisite to final approval of the polymer slurry, the Department may require construction of a trial shaft in accordance to Subsection 814.21 to evaluate the slurry's performance during drilled shaft construction. A manufacturer's representative shall be present during construction of the trial shaft or test drilled shaft to instruct DOTD and the contractor's personnel in the proper testing and construction techniques for the proposed polymer slurry.

(2) Polymer Slurry Requirements: The approved polymer slurry shall have sufficient viscosity to stabilize the shaft excavation and sufficient positive pressure head to inhibit the influx of ground water into the excavated hole. The material used to make the slurry shall not be detrimental to concrete

or surrounding ground strata. Control testing using suitable apparatus shall be carried out on the polymer slurry mixture by the contractor to determine the density, sand content, viscosity, and pH. Tests shall be performed when the slurry temperature is above 40°F (5°C). Acceptable values for these physical properties are shown in Table 814-1.

Table 814-1
Polymer Slurry Specifications

Property (Units)	At Time of Slurry Introduction	In Hole at Time of Concreting	Test Method
Density	63-64 pcf (1010 - 1026 kg/m^3) (fresh water)	63-64 pcf (1010 - 1026 kg/m^3) (fresh water)	Mud Balance (API 13B-Sec 1)
Viscosity (minimum)	45 seconds	N/A	Marsh Funnel (API 13B-Sec 2)
pH	8 – 10	8 – 10	pH Paper pH Meter (API 13B-Sec 6)
Max. Sand Content (% by Volume)	1	1	Sand Screen Set (API 13B- Sec 4)

The limits shown in Table 814-1 may be adjusted when field conditions warrant as demonstrated by a trial shaft, test drilled shaft, or other methods approved by the engineer.

(3) Polymer Slurry Mixing: The polymer slurry shall be mixed thoroughly with clean fresh water in a separate mixing tank with a high shear agitating mixer. Water hardness shall be tested prior to mixing to insure it meets the manufacturer's recommendations. The contractor shall take all steps necessary to prevent the slurry from losing the required viscosity.

(b)Mineral Slurries:

(1) Mineral Slurry Requirements: Mineral slurry shall consist of processed attapulgite, sepiolite, or bentonite clays containing pure sodium bentonite. The slurry shall have a mineral grain size such that it will remain in suspension and shall have sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper placement of concrete. The material used to make the slurry shall not be detrimental to concrete or surrounding ground strata.

The contractor shall take the steps necessary to prevent the slurry from "setting up" in the shaft excavation, including but not limited to, agitation, circulation and/or adjusting the composition and properties of the slurry.

Control testing using suitable apparatus shall be carried out on the mineral slurry mixture by the contractor to determine density, sand content, viscosity, and pH. Tests shall be performed when the slurry temperature is above 40°F (5°C). Acceptable values for these physical properties are shown in Table 814-2.

Table 814-2
Mineral Slurry Specifications

Property (Units)	At Time of Slurry Introduction	In Hole at Time of Concreting	Test Method
Density	64.3 - 69.1 pcf (1030 - 1107 kg/m^3) (fresh water)	64.3 - 75.0 pcf (1030 - 1202 kg/m$^{3)}$ (fresh water)	Mud Balance (API 13B- Sec 1)
Viscosity	28 - 45 seconds	N/A	Marsh Funnel (API 13B- Sec 2)
pH	8 – 11	8 - 11	pH Paper pH Meter (API 13B-Sec 6)
Max. Sand Content (% by Volume)	4	4	Sand Screen Set (API 13B- Sec 4)

The limits in Table 814-2 may be adjusted when field conditions warrant as demonstrated by a trial shaft, test drilled shaft, or other methods approved by the engineer.

(2) Mixing and Storage: The mineral slurry shall be premixed thoroughly with clean fresh water prior to introduction into the shaft excavation. When bentonite slurry is used, it should be held in storage for a period of time to allow complete hydration. The percentage of mineral admixture used to make the suspension shall be adequate to maintain the stability of the shaft excavation. Adequate water and/or slurry tanks are required when necessary to perform the work in accordance with these specifications. No excavated pits will be allowed without the written permission of the engineer. No mixing of slurry will be allowed in the drilled shaft excavation. Slurry shall not stand for more than four hours in the excavation without agitation. If this is not possible, the drilled shaft excavation shall be overreamed to remove filter cake.

(3) Desanding: Desanding equipment shall be provided by the contractor as necessary to control slurry sand content unless otherwise directed in the plans or special provisions. Desanding equipment will not be required
for construction of drilled shafts for sign post or lighting mast foundations unless shown in the plans or special provisions.

(c) Slurry Testing Frequency: Density, viscosity, sand content, and pH testing shall be performed initially until a consistent working pattern has been established, taking into account the mixing process, and blending of freshly mixed slurry and previously used slurry. Density, viscosity, sand content, and pH value testing shall be performed a minimum of four times during the first eight hours the slurry is in use.

Prior to placing concrete in any shaft excavation, the contractor shall ensure that heavily contaminated suspensions, which could impair the free flow of concrete from the tremie pipe, have not accumulated in the bottom of the shaft. Samples of the slurry in the shaft shall be taken from the base of the shaft and at intervals not exceeding 10 feet (3 m) up the shaft, using an approved sampling tool, until two consecutive samples produce acceptable values in accordance with slurry specifications for polymer and mineral slurries.

(d)Unacceptable Slurry Test Results: When any slurry samples are tested and found to be unacceptable, the contractor shall take whatever action is necessary to bring the slurry within specification requirements. Concrete shall not be poured until resampling and testing results produce acceptable values.

(e) Slurry Test Reports: Reports of all slurry tests required above, signed by an authorized representative of the contractor, shall be furnished to the engineer upon completion of each drilled shaft.

(f) Slurry Disposal: Disposal of all waste slurry shall be off-site in suitable areas provided by the contractor in accordance with local, state, and federal laws.

(g)Required Fluid Level: During construction, the slurry shall be maintained within the excavation at a level not less than 5 feet (1.5 m) above the highest expected piezometric water head within the shaft excavation. The slurry level may be higher if caving or sloughing soils are present above this level.

(h)Slurry Performance: If the slurry fails to stabilize the excavation, or if a sudden significant loss of slurry occurs such that the slurry level cannot practically be maintained by adding slurry to the hole, the construction of that

foundation shall be continued by the approved contingency method. Construction of new drilled shafts shall be discontinued until the contractor modifies or replaces the existing drilled shaft construction method and obtains written approval from the engineer.

(i) Blended Mineral-Polymer Slurry: If the contractor elects to use blended mineral-polymer slurry, a detailed report shall be submitted specific to the project, prepared by a qualified slurry consultant. The report shall describe slurry materials, mix proportions, mixing methods and quality control methods. Details of the slurry quality control testing criteria shall also be furnished. A manufacturer's representative shall be present during construction of the trial shaft to provide guidance on the proper proportions, mixing and quality control of the blended mineral-polymer slurry.

814.13 EXCAVATION INSPECTION AND REQUIREMENTS.

(a) Dimensions and Alignment: The contractor shall provide equipment for checking the dimensions and alignment of each permanent shaft excavation. The dimensions and alignment of the shaft excavation shall be determined by the contractor under the observation and direction of the engineer. The alignment and dimensions shall be checked by any of the following methods:

1. Check the dimensions and alignment of dry shaft excavations using reference stakes and a plumb bob.

2. Check the dimensions and alignment of casing when inserted in the excavation.

3. Insert a casing in the shaft excavations temporarily for alignment and dimension checks.

4. Other methods provided by the contractor and approved by the engineer.

Any casing, rod, or other device used to check dimensions and alignment shall be inserted by the contractor into the excavation to full depth.

(b)Depth: The depth of the shaft during drilling shall generally be referenced to appropriate marks on the Kelly bar or by other suitable methods. Final shaft depths shall be measured with a suitable weighted tape or other approved method.

(c) Drilled Shaft Cleanliness Requirements: The contractor's cleaning operation shall be adjusted so that no more than 1/2 inch (15 mm) of loose or disturbed material shall be present at the bottom of the shaft just prior to placing concrete for end bearing drilled shafts. No more than 2 inches (50

mm) of loose or disturbed material shall be present for side friction shafts. End bearing shafts shall be assumed unless otherwise noted in the plans, or directed by the engineer.

Drilled shaft bottom cleanliness will be determined by visual inspection for dry shafts or other methods deemed appropriate by the engineer for wet drilled shafts. The device proposed to check for bottom cleanliness shall be approved by the engineer prior to use. The bottom of the drilled shaft excavation shall be cleaned, regardless of the method of load distribution, with a cleanout bucket or other appropriate tool. When a cleanout bucket is used, it shall be equipped with a one-way flap gate that prevents spoil in the bucket from re-entering the drilled shaft excavation. End bearing drilled shafts, drilled by the wet construction method, shall require a final bottom cleaning with an air-lift or submersible pump prior to concrete placement. Care shall be taken not to decrease the borehole stability while utilizing the air-lift or submersible pump.

In addition, for dry excavations the maximum depth of water covering the bottom of the excavation shall not exceed 3 inches (75 mm) prior to concrete placement.

(d)Time of Excavation: No drilled shaft excavation work shall be open for more than 36 hours prior to placing concrete. The excavation time shall start at the beginning of excavation for all construction methods except the permanent casing method, which starts at the time the excavation begins below the permanent casing. If slurry is used, the contractor shall adjust his excavation operations so that the maximum time slurry is in contact with the bottom 5 feet (1.5 m) of the drilled shaft excavation does not exceed 12 hours from drilling to concreting. If these time limits are exceeded, the drilled shaft excavation may require overreaming of the sidewalls and/or overdrilling the excavation prior to performing other operations in the shaft. Costs associated with exceeding these time limits shall be at the contractor's expense.

814.14 REINFORCING STEEL CONSTRUCTION AND POSITIONING.

(a) Cage Construction and Placement: Fabrication and positioning of reinforcing steel shall conform to Section 806. The contractor shall order and fabricate the steel reinforcing cage after the final drilled shafts depths have been specified. The steel reinforcing cage, consisting of longitudinal and transverse bars, ties, and cage stiffener bars, shall be completely assembled and positioned as a unit immediately after the shaft excavation is inspected and accepted, and prior to concrete placement. The reinforcing cage shall be

rigidly braced to retain its configuration during handling and construction. If Crosshole Sonic Logging testing is required, the steel cage shall have attached to it the access tubes as described in Subsection 814.19.

(b)Cage Extension: If the drilled shaft bottom is extended to an elevation lower than the plan bottom elevation, the reinforcing cage length shall also be extended by the same amount. The reinforcing cage may be extended at the plan bottom elevation by using a lap splice or a mechanical butt splice device to attach additional longitudinal reinforcement in accordance with Section 806. Welding to extend the reinforcing steel shall not be permitted. Tie bars shall be continued for the extra depth, at the same spacing, and the stiffener bars shall be extended to the final depth.

(c) Support, Alignment and Tolerance: The reinforcement steel in the drilled shaft shall be carefully positioned and securely fastened and supported so that the reinforcing steel remains within the allowable tolerances given in Subsection 814.17(c).

(d)Spacers: Concrete wheels, with a minimum width of 1 inch (25 mm), or other non-corrosive rolling spacing devices, approved by the engineer, shall be placed at the top and bottom of the steel reinforcement cage and at sufficient intervals along the shaft to insure concentric spacing for the entire length of the steel reinforcement cage. Block type spacers will not be allowed. For longitudinal reinforcement less than 1 inch (25 mm) diameter, spacing devices shall be placed at intervals not exceeding 5 feet (1.5 m) along the shaft. For longitudinal reinforcement, 1 inch (25 mm) diameter or larger, spacing devices shall be placed at intervals not exceeding 10 feet (3 m) along the shaft. A minimum of one spacer per 3 feet (1 m) of circumference of cage with a minimum of three at each level shall be used. Additional spacers may be required if deemed necessary by the engineer. Concrete or other approved non-corrosive spacers, approved by the engineer, shall be provided at the bottom of the drilled shaft reinforcing cage to insure that the specified distance between the bottom of the cage and the bottom of the shaft is maintained. The bottom spacers shall be constructed of approved material equal in quality and durability to the concrete specified for the shaft. Bottom spacers will not be required if the steel reinforcing cage is supported at the top of the hole.

(e) Reinforcement Cage Elevation: The elevation of the top of the steel reinforcement cage shall be checked before and after the concrete is placed. If the reinforcement cage is not maintained within the specified tolerances, corrections shall be made by the contractor as directed by the engineer. No additional shafts shall be constructed until the contractor has

modified his reinforcement cage support in a manner satisfactory to the engineer.

(f) Column Steel: The minimum length of steel required for lap with column steel shall be maintained. Dowel bars in the top of the shaft shall be placed and tied prior to starting concrete pour unless approved otherwise by the engineer.

814.15 CONCRETE PLACEMENT METHOD. The contractor may use any of the placement methods described herein. Details pertaining to compliance with this specification shall be furnished in the contractor's drilled shaft installation plan.

(a) Free Fall Method:

(1) Requirements: The free fall placement of concrete shall only be permitted in dry vertical shafts where the clear opening (inside the reinforcing cage) is not less than 24 inches (600 mm) in diameter. The height of free fall placement shall not exceed 75 feet (23 m) measured from the bottom of the hopper or drop chute to the point of deposition. Concrete placed by free fall shall fall directly to the placement location without contacting either the reinforcing cage or the shaft sidewall.

A hopper shall be used at the top of the shaft to center and direct the free fall placement. The contractor shall reduce the rate of concrete placement or reduce the height of free fall as directed by the engineer if the concrete strikes the reinforcing cage or sidewall.

(2) Disqualification of Free Fall Method: If in the opinion of the engineer, concrete placement cannot be satisfactorily accomplished by the free fall method, the contractor shall change to either tremie or pumping methods to accomplish the concrete placement.

(b)Tremie and Pumped Concrete Placement Methods:

(1) Tremie: Tremies shall consist of a tube of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. Inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concreting. The wall thickness of the tremie shall be adequate to prevent crimping or sharp bends that restrict concrete placement. The tremie's inside diameter shall be at least 6 times the maximum aggregate size used in the concrete mix but shall not be less than 10 inches (250 mm). Tremies shall be clearly marked at one foot increments. Tremies used for concrete placement in dry excavations shall consist of: a tube of solid construction; a tube constructed of sections which can be added and removed; or a tube of other approved design. Aluminum

tremies will not be allowed. Tremies used for concrete placement in wet excavations shall be constructed as follows:

1. The tremie pipe is watertight and discharges concrete readily

2. The discharge end of the tremie shall prevent intrusion of slurry

3. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations

4. The tremie shall have sufficient weight that it will rest on the shaft bottom before the start of concrete placement.

(2) Pumped Concrete: The contractor may use concrete pumps approved by the engineer in lieu of tremies to place concrete for drilled shafts. Concrete pumps shall have sufficient capacity to place the concrete within the time limit specified. The pump lines shall have a minimum 4 inch (100 mm) diameter and shall be constructed so that all sections have watertight joints.

(3) Concrete Placement: Tremied or pumped concrete may be used for concrete placement in either wet or dry excavations.

a. Dry Excavations: Concrete may be passed through a hopper at the top of the tremie or through side openings as the tremie is retrieved during concrete placement. The tremie or pump line shall be supported so that the free fall of the concrete is less than 5 feet (1.5 m) at all times. If the free falling concrete causes the shaft sides to cave or slough, the contractor shall control the movement of concrete by reducing the height of free fall of the concrete and/or reducing the rate of flow of concrete into the excavation.

b. Wet Excavations: When a tremie is used for concrete placement, bottom plates or plugs will be required to ensure that there is a minimum of concrete contamination. When a bottom seal is used, the tremie shall be sealed prior to placing the tremie in the wet excavation. The tremie pipe shall be placed on the bottom of the excavation and charged with concrete prior to lifting the tremie to release the bottom seal. The tremie should only be raised enough to release the bottom seal and start the flow of concrete, approximately 1 foot (300 mm). When a plug or pig is placed at the top of the tremie it shall be inserted after the tremie is placed in the wet excavation and before the tremie is charged with concrete. The bottom of the tremie shall be placed slightly off the bottom of the excavation to allow the plug or pig to pass out of the tremie.

When a concrete pump with rigid steel pump line is used for concrete placement, a plug or pig is to be placed in the rigid pump line to minimize concrete contamination. The plug or pig is to be placed near the top of the rigid line after the rigid line has been placed in the wet excavation and before

the rigid line is connected to the surface line from the pump. The rigid pump line shall be equipped with a vent to prevent air pressure build up in the surface line at the beginning of concrete pumping operations. The air vent shall be closed when the concrete in the surface line reaches the pig in the rigid line.

The discharge end of the tremie or rigid pump line shall be immersed at least 5 feet (1.5 m) into the concrete at all times and shall not be removed after starting the flow of concrete. The flow of the concrete shall be continuous. The concrete in the tremie or pump line shall be maintained with a positive head at all times to prevent water or slurry intrusion into the shaft concrete. If at any time during the concrete pour, the tremie or pump line discharge end is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft shall be considered defective. The contractor shall have the option, at the time the concrete pour is interrupted, to recharge the tremie and continue the pour at his own risk or to remove the reinforcing cage and concrete, complete any necessary sidewall overreaming as directed by the engineer, and repour the shaft.

814.16 CONCRETE PLACEMENT REQUIREMENTS. Concrete shall be placed in accordance with Section 805 and the requirements herein.

(a) Concrete Placement Responsibility: The drilled shaft contractor shall be responsible for placement of the concrete in the drilled shaft. Prior to concrete placement, the drilled shaft contractor shall make all necessary arrangements to assure the uninterrupted delivery of concrete so that all drilled shaft foundations shall be constructed without cold joints.

(b)Concrete Placement Contingencies: The contractor shall have readily available all equipment and materials necessary for mitigating situations that may occur during drilled shaft concrete placement such as unforeseen stoppage of work, drop in concrete pressure, delays in concrete placement, etc. Contingency methods shall be submitted with the drilled shaft installation plan for approval.

(c) Concrete Placement Log: When concrete placement is under slurry, or as directed by the engineer, a concrete placement log will be maintained to document the method of concrete placement. The contractor shall assist the engineer in determining the actual volume of concrete placed, elevation of top of concrete in the shaft, and elevation of tremie or pump line discharge end.

(d)Concrete Placement Time Limitations: Concrete shall be placed as soon as possible after the reinforcing steel placement and shall be

continuous from the bottom to the top elevation of the shaft. Concrete placement shall continue after the shaft excavation is full, until good quality concrete is evident at the top of the drilled shaft. Unless approved otherwise by the engineer, the elapsed time from beginning to completion of concrete placement in the drilled shaft shall not exceed two hours for drilled shafts 5 feet (1.5 m) diameter or less. The minimum concrete placement rate for drilled
shafts larger than 5 feet (1.5 m) diameter shall be 30 cubic yards (23 cu m) per hour.

The engineer may allow an extension of the concrete placement time if the contractor adequately demonstrates by trial mix and slump loss tests that the slump of the concrete will be no less than 4 inches (100 mm) during the entire time of concrete placement during the longer placement time.

These tests shall be conducted by a DOTD certified concrete technician in the presence of the engineer. The slump loss tests shall be performed at intervals not to exceed 30 minutes and shall be made from a trial mix proportioned from the approved concrete mix design. The temperature of the trial mix shall be kept at a level representative of construction site conditions. A slump loss versus time curve shall be furnished to the engineer prior to concreting production shafts.

(e) Top of Drilled Shaft: Concrete placed under slurry shall not be vibrated, unless directed by the engineer, in the top 5 feet (1.5 m) of the drilled shaft after the slurry, contaminated concrete, and surface casing have been removed. After concrete placement is completed, the top surface shall be cured and construction joint areas shall be treated as specified in Section 805.

Concrete placement in wet excavations shall be overpoured until all slurry and contaminated concrete has been removed. Temporary sump holes used for slurry recovery and concrete overpour shall not exceed 5 feet (1.5 m) in depth. The temporary sump holes shall be cleaned out and backfilled to the satisfaction of the engineer.

814.17 DRILLED SHAFT CONSTRUCTION TOLERANCES. The following construction tolerances shall apply for drilled shafts unless otherwise stated in the contract documents. During drilling or excavation of the drilled shaft, the contractor shall make frequent checks on the plumbness, alignment, and dimensions of the shaft. Drilled shafts constructed out of tolerance are unacceptable and shall be considered defective. These out of tolerance shafts shall be backfilled, in an approved manner, when directed by the engineer until the redesign is completed and approved.

(a) Horizontal Location: When drilled shafts support a single column, the center of the top of the drilled shaft shall vary no more than 3 inches (75 mm) in the horizontal plane of the position indicated in the plans. The top of all other drilled shafts shall be constructed so that the center is within the following tolerances of the position indicated in the plans unless otherwise directed by the engineer.

Table 814-3
Drilled Shaft Horizontal Tolerance

Drilled Shaft Diameter, D		Horizontal Tolerance	
D ≤ 2 feet	D ≤ 600 mm	3 inches	75 mm
2 < D ≤ 3 feet	600 < D ≤ 900 mm	3 1/2 inches	90 mm
3 < D ≤ 4 feet	900 < D ≤ 1200 mm	4 inches	100 mm
D > 4 feet	D > 1200 mm	6 inches	150 mm

(b) Excavation Vertical Alignment: The vertical alignment of the shaft excavation shall be within 1.5 percent of plumb.

(c) Reinforcing Steel Cage: After all the concrete is placed, the top of the reinforcing steel cage shall be no more than 4 inches (100 mm) above and no more than 3 inches (75 mm) below plan position, and shall be at least 1 inch (25 mm) below the top of the shaft. When the shaft reinforcing cage is to be tied directly to the column steel the shaft reinforcing cage shall be within 1/2 inch (15 mm) of the plan location. On all other shafts, the reinforcing cage shall be concentric with the shaft within a tolerance of 1 1/2 inches (40 mm).

(d)Top Elevation of Shafts: The top elevation of the drilled shaft concrete shall be within 2 inches (50 mm) of the top of shaft elevation shown in the plans.

(e) Drilled Shaft Diameter: The minimum diameter of the drilled shaft shall be the diameter shown in the plans.

(f) Excavation Equipment And Methods: Excavation equipment and methods shall be designed so that the completed shaft excavation will have a flat bottom and shall be normal to the axis of the shaft within 3/4 inch per foot (60 mm/m) of drilled shaft diameter. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of plus or minus 3/8 inch per foot (30 mm/m) of drilled shaft diameter.

814.18 DEFECTIVE DRILLED SHAFTS. The contractor shall be responsible for correcting defective drilled shafts, including redesign, to the satisfaction of the engineer. All corrective proposals to restore or replace defective drilled shafts shall be reviewed for approval by the Department. Corrective actions may consist of, but are not limited to: removing the shaft concrete and extending the shaft deeper, providing straddle shafts, or providing a replacement shaft. No compensation will be paid for abandoned casings, concrete, etc. that remain in place. When the drilled shaft is found defective,
core sampling and additional nondestructive testing shall be at no direct pay. If the shaft is accepted, only core sampling and grouting, will be paid for by the Department. A unit price for coring will be established prior to the coring operations.

814.19 NONDESTRUCTIVE TESTING OF DRILLED SHAFTS. The nondestructive testing (NDT) method termed Crosshole Sonic Logging (CSL) shall be used to check the integrity of newly-placed concrete drilled shafts. The CSL testing system shall measure the time it takes for an ultrasonic pulse to travel from a signal source in one access tube to a receiver in another access tube.

The CSL test shall be used on all production shafts, trial shafts, and test drilled shafts when any of the following conditions occur:

1. A drilled shaft is constructed with the placement of concrete through slurry.

2. A full-length casing is used to prevent water from entering the shaft.

3. Determined to be necessary by the engineer.

The installation of access tubes and dewatering/grouting the tubes after the CSL testing has been performed shall be at no direct pay.

(a) NDT Consultant: The NDT consultant shall be an experienced independent test organization approved by the engineer prior to testing. All CSL testing and analyses shall be performed under the supervision of a registered professional engineer in the State of Louisiana. The NDT consultant shall have a minimum of three years experience in field testing and analyses of CSL test results.

(b)Testing Schedule: The CSL testing for all drilled shafts shall not be conducted until 24 hours after the placement of all concrete in a shaft. After placement of concrete, all CSL tests for production drilled shafts must be completed within 48 hours for PVC access tubes and 20 calendar days for steel access tubes. CSL tests for trial shafts and test drilled shafts must be

completed within 48 hours after placement of concrete. During the development of the CSL testing schedule, the contractor shall consider the CSL testing time constraints and the drilled shaft production schedule.

(c) Access Tubes: Access tubes used for production drilled shafts shall be 2.0 inch (50 mm) inside diameter schedule 40 steel pipe or PVC pipe. The pipes shall have a round, regular internal diameter free of defects or obstructions, including pipe joints, in order to permit the free, unobstructed passage of a 1.3 inch (33 mm) diameter source and receiver probes. The tubes and joints shall be watertight and free from corrosion with clean internal and external faces to ensure passage of the probes and a good bond between the concrete and the tubes.

Access tubes shall be installed for the full depth of each shaft to permit access of CSL testing equipment. The number of access tubes installed shall depend on the diameter of the shaft as specified in Table 814-4.

Table 814-4

Drilled Shaft Access Tubes for CLS Testing

Shaft Diameter, D (Feet)	Shaft Diameter, D (m)	Minimum Number of Access Tubes
$D < 2.5$	$D < 0.75$	2
$2.5 < D \leq 3.5$	$0.75 < D \leq 1.00$	3
$3.5 < D \leq 4.5$	$1.00 < D \leq 1.40$	4
$4.5 < D \leq 5.5$	$1.40 < D \leq 1.70$	5
$5.5 < D \leq 6.5$	$1.70 < D \leq 2.00$	6
$6.5 < D \leq 7.5$	$2.00 < D \leq 2.30$	7
$7.5 < D \leq 8.5$	$2.30 < D \leq 2.60$	8
$8.5 < D \leq 9.0$	$2.60 < D \leq 2.80$	9
$9.0 < D \leq 10.0$	$2.80 < D \leq 3.10$	10
$10.0 < D \leq 11.0$	$3.10 < D \leq 3.40$	11
$11.0 < D \leq 12.0$	$3.40 < D \leq 3.70$	12

The pipes shall each be fitted with a watertight shoe on the bottom and a removable cap on the top. The pipes shall be securely attached to the interior

of the reinforcement cage. The engineer may allow the tubes to be installed on the outside of the cage if the access tubes have a minimum concrete cover of 3 inches (75 mm) and bumpers are installed on the outside of the cage to prevent tubes from being crushed. The tubes shall be installed in each shaft in a regular, symmetric pattern such that each tube is equally spaced from the others around the perimeter of the cage. The tubes shall be as near to parallel and vertical as possible. The tubes shall be fastened to the reinforcement cage at 5 feet (1.5 m) intervals or as directed by the engineer. The tubes shall extend from 6 inches (150 mm) above the shaft bottom to at least 3 feet (1 m) above the shaft top. If the shaft top is subsurface, the tubes shall extend at least 3 feet (1 m) above the ground and/or water surface. Care shall be taken during reinforcement installation operations in the drilled shaft hole so as not to damage the tubes. Within 2 hours after concrete placement, the access tubes shall be filled with clean water and the tube tops capped or sealed to keep out debris. Care shall be exercised in the removal of caps or plugs from the pipes after concrete placement so as not to apply excess torque, hammering, or other stresses which could break the bond between the access tubes and the concrete.

(d)CSL Test Equipment: The CSL test equipment shall be capable of performing the following functions:

1. Displaying individual CSL records, recording CSL data, and analyzing receiver responses.

2. Printing of CSL logs.

3. Testing in 2 inch (50 mm) I.D. access tubes.

4. Generating an ultrasonic voltage pulse to excite the source with a synchronized triggering system to start the recording system.

5. Measuring and recording the depths of CSL probes at the time signals are recorded.

6. Filtering/amplifying signals.

(e) CSL Logging Procedures: The shaft identification, shaft bottom and top elevations, length, and date of concrete placement shall be provided to the NDT consultant prior to performing CSL testing. As a minimum, all perimeter tube pairs and major diagonal tube pairs shall be tested. If a possible defect is found, CSL testing shall be conducted between additional pairs of tubes as determined by the NDT consultant.

The CSL tests shall be carried out with the source and receiver probes in the same horizontal plane unless test results indicate potential defects in which

case the questionable zone may be further evaluated with angled tests consisting of the source and receiver vertically offset in the access tubes. CSL measurements shall be made at depth intervals of 2 inches (50 mm). The probes shall be pulled simultaneously, starting from the bottom of the tubes, over a depth measuring device. Any slack shall be removed from the cables prior to pulling to provide for accurate depth measurements.

(f) CSL Testing Results: A preliminary report shall be provided to the Pavement and Geotechnical Services Section within 72 hours of CSL testing. Two copies of the final CSL testing report shall be furnished to the engineer within 10 working days of testing. The test results shall include CSL logs with analyses of the initial pulse arrival time versus depth and pulse energy/amplitude versus depth. A CSL log shall be presented for each tube pair tested with any defect zones indicated on the logs and discussed in the test report as appropriate. A summary of the CSL test results shall be included in the report. The CSL test summary shall include the drilled shaft identification, test date, shaft age at time of CSL testing (days from concrete placement to CSL testing), drilled shaft diameter, number of CSL tubes tested, test length, average compression velocity, and a description of anomalies detected. Each CSL anomaly description shall include CSL tube number, depth below top of concrete, percent concrete wave speed reduction, and recommended concrete condition rating.

(g)Evaluation of CSL Testing: The Geotechnical Engineer will evaluate the CSL test results and determine whether the drilled shaft construction is acceptable. The contractor shall allow three working days for the evaluation to be conducted after the receipt of the testing report and logs. In uniform good quality concrete, the CSL test will produce records with good signal amplitude and energy. Longer travel times or loss of signal and lower amplitude/energy signals indicate the presence of irregularities such as poor quality concrete, voids, honeycomb and soil intrusions. Any defects indicated by the testing shall be reported to the Geotechnical Engineer and further tests shall be conducted as required to evaluate the extent of such defects. Additional nondestructive testing to determine extent of defects or to determine if tube debonding has occurred shall be at no additional pay. If the Geotechnical Engineer determines that the drilled shaft is unacceptable based on CSL or other nondestructive testing, the shaft shall be considered defective.

(h)Abandoning CSL Access Tubes: After the CSL testing has been completed and the engineer has given approval to continue construction, the

contractor shall dewater and grout the access tubes in the drilled shaft. The grout and grouting method shall be approved by the engineer.

814.20 CORE DRILLING OF DRILLED SHAFT CONCRETE. Production drilled shafts or test drilled shafts that are determined to be unacceptable by the CSL tests, or drilled shafts that, in the opinion of the engineer, are suspected to have defects, may be cored to determine the quality of the concrete. Number, depth, and location of cores shall be as determined by the engineer. Core samples shall be at least 2 inches (50 mm) in diameter. The methods and equipment used to core the drilled shaft and grout the cored hole shall be approved by the engineer prior to commencing coring operations.

(a) Concrete Core Log: An accurate log of cores shall be kept and the cores shall be placed in a crate and properly marked showing the shaft depth at each interval of core recovery. The engineer shall direct the contractor where to transport the cores along with a copy of the coring log.

(b)Concrete Core Sample Evaluation: Construction shall not proceed above a drilled shaft until the quality of the concrete in the shaft, as represented by the core samples, is determined to be acceptable and notification to continue construction is given by the engineer. If the quality of the concrete in a drilled shaft is determined to be unacceptable, then the drilled shaft shall be considered defective.

814.21 TRIAL SHAFTS. When shown in the plans or when ordered by the engineer in writing, trial shafts will be required. The construction of trial shafts will be used to determine if the methods and equipment used by the contractor are sufficient to produce a shaft excavation meeting the requirements of the plans and specifications. Trial shafts shall be constructed and approved prior to constructing production shafts. Trial shafts will be evaluated based on field observation and will not be finalized prior to receiving CSL results. The contractor will be evaluated during trial shaft excavations on his ability to:

1. Control dimensions and alignment of excavations within tolerances.

2. Seal the casing into impervious materials.

3. Control the size of the excavation under caving conditions by the use of slurry or by other means.

4. Properly clean the completed shaft excavation.

5. Construct excavations in open water areas.

6. Determine the elevation of ground water.

7. Satisfactorily place concrete meeting the specifications within the prescribed time frame.

8. Properly pick up and position the reinforcing cage.

9. Satisfactorily execute any other necessary construction operations.

The contractor shall revise his methods and equipment as necessary at any time during the construction of the trial shaft when he is unable to satisfactorily carry out any of the necessary operations described above.

(a) Location, Size, and Depth: The trial shaft shall be drilled at the location shown in the plans, or as directed by the engineer. If the diameter of the trial shaft is not shown in the plans, the trial shaft diameter shall be the diameter of the largest production drilled shafts required by the plans. If the depth of the trial shaft is not shown in the plans, the trail shaft depth shall be the depth of the deepest production drilled shaft, or as directed by the engineer.

(b)Construction Requirements: The trial shaft shall be constructed with a reinforcing cage containing the same reinforcing steel configuration as shown in the plans for the production shafts. The trial shaft shall be filled with concrete in the same manner that production reinforced drilled shafts will be constructed, unless directed otherwise by the engineer. The concreted trial shaft shall be left in place except that the top of the shaft shall be removed to a depth of 2 feet (600 mm) below the final ground line. This also shall apply to shafts constructed in water.

(c) Trial Shaft Evaluation: When the contractor fails to demonstrate, to the engineer, the adequacy of his methods or equipment, additional trial shafts shall be provided at no cost to the Department. No test drilled shafts or production shafts shall be constructed until the trial shaft has been evaluated. This evaluation will include review of excavation methods, field construction procedures, and all CSL test results.

814.22 MEASUREMENT.

(a) Drilled Shafts: Drilled shafts shall be measured from the approved tip elevation by the linear foot (lin m).

(b) Trial Shafts: Trial shafts will be measured by the linear foot (lin m) installed.

(c) Permanent Casing: Permanent casing shall be measured by the linear foot (lin m).

(d)Crosshole Sonic Logging: Crosshole Sonic Logging shall be measured for each drilled shaft tested.

814.23 PAYMENT.

(a) Drilled Shafts: Payment for drilled shafts will be made by the linear foot (lin m) and will include all necessary materials and equipment required for excavating, pumping, furnishing and placing casings, furnishing and placing concrete and reinforcement, removing casings, casings left in place, slurry, slurry testing equipment and performing slurry testing, disposing of slurry, furnishing and installing access tubes for nondestructive testing, any delays due to nondestructive testing schedule, and disposing of excess excavated

material. No payment will be made for concrete required to fill oversize casings or excavation.

Acceptance and payment for concrete drill shafts will be on a lot basis at the contract unit price per linear foot (lin m), adjusted in accordance with the following provisions. A lot will be considered as a continuous identifiable pour that is completed in one day. Multiple shafts poured on the same day but in a non-continuous pouring operation will require separate lots for each identifiable pour. Six cylinders per lot will be tested for compressive strength and in the event of sudden cessation of operation a minimum of three cylinders will constitute a lot. Acceptance and payment for each lot will be made in accordance with Table 901-5 and Note 1. Authorized overruns shall be paid as follows:

1. Payment for shaft lengths in excess of plan length, up to and including 16 feet (5 m) will be made at the contract unit price per linear foot (lin m). When reinforcing splices are required due to increases in shaft length up to and including 16 feet (5 m) the additional deformed reinforcing steel required for splices will be paid for at the contract unit price. No other compensation will be made for increases in shaft lengths up to 16 feet (5 m).

2. Payment for that portion of shaft lengths greater than 16 feet (5 m) will be made in accordance with Subsection 109.04.

(b) Trial Shafts: Payment for trial shafts will be made at the contract unit price per linear foot (lin m) and shall include the cost of CSL Testing. Payment for trial shafts required by the engineer but not specified by the

plans, except when required for acceptance of polymer slurries, will be made in accordance with Subsection 109.04.

(c) Permanent Casing: Payment for permanent casing shall be paid at the contract unit price per linear foot (lin m).

(d)Crosshole Sonic Logging: Payment for Crosshole Sonic Logging testing shall be made at the contract unit price per each drilled shaft tested. Payment shall be for all labor, materials, equipment, and incidentals necessary to perform the required test and furnish the CSL report.

Payment will be made under:

Item No.	Pay Item	Pay Unit
814-01	Drilled Shaft (Diameter)	Linear Foot (Lin m)
814-02	Trial Shaft (Diameter)	Linear Foot (Lin m)
814-03	Permanent Casing	Linear Foot (Lin m)
814-04	Crosshole Sonic Logging (Diameter)	Each

Section 815
Welding

815.01 DESCRIPTION. Welding of structural steel, steel pipe and tubular members, reinforcing steel and aluminum alloys (including qualification of procedures, welders and welding operators, destructive and nondestructive testing, etc.) shall comply with these specifications.

815.02 QUALIFICATION OF PROCEDURES, WELDERS AND WELDING OPERATORS.

(a) General:

(1) The Construction Section shall be the qualifying agency.

(2) Qualifying tests may be made at locations selected by the contractor and approved by the Department. Advance notice of not less than 1 week shall be given to the Construction Section so that the Department can arrange for the presence of the inspector.

(3) Seven copies of the required reports shall be furnished to the Construction Section.

(4) Each welder and welding operator's work shall be identified with a steel stencil.

(5) The social security number and 1 inch by 1 inch (25 mm by 25 mm) passport type picture of each qualifying welder and welding operator shall be furnished. The social security number of the qualified welder and welding operator shall be recorded on the required reports. The qualified welder and welding operator shall have the identification card in their possession when working.

(6) All costs incidental to welding qualifications shall be the responsibility of the contractor.

(b) Structural Steel, Steel Pipe and Tubular Members:

(1) Structural Steel: Welding procedures, welders and welding operators shall be qualified in accordance with the latest edition of ANSI/AASHTO/AWS D1.5 (D1.5M) Bridge Welding Code.

(2) Steel Pipe and Tubular Members: Welding procedures, welders and welding operators shall be qualified in accordance with the latest edition of ANSI/AWS D1.1 (D1.1M) Structural Welding Code-Steel.

(c) Reinforcing Steel: Welding qualification for reinforcing steel shall comply with the latest edition of AWS D 1.4Structural Welding Code-Reinforcing Steel.

(d) Aluminum: Welding qualification for aluminum alloys shall comply with the latest edition of ANSI/AWS D 1.2 Structural Welding Code-Aluminum.

(e) Electrodes:

(1) Structural Steel: Electrodes shall be qualified and certified in accordance with the latest edition of ANSI/AASHTO/AWS D1.5 (D1.5-M) Bridge Welding Code.

(2) Steel Pipe and Tubular Members: Electrodes shall be qualified and certified in accordance with the latest edition of ANSI/AWS D1.1(D1.1 M) Structural Welding Code-Steel.

(3) Aluminum: Electrodes shall be qualified and certified in accordance with the latest edition of ANSI/AWS D1.2(D1.2M), Structural Welding Code-Aluminum.

815.03 WELDING. Size, type and length of welds shall be shown on the plans. The use of electroslag and electrogas welding processes will not be permitted.

(a) Structural Steel, Steel Pipe and Tubular Members:

(1)Structural Steel: Welding of structural steel shall comply with the latest edition of ANSI/AASHTO/AWS D1.5 (D1.5M) Bridge Welding Code. All minimum preheat and interpass temperatures in this code that are less than 125°F (50°C) are amended to be a minimum of 125°F (50°C).

(2) Steel Pipe and Tubular Members: Welding of steel pipe and tubular members shall comply with the latest edition of ANSI/AWS D1.1(D1.1M) Structural Welding Code-Steel. All minimum preheat and interpass temperatures in this code that are less than 125°F (50°C) are amended to be a minimum of 125°F (50°C).

(b)Reinforcing Steel: Welding of reinforcing steel shall comply with the latest edition of AWS D1.4 Structural Welding Code-Reinforcing Steel.

(c) Aluminum: Welding of aluminum alloys shall comply with the latest edition of ANSI/AWS D1.2(D1.2M) Structural Welding Code-Aluminum.

815.04 NONDESTRUCTIVE TESTING.

(a) Structural Steel, Steel Pipe and Tubular Members:

(1) Structural Steel: Non-destructive testing shall comply with the ANSI/AASHTO/AWS latest edition of D1.5 (D1.5M) Bridge Welding Code except that the ends of all groove welds on main members shall be tested with the dye penetrant inspection method.

(2) Steel Pipe and Tubular Members: Non-destructive testing shall comply with the latest edition of ANSI/AWS D1.1(D1.1M) Structural Welding Code-Steel.

(3) Edge Block: Edge blocks shall be used when radiographing butt welds greater than 1/2 inch (13 mm) in thickness. The edge blocks shall have a length sufficient to extend beyond each side of the weld centerline for a minimum distance equal to the weld thickness, but no less than 2 inches (50 mm), and shall have a thickness equal to or greater than the thickness of the weld. The minimum width of the edge blocks shall be equal to half the weld thickness, but not less than 1 inch (25 mm). The edge blocks shall be centered on the weld with a snug fit against the plate being radiographed, allowing no more than a 1/16 inch (2 mm) gap. Edge blocks shall be made of radiographically clean steel and the surface shall have an ANSI 125 μinch (3.2 μm) or smoother finish.

(b)Reinforcing Steel: Non-destructive testing shall comply with the latest edition of AWS D1.4Structural Welding Code-Reinforcing Steel.

(c) Aluminum: Non-destructive testing shall comply with the latest edition of ANSI/AWS D1.2 (D1.2M) Structural Welding Code-Aluminum. For sign structures, the dye penetrant method shall be used on butt welds in columns and main chord members, including associated flanges, gussets or main load carrying brackets or members also on fillet welds connecting flanges to main truss chord members.

(d)Personnel Qualification: Persons performing ultrasonic testing shall be qualified by tests administered by the Construction Section, unless otherwise approved.

815.05 MEASUREMENT AND PAYMENT. There will be no direct payment for radiographic inspection, magnetic particle inspection, dye penetrant inspection or other tests as specified.

There will be no measurement or payment made for weld metal deposited; however, there will be no deduction made for removal of metal to be welded due to edge preparation.

PART IX -- PORTLAND CEMENT CONCRETE

Section No. **Page No.**

Section 901
Portland Cement Concrete

901.01 GENERAL. This section specifies requirements for portland cement concrete, including methods and equipment for handling and storing materials, and mixing and transporting concrete to the site.

