LOUISIANA
STANDARD SPECIFICATIONS
FOR
ROADS AND BRIDGES

1982
EDITION

STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION
AND DEVELOPMENT

OFFICE OF HIGHWAYS
Baton Rouge

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PART I
GENERAL PROVISIONS

Section 101
Definitions and Terms

Wherever in these specifications or other contract documents the following terms or pronouns in place of them are used, the meaning shall be interpreted as follows:

Wherever the term "Department" appears in the plans, project specifications or other contract documents, it shall be interpreted to mean the Office of Highways, Louisiana Department of Transportation and Development and when so noted in the project specifications the term "Department" may be designated and used by others.

Wherever the term "Secretary" appears in the plans, project specifications or other contract documents, it shall be interpreted to mean the Secretary of the Louisiana Department of Transportation and Development.

101.01 ABBREVIATIONS. Wherever the following abbreviations are used in these specifications or the plans, they are to be construed to be the same as the respective expressions represented:

AA	Aluminum Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ARA	American Railway Association
AREA	American Railway Engineering 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
DOTD	Department of Transportation and Development (Louisiana)
FAA	Federal Aviation Administration, Department of Transportation
EDSM	Department's Engineering Directives and Standards Manual
FHWA	Federal Highway Administration, Department of Transportation
FSS	Federal Specifications and Standards, General Services Administration
IPCEA	Insulated Power Cable Engineers Association
MIL	Military Specifications
MUTCD	Manual on Uniform Traffic Control Devices (Louisiana)
NEMA	National Electric Manufacturers Association
OSHA	Occupational Safety and Health Administration
QPL	Qualified Products List (DOTD)
SAE	Society of Automotive Engineers
SSPC	Steel Structures Painting Council
UL	Underwriters Laboratories, Inc.

101.02 ACCESS CONNECTION. Any roadway facility by means of which vehicles can enter or leave a highway. Included are intersections at grade, private driveways and ramps or separate lanes connecting with cross streets or frontage roads.

101.03 ADVERTISEMENT. A public announcement inviting bids for work to be performed or materials to be furnished.

101.04 ARTERIAL HIGHWAY. A general term denoting a highway primarily for through traffic, usually on a continuous route.

101.05 BASE COURSE. The layer or layers of specified material of designed thickness on a subbase or subgrade to support a surface course.

101.06 BIDDER. An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture submitting a proposal.

101.07 BRIDGE. A structure, including supports, erected over a depression or obstruction, 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 or spring lines of arches or extreme ends of openings for multiple boxes; may include multiple pipes where the clear distance between openings is less than half 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.

101.08 CALENDAR DAY. Every day shown on the calendar, beginning and ending at midnight.

101.09 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 includes the invitation for bids, proposal, contract form and contract bond, specifications, supplemental specifications, special provisions, general and detailed plans; also, any plan changes and supplemental agreements that are required to complete contruction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

101.10 CONTRACT BOND. The approved form of security, executed by the contractor and his surety or sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and payment of all legal debts pertaining to construction of the project.

101.11 CONTRACT ITEM (Pay Item). A specific unit of work for which a price is provided in the contract.

101.12 CONTRACT TIME. The number of working days or calendar days allowed for completion of the contract, including authorized time extensions.

If a calendar date of completion is shown in the contract, in lieu of a number of working or calendar days, such work contemplated shall be completed by that date.

101.13 CONTRACTOR. The individual, partnership, firm, corporation or any acceptable combination thereof, or joint venture contracting for performance of prescribed work.

101.14 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.

101.15 CONTROLLING ITEMS OF WORK. Items of construction that should be in progress at the time, as essential to the orderly completion of the work within the time limit specified, in accordance with the contractor's approved progress schedule.

101.16 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: Full control of access means that the authority to control access is exercised to give preference 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: Partial control of access means that the authority to control access is exercised to give preference 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.

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

101.18 DEPARTMENT. The Department of Transportation and Development of the State of Louisiana, Office of Highways, constituted under the laws of the State for the administration of highway work.

101.19 DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT. The Louisiana Department of Transportation and Development through its offices and officers, responsible for developing and implementing programs to assure adequate, safe, and efficient transportation and other public works facilities and services in the state in accordance with Act 513 of the 1976 regular session of the State Legislature as amended by the Legislature.

101.20 DIVIDED HIGHWAY. A highway with separated roadways for traffic in opposite directions.

101.21 ENGINEER. The Chief Engineer, acting directly or through duly authorized representatives, who is responsible for engineering supervision of the construction. When the term "Chief Engineer" is used, it shall mean the Chief Engineer in person.

101.22 EQUIPMENT. All machinery and equipment, with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for proper construction and acceptable completion of the work.

101.23 EXPRESSWAY. A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections.

101.24 EXTRA WORK. An item of 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.

101.25 FLUME. A structure used primarily for the passage of irrigation water.

101.26 FREEWAY. An expressway with full control of access.

101.27 GRADE SEPARATION. A crossing of two highways, or a highway and a railroad, at different levels.

101.28 HIGHWAY, STREET OR ROAD: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way. Recommended usage in urban areas — highway or street; in rural areas—highway or road.

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

101.30 INTERCHANGE. A grade-separated intersection with one or more turning roadways for travel between intersecting legs.

101.31 INVITATION FOR BIDS. The advertisement for proposals for all work or materials on which bids are required. Such advertisement will indicate location and description of the work, and time and place of opening bid proposals.

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

101.33 LOCAL STREET OR LOCAL ROAD. A street or road not in state maintained system and primarily for access to residential, business or other abutting property.

101.34 MAJOR STREET OR MAJOR ROAD. An arterial highway with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite safe movement of through traffic.

101.35 MATERIALS. Any substances specified for use in the construction of the project and its appurtenances.

101.36 MEDIAN. The portion of a divided highway separating traveled ways for traffic in opposite directions.

101.37 NOTICE TO PROCEED. Written notice to the contractor to proceed with the contract work, including the date of beginning of contract time.

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

101.39 PAVEMENT STRUCTURE. The combination of subbase, base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.40 PLAN CHANGE. A general term denoting changes to the contract.

101.41 PLAN CHANGE AND/OR SPECIAL AGREEMENT. The title of the standard form normally used to describe and detail plan changes. The document will establish reasons for the changes, specification requirements, method of measurement, basis of payment and contract time adjustments for the work affected by the changes. When approved and properly executed, the document becomes a part of the contract and a notice to proceed with the affected work.

101.42 PLANS. The contract drawings which show location, type, and dimensions of the prescribed work and may include layouts, profiles, cross sections and other details.

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

Working Drawings - Supplemental design sheets or similar data which contractor is required to submit to the engineer such as stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans and bending diagrams for reinforcing steel.

101.43 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.

101.44 PROJECT. A specific undertaking of construction as described by the plans and specifications within prescribed limits.

101.45 PROJECT ENGINEER. The engineer assigned to one or more construction projects to represent the Department through the Chief Engineer.

101.46 PROJECT NUMBER. A number used for convenience to describe and delineate certain construction with definite geographical limits.

101.47 PROPOSAL. The offer of a bidder, on the prescribed form, to perform the stated work and to furnish the labor and materials at the prices quoted.

101.48 PROPOSAL FORM. The prescribed form on which the offer of a bidder must be submitted.

101.49 PROPOSAL GUARANTY. The required security furnished with a bid proposal.

101.50 QUALIFIED PRODUCTS LISTS. Lists which are maintained by the Department's Materials Section for products which 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.

Qualification of a product is not blanket approval for its use, since qualified products are subject to certification or acceptance or verification testing as outlined in the Department's Materials Sampling Manual.

101.51 RIGHT-OF-WAY. A general term denoting land, property or interest therein, acquired for or devoted to transportation purposes.

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

101.53 ROADSIDE. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between roadways of a divided highway may also be considered roadside.

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

101.55 ROADWAY. In general, that portion of a highway, including shoulders, provided for vehicular use. A divided highway has two or more roadways. In construction specifications, a roadway is that portion of a highway within the limits of construction.

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

101.57 SERVICE ROAD OR FRONTAGE ROAD. A local street or road auxiliary to and located on the side of the mainline roadway for service to abutting property and adjacent areas and for control of access.

101.58 SPECIAL PROVISIONS. Additions and revisions to the standard and supplemental specifications covering conditions applicable to the project.

101.59 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 that are applicable to the project.

101.60 SPECIFIED. Set forth or stipulated in the plans or specifications or elsewhere in the contract documents; such as, materials, equipment or methods.

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

101.62 STRUCTURES. Bridges, culverts, catch basins, junction boxes, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains and other features encountered in the work and not otherwise classed herein.

101.63 SUBBASE. The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course.

101.64 SUBCONTRACTOR. An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, to which the contractor sublets part of the contract.

101.65 SUBGRADE. The surface of a foundation layer upon which the pavement structure and shoulders are constructed.

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

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

101.68 SUPERSTRUCTURE. The entire structure except the substructure.

101.69 SUPPLEMENTAL AGREEMENT. A written agreement made and entered into by and between the contractor and the Department covering work not otherwise provided for, revisions in or amendments to terms of the contract or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreement becomes a part of the contract when approved and properly executed.

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

101.71 SURFACE COURSE. The top course of the pavement or bridge structure.

101.72 THROUGH AND LOCAL TRAFFIC.

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

(b) Local traffic - That traffic which has either its origin or destination, or both, within the limits of the project.

101.73 THROUGH STREET OR THROUGH HIGHWAY. A highway or portion thereof on which vehicular traffic is given preferential right-of-way, and at entrances to which vehicular traffic from intersecting highways or streets is required by law to yield right-of-way to vehicles on such through highway in obedience to either a stop sign or a yield sign, when such signs are erected.

101.74 TITLES (Or Headings). The titles or headings of sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

101.75 TRAFFIC LANE. The portion of traveled way for movement of a single lane of vehicles.

101.76 TRAVELED WAY. The portion of roadway for movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.77 UNDERSTOOD PHRASES. In order to avoid cumbersome repetition of expressions in these specifications, 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 or condemned," it shall be understood as if the expression were followed by the words "by the engineer" or "to the engineer".

101.78 WORK. The furnishing of all labor, materials, equipment and incidentals necessary for successful completion of the project and the carrying out of all obligations imposed by the contract.

101.79 WORKING DAY. A calendar day, with exceptions stated herein, on which weather and other conditions not under control of the contractor will permit construction operations to proceed for at least 5 continuous hours of the day with the normal working force engaged in performing the controlling items of work.

No working days will be charged for the following days:

(1) Saturdays and Sundays.

(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.

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

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

101.80 WORK ORDER. See "Notice to Proceed", Subsection 101.37.

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 in accordance with existing State laws.

102.02 CONTRACTORS' LICENSING LAWS. Attention is directed to the rules and regulations of the State Licensing Board for Contractors in accordance with Louisiana Revised Statutes 37:2150-2163. 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 Federal funds are involved. When federal 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.

The contractor shall show his license number on the bid envelope. 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 R.S. 37:2150-2163.

102.03 CONTENTS OF PROPOSAL FORMS. Upon request, the Department will furnish prospective bidders with proposal forms. This form will state the location and description of the contemplated construction and will show the approximate estimate of the quantities and kinds of work to be performed or materials to be furnished and will have a schedule of items for which unit bid prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty, and the date, time and place of opening proposals. The form will also include any specifications or requirements which vary from or are not contained in the Standard Specifications.

All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered when the proposal is submitted.

The plans, specifications and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

The prospective bidder will be required to pay the Department the sum stated in the Notice to Contractors for each set of plans.

102.04 ISSUANCE OF PROPOSALS. The Department will refuse to issue a proposal to a bidder for any of the following reasons:

(1) Failure to comply with the prequalification requirements of the Department.

(2) Disqualification in accordance with Subsection 108.04.

(3) In default of a contract resulting in the contract currently being completed by others.

(4) On Federal-aid projects, being included on the Federal contractor debarment listing or having been found unacceptable for employment on Federal-aid projects.

102.05 INTERPRETATION OF QUANTITIES IN BID SCHEDULE. The quantities appearing in the bid schedule are prepared for comparison of bids and may be approximate. Payment to the contractor will be made in accordance with measurement and payment requirements for bid items and other requirements of the project specifications. Bid item quantities may be increased, decreased or omitted as provided in these specifications.

102.06 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE OF WORK. The bidder is expected to examine carefully the site of the proposed work, the proposal, plans, project specifications and contract forms before submitting a proposal. Submission of a bid shall be considered prima facie 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 plans, project specifications and contract forms.

Any pre-bid test and boring data in connection with subsurface conditions which have been compiled by the Department and furnished to the bidder shall not be considered as fully representative of subsurface conditions existing throughout the area tested nor shall they in any way be binding upon the Department, it being understood that said data is furnished the bidder for his convenience only and the bidder shall be solely responsible for conducting his own boring explorations he deems necessary in preparing his bid.

No claim shall be made against the Department for additional compensation due to unforeseen subsurface conditions arising during progress of the work and which might be in variance with the Department's pre-bid boring data.

102.07 PREPARATION OF PROPOSAL. Proposals shall be submitted on forms provided by the Department. A unit bid price shall be specified in words, either typed or in ink, in the spaces provided for each pay item or alternate pay item for which a quantity is given, with the following exceptions. When special forms are included in the proposal for Items 202(2), 710(1), 710(2) or 710(3), the unit bid prices for these items shall be specified in figures.

The proposal must be signed with ink by the individual; or by one or more members of the partnership; or by one or more members or officers of each firm representing a joint venture; or by one or more officers of a corporation; or by an agent of the contractor legally qualified and acceptable to the state. If the proposal is made by an individual, his name and post office address must be shown; by a partnership, the name and post office address of each partnership member; as a joint venture, the name and post office address of each member or officer of the firm represented by the joint venture; by a corporation, the name of the corporation and business address of its corporate officials.

102.08 IRREGULAR PROPOSALS. Proposals will be considered irregular and will be rejected for any of the following reasons:

(1) If the proposal is on a form other than that furnished by the Department or if the form is altered or any part thereof is detached.

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

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

(4) If the proposal does not contain a unit price for each pay item listed, except in the case of authorized alternate pay items.

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

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

(7) If the proposal guaranty does not meet requirements of Subsection 102.09.

(8) If more than one proposal for the same work is received from an individual, partner, firm, corporation, joint venture or combination thereof under the same or a different name.

102.09 PROPOSAL GUARANTY. Each bid must be accompanied by a proposal guaranty in an amount not less than the amount specified in the Notice to Contractors included in the proposal for bids. The proposal guaranty shall be either a certified check, cashier's check, postal money

order, bank money order, or bid bond guaranteed by a surety company qualified to do business in Louisiana. The check, money order or bid bond shall be made payable to the Louisiana Department of Transportation and Development.

If the proposal guaranty submitted by a bidder is in the form of a bid bond, this bond must be similar in all respects to the form of the "Bid Bond" sheet in the proposal. The bid bond must be filled out in dollars and cents; must be signed by the authorized officer, owner or partner of the bidding firm, or each firm representing a joint venture; and must be signed by the surety's agent or attorney-in-fact. The bond shall be accompanied by a notarized document granting general power of attorney to the surety's signer.

102.10 DELIVERY OF PROPOSALS. Each proposal should be submitted in a special 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 special one furnished by the Department is used, it shall be the same general size and shape and be similarly marked to clearly indicate its contents. When sent by mail, the sealed proposal shall be addressed to the Department at the address and in care of the official in whose office the bids are to be received. All proposals shall be filed prior to the time and at the place specified in the notice to contractors. Proposals received after the time for opening bids will be returned to bidders unopened.

102.11 WITHDRAWAL OR REVISION OF PROPOSALS. A bidder may withdraw or revise a proposal after it has been deposited with the Department provided the request for such withdrawal or revision is received by the Department, in person or in writing or by telegram, before the time set for opening bids.

102.12 COMBINATION OR CONDITIONAL PROPOSALS. If the Department elects, proposals may be issued for projects in combination or on separate units of the combination. The Department reserves the right to make awards on combination bids or separate bids to the best advantage of the Department. No combination bids other than those specifically proposed in the proposals by the Department will be considered. Separate contracts will be written for each project included in the combination.

Conditional proposals will be considered only when so stated in the project specifications.

102.13 PUBLIC OPENING OF PROPOSALS. Proposals will be opened and read publicly at the time and place indicated in the Notice to Contractors. Bidders, their authorized agents and other interested parties are invited to be present.

102.14 MATERIAL GUARANTY. The successful bidder may be required to furnish a statement of the origin, composition and manufacture of materials to be used in construction of the work together with samples, which samples may be subjected to the tests provided for in the project specifications to determine their quality and fitness for the work.

Section 103

Award and Execution of Contract

103.01 CONSIDERATION OF PROPOSALS. After proposals are opened and read, they will be compared on the basis of the summation of the products of the quantities shown in the bid schedule by the unit bid prices. Results of such comparisons will be immediately available to the public.

The right is reserved to reject any or all proposals, to waive technicalities or to advertise for new proposals if, in the judgment of the awarding authority, the best interests of the Department will be promoted thereby.

103.02 AWARD OF CONTRACT. The award of contract, if awarded, will be made within 30 calendar days after opening proposals to the lowest qualified bidder whose proposal complies with all requirements prescribed. The successful bidder will be notified by letter mailed to the address shown on his proposal that his bid has been accepted and he has been awarded the contract.

The award of contract for projects financed either partially or entirely with State bonds will be contingent upon approval of the project by the State Bond Commission.

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.

103.04 RETURN OF PROPOSAL GUARANTY. Proposal guaranties of unsuccessful bidders will be returned to them within 15 days after opening bids. The retained proposal guaranty of the successful bidder will be returned after a satisfactory contract bond has been furnished and the contract has been executed.

103.05 REQUIREMENT OF CONTRACT BOND. At the time of execution of the contract, the successful bidder shall furnish a surety bond or bonds in a sum equal to the amount of the contract. The form of the bonds and the security must be acceptable to the Department.

If the amount of bond required exceeds the limit fixed by the U.S. Secretary of the Treasury for which the bonding company selected by the contractor may be accepted, coinsurers will be permitted.

Louisiana R.S. 38:2216(A), revised 1982, requires the countersigning of contract bond by an insurance agent licensed and residing in Louisiana.

103.06 EXECUTION AND APPROVAL OF CONTRACT. The contract shall be signed by the successful bidder and returned, with the contract bond, within 10 days after the contract has been mailed to the bidder. If the contract is not executed by the Department within 15 days following receipt from the bidder of the signed contract and bond, the bidder shall have the right to withdraw his bid without penalty. No contract shall be considered as effective until it has been executed by all the parties thereto.

103.07 FAILURE TO EXECUTE CONTRACT. Failure by the bidder to execute the contract and file acceptable contract bond within 10 days after the contract has been mailed to the bidder 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 lowest responsible bidder or the work may be readvertised for bids, at the Department's discretion.

103.08 FAILURE TO ISSUE NOTICE TO PROCEED. If the Notice to Proceed is not issued within 3 months after execution of the contract, the contractor may at any time thereafter demand cancellation of the contract, unless an extension is approved in writing by the Department and contractor.

Section 104
Scope of Work

104.01 INTENT OF CONTRACT. The intent of the contract is to provide for construction 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 proposal and contract contains a choice to be made by the contractor of the type material to be furnished, the contractor, before the work is initiated, shall indicate his choice in accordance with the specifications for that item. Such notification shall be submitted to the engineer in writing.

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. Contract items affected by such alterations shall be performed in accordance with the project specifications and will be paid for at the same unit prices as other parts of the work, except as provided under Subsections 109.03 and 109.04.

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

The Department reserves the right to order changes in construction 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 the satisfactory completion of the work. Such changes in construction details shall be performed in accordance with the specifications and as directed, and will be paid for as provided under Subsection 109.04. Changes ordered in construction details, when such changes are allowed or required by the terms of the contract, are not alterations to the contract and the affected work will be paid for 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.

Under no circumstances shall alterations of the contract involve work beyond the termini of the proposed construction except as necessary to satisfactorily complete the project.

104.03 MAINTENANCE OF TRAFFIC. Reasonable provisions for local traffic throughout the length of the project and the life of the contract must be made by the contractor during construction, without direct compensation.

When specified, the contractor may also be required to provide for through traffic over the entire project, or designated portion thereof, without direct compensation.

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. He shall furnish, erect and maintain barricades, warning signs and delineators, and shall provide flagmen and pilot cars in accordance with the plans and the MUTCD. He shall also provide and maintan in a safe condition all required temporary approaches or crossings, intersections with roads, streets, businesses, parking lots, residences, garages and farms, without direct compensation.

If the engineer directs additional measures for the benefit of the traveling public, the contractor will be paid therefor at 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.