Structural concrete is designated by class and pavement concrete by type.

No concrete shall be mixed, placed or finished when natural light is insufficient, unless an approved artificial lighting system is provided. No concrete shall be placed on a frozen subgrade nor shall frozen aggregates be used in concrete.

Portland cement concrete shall conform to the requirements of Table 901-3, Master Proportion Table for Portland Cement Concrete. It shall be a mixture of portland cement**,** portland-pozzolan cement, or portland blast-furnace slag cement, fine aggregate, coarse aggregate, water and, when specified or allowed, approved admixtures. Fly ash or ground granulated blast furnace slag will be permitted as a partial replacement for portland cement in accordance with Subsection 901.08.

Portland cement concrete shall require a Department approved mix design, be produced from a Department certified plant and be transported in Department certified trucks. The design, control and transportation of concrete mixtures in accordance with these specifications shall be the responsibility of the contractor.

Sufficient plant capacity and transporting apparatus to ensure delivery at the required rate shall be provided. Rate of concrete delivery during concreting operations shall provide for proper handling, placing and finishing of concrete and maintaining a workable surface.

Methods of delivery and handling concrete shall facilitate placing with a minimum of rehandling and without damage to the structure or concrete.

Approved laboratory facilities and testing equipment necessary to sample, test, and control concrete mixtures shall be provided by the contractor. These facilities will not be required for plants producing only minor structure concrete complying with Table 901-3. A laboratory conforming to Section 722 shall be located at an approved location at the plant site. The laboratory shall be for quality assurance purposes.

Quality assurance requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Assurance

Specifications for Portland Cement Concrete Pavement and Structures" or "Application of Quality Assurance Specifications for Precast-Prestressed Concrete Plants."

901.02 MATERIALS. Materials shall comply with the following Subsections:

Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Masonry Cement	1001.03
Aggregates	1003.01 & 1003.02
Admixtures	1011.02
Water	1018.01
Fly Ash	1018.15
Portland Blast-Furnace Slag Cement	1001.04
Ground Granulated Blast Furnace Slag	1018.27
Microsilica (Silica Fumes)	1018.28

Cement, fly ash**,** ground granulated blast furnace slag and microsilica shall be certified by the manufacturer in accordance with the Department's current procedures.

The contractor shall keep accurate records of cement, fly ash, ground granulated blast furnace slag, and microsilica deliveries and their use in the work. Copies of these records shall be furnished to the engineer in such form as required.

901.03 TRANSPORTATION AND STORAGE OF CEMENTITIOUS MATERIALS AND MICROSILICA. Cement, fly ash, ground granulated blast furnace slag, and microsilica shall be transported in watertight conveyances and stored in separate approved facilities so that cement, fly ash, ground granulated blast furnace slag, and microsilica will be protected from dampness or water intrusion. Material that is contaminated, is partially set, or contains lumps of caked material will be rejected. When the use of bagged cement, fly ash, ground granulated blast furnace slag or microsilica is permitted, the handling and storage will be as directed.

Different brands or types or the same brand or type from different mills, shall not be mixed or used alternately unless authorized by the DOTD Materials Engineer Administrator. This requirement may be waived in case of plant breakdown during production to allow concrete conforming to the requirements of Subsection 901.01 to be furnished from another plant to finish the placement in progress.

901.04 HANDLING AND STORAGE OF AGGREGATES. Equipment and methods for stockpiling aggregates shall be such that no detrimental degradation or segregation of aggregate will result; no appreciable amount of foreign material will be incorporated into aggregate; and there will be no intermingling of stockpiled materials. Stockpiles of aggregates shall be well drained and shall have uniform moisture content. Material shall not be added to working faces of the stockpiles during continuous operations.

When specified, coarse aggregate shall be separated into two or more sizes to ensure greater uniformity of the concrete mixture. Different grades and types of aggregates shall be stored in separate stockpiles separated by bulkheads or sufficiently separated from each other to prevent material at edges of piles from intermingling. When segregation occurs in the processing and handling of Grade D coarse aggregate, the aggregate shall be separated at the 1-inch (25 mm) sieve into two stockpiles. The stockpiled material shall be reproportioned to meet the gradation requirements of Grade D. Activity that results in contamination or intermingling of aggregates, including overhead handling for the loading of bins or building of stockpiles, will not be permitted.

Aggregates shall be handled from stockpiles or other sources to the batch plant so as to secure uniform grading of material. Aggregates that have become segregated or contaminated shall not be used. Aggregates processed or handled by hydraulic methods, and washed aggregates, shall be stockpiled or placed in bins for adequate drainage. Transport containers will be accepted as an adequate bin when adequate drainage is provided. Drainage of aggregates shall meet the approval of the engineer prior to batching. The engineer may require water sprinkling of coarse aggregates in stockpiles that have dried to the extent that the aggregates absorb mixing water. Such sprinkling shall continue until aggregates are saturated.

901.05 SAMPLING AND TESTING. Sampling and testing will be done in accordance with the Department's Materials Sampling Manual and the Department's Testing Procedures Manuals. The contractor shall furnish necessary materials for testing at no direct pay.

901.06 QUALITY CONTROL OF CONCRETE. The contractor shall be responsible for quality control of materials during handling, proportioning, mixing, and placement operations; for initial determination and necessary subsequent adjustments in proportioning of materials used to produce the specified concrete; and for providing suitable equipment for

determination of aggregate gradation, moisture, air content, slump, unit weight (mass), temperature, and trial mixes as necessary. Testing and analysis of the mix for quality control purposes, the setting of dials, gages, scales or meters, adjusting batch weights, and accurate batching shall be the responsibility of the contractor.

The contractor shall have a Certified Concrete Technician present at the plant or job site to make adjustments in batch weights for moisture content, perform necessary adjustments in proportioning materials to produce the specified concrete, and perform tests necessary for control of the concrete mix within specifications requirements. Daily plant operations shall not begin unless the Certified Concrete Technician is at the plant to determine that gradations, moisture contents, and adjusted batch weights are within specifications limits. If a Certified Concrete Technician is not available at the job site, an Authorized Concrete Field Tester is allowed to perform the job site control tests for slump, air content, and mix temperature and report the results to the Certified Concrete Technician. The use of an Authorized Concrete Field Tester at the job site will not relieve the Certified Concrete Technician from performing the remaining duties as outlined in these specifications.

The contractor's Certified Concrete Technician and Authorized Concrete Field Tester shall be certified or authorized upon satisfactory completion of the Department's requirements.

(a) Mix Design: Mixtures shall produce concrete of suitable workability. Slumps shall be within the ranges shown in Table 901-3 or as specified when tested in accordance with DOTD TR 207. The engineer may authorize an increase in maximum slump, by use of water reducers, for concrete used in the construction of walls and diaphragms less than 8 inches (200 mm) thick, and where the engineer considers necessary provided the water-cement ratio is not exceeded and conventional forms are used.

Concrete mixes shall be formulated to produce concrete which, when molded and cured in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230, shall show an average compressive strength not less than as shown in Table 901-3. Class P, Class P(M) and Class P(X) concrete cylinders for compressive strength tests shall be cured by the same methods used in curing the members they represent.

The contractor's Certified Concrete Technician shall submit a proposed concrete mix design on a form provided by the Department giving the intended sources of materials and the mix design for concrete to be furnished. No work shall be started until the portland cement concrete mix

design has been reviewed and accepted. Review and acceptance of this mix design does not release the contractor from the responsibility of producing concrete that meets the minimum requirements of the specifications.

Proportioning for volume of coarse aggregates in concrete mixes, excluding concrete pipe, Types B and D pavement, and minor structure concrete shall be in accordance with Table 901-1 below. An example of proportioning of coarse aggregate is shown in the Department's publication entitled "Application of Quality Assurance Specifications for Portland Cement Concrete Pavement and Structures".

Table 901-1
Volume of Coarse Aggregate Per Unit of Volume of Concrete

Maximum Size of Aggregate, Inches (mm)	Volume of Dry-Rodded Coarse Aggregate Per Unit Volume of Concrete for Different Fineness Moduli of Fine Aggregate[1]				
	2.20	2.40	2.60	2.80	3.00
3/8 (9.50)	0.52	0.50	0.48	0.46	0.44
1/2 (12.5)	0.61	0.59	0.57	0.55	0.53
3/4 (19.0)	0.68	0.66	0.64	0.62	0.60
1 (25.0)	0.73	0.71	0.69	0.67	0.65
1 1/2 (37.5)	0.77	0.75	0.73	0.71	0.69
2 (50.0)	0.80	0.78	0.76	0.74	0.72
3 (75.0)	0.84	0.82	0.80	0.78	0.76

[1]Volumes are based on aggregates in dry-rodded condition as described in AASHTO T19, Unit Weight of Aggregate. These volumes are selected from empirical relationships to produce concrete with a degree of workability suitable for usual reinforced concrete construction. For less workable concrete such as required for concrete pavement construction, they may be increased up to 10 %. For more workable concrete, as may be required for pumping, they may be reduced up to 10%.

In developing mix designs for portland cement concrete pavement Types B and D, the proportions of the aggregate sizes to be used shall meet the requirements of Subsection 1003.02(c).

Trial mixes are required to demonstrate the mix performance and the compatibility of mix components for the following:

(1) Fly Ash
(2) Ground Granulated Blast Furnace Slag
(3) Microsilica
(4) Heavyweight Concrete
(5) Flexural Strength (when required)
(6) Unusual Materials and Applications

For the above trial mixes the contractor shall submit test results for slump, unit weight (mass), air content, set times, and compressive strength (flexural strength for pavements) at 3, 7, and 28 days. The contractor shall furnish materials to the Department for verification of trial mixes.

When requested by the contractor, the Department will determine gradation, unit weight (mass), specific gravity and absorption factor of the aggregates.

Trial mixes may be waived in writing by the District Laboratory Engineer for previously accepted mix designs.

The minimum cement factors may be waived in writing by the District Laboratory Engineer provided the contractor's mix design meets the average compressive strengths in Table 901-3 plus the over-design compressive strengths in Table 901-4.

(b) Quality Control Tests: The contractor shall be responsible for determining gradation and moisture content of fine and coarse aggregates used in the concrete mixture and for testing the mixture at the job site for slump, unit weight (mass), temperature, and air content (when used). The contractor shall conduct operations to produce a mix complying with the reviewed and accepted mix design, except that variations will be permitted within specified control limits for individual samples. Test results for gradation, slump, unit weight (mass), and air content shall be plotted on control charts for individual samples. These control charts shall be submitted to the engineer.

Times at which to obtain control test samples shall be set by the contractor using random number tables in accordance with DOTD S 605 or by random selection. Gradation control limits of aggregates shall be as shown in Subsection 1003.02. When required, additional test samples shall be taken as directed for slump, concrete temperature, and air content.

The minimum number of quality control tests to be performed by the contractor for structural and pavement concrete shall be in accordance with the Materials Sampling Manual. For minor structure concrete only, the contractor will not be required to have a Certified Concrete Technician or Authorized Concrete Field Tester, but shall implement a quality control testing program to ensure that the concrete meets the requirements of these specifications.

When producing concrete for Types B and D pavements, gradations shall be determined daily on each stockpile of aggregate to be used. All gradation calculations shall be based on percent of dry weight (mass). Upon determination of the gradation of each stockpile, the percent of the total aggregates retained shall be determined mathematically based on the

proportions of the combined aggregate blend, and checked for conformance with Table 1003-1A.

(c) Mix Adjustments: With prior notification given to the engineer, the contractor may adjust the ratio of fine to coarse aggregate as reviewed and accepted, by no more than 5 percent. In no case shall it be adjusted so as to materially affect the volume of concrete. If the proportions of the aggregate sizes used do not satisfy the gradation requirements of Subsection 1003.02(c) due to changes in the gradation of one or more stockpiles, the proportions shall be adjusted to bring the combined aggregates back within specification limits. These minor adjustments for gradation will not require a new mix design. The mix produced shall be uniform, workable and within the specification limits of Table 901-3. When plant operations do not produce a uniform and workable mix, plant operations shall cease and corrective action shall be taken prior to restart.

When tendency of individual slump, air content, concrete temperature, or gradation measurements, as plotted on control charts, indicates that the mix is not uniform and may fall outside tolerance limits, the contractor shall immediately make adjustments to keep the mix within specified limits. If the contractor fails to make proper adjustments and the mix deviates from specification requirements or if the mix is obviously defective, the mix will be rejected.

For workability properties only, changes in mix proportions will be permitted provided the water-cement ratio is not exceeded, minimum cement factor is maintained, proper batch adjustments are made, and prior notification is given to the engineer.

No changes in source of materials or percentage of cement, fly ash, ground granulated blast furnace slag, or microsilica shall be made until a new Mix Design form showing the new material or adjusted proportions has been submitted by the contractor and approved.

(d) Acceptance and Verification for Types B and D Pavements: Sampling and testing for acceptance and verification for concrete for Types B and D pavements shall be in accordance with the provisions of the Materials Sampling Manual, except as follows:

(1) Gradation testing for acceptance will not be required.

(2) Verification tests will be performed by the District Laboratory to assure conformance to the gradation of the total combined aggregates shown in Table 1003-1A at the frequency of one sample per aggregate size per lot, with a maximum of one sample per aggregate size per day. Samples are to be obtained from the aggregate feed (conveyor) belt as

described in the Materials Sampling Manual, DOTD Designation S101, Aggregates and Aggregate Mixtures.

(3) Upon determination of the gradation of each aggregate size sampled, the percent retained based on the dry weight (mass) of the total combined aggregates will be determined mathematically based on the proportions of the combined aggregate blend, and checked for conformance with Table 1003-1A.

(4) If the results of the verification sample indicate that the combination of aggregates being used does not meet the requirements of Subsection 1003.02(c), the aggregates shall be re-sampled and tested again. If the results of the second verification sample indicate that the combination of aggregates being used does not meet the requirements of Subsection 1003.02(c), the contractor will be notified and required to make adjustments to his operations to produce a mix meeting these specifications. No concrete from this plant shall be placed on DOTD projects until the adjustments are made and approved by the District Laboratory Engineer. An additional verification sample may be required prior to resuming operations.

901.07 SUBSTITUTIONS. Mixtures may be substituted with approval in accordance with Table 901-2.

Table 901-2
Portland Cement Concrete Mixture Substitutions

Structural Class[1]	Substitute
AA (M)	No Substitutions
AA	AA(M)
A(M)	AA(M), AA
A	AA(M), AA, A(M)
D	No Substitutions
F	No Substitutions
P(X)	No Substitutions
P(M)	No Substitutions
P	P(M)
S	No Substitutions
Minor Structure Class[1]	
M	AA(M), AA, A(M), A, B
R	AA(M), AA, A(M), A, B, M
Y	No Substitutions
Pavement Type[1, 2]	
B	D
D	B
E	No Substitutions

[1]The mixture being substituted shall meet the requirements of Table 901-3 and the mix design for its class or type. The compressive strength of the substituted mix shall meet the strength requirements of the original mixture specified.
[2]When justified in writing and approved by the engineer, small irregular areas of paving projects using Types B or D concrete may be substituted with Class A concrete.

901.08 COMPOSITION OF CONCRETE. Type of cement and composition of concrete shall be in accordance with the requirements of this subsection and Table 901-3.

(a) Cement: Allowable types of cement are as follows:

Use	Allowable Cement Types
General Construction (Structural Class Concrete and Minor Structure Class Concrete)	Type I or II portland cement; Type IP portland-pozzolan cement; Type IS portland blast-furnace slag cement
Concrete Pavement	Type I or II portland cement; Type IP portland-pozzolan cement; Type IS portland blast-furnace slag cement
Prestressed or Precast Concrete	Type I, II or III portland cement; Type IP portland-pozzolan cement; Type IS portland blast-furnace slag cement

For concrete placements having a least dimension of 48 inches (1200 mm) or greater or if designated on the plans or the project specifications as being mass concrete, the allowable cement type shall be Type II portland cement, Type IP portland-pozzolan cement, or Type IS portland blast-furnace slag cement. The cement, or combination of cement and fly ash or ground granulated blast furnace slag, shall be certified to generate a heat of hydration of not more than 70 calories/gram (290 kJ/kg) at 7 days.

Due to the gradation of aggregate or other conditions, additional cement may be required to achieve minimum compressive strength.

When using only Types I or II portland cement in concrete mixes, fly ash conforming to Subsection 1018.15 or grades 100 or 120 ground granulated blast-furnace slag conforming to Subsection 1018.27 may be partially substituted for portland cement on a pound (kilogram) for pound (kilogram) basis. The contractor may use a maximum of 25 percent fly ash by weight (mass) of cement for concrete pipe, up to 20 percent fly ash by weight (mass) of cement for other minor structures and concrete pavement, and up to 15 percent fly ash by weight (mass) of cement for structural concrete. In lieu of fly ash, the contractor may use grade 100 or grade 120 ground granulated blast-furnace slag up to 50 percent by weight (mass) of cement. The combination of slag and fly ash will not be allowed as a partial substitution for cement.

(b) Chemical Admixtures: An air-entraining admixture will be required in paving concrete when placed by slip-form methods or when a central mixing plant or non-agitating haul trucks are used.

Air-entraining and water-reducing admixtures will be required in Class AA, F or AA(M) concrete. When an air-entraining admixture is used, the total air content of the concrete mix shall be tested in accordance with DOTD TR 202, and shall be as specified in Table 901-3.

A water-reducing admixture will be required for mass concrete.

When the ambient air temperature is 70°F (20°C) or below, the water-reducing admixture shall be the normal-set type. When the ambient air temperature is above 70°F (20°C) and below 85°F (30°C), the water-reducing admixture may be either the normal-set type or the set-retarding type. When the ambient air temperature is 85°F (30°C) or above, the water-reducing admixture shall be the set-retarding type, except for concrete containing fly ash or ground granulated blast furnace slag where this choice is optional. Set-retarding admixtures shall be used in an amount sufficient to produce the necessary retardation; however, the amount used shall not be less than is necessary to comply with Subsection 1011.02.

The contractor shall consider the influence of different materials and job conditions, including local weather on setting characteristics. With approval of the mix design, the contractor may use approved admixtures other than as stated above in order to control setting characteristics.

Admixtures shall comply with Subsection 1011.02 and be listed on QPL 58.

Water contents for superplasticized concrete mixes shall not be reduced to levels that will restrict cement hydration. The amount of water in the superplasticizer shall be included as a part of required mixing water. The dosage of superplasticizer may be adjusted depending on the consistency of the mix.

Final slump of superplasticized concrete shall be appropriate for its application. It shall not exhibit excessive bleeding or segregation of aggregates as determined by the project engineer.

The method of adding and mixing the superplasticizer to the mix shall be as recommended by the manufacturer.

When multiple admixtures are used, the admixtures shall be manufactured by the same company and shall be compatible.

The use of admixtures in other classes or types of concrete will be optional with the contractor with written approval.

(c) Water: The total amount of water in the mixture, including admixtures and free water, shall not exceed the maximum water-cement ratio specified in Table 901-3. Free water shall include all water entering the mix with the aggregates, except water absorbed by the aggregate.

Because of the absorptive nature of lightweight aggregate and the inability to obtain a true saturated surface dry condition for determining free moisture, a maximum amount of water cannot be specified for Class Y concrete. The slump requirement of Table 901-3 or as specified will be the governing factor in determining maximum allowable water.

(d) Aggregate: All aggregates for use in portland cement concrete shall meet the requirements of Subsection 1003.01.

(1) Coarse Aggregate: Coarse aggregate, except for gradations for Types B and D pavements, shall be the grade specified in Table 901-3 and shall comply with the requirements of Subsection 1003.02(b).

(2) Fine Aggregate: Fine aggregate, except for gradations for Types B and D pavements, shall comply with the requirements of Subsection 1003.02(a).

(3) Aggregates for Types B and D Pavements: Aggregates shall comply with the requirements of Subsection 1003.02(c).

901.09 EQUIPMENT.

(a) General: Sufficient plant capacity and transporting equipment to ensure delivery at the required rate shall be provided. Rate of concrete delivery during concreting operations shall provide for proper handling, placing and finishing of concrete and maintain a workable surface. Methods of delivering and handling concrete shall facilitate placing with a minimum of rehandling and without damage to the structure or concrete.

(b) Plant Equipment: Batch plants shall include approved storage, weigh hoppers, and measuring devices. Equipment shall be properly sealed and vented to minimize dusting and loss of material.

Materials shall be incorporated into the mix by methods that will ensure uniform distribution. The amount of each material used in the mix shall be recorded and certified by the contractor's authorized representative.

The plant shall be equipped with adequate water storage and a device for automatically controlling the amount of water used in each batch.

For plants using direct-fill elevating weigh hoppers, computer controlled indicator lights may be used as an indication of aggregate weights but shall not be the sole means of control for aggregate proportioning. Means of control shall be provided so that, as the quantity desired in the weigh hopper is approached, material may be added slowly and shut off with precision. Weigh hoppers shall be constructed as to eliminate accumulation of materials and to discharge completely. Suitable provisions shall be made for removal of overload from the hopper by the operator. Approved radio communication shall be provided between the concrete batcher and front-end loader operator. Actual weights of material batched each time shall be entered on the Batch Certification Form. The plant shall demonstrate satisfactory performance by producing consistent concrete with adequate compressive strengths.

(1) Storage Bins and Silos: For plants with overhead storage bins, which feed directly into the weigh hopper, or storage bins with belt feed to the weigh hopper, the bins shall have adequate separate compartments for fine aggregate and each size of coarse aggregate. Each compartment shall be designed to discharge efficiently and freely into the weigh hopper. Means of control shall be provided so that, as the quantity desired in the weigh hopper is approached, material shall be added slowly and shut off with precision.

Silos shall be weatherproof, sealed, free of holes, and shall prevent contamination. Silos shall be designed to freely discharge and shall be equipped with vibrators to maintain flow of material and prevent accumulation. Silos shall be designed with sufficient capacity for the

operation. Silos shall be provided with a positive means of shut off without leaking into the weigh hopper. A separate silo shall be used for each dry bulk material added to the mix. If a silo is divided into compartments for cement, fly ash, ground granulated blast furnace slag and microsilica, a positive means of separation shall be provided.

(2) Measuring Devices: Materials shall be measured by weighing except where other methods are authorized.

Batch plants may be equipped to proportion materials by approved automatic weighing devices. Moisture probes can be used to determine the moisture content of aggregates for batch adjustment provided the accuracy is confirmed by the engineer to be within 0.5 percent of the results obtained by the Certified Concrete Technician in accordance with DOTD TR 106.

Fine aggregate and each size of coarse aggregate from separate bins shall be weighed either separately or cumulatively on scales in the weigh hopper. The allowable quantities of bulk fly ash, bulk ground granulated blast furnace slag, or bulk microsilica may be weighed cumulatively in the same hopper with the cement, provided the cement is weighed first and the scale system is separate from that used for the aggregates.

Weigh hoppers shall be constructed to eliminate accumulation of materials and to discharge completely. Suitable provisions shall be made for removal of an overload from the hopper by the operator.

Scales shall be accurate to 0.5 percent throughout the range of use. Maximum graduation on scales shall be 0.1 percent of the rated scale capacity. When beam type scales are used, poises shall be designed to be locked in any position to prevent accidental change of position, and the weigh beam and a telltale device shall be in view of the operator. Plant and laboratory measuring devices shall be subject to approval and shall be tested, inspected, and certified by a qualified independent scale service or the Weights and Measures Division of the Louisiana Department of Agriculture and Forestry at no cost to the Department every 90 calendar days, and more often when the engineer deems it necessary to assure their accuracy.

Individual aggregates shall be batched within 2 percent, and the total weight (mass) of aggregate shall be within 1 percent of the required weight (mass).

Cement, fly ash, ground granulated blast furnace slag, and microsilica shall be within 1 percent of the required weight (mass). Cement in standard bags need not be weighed; however, when used, they shall be used in full bag increments and the quantities of other materials shall be

adjusted accordingly. Bagged fly ash and bagged ground granulated blast furnace slag will not be allowed.

Mixing water shall be measured by volume or weight (mass). Water measuring devices shall be accurate to 1 percent at 1/2 the maximum allowable water per batch and the maximum graduation shall be 1 gallon (4 L).

Approved methods and equipment for adding air-entraining admixtures or other admixtures into the batch shall be used. The quantity of admixtures shall be measured into the mixer with an accuracy of 3 percent. Admixtures shall be mechanically dispensed in a liquid state with the mixing water. A separate dispensing device shall be provided for each admixture.

(3) Ticket Printer System: Certified concrete plants may be equipped with an approved automatic ticket printer system for recording required batching information. When an automatic ticket printer system is not used, quantities and batching information shall be determined by visual observation, recorded, and certified correct by the contractor's authorized representative.

The approved ticket printer system shall be tamper-proof and shall print time of batching, amount of water, batch weights, moisture content of aggregates, and quantities of admixtures. The Certified Concrete Technician may add moisture content of aggregates or quantities of admixtures to the printed ticket when the automatic system does not have these capabilities. During a breakdown, quantities shall be determined by visual observation and certified as stated above.

All records of batches shall show batch number, day, month, year, and time of day to the nearest minute for each batch. The maximum quantity of water that can be added at the jobsite shall be shown on the batch ticket. The engineer shall be provided with a legible copy of all batch records identified with lot number and mix design number.

(c) Hauling Equipment: Hauling equipment shall be watertight and shall be capable of discharging concrete at a satisfactorily controlled rate without segregation.

(1) Truck Mixer: Truck mixers shall be the revolving drum type, equipped with pressurized, calibrated tanks for carrying a portion of the mixing water.

Pick-up and throw-over blades in the mixing drum shall be replaced when worn beyond the limit recommended by the manufacturer. The contractor shall have available a copy of the manufacturer's design,

showing dimensions and arrangements of blades in reference to original height and depth.

Only the prescribed and verifiable amount of water is permitted in the tank unless the tank is equipped with a device by which the quantity of water added can be readily verified.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters, which display the number of revolutions. Counters shall be located to provide safe and convenient inspection.

Each truck mixer shall have attached thereto in a prominent place a metal plate on which is plainly marked the uses for which the equipment is designed, the maximum rated capacity of the drum in terms of concrete volume and rotation speed for both agitating and mixing speeds.

Truck mixers shall be equipped with means for accurately measuring the amount of water used in each batch.

(2) Agitator Hauling Equipment: Agitators shall be supplied with adequate mixing blades or paddles to agitate the mix and prevent segregation. Covers shall be provided when directed.

Each agitator shall have attached thereto in a prominent place a metal plate on which is plainly marked the uses for which the equipment is designed, the maximum rated capacity in terms of concrete volume, and agitation speed.

(3) Non-Agitator Hauling Equipment: The bodies of nonagitating hauling equipment shall be smooth, metal, and mortar tight containers. Covers shall be provided when directed.

(d) Portable Mixers: Portable mixers shall have a minimum capacity of one cubic yard (cu m) and shall be capable of uniformly mixing and discharging concrete without segregation.

901.10 BATCHING AND MIXING.

(a) General: Concrete shall be thoroughly mixed in a mixer of an approved size and type, which will ensure uniform distribution of materials through the mass.

Pick-up and throw-over blades or mixing paddles in the mixing drum or mixing unit shall be replaced when worn beyond the limit recommended by the manufacturer. The contractor shall have available a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth.

Mixing operations shall begin within 30 minutes after addition of cement to the aggregates. When cement is charged into a mixer drum containing surface-wet aggregate and the ambient temperature is above

90°F (32°C), or when high early strength cement is used, this limit shall be reduced to 15 minutes. When there is an interruption to the mixing operations, the mixer shall be thoroughly cleaned. The entire contents of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein. Materials composing a batch shall be deposited simultaneously in an operating mixer. A portion of mixing water shall enter in advance of cement and aggregates. No mixer having a rated capacity of less than one cubic yard (cu m) shall be used nor shall a mixer be charged in excess of its rated capacity. The minimum size batch shall be one cubic yard (cu m). Mixers with worn blades or excessive build-up will be rejected. Concrete exposed to salt water or a corrosive environment shall be mixed for 2 minutes and the water content of the mixture shall be carefully controlled.

(b) Central Plant and Site Mixing: Concrete shall be mixed for at least 50 seconds. Mixing time shall begin after all materials, including water, are in the mixer. Mixing time ends when the discharge chute opens. The mixer shall be equipped with an approved timing device, which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. During mixing, the mixer shall be operated at a drum speed for which it has been designed as shown on the manufacturer's name plate on the mixer.

(c) Truck Mixing: Aggregates, cement, fly ash, ground granulated blast furnace slag and microsilica for concrete shall be measured in accordance with Subsection 901.09 and charged into the drum at the proportioning plant.

Size of batch in truck mixers shall not exceed the maximum rated mixing capacity of the mixer as stated by the manufacturer and stamped on a metal plate on the mixer. When a truck mixer is used for complete mixing, each batch shall be mixed for not less than 70 nor more than 130 revolutions of the mixer drum at the rate of rotation designated as the mixing speed by the equipment manufacturer on the metal plate on the mixer. Any additional mixing shall be at the speed designated by the equipment manufacturer as the agitating speed. All materials, including mixing water, shall be in the mixer drum before actuating the revolution counter or taking an initial reading.

When the prescribed amount of water is added at the batch plant and slump is on the low side at the jobsite it will be permissible to add a minimum of 75 percent of the mixing water at the time cement and aggregates are added at the batch plant and the remaining mixing water at the job site prior to discharging concrete into forms. Water added at the

job site may be added in 1 or 2 increments with additional mixing within the range of 20 to 30 revolutions at designated mixer speed for each increment; however, the total of 130 revolutions shall not be exceeded. Water added at the jobsite shall not cause the maximum allowable water-cement ratio or slump of the batch to be exceeded.

If water or superplasticizer is allowed to be added to a partial load, only a proportional amount will be added. The method of adding and mixing superplasticizer to the mix shall be in accordance with the manufacturer's recommendation. When the slump is more than the maximum specification limit, the batch will be rejected; additional mixing or agitation to reduce the slump will not be allowed even though the maximum time limit or number of revolutions have not been exceeded.

Slump tests, unit weight (mass), acceptance cylinders, and temperature measurements will not be made until all mixing water has been added to the batch.

(d) Partial Mixing at Central Plant: When partial mixing is allowed at a central plant, the mixing time at the central plant may be reduced to 30 seconds. Additional required mixing shall be completed in a truck mixer at mixing speed. Mixing time in the truck mixer shall be a minimum of 10 and a maximum of 70 revolutions.

(e) Time Limitations: The maximum allowable time from the addition of cement to the mix to complete discharge of the concrete shall be 90 minutes or a maximum of 300 revolutions, whichever may occur first. When transport is by non-agitator truck, the maximum allowable time from the addition of cement to the mix to complete discharge of the concrete shall be 45 minutes. In hot weather or any other conditions contributing to rapid loss of plasticity or uniformity of concrete, maximum allowable time may be reduced by the engineer.

(f) Hauling Equipment: Wet batches of concrete may be transported in a truck mixer, agitator or other approved equipment. Non-agitator trucks will not be allowed for structural concrete, but will be permitted for pavement concrete when air-entrainment admixture is used. Maximum volume of mixed concrete transported in an agitator truck at agitation speed shall be in accordance with the manufacturer's specified rating.

(g) Portable Mixing: Portable mixers shall be approved in writing for mixing one cubic yard (cu m) of concrete or less per day for minor structure concrete.

(h) Delivery: Sufficient plant capacity and transporting apparatus to insure delivery at the required rate shall be provided. Rate of concrete

delivery during concreting operations shall be such as to provide for proper handling, placing and finishing of concrete and maintain a workable surface. Methods of delivering and handling concrete shall be such as will facilitate placing with a minimum of handling and without damage to the structure or concrete.

901.11 TEMPERATURE LIMITATIONS.

(a) General: Air temperature and mix temperature shall be determined at the point of placement in the shade away from artificial heat.

(b) Hot Weather Limitations: Hot weather limitations shall apply to concrete for:

(1) Bridge Decks, Approach Slabs, and Mass Concrete: Hot weather concreting practices will be required when the job site temperature in the shade and away from artificial heat is 80°F (27°C) and rising. When internal temperature of plastic concrete reaches 85°F (30°C), the contractor shall prevent the temperature of succeeding batches from going beyond 90°F (32°C) by approved methods. If necessary, forms shall be precooled by approved methods immediately prior to concrete placement.

(2) Pavement Concrete: Internal temperature of the plastic concrete shall not exceed 95°F (35°C) at the time of placement.

(c) Cold Weather Limitations: Mixing and concreting operations for concrete mixes not containing ground granulated blast-furnace slag or Type IS cement shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (5°C), and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C) provided the high temperature forecasted by the U.S. Weather Service is above 40°F (5°C). For concrete mixes containing ground granulated blast-furnace slag or Type IS cement, operations shall be discontinued at a descending air temperature in the shade and away from artificial heat of 55°F (13°C) and can resume at a temperature of 50°F (10°C) and rising provided the high temperature forecasted by the U.S. Weather Service is above 55°F (13°C). Production shall not begin until the temperature at the point of placement is within the above limitations. Concrete shall not be placed if the U.S. Weather Service forecasts the temperature to be less than 35°F (2°C) within the 24 hour period following placement unless authorized in writing.

When concrete placement at lower air temperatures is authorized in writing, aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass

uniformly and shall be arranged to prevent occurrence of overheated areas. If the air temperature is less than 35°F (2°C) at the time of placing concrete, the engineer may require water or aggregates to be heated to not less than 70°F (20°C) nor more than 150°F (65°C). After placement, the concrete shall be protected by additional covering, insulating materials, or other methods approved by the engineer.

901.12 ACCEPTANCE AND PAYMENT SCHEDULE. Acceptance and payment schedules in Table 901-5 will apply to all cast-in-place structural portland cement concrete. Acceptance and payment schedules in Table 901-6 will apply to all minor structure portland cement concrete. Acceptance and payment schedules for portland cement concrete pavement are shown in Table 601-1 of Section 601. These schedules do not apply to precast concrete.

Table 901-3
Master Proportion Table for Portland Cement Concrete

	Average Compressive Strength, psi (MPa) at 28 days	Grade of Coarse Aggregate	Min. Cement, lb/yd^3 (kg/m^3) of Concrete [9,14]	Maximum Water/Cement ratio, lb/lb (kg/kg) [1,9]	Total Air Content (Percent by volume) [4]	Slump Range [10], inches (mm)		
						Non-Vibrated	Vibrated	Slip Form Paving [2]
Structural Class [11]								
AA(M)	4400 (30.4)	A, P	560 (332)	0.44	5±1	2-5 (50-125)	2-4 (50-100)	N.A.
AA	4200 (29.0)	A, P	560 (332)	0.44	5±1	2-5 (50-125)	2-4 (50-100)	N.A.
A(M)	4400 (30.4)	A, P	510 (302)	0.53	5±2	2-5 (50-125)	2-4 (50-100)	N.A.
A	3800 (26.2)	A, F [8], P	510 (302)	0.53	5±2	2-5 (50-125)	2-4 (50-100)	1-2.5 (25-65)
D	3300 (22.8)	A, B, D, P	420 (249)	0.58	5±2	2-5 (50-125)	1-3 (25-75)	N.A.
F	3400 (23.5)[5]	A,P	460 (273)	0.44	5±1	2-5 (50-125)	2-4 (50-100)	N.A.
P(X)	7500 (51.7)[5]	A, F [8], P	700 (415)	0.40	5±2	N.A.	2-10 (50-250)	N.A.
P(M)	6000 (41.4)[5]	A, F [8], P	600 (356)	0.44	5±2	N.A.	2-6 (50-150)[7]	N.A.
P	5000 (34.5)[5]	A, F [8], P	560 (332)	0.44	5±2	N.A.	2-6 (50-150)[7]	N.A.
S	3800 (26.2)	A,P	650 (385)	0.53	5±2	6-8 (150-200)	N.A.	N.A.
Minor Structure Class [11]								
M	3000 (20.7)	A, B, P	470 (279)	0.56	5±2	2-5 (50-125)	2-4 (50-100)	1-2.5 (25-65)
R	1800 (12.4)	A, B, D, P	370 (219)	0.70	5±2	2-5 (50-125)	2-4 (50-100)	N.A.
Y	3000 (20.7)	Y	560 (332)	-[3]	6-9	N.A.	1-3 (25-75)	N.A.
Pavement Type [11]								
B	4000 (27.6)[6]	N/A[13]	475 (282)	0.53	5±2	N.A.	2-4 (50-100)	1-2.5 (25-65)
D	4000 (27.6)[6]	N/A[13]	450 (267)	0.53	5±2	N.A.	2-4 (50-100)	1-2.5 (25-65)
E	4000 (27.6)[6]	A, F[12], P	600 (356)	0.40	5±2	N.A.	2-4 (50-100)	1-2.5 (25-65)

N.A. – Not Applicable

[1] Except for Class AA, AA(M), or F concrete, the maximum volume of water; gal. (L), shall be reduced 5 percent when a water-reducing admixture is used, and 10 percent when an air-entraining admixture, or air-entraining and water-reducing admixtures, is used. When the coarse aggregate portion of the mix is 100 percent crushed aggregate, the water may be increased by 5 percent provided the maximum water listed in Table 901-3 is not exceeded.

[2] Also slump range for other concrete placed by extrusion methods.

[3] Refer to Subsection 901.08(c).

[4] Total air content ranges when air-entrainment is allowed or specified. Air content shall be designed at midrange. See Subsection 901.08(b).

[5] Values shown represent the minimum compressive strengths allowed.

[6] Average compressive strengths for Pavement Type concrete shall be 3600 psi (25.0 MPa) when air-entrainment is used.

[7] No more than a 2 inch (50 mm) slump differential for any design pour.

[8] Grade F coarse aggregate shall be used only when specified or permitted. The minimum cement content shall be increased when this aggregate is used.

[9] For mixes including partial replacement of cement with fly ash or ground granulated blast furnace slag, the minimum cement and maximum water contents shown apply to the total cement and fly ash or ground granulated blast furnace slag content of the mix. Additional cement may be required to achieve minimum compressive strength.

[10] When a slump range is specified in other sections, that range shall govern.

[11] See Subsection 901.08(a) for allowable types of cement.

[12] For use in partial depth patching.

[13] Aggregate grading shall comply with the requirements of Subsection 1003.02(c).

[14] The minimum cement factors may be waived in writing by the District Laboratory Engineer in accordance with Subsection 901.06(a).

Table 901-4
Over-Design to Meet Compressive Strength Requirements[1]

Number[2,3,5] of Tests	Standard Deviation, psi (MPa)[4]				
	300 (2.1)	400 (2.8)	500 (3.4)	600 (4.1)	700 (4.8)
	Additional Compressive Strength, psi (MPa)				
15-19	470 (3.2)	620 (4.3)	850 (5.9)	1,120 (7.7)	1,390 (9.6)
20-29	430 (3.0)	580 (4.0)	760 (5.2)	1,010 (7.0)	1,260 (8.7)
30 or More	400 (2.8)	530 (3.7)	670 (4.6)	900 (6.2)	1,130 (7.8)

[1]When designing the mix, add the tabulated amounts to the average compressive strength at 28 days shown in Table 901-3.
[2]Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi (6.9 MPa) of the specified strength may be used.
[3]If less than 15 prior tests are available the over-design should be 1,000 psi (6.9 MPa) for specified strength less than 3,000 psi (20.7 MPa), 1,200 psi (8.3 MPa) for specified strengths from 3,000 to 5,000 psi (20.7 to 34.5 MPa) and 1,400 psi (9.7 MPa) for specified strengths greater than 5,000 psi (34.5 MPa).
[4]Interpolation between standard deviations is required.
[5]A strength test result is defined as the average strength of all specimens of the same age, fabricated from a sample taken from a single batch of concrete. A strength test cannot be based on only one cylinder; a minimum of two cylinders is required for each test.

Table 901-5E
Acceptance and Payment Schedules
Cast-In-Place Structural Concrete

Average Compressive Strength per Lot, psi (28 to 31 days)					
Class A or S	Class AA	Class A(M) or AA(M)	Class D	Class F	Percent of Contract Price[1]
3800 & above	4200 & above	4400 & above	3300 & above	3400 & above	100
3400-3799	3800-4199	4200-4399	3000-3299	---	98
3000-3399	3500-3799	4000-4199	2500-2999	---	90
below 3000	Below 3500	below 4000	below 2500	below 3400	50 or remove and replace[2]

Table 901-5M
Acceptance and Payment Schedules
Cast-In-Place Structural Concrete

Average Compressive Strength per Lot, MPa (28 to 31 days)					
Class A or S	Class AA	Class A(M) or AA(M)	Class D	Class F	Percent of Contract Price[1]
26.2 & above	29.0 & above	30.4 & above	22.8 & above	23.5 & above	100
23.5- 26.1	26.2-28.9	29,0-30.3	20.7-22.7	---	98
20.7-23.4	24.1-26.1	27.6-28.9	17.2-20.6	---	90
Below 20.7	below 24.1	below 27.6	below 17.2	below 23.5	50 or remove and replace[2]

[1]When concrete is part of an item or not a direct pay item, lot sizes, sampling and acceptance testing for the required quantities will be in accordance with Subsection 805.18. The value for each cubic yard (cu m) required will be assessed at $350 ($460) for the purpose of applying payment adjustment percentages. The amount of payment adjustment for the quantity of concrete involved will be deducted from payment.

Acceptance and payment schedules shall apply to the contract item itself for cast-in-place piling.

[2]When the average compressive strength of **any batch in a lot** is less than 4000 psi (27.6 MPa) for Class A(M) or AA(M), less than 3500 psi (24.1 MPa) for Class AA, less than 3000 psi (20.7 MPa) for Class A or S, less than 2500 psi (17.2 MPa) for Class D, or less than 3400 psi (23.5 MPa) for Class F, an investigation will be made. If concrete is allowed to remain in place, payment will be based on the average compressive strength for the lot. If concrete is not allowed to remain in place, the identifiable deficient areas shall be removed and replaced at no direct pay.

When the average compressive strength for a **lot** is less than 4000 psi (27.6 MPa) for Class A(M) or AA(M), less than 3500 psi (24.1 MPa) for Class AA, less than 3000 psi (20.7 MPa) for Class A or S, less than 2500 psi (17.2 MPa) for Class D, or less than 3400 psi (23.5 MPa) for Class F, an investigation will be made. If concrete is allowed to remain in place, payment for the lot will be based on 50 percent of the contract price.

Any cores obtained in these investigations will be used for evaluation purposes only and payment will be based on original acceptance samples.

Table 901-6E
Acceptance and Payment Schedules
Cast-In-Place Minor Structure Concrete

Average Compressive Strength, psi (28 to 31 days)		
Class M or Y	Class R	Percent of Contract Price [1]
3000 & Above Below 3000	1800 & Above Below 1800	100 50 or Remove [2]

Table 901-6M
Acceptance and Payment Schedules
Cast-In-Place Minor Structure Concrete

Average Compressive Strength, MPa (28 to 31 days)		
Class M or Y	Class R	Percent of Contract Price [1]
20.7 & Above Below 20.7	12.4 & Above Below 12.4	100 50 or Remove [2]

[1]When concrete is part of an item or not a direct pay item, sampling and acceptance testing for the required quantities shall be in accordance with this section. The value for each cubic yard (cu m) of concrete required will be assessed at $350 ($460) for the purpose of applying payment adjustment percentages. The amount of payment adjustment for the quantity of concrete involved will be deducted from payment.

[2]When the average compressive strength is less than 3,000 psi (20.7 MPa) for Class M or Y, and 1,800 psi (12.4 MPa) for Class R, an investigation will be made. If concrete is allowed to remain in place, payment will be based on 50 percent of the contract price.

Any cores obtained in these investigations will be used for evaluation purposes only. Payment will be based on original acceptance samples.

PART X -- MATERIALS

Section No. **Page No.**

Part X
Materials
Preface

SAMPLING, TESTING AND CERTIFICATION: Except as otherwise specified herein, sampling, testing, and certification shall be in accordance with the following documents. In general, the following priority list will apply.

First - Louisiana Department of Transportation and Development (DOTD) Materials Sampling Manual and DOTD Testing Procedures Manuals (TR).

Second - Standards published by the American Association of State Highway and Transportation Officials (AASHTO).

Third - Standards published by the American Society for Testing and Materials (ASTM).

Sampling and testing frequencies given in these documents are the minimum required. Additional sampling or testing shall be performed as directed to ensure material quality.

When allowable variations or conflicts occur within an ASTM or AASHTO test method, the established DOTD procedures and publications shall govern. When no procedure is referenced, the Materials Engineer Administrator will decide the appropriate sampling, testing, or certification methods to be used.

QUALIFIED PRODUCTS LIST: When specified, materials shall be approved products listed in the Qualified Products List (QPL) as described in Subsection 101.03. Qualification of a product is not blanket approval for its use, since qualified products are subject to certification, acceptance, or verification testing as outlined in the Department's Materials Sampling Manual.

UNITS OF MEASURE: When the International System of Units (generally known as SI units or metric units) is the industry standard of measure for the sampling and testing of materials, only those units will be shown in Part X. However, like other parts of the standard specifications, when either English (inch-pound) units or SI (metric) units are commonly used, then both sets of units will be shown in Part X.

Section 1001
Hydraulic Cement

1001.01 PORTLAND CEMENT. Portland cement shall be from an approved source listed in QPL 7 and shall comply with AASHTO M 85.

(a) Chemical Requirements: The chemical requirements shall be as specified in AASHTO M85.

Alkali content calculated as sodium oxide equivalent shall not exceed 0.60 percent by weight for all types of cement.

(b) Process Additions: Process additions may be used in amounts not to exceed 3 percent by weight (mass) of portland cement clinker provided it meets the requirements for the cement portion of ASTM C 465 and the test results are submitted to the Department for review and approval.

1001.02 PORTLAND-POZZOLAN CEMENT. Portland-pozzolan cement shall be from an approved source listed in QPL 7, shall comply with AASHTO M 240, Type IP and shall contain 20±5 percent by weight (mass) fly ash (or bottom ash provided it is interground with the cement clinker).

The alkali content of portland-pozzolan cement calculated as sodium oxide equivalent shall not exceed 0.60 percent by weight (mass). Fly ash or bottom ash shall comply with AASHTO M 295, Class C or F.

1001.03 MASONRY CEMENT. Masonry cement shall comply with ASTM C 91.

1001.04 PORTLAND BLAST-FURNACE SLAG CEMENT. Portland blast-furnace slag cement shall be from an approved source listed in QPL 7 and shall comply with AASHTO M 240 requirements for Type IS cement. Type IS cement shall contain slag up to 50 percent by weight (mass) of portland blast-furnace slag cement. The alkali content of portland blast-furnace slag cement calculated as sodium oxide equivalent shall not exceed 0.60 percent by weight (mass). Grade 100 and grade 120 ground granulated blast-furnace slag for use in Type IS cement shall comply with AASHTO M 302.

Section 1002
Asphalt Materials and Additives

1002.01 ASPHALT. Asphalt shall be prepared by the refining of petroleum. Asphalt shall be uniform in character, free from water, and shall not foam when heated to 350°F (177°C). Asphalt shall be from an approved source listed in QPL 41.

Refinery or supplier storage tanks, piping, retorts, booster tanks, and other equipment used in delivering, storing or handling asphaltic materials shall be kept clean and in good operating condition and shall be operated as to avoid contamination of the contents with foreign materials.

Final test results for asphalt materials will be applied to the proper table in this Section for conformance to specifications.

Samples taken at the refinery or supplier shall comply with specification requirements. When the refinery or supplier sample fails to meet these requirements, the material will be rejected and shall not be shipped to the jobsite.

When asphalt materials sampled at the point of delivery do not comply with specification requirements, and in the opinion of the engineer have resulted in an unsatisfactory product based on an investigation, the materials shall be removed and replaced or otherwise corrected at no direct pay. Payment adjustment, when required, shall apply to the quantity of material represented by the sample. If no specific pay item exists, then the invoice price for the material shall be used.

1002.02 ASPHALT MATERIAL ADDITIVES.

(a) Anti-Strip: Anti-strip additives for asphalt materials shall be approved products listed in QPL 57 and will be tested in accordance with DOTD TR 317.

(b) Silicone: Silicone additives for asphalt materials shall be approved products listed in QPL 22.

(c) Polymers: Polymer modified asphalt materials shall be approved products listed in QPL 41. Polymer additives shall be preblended with the asphalt material. In-line blending will not be allowed.

(d) Fibers: A cellulose or mineral fiber, pre-approved by the Department, shall be used to prevent draindown or to serve as a filler.

(1) Cellulose Fiber: When cellulose fiber is used, it shall meet the following requirements:

Property	Requirements
Fiber Length	0.25 inches (6 mm), max.
Passing No. 100 (150 µm) Sieve[1]	60% - 80%
Ash Content[2]	13% - 23%
pH[3]	6.5 – 8.5
Oil Absorption[4]	4 to 6 times fiber weight (mass)
Moisture Content[5]	<5% by weight (mass)

[1]Sieve Analysis: This test is performed using an Alpine Air Jet Sieve (Type 200 LS). A representative five gram sample of fiber is sieved for 14 minutes at a controlled vacuum of 75 kPa (11 psi). The portion remaining on the screen is weighed.
[2]Ash Content: A representative 2-3 gram sample of fiber is placed in a tared crucible and heated between 595ºC and 650ºC (1100ºF and 1200ºF) for not less than two hours. The crucible and ash are cooled in a desiccator and reweighed.
[3]pH Test: Five grams of fiber are added to 100 ml of distilled water, stirred and let sit for 30 minutes. The pH is determined with a probe calibrated with pH 7.0 buffer.
[4]Oil Absorption Test: Five grams of fiber are accurately weighed and suspended in an excess of mineral spirits for not less than five minutes to ensure total saturation. It is then placed in a screen mesh strainer (approximately 0.5 square millimeter hole size) and shaken on a wrist action shaker for ten minutes (approximately 1 i/inch motion at 240 shakes/minute). The shaken mass is then transferred without touching, to a tared container and weighed. Results are reported as the amount (number of times its own weight) the fibers are able to absorb.
[5]Moisture content: Ten grams of fiber are weighed and placed in a 121ºC (250ºF) forced air oven for two hours. The sample is then reweighed immediately upon removal from the oven.

(2) Mineral Fiber: When mineral fiber is used, a cationic sizing will be required. The cationic sizing shall be introduced at rates recommended by the manufacturer to insure proper dispersion of the fibers. The fibers shall meet the following requirements:

Property	Requirements
Fiber Length[1]	0.25 inch (6 mm) maximum
Fiber Thickness[2]	0.0002 inch (0.005 mm) maximum

[1]The Fiber Length is determined according to the Bauer McNett fractionation.
[2]Mean Value of at least 200 fibers in a phase contrast microscope.

Table 1002-1
Performance Graded Asphalt Cements

Property	AASHTO Test Method	PG76-22m	PG70-22m	PG64-22	PG58-28
		Spec.	Spec.	Spec.	Spec.
Tests on Original Binder:					
Rotational Viscosity @ 135°C, Pa·s [1]	T 316	3.0	3.0	3.0	3.0
Dynamic Shear, 10 rad/s, G*/Sin Delta, kPa	T 315	1.00+ @ 76°C	1.00+ @ 70°C	1.30+ @ 64°C	1.00+ @ 58°C
Flash Point, °C	T 48	232+	232+	232+	232+
Solubility, % [2]	T 44	99.0+	99.0+	99.0+	99.0+
Separation of Polymer, 163°C, 48 hours, degree C difference in R & B from top to bottom [5]	ASTM D 7173 AASHTO T 53	2-	2-	---	---
Force Ductility Ratio (f_2/f_1, 4°C, 5 cm/min., f_2 @ 30 cm elongation)[3]	T 300	0.30+	---	---	---
Force Ductility, (4°C, 5 cm/min, 30 cm elongation, kg)[3]	T 300	---	0.23+	---	---
Tests on Rolling Thin Film Oven Residue:	T 240				
Mass loss, %	T 240	1.00-	1.00-	1.00-	1.00-
Dynamic Shear, 10 rad/s, G*/Sin Delta, kPa	T 315	2.20+ @76°C	2.20+ @ 70°C	2.20+ @ 64°C	2.20+ @ 58°C
Elastic Recovery, 25°C, 10 cm elongation, % [4]	T 301	60+	40+	---	---
Ductility, 25°C, 5 cm/min, cm	T 51	---	---	100+	---
Tests on Pressure Aging Vessel Residue:	R 28				
Dynamic Shear, @ 25°C, 10 rad/s, G* Sin Delta, kPa	T 315	5000-	5000-	5000-	5000- @ 19°C
Bending Beam Creep Stiffness, S, MPa @ -12°C.	T 313	300-	300-	300-	300- @ -18°C
Bending Beam Creep Slope, m value,@ -12°C	T 313	0.300+	0.300+	0.300+	0.300+ @ -18°C

[1]The rotational viscosity will be measured to determine product uniformity. The rotational viscosity measured by the supplier shall be noted on the Certificate of Delivery. A binder having a rotational viscosity of 3.0 Pa·s or less will typically have adequate mixing and pumping capabilities. Binders with rotational viscosity values higher than 3.0 Pa·s should be used with caution and only after consulting with the supplier as to any special handling procedures and guarantees of mixing and pumping capabilities.
[2]Not all polymers are soluble in the specified solvents. If the polymer modified asphalt digested in the solvent will not pass the filter media, a sample of the base asphalt used in making the polymer modified asphalt should be tested for solubility. If the solubility of the base asphalt is at least 99.0%, the material will be considered as passing.
[3]AASHTO T 300 except the second peak (f_2) is defined as the stress at 30 cm elongation.
[4]AASHTO T 301 except elongation shall be 10 cm.
[5]Prepare samples per ASTM D 7173. Determine softening point of top and bottom per AASHTO T 53.

Table 1002-2
PG 70-22m Alternate

Property	AASHTO Test Method	PG 70-22m Alternate[1] Specification
Tests on Original Binder:		
Rotational Viscosity @ 135°C, Pa·s[2]	T 316	3.0-
Dynamic Shear, @ 70°C and 10 rad/s, G*/Sin Delta, kPa	T 315	1.50+
Flash Point, °C	T 48	232+
Solubility, %[3]	T 44	99.0+
Softening Point, Ring & Ball, °C	T 53	70.0+
Tests on Rolling Thin Film Oven Residue:	T 240	
Mass Loss, %	T 240	1.00-
Dynamic Shear, @ 70°C and 10 rad/s, G*/Sin Delta, kPa	T 315	2.20+
Tests on Pressure Aging Vessel Residue:	R 28	
Dynamic Shear, @ 25°C and 10 rad/s, G*Sin Delta, kPa	T 315	5000-
Bending Beam Creep Stiffness, S, @ -12°C, MPa	T 313	300-
Bending Beam Creep Slope, @ -12°C, m value	T 313	0.300+

[1]Handling of all samples for testing shall be in accordance with ASTM D 4957, Section 7.2, which requires heating the sample in an oven maintained at 190° ± 2°C. Stir the sample occasionally until homogenous and pour in suitable container for testing. Pouring temperatures shall be 180° ± 2°C for all tests.

[2]The rotational viscosity will be measured to determine product uniformity. The rotational viscosity measured by the supplier shall be noted on the Certificate of Delivery. A binder having a rotational viscosity of 3.0 Pa·s or less will typically have adequate mixing and pumping capabilities. Binders with rotational viscosity values higher than 3.0 Pa·s should be used with caution and only after consulting with the supplier as to any special handling procedures and guarantees of mixing and pumping capabilities.

[3]Not all polymers are soluble in the specified solvents. If the polymer modified asphalt digested in the solvent will not pass the filter media, a sample of the base asphalt used in making the polymer modified asphalt should be tested for solubility. If the solubility of the base asphalt is at least 99.0%, the material shall be considered as passing.

Table 1002-3
Anionic Emulsified Asphalt

		Percent of Contract Unit Price					
		SS-1			SS-1h		
		Specifications	Deviations		Specifications	Deviations	
	Test Method	100	80	50 or Remove[1]	100	80	50 or Remove[1]
Viscosity, Saybolt Furol @ 25°C, s	AASHTO T 59	20-100			20-100		
Residue by Distillation, % by wt.	AASHTO T 59	57+	52-56	51-	57+	52-56	51-
Sieve Test (Retained on 850 µm)	AASHTO T 59	0.1-	---	---	0.1-	---	---
Cement Mixing	AASHTO T 59	2-	---	---	2-	---	---
Settlement, 5-day, %	AASHTO T 59	5.0-	---	---	5.0-	---	---
Tests on Residue by Distillation:							
Penetration, 25°C, 100 g, 5 s, dmm	AASHTO T 49	100-200	88-99 201-212	87- 213+	40-90	30-39 91-100	29- 101+
Solubility, %	AASHTO T 44	97.5+	---	---	97.5+	---	---
Ductility, 25°C, 50 mm/min, cm	AASHTO T 51	40+	26-39	25-	40+	26-39	25-

[1]At the option of the engineer.

Table 1002-4
Cationic Emulsified Asphalt (CRS-2, CMS-2, CSS-1 and CSS-1h)

		Percent of Contract Unit Price											
		CRS-2			CMS-2			CSS-1			CSS-1h		
		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations	
	Test Method	100	80	50 or Remove[1]	100	80	50 or Remove[1]	100	80	50 or Remove[1]	100	80	50 or Remove[1]
Viscosity,													
Saybolt Furol @ 50°C, s	AASHTO T 59	100-400	---	---	50-450	---	---	---	---	---	---	---	---
Saybolt Furol @ 25°C, s	AASHTO T 59						---	20-100			20-100		
Residue by Distillation,	AASHTO T 59	65+	61-64	60-	65+	61-64	60-	57+	52-56	51-	57+	52-56	51-
% by wt.											---	---	---
Oil Distillate by	AASHTO T 59	3.0-	---	---	12.0-	---	---	---	---	---	---	---	---
Volume, %													
Particle Charge	AASHTO T 59	Pos.	---	Neg.	Pos.	---	Neg.	Pos.	---	Neg.	Pos.	---	Neg.
Sieve Test													
(Retained on 850 µm), %	AASHTO T 59	0.1-	---	---	0.1-	---	---	0.1-	---	---	0.1-	---	---
Settlement, 5-days, %	AASHTO T 59	5.0-	---	---	5.0-	---	---	5.0-	---	---	5.0-	---	---
Tests on Residue by Distillation:													
Penetration, 25°C,	AASHTO T 49	100-250	84-99	83-	100-250	84-99	83-	100-200	88-99	87-	40-90	30-39	29-
100 g, 5 s, dmm			251-266	267+		251-266	267+		201-212	213+		91-100	101+
Solubility, %	AASHTO T 44	97.5+	---	---	97.5+	---	---	97.5+	---	---	97.5+	---	---
Ductility, 25°C,													
5 cm/min, cm	AASHTO T 51	80+	66-79	65-	40+	26-39	25-	40+	26-39	25-	40+	26-39	25-
Viscosity, 135°C, Pa·s	AASHTO TP 48	0.18+	0.13-0.17	0.12-	---	---	---	---	---	---	---	---	---

[1]At the option of the engineer.

Table 1002-5
Emulsified Polymerized Asphalt (CRS-2P)[1]

	Test Method	Percent of Contract Unit Price		
		Specifications	Deviations	
		100	80	50 or Remove[2]
Viscosity, Saybolt Furol @ 50°C	AASHTO T 59	100-400		
Storage Stability Test, 24 h, %	AASHTO T 59	1.0-	---	---
Settlement, 5 Day, %	AASHTO T 59	5.0-	---	---
Classification Test	AASHTO T 59	Pass	---	Fail
Particle Charge Test	AASHTO T 59	Pos.	---	Neg.
Sieve Test (Retained on 850 µm), %	AASHTO T 59	0.1-	---	---
Distillation:	AASHTO T 59			
Oil Distillate by Vol. of Emulsion, %		3.0-	---	---
Residue from Distillation, %		65+	61-64	60-
Tests on Residue by Distillation:				
Penetration, 25°C, 100 g, 5 s, dmm	AASHTO T 49	100-200	80-99 201-225	79- 226+
Softening Point (Ring & Ball), °C	AASHTO T 53	38.0-52.0	32.1-37.9 52.1-58.9	32.0- 59.0+
Solubility, %	AASHTO T 44	97.5+	---	---
Tests on Residue by Evaporation[3]:				
Force Ductility Ratio (f_2/f_1, 4°C, 5 cm/min, f_2 at second peak)	AASHTO T 300	0.30+	0.21-0.29	0.20-
Elastic Recovery, 10°C, 20 cm elongation, %	AASHTO T 301	58+	51-57	50-

[1]The addition of latex, rubber or other additives to emulsified polymerized asphalt will not be allowed.
[2]At the option of the engineer.
[3]The residue asphalt for running force ductility and elastic recovery tests shall be obtained by means of residue by evaporation (Oven) rather than residue by distillation (Aluminum-alloy Still).

Table 1002-6
MC Cutback Asphalt

		Percent of Contract Unit Price								
		MC-30			MC-70			MC-250		
		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations	
	Test Method	100	80	50 or Remove[1]	100	80	50 or Remove[1]	100	80	50 or Remove[1]
Flash Point, Open Tag, °C	AASHTO T 79	38+	---	---	38+	---	---	66+	---	--
Viscosity, Saybolt Furol @	AASHTO T 72									
25°C, s		75-150	58-74 151-167	57- 168+	---	---	---	---	---	---
60°C, s		---	---	---	35-70	24-34 71-81	23- 82+	125-250	100-124 251-275	99- 276+
Distillation Test, Distillate Percentage by Volume of Total Distillate to 360°C	AASHTO T 78									
to 225°C		0.0-25.0	---	---	0.0-20.0	---	---	0.0-10.0	---	---
to 260°C		40.0-70.0	---	---	20.0-60.0	---	---	15.0-55.0	---	---
to 316°C		75.0-93.0	---	---	65.0-90.0	---	---	60.0-87.0	---	---
Residue from Distillation to 360°C, Volume Percentage of Sample by Difference		50.0+	45.1-49.9	45.0-	55.0+	50.1-54.9	50.0-	67.0+	62.1-66.9	62.0-
Tests on Residue by Distillation:										
Penetration, 25°C, 100 g, 5 s, dmm	AASHTO T 49	120-250	102-119 251-268	101- 269+	120-250	102-119 251-268	101- 269+	120-250	102-119 251-268	101- 269+
Solubility, %	AASHTO T 44	99.0+	98.6-98.9	98.5-	99.0+	98.6-98.9	98.5-	99.0+	98.6-98.9	98.5-
Ductility, 25°C, for Residues to 200 Penetration, 5 cm/min, cm	AASHTO T 51	100+	76-99	75-	100+	76-99	75-	100+	76-99	75-
Ductility, 15.5°C, for Residues of 200-300 Penetration, 5 cm/min, cm	AASHTO T 51	100+	76-99	75-	100+	76-99	75-	100+	76-99	75-

[1]At the option of the engineer.

Table 1002-7
Cationic Emulsified Petroleum Resin (EPR-1)

	Test Method	Percent of Contract Unit Price		
		Specifications	Deviations	
		100	80	50 or Remove[1]
Viscosity, Saybolt Furol @ 25°C, s	AASHTO T 59	15-100	10-15 101-150	9- 151+
Residue by Evaporation, % by wt.	AASHTO T 59	57+	52-56	51-
Particle Charge	AASHTO T 59	Pos.	---	Neg.
Sieve Test (Retained on 850 µm), %	AASHTO T 59	0.1-	---	---
Settlement, 5 Days, %	AASHTO T 59	5.0-	---	---

[1]At the option of the engineer.

Table 1002-8
AEP Emulsified Asphalt

	Test Method	Percent of Contract Unit Price		
		Specifications	Deviations	
		100	80	50 or Remove[1]
Viscosity, Saybolt Furol @ 50°C, s	AASHTO T 59	15-150	10-15 151-200	9- 201+
Residue by Evaporation, % by wt.	AASHTO T 59	50+	46-49	45-
Oil Distillate by Volume, %	AASHTO T 59	25.0-	---	---
Sieve Test (Retained on 850 µm), %	AASHTO T 59	0.1-	---	---
Storage Stability, 24 h, %	AASHTO T 59	1.0-	---	---
Settlement, 5 Days, %	AASHTO T 59	5.0-	---	---
Test on Residue by Evaporation:				
Penetration, 25°C, 100 g, 5 s, dmm	AASHTO T 49	250+	---	---
Solubility, %	AASHTO T 44	97.5+	---	---

[1]At the option of the engineer.

Table 1002-9
Anionic Emulsified Polymer Modified Asphalt

Property	Test Method	SS-1P		
		Specification		Deviation
		100	80	50 Or Remove[1]
Viscosity, Saybolt Furol @ 25°C, s	AASHTO T 59	20-100	---	---
Storage Stability, 24 Hour, %	AASHTO T 59	1.0-	---	---
Sieve Test, retained on the No. 20, %	AASHTO T 59	0.1-	---	---
Residue by Evaporation,%	AASHTO T59	57+	---	56-
Tests On Residue From Evaporation Test:				
Penetration, 25°C, 100g, 5s, dmm	AASHTO T 49	100-200	88-99 201-212	87- 213+
Solubility, %	AASHTO T 44	97.5+	---	---
Force Ductility Ratio f_2/f_1, 4°C, 5 cm/min, f_2 @ 30 cm elongation	AASHTO T 300	0.15+	---	0.14-
Elastic Recovery , 10°C, 20 cm elongation, %	AASHTO T 301	30+	---	29-

[1]At the option of the engineer.

Table 1002-10
Anionic Emulsified Latex Modified Asphalt

Property	Test Method	SS-1L		
		Specification		Deviation
		100	80	50 or Remove[1]
Viscosity, Saybolt Furol @ 25°C, s	AASHTO T 59	20-100	---	---
Storage Stability, 24Hour, %	AASHTO T 59	1.0-	---	---
Sieve Test, retained on the No. 20, %	AASHTO T 59	0.1-	---	---
Residue by Evaporation, %	AASHTO T 59	57+	---	56-
Tests On Residue From Evaporation Test:				
Penetration, 25°C, 100g, 5s, dmm	AASHTO T 49	100-200	88-99 201-212	87- 213+
Ductility, 5 cm/min., 4°C	AASHTO T 51	50+	41-49	40-
Elastic Recovery, 10°C, 20 cm elongation, %	AASHTO T 301	50+	---	49-
Softening Point, Ring & Ball, °C	AASHTO T 53	50.0+	45.1-49.9	45.0-

[1]At the option of the engineer.

Table 1002-11
Hot Applied Modified Asphalt Cements for
Asphaltic Surface Treatment

Property	AASHTO Test Method	PAC 15	
		Spec.	Deviation
		100	90 or Remove[4]
Penetration @ 25°C, 100 g., 5 s, dmm	T 49	75-125	74- 126+
Viscosity, @ 60°C, Pa·s	T 202	150+	149-
Rotational Viscosity @ 135°C, Pa·s[1]	T 316	3.0-	3.1+
Force Ductility Ratio, f_2/f_1, 4°C, 5cm/min, f_2 @ 30 cm elongation[2]	T 300	0.30+	0.29-
Softening Point, °C	T 53	45+	44-
Flash Point, °C	T 48	230+	228-
Separation of Rubber, 163°C, 48 hours difference in R & B from top to bottom sample, °C	DOTD TR 326	2-	---
Tests on Residue from Rolling Thin Film Oven Test:	T 240		
Elastic Recovery, 25°C, 10 cm elongation, % [3]	T 301	55+	54-
Penetration Retention 25°C, RTFO/Original	T 49	0.60+ 1.00-	0.59- 1.01+

[1]The rotational viscosity will be measured to determine product uniformity. The rotational viscosity measured by the supplier shall be noted on the Certificate of Delivery. A binder having a rotational viscosity of 3.0 Pa·s or less will typically have adequate mixing and pumping capabilities. Binders with rotational viscosity values higher than 3.0 Pa·s should be used with caution and only after consulting with the supplier as to any special handling procedures and guarantees of mixing and pumping capabilities.
[2]AASHTO T 300 except the second peak (f_2) shall be defined as the stress at 30 cm elongation.
[3]AASHTO T 301 except the elongation shall be 10 cm.
[4]At the option of the engineer.

Section 1003
Aggregates

1003.01 GENERAL. Aggregates shall be environmentally acceptable for the intended use and shall be from an approved source. For a source to be approved, each sample shall comply with the requirements specified below and in the appropriate subsection. In addition to the test methods given in each subsection, the following methods shall be used in testing aggregates.

Property	Test Method
Deleterious Materials	DOTD TR 119
Unit Weight	AASHTO T 19
Specific Gravity & Absorption of Fine Aggregate	AASHTO T 84
Specific Gravity and Absorption of Coarse Aggregate	AASHTO T 85
Polish Value	AASHTO T 278 and T 279
Amount of Material Finer than the No. 200 Sieve (75 μm)	DOTD TR 112
Sieve Analysis (Gradation)	DOTD TR 113
Liquid Limit and Plasticity Index	DOTD TR 428

(a) Source Approval:

(1) The soundness loss of recycled portland cement concrete and aggregates listed in QPL 2 shall not exceed 15 percent when subjected to 5 cycles of the magnesium sulfate soundness test in accordance with AASHTO T 104. For recycled portland cement concrete produced from stockpiles that contain raw material that can be verified as portland cement concrete obtained exclusively from DOTD pavements or structures, the soundness testing requirement may be waived by the Materials Engineer Administrator.

(2) Coarse aggregate listed in QPL 2, and recycled portland cement concrete, except lightweight aggregate, shall show an abrasion loss of not more than 40 percent when tested in accordance with AASHTO T 96.

Lightweight aggregate shall be expanded clay or expanded shale and shall show an abrasion loss of not more than 40 percent when tested in accordance with DOTD TR 111.

(3) Recycled portland cement concrete shall be from dedicated stockpiles produced by an approved concrete crushing operation. The District Laboratory Engineer will inspect and evaluate crushing operations before production of material intended for DOTD projects begins. After being crushed, recycled portland cement concrete shall be reasonably free of asphaltic concrete overlay material, reinforcing steel, joint material, and other debris, but may contain a minimal amount of other base course materials resulting from normal construction methods. Stockpiles produced from raw material verified as portland cement concrete obtained exclusively from DOTD pavements or structures shall be kept separate from other stockpiles. After processing, recycled portland cement concrete shall comply with the requirements specified in the appropriate subsections. Once a stockpile has been sampled for approval, no other material shall be added without prior approval.

(4) Reclaimed asphaltic pavement shall be cold planed in accordance with Section 509 or crushed. Reclaimed asphaltic pavement shall be approved either at the time of removal from the roadway or in stockpiles. Stockpiled materials shall be uniform and reasonably free of lightweight aggregate, debris, soil, and other foreign matter.

(5) Aggregates for use in portland cement concrete will be tested for alkali reactivity properties in accordance with ASTM C 289. Carbonate rocks for use in portland cement concrete will also be subjected to X-Ray diffraction analysis to determine the presence of potentially reactive components. Aggregates categorized as innocuous by both procedures will not be restricted. Aggregates categorized as potentially deleterious by either of these procedures may be used with combinations of cement and Class F fly ash meeting the requirements of Section 1001 and Subsection 1018.15, respectively. Aggregates categorized as potentially deleterious by either of these procedures will not be allowed with combinations of cement and Class C fly ash. The restriction regarding the use of Class C fly ash will be noted in QPL 2, and will remain in effect until aggregates from the source have been subjected to additional testing and evaluation, and they have been determined by the Materials Engineer Administrator to be innocuous with respect to alkali reactivity. This evaluation shall include one or more of the following procedures as directed by the Materials Engineer Administrator: ASTM C227, ASTM C295, ASTM C586, ASTM C1105, and ASTM C1260. The performance history of the aggregate type, and the source in particular, will be considered in determining the source's potential for detrimental expansion and the procedures used in the evaluation.

(6) Fine aggregate for portland cement concrete that produces a color darker than the Organic Color No. 3 when tested in accordance with AASHTO T 21, will be subjected to the mortar strength test in accordance with AASHTO T 71. The minimum compressive strength shall be at least 95 percent of the referenced mortar compressive strength.

(b) Acceptance Testing: Acceptance of aggregates shall be based on compliance with the requirements shown in the following subsections provided the aggregates consistently comply with the requirements for source approval in Heading (a).

1003.02 AGGREGATES FOR PORTLAND CEMENT CONCRETE AND MORTAR. All aggregates for use in portland cement concrete shall comply with the requirements of Subsection 1003.01. Aggregates for use in Types B and D pavement concrete shall also conform to the requirements of Subsection 1003.02(c).

(a) Fine Aggregate: Sand shall be a natural silica sand from a source listed in QPL 2. The percentages of deleterious materials shall not exceed the following values:

Property	Percent, Max.
Coal and Lignite	0.25
Clay Lumps	0.05
Clay Lumps and Friable Particles	3.00

Fine aggregate for all portland cement concrete except Types B and D pavements shall conform to the following gradations:

Concrete Sand

U.S. Sieve	Metric Sieve	Percent Passing
3/8 inch	9.5 mm	100
No. 4	4.75 mm	95-100
No. 16	1.18 mm	45-90
No. 50	300 µm	7-30
No. 100	150 µm	0-7
No. 200	75 µm	0-3

Mortar Sand

U.S. Sieve	Metric Sieve	Percent Passing
No. 4	4.75 mm	100
No. 8	2.36 mm	95-100
No. 100	150 µm	0-25
No. 200	75 µm	0-10

(b) Coarse Aggregate: Coarse aggregates used in portland cement concrete for bridge decks shall have a Friction Rating of I, II, or III as defined in Subsection 1003.06(a). The maximum amounts by weight (mass) of deleterious materials for coarse aggregate shall be as follows:

Property	Percent, Max.
Clay Lumps	0.05
Total Clay Lumps and Friable Particles	3.0
Iron Ore	2.0[1]
Coal and Lignite	1.0[1]
Flat and Elongated Particles (5:1) ASTM D 4791	15.0
Wood (Wet)	0.05
Total Clay Lumps and Friable Particles, Iron Ore, Coal and Lignite, and Wood	5.0

[1]Aggregate used in railings shall be free from coal, lignite and iron ore.

(1) Uncrushed Coarse Aggregate: Uncrushed coarse aggregate for all portland cement concrete except Types B and D pavements shall comply with Table 1003-1.

Table 1003-1
Portland Cement Concrete Aggregates

Percent Passing						
U.S. Sieve	Metric Sieve	Grade A (Size 57)	Grade B (Size 467)	Grade D (Size 357)	Grade F ---	Grade P (Size 67)
2 1/2 inch	63 mm	---	---	100	---	---
2 inch	50 mm	---	100	90-100	---	---
1 1/2 inch	37.5 mm	100	85-100	---	---	---
1 inch	25.0 mm	90-100	---	35-70	---	100
3/4 inch	19.0 mm	---	35-70	---	100	80-100
1/2 inch	12.5 mm	25-60	---	10-30	90-100	---
3/8 inch	9.5 mm	---	10-30	---	---	20-55
No. 4	4.75 mm	0-10	0-5	0-5	15-60	0-10
No. 8	2.36 mm	0-5	---	---	0-15	0-5
No. 16	1.18 mm	---	---	---	0-5	---
No. 200	75 µm	0-1	0-1	0-1	0-1	0-1

(2) Crushed Coarse Aggregate: Crushed coarse aggregate for all portland cement concrete except Types B and D pavements shall comply with the uncrushed coarse aggregate gradations except that when the material finer than the No. 200 (75 µm) sieve consists of the dust fraction from crushing, essentially free of clay, this percentage shall be 0-2 percent. When the total material passing the No. 200 (75 µm) sieve from the coarse and fine aggregates does not exceed 5 percent, the percent passing the No. 200 (75 µm) sieve from the crushed coarse aggregate may be increased to 3 percent.

(3) Lightweight Coarse Aggregate: Lightweight coarse aggregates shall conform to the following gradation for Grade Y (Size No. 7) aggregate:

U.S. Sieve	Metric Sieve	Percent Passing
3/4 inch	19.0 mm	100
1/2 inch	12.5 mm	90-100
3/8 inch	9.5 mm	40-80
No. 4	4.75 mm	0-15
No. 8	2.36 mm	0-5

The unit weight (mass) (AASHTO T 19) of lightweight coarse aggregate shall not exceed 55 pounds per cubic foot (880 kg/cu m), dry

loose measurement. If the unit weight (mass) of any shipment of lightweight coarse aggregate differs by more than 10 percent from that of the sample submitted for acceptance tests, the shipment may be rejected.

(c) Aggregates for Types B and D Pavements: For the combined aggregates for the proposed portland cement concrete pavement mix, the percent retained based on the dry weight (mass) of the total aggregates shall meet the requirements of Table 1003-1A for the type of pavement specified in the plans. Additionally, the sum of the percents retained on any two adjacent sieves so designated in the table shall be at least 13 percent of the total combined aggregates. The maximum amounts by weight (mass) of deleterious materials for the total aggregate shall be the same as shown in Subsection 1003.02(b).

Table 1003-1A
Aggregates for Types B and D Pavements

U.S. Sieve	Metric Sieve	Percent Retained of Total Combined Aggregates	
		Pavement Type	
		Type B	Type D
2 1/2 inch	63 mm	0	0
2 inch	50 mm	0	0-20
1 1/2 inch	37.5 mm	0-20	0-20
1 inch	25.0 mm	0-20	5-20
3/4 inch	19.0 mm	5-20	5-20
1/2 inch	12.5 mm	5-20	5-20
3/8 inch	9.5 mm	5-20	5-20
No. 4	4.75 mm	5-20	5-20
No. 8	2.36 mm	5-20	5-20
No. 16	1.18 mm	5-20	5-20
No. 30	600 µm	5-20	5-20
No. 50	300 µm	0-20	0-20
No. 100	150 µm	0-20	0-20
No. 200	75 µm	0-5	0-5
Note: For the sieves in the shaded areas, the sum of any two adjacent sieves shall be a minimum of 13 percent of the total combined aggregates.			

Each type of aggregate to be used in the proposed mixture shall be sampled and tested individually. The percent of total combined aggregates retained shall be determined mathematically based on the proportions of the combined aggregate blend. All gradation calculations shall be based on percent of dry weight (mass).

1003.03 BASE COURSE AGGREGATES. Aggregates for base course shall comply with the requirements of Subsection 1003.01.

(a) Sand-Clay-Gravel: This aggregate shall be composed of a uniform mixture of sand, clay, and siliceous gravel, stone or recycled portland cement concrete.

The mixture, as determined by visual inspection, shall be reasonably free from foreign matter. The mixture shall comply with the following gradation:

U.S. Sieve	Metric Sieve	(Cement Treated or Stabilized) Percent Passing
1 1/2 inch	37.5 mm	95-100
No. 4	4.75 mm	40-65
No. 40	425 μm	20-50
No. 200	75 μm	10-25

Material passing the No. 40 (425 μm) sieve shall comply with the following requirements:

	Cement Treated or Stabilized
Liquid Limit (Max.)	35
Plasticity Index (Max.)	12

Stone and recycled portland cement concrete in the mixture shall comply with Subsection 1003.01.

(b) Stone: This material shall consist of 100 percent stone and shall comply with the following gradation:

U.S. Sieve	Metric Sieve	Percent Passing
1 1/2 inch	37.5 mm	100
1 inch	25.0 mm	90-100
3/4 inch	19.0 mm	70-100
No. 4	4.75 mm	35-65
No. 40	425 μm	12-32
No. 200	75 μm	5-12

To facilitate meeting these gradation requirements, a calcium carbonate additive approved by the Materials and Testing Section may be added to the stone. The additive shall be thoroughly blended with the stone by approved methods prior to placement on the project. When tested according to DOTD TR 428, the fraction passing the No. 40 (425 µm) sieve, including any additive, shall have a liquid limit no greater than 25, and a plasticity index of no greater than 4.

(c) Recycled Portland Cement Concrete: Recycled portland cement concrete shall be crushed portland cement concrete. After being crushed, recycled portland cement concrete may contain a minimal amount of other base course materials resulting from normal construction methods and shall conform to the following gradation.

U.S. Sieve	Metric Sieve	Percent Passing
1 1/2 inch	37.5 mm	100
1 inch	25.0 mm	90-100
3/4 inch	19.0 mm	70-100
No. 4	4.75 mm	35-65
No. 40	425 µm	12-32
No. 200	75 µm	0-8

The fraction of recycled portland cement concrete passing the No. 40 (425 µm) sieve shall be non-plastic.

(d) Crushed Slag: The material shall be 100 percent slag and shall comply with the gradation requirements of Heading (b).

1003.04 AGGREGATES FOR SURFACE COURSE. Aggregates for surface course shall comply with the requirements of Subsection 1003.01.

(a) Stone: This material shall consist of 100 percent stone and shall comply with the following gradations:

U.S. Sieve	**Metric Sieve**	**Percent Passing**
1 1/2 inch	37.5 mm	100
3/4 inch	19.0 mm	50-100
No. 4	4.75 mm	35-65
No. 40	425 µm	10-32
No. 200	75 µm	3-15

The fraction of stone passing the No. 40 (425 μm) sieve shall comply with the following requirements.

Liquid Limit (Max.)	25
Plasticity Index (Max.)	4

(b) Sand-Clay-Gravel: This material shall be a mixture of sand, clay, and siliceous gravel, stone or recycled portland cement concrete. The mixture shall be reasonably free from foreign matter as determined by visual inspection.

The mixture, prior to treatment shall comply with the following gradation:

U.S. Sieve	Metric Sieve	Percent Passing
1 1/2 inch	37.5 mm	95-100
No. 4	4.75 mm	40-65
No. 40	425 μm	---
No. 200	75 μm	10-25

The fraction passing the No. 40 (425 μm) sieve shall comply with the following requirements:

	Lime Treated
Liquid Limit (Max.)	40
Plasticity Index	4-15

Stone and recycled portland cement concrete in the mixture shall comply with Subsection 1003.01.

(c) Recycled Portland Cement Concrete: Recycled portland cement concrete shall be crushed portland cement concrete and will be permitted in combination with other approved stone for surface courses. After being crushed the recycled portland cement concrete or a combination of stone and recycled portland cement concrete shall comply with the following gradation.

U.S. Sieve	Metric Sieve	Percent Passing
1 1/2 inch	37.5 mm	100
3/4 inch	19.0 mm	50-100
No. 4	4.75 mm	35-65
No. 40	425 µm	10-32
No. 200	75 µm	3-15

(d) Reclaimed Asphaltic Pavement (RAP): Reclaimed asphaltic pavement material shall comply with Subsection 1003.01 and the following gradation:

U.S. Sieve	Metric Sieve	Percent Passing
2 1/2 inch	63 mm	100
No. 4	4.75 mm	35-75

(e) Crushed Slag: This material shall be 100 percent crushed slag and shall comply with the gradation requirements of Heading (a). The fraction of crushed slag passing the No. 40 (425 µm) sieve shall be non-plastic.

1003.05 AGGREGATES FOR ASPHALTIC SURFACE TREATMENT.

Aggregates for asphaltic surface treatment shall comply with Subsection 1003.01 and shall be either crushed gravel, crushed stone, crushed slag or lightweight aggregate and shall be assigned a Friction Rating in accordance with Subsection 1003.06(a). Aggregates shall comply with the gradation requirements in Table 1003-2.

Crushed gravel Size 1 and Size 2 shall have 60 percent minimum crushed retained on the No. 4 (4.75 mm) sieve. Crushed gravel Size 3 shall have 75 percent crushed retained on the No. 4 (4.75 mm) sieve. The percent crushed shall be determined in accordance with DOTD TR 306.

The maximum amounts of deleterious materials shall be as follows:

Property	Percent, Max.
Clay Lumps	0.05
Total Clay Lumps and Friable Particles	3.0
Iron Ore	2.0
Glassy Particles in Slag	10.0
Flat and Elongated Particles (5:1)(ASTM D 4791)	10.0
Coal and Lignite	1.0
Wood (Wet)	0.05
Total Clay Lumps and Friable Particles, Iron Ore, Coal and Lignite, and Wood	5.0

Table 1003-2
Asphaltic Surface Treatment Aggregates Percent Passing

		Size 1		Size 2	Size 3
U. S. Sieve	Metric Sieve	Slag or Stone Aggregate (Size No. 5)	Crushed Gravel[2] or Lightweight Aggregate	All Aggregate (Size No. 7)	All Aggregate (Size No. 8)
1 1/2 inch	37.5 mm	100	100	---	---
1 inch	25.0 mm	90-100	95-100	---	---
3/4 inch	19.0 mm	20-55	60-90	100	---
1/2 inch	12.5 mm	0-10	---	90-100	100
3/8 inch	9.5 mm	0-5	0-15	40- 80	85-100
No. 4	4.75 mm	---	0-5	0-15	10-40
No. 8	2.36 mm	---	---	0-5	0-10
No. 16	1.18 µm	---	---	---	0-5
No. 200	75 µm[1]	0-1	0-1	0-1	0-1

[1]The percentage passing the No. 200 (75 µm) sieve shall be 0 - 2 percent for crushed aggregates when the materials finer than the No. 200 (75 µm) sieve consist of dust fraction from crushing and handling, essentially free of clay.
[2]Uncrushed gravel may be used for Size 1 aggregate if more than one application of Asphaltic Surface Treatment is required.