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

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

All instruction sheets that are required to be furnished by the manufacturer for materials and supplies and for operation shall be delivered by the contractor to the engineer prior to final acceptance of the project, with the following warranties and guarantees:

1. The manufacturer's standard written warranty for each piece of mechanical and electrical equipment or apparatus furnished under the contract.

2. The contractor's written guarantee that, for a period of one year after the date of final acceptance of the project, all necessary repairs to or replacement of said warranted equipment or apparatus will be made by the contractor at no cost to the Department.

3. The contractor's written guarantee for satisfactory operation of all mechanical and electrical systems furnished and constructed under the contract for a period of one year after final acceptance of the project.

Section 105
Control of Work

105.01 AUTHORITY OF THE ENGINEER. The engineer will decide all questions which arise as to the 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 he deems necessary due to unsuitable weather; for conditions considered unsuitable for prosecution of the work or for any other condition or reason deemed to be in the public interest.

All 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.

105.02 PLANS AND WORKING DRAWINGS. Plans will show details of all structures, lines, grades, typical cross sections of the roadway, location and design of all structures and a summary of bid items. Only general features will be shown for steel bridges. The contractor shall keep 1 set of plans available on the work at all times.

Working drawings for structures shall be furnished by the contractor and shall consist of such detailed plans as required to adequately control the work and are not included in plans furnished by the Department. They shall include stress sheets, shop drawings, erection plans, falsework plans, form drawings, cofferdam plans, bending diagrams for reinforcing steel or any other supplementary plans or similar data required of the contractor. Working drawings must be approved by the engineer and such approval shall not relieve the contractor of his responsibility under the contract for successful completion of the work or his responsibility for details shown in the working drawings to conform in all respects to the contract plans.

Type and size of drawings furnished shall be as described in Subsection 801.03.

105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions and material requirements shown on the plans or indicated in the specifications.

If the engineer finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and project specifications but that reasonably acceptable work has been produced, he may allow the work to remain in place. In this event, the engineer will document the basis of acceptance by a plan change which will provide for an appropriate decrease in the contract price for such work or materials as he deems necessary. Reduced pay schedules will be used when such schedules are a part of the project specifications.

If the engineer finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and project specifications and have resulted in an unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by, and at the expense of, the contractor.

If due to the contractor's negligence 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, and the amount thus determined will be deducted from payments for the work.

105.04 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS. These specifications, the supplemental specifications, the plans, special provisions and supplementary documents are essential parts of the contract and 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, calculated dimensions will govern over scaled dimensions; plans will govern over standard specifications or supplemental specifications; supplemental specifications will govern over standard specifications; special provisions will govern over standard specifications, supplemental specifications and plans.

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 will be supplied without charge a maximum of 5 sets of approved plans and contract assemblies. Reduced size plans will be furnished unless full scale

plans are requested. The contractor shall keep 1 complete set of plans and contract documents available on the work at all times.

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

The contractor shall have on the work at all times, as his agent, a competent superintendent capable of reading and understanding the plans and project specifications and experienced in the type of work being performed, who shall receive instructions from the engineer. The superintendent 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 superintendent shall be furnished regardless of the amount of work sublet.

The contractor shall certify to the engineer, by written notice, the names of persons authorized to sign for him in matters pertaining to plan changes, force account or extra work, contract time charges and other fiscal 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 utility companies, pipeline owners or other parties affected and endeavor to have all 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, 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 are to be relocated or adjusted by the owners through negotiations with the Department at no expense to the contractor.

Where a utility crosses or otherwise occupies an area within the 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 at no expense to the contractor. If the required clearance will exist when the work is completed, but relocation is considered necessary by the contractor for construction purposes, the contractor shall, at his own expense, make arrangements with the owner for any relocation

or adjustment necessary to his operations. In such cases, upon completion of the work and prior to final acceptance, the final location of the utility must 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 his bid all permanent and temporary utility appurtenances in their present or relocated positions and that no additional compensation will be allowed for delays, inconvenience or damage sustained by him due to interference from the said utility appurtenances or the operation of moving them.

In general, the contract will indicate utility items to be relocated, adjusted or constructed by the contractor. The project specifications will indicate the means of adjudication, if any, in case of failure by the utility owner to comply with their responsibility in relocating or adjusting their facilities.

If 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 credits will be considered for such delays.

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 officials of utility companies to avoid delays in completion of work due to nonremoval or nonadjustment of utilities.

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 the limits of one project, each contractor shall conduct his work so as not to hinder progress of the work being performed by other contractors and shall cooperate with each other as directed.

Each contractor shall assume all liability, financial or otherwise, in connection with his contract and shall indemnify the Department from all damages or claims that arise because of inconvenience, delay or loss experienced by him due to the presence and operations of other contractors working within the limits of the project.

The contractor shall arrange his work and shall place and dispose of materials being used so as not to interfere with the operations of other contractors within the limits of the project. He shall join his work with that

Stamping of products by Department representatives at the mill, the shop or in the field shall not preclude further testing and inspection if there is reason to believe material or workmanship does not conform to the contract.

Defective materials and workmanship, wherever discovered, will be rejected and shall be repaired or replaced at no cost to the Department. All repair procedures must be approved by the Department.

(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 at its discretion allow inspection to be performed at the project site. This inspection will be performed by the shop inspector or other representatives of the Department at the contractor's expense.

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

Unacceptable work, whether the result of poor workmanship, defective materials, damage through carelessness or other cause, found to exist prior to final acceptance of the work shall be removed and replaced in an acceptable manner.

No work shall be done without lines and grades having been given by the engineer. Work done contrary to instructions of the engineer, work done beyond lines shown on the plans, or as given, except as herein specified, or extra work done without authority will be considered as unauthorized and will not be paid for. 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 and his subcontractors and suppliers shall comply with all legal load restrictions in hauling of materials or equipment on completed bridge structures, bases and pavements within the project limits. A special permit will not relieve the contractor of liability for damage resulting from moving of material or

equipment. In no case shall the legal load limits be exceeded unless permitted in writing.

Operation of equipment on the project of such weight or height or so loaded as to cause damage or overstress to structures, roadways or other construction will not be permitted. Hauling of materials over the base or surface course under construction shall be limited as directed. The contractor shall be responsible for all damage done by his hauling equipment.

The Department's Engineering Directives and Standards Manual EDSM No. III.1.1.12, entitled Enforcement of Legal Load Requirements on Construction and Maintenance Construction Projects, and EDSM No. I.1.1.8., entitled Establishment of Uniform, Regulatory, and Advisory Truck Weight Limits for Structurally Deficient Highway Bridges Located on Public Roads, will be used as the policy for enforcement of maximum load requirements on construction projects for all deliveries of materials.

105.15 MAINTENANCE DURING CONSTRUCTION. The contractor, beginning with the effective date of the Notice to Proceed, shall maintain the work during construction and until the project is accepted. This maintenance shall constitute continuous and effective work prosecuted daily with adequate equipment and forces to keep the roadway or structures in satisfactory condition at all times.

In the case of a contract for placing a course on a previously constructed course or subgrade, the contractor shall maintain the previous course or subgrade during all construction operations.

105.16 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE. If the contractor fails to comply with the provisions of Subsections 104.03 and 105.15, the engineer will immediately notify the contractor in writing of such non-compliance. If the contractor fails to remedy the condition within 24 hours after receipt of the written notice, the engineer may immediately remedy the condition, and the cost thereof will be deducted from payments for the work.

If the condition requires more immediate remedy due to hazard to life, health and property of the public, the engineer may declare an emergency and immediately remedy the condition and the costs thereof will be deducted from payments for the work.

105.17 ACCEPTANCE.

(a) Partial Acceptance: If the contractor satisfactorily completes a portion of the project, such as a structure, interchange or section of road or pavement that can be used advantageously for traffic, he may request the engineer to make final inspection of that portion. If the engineer finds upon inspection that the portion has been completed in compliance

with the contract, he 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. If partial acceptance is made, the terms of the acceptance, including the responsibilities of all parties and any allowance of additional contract time, shall be set forth in a plan change, mutually agreed to by the engineer and the contractor, with concurrence of any unit of government, political subdivision or corporation, including the contractor's surety, having monetary interest in the work. Such partial acceptance shall not void or alter any terms of the contract, except as set forth in the plan change.

(b) Final Acceptance: Upon notice from the contractor of presumptive completion of the entire project, the engineer will make an inspection. If all construction provided for in the contract is found completed to his satisfaction, that inspection shall constitute the final inspection and the engineer will make final acceptance and notify the contractor in writing of this acceptance as of the date of final inspection.

If the inspection discloses any work as being unsatisfactory, the engineer will give the contractor instructions for correction of same, and the contractor shall immediately comply with such instructions. Upon correction of the work, another inspection will be made which shall 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 ADJUSTMENT AND DISPUTES. If the contractor deems that additional compensation is due him for work or material not clearly covered in the contract or not ordered by the engineer as extra work, as defined herein, the contractor shall notify the engineer in writing of his intention to make claim for such additional compensation before he begins the work on which he bases the claim. If such notification is not given and the engineer is not afforded proper facilities by the contractor for keeping account of actual cost, the contractor agrees to waive any claim for such additional compensation. Such notice by the contractor and the fact that the engineer has kept account of the cost as aforesaid shall not be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the engineer, is found to be just, it will be paid for as extra work. Nothing in this Subsection shall be construed as establishing any claim contrary to the terms of Subsection 104.02.

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. At the option of the engineer, 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 on the plans and described in the project specifications. The quality of material in such deposits will be acceptable in general, but the contractor shall determine for himself 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 prior to incorporation in the work.

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

(b) Contractor Furnished Sources: If the contractor desires to use material from sources other than those designated, he 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 an increase in length of haul. All costs of exploring and developing such other sources shall be borne by the contractor. Use of material from other than designated sources will not be permitted until representa-

tive samples taken by the engineer have been approved and written authority is issued for the use thereof.

(c) **Use of Materials Found on the Work:** The contractor, with written approval of the engineer, may use on the project stone, gravel, sand, topsoil or other material determined acceptable by the engineer found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. The contractor shall replace at his own expense with acceptable material all removed material which was needed for embankments, backfills, approaches or otherwise. No charge for the 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 grading 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 replacement when replacement is required.

Materials from existing structures may be used temporarily by the contractor in erection of new structures. Modification of such material will not be permitted except with approval of the engineer.

(d) When material deposits are not designated in the project specifications, the contractor shall provide sources of material acceptable to the engineer. When sources of materials or material deposits are provided by the contractor, the Department may assume the cost of processing samples to determine suitability of material.

Sites from which material has been removed shall, upon completion of the work, be left in an acceptable condition.

Unless otherwise authorized by the engineer in writing, borrow pits, gravel pits and quarry sites shall be located at least 300 feet from the right-of-way.

When sources of material or material deposits 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, gravel pits, quarry sites and stockpiled materials shall be located at least 300 feet from the natural bank of the stream.

106.03 SAMPLES, TESTS, CITED SPECIFICATIONS. Materials must be inspected, tested and approved by the engineer before incorporation in the work. Work in which untested and unapproved materials are used shall be performed at the contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed, shall be removed at the contractor's expense. Sampling and testing will be performed in accordance with the cited standard method of the Department's

Materials Sampling Manual and Testing Procedures Manual; if not contained therein, by the 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. Sampling and testing procedures not contained as above shall be as determined by the engineer. All procedures will be the most recent cited which are current on the date of the advertisement for bids. Acceptance testing will be made by and at the expense of the Department. Samples will be taken by a qualified representative of the Department. Materials being used will be subject to inspection, test or rejection at any time prior to or during incorporation into the work. Copies of all test reports will be furnished to the contractor's representative upon request.

106.04 CERTIFICATES OF COMPLIANCE. A certificate of compliance shall be furnished prior to use of materials for which such certificate is required. The certificate shall be signed by the material manufacturer, the manufacturer of assembled materials or the material supplier and shall state that the materials involved comply with specifications. A certificate of compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the certificate.

Materials used on the basis of a certificate of compliance may be sampled and tested at any time. The fact that material is used on the basis of a certificate of compliance shall not relieve the contractor of responsibility for incorporating material in the work which conforms to the plans and specifications. Any such material not conforming to requirements will be subject to rejection.

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

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

106.05 PLANT INSPECTION. The engineer may inspect materials at the source. The Department reserves the right to retest all materials, prior to incorporation into the work, which have been tested and accepted at the source of supply after they have been delivered and to reject all materials which, when retested, do not meet specifications. If 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 he 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.

(c) If required by the engineer, the contractor shall arrange for an approved building for the use of the inspector, such building to be located conveniently near the plant, independent of any building used by the material producer and conforming to Section 722.

(d) Adequate safety measures shall be provided and maintained.

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

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

The contractor shall, at no cost to the Department, arrange for any required testing which the Department is not equipped to perform. All 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 shall be attached to the certificate of compliance for those materials for which certificates of analysis are required and 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 to assure delivery of uniform material in conformance with contract requirements.

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

No structural materials will be accepted which cannot be properly identified with certificates of analysis and certificates of compliance.

106.08 STORAGE OF MATERIALS. Materials shall be so stored as 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 so as to facilitate their prompt inspection. Approved portions of the right-of-way may be used for storage purposes and for placing the contractor's plant and equipment, but any additional space required must be provided by the contractor at his expense. Private property shall not be used for storage purposes without written permission of the owner and lessee and, if re-

quested by the engineer, copies of such written permission shall be furnished him. All storage sites shall be restored to their original condition or to the satisfaction of the owner or lessee by the contractor at his expense. This shall not apply to storing of topsoil or to other material salvaged from the work.

106.09 HANDLING MATERIALS. Materials shall be handled in such manner as to preserve their quality and fitness for the work. Materials shall be transported from storage site to the work in tight vehicles so constructed as 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.

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

106.11 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 all 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 all material delivered to him and deductions will be made from payments for the work to make good any shortages and deficiencies from any cause and 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 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. He shall at all times comply with such laws, bylaws, ordinances, codes, regulations, orders and decrees; and 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 himself or his employees.

Soil and any soil-moving equipment operating in regulated areas will be subject to plant quarantine regulations. In general, 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.

107.02 PERMITS, LICENSES AND TAXES. The contractor shall procure all permits and licenses, pay all charges, fees, and taxes and give all notices necessary to due and lawful prosecution of the work.

107.03 PATENTED DEVICES, MATERIALS AND PROCESSES. If the contractor employs any unspecified design, device, material or process covered by letters of patent or copyright, he shall provide for such use by legal agreement with the patentee or owner. The contractor and surety shall indemnify the State, any affected third party or political subdivision from all claims for infringement by reason of the use of any such patented unspecified design, device, material or process, or any trademark or copyright and shall indemnify the State for any costs, expenses and damages which it may be obliged to pay by reason of any infringement during prosecution or after completion of the work.

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 shall not be entitled to damages either for digging up of the highway or delays occasioned thereby.

When an individual, firm or corporation is authorized through an executed permit from the Department, the contractor shall allow parties bearing such permits, and only those parties, to make openings in the highway. The contractor shall, when ordered by the engineer, make in an acceptable manner all necessary repairs due to such openings and such necessary work will be paid for 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 and 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 the contract amount is $500,000 or more, 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 final inspection is requested for the project. In no case will the final estimate be paid until this form has been submitted to the FHWA and accepted by them.

107.06 SANITARY, HEALTH AND SAFETY PROVISIONS. The contractor shall provide and maintain in a neat, sanitary condition such accommodations for use of his employees as necessary to comply with requirements of the State and local Boards of Health or other bodies or tribunals having jurisdiction.

Attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. The contractor shall not require any worker to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his health or safety.

Disposal of sewage shall be as approved by the appropriate health agency.

107.07 PUBLIC CONVENIENCE AND SAFETY. The contractor shall so conduct his work as to assure the least possible obstruction to traffic.

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 the road in safety. Safety and convenience of the general public and the residents along the highway, and protection of persons and property, shall be a primary responsibility of the contractor.

If the contractor works at night, adequate artificial lighting, signs, flagmen or other traffic controls shall be provided to protect workmen, the work and the traveling public. When such work affects traffic safety, the contractor shall submit to the engineer for his 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 the engineer requires. 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. All costs of providing or making changes in the lighting, signs, flagmen or other traffic controls shall be the responsibility of the contractor.

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 he expects 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 site of the project and so as to clear Railway's tracks and facilities of men, equipment and obstructions to permit free flow of railway traffic. The contractor shall perform all 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 use the utmost care in protecting the Railway's property and in avoiding accidents. The contractor shall at all times keep the Railway's track and roadbed free of earth, rock, construction materials, debris and obstructions in any manner deposited during the progress of the work.

The contractor shall immobilize all his equipment parked near the Railway's track, if such equipment is unattended by watchmen, 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, and the decision of the Railway's representative as to procedures which may affect the safety of railway operation shall be final and the contractor must 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 any work for protection of its property, the required materials, labor and equipment shall be furnished by the Railway, and the contractor shall reimburse the Railway for costs incurred.

(f) If the contractor desires access across the Railway's right-of-way and tracks at any location not being 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, and agree to 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 except 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 of the project.

(g) Any engineering, inspection, flagging protection and watchmen 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 on the basis of the Railway's bills, to be rendered monthly. The contractor must include in his bid sufficient money to cover the cost of such protection.

Wage rates quoted to or used by the contractor in preparing his bid are subject to change at any time by law or by agreement between the Railway and its employees, and may be retroactive as a result of negotiations or a ruling of an authorized Governmental Agency. Additional charges on labor are also subject to change. If wage rates or additional charges are changed, the contractor shall pay on the basis of the new rates and new charges.

In order that the Railway may be prepared to furnish protective services, the contractor shall notify the Railway 72 hours in advance of when protection 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 same before final settlement.

(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 his 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 to the engineer 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, 4 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 any work on Railway right-of-way, the shop drawings and details, with supporting data and documents, must be approved by the Railway.

(k) The contractor shall notify the Railway's representative in writing not less than 1 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 must be maintained at all times during construction operations:

Vertical:	22′-6″ above top of highest rail
Horizontal:	10′-0″ from centerline of the nearest track measured at right angles thereto

If lesser clearances than the above 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″ from the centerline of any railway track, measured at right angles thereto, or 22′-6″ vertically from top of rail.

(n) The contractor shall provide, in addition to any other form of insurance or bond required, 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 so written as to furnish protection to the contractor respecting the 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 the operations in connection with construction of highway projects located wholly or partly within railroad right-of-way.

(2) Where a contractor sublets a part of the work on any project to a subcontractor, the contractor shall be required to secure insurance protection in his own behalf under Contractor's Public Liability and Property Damage Insurance policies to cover any liability imposed on him by law for damages because of 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 his own behalf to cover his 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 Volume 6, Chapter 6, Section 2, Subsection 2 of the Federal-Aid Highway Program Manual (FHPM 6.6.2.2.) 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—
$5,000,000 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—
$5,000,000 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 Policy and all insurance certificates must be approved by the Railway before any work may be started on the Railway's property by the contractor or his subcontractors. In addition, the contractor shall furnish an evidence of commitment by the insurance company to notify the Railway and the Department in writing of any material change, expiration or cancellation of the policy not less than 30 days before such change, expiration or cancellation is effective.

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

(o) Upon completion of the work, the contractor shall within 10 days remove from within the limits of 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 and satisfactory to the Railway's representative.

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

All work or operations performed by the contractor for or on account of the Railway during highway construction operations under the contract, or by the Railway in constructing and maintaining the temporary or other grade crossing for the contractor's use during highway construction, or by the Railway in furnishing flagmen or other protection in accordance with agreement between the contractor and the Railway, or for cleaning up and restoring the Railway's premises as required above, or for work contained in the contract shall be included in contract prices on 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.

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 be responsible for compliance with all provisions and conditions of the permit.

The contractor shall prepare reproducible drawings complying with the standards of the U. S. Coast Guard and the 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 x 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, erection or operation of construction equipment within the navigable limits shall not be commenced until drawings are approved.

The contractor shall display lights on his equipment operating, berthed or moored in navigable streams, and provide temporary navigational lighting on all 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, plant machinery or equipment which may be dangerous to navigation, he shall immediately remove or recover such obstruction. 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 waterway 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, and any deviations therefrom shall be only by special permission or special permit which are the responsibility of the contractor. Failure of the contractor to familiarize himself with all terms, conditions and provisions of the permits, rules and regulations applicable to the work shall not relieve him of his responsibility under the contract.

The contractor shall conduct his operations in such manner as 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 all Department obtained permits are available in the Department's Bridge Design Section. Copies of any special permits obtained by the contractor must be submitted immediately to the Bridge Design Engineer.

107.10 BARRICADES AND WARNING SIGNS. The contractor shall provide, erect and maintain all necessary barricades, suitable lights, danger signals, signs and other traffic control devices 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 and obstructions shall be illuminated during hours of darkness. Suitable warning signs shall be provided to direct traffic.

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

existing road. Such warning signs shall be placed and maintained in accordance with the plans.

Barricades, warning signs, lights, temporary signals and other protective devices shall conform with the MUTCD.

Unless a pay item for "Temporary Signs and Barricades" is provided in the contract, all materials furnished and work performed as provided by this Subsection shall be considered as subsidiary and the costs thereof shall be included in the various bid items of the contract.

107.11 USE OF EXPLOSIVES. When the use of explosives is deemed necessary for prosecution of the work, and when approved, the contractor shall exercise the utmost care not to endanger life or property, including new work. Their use 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 stored in a secure manner, in compliance with all laws and ordinances, and such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the engineer not closer than 1,000 feet from any road, building or place of human occupancy.

The contractor shall notify in writing each public utility company, having facilities in proximity to the site of work, of his intention to use explosives and such notices shall be given sufficiently in advance to enable them to take necessary steps to protect their property from damage.

107.12 PRESERVATION OF PROPERTY, LANDSCAPE AND SURVEY MONUMENTS. 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 resetting any such survey monuments, the contractor shall give sufficient advance notice in writing to the appropriate agency responsible for the monument and to the engineer of his intention to perform the work in order that such agency may have a representative present if it so desires. The contractor shall not disturb or move any such monument without approval. The engineer will designate the location and manner in which these monuments are to be reset.

The contractor shall be responsible for all damage to property during prosecution of the work resulting from any negligent act, omission or misconduct in executing the work, or due to defective work or materials, and said responsibility will not end until final acceptance of the project.

If any damage is done to public or private property by or on account of any negligent act, omission or misconduct in execution of the work, or in consequence of nonexecution thereof by the contractor, he shall restore, at his own expense, such property to a condition similar or equal to that existing before such damage was done, by repairing, rebuilding or otherwise restoring as directed, or make 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 State Fire Marshal, Conservation Commission, Forestry Department or other authority having jurisdiction governing protection of forests and performance of work within forests, and shall observe all sanitary laws and regulations with respect to performance of work in forest areas. He shall keep the areas in an orderly condition, dispose of all refuse, 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 his 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 PREVENTION OF SOIL EROSION AND WATER POLLUTION. The contractor shall exercise planning and forethought in coordinating the work of protecting the project and adjoining properties from soil erosion and siltation by effective and continuous erosion control methods of either a temporary or permanent nature. The area of bare soil exposed by construction operations shall be kept to a minimum.

Special attention is directed to Subsection 107.15 and Section 204.

107.15 ENVIRONMENTAL PROTECTION. The contractor shall comply with all Federal, State and local laws and regulations controlling pollution of the environment, including air, water and noise. He shall take necessary 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 Subsection 107.14 and Section 204 concerning temporary erosion control.

Attention is further directed to the Louisiana Air Control Commission and local air pollution control programs within the State and their rules and regulations regarding air pollution, especially open burning, fugitive dust and asphaltic concrete plant restrictions.

107.16 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 drawings, 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. All 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 familiarize himself with all applicable rules and regulations of the FAA will not relieve the contractor of his responsibility under the contract.

107.17 HAZARD ZONES. If any portion of the work is determined to be within a hazard zone because of aerial navigation, a high voltage powerline which is to remain or other permanent facility deemed to constitute a similar hazard in performance of the work, 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 with the agency concerned for any adjustments relative to his work in the area. Any liability or expense of these arrangements shall be borne by the contractor.

The contractor shall obtain and submit to the Department, a release signed by the agency involved stating that the contractor has satisfactorily discharged his obligations under terms of the arrangements. This shall be noted on the Department's Standard Release form and submitted, with required signatures, to the engineer.

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 of performing the work in accordance with the project requirements at contract unit prices.

107.18 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 on account of operations of the contractor; or on account of negligence in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any negligent act, omission or misconduct of the contractor; or because of 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; and so much of the money due the contractor under his contract as considered necessary by the Department for such purpose, may be retained for use of the State; or, in case no money is due,

his 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 he is adequately protected by public liability and property damage insurance, including railroad protective liability insurance in accordance with Subsection 107.08.

107.19 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, and may be required due to conditions or events unforeseen at the time of the contract. Such openings necessary due to the foregoing conditions shall be made when so ordered. Such openings shall not constitute acceptance of the work or a part thereof for 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, whether specified in the contract or not, 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 by the engineer to be opened for traffic, in the case of unforeseen necessity which is not the fault of the contractor, compensation for additional expense to the contractor and allowance of additional time for completion of other items of work on the opened portions of the project shall be as set forth in a plan change mutually agreed on by the engineer and the contractor.

If the contractor is dilatory in completing shoulders, drainage structures or other features of the work, the engineer may so notify him in writing and establish therein a reasonable period of time in which the work should be completed. If the contractor fails to make a reasonable effort toward completion in this period of time, 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 his construction operations so as 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 contractor's operations or unforeseen necessity, any damage to the highway not attributable to traffic which occurs on such section (except slides) shall be repaired by the contractor at his expense. Removal of slides shall be done by the contractor on a basis agreed to prior to removal of such slides.

107.20 CONTRACTOR'S RESPONSIBILITY FOR WORK. Until final acceptance of the project, the contractor shall have the charge and care thereof and shall take every precaution against damage to any part thereof by action of the elements or from any other cause, whether arising from execution or nonexecution of the work. The contractor shall rebuild, repair, restore or make good all damages to any portion of the work before final acceptance and shall bear the expense thereof, except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the contractor, including but not restricted to acts of God, the public enemy or governmental authorities.

In case of suspension of work from any cause, the contractor shall be responsible for the project and shall take such precautions as necessary to prevent damage to the project, provide for normal drainage and erect any necessary temporary structures, signs or other facilities at his expense. During such period of suspension, the contractor shall maintain in an acceptable condition 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.

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

The contractor shall cooperate with owners of underground or overhead 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 to utility services as a result of 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.

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

107.23 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, Assistant 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.

107.24 NO WAIVER OF LEGAL RIGHTS. Upon completion of the work, the Department will expeditiously make final inspection and notify the contractor of acceptance. 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 his surety, or both, such overpayment as it may sustain, or by failure by the contractor to fulfill his obligations under the contract. A waiver by the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

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

107.25 THIRD PARTY LIABILITY. Is 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.

107.26 ANTITRUST 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 antitrust laws, relating to the goods or services purchased by the Department pursuant to the contract.

107.27 CONTRACTOR'S PAYROLLS. On projects not involving Federal funds, all payrolls of the contractor and all subcontractors shall be retained in the contractor's field office until final acceptance of the contract. Such payrolls shall be made available to the engineer for inspection during the life of the contract and during normal working hours. If the contractor does not have a field office on the project, such payrolls shall be made available for inspection on the project upon request of the engineer. Refusal of the contractor to permit the engineer or his authorized representative free access to the contractor's or subcontractor's payrolls will be cause for suspension or withholding of payments to the contractor for the work. 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.

107.28 ARCHAEOLOGICAL AND HISTORICAL FINDINGS. If the contractor encounters, during his operations, 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 any necessary actions relative to the site. When directed, the contractor shall excavate the site in such manner as to preserve the artifacts encountered. Such excavation will be measured and paid for as extra work, including an appropriate adjustment in contract time. All 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 without written consent of the engineer. If such consent is given, the contractor will be permitted to sublet a portion of the work, but shall perform with his 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 cost before computing the amount of work required to be performed by the contractor with his own organization. No subcontract shall relieve the contractor of his liability under the contract and bonds.

An approved subcontractor shall not subcontract any portion of this authorized work.

108.02 NOTICE TO PROCEED. The "Notice to Proceed" will stipulate the date on which the contractor shall begin construction, which date shall be the beginning of contract time charges.

108.03 CONSTRUCTION PROGRESS SCHEDULE. Prior to issuance of the Notice to Proceed, the contractor shall submit to the Department 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 a prescribed bar graph form and submitted to the Project Control Section for approval by the Construction Section. When the Notice to Proceed is issued, a copy of the approved schedule will be returned to the contractor. The contractor shall have copies of the approved schedule available at the preconstruction conference.

If the contractor's operations are materially affected by changes in the plans or amount of work, or if he has failed to comply with the approved schedule, the contractor shall submit a revised Construction Progress Schedule. If requested by the engineer, this schedule shall show how he proposes to prosecute the balance of the work. In this case, the contractor shall submit the revised schedule within 10 days after the date of request. The schedule may be revised upon request of either party, but before a

revision requested by the contractor will apply, it must be approved by the engineer.

The approved Construction Progress Schedule will be used as the basis of establishing the controlling items of work, assessing contract time and as a check on progress of the work.

108.04 PROSECUTION OF WORK.

(a) General: The contractor shall provide sufficient materials, equipment and labor to guarantee completion of the project in accordance with the plans and specifications within the contract time limit. If the completed work is behind the approved progress schedule, the contractor shall take immediate steps to restore satisfactory progress. Each item of construction shall be prosecuted to completion without delay and the contractor shall not transfer his equipment or forces from uncompleted construction without prior notice to, and approval of, the engineer. 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, he will be notified that he will be subject to disqualification if his progress becomes delinquent by more than the percentages specified hereinafter, and such additional notification will be made as the engineer deems 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 his progress on the contract 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 his progress on the contract 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 his progress on the contract 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 will he be approved as a subcontractor on contracts. The period of disqualification will continue until the completed work on the contract is not delinquent by more than 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 Department Disqualification Review Board. The written appeal must be submitted within 10 days after disqualification and may either request (1) a meeting with the review board or (2) that the review board consider a written appeal only. A meeting of the review board will be scheduled within 10 days after receipt of appeal.

The review board will be composed of the Secretary, Assistant Secretary and Chief Engineer of the Office of Highways and one DOTD senior official to be appointed by the Secretary.

The decision of the review board will be given to the contractor in writing 10 days after all pertinent information has been considered. The decision of the review board will not operate as a waiver by the Department of its rights concerning the assessment of liquidated damages as specified under Subsection 108.08.

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

108.06 WORKMEN, METHODS AND EQUIPMENT. The contractor shall employ sufficient labor and equipment for prosecuting the work to completion in the manner and time required by these specifications.

Workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the contractor or any subcontractor who, in the opinion of the engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, upon written request of the engineer, be immediately removed by the contractor or subcontractor employing such person, and such person shall not again be employed in any portion of the work without approval of the engineer. If the contractor fails to remove such a person or fails to furnish suitable and sufficient personnel for proper prosecution of the work, the engineer may suspend the work by written notice until such orders are complied with.

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 pro-

duce a satisfactory quality of work. Equipment shall be such that no damage to the roadway, adjacent property or other highways will result from its use.

When methods and equipment to be used by the contractor in accomplishing the construction are not specified, the contractor may use any methods or equipment that will accomplish the work in conformity with the contract.

If the contractor desires to use a method or type of equipment other than specified in the contract, he may request authority from the engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and the reasons for desiring to make 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 basis of payment for construction 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, and will be known as the "Contract Time".

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 10 days in which to file a written protest setting forth in what respect said monthly statement is incorrect; otherwise, the statement shall be deemed to have been accepted by the contractor as correct.

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 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 legal action.

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, including Saturdays, Sundays, holidays and non-work days. All calendar days elapsing between the effective

dates of written orders by the engineer to suspend work and to resume work for suspensions not the fault of the contractor will be excluded.

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 the time necessary 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 set forth in the proposal, or requires performance of extra work, the contract time will be increased on a basis commensurate with the following:

(a) **Mathematical Increase:** Upon completion and acceptance of the project, the original contract time will be adjusted proportionally to the amount of the final estimate divided by the original contract amount, except that, in the case of total project cost underrun, the original contract time will not be decreased.

(b) **Increase for Difficulty:** When the contract is altered in accordance with Subsection 104.02 and the contractor requests additional contract days, the document authorizing or ordering alterations will show (1) the number of additional days justified, (2) the number of days added by anticipated overrun in costs (if any) due to alterations and (3) the difference between these two numbers. The difference between the two numbers will be added to the contract time.

If the contractor finds it impossible, for reasons beyond his control, to complete the work within the contract time as specified or as extended in accordance with the provisions of this Subsection, he may, at any time prior to the expiration of the contract time as extended, make written request to the engineer for an extension of time setting forth therein the reasons which he believes justify granting his request. 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, he may extend the contract time in such amount as conditions justify.

When final acceptance has been made by the engineer as prescribed in Subsection 105.17, daily time charges will cease.

108.08 FAILURE TO COMPLETE ON TIME. For each calendar day or working day, as specified, that any work remains uncompleted after expiration of the contract time as extended, the sum specified below will be deducted from payments due the contractor not as a penalty but as liquidated damages.

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

The Department may waive such portions of the liquidated damages that accrue after the work is in condition for safe and convenient use by the traveling public.

Based on the amount of the original contract, the following charges will be made for each contract day after expiration of the contract time as extended.

When the contract time is on a calendar day or fixed calendar date basis, the schedule for calendar days will be used. When the contract time is on a working day basis, the schedule for working days will be used.

ORIGINAL CONTRACT AMOUNT (Dollars)		DAILY CHARGE (Dollars)	
From More Than	To and Including	Calendar Day or Fixed Date	Working Day
0	25,000	45	63
25,000	50,000	75	105
50,000	100,000	110	154
100,000	500,000	150	210
500,000	1,000,000	225	315
1,000,000	2,000,000	300	420
2,000,000	5,000,000	450	630
5,000,000	10,000,000	600	840
10,000,000	- - -	700	980

The amount of liquidated damages will be deducted from payments due the contractor under the contract or any other active contract the contractor has with the Department, and the contractor and his surety shall be liable for liquidated damages in excess of amounts due the contractor.

108.09 DEFAULT AND TERMINATION OF CONTRACT. The engineer will give written notice to the contractor and his surety that the contractor may be placed in default if he:

(a) Fails to begin the work within the time specified in the "Notice to Proceed," or

(b) Fails to perform the work with sufficient workmen, equipment or materials to assure prompt completion of said work, or

(c) Performs the work unsuitably or neglects or refuses to remove materials or perform anew rejected work,or

(d) Discontinues prosecution of the work, or

(e) Fails to complete the project within the contract time as extended, or

Section 109
Measurement and Payment

109.01 MEASUREMENT OF QUANTITIES. All work completed under the contract will be measured by the engineer according to United States standard measure.

The engineer shall be the judge of the accuracy of any measurements, or approximations made in lieu of accurate determinations, and his 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 cubic yard (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 by the engineer.

A station, when used as a definition or term of measurement, will be 100 linear feet.

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

Items which are measured by the linear foot, 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.

The 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.

The term ton will mean the short ton consisting of 2,000 pounds avoirdupois. Materials which are 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 for by 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 size or type acceptable to the engineer, provided the vehicle 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 or capacity, upon arrival at the point of delivery. Vehicles will be measured in increments of 0.5 cubic yard in accordance with Department procedures; except that when tail-gate 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 and converted to volume for payment, conversion will be made to the nearest 0.1 cubic yard.

Asphaltic materials will be measured by the gallon or by the ton. When specified, volumes of liquid asphaltic materials will be converted to the gallonage at 60°F in accordance with Section 509.

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 sack (or bag) of 94 pounds or hundredweight (CWT).

Timber will be measured by the thousand feet board measure (MFBM) incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

The term lump sum when used as an item of 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 will be construed to include all necessary fittings and accessories. Rental of equipment will be measured by the time in hours of actual working time and necessary traveling time of the equip-

ment within the limits of the project unless special equipment has been ordered by the engineer in connection with force account work in which case travel time and transportation to the project will be measured. If equipment has been ordered held on the job on a standby basis by the engineer, halftime rates for the equipment will be paid.

When standard manufactured items are specified, such as fence, wire, plates, rolled shapes, pipe conduit, etc., 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.

If 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 Designation: R1 will be used.

109.02 SCOPE OF PAYMENT. The contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials and for performing all work under the contract in an acceptable manner and for all risk, loss, damage or expense arising out of the nature or prosecution of the work subject to the provisions of Subsection 107.24.

If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule requires that the said unit price be considered compensation for certain work or material essential to the item, such work or material will not be measured or paid for 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 any other reason from the quantities in the bid schedule, the contractor shall accept as payment in full, payment at the original 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 contract items of overhead expense on the part of the contractor 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 materially affect the methods or sequence of construction, an allowance will be made, either for or against the contractor, in such amount and basis as agreed to in advance of the performance of the work. The plan change 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 quantity stated in the contract 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, and when the supplemental agreement is executed, the consent of the contractor's surety shall be obtained.

Any adjustment in unit price will be made on only that portion of the major item that exceeds the 25 percent increase or decrease, and such adjustment will be made based on the actual costs to perform that portion of the work in excess of the 25 percent increase or decrease and 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 "Major Item" is defined as an item included in the contract as awarded that has a total cost equal to or greater than 10 percent of the original total contract amount.

A "Minor Item" is defined as an item included in the contract as awarded that has 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. When 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 supplemental agreement. The supplemental agreement shall be executed prior to performance of any work in excess of 12.5 percent of the contract quantity, and the requirements of the supplemental agreement shall be as described above for increases in major items.

109.04 COMPENSATION FOR ALTERATIONS OF THE CONTRACT. Work performed in accordance with Subsection 104.02 will be paid for at the unit prices or agreed prices stipulated in the plan change authorizing the work or the Department may require the contractor to do such work on a force account basis, except that compensation for altered quantities shall be in accordance with Subsection 109.03.

When the method of payment for such work is unit prices or agreed prices, the plan change authorizing the work shall show how the unit prices or agreed prices were derived. Except when otherwise authorized by the Chief Engineer, the derivation of costs shall show, as a minimum, breakdowns for labor, bond-insurance-and-tax, materials, and equipment

as detailed below in Headings (a) through (g), except that projected costs rather than actual costs will be used.

When the Department requires the contractor to do such work on a force account basis, the contractor will be compensated as follows:

(a) **Labor:** For labor and working foremen in direct charge of operations, the contractor shall receive the wage rates agreed upon in writing before beginning work for each hour that said labor and foremen are engaged in such work.

The contractor shall receive the actual costs paid to, or in behalf of, workmen 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 generally applicable to the classes of labor employed on the work, but limited to a maximum daily rate for subsistence and travel allowances, which maximum will be agreed upon prior to incurring such charges.

An amount equal to 20 percent of the sum of the above items will also be paid the contractor.

(b) **Bond, Insurance and Tax:** For property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on force account work, the contractor shall receive the actual cost thereof, to which 6 percent will be added. The contractor shall furnish satisfactory evidence of the rates paid for such bond, insurance and tax.

(c) **Materials:** For materials accepted by the engineer and used, the contractor shall receive the actual cost of such materials delivered on the work including transportation charges paid by him (exclusive of machinery rentals), to which 15 percent will be added.

(d) **Equipment:** For machinery or special equipment (other than small tools) including fuel, lubricants and transportation costs, the use of which has been authorized by the engineer, the contractor shall receive the rental rates agreed upon in writing before such work is begun for the actual time such equipment is in operation on the work.

(e) **Miscellaneous:** No additional allowance will be made for general superintendence, the use of small tools or other costs for which no specific allowance is herein provided.

(f) **Compensation:** 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 if required by the engineer. Should any work be performed by an approved subcontractor, the contractor will be paid the actual and reasonable cost of such

subcontracted work computed as outlined above, plus an additional allowance of 10 percent for materials cost and for direct labor cost to cover the contractor's profit, superintendent, administration, insurance and overhead.

(g) Statements: No payment will be made for work performed on a force account basis until the contractor has furnished the engineer with duplicate itemized statements of the cost of such force account 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 and social security tax.

Statements shall be accompanied and supported by invoices for all materials used and all 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. All invoices submitted shall be accompanied by the contractor's notarized statement that payment in full has been made for the materials.

109.05 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 and such action shall not invalidate the contract.

When an item is eliminated, the contractor will be reimbursed for authorized work done towards 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 eliminations or indirectly from unbalanced allocation among the contract items of overhead expense by the contractor and subsequent loss of expected reimbursements therefor or for other reasons.

The plan change authorizing reimbursements shall show how the reimbursements were 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).

109.06 PARTIAL PAYMENTS AND RETAINAGE ESCROW OPTION. Provided work is prosecuted in accordance with provisions of the contract and with satisfactory progress the engineer will make the first progress estimate within 2 calendar 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 proportionate value of the work performed up to the date the estimate is made and will be based on material in place and labor expended thereon, but no more than 95 percent of the total contract price of the work will be paid in advance of final acceptance. In lieu of the retained funds being held by the Department, the contractor has the option of requesting the Department to establish an escrow account in accordance with the provisions of Louisiana Revised Statutes 48:256.1 (Act 661 of 1975). If the contractor desires to have the Department place the retained funds in an escrow account, the Retainage Escrow Option Statement provided in the contract documents must be executed.

The amount of said estimate, after deducting 5 percent and all previous payments, shall be payable to the contractor.