1003.06 AGGREGATES FOR ASPHALTIC MIXTURES.

(a) Asphaltic Concrete: Aggregates shall comply with the requirements of Subsection 1003.01 except that reclaimed asphaltic pavement and recycled portland cement concrete are not required to be from sources listed on QPL 2 but shall be from approved sources. Coarse aggregates shall be defined as all material retained on or above the No. 4 (4.75 mm) sieve. Fine aggregate shall be defined as all material passing the No. 4 (4.75 mm) sieve.

(1) Gravel, Stone, and Crushed Slag: These aggregates shall comply with Subsection 1003.05 for deleterious substances and shall be assigned a Friction Rating as shown in Table 1003-3 and indicated in QPL 2.

Table 1003-3
Aggregate Friction Rating

Friction Rating	Description
I	Aggregates that have a Polish Value of greater than 37 or demonstrate the ability to retain acceptable friction numbers for the life of the pavement.
II	Aggregates that have a Polish Value of 35 to 37 or demonstrate the ability to retain acceptable friction numbers for the life of the pavement.
III	Aggregates that have a Polish Value of 30 to 34 or demonstrate the ability to retain acceptable friction numbers for the life of the pavement.
IV	Aggregates with a Polish Value of 20 to 29.

(2) Fine Aggregate: Fine aggregates shall comply with the requirements of asphaltic mixtures. Aggregates shall also comply with the specification requirements for angularity and sand equivalent as shown in Section 502, Table 502-5.

a. Fine Aggregate Angularity: Fine aggregate angularity (FAA) shall be determined in accordance with DOTD TR 121. The fine aggregate angularity of the composite mixture shall be determined by calculating the weighted average based on aggregate proportions passing the No. 4 (4.75 mm) sieve and the individual FAA values reported on the job mix formula. When individual aggregate sources do not have sufficient quantities of any of the required sieve sizes, a composite sample shall be tested for the proposed blend.

b. Sand Equivalent: Sand equivalent shall be determined in accordance with DOTD TR120. The sand equivalent requirements shall apply to individual natural sand sources only and do not apply to manufactured fines and fines produced from crushing operations.

(3) Natural Sand: Natural sand shall be coarse sand or a combination of coarse sand and fine sand which is used in the asphaltic concrete mixture. Natural sand shall consist of clean, hard, durable,

siliceous grains graded from coarse to fine and shall be reasonably free from vegetative matter or other deleterious materials.

The sand shall be nonplastic and no clay balls or clay lumps shall be incorporated into the asphaltic mixture. The gradation shall have a maximum of 25 percent passing the No. 200 (75 µm) sieve. Clay lumps shall not exceed 1.00 percent by weight (mass) when sampled from the stockpile and tested in accordance with DOTD TR 119.

The sand equivalent of the portion of the natural sand in the mixture passing the No. 4 (4.75 mm) sieve shall be as shown in Section 502, Table 502-5 when tested in accordance with DOTD TR120.

(4) Recycled Portland Cement Concrete: Recycled portland cement concrete source shall meet the requirements of Subsection 1003.02(b)(2). The maximum amount of deleterious materials shall comply with Subsection 1003.05.

Recycled portland cement concrete may be used only when specified in the plans or by special provisions.

(5) Reclaimed Asphaltic Pavement (RAP): Reclaimed asphaltic pavement shall comply with Subsection 1003.01.

(6) Mineral Filler: Mineral filler shall be an approved product listed on QPL 10 and shall consist of limestone dust, pulverized hydrated lime, portland cement, or cement stack dust. Mineral dust collected in bag houses or by other dust collectors at asphaltic concrete plants is not classified as mineral filler. Cement stack dust shall consist of material collected from waste rotary kiln gases discharged through a collector of a cement plant. Mineral filler shall comply with the following gradation:

U.S. Sieve	Metric Sieve	Percent Passing
No. 30	600 µm	100
No. 80	180 µm	95-100
No. 200	75 µm	70-100
No. 270	53 µm	60-100

Mixtures of aggregate, filler and asphalt, in proportions to meet the requirements of mixes being used, shall have an index of retained Marshall Stability (DOTD TR 313) of at least 85 percent, and a maximum of 1.0 percent volumetric swell (DOTD TR 313).

(7) Expanded Clay Coarse Aggregate: Expanded clay coarse aggregate shall consist of angular fragments of uniform density free from

an excess of foreign matter. These aggregates shall comply with Subsection 1003.05 for deleterious materials.

(b) Stone Matrix Asphalt (SMA): All aggregate sources shall be approved and listed on QPL 2. Aggregates shall be composed of clean and durable crushed stone. The combined aggregates shall be in accordance with the design gradation requirements in Table 508-1.

(1) Coarse Aggregate: Fifty percent (50%) of the coarse aggregate shall meet Class I friction requirements and the remainder shall meet Class I, II, or III friction requirements. Alternately, 100 percent of the coarse aggregate shall meet Class II friction requirements. At a 3 to 1 ratio in accordance with ASTM D 4791, the flat and elongated particle limit shall be 25 percent maximum by weight (mass). In addition, at a 5 to 1 ratio, the flat and elongated particle limit shall be 5 percent maximum.

(2) Fine Aggregate: Fine aggregate shall consist of 100 percent crushed manufactured sand. The Fine Aggregate Angularity, FAA, of each source shall be measured and the calculated fine aggregate blend shall be 45 percent minimum when tested in accordance with DOTD TR 121 (mineral filler excluded).

1003.07 GRANULAR MATERIAL. Granular material shall be non-plastic and siliceous material, and shall comply with Subsection 1003.01 and the following gradation:

U.S. Sieve	Metric Sieve	Percent Passing
1/2 inch	12.5 mm	100
No. 10	2.00 mm	75-100
No. 200	75 μm	0-10

1003.08 BEDDING MATERIAL. Bedding materials shall consist of stone, recycled portland cement concrete, or a mixture of either recycled portland cement concrete, gravel, crushed slag, or stone with granular material complying with Subsection 1003.01.

(a) Stone or Recycled Portland Cement Concrete: Stone or recycled portland cement concrete shall comply with Subsection 1003.04.

(b) Sand-Aggregate: The sand-aggregate material shall be a natural or artificial mixture of sand and gravel, crushed slag, recycled portland cement concrete, or other approved aggregate listed in this subsection. Material passing the No. 40 (425 μm) sieve shall be nonplastic. The

mixture shall be free of foreign matter as determined by visual inspection and shall comply with the following gradation prior to placement.

U.S. Sieve	Metric Sieve	Percent Passing
1 1/2 inch	37.5 mm	95-100
No. 4	4.75 mm	30-50
No. 10	2.00 mm	20-45
No. 200	75 µm	0-10

(c) Mixtures: Recycled portland cement concrete, gravel, stone, or crushed slag shall be mixed with 35±5 percent granular material by volume. The mixture shall be verified by proof of material deliveries.

(1) Gravel: Gravel shall comply with the following gradation.

U.S. Sieve	Metric Sieve	Percent Passing
1 1/2 inch	37.5 mm	95-100
No. 4	4.75 mm	0-15
No. 200	75 µm	0-2

(2) Recycled Portland Cement Concrete, Crushed Slag, or Stone: Recycled portland cement concrete, crushed slag or stone shall conform to the following gradation:

U.S. Sieve	Metric Sieve	Percent Passing
1 1/2 inch	37.5 mm	95-100
3/4 inch	19.0 mm	40-85
No. 4	4.75 mm	0-15

(3) Granular Material: Granular Material shall comply with Subsection 1003.07.

1003.09 NONPLASTIC EMBANKMENT. Nonplastic embankment materials shall be an approved sand, stone, or blended calcium sulfate. The maximum organic content shall be 4.0 percent.

(a) Sand: Sand embankment shall consist of nonplastic material with at least 75 percent passing the No. 4 (4.75 mm) sieve and containing not more than 15 percent passing the No. 200 (75 µm) sieve when tested in accordance with DOTD TR 112 and DOTD TR 113.

(b) Stone: Stone shall be coarse stone listed on QPL 2 with a dry rodded unit weight (mass) of no greater than 95 pounds per cubic foot (1520 kg/cu m) when tested in accordance with AASHTO T19. Stone shall comply with the following gradation:

U.S. Sieve	Metric Sieve	Percent Passing
2 inch	50 mm	100
1 1/2 inch	37.5 mm	85 - 100
3/4 inch	19.0 mm	35 - 88
No. 4	4.75 mm	0 - 10

(c) Blended Calcium Sulfate: Blended calcium sulfate embankment material shall consist of calcium sulfate, from a source approved by the Materials and Testing Section, blended with an approved aggregate. The source shall have a quality control program approved by the Materials and Testing Section. The source shall have been given environmental clearance by the Department of Environmental Quality for the intended use, and written evidence of such environmental clearance shall be on file at the Materials and Testing Section. DOTD monitoring for compliance with environmental regulations will be limited to the pH testing listed below. The blended material shall be non-plastic and reasonably free from organic and foreign matter. The pH shall be a minimum of 5.0 when tested in accordance with DOTD TR 430. Should the source of the aggregate that is blended with the calcium sulfate change, re-evaluation will be required. The blended embankment material shall consist of 25 to 75 percent passing the No. 4 (4.75 mm) sieve when tested in accordance with DOTD TR 113 modified to include a drying temperature not to exceed 140°F (60°C).

1003.10 AGGREGATE FOR SUBGRADE LAYER. Aggregate for subgrade layers shall consist of either stone, crushed slag, recycled portland cement concrete, or blended calcium sulfate complying with Subsection 1003.01 and the following.

(a) Stone, Crushed Slag, or Recycled Portland Cement Concrete: Stone, crushed slag, or recycled portland cement concrete shall comply with Subsection 1003.03.

(b) Blended Calcium Sulfate: Blended calcium sulfate shall comply with Subsection 1003.09 except that when tested in accordance with DOTD TR 113, modified to include a maximum drying temperature

of 140°F (60°C), blended calcium sulfate shall comply with the following gradation.

U.S. Sieve	Metric Sieve	Percent Passing
1 inch	25.0 mm	90-100
3/4 inch	19.0 mm	70-100
No. 4	4.75 mm	25-75
No. 200	75 μm	0-25

Section 1004
Masonry Units

1004.01 SEWER BRICK. Sewer brick shall be made from clay, shale or concrete.

Brick made from clay or shale for use in junction boxes, catch basins, arches, manholes and for backings shall comply with AASHTO M 91, Manhole Brick, Grade MM.

Concrete brick shall comply with ASTM C 139, except that the minimum thickness of each unit shall not be less than 3 5/8 inches (90 mm).

1004.02 BUILDING BRICK.

(a) Building brick made from clay or shale for use in brick masonry shall comply with AASHTO M 114, Grade SW.

(b) Concrete building brick for use in masonry buildings shall comply with ASTM C 55, Grade N-II.

1004.03 CONCRETE BUILDING BLOCK. Concrete hollow load-bearing building block shall comply with ASTM C 90, Grade N-II.

1004.04 CELLULAR CONCRETE BLOCKS. Cellular concrete blocks shall be manufactured by machines employing high vibratory compaction. The blocks shall comply with ASTM C 90, Type II, except the oven-dry weight (mass) of concrete shall be at least 130 pounds per cubic foot (2.1 Mg/cu m) based on bulk specific gravity. Permissible block dimension variations will be as directed.

Section 1005
Joint Materials for Pavements and Structures

1005.01 PREFORMED JOINT FILLERS.

(a) Preformed Resilient Bituminous Types: Fillers shall consist of preformed strips which have been formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly saturated with a suitable bituminous binder, or strips which have been formed from clean, granulated cork particles securely bound together by a suitable bituminous binder and encased between two layers of felt.

The type shall be as specified and shall conform to AASHTO M 2l3.

(b) Wood Fillers: Bottom boards shall be clear heart redwood. Top boards shall be any type of wood which is free from defects and meets dimensional requirements. Occasional medium surface checks will be permitted provided the board is free of defects that will impair its usefulness.

Boards shall not vary from specified dimensions in excess of the following tolerances:

	Tolerance, inches	Tolerance, mm
Thickness	-0, +1/16	-0, +2
Depth	±1/8	±3
Length	±1/4	±6

The load required to compress the material in an oven-dry condition to 50 percent of its original thickness shall not exceed 1750 psi (12 MPa).

(c) Preformed Bituminous Type: Bituminous preformed expansion joint filler shall consist of bituminous (asphalt or tar) mastic composition, formed and encased between two layers of bituminous impregnated felt. The preformed filler shall conform to ASTM D 994.

(d) Preformed Asphalt Ribbon: This filler shall consist of preformed strips of bitumen and inert filler material conforming to the following requirements:

Thickness, mm	3-5
Depth tolerance, mm	±3
Weight, kg/100 sq m, Min.	245
Tensile Strength, kg/100 mm width, Min.	90
Bitumen, % by wt (ASTM D 545), Min.	60

The tensile strength is determined by pulling a 25-by-150-mm sample at a 500-mm/min separation rate.

This material shall be resistant to cracking, tearing or permanent deformation under normal handling and installation procedures. It shall be sufficiently rigid to enable it to form a straight joint.

(e) Preformed Closed Cell Polyethylene Joint Filler: The joint filler shall comply with ASTM D 7174, Type I. This material shall be used with an adhesive-lubricant. Joint fillers and adhesive-lubricants shall be approved products listed in QPL 18.

(f) Preformed Rubber: This filler shall consist of polyurethane bonded recycled rubber in accordance with AASHTO M 153.

1005.02 POURED AND EXTRUDED JOINT SEALANT.

(a) Hot Poured Rubberized Asphaltic Type: This material shall comply with ASTM D6690, Type II. The sealant and backer materials shall be approved products listed in QPL 67. Backer materials of the appropriate size shall comply with ASTM D5249, Type I.

(b) Polyurethane Sealants: This joint system shall be either a 1- or 2-component, pourable or extrudable sealant, with required primers and backer material. It shall cure to a solid rubber-like material able to withstand both tension and compression.

Polyurethane polymer sealant with required primers and backer materials shall be approved products listed in QPL 5. Backer material of the appropriate size shall comply with ASTM D5249, Type 2 without the heat resistant requirement or Type 3.

The container shall be labeled with the name and type of material, batch number, manufacture date, and expiration date.

The material shall comply with the following requirements.

Property	Test Method[1]	Requirements
Flow, mm, Max	AASHTO T 187	3.0
Tack-Free Time, h, Max.	ASTM C 679	72
Bond, Defect, mm, Max.	ASTM D 5893	6.0
Resilience, %, Min.	ASTM D 5329	75
Ball Penetration	ASTM D 5329	5-20
Resilience (after heat aging @70±1°C for 24±2h), %, Min.	ASTM D 5329	75
Artificial Weathering	ASTM D 5893	Pass
Ozone Resistance (Exposure to100 pphm ozone for 100 h @ 40°C, sample under 20% strain or bent loop)	ASTM D 1149	No Cracks
Weight (mass) loss, %, Max.	ASTM C 792	10
Infrared Charts	DOTD TR 610	
Activator		Pass
Base		Pass

[1]All specimens shall be cured at standard laboratory conditions for a minimum of 72 hours prior to beginning any test.

(c) Silicone Sealant (Single Component): The silicone joint sealant shall comply with ASTM D 5893. Backer material of the appropriate size shall comply with ASTM D 5249, Type 3. The silicone sealant, backer materials and primers, if required, shall be approved products listed in QPL 42.

The container shall be labeled with the name and address of the manufacturer, the trade name of the sealant, classification of the sealant (non-sag or self-leveling), batch number, manufacture date, and expiration date.

(d) Silicone Sealant (Two Component - Rapid Cure): The two component silicone joint sealant shall comply with ASTM D5893 and meet the requirements for single component sealants when mixed and prepared in accordance with the manufacturer's recommendations. Backer material of the appropriate size shall conform to ASTM D5249, Type 3. The silicone sealant, backer materials and primers, if required, shall be approved products listed in QPL 42.

The container shall be labeled with the name and address of the manufacturer, the trade name of the sealant, classification of the sealant (non-sag or self-leveling), batch number, manufacture date, and expiration date.

1005.03 PREFORMED ELASTOMERIC COMPRESSION JOINT SEALS.

(a) Seals: This joint system shall be an approved product listed in QPL 6. Uncompressed depth of the seal shall be equal to or greater than the uncompressed width of the seal. Actual width of the seal shall not be less than the nominal width of the seal.

The seal will be tested for compression-deflection in accordance with DOTD TR 612.

(1) Pavement Use: The material shall comply with ASTM D 2628 with the following exceptions:

a. The test for ozone resistance may be determined by the bent loop test method.

b. The seal shall exert a minimum pressure of 3 psi (20 kPa) at 80 percent of nominal width, and a maximum of 25 psi (170 kPa) at 50 percent of nominal width. Minimum seal pressure for expansion joints shall be 4 psi (27 kPa) at 80 percent of nominal width and 25 psi (170 kPa) maximum at 50 percent of nominal width.

(2) Bridge Use: The seal shall comply with ASTM D 3542 and the seal shall exert a minimum pressure of 4 psi (27 kPa) at 80 percent of nominal width.

(b) Adhesive-Lubricant: The adhesive-lubricant for pavement and bridge use shall comply with ASTM D 4070 and shall be an approved product listed in QPL 8.

1005.04 COMBINATION JOINT FORMER/SEALER.

(a) Description: This joint former/sealer is intended for use in simultaneously forming and sealing a weakened plane in portland cement concrete pavements.

The material shall consist of an elastomeric strip epoxied into a toothed groove formed at the top of each of two rigid plastic side frames or mechanically bonded at the top of the two rigid plastic side frames and covered with a removable plastic top cap. Side frames shall be of such configuration that when the sealer is inserted into plastic concrete and vibrated, a permanent bond forms between side frames and concrete.

(b) Material Requirements:

(1) Elastomer: The elastomer strip portion of the material shall be manufactured from vulcanized elastomeric compound using polymerized chloroprene as the base polymer, and shall comply with the following requirements:

Property	Test Method	Requirements
Tensile Strength, kPa, Min.	ASTM D 412	12,400
Elongation at Break, %, Min.	ASTM D 412	200
Hardness, Shore A	ASTM D 2240	65±10
Properties after Aging, 70 h @ 100°C	ASTM D 573	
Tensile Strength, % loss, Max.		20
Elongation, % loss, Max.		25
Hardness, pts. increase, Max.		10
Ozone Resistance, 20% strain or bentloop, 300 pphm in air, 70 h @ 40°C	ASTM D 1149	no cracks
Oil Swell, IRM 903, 70 h @ 100°C, wt change, % Max.	ASTM D 471	45

(2) Bond of Elastomer to Plastic: The force required to shear the elastomer from the plastic shall be a minimum of 5.0 pounds per linear inch (90 g/mm) of sealer when tested in accordance with DOTD TR 636.

(3) Bond of Plastic to Cement Mortar: This bond will be evaluated and shall meet the following requirements:

The force required to separate the cement mortar from the plastic shall be a minimum of 5.0 pounds per linear inch (90 g/mm) of sealer when tested in accordance with DOTD TR 636.

1005.05 STRIP SEAL JOINT. Strip seal joints with neoprene strip seal shall be as shown on the plans.

The neoprene strip seal shall be an extruded neoprene material complying with ASTM D 2628 with the following exceptions:

(1) The test for ozone resistance may be determined by the bent loop method.

(2) The recovery and the compression-deflection tests shall be omitted.

1005.06 JOINT MATERIALS FOR EXPANSION JOINT-MODIFIED (TYPE EJ-MODIFIED). This material shall be a preformed polyurethane foam joint filler which complies with ASTM D3204, Type II. The cross section shape shall allow easy installation in the pavement joint with parallel sides and shall be sufficiently self-locking to prevent the material from floating out of the joint. The molded polyurethane foam shall be free of defects and internal voids greater than 1/2 inch (13 mm). When the joint filler is used to form the joint, the self-locking feature will not be required and the joint filler will extend full depth.

Lubricant-adhesive recommended by the joint filler manufacturer shall be used and applied according to the manufacturer's directions.

1005.07 WATERSTOPS.

(a) Copper waterstops shall comply with ASTM B 370, soft temper.

(b) Polyvinyl chloride (PVC) waterstops shall comply with U. S. Army Corps of Engineers Specification CRD-C 572.

(c) Rubber waterstops shall comply with U. S. Army Corps of Engineers Specification CRD-C 513.

Details of installation and splicing, when not shown on the plans, shall be submitted to the DOTD Materials Engineer Administrator for approval. When polyvinyl chloride waterstops are used, the contractor shall submit a Certificate of Compliance indicating compliance with these specifications.

Section 1006
Concrete and Plastic Pipe

1006.01 GENERAL.

(a) Cementitious materials for concrete pipe shall comply with one of the following:

(1)	Portland cement	1001.01
(2)	Portland blast-furnace slag cement	1001.04
(3)	Portland pozzolan cement	1001.02
(4)	Portland cement with ground granulated blast-furnace slag	1018.27
(5)	Portland cement with fly ash	1018.15

The concrete pipe manufacturer may use up to 50 percent grade 120 ground granulated blast-furnace slag as a substitute for portland cement on a pound-for-pound (kilogram for kilogram) basis in accordance with Subsection 901.08. Fly ash may be substituted up to 25 percent.

(b) Any admixture for portland cement concrete listed in QPL 58 is allowed for use in concrete pipe manufacture except for chloride-type accelerators and high range water reducers.

(c) Compressive strength specimens for concrete pipe shall be made and cured in accordance with DOTD TR 227 and tested in accordance with DOTD TR 230.

(d) Concrete pipe shall be cured by one of the methods listed in ASTM C 76 and no other combination or methods will be allowed.

(e) Regardless of the ASTM specifications utilized**,** the Department reserves the right to have any concrete pipe tested to ultimate load.

(f) The addition of synthetic fibers will only be allowed upon approval of the engineer.

(g) Regardless of the sampling requirements listed in the ASTM specifications, all sampling for concrete pipe shall be in accordance with the DOTD Materials Sampling Manual.

(h) Regardless of the ASTM specifications utilized, if concrete pipe is to be accepted based upon cored samples, all samples shall meet the minimum concrete strengths specified. No more than three (3) joints of pipe shall be tested per maximum of 300 joints or three (3) days consecutive production, whichever is less, unless approved by the engineer.

All coring shall be performed by the manufacturer as directed by the engineer.

1006.02 CONCRETE SEWER PIPE. Nonreinforced (plain) concrete sewer pipe shall comply with ASTM C 14, Class III. Joints shall comply with Subsection 1006.05.

1006.03 REINFORCED CONCRETE PIPE. Reinforced concrete pipe shall be from an approved product source listed in QPL 77, and shall comply with ASTM C 76, amended as follows:

(a) Unless otherwise specified, Class III, Wall A, B or C pipe shall be furnished.

(b) When extra strength pipe is required, either Class IV or Class V pipe shall be furnished as specified. Either Wall A, B or C may be furnished.

(c) For pipe sizes not included in ASTM C 76, the area of reinforcement shall be approved in accordance with ASTM C 655. The producer shall provide fabrication drawings and design calculations reflecting compliance with these specifications prior to pipe fabrication.

(d) No modified designs will be allowed.

(e) Joints shall comply with Subsection 1006.05.

1006.04 REINFORCED CONCRETE PIPE ARCH. Reinforced concrete pipe arch shall be from an approved product source listed in QPL 77, and shall comply with ASTM C 506, amended as follows:

(a) Unless otherwise specified, Class A-III pipe arch shall be furnished.

(b) No modified designs will be allowed.

(c) For pipe arch sizes not included in ASTM C 506, the area of reinforcement shall be approved in accordance with ASTM C 655. The producer shall provide fabrication drawings and design calculations reflecting compliance with these specifications prior to pipe fabrication.

(d) Joints shall comply with Subsection 1006.05.

1006.05 CONCRETE PIPE JOINTS. Joints for concrete pipe and pipe arch shall comply with AASHTO M 198 with the following modifications. Gasket material shall comply with Subsection 1006.06. All joint systems will be approved by the Materials Engineer Administrator.

(a) Type 1 Joints (T1): Type 1 pipe joints shall be soil tight, and shall use approved rubber or flexible plastic gaskets.

(b) Type 2 Joints (T2): Type 2 pipe joints shall use approved rubber or flexible plastic gaskets and shall pass the 5 psi (35 kPa) hydrostatic pressure test.

(c) Type 3 Joints (T3):

(1) Pipe for Type 3 joints shall have a maximum taper of 12 degrees and a maximum differential between the joint taper of the bell and spigot (tongue and groove) of 2 degrees provided that it passes the 10 psi (70 kPa) hydrostatic pressure test. The 10 psi (70 kPa) hydrostatic pressure test requirement will apply to all pipe with diameters greater than 15 inches (375 mm).

(2) Joints for use with rubber gaskets and with a taper less than 6 degrees will require the 10 psi (70 kPa) hydrostatic pressure test, only when the maximum differential between the joint taper of the bell and the spigot is greater than 2 degrees. If the joint taper is 6 degrees to 8 degrees inclusive, its use will be permitted provided the joint will pass the 10 psi (70 kPa) hydrostatic pressure test.

(3) Joints for use with flexible plastic gaskets will be permitted provided the joint will pass the 10 psi hydrostatic pressure test.

(d) Repair of Joints: Joint repairs shall conform to ASTM C 443.

1006.06 GASKET MATERIALS. Gasket material sizes shall be as approved by the Materials and Testing Section.

(a) Rubber Gaskets: Rubber gaskets for pipe joints shall comply with AASHTO M 315. The rubber gaskets and lubricant shall be approved products listed in QPL 4. Each rubber gasket shall be identified with a batch or lot number.

(b) Flexible Plastic Gaskets: Flexible plastic gaskets for pipe joints shall comply with AASHTO M 198. The hydrostatic test shall be performed using AASHTO M 315. Flexible plastic gasket material and primer shall be approved products listed in QPL 4.

1006.07 PLASTIC PIPE. Plastic pipe and joint systems shall be approved products listed in QPL 66.

(a) Storm Drains: Plastic pipe for storm drains shall be Ribbed Polyvinyl Chloride Pipe (RPVCP). Ribbed Polyvinyl Chloride Pipe shall comply with ASTM F 794 or ASTM F 949, Series 46 with UV inhibitors. The resin shall have a minimum cell classification of 12454-C in accordance with ASTM D 1784.

(b) Cross Drains: Plastic pipe for cross drains shall be Ribbed Polyvinyl Chloride Pipe (RPVCP). Ribbed Polyvinyl Chloride Pipe shall comply with ASTM F 794 or ASTM F 949, Series 46 with UV inhibitors. The resin shall have a minimum cell classification of 12454-C in accordance with ASTM D 1784.

(c) Side Drains: Plastic pipe for side drains shall be one of the following:

(1) Ribbed Polyvinyl Chloride Pipe (RPVCP): Ribbed Polyvinyl Chloride Pipe shall comply with ASTM F 794 or ASTM F 949, Series 46 with UV inhibitors. The resin shall have a minimum cell classification of 12454-C in accordance with ASTM D 1784.

(2) Corrugated Polyethylene Pipe (Double Wall) (CPEPDW): Corrugated Polyethylene Pipe (Double Wall) shall comply with AASHTO M 294, Type S. The minimum cell classification shall be 335400C in accordance with ASTM D 3350.

(d) Joints for Plastic Pipe: Joints shall be approved by the DOTD Materials Engineer Administrator and listed on the QPL. Joint gasket materials shall comply with Subsection 1006.06. Joint requirements are as follows:

(1) Type 1 Joints (T1): These joints shall provide a soil tight joint.

(2) Type 2 Joints (T2): These joints shall pass a 5 psi (35 kPa) hydrostatic pressure test.

(3) Type 3 Joints (T3): These joints shall pass a 10 psi (70 kPa) hydrostatic pressure test.

(4) Joints With Split Coupling Bands: Split coupling bands shall be one piece and composed of the same material as the pipe. The bands shall be the same thickness as the base pipe. The width of the band shall be equal to one-half the diameter of the pipe but shall be a minimum of 12 inches (300 mm) wide. The band shall be secured to the pipe with a minimum of five stainless steel or other approved corrosion resistant circumferential bands.

1006.08 PLASTIC UNDERDRAIN PIPE. Plastic pipe for underdrains shall be perforated or nonperforated, as specified, and shall be an approved product listed on QPL 73 and one of the following.

(a) Corrugated Polyethylene Pipe (Single Wall) (CPEPSW): Corrugated Polyethylene Pipe (Single Wall) shall be perforated and shall comply with AASHTO M 252, Type C. Perforations shall comply with

AASHTO M 252. Corrugated Polyethylene Pipe (Single Wall) shall not be used as shoulder outlet underdrain pipe.

(b) Polyvinyl Chloride Pipe (PVCP): Polyvinyl Chloride Pipe shall comply with AASHTO M 278 or ASTM D 3034, SDR 35. Perforations, if specified, shall comply with AASHTO M 252.

(c) Corrugated Polyethylene Pipe (Double Wall) (CPEPDW): Corrugated Polyethylene Pipe shall comply with AASHTO M 252, Type S. Perforations, if specified, shall comply with AASHTO M 252.

1006.09 PLASTIC YARD DRAIN PIPE.

(a) Pipe: Plastic pipe for yard drains shall be an approved product listed on QPL 73 and one of the following:

(1) Polyvinyl Chloride Pipe (PVCP): Polyvinyl Chloride Pipe shall comply with AASHTO M 278 or ASTM D 3034, SDR 35.

(2) Corrugated Polyethylene Pipe (Double Wall) (CPEPDW): Corrugated Polyethylene Pipe (Double Wall) shall comply with AASHTO M 252, Type S, with a resin of minimum cell classification of 324420C in accordance with ASTM D 3350 or AASHTO M 294, Type S, with a resin of minimum cell classification of 335400C in accordance with ASTM D 3350.

(3) Ribbed Polyvinyl Chloride Pipe (RPVCP): Ribbed Polyvinyl Chloride Pipe shall comply with ASTM F 794 or ASTM F 949.

(b) Joints: Gaskets for joining plastic yard drain pipe shall comply with the requirements of Subsection 1006.06.

Section 1007
Metal Pipe

1007.01 CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits shall comply with the requirements of Type I (culvert pipes, circular section) and Type II (culvert pipes, other than circular section) of AASHTO M 36 amended as follows:

(a) Pipe and pipe arch shall be galvanized in accordance with AASHTO M 218.

(b) Elbows, tees and other in-line fittings shall be fabricated from sheets of the same thickness and coating material as the pipe or pipe arch to which they are joined. Flared end sections shall be as specified.

(c) Shop-formed elliptical pipe and shop-strutted pipe shall be furnished when specified.

(d) For helical pipe, no coil splices at pipe manufacturing plants will be allowed for pipe 30 inches (750 mm) in diameter or less.

(e) Helical pipe shall have annular ends and shall have the ends of seams welded a minimum of 2 inches (50 mm). Helical pipe ends shall be rerolled a minimum of two full standard corrugations to the same corrugation depth as the pipe when used with the appropriate jointing system.

(f) Pipe Arch Dimensions shall comply with AASHTO M 245 and Table 1007-1 of this section.

(g) Pipe joints shall comply with Subsection 1007.09 and shall be as shown on the plans.

(h) A minimum of two approved lifting lugs shall be provided on pipe larger than 30 inches (750 mm) in diameter, pipe arch larger than 30 inches (750 mm) in equivalent diameter, and any diameter of pipe or pipe arch longer than 30 feet (9 m).

(i) Damaged metallic coating shall either be recoated or shall be repaired with an approved cold galvanizing repair compound listed in QPL 23.

1007.02 BITUMINOUS COATED CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits shall be coated in accordance with AASHTO M 190 amended as follows:

(a) AASHTO M 36 is amended in accordance with Subsection 1007.01.

(b) Coating shall be Type A, fully bituminous coated.

(c) Pipe joints shall comply with Subsection 1007.09 and shall be as shown on the plans.

1007.03 BITUMINOUS COATED CORRUGATED STEEL UNDERDRAIN PIPE. Pipe and coupling bands shall comply with the requirements of Type III (underdrain pipes) of AASHTO M 36. The pipe shall be coated with a bituminous material in accordance with AASHTO M 190, Type A coating, except the minimum coating thickness shall be 0.03 inch (0.75 mm). The specified minimum diameter of perforations shall apply after coating. Minimum sheet thickness shall be 0.064 inch (1.63 mm) (16 gage).

1007.04 STRUCTURAL PLATE FOR PIPE, PIPE ARCH AND ARCH. This material shall comply with AASHTO M 167 for steel, and AASHTO M 219 for aluminum.

1007.05 CORRUGATED ALUMINUM PIPE AND PIPE ARCH. Pipe shall comply with AASHTO M 196 with the following exceptions:

(a) Helical pipe shall have annular ends and shall have the ends of seams welded a minimum of 2 inches (50 mm). Helical pipe ends shall be rerolled a minimum of two full standard corrugations to the same corrugation depth as the pipe when used with the appropriate jointing system.

(b) Pipe Arch Dimensions shall comply with Table 1007-1.

(c) Pipe joints shall comply with Subsection 1007.09 and shall be as shown on the plans.

(d) A minimum of two approved lifting lugs shall be provided on pipe larger than 30 inches (750 mm) diameter, pipe arch larger than 30 inches (750 mm) equivalent diameter, and any diameter of pipe or pipe arch longer than 30 feet (9 m).

(e) The pipe shall be fabricated from Alloy 3004-H34.

1007.06 CORRUGATED ALUMINUM UNDERDRAIN PIPE. Pipe and coupling bands shall comply with the requirements of Type III (underdrain pipes) of AASHTO M 196, Alloy 3004-H34. Minimum sheet thickness shall be 0.060 inch (1.52 mm) (16 gage).

1007.07 RESERVED

1007.08 PIPE ARCH DIMENSIONS. Pipe arch dimensions shall comply with Table 1007-1. Pipe arch tolerances shall comply with the plans.

Table 1007-1E
Metal Pipe Arch Dimensions (Inches)

	Steel & Aluminum	Steel
Round Equivalent	2 2/3 by 1/2 in. Corrugation	3 by 1 in. or 5 by 1 in. Corrugation
15	17 x 13	---
18	21 x 15	---
21	24 x 18	---
24	28 x 20	---
30	35 x 24	---
36	42 x 29	40 x 31
42	49 x 33	46 x 36
48	57 x 38	53 x 41
54	64 x 43	60 x 46
60	71 x 47	66 x 51
66	77 x 52	73 x 55
72	83 x 57	81 x 59
78	---	87 x 63
84	---	95 x 67
90	---	103 x 71
96	---	112 x 75
102	---	117 x 79
108	---	128 x 83
114	---	137 x 87
120	---	142 x 91

Table 1007-1M
Metal Pipe Arch Dimensions (Millimeters)

Round Equivalent	Steel & Aluminum	Steel
	68 by 13 mm Corrugation	75 by 25 mm or 125 by 25 mm Corrugation
375	425 x 325	---
450	525 x 375	---
525	600 x 450	---
600	700 x 500	---
750	875 x 600	---
900	1050 x 725	---
1050	1225 x 825	---
1200	1425 x 950	1325 x 1025
1350	1600 x 1075	1500 x 1150
1500	1775 x 1175	1650 x 1275
1650	1925 x 1300	1825 x 1375
1800	2075 x 1425	2025 x 1475
1950	---	2175 x 1575
2100	---	2375 x 1675
2250	---	2575 x 1775
2400	---	2800 x 1875
2550	---	2925 x 1975
2700	---	3200 x 2075
3000	---	3425 x 2175
3300	---	3550 x 2275

1007.09 PIPE JOINTS. Coupling bands for joining metal conduit shall be approved by the DOTD Materials Engineer Administrator and shall comply with AASHTO M 36 for steel conduit and AASHTO M 196 for aluminum conduit with the following modifications:

(a) Coupling Bands: Bands shall be of an approved design and shall be fabricated from metal sheets of the same material as the conduit. The band thickness shall be the same as the conduit thickness with a maximum of 12 gage (2.77 mm). Coating shall be the same as used on the conduit. Minimum band width shall be 12 inches (300 mm).

(b) Rubber Gaskets: Rubber gaskets shall comply with Subsection 1006.06(a). Gasket cross section shall be 13/16-inch (20 mm) for pipe 36 inches (900 mm) in diameter and 7/8-inch (22 mm) for pipe greater than 36 inches (900 mm) in diameter for 1/2-inch (13 mm) deep corrugations and 1 3/8-inches (35 mm) for 1-inch (25 mm) deep corrugations.

(c) Flexible Plastic Gaskets: Flexible plastic gaskets shall comply with Subsection 1006.06(b). Gasket material shall be a minimum of 1 inch (25 mm) for 1/2-inch (13 mm) corrugation depth, and a minimum of 1 1/2 inches (40 mm) for 1-inch (25 mm) corrugation depth.

(d) Hardware: Hardware shall be galvanized in accordance with ASTM A 153 or B 633, Class Fe/Zn 25 or an approved mechanical galvanizing process complying with ASTM B 695 that provides the same coating thickness.

(e) Steel Banding Rods: Steel banding rods shall comply with AASHTO M 270, Grade 36 (M 270M, Grade 250). Welding of rods will not be permitted. No more than two splices will be allowed.

(f) Type 1 (T1) Joints: These joints shall be soil tight. A Type 2, 3 or other approved joint system may be substituted for a Type 1 joint. At least one line of approved gasket material shall be required under the band on each pipe end.

(g) Type 2 (T2) Joints: These joints shall pass the 5 psi hydrostatic pressure test. Joint details shall be as shown on the plans.

(h) Type 3 (T3) Joints: These joints shall pass the 10 psi hydrostatic pressure test. Joint details shall be as shown on the plans.

1007.10 CAST IRON SOIL PIPE AND FITTINGS. Cast iron soil pipe and fittings shall comply with ASTM A 74. Joints shall be made with rubber gaskets complying with ASTM C 564.

1007.11 DUCTILE IRON PIPE. Ductile iron pipe shall comply with ANSI A 21.51.

1007.12 BLACK AND GALVANIZED WELDED AND SEAMLESS STEEL PIPE. Steel pipe for ordinary uses shall comply with ASTM A 53.

Section 1008
Paints

1008.01 GENERAL.

(a) Packaging: Paints shall be delivered in minimum 5-gallon (15 L), full lid, shipping containers complying with Surface Transportation Board (STB) requirements. Used containers will not be permitted unless they have been satisfactorily reconditioned and thoroughly cleaned.

(b) Identification: Each paint container shall bear a label with the following information: name and address of manufacturer, trade name or trademark, kind of paint, color of paint, number of liters, batch number and date of production.

(c) Storage: After one year from date of manufacture, the material shall not show skinning, settling, color change, thickening or livering that cannot be eliminated by normal mixing procedures. After one year, the paint shall be retested prior to use and shall show no change from when originally approved. No material shall be used after the manufacturer's recommended shelf life.

1008.02 THREE-COAT WATERBORNE PAINT SYSTEM (Two Primers And One Topcoat). The Three-Coat Waterborne Paint System (Two Primers and One Topcoat), shall be an approved system listed on QPL 68. Each system shall be tested for a minimum of 1500 hours in a salt spray (fog) apparatus and fluorescent UV-Condensation Exposure Apparatus in accordance with ASTM B 117 and G 154. The paint system shall show no rusting, checking, cracking, delamination or undercutting. There shall be only slight chalking or discoloration and there shall be no blisters larger than number 8 when rated in accordance with ASTM D 714.

Standard X-ray and infrared curves will be made of all approved coatings in accordance with ASTM D 5380 and DOTD TR 610. When the project sample deviates from these curves, the material represented by the sample will be rejected.

The following specification is not a formula. The manufacturer assumes all responsibility in formulating products which meet these specification requirements in laboratory testing, field application, and performance.

Each paint system shall comply with the following requirements.

(a) Primer:

(1) System A:

a. Pigment: The pigment shall be composed of the following materials:

	Percent By Weight (mass)
Zinc Phosphate Dihydrate, Min.	22
Red Iron Oxide (ASTM D 3722), Min.	10
Barium Sulfate (ASTM D 602), Min.	50

The balance of the pigment shall include any application aids, thixotropes, tinting pigments, etc. which may enhance the performance of the material.

b. Vehicle: The vehicle shall be composed of a minimum of 80 percent resin solution with the balance being water, surfactants, antifoam additives, stabilizers, pH adjusters, etc. The resin shall be of vinyl acrylic copolymer latex having a pH between 1 and 2 and a chlorine content of 64 percent based on latex solids.

c. Mixed Paint: The mixed paint shall have the following properties:

PROPERTY	TEST METHOD	REQUIREMENT
Pigment, % by wt., Min.	ASTM D 3723	23
Weight/gallon, pounds, Min.	ASTM D 1475	12
Solids, % by wt. Min.	ASTM D 3723	60
Non-volatile in Vehicle, % by wt., Min.	ASTM D 3723	49
Viscosity, Ku	ASTM D 562	70 - 90
Fineness of Grind, Hegman Scale, Min.	ASTM D 1210	5
Dry to Touch, Minutes, Max.	ASTM D 1640	30
Dry Through, Hours, Max.	ASTM D 1640	1
PH	ASTM E 70	4.5 - 5.5
Sag, Lenetta, Mils, Min.	ASTM D 4400	12

(2) System B (Color Contrasting Primers):

a. First Coat Primer: See heading 1008.02(a)(1)a.

b. Second Coat Primer: The second coat primer shall meet the vehicle requirements of the first coat primer. The second coat primer pigmentation shall be changed to allow for color contrast between the first coat red primer, second coat primer and gray topcoat.