Monthly estimates will be approximate and subject to corrections in the estimate rendered following discovery of any error in any previous estimates.

Should defective work or material be discovered or reasonable doubt arise as to the integrity of any part of the work completed prior to final acceptance and payment, there will be deducted from the first estimate rendered after such discovery an amount equal in value to the defective or questioned work, and this work will not be included in a subsequent estimate until defects have been remedied or causes for doubt removed.

If the contractor is not a corporation, the contractor's Federal Identification Number (if a firm) or Social Security Number (if an individual) shall be furnished to the Department upon request before payments will be made to the contractor for any work under the contract.

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.

109.07 PAYMENT FOR STOCKPILED OR STORED MATERIAL.

(a) General: When approved, advance payments may be made for

fabricated or natural materials that are to be incorporated in the project when such materials are stockpiled or stored on the project or in acceptable facilities outside the limits of the project or within the boundaries of the State of Louisiana. Payments shall be limited to durable materials described herein and must represent a significant portion of the project cost. Perishable articles and small warehouse items are not included. These materials must meet the specifications and 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 may be the invoice price for the materials. 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 and the invoice values will not exceed the appropriate portion of the contract items in which such materials are to be incorporated.

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

Partial payment must be requested by the contractor in writing and the following documents must be furnished before approval can be made:

(1) Written consent from the contractor's surety for the Department to make such partial payment.
(2) A copy of the invoices from supplier or manufacturer verifying the cost and quantity of material.
(3) If storage is on private property, a copy of the lease or agreement granting the Department right of entry to property.

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 a given item and contractor desires a decision by the Chief Engineer prior to bidding, this can be done by written request.

Within 30 days after payment by the Department, the contractor shall submit a copy of certified invoices for each item for which payment has been made and all such invoices submitted shall be accompanied by the contractor's notarized statement that payment in full has been made 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, and the making of advancements therefor by the Department shall not release the contractor from the responsibility for any portion thereof.

(b) **Fabricated Material:** This shall be fabricated or manufactured materials and may include the following:

Structural steel, fabricated structural steel items, steel piling; reinforcing steel, electrical equipment; precast concrete items including piling, girders and bridge sections; structural timber; timber piling, fencing and guard rail materials including posts; fabricated sign structures and sign panels.

(c) **Natural Material:** These materials would normally be large quantities of aggregate. The contractor's request for payment of stockpiled natural material must give a detailed description of the material, its intended use and location of the site. This material must be in approved stockpiles on the project or in the vicinity of the project and must be inspected and approved by the engineer in writing.

109.08 ADJUSTMENT FOR CHANGES IN COMMON CARRIER RATES. It is agreed that the accepted proposal for this project is based on common carrier rates on file with the Interstate Commerce Commission 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 as extended. 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 of his invoices a breakdown showing the freight rate, quantity of material and total freight cost, and the contractor shall furnish the supplier's written quotation made prior to the date of bid opening and shall furnish a notarized statement that he has paid the increased freight rate.

This provision does not apply to any other than shipments by common carrier.

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 days after final acceptance of the project.

109.09 ACCEPTANCE AND FINAL PAYMENT. Upon completion and acceptance of the work, the Chief Engineer will execute a certificate that all work provided for in the contract has been completed and accepted under the terms of the contract and said 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 all retained percentages, 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 days, but shall be prior to the expiration of 90 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 must 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 his 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 persons through the fault, negligence or conduct of the contractor or any of his employees.

PART II

EARTHWORK

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 objects that are designated to remain or to be removed in accordance with other Sections of these specifications.

(a) **Clearing and Grubbing:** This consists of cutting timber, logs, brush, stumps and debris; excavation and removal of all stumps, roots, submerged logs, snags, corduroy and other perishable and objectionable material; and disposing of removed material and cleaning up the area to be cleared. Clearing and grubbing shall be done within the construction limits and to a point in fills 15 feet beyond the toes of foreslopes and in cuts 15 feet 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. If fencing or utility relocation is required, it shall include an area 10 feet wide adjacent to and inside the right-of-way line. It shall also include clearing of fruit trees, shrubbery and flowers within the above limits which are not removed by their owners.

(b) **Selective Clearing and Grubbing:** This consists of selectively clearing areas within the limits of the right-of-way which are not included under "Clearing and Grubbing" of all nonvaluable trees, shrubs, vines, logs, brush, stumps, snags and debris.

201.02 GENERAL CONSTRUCTION REQUIREMENTS. The engineer will establish right-of-way and construction lines and shall designate trees, shrubs, plants and other items to remain. The contractor shall preserve all items designated to remain. Equipment, materials and supplies shall not be stored in proximity of trees designated to remain. Trees shall be felled and removed in such manner as to avoid damage to other items marked to remain. In case of damages to bark, trunks, limbs or roots of vegetation marked to remain, the contractor shall repair such damage without additional compensation, by corrective pruning, bark tracing, wood painting and other acceptable horticultural and tree surgery prac-

tices. Trees falling outside the right-of-way shall be removed. When directed, dead trees outside the limits of clearing and grubbing shall be cleared from the right-of-way.

201.03 CLEARING AND GRUBBING. Trees, stumps, roots and other protruding obstructions not designated to remain shall be cleared and grubbed (including mowing as required); however, undisturbed stumps, roots and nonperishable solid objects which will be a minimum of 2 feet below subgrade or slope of embankments will be permitted to remain provided they do not extend more than 6 inches above the ground line or low water level.

Grubbing with explosives will not be permitted without written permission from the engineer.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled and compacted to the satisfaction of the engineer.

Burning of perishable material shall be under constant care of watchmen and in such manner that anything designated to remain on the right-of-way, the surrounding forest cover or other adjacent property will not be jeopardized.

Burning shall be in accordance with all applicable laws and ordinances and in particular Section 11, entitled "Control of Air Pollution from Outdoor Burning" of the current regulations of the Louisiana Air Control Commission.

Materials and debris which cannot be burned and perishable materials which are not burned shall be removed from the right-of-way and disposed of at locations off the project outside the limits of view of the traveling public. The contractor, at his expense, shall make arrangements with property owners for obtaining suitable disposal locations. Copies of agreements with property owners shall be furnished to the engineer.

Merchantable timber in the clearing area which has not been removed from the right-of-way prior to beginning construction 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. Branches of trees extending over the roadbed shall be trimmed to a height of 20 feet above the pavement surface. Trimming shall be done in accordance with accepted tree surgery practices.

201.04 SELECTIVE CLEARING AND GRUBBING. Areas to be selectively cleared and grubbed shall be cleared of all trees and vegetation, except those selected to remain, and shall be cleared of all stumps, rubbish and other perishable or objectionable matter. The contractor shall notify

the engineer in writing at least 2 weeks in advance of beginning clearing operations.

Any trees found to be dead or dying before final acceptance of the project in areas that have been selectively cleared shall be removed by the contractor at his expense.

201.05 METHOD OF MEASUREMENT. Measurement will be by the lump sum; no measurement of area will be made.

201.06 BASIS OF PAYMENT. When a pay item is included in the contract, clearing and grubbing will be paid for 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 the contract does not contain an item for clearing and grubbing, the work will not be paid for directly.

Payment will be made under:

Item No.	Pay Item	Pay Unit
201(1)	Clearing and Grubbing	Lump Sum
201(2)	Selective Clearing and Grubbing	Lump Sum

Section 202

Removal of Structures and Obstructions

202.01 DESCRIPTION. This work consists of removal and satisfactory disposal of all buildings, septic tanks, fences, culverts, structures, pavements, abandoned pipelines and other obstructions not designated or permitted to remain, except obstructions to be removed under other contract items. It shall also include salvaging of designated materials and backfilling 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.

202.02 GENERAL CONSTRUCTION REQUIREMENTS. The contractor shall remove and dispose of all portions of buildings and foundations, fences and other obstructions on the right-of-way, except utilities and those items for which other provisions have been made for removal. When specified, the contractor shall remove building foundations, slabs and appurtenances that extend beyond the right-of-way or that are entirely on private property. The contractor is cautioned to keep off private property except in these areas. Designated salvageable material shall be removed, without unnecessary damage, in sections which may be readily transported and shall be stacked at specified storage areas by the contractor. If no storage sites are specified, the salvaged materials shall be delivered to the nearest DOTD maintenance unit. Materials not designated to be salvaged shall be disposed of off the project outside the limits of view of the traveling public with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners shall be furnished the engineer. Cavities left by structure removal shall be filled to the level of the surrounding ground and, if within construction limits, shall be compacted as directed.

202.03 REMOVAL OF BRIDGES AND OTHER DRAINAGE STRUCTURES. Bridges and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise directed, substructures shall be removed to natural stream bottom and those parts outside the stream shall be removed to 1

foot 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 carefully dismantled without unnecessary damage. This dismantling shall include stripping all hardware and removing all nails. Steel members shall be match-marked before dismantling. All salvaged material shall be stored or removed as specified in Subsection 202.02.

Blasting (when approved in writing by the engineer) 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 REMOVAL OF PIPE. Pipe to be salvaged shall be carefully removed and precaution taken to avoid damaging the pipe. Pipe to be relaid shall be removed and so stored that there will be no loss or damage before relaying. The contractor shall replace sections lost from storage or damaged by negligence. Pipes not to be relaid and considered usable shall be salvaged, cleaned of soils or other materials, stored or removed and stacked as specified in Subsection 202.02.

202.05 REMOVAL OF PAVEMENT, SIDEWALKS, CURBS, ETC. Concrete pavement, base course, sidewalks, curbs, gutters, etc., designated for removal, shall be disposed of outside the right-of-way and beyond the limits of view of the traveling public in accordance with Subsection 202.02.

202.06 METHOD OF MEASUREMENT. 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. Where the contract stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract.

If the contract does not include pay items for removal of structures and obstructions, the removal work will not be measured for payment.

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

202.07 BASIS OF PAYMENT. Removal of structures and obstructions will be paid for at the contract lump sum price.

Specific obstruction items stipulated for removal or disposal under unit price pay items will be paid for at the contract price per unit specified, which includes removal and disposal of such items, excavation and subsequent backfill incidental to their removal (except for pavements, surfacing

and stabilized base courses). The price shall also include salvage of materials removed, their custody, preservation, storage on the right-of-way and disposal.

Payment will be made under:

Item No.	Pay Item	Pay Unit
202(1)	Removal of Structures and Obstructions	Lump Sum
202(2)	Removal of _____	Each, Linear Foot, Lump Sum, Square Yard

Section 203

Excavation and Embankment

203.01 DESCRIPTION. This work consists of excavation, disposal, placement and compaction of all materials that are not provided for under other Sections of these specifications, including excavation and embankment construction for roadways and other structures, excavation for ditches and channels, and all other grading operations necessary for the work 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.

The plans may include data regarding the boring and classification of existing materials. The Department does not guarantee the accuracy of such information and bidders should make, at their own expense, such additional investigations as they consider necessary. No additional payment will be made for any increased costs due to inaccuracy of soil boring data shown on the plans.

The contractor shall comply with Subsection 107.09 for work in, over or adjacent to navigable waters and wetlands, and shall comply with Subsection 107.28 if cultural artifacts, historical sites or archaeological sites are encountered.

203.02 UNCLASSIFIED EXCAVATION. Unclassified excavation consists of the excavation and disposal of all materials within the right-of-way not otherwise classified.

203.03 DRAINAGE EXCAVATION. Drainage excavation includes all excavation made for the primary purpose of facilitating drainage beyond the limits of the roadway section except for wing ditches at cuts. Drainage excavation also includes inlet and outlet ditches to structures or roadway; 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 MUCK EXCAVATION. Muck excavation consists of the removal of soils and organic matter not usable for foundation material. Muck shall include materials which will decay or produce subsidence in the embankment and may consist of decaying stumps, roots, logs, humus or

other material not satisfactory for use in the embankment. The engineer will determine the material to be classified as muck and all such material shall be wasted.

203.05 BORROW. Borrow is defined as usable soils required for construction of embankments or other portions of the work in excess of usable material available from required excavation and obtained from an approved source. The contractor shall make his own arrangements for obtaining borrow at no additional expense to the Department. Borrow may be required even though not shown on the plans.

Securing of exclusive option by any contractor on borrow areas or materials for the work will be considered a violation of Section 423 of Title 48 of the Louisiana Revised Statutes of 1950 and will be a basis for rejection of bids or such other action the Department deems advisable.

Except as specified in Subsection 203.09, borrow areas resulting in a depression shall be located a minimum distance of 300 feet from the right-of-way. If pits are located closer than 300 feet and are visible from the roadway, they shall be dressed and seeded as directed and screened in accordance with Department requirements at no additional cost to the Department.

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, the borrow pits and any stockpiled materials shall be located at least 300 feet from the natural bank of the stream.

203.06 USABLE SOILS. Usable soil is defined as soil material whose composition is designated satisfactory for use in embankment construction. Moisture content has no bearing upon such determination.

Soil materials, whether from required excavations or borrow excavation, shall have been tested and classified in their original position by the Laboratory before being placed in embankments or other final position on the project; shall be subject to the restrictions for soil materials hereinafter contained; and shall be soils conforming to DOTD Designation: TR 423, Classes A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-3, A-4, A-5, A-6, A-7-5 and/or A-7-6, except that soils in Classes A-5, A-6, A-7-5 and A-7-6 considered unusable by the engineer, and soils with a Plasticity Index exceeding 60, will not be accepted.

Fill material for the upper 8 feet of embankments shall be soil materials with a Plasticity Index not exceeding 35; however, at the contractor's option and at his expense, soils with a Plasticity Index of 36 to 60 may be made usable by the addition of lime conforming to Subsection 1018.03 or other approved additive. If the lime treatment method of soil modification is used, the lime shall be added to the soil in accordance with Section 304

for Type E Treatment at the rate specified in the following table. The PI values will be determined by the Laboratory.

PI Value	Percent Lime by Volume
36 to 45*	4
46 to 60	6

*This soil may be used without lime treatment provided the moisture content at the time of compaction is at least 2 percent over the optimum moisture determined in accordance with DOTD Designation: TR 415.

If Class A-1-b or A-3 materials are used, the contractor shall use on both cut and fill slopes a plastic material of Class A-4, A-6, A-7-5 or A-7-6, with a minimum Plasticity Index of 10 and a Ph between 5.0 and 8.0 that will support adequate vegetation. When required to support vegetation, the plastic soil shall be treated with agricultural lime and/or other materials at the contractor's expense. The compacted thickness of the plastic material shall be at least 12 inches.

When "Selected Soils" are specified, the soil materials furnished shall be soils conforming to DOTD Designation: TR 423 Classes A-1-a, A-1-b, A-3, A-2-4, A-2-6, A-4 or A-6 having a maximum Liquid Limit of 35 and a maximum Plasticity Index of 15.

"Nonplastic Embankment" material shall be as specified in Subsection 203.09.

The contractor shall notify the engineer in writing at least 15 days in advance of borrow operations so that samples may be taken and soil tests completed prior to beginning the excavation. The contractor's notification shall include a location sketch of the borrow area. The contractor will not be permitted to begin borrow operations until soil tests have been completed and materials approved for use.

203.07 GENERAL REQUIREMENTS. Excavation and embankment shall be finished to reasonably smooth and uniform surfaces. Excavation operations shall be so conducted that material outside construction limits will not be disturbed.

Prior to beginning excavation, grading and embankment operations in an area, all necessary clearing and grubbing in that area shall have been completed.

Drainage excavation and rough grading shall be performed simultaneously, unless otherwise directed or permitted. Roots, stumps and other obstructions in sides and bottom of ditches and channel changes shall be cut to conform to required cross section and grade. No excavated material shall be left within 3 feet of the edge of ditch or channel.

When obliteration of old roadways is required, it shall include all grad-

ing operations necessary to satisfactorily incorporate the old roadway into the new roadway and surroundings. Roadway obliteration will be paid for as unclassified excavation.

In preparation of the natural ground to receive embankment material or preparation of the finished section in a cut area on which fill or base material is to be placed, the contractor shall attempt all normal earthwork construction methods before undercutting or modifying the soil with additives will be considered by the Department. Such construction methods shall include, but are not limited to, the following:

(a) Draining and drying of the surface until the material is within reasonable limits of optimum moisture before compaction is attempted.

(b) Using lighter construction equipment for manipulation, disking, drying and compaction of the material.

(c) Dumping successive loads of material in a uniformly distributed layer of a thickness necessary to support the equipment while placing subsequent layers.

(d) Rerouting heavy construction equipment around the area until the embankment can support such equipment without damage to foundation soils.

Unstable materials shall be removed by undercutting, unless otherwise directed, and the areas backfilled to the required section with usable soils as directed.

If undercutting is required, the contractor shall conduct his operations in such manner that the engineer can make the necessary measurements before the backfill is placed. Undercut will be paid for as unclassified excavation, and the required usable soils for backfilling will be paid for as embankment. Measurement of undercut will be made to the subgrade or original ground line, whichever is lower.

Embankment construction consists of constructing roadway embankments, including preparation of the areas upon which they are to be placed; constructing dikes, when required; placing and compacting of 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. Embankment materials shall not be placed or spread on portland cement concrete or asphaltic concrete pavements (including friction, wearing, binder or base courses) and embankment operations shall be conducted in such manner that pavement surfaces, edges and joints are not damaged.

The contractor shall be responsible for the stability of all embankments constructed under the contract until final acceptance of the work and shall bear the expense of replacing any portions which have become displaced due to negligent work by the contractor, or to damages resulting from natural causes, such as rainfall, etc., and not attributable, in the opinion of the engineer, to unavoidable movements of the ground on which the embankment is constructed.

Rocks, broken concrete or other solid materials shall not be placed in embankment areas where piling is to be placed.

If embankments are to be 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 the fill is placed. If a new roadway is to be constructed on an existing roadbed, and the surface of the existing roadbed is within 1 foot of the finished subgrade, the existing roadbed shall be scarified full width to a depth of not less than 9 inches and recompacted as directed.

Where an embankment is to be constructed to a height of less than 3 feet, heavy sod and objectionable vegetable matter shall be removed from the embankment area and the area shall be scarified to a depth of approximately 9 inches. This area shall be recompacted as directed. When height of fill is 3 feet or more, removal of sod will not be required but the area on which embankment is to be placed shall be thoroughly disked and satisfactorily recompacted before construction of embankment.

If embankment material is to be deposited on one side only of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause excessive pressure against the structure. The 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 so conducted 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.

Excess and unusable excavated material, when permitted, may be placed on the side slopes of the nearest fill or berm in a satisfactory manner. If it is impossible to dispose of all such material in the manner described, the remainder shall be satisfactorily disposed of beyond the limits of the right-of-way.

In cut areas, for the full width of roadbed, the top 9-inch layer on which fill or base material is to be placed shall be thoroughly scarified and the moisture content increased or reduced as necessary and compacted to at least 95 percent of maximum density.

Maximum density will be determined in accordance with DOTD Designation: TR 418 and in-place density in accordance with DOTD Designation: TR 401. The frequency for density testing will be a minimum of 1 test per lift per 1,000 linear feet of roadway.

203.08 EMBANKMENT CONSTRUCTION (OTHER THAN NONPLASTIC EMBANKMENT AS DEFINED IN SUBSECTION 203.09). Embankment material shall be placed in layers approximately parallel to the finished grade line not exceeding 12 inches thick (loose). Each layer shall be placed for the full width of embankment, brought to a uniform moisture content and compacted to at least 95 percent of maximum density before the next layer is placed. Operations shall be conducted in such manner as to obtain proper bonding between layers. Water shall be added or removed as necessary to obtain required density. At the contractor's option, approximately the top 2 inches of intermediate layers may be compacted with the succeeding layer. The 2-inch layer of the previous lift shall be brought to optimum moisture before placing the subsequent lift.

Compaction of embankments may be accomplished by any method that will obtain the specified density. Dumping and rolling areas shall be kept separate.

When embankments are constructed in lakes, streams, swamps or other unstable areas and the unstable material cannot be economically removed or the area drained, the requirement for placing material in layers as outlined above may be waived and the embankment placed by end dump or other approved methods to an elevation where it is determined by the engineer that normal construction methods can begin. Embankments placed above this elevation shall be constructed in layers as specified above.

203.09 NONPLASTIC EMBANKMENT CONSTRUCTION.

(a) Materials: Nonplastic embankment materials shall be sand or shell or a sand-shell mixture.

(1) Sand: Sand embankment shall consist of nonplastic material with at least 75 percent passing the No. 4 sieve and containing not more than 15 percent passing the No. 200 sieve when tested in accordance with DOTD Designation: TR 112.

(2) Shell: Shell embankment materials shall be clam shell or reef shell or any combination thereof. The material shall be reasonably free of fragmented reef shell. The foreign matter content and material passing the No. 200 sieve shall not exceed 15 percent when tested in accordance with DOTD Designation: TR 109.

(3) Sand-Shell Mixtures: Sand-shell embankment materials

shall be a mixture of any proportions of sand and shell conforming to the above requirements.

(b) General Requirements: Embankment material shall be placed in such manner as to avoid entrapment of muck; the contractor shall remove any trapped muck.

The embankment (with surcharge, if required) will be approved in increments of 1,000 linear feet, except terminal increments which may be less than 1,000 feet. Surcharge materials shall be allowed to remain on the embankment for at least the specified number of days after approval of the increment. Any damage to embankment increments due to the contractor's operations shall be satisfactorily repaired by the contractor at his expense. It is anticipated that no major embankment settlement will occur after the specified surcharge period; therefore, the contractor will be permitted to remove excess surcharge materials after the surcharge period. Verification cross sections of the final embankment will be taken within 90 days after removal of the surcharge, and the Department will assume all liability for subsidence after these sections are taken. After all embankment increments have been surcharged, excess surcharge material shall be satisfactorily disposed of outside the right-of-way.

As soon as possible after completion of the embankment and removal of any surcharge materials, the contractor shall furnish and place a protective soil blanket conforming to Subsection 203.06 that will support adequate vegetation on embankment slopes. The thickness of the completed soil blanket shall be 12 inches. Embankment areas to be protected shall be approved by the engineer prior to placement of the protective blanket. After placing and spreading materials, all objectionable lumps, stones, roots and other foreign matter shall be removed from the area. Blanket material shall be compacted with a cultipacker or by other approved methods. Protective soil blanket will be included in the pay volume for the embankment.

(c) Sand Embankment Construction: Sand embankment may be constructed by either hydraulic or mechanical methods.

(1) Hydraulic Placement: Embankment material placed by hydraulic methods may be constructed without lift thickness requirements; however, the top 2 feet of the completed embankment shall be compacted to at least 95 percent of maximum density.

Embankment materials shall be dredged and pumped from approved sources, shaped to conform to lines, grades and cross sections indicated on the plans. The contractor must procure all necessary per-

mits from the proper authorities to operate in waters under their control. He shall also obtain all necessary permits for passage of discharge pipes over private property. Dredging and other equipment adequate to assure completion of embankments shall be furnished and shall be subject to approval.

No material shall be obtained from sources closer than 500 feet from the toe of the embankment slope. Unusable material shall be removed from the borrow area before embankment material is removed. Placement of material in the embankment shall begin at the centerline and proceed in either or both directions toward the toes of slopes and the discharge shall be along and parallel to the centerline, unless otherwise permitted. Method of discharge shall not cause erosion or damage to property of others. Material shall be deposited in such manner as to maintain a higher elevation near the center. If material is deposited on private property, written permission from the owners must be secured by the contractor. Precautions shall be taken in accordance with Subsection 204.02 to prevent siltation of streams and waterways. The contractor assumes all responsibility for compression, subsidence, displacement or slides in the hydraulic fill, and no payment will be made for materials outside the limits of the net pay section. Discharge pipelines that cross the surface of an existing highway shall be satisfactorily bridged, and traffic shall be properly protected by warning signs and signals. Any damage to existing highway facilities due to the contractor's operations shall be repaired by the contractor at his expense.

(2) Mechanical Placement: Mechanically placed embankment material shall be constructed in lifts not exceeding 4 feet (compacted) after establishing a working table as directed. The top 2 feet of each lift shall be compacted to at least 95 percent of maximum density prior to placing a subsequent lift.

(d) **Shell or Sand-Shell Embankment Construction:** Shell or sand-shell embankment material shall be placed in lifts not exceeding 12 inches thick (loose) after establishing a working table as directed. Each lift shall be compacted to at least 95 percent of maximum density prior to placement of a subsequent lift.

203.10 METHOD OF MEASUREMENT.

(a) General: All excavated material shall become the property of the contractor. Usable material from excavation items may be used in embankments or other finished sections of the project. Excavated material that is surplus or unusable shall be disposed of by the contractor beyond the right-of-way limits or as provided in Subsection 203.07.

No measurement will be made of material temporarily removed and replaced to facilitate compaction of the material.

(b) Unclassified Excavation, Drainage Excavation, Muck Excavation, Embankment and Nonplastic Embankment: Measurement will be made per cubic yard, computed by the average end area method. The end area will be bounded by (1) the original ground line established by field cross sections taken after completion of all required clearing and grubbing and (2) the final theoretical pay line shown on the plans or established by the engineer.

(1) Verification of Final Theoretical Pay Lines:

a. Muck Excavation: After completion of all muck excavation operations, final theoretical excavation lines will be verified by the engineer. Elevations for underwater mucking will be determined in accordance with DOTD Designation: TR 426.

A depth tolerance of ± 0.5 foot in mucked areas will be permitted, with a corresponding allowable width variation. Overdepth and overwidth will be waived at no additional cost to the Department; however, no measurement for payment will be made for additional embankment material required to backfill areas beyond theoretical muck lines.

b. Embankments and Other Excavations: After completion of excavation and embankment operations, final excavation and embankment material required to backfill areas beyond theoretical muck lines.

Final excavation and embankment slope lines shall be uniform in appearance. If final excavation and embankment slope lines vary by more than 0.03 foot per linear foot of slope dip in embankments and 0.03 foot per linear foot of slope swell in excavations, measured from a straight line between the top of the embankment and the toe of the slope, the slopes shall be reworked by the contractor until the above criteria has been met. The top of the embankment shall not vary from the established grade by more than ± 0.1 foot.

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.

For an embankment item paid for 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 and other minor installations will not be included in the measurement.

(2) Final Field Cross Sections: Final field cross sections in lieu of final theoretical pay lines will be used to determine pay quantities for

excavation and embankment if payment lines are not shown on the plans and cannot be reasonably established.

If deficient excavation and embankment areas are permitted to remain without correction, the Department reserves the right to determine pay quantities based on final field cross sections in lieu of theoretical pay lines.

(c) Excavation and Embankment:

(1) Linear Measurement: When excavation and embankment is to be measured on a linear basis, the length will be measured in stations of 100 linear feet, which includes performing all excavation, embankment and grading work necessary for construction of the project. It is the contractor's responsibility to determine the quantities of earthwork necessary to complete this item.

If an item for borrow material is not included in the contract, all necessary borrow material will be paid for under this item.

(2) Lump Sum Measurement: When excavation and embankment is to be measured by the lump sum, this item includes performing all 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 the contract price will be made due to errors in any estimated earthwork quantities shown on the plans. Payment for all required borrow material will be included in the contract price for this item.

(d) Borrow (Vehicular Measurement): The material will be measured by the cubic yard in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

203.11 BASIS OF PAYMENT. The accepted quantities will be paid for at the contract unit prices, which includes furnishing all equipment, labor and materials necessary to complete the items.

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, and furnishing necessary water and watering equipment.

When there is no pay item for furnishing and manipulation of lime, the cost thereof shall be included in the pay items that allow or require lime treatment.

Payment will be made under:

Item No.	Pay Item	Pay Unit
203(1)	Unclassified Excavation	Cubic Yard
203(2)	Drainage Excavation	Cubic Yard
203(3)	Muck Excavation	Cubic Yard
203(4)	Embankment	Cubic Yard
203(5)	Nonplastic Embankment	Cubic Yard
203(6)	Excavation and Embankment	Lump Sum
203(7)	Excavation and Embankment	Station
203(8)	Borrow (Vehicular Measurement)	Cubic Yard

No measurement will be made for excavation for culverts or culvert headwalls, except as provided below.

If the grade line of a pipe or box culvert is raised or lowered more than 2 feet 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 3 times the contract unit price for Unclassified Excavation (or Embankment if Unclassified Excavation is not a contract pay item).

The volume to be used in the payment adjustment 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, and the average change in invert elevation minus 2 feet.

Section 204

Temporary Erosion Control

204.01 DESCRIPTION. This work consists of providing temporary erosion control measures on the project and in areas outside the right-of-way where work is accomplished in conjunction with the project, to prevent pollution of water, detrimental effects to property adjacent to the right-of-way and damage to work on the project. These measures shall consist of construction and maintenance of 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 assure economical, effective and continuous control of erosion and water pollution throughout the life of the contract.

Due to unanticipated conditions, the engineer may direct the use of control features or methods other than those included in the original contract. Such work will be paid for as extra work.

204.02 CONTROL OF WATER POLLUTION. The contractor shall take precautions to prevent pollution of streams, canals, lakes, reservoirs and other water impoundments with fuel, oil, asphalt or other harmful materials. Also, he shall conduct his operations so as to avoid siltation of such streams, etc., and interference with movement of migratory fish. No residue from dust collectors or washers shall be dumped into any stream.

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 promptly cleared of obstructions placed therein or caused by construction operations.

When bridges are constructed over streams, stream banks shall be kept in their natural state as much as possible. The contractor shall not unduly strip existing protective vegetation in the vicinity of the stream banks and shall so conduct his operations as not to damage banks. No bank shall be

excavated except as shown on the plans. No work roads shall be constructed upstream where it is necessary to cut the banks except by approval of the engineer. Banks cut for work roads shall be located downstream and replaced by the contractor to their original shape and density. Unnecessary stripping of vegetation along banks in the construction area will not be permitted.

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

Except as necessary for construction, excavated material shall not be deposited in streams or impoundments, or in a position close enough thereto to be washed away by high water or runoff.

The contractor shall not disturb lands or waters outside the limits of construction, except as authorized.

The location of, and method of operation in, borrow pits, material pits and disposal areas furnished by the contractor for waste material from the project (other than commercially operated sources) shall meet the approval of the engineer as being such that erosion during and after completion of the work will not result in detrimental siltation or water pollution.

204.03 MATERIALS. All 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 unless such material is to be incorporated into the completed project. Acceptance will be on the basis of visual inspection.

(a) Mulches: Vegetative mulch conforming to Subsection 1018.19 and emulsified asphalt conforming 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.

(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 be a standard commercial grade acceptable to the engineer conforming to Subsection 1018.16.

(e) Silt Fencing: Silt fencing shall consist of standard woven livestock wire, a minimum of 36 inches in height and a minimum of 14-gage wire with a maximum mesh spacing of 6 inches; posts shall be either wood or steel with a minimum length of 5 feet; and filter material shall be burlap weighing approximately 7 1/2 ounces per square yard or approved jute fabric or geotextile fabric (plastic filter cloth). Other silt fencing systems may be used when approved.

204.04 PRECONSTRUCTION CONFERENCE. At the preconstruction conference or prior to the start of the applicable construction, the contractor shall present his proposed schedule for construction of the project in accordance with the requirements of this Section. The schedule shall be in written form except for projects on which erosion is of minor significance. This schedule shall indicate the sequence of clearing and grubbing, earthwork operations and construction of permanent erosion control features, and the proposed use of temporary erosion control features. It shall also include proposed methods to prevent pollution of streams, lakes, tidal waters, reservoirs, canals and other impondments as the result of construction operations. The contractor shall also outline his proposed methods of controlling erosion and preventing pollution on haul roads and in borrow pits, material pits and areas used for disposal of waste materials from the project.

No work shall be started until the aforementioned schedules have been approved; however, contract time charges will begin on the date stipulated in the Notice to Proceed. The contractor will be responsible for accomplishment of the work in accordance with the accepted plans and schedules. The engineer may approve changes made necessary by unforseen conditions.

204.05 EXPOSURE OF ERODIBLE EARTH. The engineer may limit the surface areas of unprotected erodible earth exposed by clearing and grubbing, excavation or filling operations and may direct the contractor to provide immediate permanent or temporary erosion or pollution control measures to prevent contamination of any stream, lake, tidal waters, reservoir, canal or other impoundment or prevent detrimental effects on property outside the right-of-way and damage to the project. Limitations of areas in which excavation and filling operations may be underway shall be commensurate with the contractor's capability and progress in keeping finish grading and permanent erosion control measures in accordance with the accepted schedule.

204.06 INCORPORATION OF EROSION CONTROL FEATURES. Permanent erosion control features shall be incorporated into the project at the earliest practical time. 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 on the project.

Temporary erosion control features may be authorized for use in controlling erosion 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.

204.07 CONSTRUCTION REQUIREMENTS. Temporary erosion control features shall consist of, but not be limited to, temporary seeding, temporary mulching, sandbagging, slope drains, sediment basins, sediment checkdams, erosion checks, artificial coverings and berms. The engineer may direct use of temporary erosion control features or methods other than those included in the original contract.

(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 rate of application reduced as directed.

(b) **Temporary Mulching:** Vegetative 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 to control erosion and siltation.

(d) **Baled Hay:** Baled 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.

(e) **Slope Drains:** Slope drains shall be constructed with acceptable materials in accordance with plan details or as directed. 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. The cost of the required cleanout operations will be included under the sediment basins item.

(g) **Sediment Check Dams:** Check dams shall be constructed at locations shown on the plans or as directed in accordance with plan details. Check dams shall be constructed before clearing and grubbing or grading in the affected area is begun unless otherwise directed. Embankment material for earth dams shall be obtained from locations outside the affected area. The contractor shall satisfactorily maintain the dams.

(h) **Silt Fencing:** Silt fencing shall be furnished and constructed at designated locations. The contractor shall satisfactorily maintain the fencing.

(i) **Berms:** Earth berms shall be constructed as directed to divert the flow of water from erodible surfaces.

(j) **Unforeseen Conditions:** Due to unforeseen conditions, 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. Payment for such other devices will be made at the contract unit prices for similar devices shown on the plans, or as extra work if plan details are not applicable.

(k) **Removal of Temporary Erosion Control Features:** In general, temporary erosion control features existing at the time of construction of the 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.

204.08 PROTECTION DURING SUSPENSION OF CONTRACT TIME. If it is necessary that construction operations be suspended for an appreciable length of time, 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 to carry runoff from cuts and embankments located in the vicinity of streams and impoundments. If such preventive measures fail, the contractor shall immediately take such other action as necessary to prevent erosion and siltation. The engineer may direct the contractor to perform, during such suspensions of time, other erosion control work deemed necessary.

204.09 METHOD OF MEASUREMENT. If temporary erosion and pollution control measures are required due to the contractor's negligence or failure to install permanent controls as a part of the work as scheduled or ordered, such work shall be performed by the contractor at his expense.

Temporary erosion and pollution control work required which is not due to the contractor's negligence will be measured as follows:

(a) When separate items for temporary erosion control features are included in the contract, and the work is ordered, the quantities to be paid for will be (1) the weight in pounds of Temporary Seeding, and in tons of Temporary Mulching; (2) the volume in cubic yards of Sandbagging with the measurement of sand being made in a batch box or other satisfactory means; (3) the dry weight in tons of Hay Bales; (4) the length in feet of Temporary Slope Drains measured along the ground surface, and Silt Fencing measured along ground surface between end posts; (5) the number of Sediment Basins and Sediment Check Dams acceptably constructed; and (6) the number of gallons of emulsified asphalt.

Temporary Sandbagging and Baled Hay will be paid for directly when used other than in the construction of Temporary Slope Drains, Temporary Sediment Basins and Temporary Sediment Check Dams. When sandbags and baled hay are used in construction of slope drains, sediment basins and sediment check dams, payment will be made under these items.

Temporary erosion control items may be eliminated if conditions do not justify their use.

(b) 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 104.02 except that no extra work order will be required prior to starting work.

Erosion control work for the protection of construction areas outside the right-of-way, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured for payment.

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 repeated failures of the contractor to control erosion, pollution or siltation, the engineer reserves the right to employ outside assistance or to 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.

204.10 BASIS OF PAYMENT. Payment for temporary erosion control items that are included as contract items will be paid for at the contract unit prices, subject to the payment adjustment provisions in Section 1002 for specification deviations of asphatic materials.

Temporary erosion control work not covered by contract items that is ordered will be paid for in accordance with Subsection 109.04.

Payment will be made under:

Item No.	Pay Item	Pay Unit
204(1)	Temporary Mulching	Ton
204(2)	Temporary Emulsified Asphalt	Gallon
204(3)	Temporary Seeding	Pound
204(4)	Temporary Sandbagging	Cubic Yard
204(5)	Temporary Baled Hay	Ton
204(6)	Temporary Slope Drains	Linear Foot
204(7)	Temporary Sediment Basins	Each
204(8)	Temporary Sediment Check Dams	Each
204(9)	Temporary Silt Fencing	Linear Foot

PART III

BASE AND SUBBASE COURSES

Section 301

Base Course

301.01 DESCRIPTION. This work consists of furnishing and placing a base course on a prepared surface in accordance with these specifications, in conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer. Unless approved in writing, the same base course material shall be used throughout the project.

(a) Types of Base Course: If not specified, the base course may be composed of any of the types of material listed below (except multilayered base courses), at the option of the contractor.

Soil Cement
Cement Treated Sand Clay Gravel
Cement Treated Sand-Shell
Sand Clay Gravel
Shell
Sand-Shell
Stone
Asphaltic Concrete
Multilayered

Multilayered base course shall consist of (1) one of the stabilized or treated base courses, or asphaltic concrete base course, and (2) sufficient material of the same type or, when specified, soil materials in accordance with Section 301.02, to provide the total thickness of base course shown on the plans.

With approval, Class R concrete conforming to Section 902 may be used in lieu of the specified 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.

(b) Classes of Base Course: A base course class is defined as a group of selected base course types required to meet design requirements for a specific pavement structure.

When Class I base course is specified, it shall consist of one of the following types:

(1) 8-1/2" Soil Cement
(2) 8-1/2" Stone
(3) 8-1/2" Sand-Shell with top 6" Cement Treated
(4) 8-1/2" Sand Clay Gravel with top 6-1/2" Cement Treated
(5) 8-1/2" Multilayered Base Course, (4-1/2" Asphaltic Concrete (Type 5A) on 4" Embankment Material).

301.02 MATERIALS. Materials shall conform to the following Subsections and requirements:

Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Emulsified Asphalt	1002.01
Cutback Asphalt	1002.01
Sand Clay Gravel	1003.03(a)
Shell	1003.03(b)
Sand-Shell	1003.03(c)
Stone	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 Designation: TR 423. Such materials are those soils classified as A-1-a, A-1-b, A-2-4, A-2-6, A-3, A-4 and A-6 in accordance with DOTD Designation: TR 423.

Soil with a liquid limit greater than 35, a plasticity index greater than 15, or an organic content greater than 5 percent shall not be used. Organic content will be determined in accordance with DOTD Designation: TR 413. Soil with silt content above 79 percent may be used if approved prior to use.

The contractor shall obtain the material to be stabilized from outside right-of-way limits except as provided in Subsection 106.02(c).

(b) Soils for Multilayered Base Course: The soil layer for multilayered base course shall consist of embankment material conforming to Subsection 203.06.

(c) Portland Cement: Portland cement shall be Type I, I(B) or II. The quantity of cement used shall be supported by proof of delivery.

(d) Portland-Pozzolan Cement: The cement shall be Type IP. The quantity of cement used shall be supported by proof of delivery.

(e) Asphaltic Concrete Base Course: The material requirements for asphaltic concrete base course shall be described in Section 501.

301.03 EQUIPMENT. Equipment necessary to produce a finished base course which meets specification requirements shall be furnished and

maintained by the contractor. All equipment shall be subject to approval prior to use.

Cement for in-place mixing shall not be placed directly on the base from transport trucks, but shall be placed with approved mechanical spreaders.

301.04. GENERAL CONSTRUCTION REQUIREMENTS. Asphaltic concrete base course shall be constructed in accordance with Section 501.

The soil layer for multilayered base course shall be constructed in accordance with Section 203.

Base course material shall be placed on a subgrade prepared in accordance with Section 203, or if provided, with Section 302.

301.05 MIXING.

(a) **Soil Cement:** Soil shall be combined with cement and water by travel plant, central plant or other approved methods and shaped on the approved subgrade. Water needed to bring the moisture content of the mixture within specified tolerance shall be added through the plant at the time of mixing and uniformly mixed with the materials. If prior to spreading the cement, the moisture content of the soil is excessive, the soil shall be manipulated until the moisture content is within specified tolerances.

If in-place mixing methods are to be used, the soil shall be shaped to required section and compacted to at least 93.0 percent of maximum density at the required grade (± 1/2 inch) prior to mixing with cement.

The percentage of cement will be determined in accordance with DOTD Designation: TR 432 (Method A or B for portland cement; Method B for portland-pozzolan cement) prior to mixing, from materials sampled in-place on the project. Depending on the type of cement and soil to be used, normal testing time to determine required cement content may be extended to 15 days. The method of mixing shall be such that the amount of cement used can be readily determined.

When central plant mixing is used, a reduction of 1 percent in the volume of cement required will be permitted.

Optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture, by dry weight, shall not vary from the specified optimum percentage of moisture by more than 2 percent at the time of compaction.