(b) Topcoat:

(1) Pigment: The pigment shall be composed of 95 percent by weight of Titanium Dioxide ($Ti0_2$) in accordance with ASTM D 476. The balance of the pigments shall include any application aids, thixotropes, tinting pigments, etc., which may enhance the performance of the material.

(2) Vehicle: The vehicle shall be composed of a minimum of 87 percent solution with the balance being water, dispersant, rheological modifiers, stabilizers, etc. The resin shall be a 41.5 percent solids small particle size aqueous dispersion copolymer consisting of acrylic, acrylonitrile and styrene monomers. The resin shall have a personal modulus between 38°C and 42°C and a pH between 7.2 and 7.8.

(3) The topcoat shall be tinted to match the standard "Louisiana Gray" topcoat available from the Materials and Testing Section. The paint shall have the following properties:

PROPERTY	TEST METHOD	REQUIREMENT
Pigment, % by wt., Min.	ASTM D 3723	13
Weight/gallon, pounds, Min.	ASTM D 1475	9.2
Solids, % by wt. Min.	ASTM D 3723	46
Non-volatile in Vehicle, % by wt., Min.	ASTM D 3723	39
Viscosity, Ku	ASTM D 562	90 - 110
Fineness of Grind, Hegman Scale, Min.	ASTM D 1210	5
Dry to Touch, Minutes, Max.	ASTM D 1640	30
Dry Through, Hours, Max.	ASTM D 1640	2
Sag, Resistance, Lenetta, Mils, Min.	ASTM D 4400	12

1008.03 ASPHALTIC VARNISH.

(a) Material: Asphaltic varnish shall be composed of hard native asphalts or asphaltites (gilsonite, for example), run (fluxed) and blended with properly treated drying oils, and thinned with suitable solvents with the necessary amount of dryers.

(b) Appearance: The film shall be smooth and homogeneous when a thoroughly mixed sample is poured and examined on a clean, clear, glass plate and placed in a vertical position until the excess varnish has drained off. The film will be examined by transmitted light.

(c) Color: Color shall be jet black when examined by reflected light.

(d) Nonvolatile Matter: Nonvolatile matter shall be not less than 40 percent by weight (mass) when tested in accordance with ASTM D 2369.

(e) Drying of film:

(1) Set to Touch: Film shall set to touch in not more than 8 hours when tested in accordance with ASTM D 1640.

(2) Dry Through: Film shall dry through in not more than 36 hours when tested in accordance with ASTM D 1640.

(f) Working Properties and Appearance of Dried Film: Varnish shall have good brushing, flowing, covering and leveling properties. Dried film shall be jet black, smooth and free from brush marks, blisters, pinholes and other defects.

(g) Water Resistance: Film shall show no whitening, dulling or other defects after a dried film is immersed in water for 18 hours and air dried for 2 hours.

1008.04 COAL TAR EPOXY-POLYAMIDE PAINT. This paint shall comply with SSPC Paint No. 16.

1008.05 COLD GALVANIZED REPAIR COMPOUND. This material shall be used for the spot repair of galvanized surfaces and shall be an approved product listed in QPL 23. The material shall be supplied in aerosol cans or friction top cans. The cans shall be labeled with the manufacturer's name, product name, and batch number. The pigment shall contain a minimum of 90 percent metallic zinc.

Test panels coated with the compound shall be tested in a salt fog apparatus in accordance with ASTM B 117 for 1500 hours. The panels shall show no sign of rust, blistering, undercutting, delamination, or other deleterious properties when evaluated in accordance with DOTD TR 503.

1008.06 CORROSION INHIBITING ALKYD PAINT SYSTEM. The Corrosion Inhibiting Alkyd Paint System shall be a three-coat paint system applied to properly prepared structural steel surfaces that are permanently exposed to weather. The paint shall be compatible with basic lead silico chromate paint. Either System A or System B can be used, however, whichever system is selected shall be used on the entire project. The corrosion inhibiting pigment in System A shall be zinc hydroxy phosphite and the corrosion inhibiting pigment in System B shall be calcium borosilicate. The primer and the intermediate coats shall be tinted for color contrast. An aluminum topcoat in accordance with AASHTO M69, Type I shall be applied in both systems.

(a) Specific Requirements: Test methods shall be the latest in effect. The manufacturer assumes all responsibility in formulating products which meet these specifications requirements.

Systems A and B shall comply with the following requirements.

PROPERTY	TEST METHOD	REQUIREMENT SYSTEM A MIN	MAX	SYSTEM B MIN	MAX
PRIMER					
Pigment, % by wt	ASTM D 2371	50	--	53	--
Vehicle, % by wt	ASTM D 2371	--	50	--	47
Weight/gallon, pounds @ 77°F	ASTM D 1475	12.3	--	11.4	--
Water, %		--	0.5	--	0.25
Coarse Particle and Skins (Total Residue Retained on No. 325 Sieve Based on Paint), %	ASTM D 185	--	1.0	--	1.0
Fineness of Grind (North Std)	ASTM D 1210	5	--	5	--
Viscosity (Stormer-Krebs Units) @ 77°F	ASTM D 562	70	80	75	85
Dry Through, Hours	ASTM D 1640	18	--	18	--
Non-volatile in Vehicle, % by wt	ASTM D 2369 & ASTM D 2372	66	--	57	--

PROPERTY	TEST METHOD	REQUIREMENT SYSTEM A MIN	MAX	SYSTEM B MIN	MAX
INTERMEDIATE COAT					
Pigment, % by wt	ASTM D 2371	50	--	44	--
Vehicle, % by wt	ASTM D 2371	--	50	--	56
Weight/gallon, pounds @ 77°F	ASTM D 1475	12.3	--	10.2	--
Water, %		--	0.25	--	0.25
Coarse Particle and Skins (Total Residue Retained on No. 325 Sieve Based on Paint), %	ASTM D 185	--	1.0	--	1.0
Fineness of Grind (North Std)	ASTM D 1210	5	--	5	--
Viscosity (Stormer-Krebs Units) @ 77°F	ASTM D 562	70	80	75	85
Dry Through, Hours	ASTM D 1640	--	18	--	10
Non-volatile in Vehicle, % by wt	ASTM D 2369 & ASTM D 2372	66	--	45	--

(1) System A:

a. Vehicle: The vehicle shall consist of not less than 66.0 percent non-volatile vehicle. The balance shall be combined drier and thinner.

The non-volatile vehicle shall be composed of raw linseed oil and alkyd resin combined in the approximate proportions of 1:1 respectively by weight. The alkyd resin furnished as a solution shall meet the requirements of Federal Specifications TT-R-266C Type I, Class A. The raw linseed oil shall meet the requirements of ASTM D234.

The volatile vehicle shall be mineral spirits meeting the requirements of Rule 66.

b. Pigment:

	PERCENT BY WEIGHT	
PRIMER PIGMENT	**MIN**	**MAX**
Zinc hydroxy phosphite, ASTM D 4462	73.0	75.0
Red Iron Oxide (98% Fe203)	24.0	26.0
Organo Montmorillonite	0.75	--

	PERCENT BY WEIGHT	
INTERMEDIATE PIGMENT	**MIN**	**MAX**
Zinc hydroxy phosphite, ASTM D 4462	75.0	77.0
Titanium Dioxide, Rutile Non Chalking, ASTM D476	19.0	21.0
Organo Montmorillonite	0.75	--
Tinting Pigments[1]	--	--
Yellow Oxide	--	--
Red Oxide	3.0	3.5
Lampblack	--	--

[1]Tinting pigment may be added as predispersion pigment.

(2) System B:

a. Primer:

PIGMENT	MIN	MAX
Calcium Boro-Silicate, ASTM D 4288	80.0%	--
Synthetic Iron Oxide, ASTM D 84, Class I	16.0%	18.0%
Organo Montmorillonite	1.0%	2.0%
VEHICLE		
Alkyd Resin Solution, Fed. Spec TT-R-266, Type I, Class A	43.0%	50.0%
Linseed Oil, ASTM D 234	20.0%	27.0%
Mineral Spirits, Fed. Spec TT-T-291E, Type II[1]	--	28.0%
Driers	1.0%	2.0%

[1] Small quantities of alcohols or alcohol/water mixtures may replace some mineral spirits where such materials are used as polar additives for the suspending aid.

b. Intermediate Coat:

PIGMENT	MIN	MAX
Calcium Boro-Silicate, ASTM D 4288	80.0%	--
Synthetic Iron Oxide, ASTM D 84, Class I	17.5%	18.5%
Organo Montmorillonite	1.5%	2.5%
Lampblack	--	2.0%
VEHICLE		
Alkyd Resin Solution, Fed. Spec TT-R-266, Type I, Class A	65.0%	--
Mineral Spirits, Fed. Spec TT-T-291E, Type II*	--	34.0%
Driers	1.0%	1.5%

*Small quantities of alcohols or alcohol/water mixtures may replace some mineral spirits where such materials are used as polar additives for the suspending aid.

1008.07 ZINC PAINT SYSTEMS FOR NEW STRUCTURAL STEEL AND 100 PERCENT BARE EXISTING STRUCTURAL STEEL. The zinc paint system shall be an approved system listed on QPL 78. Each system shall be tested in accordance with AASHTO R 31 and meet the following requirements.

Performance Requirements	Zinc Paint Systems	
	Inorganic Zinc Primer	Organic Zinc Primer
Rust Criteria after 5000 hrs exposure to Salt Fog Resistance Test in accordance with ASTM B 117.		
Maximum Creep, mm - Evaluated in accordance with AASHTO R 31, Subsection 8.2.2.2.	4	4
Maximum Average Creep, mm - Evaluated in accordance with AASHTO R 31, Subsection 8.2.2.2.	2	2
Maximum length, mm - Evaluated in accordance with AASHTO R 31, Subsection 8.2.2.3.	3	15
Blister Criteria after 4000 hrs exposure to Salt Fog Resistance Test in accordance with ASTM B 117.		
Minimum Conversion # - Blistering evaluated in accordance with ASTM D 714. Blister size and frequency converted using blister value conversion table.	8	7
Rust Criteria after 5040 hrs exposure to Cyclic Weathering Resistance Test in accordance with ASTM D 5894.		
Maximum Creep, mm - Evaluated in accordance with AASHTO R-31, Subsection 8.2.2.2.	4	12
Maximum Average Creep, (mm) - Evaluated in accordance with AASHTO R 31, Subsection 8.2.2.2.	2	5
Blister Criteria after 4032 hrs exposure to Cyclic Weathering Resistance Test in accordance with ASTM D 5894.		
Minimum Conversion # - Blistering evaluated in accordance with ASTM D 714. Blister size and frequency converted using blister value conversion table.	9	8
Adhesion Criteria - Minimum pull-off strength shall be tested in accordance with ASTM D 4541.		
Minimum for both primer and PIT (Primer, Intermediate, Topcoat) panels.	(2.4 MPa) 350 psi	(4.1 MPa) 600 psi
Freeze Thaw Criteria – After 30 freeze/thaw cycles as defined in AASHTO R 31, Subsection 8.6.1 there shall be no loss of adhesion when compared with above adhesion results.		

Blister Value Conversion Table

Blister Size	Blister Frequency			
	Few	Medium	Medium Dense	Dense
#8	9	8	7	6
#6	8	7	6	5
#4	7	6	5	4
#2	6	5	4	3
#1	5	4	3	2

Products to be used on projects will be sampled and tested and shall comply with the following requirements:

PROPERTY	TEST METHOD	Specification Acceptance[1]
Pigment Content.	ASTM D 2698	Target Value ±2.0%
Density	ASTM D 1475	Target Value ±0.25 lbs/gal (±0.03 kg/l)
Solids Content	ASTM D 2369	Target Value ±2.0%
Non-volatile in Vehicle Content	ASTM D 2698	Target Value ±2.0%
Viscosity, Ku	ASTM D 562	Target Value ±5KU
Dry to Touch	ASTM D 1640	Target Value ±10%
Dry Through	ASTM D 1640	Target Value ±10%
Sag, Lenetta	ASTM D 4400	Target Value ±10%
Infrared Spectrum	ASTM D 2621	[2]
X-Ray Diffraction	ASTM D 2321	[2]

[1]Target Values shall be established by the Materials Section upon qualification of the paint system.
[2]Standards for infrared spectrum and x-ray diffraction shall be kept on file and compared to project samples for acceptance purposes.

The topcoat shall be tinted to match the standard "Louisiana Gray" topcoat available from the Materials and Testing Section.

When weathering steel is used for structural members such as bridge girders, the ends of the members shall be painted with the zinc paint system for a distance of 1.5 times the member depth, not to exceed 10 feet (3 m). The topcoat color shall match the color of the weathered steel.

Section 1009
Reinforcing Steel and Wire Rope

1009.01 REINFORCING STEEL. Reinforcing steel for concrete shall comply with the following unless otherwise specified. Reinforcing steel used in bridge superstructures and substructures shall be grade 60 (420). In other structures, deformed bars No. 3 (10) thru No. 6 (19) shall be either Grade 40 (300) or 60 (420); No. 7 (22) and larger shall be Grade 60 (420). Bars smaller than No. 3 (10) need not be deformed. All deformed bars shall comply with Headings (a), (b) or (c) below. Size W 5 wire complying with Heading (d) below may be used in lieu of bars smaller than No. 3 (10).

(a) Billet-Steel Deformed and Plain Bars shall comply with ASTM 615 (ASTM A 615M) and shall be an approved product listed on QPL 71.

(b) Rail-Steel and Axle-Steel Deformed and Plain Bars shall comply with ASTM A 996 (ASTM A 996M).

(c) Cold-Drawn Steel Wire, ASTM A 82 with the following amendment: For material testing over 110,000 psi (760 MPa) tensile strength in high strength applications such as spirals and ties, the 25 percent minimum reduction in area shall be reduced 5 percent for each 10,000 psi (70 MPa) increment of tensile strength exceeding 110,000 psi (760 MPa).

(d) Welded Steel Wire Fabric shall conform to ASTM A 185.

(e) Epoxy Coated Reinforcing Steel and patching materials shall comply with AASHTO M 284 and shall be approved products listed on QPL 51.

1009.02 SPIRAL REINFORCING. Spiral reinforcing shall comply with Subsection 1009.01(a), (b), (c) or (d).

1009.03 TIE BARS. Tie bars shall comply with Subsection 1009.01 (a), (b) or (c). Tie bars to be bent and restraightened during construction shall be Grade 40 (300).

1009.04 DOWEL BARS. Dowel bars may be placed in approved dowel bar assemblies in accordance with the plans.

Dowel bars shall be plain steel bars complying with Subsection 1009.01 (a), (b) or (c). Dowels shall have a uniformly round cross section and shall be saw cut, smooth and free of burrs, projections and deformations.

Dowel bars shall be undercoated with an adhesive and given an outer coat of polypropylene or polyethylene. The coated dowel bar shall comply with AASHTO M 254.

1009.05 STEEL STRAND FOR PRETENSIONING. Strand for pretensioning shall comply with ASTM A 416. The strand manufacturer shall submit to the Construction Section three copies of Certificates of Analysis of all test results as stipulated in ASTM A 416, and as part of this document, shall provide the modulus of elasticity of that particular mill heat of strand. The Department reserves the right to conduct inspections at the site of manufacture and to have all tests witnessed by its inspector. The data from the manufacturer's typical curve shall be used when computing the required elongation for each strand.

1009.06 BARS FOR POST-TENSIONING. Bars shall be steel complying with ASTM A 722 having a minimum modulus of elasticity of 25,000,000 psi (170,000 MPa), and shall be equipped with wedge-type end anchorages which will develop the minimum specified ultimate bar stress on the nominal bar area.

1009.07 PARALLEL WIRE ASSEMBLIES FOR POST-TENSIONING. Assemblies shall consist of parallel wire of the specified number and size. Wire shall be high tensile strength, hard-drawn, stress-relieved and uncoated, delivered in coils of 54 inches (1350 mm) minimum diameter. Wire shall comply with ASTM A 421, Type WA.

1009.08 ANCHORAGES FOR POST-TENSIONED TENDONS.

(a) Bars: Wedge-type anchorages shall be used for bars. Wedge devices shall develop the minimum ultimate stress specified for the nominal bar area. Wedge anchorages shall bear against anchorage plates fabricated of hot-rolled steel having characteristics not less than as specified for No. 1040 of the AISI specifications.

(b) Parallel Wire Assemblies: Wedge-type anchorages of the sandwich plate or conical type shall be used. Anchorage device shall be capable of developing the ultimate strength of the total number of wires anchored. Conical-type anchorages shall be embedded within ends of

concrete members. Anchorages shall bear against embedded grids of reinforcing steel of approved type.

(c) Alternate Anchorage Types: Alternate anchorage types complying with the physical requirements specified above for wedge-type anchorages will be considered. Anchorages shall either develop the specified ultimate strength of reinforcing tendons, or the allowable stress on the tendon will be based on anchorage strength.

Alternate type anchorages shall show evidence of being capable of withstanding at least 3 million cycles of twice the maximum live load stress variation.

1009.09 ANCHORAGES AND HARDWARE FOR PRETENSIONING. Anchorages, including holddown and miscellaneous hardware, shall be sampled in accordance with the Materials Sampling Manual and submitted to the Construction Section for approval by evaluation or testing.

1009.10 WIRE ROPE. Wire rope shall comply with Federal Specifications RR-W-410D and the following requirements.

The type and classification of wire rope shall comply with one shown in Table 1009-1.

When wire joints are necessary, they shall be electrically butt-welded; and in the stranding operation, no two joints in any strand shall be closer than 25 feet (7.5 m) apart, except for filler wires.

Table 1009-1
General Wire Rope Classification and Usage

Type	Classification	Usage
I	1. (6x7)	Haulage rope, for use where strength and durability are desirable, but not much bending is required. May be used as single line for pulling load, but not suitable for sheave work.
	2. (6x19)	Most widely used for cranes, derricks, dredges, draglines and scrapers. This classification is very rugged, withstands abrasion well and is generally suited for all-around use.
	3. (6x37)	For hoisting rope where maximum flexibility is required; for instance, hoisting rope that runs over small sheave on draglines.
II	2. (8x19)	High speed elevator rope.
III (Marine)	1. (6x6)	Deck lashing ropes.
	2. (6x12)	Running ropes.
	3. (6x24)	Mooring lines.
	4. (6x3x7)	Spring lay.
	5. (6x3x19)	Spring lay.
	6. (6x42)	Tiller or hand control rope.
IV (Special)	2. (18x7)	Nonrotating (for drill rigs)

1009.11 COUNTERWEIGHT ROPES. Counterweight ropes shall comply with Table 1009-2 and shall be improved plow steel, uncoated, preformed 6 x 25 filler wire construction with hard fiber core and right regular lay. Each strand shall consist of 19 main wires and 6 filler wires fabricated in one operation, with all wires interlocking. Lay of wires in strands shall be such as to make wires approximately parallel to the axis of the rope where they would come in contact with a circular cylinder circumscribed on the rope.

Fiber cores shall be prelubricated by the cordage manufacturer. Component parts of wire rope, fiber cores, wires and strands shall be lubricated during fabrication with an approved lubricant containing a rust inhibitor.

Every effort shall be made to fabricate wire ropes of uniform physical properties, and counterweight wire ropes operating as a group in one equalizing system shall be cut from one continuous manufactured length.

No splicing of wire rope or its component strands will be permitted. Wire from which wire ropes are made shall be tested in the presence of the engineer, except that filler wires may be made to the manufacturer's standards.

Wire rope shall be prestressed and measured for length by the manufacturer prior to delivery. The contractor shall notify the engineer at least 10 calendar days in advance of prestressing operations so the Department may have its inspector present for the operations.

Counterweight ropes shall be prestressed. The prestressing load shall be 35 percent of the listed breaking strengths of the wire ropes. Loading shall be applied three times to the wire ropes. The cycle of loading shall be between the limits of 5 to 35 percent. The maximum loading shall be held on the wire rope for 15 minutes each.

The length of each wire rope from centerline of open socket pins or from the bearing of closed sockets shall be measured under a tension of 12 percent of the listed breaking strengths. A metal tag having the length stamped thereon shall be securely attached to the wire rope. Length of each rope shall also be stamped on each socket. After wire rope has been measured as noted herein, it shall have a stripe painted on one side along its entire length to assure the twist of the wire rope during erection of the bridge. The rope number shall be stamped on each socket, counterweight and span lifting point. While being measured, each rope shall be twisted to correct lay and shall be supported throughout its length in a straight line at maximum 25-foot (7.6 m) intervals.

Lengths of wire rope in excess of 100 feet (30 m) shall not vary from specified length by more than 0.0002 times the specified length. For wire rope lengths of 100 feet (30 m) or less, the tolerance from specified length shall be ±1/4 inch (±5 mm).

Sockets and socket pins used with wire ropes shall be forged, without welds, from solid steel and shall conform to ASTM A 688, Class D, normalized except that sockets for ropes 2 1/2 inches (63 mm) or greater diameter may be cast steel conforming to ASTM A 148, Grade 80-50. The socket shall be attached to the wire rope by using zinc of a quality not less than defined for Intermediate Grade in ASTM B 6. Wire rope shall not slip appreciably in its connection.

Full-sized specimens of rope shall be fitted with sockets, attached not less than 25 rope diameters but not more than 12 feet (3.6 m) apart, and shall be tested to destruction. Sockets used for these tests shall not be used in the structure.

Movement of the zinc cone in the socket basket when the wire rope is stressed to 80 percent of listed breaking strength shall not exceed 1/6 the nominal diameter of the wire rope. If a greater movement occurs, the method of attachment shall be changed until a satisfactory method is found. The number of test specimens shall not exceed 10 percent of the total number of finished lengths of rope to be made, nor shall there be less than two specimens taken from each original length of rope.

The manufacturer shall provide proper facilities for making the tests and shall make them at no direct pay. The contractor shall furnish the engineer with certified test reports for all required tests.

If a socket breaks during tests of the wire rope, two other sockets shall be selected and attached to another piece of rope, and the test repeated. This process shall be continued until reliability of the sockets is established, in which case the lot shall be accepted. If, however, 10 percent or more of the sockets tested break at a load less than the specified minimum strength of the rope, the entire lot will be rejected.

The engineer reserves the right to test each wire rope at the Department's expense after sockets are attached, by a load equal to 1/2 the listed breaking strength of the wire rope. If the assembly shows weakness, it will be rejected and replaced.

Wire ropes shall be suitably marked or tagged for identification for proper erection.

Wire rope shall be shipped on reels or in coils. The minimum reel diameter or the inside diameter of coils shall not be less than 25 times the minimum diameter of the wire rope.

Wire ropes shipped on reels shall be removed by revolving the reels, and wire ropes shipped in coils shall be mounted on a turntable for uncoiling. In uncoiling and erecting, wire ropes shall be carefully handled to avoid kinks, sharp bends or twisting.

Table 1009-2
Counterweight Rope

Rope Diameter				Approximate Circumference,		Maximum Strand Pitch,		Approximate Weight (mass),		Minimum Breaking Strength on Bright (Uncoated) Wire Ropes	
Minimum,		Maximum,									
in.	mm	in.	mm	in.	mm	in.	mm	lb/ft	kg/m	lb.	kg
1/4	6.0	9/32	7	3/4	20	1 11/16	43	0.105	0.156	5,343	2 424
5/16	7.5	11/32	9	1	25	2 1/8	54	0.164	0.244	8,307	3 768
3/8	9.5	13/32	10.5	1 1/8	30	2 17/32	64	0.236	0.351	11,895	5 396
7/16	11	15/32	12	1 3/8	35	2 31/32	75	0.32	0.48	16,127	7 315
1/2	12.5	17/32	13.5	1 5/8	40	3 3/8	86	0.42	0.63	20,865	9 464
9/16	14	19/32	15	1 3/4	45	3 13/16	97	0.53	0.79	26,325	11 941
5/8	15.5	21/32	17	2	50	4 7/32	107	0.66	0.98	32,565	14 771
3/4	19	25/32	20	2 3/8	60	5 1/16	129	0.95	1.41	46,410	21 050
7/8	22	59/64	23.5	2 3/4	70	5 29/32	150	1.29	1.92	62,790	28 480
1	25	1 3/64	27	3 1/8	80	6 3/4	171	1.68	2.50	81,510	36 970
1 1/8	28.5	1 11/64	30	3 1/2	90	7 19/32	193	2.13	3.17	102,570	46 525
1 1/4	32	1 5/16	33.5	3 7/8	100	8 7/16	214	2.63	3.91	125,970	57 140
1 3/8	34.5	1 7/16	36.5	4 3/8	110	9 9/32	236	3.18	4.73	151,515	68 725
1 1/2	38	1 9/16	40	4 3/4	120	10 1/8	257	3.78	5.63	179,400	81 370
1 5/8	41	1 23/32	44	5 1/8	130	10 31/32	279	4.44	6.61	208,650	94 640
1 3/4	44.5	1 27/32	47	5 1/2	140	11 13/16	300	5.15	7.66	241,800	109 680
1 7/8	47.5	1 31/32	50	5 7/8	150	12 21/32	322	5.91	8.80	274,950	124 720
2	50.5	2 3/32	53.5	6 1/4	160	13 1/2	343	6.72	10.00	312,000	141 500
2 1/8	54	2 7/32	56.5	6 5/8	170	14 11/32	364	7.59	11.30	349,050	158 350
2 1/4	57	2 11/32	60	7 1/8	180	15 3/16	386	8.51	12.66	390,000	176 900
2 1/2	63	2 5/8	67	7 7/8	200	16 7/8	429	10.5	15.6	475,800	215 800
2 3/4	70	2 7/8	73	8 5/8	220	18 9/16	472	12.7	18.9	569,400	258 300

Section 1010
Fence and Guard Rail

1010.01 BARBED WIRE. Barbed wire shall be either steel or aluminum alloy and shall be 12 1/2 gage (2.5 mm diameter).

(a) Steel Barbed Wire: Steel barbed wire shall comply with ASTM A 121.

(b) Aluminum Alloy Barbed Wire: Aluminum alloy barbed wire shall comply with ASTM B 211, Alloy 5052-0 for line wire and Alloy 5052-H38 for barbs.

1010.02 WOVEN WIRE. Woven wire shall comply with one of the following Design Numbers and Grades of ASTM A 116.

Design No.	Grade
939-6-11	60
939-6-12 1/2	60
939-6-14 1/2	125
939-6-12 1/2	125

1010.03 POSTS AND BRACES FOR FIELD AND LINE TYPE FENCE. Posts and braces shall be either steel or treated timber.

(a) Treated Timber Posts and Braces: Braces shall be either round or square. Posts shall be round.

Treated timber posts and braces shall comply with Section 1014.

(b) Steel Posts and Braces: Steel posts and braces shall be equipped with corrugations, knobs, notches, holes or studs so placed and constructed as to engage a substantial number of fence wires in proper position. Posts may be punched with holes in such position and of such size as will not unduly impair the strength of the posts. Posts with punched tabs used for fastening wires are not acceptable. Corner, end and bracing posts shall be supplied with necessary holes and with galvanized bolts of standard commercial quality or other satisfactory substitute, such as castings, for fastening braces to the posts.

Line posts, anchor plates and braces shall comply with ASTM A 702, except that a hardness test may not be substituted for the tensile test. Steel posts, anchor plates and braces shall be galvanized in accordance with ASTM A 123.

1010.04 STAPLES AND NAILS. Staples and nails shall be made of galvanized steel wire. Minimum galvanized coating shall be not less than 0.20 ounce per square foot (60 g/sq m) when tested in accordance with ASTM A 90.

1010.05 METAL FASTENERS FOR STEEL POSTS. Metal fasteners for steel posts shall be galvanized steel-wire fasteners or clamps and shall be satisfactory for use with the type of steel post furnished. Wire shall be not less than 0.120 inch (3.0 mm) diameter. Galvanized coating shall not be less than 0.20 ounce per square foot (60 g/sq m) when tested in accordance with ASTM A 90.

1010.06 GATES FOR FIELD AND LINE TYPE FENCE.

(a) Gates: Steel used in fabricating gates shall be galvanized in accordance with ASTM A 653 Coating Designation G60 (A653M Coating Designation Z180).

(b) Posts:

(1) Treated Timber: Treated timber posts shall comply with Section 1014.

(2) Metal: Metal posts shall be made of galvanized steel pipe, standard weight, complying with ASTM A 53.

(c) Hardware: Hinges, washers, nails, staples, welded chains and latches shall be galvanized, of acceptable quality, and of satisfactory type for use with the gate and posts selected.

(d) Gate Stops:

(1) Treated Timber: Gate stops shall be timber complying with Subsection 1010.03(a) treated in the same manner as posts.

(2) Metal: Gate stops shall be acceptable galvanized steel suitable for welding to the post.

(e) Stop Posts: Stop posts for double swinging driveway gates shall be treated timber complying with Section 1014.

1010.07 CHAIN LINK FENCE, GATES AND APPURTENANCES. Materials shall comply with AASHTO M 181 except for the following.

(a) Wire ties, fabric ties, hog rings and tension wire for Type I, II or III fencing shall be either aluminum alloy, galvanized ductile steel or aluminum-coated ductile steel wire.

(1) Wire Ties: Wire ties, fabric ties and hog rings shall have 20,000 psi (140 MPa) minimum tensile strength, and 10 percent minimum elongation. Steel shall be coated with at least 0.60 ounce (180 g) of zinc or

0.40 ounce (120 g) of aluminum alloy per square foot (sq m) of uncoated wire surface. Wire ties shall be AWG No. 9 (6.60 sq mm). Fabric ties and hog rings shall be AWG No. 12 (3.31 sq mm).

(2) Tension Wire:

a. Galvanized and aluminum-coated steel tension wire shall be AWG No. 9 (6.60 sq mm) wire having at least 75,000 psi (515 MPa) tensile strength with at least 0.70 ounce (210 g) of zinc or 0.40 ounce (120 g) of aluminum alloy per square foot of uncoated wire surface.

b. Aluminum alloy tension wire shall be AWG No. 6 (13.30 sq mm) wire having at least 42,000 psi (290 MPa) tensile strength, 35,000 psi (240 MPa) yield strength, and 10 percent elongation.

(b) Barbed wire used with chain link fence shall comply with Subsection 1010.01.

(c) Padlocks shall be solid jacket, extruded brass metal with interchangeable cores and 1 3/4-inches (45 mm) cases. All padlocks shall be keyed alike. Two keys shall be furnished for each padlock.

1010.08 METAL BEAM FOR HIGHWAY GUARD RAIL. Rail elements shall be corrugated sheet steel beams from a source shown on QPL 81. Guard rail elements, terminal sections and fittings shall be interchangeable with similar parts, regardless of source or manufacturer.

Guard rail, terminal sections and appurtenances shall comply with AASHTO M 180.

The fabricator shall annually file a Brand Registration and Guarantee with the DOTD Materials Engineer Administrator in accordance with AASHTO M 180.

1010.09 GUARD RAIL POSTS AND SPACER BLOCKS. Railing posts shall be either timber or steel. When the choice of post is at the option of the contractor, there shall be only one kind furnished on the project. Spacer blocks shall be timber or an alternate material approved based upon results of NCHRP 350.

(a) Timber Posts and Spacer Blocks: Timber and treatment shall comply with Section 1014.

(b) Steel Posts: Steel posts and shall conform to AASHTO M 270, Grade 36 (M 270M, Grade 250) or ASTM A 769, Grade 40 (A 769M, Grade 275) galvanized in accordance with ASTM A 123. Certificates of Analysis (Mill Test Reports) together with a Fabricator's Material Statement and Certificate of Compliance shall be furnished in accordance

with Subsection 1013.01. Welding, if required, shall be in accordance with Section 815.

(c) Concrete for anchorages shall comply with Section 901 Class M. Reinforcement for anchorages shall comply with Section 1009.

1010.10 GUARD RAIL HARDWARE. Splices, end connections, anchor rods and accessories shall be of such strength as to develop the full design strength of the rail elements.

Bolts shall comply with ASTM A 307 and nuts shall comply with ASTM A 563, Grade A (A563M, Property Class 5).

Fittings, bolts, washers and other accessories for steel guard rail shall be galvanized after fabrication in accordance with ASTM A 123 or A 153, or by an approved mechanical galvanizing process complying with ASTM B 695 that provides the same coating thickness. All galvanizing shall be done after fabrication.

1010.11 WIRE ROPE AND FITTINGS FOR HIGHWAY GUARD RAIL. Wire rope or wire cable and fittings shall comply with AASHTO M 30.

Section 1011
Concrete Curing Materials, Admixtures and Special Finishes

1011.01 CURING MATERIALS.

(a) Liquid Membrane-Forming Compounds: This material shall comply with AASHTO M 148 and be an approved product listed in QPL 65. The types shall be Type 2 white-pigmented or Type 1-D, clear or translucent with a fugitive dye, as specified.

(b) Burlap Cloth made from Jute or Kenaf shall comply with AASHTO M 182, Class 3.

(c) Waterproof Paper shall comply with AASHTO M 171.

(d) White Polyethylene Sheeting shall comply with AASHTO M 171.

(e) Combined Burlap and White Polyethylene Sheeting shall comply with AASHTO M 171.

1011.02 ADMIXTURES.

(a) Physical Requirements: Concrete admixtures shall be an approved product listed in QPL 58 and shall comply with the requirements in Table 1011-1 when tested in accordance with DOTD TR 224.

(b) Chemical Requirements: Unless a chloride type admixture is specified, the contribution of chloride ion resulting from the addition of admixtures to the concrete shall not exceed 0.02 pound per cubic yard (12 g/cu m) of concrete, when tested in accordance with DOTD TR 643.

(c) Acceptance Testing: The admixture shall be tested by analytical infrared (IR) spectroscopy in accordance with DOTD TR 610. The percent solids by weight (mass) shall be determined in accordance with DOTD TR 524. The IR spectrum shall compare favorably to the standard IR spectrum of the original material tested and listed in QPL 58. The percent solids content shall not deviate more than ±10 percent from that of the original approved material which was determined by the Materials and Testing Section.

Tests to determine rate of hardening, compressive strength or other properties may be made at any time during the work to ensure continued compliance with these specifications.

1011.03 SPECIAL SURFACE FINISH FOR CONCRETE. This material shall be an approved product listed in QPL 14 and comply with

established tolerances. The material shall provide a uniform, fine-textured finish complying with these specifications. Method and rate of application shall be as recommended by the manufacturer, except that application rate shall not exceed 60 square feet per mixed gallon (1.5 sq m per mixed L).

The material shall consist of a water-based one-component coating system containing pigments, texturizers, resins and water, and shall be supplied in containers not smaller than 5 gallons (15 L). The coating shall contain fungicides to adequately prevent the growth of mildew, mold, etc. No field additions to the coating will be permitted.

When tested in accordance with the QPL 14 Qualification Procedure, DOTD TR 620, the material shall comply with the following requirements:

(a) The average number of cycles to failure shall be not less than 50 cycles when tested in accordance with ASTM C 666. Test specimens shall show no flaking, cracking, spalling or loss of bond.

(b) The material shall be unaffected except for slight chalking or discoloration when exposed to 1000 hours of accelerated weathering using UV-B lamps in accordance with ASTM G 154.

(c) Color and texture of the material when applied to the test panel shall closely match that of the standard "Louisiana Gray" color chip on file at the Materials and Testing Section.

Table 1011-1
Physical Requirements for Admixtures

Property	Test Method	Water-Reducing			High Range Water Reducing		Set Accelerating
		Air Entraining	Normal Set	Set Retarding	Normal Set	Set Retarding	
Unit Water Content,							
Max. % of Control		90	95	95	88	88	---
Min. % of Control		---	89	89	---	to	---
Air Content, %, Total	DOTD TR 202	5 ± 1	0 to 3	0 to 3	0 to 3	0 to 3	0 to 3
Time of Setting, allowable deviation from control, hr:min.	AASHTO T 197						
Initial: at least		---	---	1:30 later	---	1:30 later	1:00 earlier
not more than		---	1:00 earlier or 1:30 later	3:30 later	1:00 earlier or 1:30 later	3:30 later	3:30 earler
Final: at least		---	---	---	---	---	1:00 earlier
not more than		---	1:00 earlier or 1:30 later	3:30 later	1:00 earlier or 1:30 later	3:30 later	---
Compressive Strength, Min. % of Control	DOTD TR 230						
1 Day		---	---	---	140	125	125
3 Days		---	---	---	125	125	100
7 Days		85	105	105	115	115	100
28 Days		85	105	105	110	110	100
6 Months		---	---	---	100	100	---
1 year		---	---	---	100	100	---
Flexural Strength, Min. % of Control	AASHTO T 97						
3 Days		---	---	---	110	110	---
7 Days		---	---	---	100	100	100
28 Days		---	---	---	100	100	100
Relative Durability Factor, Min. % of Control	AASHTO T 161	---	---	---	100	100	100

Section 1012
Bridge Railings and Barriers

1012.01 CONCRETE. Concrete for bridge railings and barriers shall be Class AA complying with Section 901.

1012.02 REINFORCING STEEL. Reinforcing steel shall be deformed bars complying with Subsection 1009.01.

1012.03 STRUCTURAL STEEL. Structural steel for railings and railing posts shall be AASHTO M 270, Grade 36 steel complying with Subsection 1013.01, except that the maximum tensile strength requirement will be waived.

1012.04 GALVANIZED STEEL PIPE RAILINGS.

(a) Galvanized Steel Pipe: Galvanized steel pipe shall be standard weight complying with ASTM A 53.

(b) Fittings and Castings: Fittings and castings for steel pipe shall be malleable iron or cast steel complying with ASTM A 47, Grade 32510 or A 27, Grade 70-36. Fittings and castings shall be galvanized in accordance with ASTM A 153. Repairs to galvanized surfaces shall be made in accordance with Subsection 811.12.

Three copies of Certificates of Analysis giving chemical and physical test results shall be forwarded for approval to the Construction Section for each heat or foundry pour of iron or steel post castings, with Certificates of Compliance as to the ounces per square foot (g/sq m) of galvanized coating applied.

(c) Bolts, Nuts and Washers: High strength bolts shall comply with ASTM A 325 (A 325 M). Bolts, nuts and washers shall be galvanized in accordance with ASTM A 153 or by an approved mechanical galvanizing process complying with ASTM B 695 that provides the same coating thickness. High strength nuts and washers shall comply with Subsection 1013.08(b).

When high strength bolts are not required, bolts shall comply with ASTM A 307 Grade A, and nuts shall comply with ASTM A 563. Unless otherwise specified, any appropriate steel washers can be used and the coating must be similar to the bolts and nuts.

(d) Screws: Machine screws for fastening access door covers to railing posts, and socket head cup point set screws for fastening pipe rail to railing posts and pipe caps to railing, shall be stainless steel and furnished by the supplier.

Section 1013
Metals

1013.01 STRUCTURAL STEEL. The contractor shall obtain all applicable physical and chemical tests and furnish the Construction Section five copies of the Certificates of Analysis (Mill Test Reports) together with a Fabricator's Material Statement and Certificate of Compliance. This form will be furnished by the Department upon request.

Structural steel shall comply with AASHTO M 270 (M 270M) specifications.

Longitudinal Charpy V-Notch Testing: When specified, the main load-carrying structural member components that are subject to tensile stress shall meet the longitudinal Charpy V-Notch requirements contained in the AASHTO M 270 (M 270M) Supplemental Requirements for Non-Fracture Critical Impact Test Requirements and for Fracture Critical Impact Test Requirements. Sampling and testing procedures shall be in accordance with AASHTO T 243 (T 243M) and AASHTO T 244 and the following requirements: the (H) frequency of heat testing shall be used for all steels except that for AASHTO M 270, Grade 100 (M 270M, Grade 690) steel the (P) frequency of piece testing shall be used.

1013.02 RIVET STEEL.

(a) Structural Rivet Steel shall comply with ASTM A 502, Grade 1.

(b) High Strength Rivet Steel shall comply with ASTM A 502, Grade 2.

1013.03 COPPER BEARING STEEL. When copper bearing steel is specified, the steel shall contain at least 0.2 percent copper.

1013.04 STEEL FORGINGS AND STEEL SHAFTING.

(a) Carbon and Alloy Steel Forgings: Steel forgings shall comply with ASTM A 668 (ASTM A 668M). Class C forgings shall be furnished except in cases specified below:

(1) Forged Shafts: Forged shafts shall comply with ASTM A 668 (ASTM A 668M), Class F.

(2) Forged Trunnions: Forged trunnions shall comply with ASTM A 668 (ASTM A 668M), Class G.

(b) Alloy Steel Forgings for Pinions and Reduction Gears: Alloy steel forgings for pinions and reduction gears shall comply with ASTM A 291, Class 3 or 3A.

(c) Cold Finished Steel Shafting: Cold finished carbon steel shafting shall comply with ASTM A 108. Cold finished alloy steel shafting shall comply with ASTM A 331.

1013.05 STEEL CASTINGS.

(a) Steel castings for highway bridges shall comply with ASTM A 27, Grade 70-36 (ASTM A 27M, Grade 485-250).

(b) High strength steel castings shall comply with ASTM A 148 (ASTM A 148M).

(c) Chromium alloy steel castings shall comply with ASTM A 743 (ASTM A 743M), Grade CA-15.

1013.06 CASTINGS. Castings shall be true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, blowholes and other defects in positions affecting their strength and value for the service intended. Castings shall be boldly filleted at angles, and rises shall be sharp and perfect. Castings shall be sandblasted or otherwise effectively cleaned of scale and sanded to a smooth, clean and uniform surface.

(a) Gray Iron Castings shall comply with AASHTO M 306.

(b) Malleable Castings shall comply with ASTM A 47, Grade 32510. (ASTM A 47M, Grade 22010).

(c) Ductile Iron Castings shall comply with ASTM A 536, Grade 60-40-18. Castings weighing more than 1,000 pounds (450 kg) shall be ultrasonically tested for voids. If voids are found, the casting will be rejected.

1013.07 BRONZE OR COPPER ALLOY BEARING AND EXPANSION PLATES.

(a) Bronze Bearing and Expansion Plates shall comply with ASTM B 22, Alloy C 91100.

(b) Rolled Copper-Alloy Bearing and Expansion Plates shall comply with ASTM B 100, Alloy C 51000.

1013.08 BOLTS, NUTS AND WASHERS.

(a) Carbon Steel Bolts, Nuts, and Washers: When high strength bolts are not required, bolts shall comply with ASTM A 307 Grade A, and nuts shall comply with ASTM A 563. Unless otherwise specified,

any appropriate steel washers can be used and the coating must be similar to the bolts and nuts.