A minimum of 70 percent of the pulverized soil, as determined by DOTD Designation: TR 431, shall pass No. 4 sieve after mixing.

(b) Cement Treated Sand Clay Gravel: Sand clay gravel shall be combined with cement and water by travel plant, central plant or other approved methods and shaped on the approved subgrade. Water needed to bring the moisture content of the mixture within the specified tolerance shall be added through the plant at the time of mixing and uniformly mixed with the materials. If prior to spreading the cement, the moisture content of the material is excessive, the material shall be manipulated until the moisture content is within the specified tolerance.

The percentage of portland cement required will be 6 percent by volume, and the percentage of portland-pozzolan cement required will be determined in accordance with DOTD Designation: TR 432, Method B. The method of mixing shall be such that the amount of cement used can be readily determined. When central plant mixing is used, a reduction of 1/2 percent in the voulme of cement required will be permitted.

Optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture, by dry weight, shall not vary from the specified optimum percentage of moisture by more than 2 percent at the time of compaction.

(c) Cement Treated Sand-Shell: Sand-shell shall be combined with cement and water by travel plant, central plant or other approved methods and shaped on the approved subgrade. Water needed to bring the moisture content of the mixture within the specified tolerance shall be added through the plant at the time of mixing and uniformly mixed with the materials. If prior to spreading the cement, the moisture content of the material is excessive, the material shall be manipulated until the moisture content is within the specified tolerance.

The percentage of portland cement required will be 5 percent by volume, and the percentage of portland-pozzolan cement required will be determined in accordance with DOTD Designation: TR 432, Method B. The method of mixing shall be such that the amount of cement used can be readily determined. When central plant mixing is used, a reduction of 1/2 percent in the volume of cement required will be permitted. Optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture, by dry weight, shall not vary from the specified optimum percentage of moisture by more than 2 percent at the time of compaction.

(d) Stone: Stone shall be uniformly mixed in an approved pugmill or on a mixing table or by other mechanical means (such as, quarry blending operations) prior to placement on the subgrade. Test samples will be taken after mixing, and the material shall conform to specified

requirements prior to placement on the subgrade. The material shall be wetted during mixing operations if necesary for proper blending.

(e) Sand Clay Gravel: Sand clay gravel shall be uniformly mixed. If mixed prior to placement, it shall be mixed in an approved pugmill or on a mixing table. Materials shall be wetted during mixing operations, if necessary for proper blending. Test samples will be taken after materials have been mixed.

(f) Shell or Sand-Shell: The base shall be uniformly mixed. If mixed prior to placement, it shall be mixed in an approved pugmill or on a mixing table. Materials shall be wetted during mixing operations, if necessary for proper blending. The sand and shell shall be tested and approved prior to mixing.

301.06 TRANSPORTING AND PLACING ON SUBGRADE. Transportation and spreading methods shall be such as to avoid damage to the subgrade. It shall be the contractor's responsibility to place and spread sufficient material to obtain required width and compacted thickness within the tolerance set forth in Subsection 301.11. Every effort shall be made to prevent subgrade materials from contaminating 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, and base course construction operations shall be conducted in such manner that pavement surfaces, edges and joints are not damaged.

301.07 COMPACTING AND FINISHING.

(a) Soil Cement: The mixture shall be uniformly compacted immediately upon completion of mixing or placement. The number and type of rollers used shall be sufficient to uniformly compact the base course to specified depth and width within the specified time. Vibratory rollers will not be permitted in areas with high water tables. The surface shall be kept uniformly moist during compaction and final finishing.

For soil containing more than 65 percent silt, classified as silty loams or silts, and having a plasticity index of 5 or less, compaction shall be by a sheepsfoot or similar type roller followed by a pneumatic roller not exceeding 10 tons.

Compaction shall continue until the entire depth of each lift of base course has met the requirements of Subsection 301.11.

At all places inaccessible to rollers, such as edges adjacent to curb and gutter sections, the mixture shall be compacted using devices that will obtain required density without damage to adjacent structures.

All compaction shall be completed within 3 hours after initial mixing of cement with base course materials. Upon expiration of the 3-hour period after initial mixing, only blading of the base course surface will be allowed, and the bladed material shall not be drifted along the base but shall be wasted. The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, waves, laminations, loose material or laitance.

(b) **Cement Treated Sand Clay Gravel:** Compaction and finishing requirements shall be the same as specified for soil cement.

(c) **Cement Treated Sand-Shell:** Compaction and finishing requirements shall be the same as specified for soil cement, except that sheepsfoot or similar type rollers will be required for primary compaction.

(d) **Multilayered Base Course:** Compaction and finishing requirements shall be as follows:

(1) The asphaltic concrete layer shall be compacted and finished in accordance with Section 501.

(2) The cement stabilized or treated layer shall conform to the requirements specified for soil cement.

(3) The remaining portion of the base course shall meet the requirements specified for untreated sand clay gravel, shell, sand-shell or crushed stone, or if the remaining portion is soil, the requirements of Section 203.

(e) **Sand Clay Gravel:** Following the placing, spreading and shaping of base course material, it shall be brought to optimum moisture content and compacted to the specified density. Optimum moisture and maximum density will be determined in accordance with DOTD Designation: TR 418. Waves or irregularities that develop during rolling shall be corrected by scarifying and adding or removing material until the surface is smooth. Between rollings, the surface shall be machined as necessary. Machining, watering and rolling shall continue until the full depth of base course has met the compaction requirements specified in Subsection 301.11. The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, depressions or loose material.

(f) **Shell or Sand-Shell:** Compaction and finishing requirements shall be the same as specified for sand clay gravel, except that sheepsfoot or similar type rollers will be required for primary compaction.

(g) **Stone:** Compaction and finishing requirements shall be the same as specified for sand clay gravel, except that optimum moisture and maximum density will be determined in accordance with AASHTO

Designation: T 180. Water to facilitate compaction shall be added in such manner as not to damage underlying materials.

301.08 PROTECTION AND CURING.

(a) **Soil Cement, Cement Treated Sand Clay Gravel, Cement Treated Sand-Shell and Multilayered Base Course:** Upon completion of smooth rolling of the final lift, the base shall be protected against rapid drying for a period of 72 hours by applying an asphaltic curing membrane conforming to Section 506.

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, unless permitted by the engineer. 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 whenever conditions permit.

If traffic is permitted to use the completed base course subsequent to the 72-hour curing period and prior to the construction of the surface course, the base shall be further protected by additional applications of asphaltic curing membrane as directed.

If the base course material consists of soil containing more than 65 percent silt classified as silty loam or silt and having a plasticity index of 5 or less, and if public traffic or construction traffic is permitted, the surfacing shall be constructed on the base course immediately after the 72-hour curing period.

Prior to construction of the surface course, the contractor shall clean the surface of the base course, properly repair any damages caused by traffic and apply an additional application of asphaltic curing membrane (if necessary), all without additional compensation.

(b) **Sand Clay Gravel, Shell, Sand-Shell, Stone, and Soil for Multilayered Base Course:** The completed base course shall be opened to traffic when specified or as directed. Any weak spots that develop shall be satisfactorily corrected and the base kept free from irregularities and true to profile, grade and cross section. The base course shall not be allowed to become dusty with consequent loss of binder. The surface shall be kept moist as directed to avoid loosening of surface material. The base course, and soil for multilayered base course, shall be primed in accordance with Section 505.

301.09 MAINTENANCE. The contractor shall protect the completed base course from damage due to either public traffic or the contractor's operations, and shall maintain the completed base course in a satisfactory condition at all times, including asphaltic curing membrane or prime coat. Any damaged base course shall be immediately repaired by the

contractor at his expense. If patching of the base course is required, in addition to removing all damaged or unsound base course, the contractor shall remove a sufficient width and depth of base course to insure satisfactory placement of patching material. All patching or other repair of the base course shall be made in such manner as to restore a uniform surface and shall be completed at least 24 hours prior to surfacing or paving operations.

301.10 WEATHER LIMITATIONS (CEMENT STABILIZED OR TREATED BASE COURSE). Mixing will not be permitted when the base course material is frozen or when the air temperature at the project site in the shade and away from artificial heat is below 35°F.

301.11 ACCEPTANCE REQUIREMENTS. The contractor shall control the placement, mixing and compaction of materials in such manner that the completed base course is uniform and conforms to plan dimensions and other acceptance requirements as provided herein. The contractor shall be responsible for taking such tests as necessary to adequately control the work.

The completed base course will be checked for determining acceptance in increments of 1,000 linear feet of roadway as provided herein.

(a) **Density Requirements:** Upon completion of compaction operations, the density of the base course will be determined in accordance with DOTD Designation: TR 401. One density test will be taken per 1,000 linear feet of roadway. If any density test is below the requirements, 2 additional tests will be taken within 5 feet of the failing test location and the average of the 3 tests will be used as the value for the 1,000-foot section.

The density requirements shall be as follows:

Base Course Type	Test Method	% of Maximum Density (Min.)
Soil Cement	DOTD TR 418 (B)	95.0
Cement Treated Sand Clay Gravel	DOTD TR 418 (F)	95.0
Cement Treated Sand-Shell	DOTD TR 418 (D)	95.0
Sand Clay Gravel	DOTD TR 418 (E)	100.0
Shell or Sand-Shell	DOTD TR 418 (C)	100.0
Stone	AASHTO T 180	95.0
Soil for Multilayered	DOTD TR 418 (A)	95.0
Multilayered	See Note	
Asphaltic Concrete	See Note	

Note: Multilayered base courses (except soils) shall meet the density requirements given in the preceding table for the top layer. The bottom layer shall be compacted to such density that the requirements of the top layer can be met. When soil is used as a layer of multilayered base courses, the compaction requirements shall be as given in the preceding table.

The density requirements for asphaltic concrete base course shall be as specified in Section 501.

(1) Sand Clay Gravel, Shell, Sand-Shell, Stone, and Soil for Multilayered Base Course: If any test value is less than that required in the preceding table, compaction shall continue until the specified density is obtained.

(2) Soil Cement, Cement Treated Sand Clay Gravel, Cement Treated Sand-Shell and that Portion of Multilayered Bases Using One of These Types: If the density test value for the 1,000-foot section is below 95.0 percent, a price adjustment will be applied as follows.

Density Test Value	% 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*

*At the option of the engineer

(b) Thickness Requirements: The thickness of the completed base course will be determined in accordance with DOTD Designation: TR 602.

The completed base course shall not vary from plan thickness in excess of the following tolerances. Base course thickness deficiencies in excess of these tolerances shall be corrected as specified herein at the contractor's expense.

(All Bases Except Asph. Conc.) Underthickness	(Stab. & Treat. Bases) Overthickness
3/4 inch	1 1/2 inches

If an individual test exceeds allowable tolerances, 2 additional tests will be taken within 5 feet of the failing test location and the average of the 3 tests (rounded off to the nearest 1/4 inch) will be used as the value for that location. Any failing area will be isolated for purposes of correction.

(1) Sand Clay Gravel, Shell, Sand-Shell and Stone Base Course: Overthickness will be waived at no additional cost to the Department. Underthickness in excess of 3/4 inch shall be corrected to plan thickness by furnishing, placing, shaping and compacting additional base course material as required.

(2) **Stabilized or Treated Base Course:** Overthickness of pug-mill-mixed stabilized or treated base course will be waived at no additional cost to the Department.

If no grade adjustments are permitted, all other thickness 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 conforming to Section 501
c. Class R concrete conforming to Section 902.

If grade adjustments are permitted, the contractor shall have the option of correcting thickness deficiencies by furnishing and placing a supplemental layer of asphaltic concrete conforming to Section 501 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 as follows:

Underthickness (Inches)	Overthickness (Inches)	Minimum Thickness of Supplemental Asphaltic Concrete (Inches)
1 to 1 1/4	1 3/4 to 2	1
1 1/2 to 1 3/4	2 1/4 to 2 1/2	1 1/2
2 to 2 1/2	2 3/4 to 3	2
Over 2 1/2	Over 3	Remove & Replace

(3) **Asphaltic Concrete Base Course:** Overthickness shall be waived at no additional cost to the Department when permitted to remain in place. Underthickness in excess of the tolerances given in Subsection 501.11 shall be corrected to plan thickness by removing and replacing the full depth of base course, or by placing and compacting additional base course material as directed.

(c) **Width Requirements:** The width of the completed base course will be determined in accordance with DOTD Designation: TR 602. Roadway base course width shall not vary from plan width in excess of 6 inches. Shoulder base course width shall not vary from plan width in excess of 3 inches. If the base course for both roadway and shoulders is built at the same time, the 6-inch width tolerance will be applied. Base course width deficiencies in excess of the foregoing tolerances shall be corrected as follows at the contractor's expense:

(1) **Sand Clay Gravel, Shell, Sand-Shell and Stone Base Course:** 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, shaping and compacting additional base course material as required.

(2) Stabilized, Treated and Asphaltic Concrete Base Course:

a. Overwidth: Overwidths of asphaltic concrete and pugmill-mixed stabilized or treated base course will be waived at no additional cost to the Department.

If no grade adjustment is permitted, the full depth and width of base course in isolated 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 conforming to Section 501.
3. Class R concrete conforming to Section 902.

In lieu of removing and replacing the deficient areas of base course, at the contractor's option the deficient base course will be allowed to remain in place at an adjusted payment of 90 percent of the contract unit price for the 1,000-foot section.

If 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-inch thick supplemental layer of asphaltic concrete conforming to Section 501 on the 1,000-foot 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 by furnishing and placing additional materials; however, the width of widening materials shall be not less than 12 inches. Materials used for widening deficient base course shall be one of the following:

1. The same type of base course.
2. Asphaltic concrete conforming to Section 501.
3. Class R concrete conforming to Section 902.

(d) Dimensional Tolerances of Multilayered Base Course: The combined depth and width of the components shall meet the thickness and width requirements of aggregate base courses (nonstabilized or untreated). The asphaltic concrete, stabilized or treated portion of this base course shall meet the width and depth requirements specified for these type base courses. Any price adjustment applied to multilayered base course will be applied to entire depth of the base course.

301.12 SHOULDER CONSTRUCTION WITH BASE COURSE. Aggregate and soil materials required on shoulders in conjunction with base course shall be constructed to the depths shown on the plans. Soil shall be approved materials compacted to the satisfaction of the engineer. Aggregate surfacing shall conform to Section 401.

301.13 METHOD OF MEASUREMENT. The quantities of base course for payment will be the design volumes or areas as 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.

301.14 BASIS OF PAYMENT. Base course will be paid for at the contract unit price, adjusted as specified in Subsection 301.11 and the following provisions, which includes furnishing and placing all required base course materials, portland cement, portland-pozzolan cement, water, asphaltic curing membrane and prime coat.

Price adjustments will be applied for specification deviations of asphaltic materials in accordance with Section 1002.

Asphaltic concrete base course will be further subject to price adjustments for deficiencies in Marshall stability, roadway density, aggregate gradation or anti-strip additive as specified in Table 2 of Section 501. Only one price adjustment will be made for these deficiencies, and the schedule requiring the greatest reduction in contract unit price will be used for the price adjustment.

Payment will be made under:

Item No.	Pay Item	Pay Unit
301(1)	Base Course	Cubic Yard
301(2)	Base Course (__" Thick)	Square Yard

Section 302

Scarifying and Compacting Roadbed

302.01 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 by the engineer.

302.02 CONSTRUCTION REQUIREMENTS. Existing materials shall be scarified for the full width of roadbed and a minimum depth of 6 inches, shaped to the required section, and uniformly compacted to at least 95 percent of maximum density for subbase, and 100 percent for base, as determined by DOTD Designations: TR 401 and TR 418. 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 in advance of compacting the roadbed, unless otherwise permitted. The recompacted roadbed shall be primed in accordance with Section 505.

302.03 METHOD OF 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 length of the roadbed 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.

302.04 BASIS OF PAYMENT. Scarifying and compacting roadbed will be paid for at the contract unit price, which includes prime coat.

Price adjustments will be applied for specification deviations of asphaltic materials in accordance with Section 1002.

Payment will be made under:

Item No.	Pay Item	Pay Unit
302(1)	Scarifying and Compacting Roadbed (__" Thick)	Mile
302(2)	Scarifying and Compacting Roadbed (__" Thick)	Square Yard

Section 303

In-Place Cement Stabilized Base Course

303.01 DESCRIPTION. This work consists of scarifying, pulverizing, blending, shaping and stabilizing existing roadbed material with portland cement or portland-pozzolan cement in accordance with these specifications, in conformity with the lines, grades, thickness and sections shown on the plans or established by the engineer.

This cement stabilization shall be primarily for existing roadbed materials; however, it shall include materials furnished and placed on the roadbed under other pay items.

For bid purposes, the estimated rate of portland cement or portland-pozzolan cement required for stabilization is 10 percent by volume; however, the actual rate of cement to be used for stabilization will be determined by the Laboratory. If the actual rate of cement differs from the estimated rate, a payment adjustment will be made as specified in Subsection 303.12.

With the approval of the engineer, Class R concrete conforming to Section 902 may be used in lieu of the specified base course material in areas that are inaccessible to mixing and compacting equipment, in turnouts and crossovers, and in other isolated or irregular areas. The concrete shall be placed, consolidated, finished and cured as directed. The contractor shall, at his own expense, remove and satisfactorily dispose of existing materials as required to accommodate placement of the Class R concrete.

303.02 MATERIALS. Materials shall conform to the following Subsections:

Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Emulsified Asphalt	1002.01
Water	1018.01

Portland cement shall be Type I, I(B) or II. Portland-pozzolan cement shall be Type IP. The quantity of cement used shall be supported by proof of delivery.

303.03 EQUIPMENT. Equipment necessary to produce a finished base course meeting specification requirements shall be furnished and maintained by the contractor. All equipment shall be subject to approval.

Cement shall not be placed directly on the base from transport trucks, but shall be placed with approved mechanical spreaders.

303.04 PREPARATION OF ROADBED. The contractor shall scarify and pulverize materials to be stabilized for the full width and depth of the cement stabilized base course. Any existing asphaltic surfacing shall be pulverized and uniformly mixed with materials below the surfacing.

Surfacing or base materials which cannot be satisfactorily pulverized shall be removed and disposed of as directed at no additional cost to the Department.

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 the satisfaction of the engineer.

303.05 MIXING. After preparation of materials to be stabilized, cement shall be uniformily spread and mixed with the material and shaped to the required section.

Prior to mixing, the percent of cement to be used for stabilization will be determined by the Laboratory in accordance with DOTD Designation: TR 432 (Method A or B for portland cement, Method B for portland-pozzolan cement) from materials sampled in-place on the project. Depending on the type of cement to be used and the materials to be stabilized, normal testing time to determine the required cement content may be extended to 15 days. The method of mixing shall be such that the amount of cement used can be readily determined.

Water shall be added as needed by means of the mixer and shall be uniformly incorporated in the mixture in amounts required to attain the optimum moisture content specified for the mixture.

Optimum moisture of the mixture will be determined by the Laboratory in accordance with DOTD Designation: TR 418. The percentage of moisture in the mixture by dry weight shall not vary from the specified optimum percentage of 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. The number and type of rollers used shall be sufficient to uniformly compact the base course to the specified depth and width, and within the specified time. The surface shall be kept uniformly moist at all times during compacting and final finishing. Compaction shall continue until the entire depth of each lift of the base course has met the requirements of Subsection 303.10.

At all 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.

All compaction shall be completed within 3 hours after initial mixing of cement with base course materials. Upon expiration of the 3-hour period after initial mixing, only blading of the base course surface will be allowed, and bladed material shall not be drifted along the base but shall be wasted. The finished base course shall have a smooth, uniform, closely knit surface, free from ridges, waves, laminations, loose material or laitance.

303.07 PROTECTION AND CURING. Upon completion of smooth rolling of the final lift, the base shall be protected against rapid drying for a period of 72 hours by applying an asphaltic curing membrane conforming to Section 506.

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, unless permitted by the engineer. When maintenance of traffic is required, both public traffic and construction traffic shall be routed onto shoulders or other suitable areas during the 72-hour curing period whenever conditions permit.

If traffic is permitted to use the completed base after the 72-hour curing period and prior to the construction of the surface course, the base shall be further protected by additional applications of asphaltic curing membrane as directed.

Prior to construction of the surface course the contractor shall clean the surface of base course, properly repair any damages caused by traffic and apply an additional application of asphaltic curing membrane (if necessary), all without additional compensation.

303.08 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 asphaltic curing membrane. Any damaged base course shall be repaired by the contractor at his expense. If patching of base course is required, in addition to removing all damaged or unsound base course, the contractor shall remove a sufficient width and depth of base course to insure satisfactory placement of patching material. All patching or other repair of the base course shall be made in such manner as to restore a uniform surface and shall be completed at least 24 hours prior to surfacing.

303.09 WEATHER LIMITATIONS. Mixing will not be permitted when the base course material is frozen or when the air temperature at the project site in the shade and away from artificial heat is below 35°F.

303.10 ACCEPTANCE REQUIREMENTS. The completed base course will be checked for determining acceptance as provided herein.

(a) Density Requirements: Upon completion of compaction operations, the density of the completed base course will be determined in

accordance with DOTD Designation: TR 401. A minimum of 1 density test will be taken per 1,000 linear feet per roadway. If any density test is below the requirements, 2 additional tests will be taken within 5 feet of the failing test location and the average of the 3 tests will be used as the value for the 1,000-foot section.

The density requirement as based on DOTD Designation: TR 418 will be 95.0 percent of maximum density.

If the density test value for the 1,000-foot section is below 95.0 percent, a price adjustment will be applied as follows:

Density Test Value	% 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*

*At the option of the engineer

(b) **Thickness Requirements:** The thickness of the completed base course will be determined in accordance with DOTD Designation: TR 602.

The completed base course shall not vary from plan thickness in excess of the following tolerances. Base course thickness deficiencies in excess of these tolerances shall be corrected as specified herein at the contractor's expense.

Underthickness	Overthickness
1 inch	1 1/2 inches

If an individual test exceeds allowable tolerances, 2 additional tests will be taken within 5 feet of the failing test location and the average of the 3 tests (rounded off to the nearest 1/4 inch) will be used as the value for that location. 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.

If no grade adjustments are permitted, thickness deficiencies shall be corrected by 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 conforming to Section 501.
(3) Class R concrete conforming to Section 902.

If grade adjustments are permitted, the contractor shall have the option of correcting thickness deficiencies by furnishing and placing a supplemental layer of asphaltic concrete conforming to Section 501 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 as follows:

Underthickness (Inches)	Overthickness (Inches)	Minimum Thickness of Supplemental Asphaltic Concrete (Inches)
1/4 to 1 1/2	1 3/4 to 2	1
1 3/4 to 2	2 1/4 to 2 1/2	1 1/2
2 1/4 to 2 1/2	2 3/4 to 3	2
Over 2 1/2	Over 3	Remove and Replace

(c) Width Requirements: The width of the completed base course will be determined in accordance with DOTD Designation: TR 602. Roadway base course width shall not vary from plan width in excess of 6 inches. Shoulder base course width shall not vary from plan width in excess of 3 inches. If the base course for roadway and shoulders are constructed at the same time, the 6-inch width tolerance will be applied. Base course width deficiencies in excess of foregoing tolerances shall be corrected as specified herein at the contractor's expense.

(1) Overwidth: If no grade adjustment is permitted, the full depth and width of base course in isolated areas having overwidths in excess of the foregoing tolerances shall be removed and replaced to the plan width with one of the following materials:

a. Cement stabilized base course.
b. Asphaltic concrete conforming to Section 501.
c. Class R concrete conforming to Section 902.

In lieu of removing and replacing deficient base course, at the contractor's option the deficient base course will be allowed to remain in place at an adjusted payment of 90 percent of the contract unit price for the 1,000-foot section.

If 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-inch thick supplemental layer of asphaltic concrete conforming to Section 501 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 furnishing and placing additional materials; however, the width of the widening materials shall be not less than 12 inches. Materials used for widening the deficient base course shall be the same as specified for overwidth correction in Heading (1).

303.11 METHOD OF MEASUREMENT. The quantities of in-place cement stabilized base course 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 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.

303.12 BASIS OF PAYMENT. In-place cement stabilized base course will be paid for at the contract unit price, adjusted as specified in Subsection 303.10 and the following provisions, which includes furnishing all required portland cement, portland-pozzolan cement, water and asphaltic curing membrane, and performing all necessary roadbed preparation.

Price adjustments will be applied for specification deviations of asphaltic materials in accordance with Section 1002.

If the actual rate of cement required differs from the estimated rate of 10 percent by volume, payment will be increased or decreased at the rate of $3.25 per hundred pounds (cwt) of cement.

Payment will be made under:

Item No.	Pay Item	Pay Unit
303(1)	In-Place Cement Stabilized Base Course (__" Thick)	Square Yard

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, thicknesses and sections shown on the plans or established by the engineer.

Lime treatment will be designated as Type A, B, C, D or E. Table 1 of this Section gives a synopsis of the requirements for the types of treatment.

304.02 MATERIALS. Materials shall conform to the following Subsections:

Emulsified Asphalt	1002.01
Water	1018.01
Lime	1018.03

304.03 EQUIPMENT. Equipment necessary to produce a finished product meeting specification requirements shall be furnished and maintained by the contractor.

304.04 GENERAL CONSTRUCTION REQUIREMENTS. Materials shall be kept moist after lime is applied. Water shall be added as needed during mixing and remixing operations, during the curing period, and to keep the cured material moist until covered.

If granular quicklime is applied in dry form, precautions shall be taken to prevent injury to persons, livestock and plants. Any quicklime spilled or deposited outside areas designated for treatment shall be immediately collected and buried or slaked to the satisfaction of the engineer.

Lime shall not be applied on a frozen foundation. Lime for Type A, B and C treatments shall not be applied when the air temperature at the project site in the shade away from artificial heat is below 35°F.

Type A Treatment: Two increments of lime shall be incorporated in the following sequence: Spreading the first increment of lime, initial mixing, watering, sealing, mellowing for a minimum of 48 hours and mixing until pulverization requirements are met; and spreading the second increment of the lime, final mixing, watering as necessary,

compacting, finishing and maintaining. Material for Type A treatment will be tested in accordance with DOTD Designation: TR 433.

Type B Treatment: One increment of lime shall be incorporated in the following sequence: Spreading the lime, initial mixing, watering, sealing and mellowing for a minimum of 48 hours; and mixing until pulverization requirements are met, compacting, finishing and maintaining. Material for Type B treatment will be tested in accordance with DOTD Designation: TR 433.

Type C Treatment: One increment of lime shall be incorporated in the following sequence: Spreading the lime, initial mixing, watering, sealing and mellowing for a minimum of 48 hours; and mixing until pulverization requirements are met, compacting and finishing to the satisfaction of the engineer. Material for Type C treatment will be tested in accordance with DOTD Designation: TR 416.

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.

Type E Treatment: One increment of lime shall be spread and mixed with materials to be treated.

304.05 SPREADING AND MIXING. The percentage of lime to be incorporated shall be as specified. If not specified, the required percentage of lime will be determined by the Laboratory.

A unit weight of 35 pounds per cubic foot will be used to compute the required application rate of hydrated lime or quicklime (except calcined shell), regardless of the actual unit weight of the lime used. The required application rate of calcined shell quicklime shall be as specified in the Qualified Products List.

Lime may be furnished in bags or bulk and distributed, either in powder form or in a slurry, in such manner as to assure obtaining the required proportion. Dry lime shall be prevented from blowing by adding water or by other suitable means.

The lime shall be uniformly spread and uniformly mixed with the soil to the width and depth shown on the plans or as directed. Any procedure which results in excessive loss or displacement of lime shall be immediately discontinued.

Lime shall be applied on such areas as can be properly processed during the same working day. Any lime exposed to air for more than 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 additional cost to the Department.

(a) **Types A and B Mixing:** Following the 48-hour mellowing period, the mixture shall be kept moist and manipulated until the requirements of Subsection 304.06 have been met.

The first application of lime for Type A treatment shall be processed to line and grade and sealed. Following the 48-hour mellowing period, the second application of lime shall be spread and mixed as described herein for the first application.

(b) **Type C Mixing:** Following the 48-hour mellowing period, the lime treated mixture shall be thoroughly manipulated to the satisfaction of the engineer. The mixture shall meet the gradation requirements of Subsection 304.06 prior to subsequent stabilization or treatment with portland cement.

(c) **Types D and E Mixing:** Mixing shall be accomplished with normal embankment construction methods and equipment.

304.06 PULVERIZATION. For Type A, B and C treatment, the pulverized mixture, exclusive of aggregate material, when tested in accordance with DOTD Designation: TR 431, shall meet the following gradation requirements:

U. S. Sieve	Percent Passing (By Weight)
3/4"	95
No. 4	50

Pulverization requirements for Type A treatment shall be met prior to the second application of lime. Pulverization requirements for Types B and C treatments shall be met prior to final compaction and finishing.

304.07 COMPACTING AND FINISHING.

(a) **Type A:** After the second application of lime has been spread and mixed, the mixture shall be uniformly compacted to at least 95.0 percent of maximum density as determined by DOTD Designations: TR 401 and TR 418. All compaction shall be completed within 6 hours after meeting pulverization requirements or the last application of lime.

One density test will be taken per 1,000 linear feet per roadway. If any density test is below 95.0 percent compaction, 2 additional tests will be taken within 5 feet of the failing test location and the average of the 3 tests will be used as the value for the 1,000-foot section. Any section not meeting the required density shall be reconstructed in accordance with these specifications at the contractor's expense.

At places inaccesssible 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.

The final finish shall have a smooth, uniform, closely knit surface, free from ridges, waves, loose material or laitance.

(b) **Type B:** Compacting and finishing of the Type B lime treated materials shall be as described for Type A treatment.

(c) **Type C:** Type C lime conditioned materials shall be shaped and uniformly compacted to the required sections.

(d) **Type D:** Type D lime treated materials shall be uniformly compacted and finished to the satisfaction of the engineer.

(e) **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 PROTECTION AND CURING (TYPES A AND B). After finishing operations have been completed, the material shall be protected against rapid drying for a period of 72 hours by applying an asphaltic curing membrane conforming to Section 506. The application shall be placed immediately following smooth rolling and shall be adequately maintained during the 72-hour curing period.

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, unless permitted. When maintenance of traffic is required, both public traffic and construction traffic shall be routed onto shoulders or other suitable areas during the 72-hour curing period when conditions permit.

If traffic is permitted to use the completed surface after the 72-hour curing period, the lime treated material shall be further protected by additional applications of the curing membrane as required. Any damages thereto caused by traffic shall be properly corrected without additional compensation.

304.09 DIMENSIONAL TOLERANCES (TYPES A AND B TREATMENTS).

(a) **General:** Thickness and width of completed lime treated courses will be checked for determining acceptance in accordance with DOTD Designation: TR 602.

Areas not meeting the tolerances specified herein will be delineated and shall be corrected to plan dimensions by scarifying, remanipulating and recompacting the deficient areas at the contractor's expense.

(b) **Thickness Requirements:** Underthickness shall not exceed 3/4 inch. Overthickness will be waived at no additional cost to the Department.

(c) **Width Requirements:** Roadway underwidth shall not exceed 6 inches. Shoulder underwidth shall not exceed 3 inches. If lime treat-

ment for both roadway and shoulders is constructed at the same time, the 6-inch underwidth tolerance shall apply. Overwidth will be waived at no additional cost to the Department.

304.10 METHOD OF MEASUREMENT.

(a) **Lime:** Lime will be measured by the ton (2,000 pounds). If lime is furnished in bags, the number of bags used and the weight per bag will be used for measurement. When lime is furnished in bulk, the contractor shall furnish certified weights for each transport load or furnish certified scales on the project site so each transport used can be weighed.

(b) **Treatment:** The quantities of Type A, B, C and D lime treatment 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 lime treatment 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.

No measurement for payment will be made for Type E lime treatment other than measurement as specified above for the quantity of lime used.

Water used in lime treatment and asphaltic curing materials will not be measured for payment.

304.11 BASIS OF PAYMENT.

(a) **Lime:** Lime will be paid for at the contract unit price per ton.

(b) **Treatment:** Types A, B, C and D lime treatment will be paid for at the respective contract unit prices per square yard, adjusted as specified in Section 1002 for specification deviations of asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
304(1)	Lime	Ton
304(2)	Lime Treatment (Type A) (___" Thick)	Square Yard
304(3)	Lime Treatment (Type B) (___" Thick)	Square Yard
304(4)	Lime Treatment (Type C) (___" Thick)	Square Yard
304(5)	Lime Treatment (Type D) (___" Thick)	Square Yard
304(6)	Lime (Type E Treatment)	Ton

TABLE 1
LIME TREATMENT

Type	Use	Requirements
A	Base or Subbase	1. Two applications of lime 2. 48-hour mellowing or aging period 3. Pulverization after 1st application 4. Density control 5. Minimum thickness and width 6. 72-hour cure after 2nd application
B	Subbase	1. One application of lime 2. 48-hour mellowing or aging period 3. Pulverization 4. Density control 5. Minimum thickness and width 6. 72-hour cure.
C	Conditioning for Cement Treatment or Stabilization	1. One application of lime 2. 48-hour mellowing or aging period 3. Pulverization 4. Compact to engineer's satisfaction 5. No cure required
D	Working Table	1. One application of lime 2. Compact to engineer's satisfaction 3. No cure required
E	Conditioning and Drying	1. One application of lime per embankment lift 2. Embankment construction requirements.

Section 305

Subbase Treatment

305.01 DESCRIPTION. This work consists of treating subbase materials with either lime, portland cement or portland-pozzolan cement in accordance with plan details and these specifications. Subbase materials to be treated shall be existing materials furnished and placed under other pay items. The width and depth of the subbase treatment, and the required volumetric percentage of lime or cement for treatment, shall be as specified.

305.02 MATERIALS. Materials shall conform to the following Subsections:

Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Emulsified Asphalt	1002.01
Water	1018.01
Lime	1018.03

305.03 EQUIPMENT. Equipment necessary to produce a finished product meeting specification requirements shall be furnished and maintained by the contractor.

305.04 CONSTRUCTION REQUIREMENTS.

(a) **Lime Treatment:** Subbase treatment with lime shall be constructed in accordance with the requirements of Section 304 for Type B lime treatment.

(b) **Cement Treatment:** Subbase treatment with portland cement or portland-pozzolan cement shall be constructed in accordance with Section 303.

305.05 METHOD OF MEASUREMENT. The quantities of subbase treatment 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 complete subbase treatment 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.

Required lime, portland cement, portland-pozzolan cement, water and asphaltic curing materials will not be measured for payment.

305.06 BASIS OF PAYMENT. Subbase treatment will be paid for at the contract unit price per square yard, adjusted as specified in Subsection 303.10 for deficiencies in density, thickness and width and also adjusted as specified in Section 1002 for specification deviations of asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
305(1)	Subbase Treatment (___" Thick)	Square Yard

PART IV
SURFACE COURSES

Section 401

Aggregate Surface Course

401.01 DESCRIPTION. This work consists of furnishing and constructing aggregate surface courses for roadways, 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 by the engineer.

401.02 MATERIALS. The contractor has the option of furnishing any one of the following types of aggregate surface course materials (except Untreated Sand Clay Gravel) conforming to the indicated Subsections. Untreated Sand Clay Gravel shall be furnished only when specified.

Stone	1003.04(a)
Sand Clay Gravel	1003.04(b)
Lime Treated Sand Clay Gravel	1003.04(b), 1018.03
Asphalt Treated Sand Clay Gravel	1003.04(b), 1002.01
Shell	1003.04(c)

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.

401.04 SUBGRADE. The subgrade shall be prepared as provided in Section 203 and shall be approved before surfacing material is placed. On existing shoulders, all vegetation shall be removed and the shoulders shaped and compacted to the satisfaction of the engineer prior to placing aggregate surfacing. Material removed from shoulders shall be uniformly spread on adjacent slopes. Preparation of existing shoulders will not be measured for payment.

401.05 PLACING MATERIALS. The material shall be deposited directly on the subgrade from hauling vehicles or spreading equipment. No surface course shall be placed on a muddy or rutted subgrade.

Aggregate surfacing materials shall not be placed or spread on portland cement concrete or asphaltic concrete pavements, and aggregate surfacing

operations shall be conducted in such manner that pavement surfaces, edges and joints are not damaged.

401.06 MIXING.

(a) **Stone:** Stone shall be uniformly mixed, sampled in dedicated stockpiles and approved prior to placement.

(b) **Sand Clay Gravel:** Sand clay gravel shall be uniformly mixed, sampled from dedicated stockpiles and approved prior to placement.

(c) **Lime Treated Sand Clay Gravel:** Prior to treatment or placement, the sand clay gravel shall be mixed, sampled and approved as specified in (b) above. Either before or after placement, the approved aggregate shall be uniformly mixed with 6 percent lime by volume.

(d) **Asphalt Treated Sand Clay Gravel:** Prior to treatment or placement, the sand clay gravel shall be mixed, sampled and approved as specified in (b) above. Either before or after placement, the approved aggregate shall be uniformly mixed with cationic emulsified asphalt Grade CSS-1h at an application rate that results in at least 3 percent residual asphalt by weight. The asphalt shall be combined with the aggregate when the ambient air temperature is above 40°F and the moisture content of the aggregate mixture is at least 5 percent (based on total material).

(e) **Shell:**

(1) **Surface Width Less Than 5 Feet:** Shell materials shall be uniformly mixed, sampled from dedicated stockpiles and approved prior to placement.

(2) **Surface Width 5 Feet or Over:** Shell materials shall be uniformly mixed either before or after placement, at the contractor's option.

401.07 SHAPING AND COMPACTING. The material shall be shaped by suitable means while being compacted. Any ruts formed shall be filled by blading as often as necessary to prevent breaking through the surfacing material into the subgrade. Holes, waves and deficiencies in thickness which develop and are not filled by blading shall be filled by adding more material. Shaping and compacting shall continue until the surface reasonably conforms to the required sections and is free from ruts and waves. Aggregate surfacing shall be initially compacted to the satisfaction of the engineer with a 5,000-pound sheepsfoot roller with a single 3 to 4-foot diameter drum or other approved method of compaction. On narrow shoulders, the surfacing shall be initially compacted with a small vibratory roller or other approved compaction equipment in lieu of a sheepsfoot roller. Upon completion of initial compaction, the surface shall be wetted as necessary and rolled with a pneumatic-tire roller or steel-wheel roller to a tight, uniform surface.

(a) Lime Treatment: Final compaction and finishing of lime treated materials shall be completed within 72 hours after initial mixing with lime.

(b) Asphalt Treatment: Final compaction and finishing of asphalt treated materials shall be performed after curing of the asphalt (usually 48 hours after application) and shall be completed within 72 hours after initial mixing with asphalt.

401.08 DIMENSIONAL TOLERANCES. When net section measurement is specified, the thickness and width of completed aggregate surface course will be checked for determining acceptance in accordance with DOTD Designation: 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 the contractor's expense.

(a) Thickness: Underthickness shall not exceed 3/4 inch. Overthickness will be waived at no additional cost to the Department.

(b) Width: Underwidth on roadways shall not exceed 6 inches. Underwidth on shoulders shall not exceed 3 inches. Overwidth will be waived at no additional cost to the Department.

401.09 METHOD OF 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 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 in the hauling vehicles and divided by the following factor to determine the pay volume:

	Factor
Limestone	1.3
Sandstone	1.3
Sand Clay Gravel (Treated or Untreated)	1.3
Shell	1.7

Materials delivered by weight will be measured by the ton (2000 pounds) in the hauling vehicles and divided by the following factor to determine the pay volume:

	Factor
Limestone	1.95
Sandstone	1.82
Sand Clay Gravel (Treated or Untreated)	1.89
Shell	1.62

401.10 BASIS OF PAYMENT. Aggregate surface course will be paid for at the contract unit price per cubic yard, which includes furnishing and placing all required aggregate materials, water, lime or asphalt, subject to the provisions in Section 1002 for specification deviations of asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
401(1)	Aggregate Surface Course (Net Section)	Cubic Yard
401(2)	Aggregate Surface Course (Adjusted Vehicular Measurement)	Cubic Yard

PART V

ASPHALTIC PAVEMENTS

Section 501

Asphaltic Concrete Mixtures

501.01 DESCRIPTION. These specifications are applicable to asphaltic concrete wearing, binder and base course mixtures of the plant mix type. Additional specifications for asphaltic concrete friction course are contained in Section 502.

This work consists of furnishing and constructing one or more courses of asphaltic concrete mixture applied hot to the prepared and approved foundation in conformance with lines, grades, thicknesses and typical cross sections shown on the plans or established by the engineer within tolerances specified. The mixture shall consist of aggregates and asphalt with additives, combined in such proportions to meet the requirements in Table 1 of this Section.

All equipment and processes shall conform to Section 503.

No substitutions will be allowed for shoulder wearing course or Type 3 mixes without written approval. Substitutions will be allowed for other mixes as follows:

1. Wearing course for binder course.
2. Wearing or binder course for base course.
3. Higher stability for lower stability mix of the same course.

In such cases, the requirements for the mix used shall apply.