(b) High Strength Bolts, Nuts and Circular Washers: Bolts, nuts and washers shall have plain surface finish unless otherwise specified.

(1) High strength bolts shall comply with ASTM A 325 (ASTM A 325M) or ASTM A 490 (ASTM A 490M), as specified. For ASTM A 325 (ASTM A 325M) bolts, Type 1 bolts shall be used; except that Type 3 bolts shall be used with unpainted AASHTO M 270, Grade 50W (M 270M, Grade 345W) steel.

(2) For Type 1 bolts, the nuts shall comply with ASTM A 563, Grade DH (ASTM A 563M, Property Class 12) or ASTM A 194 (ASTM A 194M), Grade 2H. For Type 3 bolts, the nuts shall comply with ASTM A 563, Grade DH3 (ASTM A 563M, Property Class 12).

(3) Circular washers for high strength bolts shall comply with ASTM F 436 (ASTM F 436M).

(c) Lock-Pin and Collar Fasteners: Subject to approval, high strength steel lock-pin and collar fasteners, including washers, may be used as an alternate for high strength bolts or rivets. Shank and head of high strength steel lock-pin and collar fasteners shall meet the chemical and mechanical requirements of ASTM A 325 (ASTM A 325M) or ASTM A 490 (ASTM A 490M), as specified. Each fastener shall provide a solid shank body of sufficient diameter to provide tensile and shear strength equivalent to the bolt or rivet specified. Each fastener shall have a cold-forged head on one end of approved type and dimensions, a shank length suitable for material thickness fastening and locking grooves, breakneck groove, and pull grooves (all annular grooves) on the opposite end. Each fastener shall provide a steel locking collar of proper size for the shank diameter used, which by suitable installation tools, is cold-swaged into the locking grooves forming a head for the grooved end of the fastener after the pull groove section has been removed. The steel locking collar shall be a standard product of an established manufacturer of lock-pin and collar fasteners.

1013.09 STEEL PILES. Steel piles shall comply with AASHTO M 270, Grade 36 (M 270M, Grade 250).

1013.10 SHEET PILES. Steel sheet piles shall comply with ASTM A 328 (ASTM A 328M). Aluminum sheet piles shall comply with ASTM B 221 (ASTM B 221M), Alloy 6061-T6 or Alloy 6063-T6 or ASTM B 209 (ASTM B 209M) Alloy 3064-H34.

1013.11 STEEL PIPE PILES. Steel pipe piles shall comply with ASTM A 252, Grade 2.

1013.12 SHEET COPPER. Sheet copper shall comply with ASTM B 152.

1013.13 SHEET LEAD. Sheet lead shall comply with ASTM B 29.

1013.14 SHEET ZINC. Sheet zinc shall comply with ASTM B 69, Type II.

1013.15 COLD-ROLLED STEEL. Cold-rolled steel shall be cold-finished steel complying with ASTM A 108.

1013.16 BRONZE.

(a) Center discs for movable bridges shall comply with ASTM B 22, Alloy C91300.

(b) Trunnion and similar bearings for movable bridges shall comply with ASTM B 22, Alloy C91100.

(c) Shafts and ordinary bearings shall comply with ASTM B 22, Alloy C90500.

(d) Gears, nuts transmitting motion, and other parts involving stresses other than compression shall comply with ASTM B 22, Alloy C90500.

1013.17 BABBITT METAL. Babbitt Metal shall comply with ASTM B 23, Alloy 3.

1013.18 STEEL FOR CENTER DISCS (Movable Bridges). Steel for center discs shall comply with ASTM A 668 (ASTM A 668M), Class F.

1013.19 STEEL FOR KEYS (Movable Bridges). Steel for keys shall comply with Subsection 1013.15 or ASTM A 668 (ASTM A 668M), Class D.

1013.20 SEAMLESS STEEL PIPE AND TUBING FOR HYDRAULIC LINES. Carbon steel pipe for hydraulic lines shall comply with ASTM A 106, Grade B. Fittings for hydraulic lines shall comply with ASTM A 105 (ASTM A 105M).

Stainless steel tubing shall be seamless austenitic stainless steel and shall comply with ASTM A 269.

1013.21 STEEL FOR OPEN GRID BRIDGE FLOORING. Steel shall comply with Subsection 1013.01.

1013.22 DUCTILE CAST IRON BEARINGS. Ductile cast iron bearings shall comply with ASTM A 536.

1013.23 SHEAR CONNECTORS. Shear connector studs shall be Type B studs complying with ANSI/AASHTO/AWS D 1.5 (D 1.5M), Bridge Welding Code.

1013.24 CONCRETE ANCHOR STUDS. Concrete anchor studs used for end dam plates, bearing plates or other concrete anchorage shall be Type A Studs complying with the latest edition of ANSI/AASHTO/AWS D1.5- (D 1.5M), Bridge Welding Code.

1013.25 STEEL FOR STAY-IN-PLACE FORMS. Zinc-coated steel sheets shall comply with ASTM A 653 with a minimum G 165 coating.

Section 1014
Timber and Timber Preservatives

1014.01 STRUCTURAL TIMBER AND LUMBER. Species and grade of structural timber and lumber shall comply with AASHTO M 168 and the following requirements.

(a) Southern Pine: Referring to the latest Standard Grading Rules for Southern Pine Lumber, as published by the Southern Pine Inspection Bureau (SPIB), Southern Pine lumber shall be furnished in grades with definite unit working stresses assigned as indicated for grade of lumber required.

(1) Caps, stringers, decking and bridge rails shall be Grade No. 1 Dense SR Timbers.

(2) Items other than caps, stringers, decking and bridge rail shall be Grade No. 1 SR Timbers.

(b) Douglas Fir: Referring to the latest Standard Grading Rules for Western Lumber, Douglas Fir lumber shall be furnished in accordance with the following:

(1) Caps, stringers, decking and bridge rail shall comply with Section 70.10, Select Structural. Design values shall be in accordance with Table 4, page 176, "Recommended Design Values in Pounds Per Square Inch".

(2) Items other than caps, stringers, decking and bridge rail shall conform to Section 70.11, Grade 1. Design values shall be in accordance with Table 4, page 176, "Recommended Design Values in Pounds Per Square Inch".

1014.02 TIMBER PILES, POLES, POSTS AND BRACES.

(a) Timber Piles: Timber piles shall be Southern Yellow Pine or Douglas Fir and shall comply with ASTM D 25, except that Table 1014-1 herein shall be used in lieu of Tables I and II in ASTM D 25.

(b) Timber Poles: Timber poles shall be Southern Pine or Douglas Fir and shall comply with ANSI D 05.1.

(c) Timber Posts and Braces: Posts and braces shall be cut from sound trees (not limbs) and shall contain no unsound knots. Sound knots will be permitted if the diameter of the knot does not exceed 1/3 the diameter of the piece at the point where it occurs. Posts and braces shall be free from decayed wood, rot and red heart. Ring shakes and season checks

which penetrate more than 1/4 inch (6 mm) will be cause for rejection. Posts and braces shall show at least four annular rings per inch (25 mm) and at least 1/3 summer wood.

Fence posts shall be peeled for their full length and bark and inner skin removed. Knots shall be trimmed close to the body of the post before treatment. A line drawn from center of top to center of butt shall not fall outside the body of the posts nor at any point be more than 2 inches (50 mm) from the geometric center of the post. Posts and braces shall be free from short or reverse bends. Excessive bow, camber, twist or other such defects in posts and brace will be cause for rejection. Ends shall be sawed square.

Guard rail posts and spacer blocks shall be treated timber of Southern Pine Grade No. 1 S.R. or Douglas Fir Dense Construction quality. Posts and spacer blocks shall be fabricated before treatment.

When round timber posts are specified or shown in the plans for guard rail, the posts shall be 7 1/4 inches (184 mm) in diameter plus or minus 1/8 inch (3 mm) at any point, as determined by a circumference-diameter tape. The length of the post shall be 6 feet-3 inches (1.875 m) for W-Beam and 6 feet-9 inches (2 m) for thrie beam guard rail and shall not vary more than 1 inch (25 mm) in length. The round timber post top shall be domed approximately hemispherical in shape and the radius of the dome shall be 4 inches (100 mm). The dome shall be smooth, and the distance from the top of the dome to the base of the dome shall not vary more than 3/4 inch (19 mm) at any location. All round timber posts shall be smooth shaved by machine and no "ringing" will be permitted. All outer and inner bark shall be removed during the shaving process. All knots and knobs shall be trimmed smooth and flush with the surface of the post. Each post shall have minimum sapwood depth of 1 inch (25 mm) measured at any location within the circumference. The maximum diameter of any single knot shall not exceed 3 inches (75 mm). The sum of the diameters of all knots greater than 0.5 inch (13 mm) in any 1-foot (300 mm) section shall not exceed 8 inches (200 mm). A straight line drawn from the center of the top to the center of the butt of any post shall not deviate from the centerline of the post more than 1/4 inch (6 mm) at any point. Splits or ring shakes are not permitted in the top for round post. Splits are not permitted in the butt. A single shake is permitted in the butt, provided it is not wider than one half the butt diameter.

Guard rail timber species (spacer blocks/braces) shall be the same as those furnished for the timber posts. The actual finished size of spacer blocks for round timber posts shall be 5 3/4 inch square (146 mm), with a

tolerance of 1/8 inch (3 mm) plus or minus. Each of the four corners of each block shall be machined down to provide a flat 1 inch (25 mm) surface the entire length of the block with a tolerance of 1/4 inch (6 mm) plus or minus. Each block shall be machine concaved to a radius of 3 5/8 inches (92 mm), and to a depth of 3/4 inch (18 mm). The size and hole location shall be as shown on the plans. Spacers shall be of medium grain, at least 4 rings per inch, and free from splits, shakes, compression wood or decay in any form. Individual knots, knot clusters or knots in the same cross section of a face are permitted, provided they are sound or firm, and are limited in cumulative width (when measured between lines paralleled to the edges) to no more than one third the width of the face. Grain deviation is limited to 1 inch (25 mm) in 6 inches (150 mm). The material may be sawn or surfaced.

Table 1014-1
Circumferences and Diameters of Timber Pile[1]

Length, feet (m)	3 Feet from Butt, inches (mm)				At Tip, inches (mm)	
	Minimum		Maximum		Minimum	
	Circumference	Diameter (Approx.)	Circumference	Diameter (Approx.)	Circumference	Diameter (Approx.)
Under 40 (12.2)	38 (960)	12 (300)	63 (1600)	20 (500)	25 (630)	8 (200)
40 to 54 Incl. (12.2-16.4)	38 (960)	12 (300)	63 (1600)	20 (500)	22 (560)	7 (175)
55 to 74 Incl. (16.5-22.6)	41 (1040)	13 (330)	63 (1600)	20 (500)	22 (560)	7 (175)
75 to 90 Incl. (22.7-27.4)	41 (1040)	13 (330)	63 (1600)	20 (500)	19 (480)	6 (150)
Over 90 (27.4)	41 (1040)	13 (330)	63 (1600)	20 (500)	16 (400)	5 (125)

[1]Measurements shall be taken with the bark removed. Diameter at 3 feet (900 mm), from butt shall not exceed 20 inches (500 mm).

1014.03 TIMBER PRESERVATIVES. The type preservatives to be used are as follows:

(a) Creosote: Creosote for land, fresh and coastal water use shall comply with AWPA P1/P13.

(b) Creosote Solutions: Creosote solutions for fresh and coastal water use shall comply with AWPA P2.

(c) Pentachlorophenol-Petroleum Solution:
Pentachlorophenol-Petroleum Solution shall comply with AWPA P8 and P9.

(d) Chromated Copper Arsenate (CCA): Chromated copper arsenate shall comply with AWPA P5, Type B or C.

(e) Creosote for Field Repairs: Creosote for field repair shall comply with AWPA M4.

1014.04 TREATMENT.

(a) General: Materials shall be treated according to current AWPA Standard Specifications for Preservative Treatment by Pressure Processes, modified as follows:

Timber and Lumber	C1 and C2
Piles	C1 and C3
Poles	C1 and C4
Round Posts	C1 and C5
Square Sawed Posts	C1 and C2
Fire Retardant Lumber	C1 and C20

Kiln-dried timber shall be steamed prior to treatment for a minimum of 2 hours.

(b) Amount of Preservative: The amount of preservative shall be the minimum specified in Table 1014-2 herein determined by assay. The assay zone shall be as specified in AWPA Standards, with the exception of bridge decking and timbers which will require an assay zone of 0 to 1 1/2 inches (0 to 37 mm) from the surface of the material. All penetration requirements of AWPA Standards shall be met. Treating reports shall be made available to the Department's inspector upon request, and at the Department's discretion may be used for acceptance of small miscellaneous charges of material.

(c) Painting: When painting of treated material is required, one of the following preservatives shall be used.

(1) Chromated Copper Arsenate (CCA) Type B or C complying with AWPA P5.

(2) Pentachlorophenol complying with AWPA P8. Hydrocarbon solvents for oil-borne preservatives shall comply with AWPA P9, Type B (Volatile Petroleum Solvent, LPG) or Type D (Chlorinated Hydrocarbon Solvent-Inhibited Grade of Methylene Chloride).

Minimum net retention of preservative by assay shall be 0.50 pounds per cubic foot (8 kg/cu m).

1014.05 TIMBER CONNECTORS, HARDWARE AND STRUCTURAL SHAPES. Timber connectors, hardware and structural shapes shall comply with Subsections 1018.07 and 1018.08.

1014.06 QUALITY ASSURANCE. Inspection shall be in accordance with AWPA M2. Quality control shall be in accordance with AWPA M3. Care of the treated wood products shall be in accordance with AWPA M4.

Table 1014-2
Minimum Retention of Preservative
(Pounds Per Cubic Foot (kg/cu m) of Wood)

Material and Usage	CREOSOTE	Creosote-Solutions	Pentachloro-phenol	CCA[1]
Timber & Lumber				
Above Ground:				
Southern Pine or Douglas Fir	12.0 (192)	12.0 (192)	0.60 (9.6)	0.60 (9.6)
Land and Fresh Water:				
Southern Pine or Douglas Fir	16.0 (256)	16.0 (256)	N/A	0.80 (12.8)
Coastal Water:				
Southern Pine or Douglas Fir	20.0 (320)	20.0 (320)	N/A	2.50 (40.0)
Piles[3]				
Non-Foundation				
Land & Fresh Water:				
Southern Pine	16.0 (256)	16.0 (256)	N/A	0.80 (12.8)
Douglas Fir	17.0 (272)	17.0 (272)	N/A	1.00 (16.0)
Coastal Water:				
Southern Pine or Douglas Fir	20.0 (320)	20.0 (320)	N/A	2.50 (40.0)
Foundation				
Land & Fresh Water:				
Southern Pine	12.0 (192)	12.0 (192)	0.60 (9.6)	0.80 (12.8)
Douglas Fir	17.0 (272)	17.0 (272)	0.85 (13.6)	N/A
Coastal Water:				
Southern Pine or Douglas Fir	20.0 (320)	20.0 (320)	N/A	2.50 (40.0)
Poles				
Southern Pine	12.0 (192)	N/A	0.60 (9.6)	0.60 (9.6)
Douglas Fir	15.0 (240)	N/A	0.80 (12.8)	0.80 (12.8)
Fence				
Gate Posts/Braces	8.0 (128)	8.0 (128)	0.40 (6.4)	0.40 (6.4)
Guard Rail Posts/Spacer Blocks, Bridge Rails & Dead End Road Installations	12.0[2] (192)	N/A	0.60 (9.6)	0.60 (9.6)

[1]Material treated with Chromated Copper Arsenate (CCA) shall be conditioned by kiln drying prior to treatment.
[2]Timber guard rail posts, spacer blocks, bridge rails, poles and dead end road installations treated with creosote shall be steam flushed for a minimum of 1 hour at 240ºF (116ºC) after treatment.
[3]A foundation pile is one which is embedded in the ground and capped with concrete. Pile supported approach slab piles are classified as non-foundation.

Section 1015
Signs and Pavement Markings

1015.01 GENERAL REQUIREMENTS. The materials shall comply with these specifications, the plans and the MUTCD. When directed, the contractor shall furnish and prepare samples for testing in accordance with Department instructions.

1015.02 METALS.

(a) Ferrous Metals:

(1) Structural Steel: Structural steel for posts, stringers, framing and miscellaneous steel shall comply with AASHTO M 270, Grade 36 (M 270M, Grade 250). Steel shall be galvanized in accordance with Subsection 811.12.

(2) Steel Pipe: Steel pipe or tubing for structures shall be Schedule 40 (STD) complying with ASTM A 53, Type E or Type S Grade B, or hot formed tubing complying with ASTM A 36 (ASTM A 36M) and ASTM A 501.

(3) Steel Posts for Small Signs, Markers and Delineators: Posts shall be steel of the flanged channel type shown on the plans, galvanized after fabrication in accordance with Subsection 811.12. Before fabrication, posts shall be within 3.5 percent of the specified weight (mass).

Posts shall be fabricated from steel complying with either ASTM A 499, Grade 60 with chemical properties conforming to ASTM A 1 for 91-lb/yd (45 kg/m) or heavier rail steel, or ASTM A 576, Grade 1080 with 0.10 percent -0.20 percent silicon. Holes 3/8 inch (10 mm) in diameter shall be drilled or punched through the middle of each post on one inch (25-mm) centers for at least 36 inches (900 mm) from the top of each post.

(b) Aluminum Alloy: Structural members shall be aluminum complying with ASTM B 221 (ASTM B 221M) or ASTM B 429, Alloy 6061-T6. Miscellaneous aluminum shall comply with ASTM B 209 (ASTM B 209M), Alloy 6061-T6.

(c) Fittings:

(1) Structural Bolts, Nuts and Washers: High strength bolts shall be ASTM A 325 (ASTM A 325M), and other bolts shall be ASTM A 307, Grade A or Grade B. Bolts shall have hexagonal heads and be supplied with two flat and one lock washer and hexagonal-head nut. Bevel washers, where required, shall be wrought steel. Bolts, nuts and washers

shall be galvanized in accordance with ASTM A 153 or by an approved mechanical galvanizing process complying with ASTM B 695 that provides the same coating thickness.

Anchor bolts shall be AASHTO M 270, Grade 36 (M 270M, Grade 250) steel except the maximum tensile strength shall be 88,000 psi (605 MPa) and galvanized in accordance with Subsection 811.12 unless otherwise specified.

Stainless steel bolts shall comply with ASTM A 320 (ASTM A 320M), Grade B 8, annealed or approved equal.

(2) Fasteners: Fasteners used in fabricating sign faces, including splice plates for joining two panels, sills and border angles, and attaching route marker shields shall be 1/4 inch (6 mm) aluminum blind rivets that provide positive mandrel retention. These rivets shall have a minimum tensile strength of 875 pounds (397 kg) and a minimum sheer strength of 850 pounds (386 kg).

Fasteners used in attaching demountable legend to sign faces (except for shields) shall be 1/8 inch (3 mm) diameter blind rivets manufactured from aluminum alloy complying with ASTM B 316 (ASTM B 316M), Alloy 1100-H14.

Fasteners for delineator, object marker and milepost assemblies shall be vandal resistant and will be subject to approval prior to use.

1015.03 FLEXIBLE POSTS. Flexible posts for small signs, markers and delineators shall be approved products listed in QPL 39.

1015.04 SIGN PANELS.

(a) Permanent Sign Panels: Flat panels shall be aluminum sheets or plates complying with ASTM B 209, Alloy 6061-T6 or Alloy 5052-H38. Extruded aluminum panels shall comply with ASTM B 221 (ASTM B 221M), Alloy 6063-T6.

(b) Temporary Sign Panels: Substrate for barricade panels shall be either wood or rigid thermoplastic. Substrate for portable signs shall be aluminum, wood or plastic. Substrate for post mounted signs shall be aluminum, wood, rigid thermoplastic or aluminum clad low density polyethylene plastic.

(1) Aluminum: Aluminum sheeting shall be 0.080 inch (2 mm) thickness complying with ASTM B 209 (ASTM B 209M), Alloy 6061-T6 or Alloy 5052-H38.

(2) Wood: Plywood sheeting of exterior type Grades either High Density Overlay or Medium Density Overlay, are acceptable for use provided the following requirements are met.

Panels shall be a minimum of 5/8 inch (15 mm) thick and shall comply with the latest American Plywood Association specifications and be identified with the APA edge mark or back stamp to verify inspection and testing. Prior to application of reflective sheeting, the surface shall be abraded with steel wool or fine sandpaper, and wiped thoroughly clean. The surface shall be allowed to dry a minimum of 8 hours prior to application of sheeting. Cut edges of plywood panels shall be sealed with an approved aluminum pigmented polyurethane sealer.

(3) Plastic: Plastic substrate for barricade panels and signs shall be as follows.

a. Fiber Reinforced Vinyl (PVC): The substrate shall have a nominal composite thickness of 0.04 inches (1 mm) and be bonded to an approved retroreflective material by the manufacturer.

b. Rigid Thermoplastic: Rigid thermoplastic substrate shall consist of either High Density Polyethylene (HDPE) or High Density Polycarbonate (HDPC). The rigid thermoplastic for barricade panels shall be hollow core HDPE or HDPC with a minimum thickness of 0.625 inch (16 mm). The thermoplastic for sign panels shall be either 0.40 inch (10 mm) thick thin wall, fluted substrate or 0.625 inch (16 mm) thick blow molded substrate. Substrates shall be sufficiently rigid to maintain a flat face and shall be capable of attachment to the sign mounting in such a manner as not to crush or otherwise deform the substrate. Reflectorized sheeting applied to rigid thermoplastic shall have its manufacturer's approval for use on the substrate.

c. Aluminum Clad Low Density Polyethylene (AL/LDPE) Plastic: The aluminum clad low density polyethylene plastic substrate shall be 0.080 inch (2 mm) thick. The substrates shall be sufficiently rigid to maintain a flat face and shall be capable of attachment to the sign mounting in such a manner as not to crush or otherwise deform the substrate. Reflectorized sheeting applied to aluminum clad low density polyethylene shall have its manufacturer's approval for use on this substrate.

1015.05 REFLECTIVE SHEETING.

(a) Permanent and Temporary Standard Sheeting: Reflective sheeting shall be one of the following standard types as specified on the plans and complying with ASTM D 4956 except as modified herein. The sheeting shall be an approved product listed in QPL 13.

Type III- A high-intensity retroreflective sheeting, that is typically encapsulated glass-bead retroreflective material.

Type VI - An elastomeric-high-intensity retroreflective sheeting without adhesive. This sheeting is typically a vinyl microprismatic retroreflective material.

Type IX - A very high-intensity retroreflective sheeting having highest retroreflectivity at short distances as determined by the RA values at 1° observation angle. This sheeting is typically an unmetalized microprismatic retroreflective element material.

Type X (Fluorescent Orange) - A super high-intensity retroreflective sheeting having highest retroreflectivity characteristics at medium distances. This sheeting is typically an unmetalized microprismatic retroreflective element material.

(b) Fluorescent Pink Retroreflective Sheeting: When used for temporary control of traffic through incident management areas, fluorescent pink retroreflective sheeting shall be as specified in the MUTCD. Temporary traffic control signs for incident management shall be placed to notify motorists of upcoming incidents on the roadway, and shall be removed from public view once the incident has been managed. Physical properties shall comply with ASTM D 4956. Photometric properties shall be as follows.

(1) Retroreflectivity: Minimum Coefficients of Retroreflection shall be as specified in Table 1015-1.

Table 1015-1
Coefficients of Retroreflection for Fluorescent Pink Sheeting[1]

Observation Angle, degrees	Entrance Angle, degrees	Fluorescent Pink
0.2	-4	100
0.2	+30	40
0.5	-4	40
0.5	+30	15

[1]Minimum Coefficient of Retroreflection (R_A) (cd $lx^{-1}m^{-2}$)

(2) Color and Daytime Luminance: Color Chromaticity Coordinates and Daytime Luminance Factors shall be as specified in Table 1015-2.

Table 1015-2
Fluorescent Pink Color Specifications Limits (Daytime)

Chromaticity Coordinates (corner points) [1]								Luminance Factor, min.
1		2		3		4		Y%
x	y	x	y	x	y	x	y	25
0.450	0.270	0.590	0.350	0.644	0.290	0.536	0.230	

[1]The four pairs of chromaticity coordinates measured with CIE 2° Standard Observer and 45/0 (0/45) geometry and CIE D65 Standard Illuminant.

(c) Adhesive Classes: The adhesive required for retroreflective sheeting shall be Class 1 (pressure sensitive) or Class 2 (heat activated) as specified in ASTM D 4956.

(d) Accelerated Weathering: Reflective sheeting, when processed, applied and cleaned in accordance with the manufacturer's recommendations shall perform in accordance with the accelerated weathering standards in Table 1015-3.

Table 1015-3
Accelerated Weathering Standards[1]

Type	Retroreflectivity[2]				Colorfastness[3]	
	Orange		All colors, except orange		Orange	All colors, except orange
III	1 year	80[4]	3 years	80[4]	1 year	3 years
III (for drums)	1 year	80[4]	1 year	80[4]	1 year	1 year
VI	1/2 year	50[5]	1/2 year	50[5]	1/2 year	1/2 year
IX	Not used		3 years	80[6]	Not used	3 years
X (Fluorescent Orange)	1 year	80[7]	Not used		1 year	Not used

[1]At an angle of 45° from the horizontal and facing south in accordance with ASTM G 7 at an approved test facility in Louisiana or South Florida.

[2]Percent retained retroreflectivity of referenced table after the outdoor test exposure time specified.

[3]Colors shall conform to the color specification limits of ASTM D 4956 after the outdoor test exposure time specified.

[4]ASTM D 4956, Table 8.

[5]ASTM D 4956, Table 13.

[6]ASTM D 4956, Table 3.

[7]ASTM D 4956, Table 4.

(e) Performance: Reflective sheeting for signs, when processed, applied and cleaned in accordance with the manufacturer's recommendations shall perform outdoors in accordance with the performance standards in Table 1015-4.

Table 1015-4
Reflective Sheeting Performance Standards

Type	Retroreflectivity[1] -- Durability[2]				Colorfastness[3]
	Orange		All colors, except orange		
III	3 years	80[4]	10 years	80[4]	3 years
IX	Not used		7 years	80[5]	3 years
X (Fluorescent. Orange)	3 years	80[6]	Not used		3 years

[1]Percent retained retroreflectivity of referenced table after installation and the field exposure time specified.
[2]All sheeting shall maintain its structural integrity, adhesion and functionality after installation and the field exposure time specified.
[3]All colors shall conform to the color specification limits of ASTM D4956 after installation and the field exposure time specified.
[4]ASTM D4956, Table 8.
[5]ASTM D 4956, Table 3.
[6]ASTM D 4956, Table 4.

(f) Temporary Signs, Barricades, Channelizing Devices, Drums and Cones: Reflective sheeting for temporary signs, barricades and channelizing devices, shall meet the requirements of ASTM D 4956, Type III except that the initial sequence of temporary advanced warning construction signs used on the mainline of freeways and expressways shall meet the requirements of ASTM D 4956, Type X (Fluorescent Orange).

Reflective sheeting for vertical panels shall meet the requirements of ASTM D 4956, Type III.

Reflective sheeting for drums shall be a minimum of 6 inches (150 mm) wide and shall meet the requirements of ASTM D 4956, Type III, and the Supplementary Requirement S2 for Reboundable Sheeting as specified in ASTM D 4956. Reflective sheeting for traffic cone collars shall meet the requirements of ASTM D 4956, Type VI.

(g) Sheeting Guaranty. The contractor shall provide the Department with a guaranty from the sheeting manufacturer stating that if the retroreflective sheeting fails to comply with the performance requirements of this subsection, the sheeting manufacturer shall do the following:

Table 1015-5
Manufacturer's Guaranty-Reflective Sheeting

Type	Manufacturer shall restore the sign face in its field location to its original effectiveness at no cost to the Department if failure occurs during the time period[1] as specified below		Manufacturer shall replace the sheeting required to restore the sign face to its original effectiveness at no cost to the Department if failure occurs during the time period[1] as specified below
	Orange	All colors, except orange	All colors, except orange
III	<3 years	<7 years	7-10 years
IX	Not used	<5 years	5-10 years
X (Fluorescent Orange)	<3 years	Not used	Not used

[1]From the date of sign installation.

Replacement sheeting for sign faces, material, and labor shall carry the unexpired guaranty of the sheeting for which it replaces.

The sign fabricator shall be responsible for dating all signs with the month and year of fabrication at the time of sign fabrication. This date shall constitute the start of the guaranty obligation period.

1015.06 NONREFLECTIVE SHEETING.

(a) General Requirements: Nonreflective sheeting film shall consist of an extensible, pigmented, weather-resistant plastic film. Face side of film shall be supported and protected by a paper liner which is readily removable after application without the necessity of soaking in water or other solvents. Colors shall be matched visually and be within the limits shown in Table 17 of ASTM D 4956.

(b) Adhesive Requirements: Sheeting shall have a precoated pressure-sensitive adhesive backing or a tack-free heat-activated adhesive backing, either of which may be applied without additional coats on either sheeting or application surface. Adhesive shall comply with ASTM D 4956, Class 1 (pressure sensitive) or Class 2 (heat activated).

(c) Physical Characteristics: The film shall be readily cut by normal fabricating methods without cracking, checking or flaking. Applied film shall be free from ragged edges, cracks and blisters. The material

shall have demonstrated its ability to withstand normal weathering without checking, cracking or excessive color loss.

1015.07 SIGN ENAMELS, PAINTS, SILK SCREEN PASTE AND OVERLAY FILM.

(a) Sign Enamels and Paints: These shall be applied in accordance with the sheeting manufacturer's recommendations. Final appearance as well as materials used shall be subject to approval.

(b) Silk Screen Paste: Constituents used in manufacture of silk screen paste shall meet approval of the engineer. Silk screen paste shall be mixed at the factory, well ground to a uniform consistency and smooth texture, and shall be free from water and other foreign matter. It shall dry within 18 hours to a film that does not run, streak, or sag. Paste which has livered, hardened or thickened in the container, or in which pigment has settled out so that it cannot be readily broken up with a paddle to a uniform usable consistency, will be rejected. Paste and thinner shall be used in accordance with the sheeting manufacturer's recommendations.

Paste shall have proper pigmentation and consistency for use in silk screen equipment. The material shall produce the desired color and the same retroreflectivity values as required for reflective sheeting of the same type and color when applied on reflective sheeting background. Paste shall meet the quality and test requirements for appearance, coarse particles, and moisture and water resistance as specified for sign paints.

(c) Overlay Film: Transparent electronic cuttable overlay film shall produce the desired color and the same reflectivity values as required for reflective sheeting of the same type and color when applied on reflective sheeting background. The film shall be an approved product listed in QPL 13.

1015.08 TEMPORARY PAVEMENT MARKINGS.

(a) Temporary Tape: Temporary tape shall comply with ASTM D 4592, Type I (removable) or Type II (non-removable) and shall be an approved product listed in QPL-60.

(b) Painted Stripe: Paint shall be an approved traffic paint complying with Subsection 1015.12. Glass beads for drop-on application shall comply with Subsection 1015.13.

(c) Temporary Raised Pavement Markings for Asphaltic Surface Treatment: Temporary raised pavement markers for asphaltic surface treatment shall be flexible reflective tabs having a nominal width of 4 inches (10 cm). The markers shall be yellow with amber reflective area

on both sides. The body of the marker shall consist of a base and vertical wall made of polyurethane or other approved material and shall be capable of maintaining a reasonable vertical position after installation. The initial minimum Coefficient of Luminous Intensity at an entrance angle of -4 degrees and an observation angle of 0.2 degrees shall be 230 mcd/lx when measured in accordance with ASTM E 810.

The reflective material shall be protected with an easily removable cover of heat resistant material capable of withstanding and protecting the reflective material from the application of asphalt at temperatures exceeding 325°F (160°C).

1015.09 RAISED PAVEMENT MARKERS. Markers shall be either nonreflectorized or reflectorized, as specified. Markers shall be approved products listed in QPL 9. Infrared curves of materials used in markers shall match approved curves on file at the Department's Materials and Testing Section.

(a) Nonreflectorized Markers:

(1) Description: Nonreflectorized markers shall consist of an acrylonitrile-butadiene-styrene polymer or other approved material, and shall be 4-by-6-inches (100-by-150-mm).

(2) Physical Requirements: Markers shall comply with the compressive strength requirements of ASTM D 4280. The color shall be in accordance with the plans and the MUTCD.

(b) Reflectorized Markers: Reflectorized markers shall comply with ASTM D 4280, Designation H and Designation F. The type and color shall be in accordance with the plans and the MUTCD. The markers shall be either standard having approximate base dimensions of 4-by-4-inches (100-by-100-mm) and a maximum height of 0.80 inches (20 mm) or low profile having approximate base dimensions of 4-by-2-inches (100-by-50-mm) and a maximum height of 0.60 inches (15 mm).

(c) Adhesive:

(1) Epoxy Adhesive: Epoxy adhesive shall be Type V epoxy resin system complying with Subsection 1017.02.

(2) Bituminous Adhesive: The adhesive shall conform to ASTM D 4280 and shall be an approved product listed in QPL 59.

1015.10 THERMOPLASTIC PAVEMENT MARKINGS.

(a) Description: This specification covers hot-sprayed or hot-extruded reflective thermoplastic compound for pavement markings on asphaltic or portland cement concrete pavement. Thermoplastic marking

material applied to asphaltic surfaces shall consist of an alkyd based formulation. Thermoplastic marking material applied to portland cement concrete surfaces shall consist of either an alkyd based or hydrocarbon based formulation. Material shall be so manufactured as to be applied by spray (40 mil (1.0 mm)) or extrusion to pavement in molten form, with internal and surface application of glass spheres, and upon cooling to normal pavement temperature, shall produce an adherent, reflectorized pavement marking of specified thickness and width, capable of resisting deformation.

Material shall not scorch, break down, or deteriorate when held at the plastic temperature specified in Subsection 732.03(f)(1) for 4 hours or when reheated four times to the plastic temperature. Temperature-vs-viscosity characteristics of plastic material shall remain constant when reheated four times, and shall be the same from batch to batch. There shall be no obvious change in color of material as the result of reheating four times or from batch to batch.

(b) Suitability for Application: Thermoplastic material shall be a product especially compounded for pavement markings. Markings shall maintain their original dimension and placement and shall not smear or spread under normal traffic at temperatures below 140°F (60°C). Markings shall have a uniform cross section. Pigment shall be evenly dispersed throughout the material thickness. The exposed surface shall be free from tack and shall not be slippery when wet. Material shall not lift from pavement in freezing weather. Cold ductility of material shall be such as to permit normal movement with the pavement surfaced without chipping or cracking.

(c) Standard (Flat) Thermoplastic Pavement Markings: Materials shall be approved products listed in QPL 63 and shall comply with AASHTO M 249 as modified herein:

(1) Color:

a. Laboratory Performance: The yellow thermoplastic shall comply with the requirements of Table 1015-6 when tested in accordance with ASTM E 1349.

Table 1015-6
Color Specification Limits (Daytime)

Color	1		2		3		4	
	x	y	x	y	x	y	x	y
Yellow	0.4756	0.4517	0.4985	0.4779	0.5222	0.4542	0.4919	0.4354

(The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 Standard Colorimetric System measured with Standard 2° Observer and Standard Illuminant D65.)

b. Field Performance: The initial daytime color and luminance factor (Cap Y) readings will be taken by the Department from 7 to 30 days after installation. For standard thermoplastic the initial daytime color and luminance factor (Cap Y) will be tested by the Department according to ASTM D 6628.

(2) Whiteness Index: The white thermoplastic shall have a minimum whiteness index of 40 when tested according to ASTM E 313.

(3) Retroreflectivity: Initial retroreflectivity readings will be taken by the Department from 7 to 30 days after installation. Additional retroreflectivity readings will be taken 180 days after initial readings.

For standard thermoplastic, the initial retroreflectance for the in-place marking shall have a minimum retroreflectance value of 375 mcd/lux/sq m for white and 250 mcd/lux/sq m for yellow. The 180-day readings shall be at least 325 mcd/lux/sq m or greater for white and 200 mcd/lux/sq m or greater for yellow when measured with a geometry of 1.05 degrees observation angle and 88.76 degrees entrance angle.

(4) Retained Retroreflectivity: Standard thermoplastic pavement marking material shall retain a minimum retroreflectance value of 100 mcd/lux/sq m for white and 75 mcd/lux/sq m for yellow at least three years after placement when measured with a geometry of 1.05 degrees observation angle and 88.76 degrees entrance angle. Material shall not chip or flake during the required retained retroreflectivity performance period.

1015.11 PREFORMED PLASTIC PAVEMENT MARKING TAPE.

(a) General: Preformed plastic pavement marking tape shall be approved products listed on QPL 64 and shall comply with ASTM D4505 Type I, Type I - High Performance (as specified below) or Type V, except as modified herein. The marking tape shall be Grade A, B, C, D, or E. The type and color shall be in accordance with the plans and the MUTCD.

(b) Thickness: All preformed plastic pavement marking tape shall have a minimum overall thickness of 0.060 inches (1.5 mm) when tested without the adhesive.

(c) Friction Resistance: The surface of the Type I preformed plastic pavement marking tape shall provide a minimum frictional resistance value of 35 British Polish Number (BPN) when tested according to ASTM E303. The surface of the Type I - High Performance and Type V preformed plastic pavement marking tape shall provide a minimum frictional resistance value of 45 BPN when tested according to ASTM E303 except values for the Type V are calculated by averaging values taken at downweb and at a 45 degrees angle from downweb.

(d) Retroreflective Requirements: The preformed plastic pavement marking tape shall have the minimum initial specific luminance values shown in Table 1015-7 when measured in accordance with ASTM D 4061.

Table 1015-7
Specific Luminance of Preformed Plastic Tape

Type	Observation Angle, degrees	Entrance Angle, degrees	Specific Luminance (mcd/sq m/lx) White	Yellow
I	1.05	88.76	250	175
I - High Performance	1.05	88.76	375	250
V	1.05	88.76	500	300

(e) Durability Requirements: The Type I - High Performance preformed plastic pavement marking tape shall show no appreciable fading, lifting or shrinkage for a least 12 months after placement when placed in accordance with the manufacturer's recommended procedures on pavement surfaces having a daily traffic count not to exceed 15,000 ADT per lane.

The Type V preformed plastic pavement marking tape shall show no appreciable fading, lifting or shrinkage for a least 4 years after placement for longitudinal lines and at least 2 years after placement for symbols and legends.

The Type V preformed plastic pavement marking tape shall also retain the following reflectance values for the time period detailed in Table 1015-8.

Table 1015-8
Retained Specific Luminance for Type V
Preformed Plastic Pavement Marking Tape

Time	Observation Angle, degrees	Entrance Angle, degrees	Specific Luminance (mcd/sq m/lx) White	Yellow
1 year	1.05	88.76	400	240
4 years (2 years for symbols and legend)	1.05	88.76	100	100

(f) Plastic Pavement Marking Tape Guaranty (Type I - High Performance and Type V): If the plastic pavement marking tape fails to comply with the performance and durability requirements of this subsection within 12 months for Type I - High Performance and 4 years for Type V, the manufacturer shall replace the plastic pavement marking material at no cost to the Department.

1015.12 TRAFFIC PAINT. The contractor shall have the option of furnishing either alkyd traffic paint or water-borne traffic paint; however, the same type paint shall be used throughout the project. Each paint container shall bear a label with the name and address of manufacturer, trade name or trademark, type of paint, number of gallons, batch number and date of manufacture.

Paints shall be approved products listed in QPL 36, shall show no excessive settling, caking or increase in viscosity during 6 months of storage, and shall be readily stirred to a suitable consistency for standard spray gun application.

An infrared curve shall be generated in accordance with DOTD TR 610 and compared with the standard curve made during the initial qualification process.

(a) Alkyd Traffic Paint: This material shall be a rapid-setting compound suitable for use with hot application equipment. The material shall meet the requirements of Table 1015-9.

Table 1015-9
Alkyd Traffic Paint Physical Properties

Property	Test Method	Requirements Min.	Max.
Weight, kg/L	ASTM D 1475	1.5	---
Viscosity @ 25°C, Krebs Units	ASTM D 562	85	115
Dry to No Pick Up, s	ASTM D 711	---	180
Directional Reflectance, %	ASTM E 97		
White		80	---
Yellow		50	---
Bleeding	Fed. Spec. TT-P-115	Pass	
Total Solids, % by mass	ASTM D 1644, Method A	70	---
Film Shrinkage	[1]	Pass	
Hiding Power	[2]	Pass	
Pigment, %	ASTM D 2371	50	55
Nonvolatiles in Vehicle, % by mass	ASTM D 215	35	---
Flexibility	Fed. Spec. TT-P-1952	Pass	
Pigment Composition	[3]	Pass	

[1]Film Shrinkage: With a film applicator, cast a wet film with a thickness of 30 mils (750 µm) over a smooth glass plate. Allow sample to cure at room condition for 4 to 5 hours. Using a micrometer, measure the plate thickness before the film is cast using five measurements to obtain an average. The cured film shall have a minimum thickness of 12 mils (300 µm).
[2]Hiding Power: The paint shall have a wet hiding power of at least 350 square feet per gallon (8.6 m^2/L). The compound shall have sufficient hiding power to cover any pavement when applied at a wet film thickness of 15 mils (375 µm).
[3]Pigment Composition: White paint shall contain at least 1.5 pounds (180 g) of titanium dioxide ($Ti0_2$) pigment per gallon as determined using DOTD TR 523 with at least 92 percent $Ti0_2$ content. The $Ti0_2$ shall comply with ASTM D 476. Yellow paint shall contain at least 1.3 pounds (160 g) of medium chrome yellow pigment per gallon (L) as determined using DOTD TR 523. Medium chrome yellow pigment shall comply with ASTM D 211, Type III.

(b) Water Borne Traffic Paint: This material shall be a rapid setting waterborne compound suitable for use with hot application equipment. The material shall meet the requirements of Table 1015-10.

Table 1015-10
Water Borne Traffic Paint Physical Properties

Property	Test Method	Requirements Min.	Max.
pH	ASTM E 70	9.9	---
Viscosity, at 25°C Krebs Unit	ASTM D 562	78	95
Drying Time, minutes[1]	ASTM D 711	---	10
Total Solids, % by mass	ASTM D 2369	73	79
Percent Pigment[2]	ASTM D 3723	55	62
Nonvolatiles in Vehicle, % by weight	ASTM D 215	43	---
Weight per Gallon, lb/gal	ASTM D 1475	---	---
White		13.7	---
Yellow		13.1	---
Daylight Reflectance, %	ASTM E 1349		
White		80	---
Yellow		50	---
Fineness of Grind	ASTM D 1210	3	---
Color	[3]	Pass	
Shelf Life, months		12	---
Pigment Composition	[4]	Pass	
Infrared Spectroscopy (IR)	DOTD TR 610	Pass	

[1]Drying time to no track - Paint applied at 15 mils (375 µm) wet on the road surface with paint heated to 120-150°F (50-65°C) shall not show tracking when a standard size automobile crosses in a passing maneuver at 3 minutes.
[2] No theoretical empirical factor shall be applied in determining the percent of the paint. Percent pigment shall not be calculated by adding back the burned-off organic constituents of the pigment.
[3]Color (without glass beads) - Yellow paint shall comply with the requirements of Table 1015-11 when tested in accordance with ASTM E 1349. White shall be a clean, bright, untinted binder.
[4]The white paint shall contain a minimum of 1.0 pound per gallon (120 g/L) of titanium dioxide ($Ti0_2$) as determined using DOTD TR 523. The titanium dioxide shall comply with ASTM D 476.

Table 1015-11
Water Borne Traffic Paint Color Specification Limits (Daytime)

Color	1		2		3		4	
	x	y	x	y	x	y	x	y
Yellow	0.493	0.473	0.518	0.464	0.486	0.428	0.469	0.452

(The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 Standard Colorimetric System measured with Standard 2° Observer and Standard Illuminant D65.)

(c) Initial Retroreflectivity: For traffic paint, initial retroreflectance shall have a minimum retroreflectance of 250 mcd/lux/sq m for white and 175 mcd/lux/sq m for yellow when measured with a geometry of 1.05

degrees observation angle and 88.76 degrees entrance angle (30 m geometry). The initial retroreflectivity readings shall be taken between 7 and 30 days after installation.

(d) Initial Daytime Color and Luminance Factor: For traffic paint, initial daytime color and luminance factor (Cap Y) will be tested according to and in compliance with the requirements of ASTM D6628. The readings will be taken by the Department from 7 to 30 days after installation.

(e) Durability: Traffic paint shall retain the minimum reflectance value of 150 mcd/lux/sq m for white and 100 mcd/lux/sq m for yellow at least 6 months after placement when measured with a geometry of 1.05 degrees observation angle and 88.76 degrees entrance angle (30 m geometry).

Material shall not chip or flake during the 6 months after placement. Failure to meet this requirement shall require the contractor to replace the portion of the material shown to be below these minimums.

1015.13 GLASS BEADS FOR PAVEMENT MARKINGS. Glass beads for use with painted traffic striping and flat thermoplastic striping shall be transparent, clean, colorless glass, smooth and spherically shaped, free from milkiness, pits, or excessive air bubbles and conform to the specific requirements for the class designated. The beads shall be non-flotation, embedment coated and conform to the following specific requirements.

(a) Moisture Resistance - Flow Characteristics: The beads shall not absorb moisture in storage. They shall remain free of clusters and lumps and shall flow freely from the dispensing equipment.

(b) Gradation: The testing for gradation of the beads shall be in accordance with ASTM D 1214 and shall meet the gradation requirements specified below.

(1) Painted Traffic Striping: Glass beads for painted traffic striping shall meet the gradation requirements of Table 1015-12.

Table 1015-12
Gradation of Large Embedment Coated Glass Beads for Painted Traffic Striping

U.S. SIEVE (METRIC SIEVE)	PERCENT RETAINED
No. 12 (1.7 mm)	0
No. 14 (1.4 mm)	0-5
No. 16 (1.18 mm)	5-20
No. 18 (1.00 mm)	40-80
No. 20 (850 µm)	10-40
No. 25 (710 µm)	0-5
PAN	0-2

(2) Flat Profile Thermoplastic Striping: Drop-on beads for flat profile thermoplastic striping shall meet the gradation requirements of Table 1015-13 as determined by the thickness of the striping.

Table 1015-13
Gradation of Embedment Coated Glass Beads for Flat Profile Thermoplastic Striping

THICKNESS	NUMBER OF BEAD DROPS	APPLICATION #1	APPLICATION #2
40 mils	Single Drop	See Table 1015-12	N/A
90 mils or greater	Double Drop	See Table 1015-14	AASHTO M 247 Type I

Table 1015-14
Gradation of Large Embedment Coated Glass Beads for First Drop on Flat Thermoplastic Striping

U.S. SIEVE (METRIC SIEVE)	PERCENT RETAINED
No. 10 (2.0 mm)	0
No. 12 (1.7 mm)	0-5
No. 14 (1.4 mm)	5-20
No. 16 (1.18 mm)	40-80
No. 18 (1.00 mm)	10-40
No. 20 (850 µm)	0-5
PAN	0-2

(c) Roundness: The beads shall have a minimum of 80 percent rounds per screen for the two (2) highest sieve quantities. The remaining sieve fractions shall have no less than 75 percent rounds as determined by microscopic examination.

(d) Angular Particles: The beads shall have no more than three (3) percent angular particles per screen.

(e) Refractive Index: The beads shall have a refractive index of 1.50 to 1.52 when tested by the liquid immersion method.

(f) Embedment Coating: The large beads for thermoplastic striping shall be coated with an adhesion assuring coating. The smaller AASHTO M247 Type I beads shall be coated to provide free flowing characteristics when tested in accordance with AASHTO M247 Section 4.4.1. and assure adhesion. Glass beads shall be properly coated and conform to the requirements when tested as described in DOTD TR 530 Determination of Embedment Coating on Large Embedment Coated Glass Beads for Pavement Markings.

(g) Packaging and Marking: The beads shall be packaged in moisture proofed containers. Each container shall be stamped with the following information: Name and address of manufacturer, shipping point, trademark or name, the wording "Large Embedment Coated Glass Beads", class, weight, lot number and the month and year of manufacture. The container for the AASHTO M 247 Type I beads shall be similarly stamped except that the wording shall be "Glass Beads".

Section 1016
Precast Reinforced Concrete Drainage Units

1016.01 GENERAL. This specification covers the manufacture of precast reinforced concrete box culverts, manhole sections, catch basins, junction boxes, and safety ends. Precast reinforced concrete drainage units shall be as listed on QPL 77.

(a) Portland Cement and Portland-Pozzolan Cement: Portland cement shall comply with Subsection 1001.01. Portland-pozzolan cement shall comply with Subsection 1001.02.

(b) Admixtures: Any admixture for portland cement concrete listed in QPL 58 is allowed for use in the manufacture of precast units except for chloride-type accelerators and high range water reducers.

(c) Strength: Compressive strength specimens for precast units shall be made and cured in accordance with DOTD TR 226 or DOTD TR 227, and tested in accordance with DOTD TR 230. Compressive strength shall comply with ASTM C 76 (C 76M).

(d) Pipe Connections: For grout connections, each opening shall be 4±1/2 inches (100±13 mm) larger than the outside diameter of the pipe for which it is provided. Units shall be cast with the specified number and size of pipe openings to incorporate the unit into the drainage system.

Other methods for connecting pipe to precast units using resilient connectors shall conform to ASTM C 923.

(e) Marking: The name or trademark of the manufacturer, the date of casting, the structure number or the station number as shown on the plans, and the lot number shall be indented into the concrete or painted thereon with waterproof paint on each unit on the inside and outside of the unit in such a manner as to be legible at time of delivery.

1016.02 PRECAST REINFORCED CONCRETE BOX CULVERTS. Precast reinforced concrete box culverts shall be approved products listed on QPL 77. The compressive strength of box culverts shall comply with ASTM C 76 (C 76M). Precast reinforced concrete box culverts shall comply with ASTM C 1433 amended as follows:

(a) Table 1 shall be used.

(b) No modified designs will be allowed.

(c) Joints shall be approved by the Materials and Testing Section, and shall comply with the following:

(1) Joint gasket materials shall comply with Subsection 1006.06.

(2) Type 1 Joints (T1): These joints shall provide a soil tight joint.

(3) Type 2 Joints (T2): These joints shall pass the 5 psi (35 kPa) hydrostatic pressure test.

(4) Type 3 Joints (T3): These joints shall pass the 10 psi (70 kPa) hydrostatic pressure test.

(d) Inside horizontal and vertical dimensions shall not vary by more than ±1 percent with a maximum of ±1/2 inch (±13 mm) from design dimensions.

(e) Sides of each box section shall not vary from being perpendicular to the top and bottom by more than 1/2-inch (±13 mm) when measured diagonally between opposite interior corners of each end.

(f) Culvert units shall be cured by one of the methods listed in ASTM C 1433. The selected method shall be approved by the Construction Section.

1016.03 PRECAST REINFORCED CONCRETE MANHOLES, CATCH BASINS, JUNCTION BOXES, AND SAFETY ENDS. Precast reinforced concrete manholes, catch basins, junction boxes, and safety ends shall comply with the dimensions shown on the plans, and shall meet the following requirements:

(a) Materials:

(1) Precast reinforced concrete manholes, catch basins and junction boxes shall comply with the following Sections and Subsections:

Portland Cement Concrete, Class M	901
Reinforcing Steel	1009
Frames, Grates and Covers	1018.04

Portland cement concrete shall attain a minimum compressive strength of 4000 psi (27.6 MPa) before shipping of the units.

(2) Precast safety ends shall comply with Subsection 702.04(c).

(b) Casting Concrete: When multiple castings are to be made using the same forms, the engineer may require the use of metal forms. Concrete in each sectional unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by hand-tamping as necessary, to force the concrete into the corners of forms and prevent formation of stone pockets or cleavage planes.

(c) Reinforcement: Reinforcement shall be as shown on the plans, and shall not vary more than 1/4 inch (6 mm) from the positions shown, except at pipe connections. At pipe connections no variance from the

positions shown is allowed. Cover on reinforcement shall not be less than that shown on the plans.

(d) Curing: Units shall be cured in accordance with Subsection 805.10 or Subsection 805.14(e).

(e) Form Removal: Forms shall remain in place for 1 curing day in accordance with Subsection 805.11, Method 2.

(f) Joints and Gasket Material: Joints and gasket material shall comply with Subsection 1006.06(b).

(g) Workmanship: Units shall be true to shape, and surfaces shall be smooth, dense and uniform in appearance. Units will be rejected for defeats in workmanship for any of the following:

(1) Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

(2) Surface defects indicating honeycombed or open texture that would adversely affect the function of the unit.

(3) Damaged or cracked ends, where such damage would prevent making a satisfactory joint.

(4) Any continuous crack having a surface width of 0.01 inch (0.25 mm) or more and extending for a length of 12 inches (300 mm) or more, regardless of position.

When approved, minor surface cavities or irregularities which do not impair the service value of the unit and which can be corrected without marring its appearance shall be pointed with approved patching material listed in QPL 49 as soon as forms are removed.

(h) Quality Assurance: Acceptability of units will be determined by results of compression tests on concrete cylinders and by inspection during manufacture to determine their compliance with the design and workmanship prescribed in these specifications and on the plans. Units will be rejected for defects in workmanship in accordance with Subsection 1016.03(g).

A minimum of four cylinders for source approval and verification shall be made and cured in accordance with DOTD TR 226 or DOTD TR 227 and tested in accordance with DOTD TR 230 for each pour. Additional cylinders shall be made in pairs and used to determine the strength for moving within the plant.

Section 1017
Epoxy Systems

1017.01 GENERAL. This Section covers the material requirements for epoxy resin systems.

1017.02 EPOXY RESIN SYSTEMS.

(a) General: Epoxy resin systems for applications as specified herein, shall be approved products listed in QPL 32. Epoxy resin systems shall consist of two components which, when combined in accordance with the manufacturer's recommendations, shall comply with the requirements of this Subsection.

(b) Packaging and Marking: Both components shall be supplied in separate containers that are nonreactive with the contents. The containers shall be identified as Component A for the epoxy resin and Component B for the curing agent and shall show the product name, formulator, lot or batch number, date of packaging, shelf-life, and recommended mixing ratio either by weight or volume unless specified.

(c) Classification: Epoxy resin systems shall be classified by type and grade based on the following applications and consistencies:

(1) The types of epoxy resin systems are defined according to the following applications:

Type I - For use primarily in bonding hardened concrete and other materials to hardened concrete, setting dowels or bolts and other applications where a thin glue line is required; also as a binder for high strength epoxy mortars for structural repairs.

Type II - For use in bonding plastic concrete to hardened concrete.

Type III - For use in bonding skid-resistant materials to hardened concrete, and as a binder in epoxy mortars.

Type V - For use primarily in bonding raised pavement markers to portland cement concrete. Equal parts, by volume, of the epoxy resin and hardener components must be mixed together to obtain the finished adhesive.

(2) The grades are defined according to consistency characteristics of the mixed components as shown in Heading (e)(1) for Types I, II and III epoxy resin systems.

Grade A - A low viscosity material used primarily for crack injection and horizontal surface applications.

Grade B - A medium viscosity material or thin paste primarily used for horizontal or slight incline surface applications.

Grade C - A nonsagging gel or nonsagging paste primarily used for vertical or overhead surfaces.

(d) Properties of Epoxy Resin Systems: Component A of epoxy resin systems classified as Types I, II, and III shall contain a bisphenol-A, epichlorohydrin epoxy resin with or without a reactive diluent. Component B for epoxy resin systems of all types classified above shall contain one or more curing agents, which on mixing with Component A will cause the mixture to harden.

The mixed epoxy system, along with the separate components, shall comply with the applicable physical requirements and the following general requirements:

(1) All fillers, pigments, and thixotropic agents in either component shall be of sufficiently fine particle size and dispersed so that no appreciable separation or settling will occur during storage. Any fillers present in a Type I Grade A epoxy resin system shall be of such a nature that they shall not interfere with application by injection equipment or damage such equipment.

(2) The components shall be free of lumps, skinning or foreign material.

(3) The consistency of the individual components shall not change more than ±15 percent after 14 days in closed containers at 115±3°F (46±2°C).

(e) Test Requirements: Epoxy resin systems submitted for approval shall be specified by the manufacturer as being one or more of the types shown in Heading (c). Test procedures and requirements for each type shall be as follows:

(1) Types I, II and III epoxy resin systems, shall comply with Table 1017-1.

Table 1017-1
Epoxy Resin Systems

Property	Test Method	Type I		Type II		Type III	
		Min.	Max.	Min.	Max.	Min.	Max.
Consistency: Grade A, #3 Spindle a 20 RPM, poises (Pa·s) Grade B, #3 Spindle at 20 RPM, poises (Pa·s) Grade C, Sag, inches (mm)	ASTM C 881	--- 20 (2.0) ---	20 (2.0) --- 0.25 (6.4)	--- 20 (2.0) ---	20 (2.0) --- 0.25 (6.4)	--- 20 (2.0) ---	20 (2.0) --- 0.25 (6.4)
Epoxide Equivalent of Comp. A, g/g mole	DOTD TR 518	155	275	155	275	155	275
Gel Time, minutes[1]	DOTD TR 703	20	---	20	---	20	---
Water Absorption, 24 hr. Immersion, %	ASTM D 570	---	0.8	---	0.8	---	0.8
Compressive Strength, 24 hr, psi (MPa)	DOTD TR 705	5000 (34)	---	---	---	3000 (20)	---
Tensile Bond Strength, psi (MPa) 24 hours (dry cure) 72 hours (moist cure)	DOTD TR 706	 350 (2.4) ---	 --- ---	 --- 150 (1.0)	 --- ---	 250 (1.7) ---	 --- ---
Diagonal Shear Strength, psi (MPa) 2 days (dry cure) 14 days (moist cure)	ASTM C 882	 4000 (28) ---	 --- ---	 --- 3000 (20)	 --- ---	 1000 (6.8) ---	 --- ---
Thermal Compatibility	ASTM C 884	---		---	---	---	Pass

[1]Specification limits apply to working life of Grade C material. The minimum gel time for Type I Grade A material used for crack injection is 15 minutes.

(2) Type V epoxy resin system shall comply with the requirements of Table 1017-2.

Table 1017-2
Type V Epoxy Resin Systems

		Type V Standard		Type V Rapid	
Property	Test Method	Min.	Max.	Min.	Max.
Consistency: Component A (Resin) TD Spindle at 5 RPM, poises (Pa·s)	AASHTO T 237	1000 (100)	3500 (350)	1000 (100)	3500 (350)
Component B (Hardener) TD Spindle at 5 RPM, poises (Pa·s)		1000 (100)	3500 (350)	1000 (100)	3500 (350)
Shear Ratio (each component)		2.0	---	2.0	---
Gel Time, Minutes[1]	AASHTO T 237	6	10	6	10
Tensile Bond Strength to reach 170 psi (1.17 kPa), minutes	AASHTO T 237	---	210	---	40
Diagonal Shear Bond Strength 24 hour, psi (MPa)	AASHTO T 237	2000 (14.0)	---	1000 (7.0)	---
24 hour, plus 7 day water soak, psi (MPa)		1500 (10.0)	---	800 (5.5)	---

[1]The gel time for mixtures that are mixed and dispensed by hand shall be a minimum of 7 minutes to a maximum of 13 minutes.

Section 1018
Miscellaneous Materials

1018.01 WATER FOR CEMENT. Water suitable for human consumption may be used in mixtures with portland cement without testing. Water obtained from other sources, when tested in accordance with AASHTO T 26 shall meet the following requirements.

	Percent by Weight (Mass)(Max.)
Alkali	0.1
Solids (Organic)	0.1
Solids (Inorganic)	0.4
Salt (NaCl)	0.5
Sugar, Oil, or Acid	0.0

1018.02 CALCIUM CHLORIDE. Calcium chloride shall comply with AASHTO M 144.

1018.03 LIME. Lime shall be hydrated lime or quicklime from an approved source listed in QPL 34 and shall comply with AASHTO M 216 when tested in accordance with DOTD TR 525 with the following exceptions:

(a) Maximum free moisture shall be 1.50 percent for hydrated lime.

(b) Quicklime shall contain no more than 8 percent MgO by weight (mass) of total material. Quicklime shall be protected from contact with moisture prior to testing, shall be free flowing and graded so that 100 percent will pass a 3/8 inch (9.5 mm) sieve. When the quicklime is to be used in a slurry the gradation shall be a minimum of 95 percent passing the 3/4 inch (19 mm) sieve.

1018.04 FRAMES, GRATES AND COVERS FOR MANHOLES, CATCH BASINS, AND JUNCTION BOXES. Metal units shall comply with the following requirements:

(a) Gray iron castings shall comply with Subsection 1013.06.

(b) Steel castings shall comply with Subsection 1013.05.

(c) Malleable iron castings shall comply with Subsection 1013.06.

(d) Galvanizing shall comply with ASTM A 123.

1018.05 GROUND ROD ASSEMBLIES. Ground rod assemblies suitable for grounding fences and other applicable grounding requirements shall meet the following requirements:

(a) Ground rods shall be a minimum 5/8 inch 16 mm nominal diameter copper weld steel rod with a minimum length of 8 feet (2.4 m).

(b) Ground wire shall be an AWG No. 6 (13.30 sq mm) solid copper conductor firmly attached in such a manner that fence fabric, barbed wire, metal post and ground rod are electrically connected.

(c) Mechanical connectors for attaching ground wire to fence fabric, barbed wire and metal posts shall be solid copper alloy UL approved. Coated steel hardware will not be permitted.

(d) Mechanical connectors for attaching ground wire to ground rods shall be solid copper alloy UL approved.

1018.06 PREFABRICATED MASONRY PADS.

(a) Type A Pads: These pads shall be composed of multiple layers of 8-ounce (230 g) cotton duck impregnated and bound with high quality rubber compound, or of equally suitable materials compressed into resilient pads of uniform thickness after compressing and vulcanizing.

Pads shall withstand 10,000 psi (70 MPa) compressive loads perpendicular to the plane of laminations. Load deflection properties in accordance with MIL-C-882C shall be the following maximum percentages of total pad thickness: 10 percent at 1,000 psi (7 MPa); 15 percent at 2,000 psi (14 MPa). When loaded to 1,500 psi (10 MPa), the permanent set, as load is removed in accordance with MIL-C-882C, shall be a maximum of 2.5 percent of the original "zero point" thickness. Shore "A" Durometer hardness shall be 90±5. The material shall not lose effectiveness throughout a temperature range of -65 to +150°F (-55 to +65°C). There shall be no visual evidence of damage or deterioration by effects of sunshine, humidity, salt spray, fungus and dust in accordance with MIL-E-5272C. Thickness shall not vary from that specified by more than 5 percent.

(b) Type B Pads: These pads shall consist of fabric and rubber body made from new unvulcanized rubber and new fabric fibers in proper proportion to maintain strength and stability.

The vulcanized and cured pad shall have a Shore "A" Durometer hardness of 80±10 and shall withstand a 10,000 psi (70 MPa) compressive load without excessive extrusion or detrimental reduction in thickness.

Thickness shall not vary from that specified by more than 1/32 inch (1 mm).

1018.07 TIMBER CONNECTORS. Connectors for treated timber structures, except those of malleable iron, shall be galvanized in accordance with ASTM A 123.

(a) Split Ring Connectors: Split rings of 2 1/2 inches (65 mm), 4 inches (100 mm) and 6 inches (150 mm) inside diameter shall be manufactured from hot-rolled, low-carbon steel conforming to ASTM A 711, Grade 1015. Each ring shall form a closed true circle with an outside cylindrical surface parallel to the axis of the ring. The inside surface, except for the 6-inch (150 mm) ring, shall be beveled from the median line toward the edges. It shall be cut through in one place in its circumference to form a tongue and slot.

Connector grooves in timber shall be cut concentric with the bolt hole and shall have the dimensions shown in Table 1018-1.

Table 1018-1
Split Ring Timber Connector Dimensions, Inches (mm)

Nominal Ring Size	Inside Diameter	Groove Width	Groove Depth
2 1/2 (65)	2.56 (65)	0.18 (4.6)	0.37 (9.4)
4 (100)	4.08 (104)	0.21 (5.3)	0.50 (12.7)
6 (150)	(6.12 (155)	0.27 (6.9)	0.62 (15.7)

(b) Toothed-Ring Connectors: Toothed-ring connectors shall be stamped cold from 0.060 inch (1.5 mm) thick rolled sheet steel complying with ASTM A 711, Grade 1015, and shall be bent cold to form a circular, corrugated, sharp-toothed band and circle and shall be parallel to the axis of the ring. The central band shall be welded to fully develop the strength of the band. All sizes shall have an overall depth of 0.94 inch (24 mm) and depth of fillet of 0.25 inch (6 mm).

(c) Shear Plate Connectors: Shear plate connectors shall be of the following types:

(1) Pressed Steel Type: Pressed steel shear plates of 2 5/8 inches (67 mm) in diameter shall be manufactured from steel complying with ASTM A 711, Grade 1015. Each plate shall be a true circle with a flange around the edge, extending at right angles to the face of the plate and extending from one face only. The plate portion shall have a central

bolt hole and two small perforations on opposite sides of the hole and midway from the center and circumference.

(2) Malleable Iron Type: Malleable iron shear plates of 4-inch (100 mm) diameter shall be manufactured according to ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010). Each casting shall consist of a perforated round plate with a flange around the edge extending at right angles to the face of the plate and projecting from one face only. The plate portion shall have a central bolt hole reamed to size with an integral hub concentric to the bolt hole and extending from the same face as the flange.

(d) Claw-Plate Connectors: Claw-plate connectors of 2 5/8 inches (67 mm), 3 1/8 inches (80 mm) and 4 inches (100 mm) in diameter shall be of malleable iron, manufactured according to ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010). Each claw-plate shall consist of a perforated circular flanged plate with three-sided teeth arranged about the perimeter of one face. The male plate shall have integral cylindrical hubs on both faces concentric to a bolt hole through the center of the plate. The female plate shall be flat on the side opposite the teeth, but shall have an integral cylindrical hub concentric to the central bolt hole and on the face with the teeth.

(e) Spike-Grid Connectors: Spike-grid connectors shall be manufactured according to ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010). They shall consist of four rows of opposing spikes forming a 4 1/8 inch (105 mm) square grid with 16 teeth which are held in place by fillets. Fillets for the flat grid in cross section shall be diamond shaped. Fillets for single and double curve grids shall be increased in depth to allow for curvature and shall maintain a thickness between sloping faces on fillets equal to the width of the fillet.

1018.08 HARDWARE AND STRUCTURAL SHAPES.

(a) Hardware: Bolts shall conform to ASTM A 307. Dowels shall conform to AASHTO M 270, Grade 36 (M 270M, Grade 250) except the maximum tensile strength shall be 88,000 psi (605 MPa). Washers shall be cast ogee gray iron or malleable castings. A Standard washer shall be used under heads of lag screws.

Machine bolts may have either square or hex heads and nuts. Nails shall be cut or round wire of standard form. Spikes shall be cut wire or boat spikes. Bridge hardware shall be galvanized in accordance with ASTM A 153 or ASTM A 123 or by an approved mechanical galvanizing process complying with ASTM B 695 that provides the same coating thickness.

(b) Structural Shapes: Structural shapes, rods and plates shall be of structural steel complying with Section 1013.

(c) Electrical Hardware: Hardware for electrical apparatus shall comply with ASTM A 193, Grade B8 (bolts and studs) and ASTM A 194, Grade 8 or 8A (nuts).

(d) Eyebolts: Eyebolts shall comply with ASTM A 489.

1018.09 RIGID METAL ELECTRICAL CONDUIT. Rigid metal electrical conduit shall comply with ANSI C 80.1 or ANSI C 80.5.

1018.10 ELECTRICAL CONDUCTORS. Electrical conduction shall comply with IPCEA Publication No. S-19-81, IPCEA Publication S-66-524, and IPCEA Publication S-61-402.

1018.11 ALUMINUM PLATE FOR ELECTRICAL BOXES. Aluminum plate shall comply with ASTM B 209, Alloy 6061-T6.

1018.12 BARRICADE WARNING LIGHTS.

(a) General: Types A, B and C barricade warning lights shall be in accordance with the MUTCD and shall be an approved product listed in QPL 16.

(b) Markings: Each light submitted for approval and each light placed on a project shall have a permanently attached identification plate or other permanent markings with the following information:

(1) Manufacturer's name
(2) Model number
(3) Type
(4) Lens manufacturer and identification number
(5) Circuit manufacturer and identification number
(6) Bulb number
(7) Minimum operating voltage required to conform to minimum intensity requirements
(8) Year of manufacture

(c) Certification: Prior to installation, the contractor shall furnish the engineer with the following information:

(1) Material certification (Certificate of Compliance)
(2) Proposed number of warning lights to be used,
(3) Type
(4) Trade name
(5) Manufacturer's name and model number as contained in QPL 16

The certification shall also state that each light assembly has been tested, is functioning properly and will be maintained in satisfactory working order.

1018.13 ROOFING PITCH. Roofing pitch shall comply with ASTM D 4586.

1018.14 ELASTOMERIC BRIDGE BEARING PADS.

(a) General: Elastomeric bridge bearing pads shall be either plain (consisting of elastomer only) or laminated (consisting of layers of elastomer separated by nonelastic laminates. The elastomer portion of the compound used for bearings shall be 100 percent virgin chloroprene stock. Natural rubber, vulcanized rubber (natural or synthetic) or other synthetic rubber-like materials will not be acceptable.

Nonelastic laminates shall be a nominal 1/16 inch (1.5 mm) thickness rolled steel sheets with a minimum yield strength of 33,000 psi (225 MPa).

Elastomeric bridge bearing pads shall be an approved product listed in QPL 3.

(b) Physical Properties of Elastomer: The elastomer compound for plain and laminated bearings shall be a virgin, low temperature Grade 2, polychloroprene complying with AASHTO M 251. In addition, the pad shall comply with Level II acceptance criteria of AASHTO M251. All tests shall be made on the finished product. Special molded or prepared specimens, where required, shall comply with the specimen preparation requirements of the test involved.

(c) Manufacturing Requirements: Components of laminated bearing pads shall be molded into an integral unit. Edges of the nonelastic laminations shall be covered by a minimum of 1/8 inch (3 mm) of elastomer. Laminates shall be parallel with the bottom surface of the bearing, subject to the tolerances that follow.

The preparation of elastomer compound prior to placement in the mold shall be such as to result in a homogeneous, finished bearing pad free of voids, blisters, cracks, folds, cuts, nonfills and any appearance of layers or ply separation on the surface or within the pad. Plain bearing pads may be molded individually or cut to length from previously molded strips or slabs. No pads shall be formed from the lamination of previously cured sheets or slabs. Finish of cut surfaces shall be at least as smooth as ANSI No. 250 finish.

Each bearing pad shall be marked with the manufacturer's identification number in such manner as to remain legible until the bearing pad is placed

in the structure. This number shall identify the batch from which it was produced. A batch is defined as the quantity of compound produced from each separate mixture of ingredients.

(d) Appearance and Dimensions: Flash tolerance and appearance shall comply with Drawing RMA F3-T.063 of the RMA Rubber Products Handbook as published by the Rubber Manufacturers Association, Inc.

For both plain and laminated bearings, permissible variations from specified dimensions and configuration shall be in accordance with AASHTO M251.

	Tolerance Inches (mm)
Variation from Plane Parallel to Theoretical Surface	
Individual Nonelastic Laminates (determined by measurements at edges of bearing)	±1/8 (±3)
Thickness of Nonelastic Laminates	-0, +1/16 (-0, +1.5)

(e) Load Testing: For laminated bearings, each bearing shall be subjected to an average compression test loading of 1,500 psi (10 MPa) by the manufacturer. The performance of each bearing will be considered satisfactory if there is no visible evidence of bond failure or other damage to the bearing because of this loading. The Department will verify that pads meet this requirement by means of random testing.

(f) Certification: Prior to installation, the contractor shall furnish the Materials Engineer Administrator with a notarized material Certificate of Analysis and a list of:

(1) the proposed number of laminated bearing pads to be used itemized by type and size.

(2) manufacturer's name and identification number.

(3) the state project number.

The certification shall also state that each laminated bearing pad shipped has been load tested and found to comply with specifications as described in Subsection 1018.14(e). It shall also state that the steel laminates in each pad are aligned as required in Subsection 1018.14(d).

1018.15 FLY ASH. Fly ash shall be from an approved source listed in QPL 50 and shall comply with AASHTO M 295 for Class C and Class F only.

1018.16 FERTILIZER. Fertilizer shall be a commercial type complying with the commercial fertilizer laws in effect as regulated by the Louisiana Department of Agriculture and Forestry. The chemical composition shall be as specified and shall be designated by a 3-number sequence representing minimum percentages by weight, respectively, of nitrogen (N), available phosphoric acid (P_2O_5) and soluble potash (K_2O).

Fertilizer supplied in granular, pellet or tablet form shall be packaged in moisture proof containers.

Fertilizer tablets shall be an approved brand containing nitrogen fixing and phosphorus solubilizing bacteria, slow-release nitrogen, natural organic nutrients, and humic acid. For backfill mix, fertilizer tablets shall be controlled release tablets, 21 gram, 20-10-5 (N-P-K) with calcium, sulfur and iron.

1018.17 AGRICULTURAL LIME. Agricultural lime shall consist of ground limestone or seashells containing at least 90 percent calcium carbonate equivalent ($CaCO_3$) when tested in accordance with ASTM C 602. The material shall be ground so that a minimum of 90 percent passes a No. 10 (2.00 mm) sieve and 25 percent passes a No. 100 (150 μm) sieve.

1018.18 SEED. Seed shall comply with requirements of Louisiana law. The minimum percentage of pure live seed and the maximum percentage of weed seed permitted shall be in accordance with Table 1018-2.

Table 1018-2
Seed Requirements

Variety	Minimum Percent of Pure Live Seed (Purity Times Germination Including Hard Seed by Count)	Maximum Percent of Weed Seed, by Count
Hulled Bermuda	83	1
Pensacola Bahia	81	2
Crimson Clover	78	1
Kentucky 31 Fescue	80	1
Unhulled Bermuda	80	1
Ball Clover	80	1
Vetch (Common)	80	1
Lespedeza	80	1
Annual Rye	80	1
Browntop Millet	80	1

Each variety of seed shall be furnished and delivered in separate bags or other containers. Each bag or container shall bear an analysis tag which is a minimum No. 6 standard shipping tag having all information required by the Louisiana Seed Law, arranged as shown in Table 1018-3.

Table 1018-3
Seed Analysis Tag

Kind & Variety		
Where Grown	Net Wt.	Lot No.
Pure Seed %	Germination %	
Inert Matter %	Hard Seed %	
Crop Seed %	Total Germ. & Hard Seed %	
Weed Seed %	Date of Test	
Name & No. of Noxious Weed Seed per lb.		
Name		
Address		

Seed furnished shall be the previous season's crop (the last crop year for the crop kind in question) and the date of analysis shown on each tag shall be within 5 months (excluding the month in which the test is completed) of the time of delivery to the project.

(a) Noxious Weeds: Noxious weeds shall be interpreted to mean that list of weeds, except Bermuda, which has been adopted by the Louisiana Seed Commission as being noxious in Louisiana. Noxious weed seeds shall not exceed the limitations prescribed in the regulations and in no case shall they exceed 500 per pound (1100/kg).

Analysis tags shall be removed from each bag or container only by the engineer or an authorized representative.

(b) Test Report: A copy of the laboratory test report of an "official" sample taken and tested for each lot of seed furnished as prepared by the State Seed Analyst of the Louisiana Department of Agriculture and Forestry shall be submitted to the engineer by the contractor. The Department will accept test reports from the Agricultural Departments of other states provided the requirements of these specifications are met. The

lot number on the analysis tag shall match the laboratory test report lot number.

1018.19 MULCH. Mulch shall consist of either tacked vegetative mulch or an approved fiber mulch product complying with the following:

(a) Tacked Vegetative Mulch: Vegetation shall consist of pine straw, stems or stalks of oats, rye, rice, or other approved straws. The contractor may also use hay obtained from various legumes and grasses such as lespedezas, clover, vetches, soybeans, Bermuda, Dallis, carpet sedge, fescue or other approved legumes or grasses of any combination thereof. Straw or hay shall be reasonably dry and free from mold, Johnson grass or other noxious weeds.

Vegetative mulch shall be tacked with one of the following:

(1) Emulsified asphalt complying with Section 1002, or

(2) An approved tacking agent for vegetative mulch listed in the Qualified Products List (QPL 72). The minimum allowable vegetation density for source approval of tacked vegetative mulch shall be 70 percent for clay soils and 60 percent for sandy soils when evaluated in accordance with the Texas Transportation Institute (TTI) Field Performance Testing Procedure of Selected Erosion Contol Products.

(b) Fiber Mulch Products: Fiber mulch products shall be listed in the QPL 72 and consist of organic fiber mulches. The minimum allowable vegetation density for source approval of fiber mulch products shall be 70 percent for clay soils and 60 percent for sandy soils when evaluated in accordance with the TTI Field Performance Testing Procedure of Selected Erosion Control Products.

1018.20 SACKS FOR SACKED CONCRETE. Sacks for sacked concrete revetment shall be suitable new burlap bags. Burlap shall comply with AASHTO M 182.

1018.21 HARDWARE CLOTH. Hardware cloth shall comply with the requirements of ASTM A 740, have a minimum wire diameter of 0.041 inch (1.04 mm), and be constructed of 1/2 inch x 1/2 inch (12.5 mm x 12.5 mm) mesh galvanized in accordance with ASTM A 153.

1018.22 CONCRETE ANCHOR SYSTEMS. Concrete anchor systems shall consist of mechanical anchor devices, epoxy systems or other approved methods for anchoring fasteners to hardened concrete. These systems shall be approved products listed in QPL 40.

1018.23 EROSION CONTROL MATTING AND HARDWARE.

(a) General: Erosion control systems shall consist of approved hydraulically applied fiber mulch systems, or rolled erosion control products (mats) including hardware and installation plan.

(b) Requirements: Erosion control systems shall be listed in the QPL 72 and shall comply with the performance requirements in Table 1018-4 when evaluated in accordance with the Department's qualification procedure for erosion control systems.

Table 1018-4
Erosion Control Systems

Slope Protection			
Type[1]	Test Site Conditions for Evaluations	Maximum Sediment Loss, lb/yd^2 (kg/m^2)	Minimum Vegetation Density, %
A	3:1 Slope	0.06 (0.034)	80
B	2:1 Slope	0.06 (0.034)	80
Flexible Channel Liners			
Type[1]	Test Site Conditions for Evaluation	Maximum Sediment, inches (mm)	Minimum Vegetation Density, %
C	Shear Stress Range 0 to 2 psf (0 to 96 Pa)	0.45 (11.5)	70
D	Shear Stress Range 0 to 4 psf (0 to 192 Pa)	0.40 (10.0)	70
E	Shear Stress Range 0 to 6 psf (0 to 287 Pa)	0.40 (10.0)	70
F	Shear Stress Range 0 to 8 psf (0 to 383 Pa)	0.30 (8.0)	70

[1]Types are listed in increased order of protection.

The manufacturer's installation plan shall include a description of all hardware and shall comply with the installation procedure used during the evaluation of source approval. A copy of the approved installation plan shall accompany each shipment.

1018.24 FORM RELEASE AGENT. Form release agent for concrete shall be an approved product listed in QPL 29.

1018.25 MIX RELEASE AGENT FOR ASPHALTIC CONCRETE. Mix release agent for asphaltic concrete shall be an approved product listed in QPL 25. Diesel is not allowed as a mix release agent.

1018.26 NON-SHRINK GROUT. Non-shrink grout shall comply with ASTM C 1107 and shall be an approved product listed in QPL 47.

1018.27 GROUND GRANULATED BLAST-FURNACE SLAG: Grade 100 and grade 120 ground granulated blast-furnace slag shall be from an approved source listed on QPL 70 and shall comply with AASHTO M 302, except alkali content calculated as sodium oxide equivalent shall not exceed 0.60 percent by weight.

1018.28 MICROSILICA (SILICA FUME). Microsilica shall be from an approved source listed in QPL 80 and shall comply with AASHTO M-307.

1018.29 WATER MANAGEMENT GEL: Water management gel shall consist of an acrylamide copolymer gel with the ability to retain and release available water to the root zone. The manufacturer's recommended amount of water management gel shall be mixed with the required amount of backfill soil per plant before backfilling.

1018.30 MYCORRHIZAL INOCULANT: Mycorrhizal inoculant shall consist of live spores and/or root fragments or mycelium of Vesicular-Arbuscular (VA) Endomycorrhizal fungi and Ectomycorrhizal fungus and beneficial bacteria which have been chosen based on their ability to survive and influence plants over a broad pH range. Rhododendrons, Azaleas, and Laurels require ericoid Mycorrhizae. Each Endomycorrhizal Inoculant shall carry a supplier's guarantee of numbers of propagules per unit weight or volume of bulk material. If more than one fungal species is claimed by the supplier, the label shall include a guarantee for each species of Mycorrhizal fungus claimed. The project engineer will verify that the expiration date or shelf life of each container has not expired before approving its use.

Section 1019
Geotextile Fabric and Geocomposite Systems

1019.01 GEOTEXTILE FABRIC.

(a) General Requirements: The geotextile fabric shall be composed of at least 85 percent by weight (mass) of polyolefins, polyesters, or polyamides. The geotextile fabric shall be resistant to chemical attack, rot and mildew and shall have no tears or defects which adversely alter its physical properties. When required, the geotextile fabric shall contain stabilizers and/or inhibitors added to the base material to make filaments resistant to deterioration due to ultraviolet and heat exposure. Edges of geotextile fabric shall be finished to prevent the outer yarn from pulling away from the fabric. Fibers of other composition may be woven into the geotextile fabric for reinforcing purposes. Durability of these fibers shall be equivalent to that of the geotextile fabric.

Geotextile fabric rolls shall be furnished with an opaque, waterproof wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged with the manufacturer's name, date of manufacture, batch number, name of product.

Unless otherwise specified on the plans or in the project specifications, the geotextile fabric shall be an approved product in QPL 61.

(b) Detailed Requirements: The geotextile fabric shall comply with the requirements in Table 1019-1 and shall be utilized as follows unless otherwise specified:

Use	Classes
(1) Drainage:	
Underdrains	A, B, C or D
Pipe and Precast Manhole Joints	A, B, C or D
Weep Holes	A, B, C or D
Bedding Fabric	B, C, or D
Approach Slabs	B, C, or D
Fabric for Geocomposite Drainage Systems[1]	B, C, or D
(2) Stabilization:	
Bulkheads	C or D
Flexible Revetments	C or D

Rip Rap	D
Railroad Crossings	D
Base Course	D
Subgrade Layer	D
Soil Stabilization	C, D, or S

(3) Paving Fabric[2]: B or C (modified)

(4) Silt Fencing:

Wire Supported	F
Self Supported	G

[1]Refer to Subsection 1019.02 for additional requirements.
[2]Refer to Subsection 1019.03 for additional requirements.

Table 1019-1
Geotextile Fabrics

Property	Test Method	Requirements Classes						
		A	B	C	D	S	F	G
AOS, Metric Sieve,µm, Max.	ASTM D 4751	300	300	300	212	600	850	850
Grab Tensile, N, Min.	ASTM D 4632	330	400	580	800	800	400	400
% Elongation @ Failure, Min.	ASTM D 4632	---	---	50	50	---	---	---
% Elongation @ 200 N, Max.	ASTM D 4632	---	---	---	---	---	---	50
Burst Strength, N, Min.	ASTM D 3787	440	620	930	1290	1390	---	---
Puncture, N, Min.	ASTM D 4833	110	130	180	330	330	---	---
Trapezoid Tear Strength, N, Min.	ASTM D 4533	110	130	180	220	220	---	---
Permittivity, $Sec.^{-1}$, Min.	ASTM D 4491	1.0	1.0	1.0	1.0	0.2	0.01	0.01
Grab Tensile Strength Retained after weathering 150 h, UVA lamps, %, Min	ASTM D 4632 ASTM G 154	70	70	70	70	70	---	---
Grab Tensile Strength Retained after weathering 500 h, UVA lamps, %, Min	ASTM D 4632 ASTM G 154	---	---	---	---	---	70	70

1019.02 GEOCOMPOSITE DRAINAGE SYSTEMS. The geocomposite fabric drain shall consist of a nonwoven geotextile fabric and a core as specified below with the geotextile completely enveloping the core. Fittings shall be as recommended by the manufacturer. The geotextile fabric shall be sufficiently secured to the core to prevent separation of the geotextile fabric and intrusion of the backfill material during installation. The geocomposite drainage system shall be an approved product listed in QPL 62.

(a) Geotextile Fabric: The fabric shall meet the requirements for Class B, C, or D geotextile fabric of Subsection 1019.01 with the following modifications:

Property	Test Method	Requirements
Elongation, %, Min.	ASTM D 4632	20
Sewn Seam Strength (Fabric to Fabric), kN/m width, Min.	ASTM D 4437	2600

(b) Cores for Wall Drains (Single Sided): The core shall be a flexible, solid-backed, rectangular design made of a polyolefin material not sensitive to moisture. The geocomposite design shall allow drainage of water from one side only. The core shall consist of supports having a minimum height of 5/16 inch (8 mm) upon which the fabric shall be securely fastened. The cross section open area of the core which will allow the passage of water shall be a minimum of 40 percent.

The core shall meet the following requirements:

Property	Test Method	Requirements
Compressive Strength, kPa @ 20% Max. deflection, Min.	ASTM D 1621	380

1019.03 PAVING FABRIC. In addition to the specifications for Class B or C geotextile fabric of Subsection 1019.01, the paving fabric shall also comply with the following requirements:

Property	Test Method	Requirements
Asphalt Retention, L/sq m	AASHTO M 288	0.9
Change in Area at 135°C, %, Max.	AASHTO M 288	15.0

Section 1020
Traffic Signals

1020.01 TRAFFIC SIGNAL HEADS.

(a) General Requirements: Traffic signal sections, beacon sections and pedestrian signal sections shall be of the adjustable type. Materials and construction of each section shall be the same.

Signals shall be constructed for either 8 or 12-inch (200 mm or 300 mm) lens in accordance with the plans. Signal sections shall have three to five sections per face and beacon sections have only one section per face. Signal sections and associated brackets shall be finished inside and out with two coats of high grade green enamel (Outdoor Advertising Association No. 144) with each coat independently baked. Visors shall be coated green on the outside and black on the inside. Edges shall be deburred and smooth with no sharp edges.

(b) Housing, Housing Doors, and Visors: Housing and doors shall be constructed of cast aluminum conforming to ASTM B 85 or B 108 with a minimum tensile strength of 17,000 psi (117 MPa). Hardware for the signals, such as hinges, locking devices, screws, bolts, etc., shall be stainless steel.

(1) Housing: Housing shall be sectional and each face shall consist of as many sections as there are optical units, with a suitable top and bottom. Sections shall be rigidly and securely fastened together in a manner that provides mechanical integrity and a weatherproof optical unit.

Each face shall be provided with round openings (slip-fit for 2-inch (50 mm) opening) in the top and bottom so that it may be rotated 360 degrees about its axis as a complete unit between waterproof supporting brackets or trunnions and be capable of being directed and locked at 5 degrees intervals. Serrations, detents, bolts, or similar locking devices are required. Friction will not be an acceptable lock. These locks shall be such that any face will resist a torque of 20 ft-lb (27 N·m) when assembled in accordance with the manufacturer's recommendations.

The portion of the housing adjacent to the bracket shall be reinforced to have sufficient strength against breakage from shock. Seals, gaskets, labyrinths, or a suitable combination shall be provided at bracket attachment points and at section joints to ensure water shedding. Supporting brackets or trunnions shall be used at the top and bottom of section assemblies to rigidly support all faces.

The bracket at the supported end of the signal section shall be 1 1/2 inch (38 mm) conduit or a conduit with an equivalent inside clearance for wiring. The bracket at the opposite end of the section may be either the same as the top or solid. A set screw engaging a drilled hole shall be provided at each joint on the bracket where conduit type joints are used or an equivalent locking device shall be provided.

A 6-position terminal block for connection of wires from the socket and incoming wires from signal circuits shall be provided in the center section of the signal housing and shall include provisions for grounding.

(2) Housing Doors: Housing doors shall contain locking devices which can be operated without tools. Door hinge pins shall be designed so that the door will not become disconnected from housing when open, regardless of signal position. Doors shall be field removable.

Weather resisting, mildew-proof neoprene or silicone rubber sponge gasketing between the body of the housing and the doors shall be provided that will exclude dust and moisture.

(3) Visors: Each signal section shall have a visor in accordance with the plans which tilts downward approximately 8 degrees from the horizontal. Visors shall be constructed of aluminum alloy sheet not less than 0.05 inch (1.3 mm) (No. 18 Gage) thick, or plastic (when specified).

Visors shall be the standard Type A as shown on the plans. Type B tunnel visors shall be used where louvers are shown on the plans. Louvers shall be five vane and painted flat black. Visors shall be designed to fit tightly to the door and shall not permit any filtration of light between door and visor.

Visors for pedestrian signals shall be Type A and shall encompass the tops and sides of the signal face and be a shape and size to adequately shield the face from external light sources.

(c) Optical Unit: The optical unit shall consist of lens, reflector, lamp socket and lamp. The optical unit and visor shall be designed as a unit to eliminate the return of outside sunlight from entering the unit from above the horizontal (known as sun phantom). The optical unit shall be designed and assembled so that no light can escape from one indication to another.

(1) Reflectors: Reflectors shall be rigidly mounted in the housing to assume proper alignment and arranged to be easily swung out of the housing and away from the door to provide access to the interior of the housing. An approved neoprene or rubber gasket shall be placed between the reflector and lens to ensure a dust tight seal. The gasket shall not be detrimental to the optical performance of the signal.

Reflectors shall be made of specular Alzak Aluminum spun or punched from metal not less than 0.025-inch thick (650 μm), equipped with a bead or flange on the outer edge to stiffen the reflector and ensure trueness of shape. The thickness of the anodic coating shall be a minimum of 0.0003 inches (7.5 μm). The reflecting surface shall be free of flaws, scratches, defacements or mechanical distortion.

(2) 12-Inch (300 mm) LED Traffic Signal Lamp Unit (Mast Arm and Span Wire Mount):

a. General: The 12-inch (300 mm) LED traffic signal lamp unit shall be used in new traffic signal heads or as a retrofited replacement for existing incandescent signal lamps. No special tools will be required for installation. When used as a retrofitted replacement for existing incandescent signal lamps, the 12-inch (300 mm) LED traffic signal lamp unit shall fit into existing traffic signal housings without modifications.

If proper orientation of the LED traffic signal lamp unit is required for optimum performance, prominent and permanent directional marking(s), such as an "UP arrow", for correct indexing and orientation shall exist on the unit.

The manufacturer's name, individual serial number, manufactured date, model number, and batch number shall be permanently marked on the backside of the LED traffic signal lamp unit. A label shall be placed on the unit certifying compliance to ITE standards.

b. Physical and Mechanical Requirements: The LED traffic signal lamp unit shall be a single, self-contained device, not requiring on-site assembly for installation into a new or existing traffic signal housing.

The assembly and manufacturing process for the LED traffic signal lamp unit assembly shall be such as to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

Each LED traffic signal lamp unit shall be comprised of a UV stabilized polymeric outer shell, multiple LED light source, and a regulated power supply. LEDs are to be mounted on a polycarbonate positioning plate or conformally coated printed circuit (PC) board.

The external lens shall be smooth on the outside to prevent excessive dirt/dust buildup. The optical lens/appearance of the lamp shall reflect a light distribution look similar to that of an incandescent lamp.

c. Optical and Light Output Requirements: The LEDs shall be manufactured using AlInGaP (Aluminum-Indium-Gallium-

Phosphide) technology or other LEDs with lower susceptibility to temperature degradation than AlGaAs (Aluminum-Gallium-Arsenide). AlGaAs LEDs will not be allowed.

Each LED traffic signal lamp shall meet minimum laboratory light intensity values, color (chromaticity), and light output distribution as described in ITE VTCSH (Vehicle Traffic Control Signal Head Standard) part 2 of the specifications 6.4.2.1, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.5 and 6.4.6 as a minimum. The LED traffic signal lamp units shall be certified by the laboratory to meet initial luminous values that are at least 115 percent of the required minimum values in the tables below. Tables 1020-1 through 1020-4 replace the values in Table 1 of Section 4.1.1 of the ITE VTCSH. The 6.4.2.1 test shall include an expanded view with the following minimums:

Table 1020-1
Grid Specification for 12–Inch (300 mm) Red
(Minimum Luminous Intensity Values (candelas))
(Shaded area is ITE requirements for light intensity)

Degrees	27.5	22.5	17.5	12.5	7.5	2.5	-2.5	-7.5	-12.5	-17.5	-22.5	-27.5
22.5U												
17.5U			3			10	10			3		
12.5U			14			20	20			14		
7.5U			20			54	54			20		
2.5U			58			220	220			58		
2.5D			77	141	251	339	339	251	141	77		
7.5D	16	38	89	145	202	226	226	202	145	89	38	16
12.5D	16	22	34	44	48	50	50	48	44	34	22	16
17.5D	16	20	22	22	22	22	22	22	22	22	20	16
22.5D			7			10	10			7		
27.5D												

Table 1020-2
Grid Specification for 12–Inch (300 mm) Green and Yellow
(Minimum Luminous Intensity Values (candelas))
(Shaded area is ITE requirements for light intensity)

Degrees	27.5	22.5	17.5	12.5	7.5	2.5	-2.5	-7.5	-12.5	-17.5	-22.5	-27.5
22.5U												
17.5U			7			20	20			7		
12.5U			27			41	41			27		
7.5U			41			108	108			41		
2.5U			115			441	441			115		
2.5D			154	283	501	678	678	501	283	154		
7.5D	32	77	178	291	404	452	452	404	291	178	77	32
12.5D	32	44	69	89	97	101	101	97	89	69	44	32
17.5D	32	41	44	44	44	44	44	44	44	44	41	32
22.5D			14			20	20			14		
27.5D												

Table 1020-3
Arrow Indications (candelas/m²)

	Red	Yellow	Green
Arrow Indication	5 500	11 000	11 000

LEDs for arrow indications shall be spread evenly across the illuminated portion of the arrow area. Arrow LED traffic signal lamp units shall be tested in conformance with California Test 3001.

Measured chromaticity coordinates of LED traffic signal lamp units shall conform to the chromaticity requirements of the following table, for a minimum period of 60 months, over an operating temperature range of -40ºF (-40ºC) to 165ºF (74ºC). Each LED traffic signal lamp unit shall meet the minimum requirements for light output for the entire range from 80 to 135 volts.

Table 1020-4
Chromaticity Standards

Red	Y: not greater than 0.308, or less than 0.998x
Yellow	Y: not less than 0.411, nor less than 0.995 – x, nor greater than 0.452
Green	Y: not less than 0.506 – 0.519x, nor less than 0.150 + 1.068x, nor greater than 0.730 – x

LED traffic signal lamp units tested shall be representative of typical production units. Optical testing shall be performed with LED traffic

signal lamp units mounted in standard traffic signal section without visors or hood attached to the signal sections.

After burn-in, LED traffic signal lamp units shall be tested for rated initial luminous intensity in conformance with the provisions contained herein above. Before measurement, LED traffic signal lamp units shall be energized at rated voltage, with 100 percent on-time duty cycle, for a time period of 30 minutes. Test results for this testing shall record the current, voltage, total harmonic distortion (THD) and power factor (PF) associated with each measurement.

Photometric, luminous intensity and color measurements for yellow LED traffic signal lamp units shall be taken immediately after the units are energized. The ambient temperature for these measurements shall be 77ºF (25ºC). Test results for this testing shall record the current, voltage, total harmonic distortion (THD) and power factor (PF) associated with each measurement.

d. Electrical: Each LED traffic signal lamp unit shall incorporate a regulated power supply designed to electrically protect the LEDs and maintain a safe and reliable operation. The power supply shall provide capacitor filtered DC regulated current to the LEDs in accordance with the LED manufacturer's specification. Design of the power supply shall be such that the failure of an individual component or any combination of components cannot cause the LED traffic signal lamp unit to be illuminated after AC power is removed. The power supply must be current regulated.

The LED traffic signal lamp unit shall operate on a 60Hz AC line voltage ranging from 80 volts RMS to 135 volts RMS. The circuitry shall prevent flickering over this voltage range. Nominal rated voltage for all measurements shall be 117 volts RMS.

The LED traffic signal lamp unit shall be operationally compatible with all TS1, TS2, and 2070 controllers, conflict monitors with plus features, and malfunction management units. In the case of conflicts between specifications, the latest LADOTD specifications will control.

A circuitry shall be provided that will shutdown the LED traffic signal lamp unit and power supply when 85 percent ITE light intensity specifications as amended herein are not satisfied. The manufacturer may be required to effectively demonstrate this feature.

Each shipment shall be accompanied with a certified test report from an independent testing lab. Random testing of average production units shall be conducted to ensure compliance with specifications.

Two, color coded, 36 in. long, 600 V, 18 AWG minimum jacketed wires, properly terminated to the LED traffic signal lamp unit to prevent moisture, dust, and other environmental substances from entering the unit, conforming to the National Electric Code, and rated for service at 221ºF (105ºC), shall be provided for an electrical connection.

Individual LED's shall be wired so that a catastrophic failure of one LED light source will result in the loss of only one LED light source.

The LED traffic signal lamp unit shall operate with a minimum 0.90 power factor.

Total harmonic distortion (current and voltage) induced into an AC power line by an LED traffic signal lamp unit shall not exceed 20 percent.

LED traffic signal lamp units and associated on-board circuitry shall conform to the requirements in Federal Communications Commission (FCC) Title 47, SubPart B, Section 15 regulations concerning the emission of electronic noise.

e. Environmental Requirements: The LED traffic signal lamp unit shall be rated for use in the ambient operating temperature range of -40ºF (-40ºC) to 165ºF (74ºC). The unit shall consist of a housing that is a sealed watertight enclosure that eliminates dirt contamination and allows for safe handling in all weather conditions. Moisture resistance testing shall be performed on LED traffic signal lamp units in conformance with the requirements in NEMA Standard 250-1991 for Type 4 enclosures. Evidence of internal moisture after testing shall be cause for rejection.

f. Production Testing Requirements: Each new LED traffic signal lamp unit shall be energized for a minimum of 24 hours at an operating temperature of 140ºF (60ºC) in order to cause any electronic infant mortality to occur, and to ensure electronic component reliability prior to shipment. After the burn-in procedure is completed, each LED traffic signal lamp unit shall be tested by the manufacturer for rated initial intensity at rated operating voltage.

g. Certifications: The contractor shall submit a test report certified by an independent laboratory that is certified to test in accordance with ITE standards that the LED traffic signal lamp unit model to be furnished meets ITE Standards for light distribution as amended herein, chromaticity, and power (consumption, power factor and harmonic distortion).

h. Warranty: The manufacturer shall provide a written warranty against defects in material, workmanship, or intensity for LED traffic signal lamp units for a period of 60 months after their installation. The traffic signal lamp units shall be warranted to maintain, throughout the

warranty period, minimum luminous intensity values that are shown in the tables in paragraph c above. During the warranty period the manufacturer may be required to test any LED traffic signal lamp unit that is suspected to not meet the minimum intensity requirements at no cost to the Department. Any LED traffic signal lamp unit that fails during the warranty period shall be replaced. Replacement LED traffic signal lamp units shall be provided within 5 days after receipt of failed LED traffic signal lamp units at no cost to the Department.

The measured chromaticity coordinates of light emitting diode traffic signal lamp units shall conform to the requirements for chromaticity in Section 8.04 and Figure 1 of the ITE VTCSH over the temperature range of -40ºF (-40ºC) to 165ºF (74ºC).

(3) Lamp Receptacle: Lamp receptacles shall be made of heat resisting materials designed to properly position a traffic signal lamp with means for correct filament positioning. Lamp receptacles shall be designed to properly position a Type A lamp in the 8-inch lens section and Type B lamp in the 12-inch (300 mm) lens section. The receptacle shall be provided with a lamp grip to prevent the lamp from working loose due to vibration. Provisions shall be made to permit rotation of the lamp so that the lead wires are up and securely fastened, but shall not permit any change of position of the socket with respect to the optical center of the reflector. The metal portion of the lamp receptacle shall be brass or copper. A suitable dust-tight gasket (not cork) shall be placed between reflector and lamp socket.

Each lamp receptacle shall be provided with two color coded No. 18 or larger lead wires, Type TEW, 600-volt, AWM fixture wire with 3/64 inch (1.2 mm), 105°C rated thermoplastic insulation, securely fastened to the socket with sufficient length to reach the terminal block with the reflector fully open. The thermoplastic insulation shall, at 34°F (1°C), be capable of being wrapped 6 times around a 1-inch (25 mm) mandrel without damage to its insulating properties at rated voltage. Each lead shall have a terminal attached to its end, for connection to the terminal block in the signal housing with a screw driver.

(4) Pedestrian Signals: Pedestrian indications shall attract the attention of and be readable to the pedestrian both day and night and at all distances from 10 feet (3 m) to the full width of the area to be crossed.

The indicators shall be rectangular and shall consist of the International Symbol Indications "WALKING PERSON" and the "RAISED HAND." When illuminated, the "WALKING PERSON" indication shall be lunar white and the "RAISED HAND" indication shall be Portland Orange

meeting ITE standards. All but the symbols shall be obscured by an opaque material.

When not illuminated, the "WALKING PERSON" and "RAISED HAND" indications shall not be distinguishable by pedestrians at the far end of the crosswalk they control.

(d) Brackets: Brackets for the assembly of 2-way, 3-way and 4-way signal sections shall be constructed to have the center of the attachment points arranged on a 8-inch (200 mm) radius. Attachment to signal head shall be made with 1 1/2-inch (38 mm) conduit or 3-bolt type fittings with a bolt length 1 1/2 inches (38 mm). Fittings at the center of the bracket shall have a removable lower plate for access to the wireway.

The bracket at the supported end of the signal section shall be 1 1/2-inch (38 mm) conduit or a conduit with an equivalent inside clearance for wiring and a fitting with cover for access to the wire-way. The bracket at the opposite end of the section may be either the same as the top or solid. A set screw engaging a drilled hole shall be provided at each joint on the bracket where conduit type joints are used or an equivalent locking device shall be provided.

The attachment point for mounting on the bracket shall be a 2-inch (50 mm) opening. When slip-fit is used, the section shall come complete with the necessary nuts and washers for 1 1/2-inch (38 mm) conduit. Provisions shall be made for a positive lock to prevent accidental bracket rotation. Locking may be accomplished by means of serrations, detents, set screws, or similar devices. Friction locking will not be acceptable. An acceptable alternative to the 1 1/2-inch (38 mm) conduit will be a tri-stud type fitting with appropriate washer. Tri-stud length shall be 1 1/2 inches (38 mm).

Unused openings of signal sections shall be closed with a standard waterproof plug for a 1 1/2-inch (38 mm) opening. The minimum length of the plug shall be 1 1/2-inches (38 mm). Steel plugs shall be galvanized in accordance with ASTM A 153. The exposed portions of plugs shall be painted to match the color of the signal heads.

Carbon steel components shall be galvanized in accordance with ASTM A 153.

(e) Signal Mounts: Signal sections and beacon sections shall be as shown on the plans and shall be suitable for one of the following standard mounts, the type mount for each shall be specified in the plans.

(1) Support Cable Mount: Support cable mounted signals shall come with a disconnect hanger and clamp described in Subsection 1020.01(g).

(2) Pedestal Mount: Pedestal mounts shall be furnished with a slip fitting for placement on a 4-inch (100 mm) inside diameter pipe pedestal having set screws for correct alignment of the signal. Provisions for the entrance of signal cables shall be incorporated into the design of the bracket assembly.

The bracket assembly shall incorporate a weatherproof terminal compartment or box with a removable cover allowing complete access. The box shall be a suitable size to accommodate, and shall come equipped with, a terminal strip with terminals equal to the number of signal indications in the signal heads plus one or more for common and for equipment ground. The terminal compartment shall be neat in appearance and shall be adjacent to or near the pedestal mount. In no case shall feed wires be required to pass through a signal section or face to reach the terminal compartment. A terminal compartment integral with the bracket will be permitted.

(3) Mast Arm Mount: This mount shall be furnished and installed with an adjustable stainless steel strap or cable clamp, malleable clamp casting, tightening mechanism, vertical support tube, top and bottom signal head support with set screws, and bolts. The vertical support tube shall be a minimum of 5 feet (1.5 m) long.

Supporting brackets, trunnions, and fittings shall be made of cast aluminum, steel, or cast iron.

(4) Side Mount: This mount shall be furnished for attaching brackets to vertical supports as shown on the plans. The bracket mounting hub shall accept 1 1/2-inch (38 mm) conduit and provide for a wire opening equivalent to a 1 1/2-inch (38 mm) condulet. For timber pole installation, the side mounts shall have a vertical entrance for 1-inch (25 mm) conduit.

(5) Flashing Beacon Signal Mount: The flashing beacon signal shall attach to the support cable by a bracket as shown on the plans. The bracket shall be provided with a cable entrance adapter with provisions for balancing and securing the signal.

(f) Backplates: Backplates shall be designed to fit the combination of sections of each signal face. Backplates shall be flat aluminum alloy at least 0.05 inch (1.3 mm) (No. 18 gage) thick and shall withstand distortion in 70 mph (115 km/h) winds and shall be firmly attached to each signal face to withstand the above wind load and to permit the opening of any signal door independent from the other doors in the signal face. Width of backplates shall extend a minimum of 5 1/2 inches (140 mm) from the

signal head in all directions or as specified on the plans. Backplates shall be furnished with an oven baked black enamel.

(g) Disconnect Hanger for Traffic Signal Head: The hanger shall provide a means for connecting and disconnecting the signal head electrically and mechanically from signal support cable and span wire without use of tools.

The hanger, with top and bottom attachments and clamps, shall not increase signal height from the span wire to the bottom of the signal by more than 6 inches (150 mm).

The hanger shall be as shown on the plans and shall conform to the requirements of the clamp, housing and terminal block, plug, and adapter.

(1) Clamp: The clamp shall be capable of attaching to a 1/4 inch to 7/16 inch (6 mm to 11 mm) support cable and shall attach to or be integral with a balance adjusting device and a suitable weatherproof entrance for signal cable. The support cable clamp shall utilize a minimum of two "J" or "U" type bolts 3/8 inch (M10) or larger. A 5/8 inch (16 mm) clevis type suspension clamp shall be provided with a 5/8-inch (16 mm) diameter. The balance adjustor shall be suitable for mating with a clevis-type clamp having a horizontal clearance of 5/8 inch (16 mm) and pin of 5/8 inch (16 mm). All steel shall be galvanized in accordance with ASTM A 153.

(2) Housing: The housing and accessories shall be high-strength aluminum alloy and shall be equipped with a door of similar material. The door shall be held shut by a device operable with one hand without use of tools and shall not be easily removable. The door, when open, shall provide complete access to the interior of the housing and a device shall be included to hold the door open while working inside the hanger if it will not remain open.

The housing shall be equipped with two or more weatherproofed openings for signal cable entrance. The openings shall be equipped with suitable bushings for cable protection. Cable entrances shall be capable of accommodating three signal cables 11/16 inch (18 mm) in diameter. No cable opening shall be less than 1 inch (25 mm) in diameter.

The housing shall be provided with a permanently mounted clamping device to prevent the cable from twisting. The clamping device shall not damage the cable jacket, insulation, or break wires.

The housing shall be provided with a 3 1/2-inch-by-3 1/2-inch (90 mm by 90 mm) cast aluminum flange adaptor as shown on the plans for connecting to the signal head or bracket.

(3) Terminal Block and Plug: An easily accessible pressure type terminal block shall be located in the housing and shall accommodate from twelve or eighteen separate lines, as specified. Each terminal shall be permanently numbered for identification, shall accommodate a minimum of two AWG No. 12 conductors, and shall be sufficiently rugged to permit tightening for proper electrical connection without damaging the wire.

The terminal block shall be wired to a multi-circuit female jack connector mounted in the housing and aligned in accordance with the plans.

A minimum size No. 18 AWG wire, with 600-volt polyethylene or polyvinylchloride insulation, shall be used between the terminal strip and the jack connector. The numbered terminals on the terminal strip shall be wired to the corresponding numbered pin in the jack connector.

A suitable male plug with clamp for the corresponding female jack connector shall be furnished and shall be equipped with 4 feet (1.2 m) of cabled leads for connection to the signal heads. Wire shall be No. 18 AWG, 600-volt polyethylene or polyvinylchloride insulated and neatly cabled.

1020.02 TRAFFIC DETECTORS AND ASSOCIATED EQUIPMENT.

Loop detection shall be used for vehicle detection on actuated phases of signal operation. Pedestrian push-buttons shall be used as pedestrian detectors.

(a) Loop Detectors: Detector units for signalized intersections are included as part of DOTD Traffic Control Standard 18A. Detector units required at remote vehicle detection locations shall comply with NEMA TS1, Section 15, with or without delay and extension timing as specified.

Two types of inductive detector units are specified, those with and without the ability to delay and extend a call, NEMA Type 1 and Type 1 T.

Detector units shall be suitable for accurate detection of vehicles from motorcycles to tractor-trailer combinations which ordinarily travel public streets and highways with sufficient conductive material, suitably located to permit recognition and response by the detector system.

Detector units shall also comply with NEMA TS1, Section 15.2.6.

(1) Size and Case: The amplifier case shall be constructed of rugged metallic material with a protective coating. A removable cover shall be provided to allow access to internal circuitry. The cover shall be removable with hand tools.

(2) Connectors, Switches, and Fuses: Switches, connectors, and fuses shall be located on the front of the unit.

a. Each switch shall be permanently labeled to identify its function. Each position shall be permanently labeled to identify its mode of operation. Each mode of operation shall be simple to program with one switch position assigned to one function.

b. A single connector shall be required on the front of the unit to comply with NEMA TS1, Section 15.2.28.1. This connector shall mate with cable connections MS 3106A-18-1S.

c. Plug wiring shall be as follows.

PIN[1]	FUNCTION
Pin A	AC(-)
Pin B	Relay Common
Pin C	AC(+)
Pins D & E	Loop Leads
Pin F	Relay (N.O.)
Pin G	Relay (N.C.)
Pin H	Chassis Ground
Pin I	Spare
Pin J	Delay Override

[1]No pins shall be used for any other purpose than those listed above.

d. Fuseholders shall be permanently labeled identifying the size of the fuse.

(3) Electrical Characteristics:

a. Detector unit outputs shall be a relay type as referenced in NEMA TS1, Section 15.2.29.1. The output operation shall be indicated by a high intensity light emitting diode.

b. Color coding for the wire shall be as follows:

Function	Color Code
Detector Wiring	Not Specified
AC(+)	Black
AC(-)	White
Relay Common	White/Black Stripe
Ground	Green

c. The operation of the detector unit shall comply with NEMA TS1, Section 15.2.1. In addition, the detector unit shall retune to a new inductance value following an excessively large inductance change.

d. When sensor loop and loop lead-in network falls outside the specifications in NEMA TS1, Section 15.2.13, the detector shall generate a fail safe continuous output in both presence and pulse modes. The continuous output shall remain until the memory is cleared by removing power or resetting.

e. When specified, the detector unit shall have the ability to delay and extend a call to the controller. The Delay/Extension operations shall comply with NEMA TS1, Section 15.2.24.

1. The delay time shall begin when a vehicle enters the detection area until the call relay is closed representing an activation and shall be selectable in the range between 0 and 30 seconds.

2. The extension time shall begin timing when the vehicle leaves the detection area, continuing the activation for the selected time. The time shall be selectable in the range of 0 to 7 1/2 seconds.

(4) The detector unit shall have at least three selectable frequencies which shall be visible at all times on the front of the detector unit.

(5) The Sensitivity Control shall comply with NEMA TS1, Section 15.2.14 and Section 15.2.15. There shall be at least three selectable sensitivity ranges located on the front of the detector unit. The sensitivities shall be nominally 0.02 percent, 0.08 percent, and 0.32 percent change in total loop inductance.

(6) The modes of operation shall comply with NEMA TS1, Section 15.2.17. There shall be two presence modes and one pulse mode. The selected mode shall be indicated at all times on the front of the detector unit.

a. Long presence mode shall continue to detect the same vehicle within the detection area for at least 3 1/2 minutes for a Class 1 type test vehicle.

b. Medium presence mode shall continue to detect the same vehicle within the detection area for at least 20 seconds for a Class 1 type test vehicle.

(7) Fail Safe: The detector shall operate with the sensor loop shorted to ground or of poor quality. The unit shall generate a continuous call when returning failed sensor loop, failed detector unit, or power failure.

(b) Pedestrian Pushbuttons: Pedestrian pushbuttons shall consist of a direct push type button and single momentary contact switch in a cast metal housing on which shall be attached the pushbutton sign shown in the plans. The cast metal housing shall include conduit fittings for 1/2-inch

(13 mm) conduit on the back and bottom. Operating voltage for pedestrian pushbuttons shall not exceed 24 volts DC.

The assembly shall be weatherproof and constructed so that it will be impossible to receive an electrical shock under any weather condition.

When a pedestrian pushbutton is attached to a pole, the housing shall be shaped to fit the curvature of the standard or post to which it is attached to provide a rigid installation.

When a pushbutton is to be mounted on top of a 2 1/2-inch (65 mm) post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

(c) Loop Detector Sealant: The loop detector sealant shall comply with Table 1020-5:

Table 1020-5
Loop Detector Sealants

Physical Property	Test Method	Hot Applied	Cold Applied					
			Single Component		Two Component			
					Rapid Set		Slow Set	
			Self Leveling	Non-Sag	Self Leveling	Non-Sag	Self Leveling	Non-Sag
Total Solids by weight,%, Min.	ASTM D 2834		60	60	60	60	60	60
Tack Free Time, hr, Max.	ASTM C 679		4	4	2	2	4	4
Rheological Properties	ASTM C 639 Type 1		Smooth surface		Smooth surface		Smooth surface	
Slump, mm	ASTM D 2202			7.6		7.6		7.6
Extrusion Rate, mL/min, Min.	ASTM C 1183		50	50				
Hardness shore A, Min.	ASTM D 2240		10	10	10	10	10	10
Penetration @ 25°C, Min.	ASTM D 5	60						
Softening Point, °C, Min.	ASTM D 36	82						
Asphalt Compatibility[1]	ASTM D 5329	pass	pass	pass	pass	pass	pass	pass
Pot Life, minutes, Min.	ASTM C 881				12	12	30	30
Dielectric Strength, 60 Hz, Short Time test, Electrode 1 in air @ 25°C kV/mm, Min.	ASTM D 149	13.8	13.8	13.8	13.8	13.8	13.8	13.8
Flex @-7°C, inch, 90° Bend	ASTM D 5329	pass	pass	pass	pass	pass	pass	pass

[1]Not applicable when used to seal portland cement concrete pavement

1020.03 TRAFFIC SIGNAL HARDWARE AND EQUIPMENT.

(a) General: This Subsection defines the general requirements that shall apply to all hardware and equipment not specifically listed. When design tests are specified, documentation may be provided indicating that such tests have previously been satisfactorily completed.

(b) Miscellaneous Hardware: Screws, nuts, and lock washers shall be stainless steel or galvanized in accordance with ASTM A 153. No self tapping screws shall be used unless approved.

(c) Pedestal Anchor Bolts: Steel anchor bolts shall be as shown on the plans and shall be fitted with one hex nut and one washer. Nuts, washers, and anchor bolts shall be galvanized in accordance with ASTM A 153.

(d) Support Cable: Support cable for interconnect and detector support cable shall be 1/4-inch (6 mm) outside diameter and signal support cable and guy wire shall be 3/8-inch (9 mm) outside diameter and shall comply with ASTM A 475, 7-strand Siemens-Martin grade with Class A coating.

(e) Guy Components: Guying components and hardware shall be galvanized in accordance with ASTM A 123 and ASTM A 153.

Guy clamps shall be steel, 3-bolt type, 6 inches (150 mm) in length, and of proper strand size to fit both sizes of cable. Clamp bolts shall have an upset shoulder fitting into the clamp plate.

(f) Traffic Signal Cable: The cable shall be 600 volt insulated cable. Filler material, when used, shall be non-metallic, moisture resistant, non-hydroscopic, non-wicking, and non-absorbent. The conductors that are to be marked with tracer in addition to the solid color shall have the tracer as part of the insulation, ink marking is not acceptable. The outside jacket shall be smooth and shall not display patterns of the conductor lay on the outside of the jacket.

The traffic signal cable shall be No. 14 AWG solid conductor. Interconnect cable shall be No. 16 AWG in the 24 conductor and 12 AWG in the 7 conductor. All material, color code, and testing shall comply with IMSA 20-1. The interconnecting cable between intersections for closed loop and telemetry operation shall be 6 pair IMSA 20-6.

Loop lead-in cable shall be tinned No. 14 AWG stranded conductor, twisted pair with an overall shield. The cable shall comply with IMSA 50-2. Loop detector wire shall comply with IMSA 51-3 and shall be No. 16 AWG-19 strands/No. 29 AWG copper. Insulation shall be 0.080-inch XLPE.

(g) Electrical Junction Box: Junction boxes shall be constructed of Class M concrete, cast iron or epoxy/sand composite, as shown on the plans.

Class M concrete shall conform to Section 901. Reinforcement shall consist of welded wire fabric, 4-inch-by-4-inch (100 mm by 100 mm) No. 4/4 complying with Section 1009. Pull boxes may be cast-in-place or precast.

Epoxy/sand composite boxes shall be manufactured in accordance with the plans. The composite material shall have a minimum compressive

strength of 11,000 psi (75 MPa). The manufactured box shall have a minimum compressive strength of 50 psi (345 kPa) on the cover when installed on the box.

1020.04 POLES FOR TRAFFIC SIGNAL SYSTEMS.

(a) Pedestal Support Signal Poles: The pole shall be in accordance with the plans. The base of the pedestal shall be cast iron or aluminum and shall be at least 16 inches (400 mm) wide at the bottom, at least 16 inches (400 mm) high and shall be octagonal.

The upper end of the base shall be threaded to receive a 4-inch (100 mm) diameter pipe shaft.

The base shall be designed so that it may be fastened to the foundation using 5/8-inch-by-16-inch (16 mm by 400 mm) anchor bolts located 90 degrees apart on the circumference of a circle 12 3/4 inches (325 mm) in diameter.

The base shall contain a removable door to allow access to anchor bolts and to permit cable splicing. This door shall be fastened to the base using a hex head stainless steel screw into a threaded hole in the base.

The shaft shall be 4 1/4 inches (108 mm) in inside diameter welded steel tubing with a minimum 1/8-inch (3 mm) wall thickness. The lower end of the shaft shall be welded to a 6-inch (150 mm) nipple to screw into the base. This shaft shall be a single piece of tubing.

Pedestals shall be finished with at least one coat of rustproofing primer, applied to a clean surface and one coat of green enamel.

The length of pedestal, shaft plus base, shall be a minimum of 8 feet (2.4 m).

(b) Steel Signal Support Pole:

(1) General: Poles and fittings shall be in accordance with the plans and shall be galvanized in accordance with ASTM A 123 and A 153. Poles shall be suitable for a minimum horizontal load of 4,000 pounds (1800 kg) applied 1 foot (300 mm) below the top of pole.

(2) Pole Shaft: The pole shaft shall have a minimum base diameter of 11 inches (280 mm) and a maximum base diameter of 11 3/4 inches (295 mm). The pole shaft shall be tapered to approximately 7-inch (175 mm) diameter at the top. The pole shaft may have a round or octagonal cross section. A cap shall be used to cover the pole shaft top.

The pole shall be designed so that its maximum deflection is as shown in Table 1020-6.

Table 1020-6
Steel Pole Deflection

Pole Length, ft (m)	Maximum Deflection, in/100 lb (mm/50 kg)
26 (7.9)	0.25 (7.0)
28 (8.5)	0.30 (8.4)
30 (9.1)	0.38 (10.6)

(3) Hand Holes and Bosses: A hand hole shall be provided approximately 18 inches (450 mm) above the base with approximate dimensions of 4 inches by 6 1/2 inches (100 mm by 165 mm) and cover shall be provided. The cover shall be restrained to the pole with a 15 inch (380 mm) No. 35 stainless steel chain fastened to the cover and to the inside of the hand hole so that the chain will be inside the pole after the cover is installed on the pole. There shall be no sharp edges on the cover, in the hand hole, or in the pole. The cover shall have the manufacturer's name and the pole height stenciled on it, readable from the outside of the pole. The stencil shall be legible after galvanizing. The hand hole strain bar shall be formed to provide a mechanical lock against the hand hole to prevent turning. No obstructions shall be in the hand hole with the cover removed. A grounding nut (1/2 inch (13 mm)-13NC) shall be welded to the inside of the shaft 90 degrees left and horizontal from the hand hole. A grounding lug shall be provided with each pole.

All poles shall have 1 inch (25 mm) and 3 inch (75 mm) bosses centered on a horizontal line 18 inches (450 mm) from the base and 18 inches (450 mm) from the top. When facing the bosses, the 1-inch (25 mm) boss shall be 35 degrees (±3) to the right of the 3-inch (75 mm) boss. The 3-inch (75 mm) boss shall be located 180 degrees from the hand hole. The bosses at the top of the pole shall be in line with the bosses at the bottom. The poles shall be shipped with all bosses plugged using galvanized steel conduit plugs installed to full thread depth. On octagonal poles the 3-inch boss shall be centered on one face that is parallel to one edge of the base plate.

(c) Steel Signal Support Standards and Mast Arms:

(1) General: Standards, mast arms and fittings shall be galvanized in accordance with ASTM A 123 and A 153. The height of poles, shaft dimensions, and wall thickness shall meet the design requirements and mounting height of traffic signals set forth in the project specifications and in the plans. The length of arms shall be as shown on the plans.

Standards shall consist of straight or uniformly tapered shafts, cylindrical or octagonal in cross section, having a base welded to the lower

end with anchor bolts. Castings shall be clean and smooth with details well defined and true to pattern. Mechanical control shall prevent the arm from twisting on the shaft. Friction is not acceptable.

Mast arms shall be compatible with poles in materials, strength, shape, and size. Mast arms shall slip fit on the shaft.

(2) Hand Holes and Bosses: A hand hole shall be provided for access to the wireway at the union of the arm and the pole shaft. Bosses shall be 1 1/2 FPT in the mast arm and set at 45 degrees from horizontal (downward rotation at the center of the boss, 0 degrees toward the arm top). Bosses shall be located a horizontal distance of 10 feet (3 m) apart, the first located 16 inches (400 mm) from the top of the arm. The number of bosses required is listed in Table 1020-7.

Table 1020-7
Steel Signal Support Standards

Shaft		Shaft Base Plate	
Arm Length, ft (m)	Number of Bosses	Diameter, Inches, (mm) Max.	Bolt Circle, Inches, (mm) Max.
15 -20 (3.0-6.5)	2	10 (250)	14 1/2 (370)
25-30(7.5-9.5)	3	12 (300)	15 (375)
35-50 (10.5-15.5)	4	13 (330)	16 (400)

(3) Hanger Plate: A hanger plate and horizontal boss shall be at the tip of the arm. The arm shall have an up-sweep design. Design load on the arm shall be sufficient to place a signal head at each boss.

(4) Design Requirements: For establishing the loads, applied to each structure, the weights and projected areas of Table 1020-8 shall be used for traffic signal heads.

Table 1020-8
Steel Signal Support Standards Design Requirements

Type[1]	Design Weight (Mass) Per Signal, pounds[1] (kg[1])	Projected Area Per Signal	
		Less Backplates, square feet (sq m)	Backplates, square feet (sq m)
1-Way, 3 Section	62 (28)	4.8 (0.446)	8.9 (0.827)
1-Way, 4 Section	76 (34.5	6.6 (0.613)	11.2 (1.041)
2-Way, 3 + 3 Sections	126 (57)	8.7 (0.808)	12.2 (1.133)
3-Way, 3+3+3 Sections	179 (81)	13.35 (1.240)	15.6 (1.449)
4-Way, 3+3+3+3 Sections	235 (106.5)	13.2 (1.226)	15.6 (1.449)

[1]When signal heads of a type different from that shown above are used, the weights (mass) and projected area shown above shall be increased for the equipment proposed for use. Adjusted values shall be based on the use of 12-inch (300 mm) diameter lenses and backplates (when used) extending 5 inches (125 mm) beyond signal enclosure.

(5) Standard Shaft: The standard shaft base shall have a minimum diameter of 11 inches (280 mm). Mast arm standards shall be provided with a transformer type base.

Each pole shall be bolted to transformer base with four hex head bolts with two washers and one nut for each bolt.

(6) Transformer Base: The transformer base shall be approximately 20 inches (500 mm) high. The top of the transformer base shall have four 1 1/2-inch-by-2 1/2-inch (38 mm by 64 mm) slots for bolting the pole to the transformer base. The 2 1/2-inch (64 mm) dimension of the slot shall be centered on and perpendicular to a 13 1/2-inch (340 mm) bolt circle.

A removal panel on the side of the transformer base shall be provided for access to the base. A 1/2-inch (13 mm)-13NC grounding nut shall be provided 90 degrees left of this panel. A grounding lug shall be provided with each pole. The bottom of the transformer base shall fit a 16-inch (400 mm) bolt circle using four 1 3/4-inch (45 mm) bolts supplied with each pole. These bolts shall conform to these specifications and plan details with exception that the cap nuts shall be replaced with the regular hex nuts. The transformer base shall be capable of being rotated 360 degrees.

(7) Wireways: The pole shaft and mast arm shall be suitable for wireways throughout their length.

(8) Identification: The pole shaft, mast arm and arms, and transformer base shall have a matching serial number. Serial numbers shall

be assigned by the Traffic Engineering and Services Administrator or shown on the plans.

(d) Anchor Bolts for Steel Signal Support Poles and Standards: Anchor bolts shall be supplied in accordance with the standard details and shall be 1 3/4 inch (45 mm), 5 NC thread with a yield strength of 105,000 psi (724 MPa). and hot dipped galvanized for the top 12 inches (300 mm) and shall comply with ASTM A687-B7 or ASTM A193-B7. One additional anchor bolt shall be supplied by the contractor at no cost for acceptance testing by the department.

(e) Loop Detector Sealants: Loop detector sealant shall be as specified in Sub 1020.02(c).

(f) Timber Wood Poles: Poles shall comply with Section 1014.

INDEX