501.02 MATERIALS. The contractor shall keep accurate records, including proof of deliveries of all materials for use in the asphaltic concrete mixtures. Copies of these records shall be furnished to the engineer upon request. Materials shall conform to the following Subsections:

Asphalt	1002.01
Additives	1002.02
Aggregates	1003.06(a)
Mineral Filler	1003.06(a)(8)

(a) Asphalt: Asphalt cement Grade AC 30 shall be used. Processing shall conform to Subsection 503.09.

(b) Additives: Silicone and anti-stripping additives shall be

approved products listed on the Qualified Products List. Processing shall conform to Subsection 503.09.

(1) **Silicone:** Silicone additives, when needed, shall be dispersed into the asphalt by methods and in concentrations given in the Qualified Products List.

(2) **Anti-Stripping:** An anti-strip additive, added at the minimum rate of 0.5 percent by weight of asphalt, shall be thoroughly mixed with the asphalt cement at the plant when siliceous gravel aggregate is used. Pay adjustments will be applied in accordance with Table 2 of this Section for failure to add required anti-strip additive. Anti-strip additive will not be required when shell, limestone or expanded clay aggregate is the only coarse aggregate in the mixture.

501.03 DESIGN AND QUALITY CONTROL OF MIXTURES.

(a) General: It is the intent of these specifications that the asphaltic mixtures produced and placed shall meet the requirements for 100 percent payment. The contractor shall have responsibility for the design, production, transportation and laydown of asphaltic concrete mixtures. All phases of this work shall meet the requirements of this Section and be subject to inspection and acceptance by the Department.

The contractor shall exercise quality control over materials and their assembly, design, processing, production, hauling, laydown and all associated equipment. Quality control is defined as the constant monitoring of equipment, materials and processes to ensure that asphaltic concrete mixtures produced and laid are uniform, are within control limits, and meet all requirements in Table 1 of this Section and other specification requirements. If 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, but correlated with, the Department's acceptance testing and shall verify that all requirements of the job mix are being achieved and that necessary adjustments provide specification results.

The contractor should conduct such tests as are necessary in addition to the required tests to design, control and place mixtures within the limits of the specifications for the type mix produced.

The quality of asphaltic concrete mixtures will be evaluated during two separate process phases, (1) mixture produced at the plant and (2) mixture hauled, laid and compacted in its final state on the roadway. Quality of both phases, plant and roadway, will be evaluated in series of lots. 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. If a plant is producing mix simultaneously for different Department projects or purchase orders, the lot is the total lot quantity as detailed in Subsection 501.12. Plant quality control testing shall be conducted on each lot independent of delivery points. Roadway quality control testing shall be conducted on each project for that portion of the lot placed on that project.

At all times when the plant is in operation, the contractor shall have a Certified Asphaltic Concrete Technician at the plant or jobsite who is capable of designing the asphaltic concrete mixes, conducting any test or analysis necessary to put the plant into operation and producing a mixture meeting the specifications. Daily plant operations shall not begin unless the Certified Asphaltic Concrete Technician is present at the plant. The Asphaltic Concrete Technician certification will be awarded by the Department upon satisfactory completion of an examination.

(b) Job Mix Formula: The contractor will be required to design the mixtures for optimum asphalt content and comply with all requirements of DOTD Designation: TR 303, Method A; however, Method B may be used when approved. The job mix formula shall be submitted for approval to the District Laboratory Engineer on an Asphaltic Concrete Job Mix Release Form properly completed and supported by appropriate design data. No mixture shall be produced until the contractor's job mix formula has been approved. The job mix formula will allow the full range of gradation mix tolerances within the mix type specification limits.

The plant shall be so operated as to produce on a continuing basis a mixture conforming to the approved job mix formula, the requirements in Table 1 of this Section and other specification requirements. When this is not the case, the contractor shall begin making satisfactory adjustments or cease operations. The District Laboratory Engineer may permit the contractor to submit a new Asphaltic Concrete Job Mix Release Form for approval.

501.04 WEATHER LIMITATIONS. Asphaltic concrete mixtures shall not be applied on a wet surface or when the air temperature in the shade and away from artificial heat is below 45°F, except that material in transit or in surge bins at the time plant operation is discontinued may be laid; however, the mixtures laid shall perform satisfactorily and meet specification requirements.

If materials are placed in thicknesses of 2 3/4 inches or greater, these temperature limitations shall not apply provided all other requirements of the specifications are met.

501.05 SURFACE PREPARATION: The surface to be covered

shall be prepared and approved prior to placing asphaltic concrete mixtures. The contractor shall maintain the prepared surface until covered.

(a) **Cleaning:** The surface to be covered shall be swept clean of dust, dirt, caked clay and loose foreign 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 previously overlaid portland cement concrete pavement, the contractor shall remove excess joint filler from the surface by an approved burning method.

(b) **Applying Liquid Asphaltic Materials:** Before constructing a layer of asphaltic concrete, an approved asphaltic material shall be applied as directed to the underlying surface.

(1) **Existing Pavement Surfaces:** Before constructing each course, an approved asphaltic tack coat shall be applied in accordance with Section 504. The contractor shall protect the tack coat and spot patch as required.

(2) **Raw Aggregate Base Course and Raw Embankment Surfaces:** The contractor shall protect the in-place asphaltic prime coat and spot patch as required with asphaltic prime coat in accordance with Section 505. Prime coat will not be required for pavement patching, pavement widening or paved drives and turnouts.

(3) **Cement and Lime Stabilized or Treated Embankment and Base Course Surfaces:** The contractor shall protect the in-place asphaltic curing membrane and spot patch as required with asphaltic material conforming to Section 506.

(4) **Other Surfaces:** Contact surfaces of curbs, gutters, manholes, longitudinal edges and joints and other structures shall be painted with a thin, uniform coating of asphaltic tack coat conforming to Section 504 before placing the asphaltic mixtures.

501.06 JOINT CONSTRUCTION. Longitudinal joints in 1 layer shall offset those in the layer immediately below by approximately 3 inches; however, the joint in the top layer shall be offset 3 to 6 inches from the centerline of pavement if the roadway comprises 2 lanes of width, or offset 3 to 6 inches from lane lines if the roadway is more than 2 lanes.

Transverse joints shall be butt joints formed by cutting back on the previously placed mixture to expose the full depth of the course. Transverse joints in succeeding courses shall be offset at least 2 feet. When directed, asphaltic tack coat shall be placed on contact surfaces of transverse joints before additional mixture is placed against them.

501.07 HAULING, SPREADING AND FINISHING. Mixtures shall be transported from the plant and delivered to the paver at the site of

work at a temperature no cooler than 25°F below the lower limit of the approved job mix formula. No loads shall be sent out so late in the day as to prevent completion of spreading and compaction of the mixture during daylight, unless artificial lighting has been approved.

Each course of asphaltic mixture shall be placed in accordance with the lift thickness requirements shown on the plans. If no lift requirements are shown on the plans, binder and wearing course mixture shall be placed in lifts not exceeding 2 1/2 inches thick, unless thicker lifts are permitted by the engineer; base course mixtures shall be placed in lifts of such thickness that all specification requirements are met.

With the engineer's approval, blade graders may be used to fill isolated depressions in the initial layer.

(a) Coordination of Production: The contractor shall coordinate and manage plant production, transportation of mix and laying operations to achieve a high quality pavement and shall have sufficient hauling vehicles to insure reasonably continuous plant and roadway operations with minimum idle time between loads. The Department reserves the right to order a halt to operations if sufficient hauling vehicles are not available. If less than the optimum number of hauling vehicles are available and it is determined that satisfactory quality can be obtained, the contractor will be permitted to work provided plant production and hauling vehicles are coordinated to minimize the effect of idle time between loads.

(b) Paving Operations: Transfer of asphaltic mixture from haul truck to paver may be made by direct unloading into the spreader hopper or by use of approved mechanical loading devices. Delivery of material to the paver shall be at a uniform rate and in an amount within the capacity of paving and compacting equipment. Equipment shall be so designed and operated that the finishing machine will place mixtures to required line, grade and surface finish without resorting to hand finishing. Equipment which leaves tracks or indented areas which cannot be corrected in normal operations, or which produces flushing or other permanent blemishes, or fails to produce a satisfactory surface shall not be used. Any operation of equipment resulting in accumulation of material and subsequent shedding of accumulated material into the asphaltic mixture will not be permitted.

All mixtures shall flow through the spreader hopper. Mixtures dropped on the pavement in front of the spreader shall be either lifted into the hopper or rejected and cast aside.

Longitudinal joints and edges shall be constructed along reasonably true lines. These lines shall be established by the engineer, and stringlines or other devices 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 directly behind the paver.

After the first load of material has been spread, 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 initial compaction. Segregation of materials will not be permitted. If segregation occurs, spreading operations shall be immediately suspended until the cause is determined and corrected.

Irregularities in the surface shall be corrected directly behind the paver. Excess material forming high spots shall be removed. Indented areas shall be filled and finished reasonably smooth. Casting of material over the surface will not be permitted on the final wearing course layer.

Edges shall be tamped prior to rolling. All edges, except outside edges of the final wearing course, shall be reasonably vertical. The outside edge of the final wearing course layer shall be beveled to approximately 45°.

If spreading and finishing operations are interrupted to such extent that some of the mixture remaining in trucks, paver, spreader hopper or on the roadway cools to such extent that it cannot be laid, 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 the contractor's expense.

The 30-foot (minimum) traveling stringline method of construction will be required except where the engineer directs the use of an erected stringline.

The following requirements shall apply for mechanical pavers:

(1) 30-Foot (Minimum) Traveling Stringline: The initial lane of each layer of mixture shall be constructed using the traveling stringline and automatic slope control method; however, if permitted, the portion of mixtures required to level isolated depressions in the initial layer may be placed without automatic screed control.

After the initial lane of each layer is finished and compacted, adjacent lanes shall be laid to the grade of the initial lane using a shoe device or traveling stringline to control grade and a slope control device to control cross slope.

If directed, the traveling stringline shall be used to control the grade of adjacent lanes on all layers. In construction of multilane pavements, the sequence of lane construction will be subject to approval of the engineer.

If both outside edges of the lane 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 as the paver is in motion so that a smooth transition in grade is obtained. This change in cross slope shall be accomplished within the transition distance specified.

(2) **Erected Stringline:** The initial lane of the first layer of mixture shall be constructed using an erected stringline referenced to grade established by the engineer; however, if permitted, the portion of the mixtures required to level isolated depressions may be placed without automatic screed control. Subsequent layers may be constructed by use of the traveling stringline attached to the paver, provided surface and grade tolerances are met on the previous layer.

Only one grade sensor and the slope control device are necessary for normal crown on tangents. Superelevated curves will require the use of 2 grade sensors and 2 erected stringlines to obtain proper grade and slope; however, if the automatic screed control device furnished by the contractor 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 lane of the first layer is finished and compacted, adjacent lanes shall be laid in accordance with the methods described in Heading (1) above.

(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 Spreading:** In areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand to the satisfaction of the engineer. Casting of mixtures from the truck to the grade will not be permitted. During spreading operations, all 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 all irregularities corrected.

501.08 COMPACTION. After spreading and striking off and while still hot, each layer shall be thoroughly and uniformly compacted to the density shown in Table 1 of this Section by rolling.

The number and weight of rollers shall be sufficient to compact the mixture to the specified density and surface smoothness while it is in a

workable condition and they shall be capable of maintaining the pace of the paver. The use of rollers which result in crushing of aggregate will not be permitted.

Rolling shall be conducted in consistent sequences and by uniform methods that will obtain the specified density and smoothness. Each roller shall be operated by a competent, experienced operator and, while the work is underway, shall be kept as nearly as practicable in a continuous and uniform operation.

The motion of rollers shall be slow enough to avoid displacement of mixtures. Any displacement occurring as a result of reversing the direction of rollers or from any other cause shall be immediately corrected. To prevent adhesion of mixture to roller, wheels shall be kept properly moistened, but excess water will not be permitted. Rolling shall continue until roller marks have been eliminated.

If a pneumatic-tire roller is used, the highest contact pressure that will give the specified density shall be used. The pneumatic-tire roller shall be kept approximately 6 inches from unsupported edges of the lane; however, when more than one lane is down, it shall be overlapped at least 6 inches to obtain additional sealing of the joint.

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 where mix is placed on newly constructed cement or lime stabilized or treated base or subbase course unless permitted.

Along forms, curbs, headers and walls and at other places not accessible to the roller, the mixture shall be thoroughly and uniformly compacted to the specified density with hot hand tampers or mechanical tampers.

Surface of mixtures after compaction shall be smooth and true to established cross slope and grade within the tolerances specified. Mixtures that become loose, broken, contaminated or in any way defective shall be removed and replaced with fresh hot mixture which shall be immediately compacted to conform with the surrounding area.

Newly finished pavements shall be protected from traffic until they have sufficiently hardened.

501.09 PAVEMENT SAMPLES. The contractor shall furnish samples cut from the completed work. The area of pavement so removed shall be replaced with new mixture and refinished. 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 Subsection 501.12(c); however, cores less than 1 1/4 inches thick shall not be used as pavement samples. Saws or core drills of

an approved type will be required. The size of each sample shall be approximately 4 inches square or 4 inches in diameter.

501.10 SURFACE FINISH REQUIREMENTS: Testing of each course for surface tolerances as outlined in Table 1 of this Section will be the responsibility of the Department. Control checks for these courses and all other courses will be the responsibility of the contractor. The contractor shall furnish a 10-foot rolling straightedge for longitudinal testing and a 10-foot (minimum) static straightedge for transverse testing, both of which shall be acceptable to the engineer. The rolling straightedge shall be calibrated and used in accordance with DOTD Designations: TR 603 and TR 618.

Surface finish testing will be required on roadway wearing and binder courses and shoulder wearing course. For the purpose of surface finish requirements, the wearing course is defined as the last course placed, friction course excluded; and the binder course is defined as the last course placed prior to the wearing course.

Other courses on which additional asphaltic concrete is to be placed shall be finished in such manner that succeeding courses will meet the requirements in this Section. Base courses on which portland cement concrete pavement is to be placed shall be finished in such manner that the pavement will meet the requirements of Section 601. The contractor should conduct such checks as he deems necessary.

(a) Longitudinal Surface Finish: The finished surface will be tested by the engineer in the longitudinal direction for conformance to surface finish requirements in Table 1 of this Section. One path in each lane will be selected at random in accordance with the Department's Materials Sampling Manual. The entire lot will be tested.

Longitudinal variations in the roadway wearing course surface, friction course excluded, will be subject to provisions of Subsection 501.12(d). Surface finish deficiencies exceeding 1/4 inch shall be corrected in accordance with Heading (e) of this Subsection. After corrections have been made, the entire lot will be subject to the provisions of Subsection 501.12(d).

Longitudinal surface finish variations in binder course and shoulder wearing course shall be subject to the provisions of Table 1 of this Section. Deficiencies shall be so corrected that no more than 3 percent of the lot exceeds tolerances. Any surface finish deficiency that exceeds 3/8 inch shall be corrected in accordance with Heading (e) of this Subsection.

(b) Transverse Surface Finish: The transverse surface finish shall be so controlled that the values shown in Table 1 will not be exceeded. The surface for binder and wearing courses will be tested at

selected locations by the engineer in the transverse direction for conformance to surface finish requirements of Table 1 of this Section. Corrections shall be made as directed in accordance with Heading (e) of this Subsection.

(c) Cross Slope: When the plans require the section to be constructed to a specified cross slope, tests shall be run at selected locations, using a stringline, slope board or other comparable method. The cross slope shall be so controlled that the values shown in Table 1 of this Section will not be exceeded. Cross slope variations allowed in Table 1 shall apply to each lane constructed.

(d) Grade: When the plans require the pavement to be constructed to a grade, tests for conformance shall be run at selected locations, using a stringline or other comparable method. Grade variations shall be so controlled that the tolerance shown in Table 1 of this Section will not be exceeded. If the pavement is consistently above or below the established grade for a reasonably long segment, the engineer may, for the purpose of determining conformance to the tolerance, use a new grade approximately parallel to the established grade; in which case, any required transition in grade or vertical curve at each extremity of the segment will be in accordance with the best design requirements. Grade tolerances shall apply to only one longitudinal line, such as the centerline or outside edge of pavement. Corrections shall be made in accordance with Heading (e) of this Subsection.

(e) Correction of Deficient Areas: Deficiencies to be corrected in the final wearing course shall be corrected by milling, removing and replacing, or furnishing and placing a supplemental layer of wearing course mixture at least 1 inch thick for the full width of the roadway; all in a satisfactory manner at no additional cost to the Department. Deficiencies to be corrected in binder and shoulder courses shall be corrected in a satisfactory manner at no additional cost to the Department. All corrections shall be made before subsequent courses are constructed.

501.11 DIMENSIONAL REQUIREMENTS: Mixtures that are specified for payment on a cubic yard or square yard basis shall conform to the following dimensional requirements. Overthickness and overwidth will be waived at no additional cost to the Department.

(a) Thickness: The thickness of the mixture shall be determined in accordance with DOTD Designation: TR 602. Underthickness shall not exceed the following tolerances.

Plan Thickness	Underthickness Tolerances
4″ or less	1/4″
More than 4″	1/2″

For all mixtures except the final surface course, areas with underthickness in excess of the foregoing tolerances shall be corrected to plan thickness at the contractor's expense by furnishing and placing additional mixture as required. For the final surface course, areas with underthickness in excess of the foregoing tolerances shall be corrected to plan thickness at the contractor's expense by furnishing and placing a supplemental layer of wearing course mixture; however, the supplemental layer shall be at least 1 inch thick and shall be placed over the entire area for the full width of the roadway.

(b) **Width:** The width of completed courses will be determined in accordance with DOTD Designation: TR 602. Underwidth of completed base course mixtures shall not exceed 3 inches on each side of the roadway; underwidth of completed binder or wearing course mixtures shall not exceed 1 1/2 inches on each side of the roadway. Underwidths in excess of the foregoing tolerances shall be corrected to plan width at the contractor's expense by furnishing and placing additional mixture as required.

501.12 ACCEPTANCE REQUIREMENTS. Asphaltic concrete mixtures placed on the roadway shall meet all requirements of Table 1 of this Section. Any section of the roadway or portion of the mixture that is obviously deficient shall be satisfactorily corrected or replaced. Sampling and testing for the purpose of determining acceptability shall be conducted on each lot of material in accordance with Headings (a) Marshall Stability, (b) Aggregate Gradation, (c) Pavement Density and (d) Surface Tolerance. Final approval of mixtures will be the responsibility of the Department.

All sampling and testing shall be accomplished following a stratified sampling plan in accordance with the Department's Materials Sampling Manual. All times and locations shall be set by the engineer.

A lot is 1,000 tons of consecutive production of asphaltic concrete mix from the same job mix formula produced for the Department at an individual plant; however, minor adjustments will be made in the 1,000-ton lot size to accommodate hauling unit capacity. Acceptance testing for Marshall stability and aggregate gradation will be conducted on the total lot quantity. Acceptance testing for pavement density, surface tolerance and dimensional tolerances will be conducted for each contract on that portion of the lot placed on the roadway.

When historical records indicate good and uniform mix, the lot size may be increased when agreed upon by the engineer and contractor. The engineer may decide upon a smaller lot size when the total interval between continuous production exceeds 2 days, or a new job mix formula is accepted, or the final lot is less than 1,000 tons. In the event of a smaller lot

size, the plant mix shall be accepted on the average values of those tests run.

(a) Marshall Stability: Acceptance testing for Marshall Stability will be conducted by the Department. Compacted specimens of mixture shall conform to the properties in Table 1 of this Section when tested in accordance with DOTD Designation: TR 305 for both an individual sample and an average of 4 samples taken from each lot after the mixture is placed in trucks. A sampling plan shall be utilized such that 1 sample from each of 4 sublots is obtained. Mix temperature at the time of molding specimens shall be within 15°F of mix temperature at the time of sampling.

When an individual test or the average of tests representing the lot is outside acceptance limits shown in Table 1 of this Section, an adjustment in unit price for the lot will be made in accordance with Table 2 of this Section.

(b) Aggregate Gradation: Acceptance testing for aggregate gradation will be conducted by the contractor's technician and observed by the Department's inspector. Two samples from each lot of mixture produced will be sampled after placement in trucks. A sampling plan shall be utilized such that 1 sample from each of 2 sublots is obtained; however, if either or both of these tests fail to meet specification requirements, the contractor may obtain a third sample. The sampling location for the third sample will be subject to approval of the engineer, and test results for the 3rd sample will be averaged with the other 2 sample test results for the lot. Each sample shall be tested in accordance with DOTD Designations: TR 308 and TR 309.

If test results for a lot are outside the job mix control limits for aggregate gradation given in Table 1 of this Section, an adjustment in unit price for the lot will be made in accordance with Table 2 of this Section. This adjustment in unit price is determined by percent deviation from job mix control limits for the Nos. 4, 40 and 80 sieves, and only the sieve with the greatest adjustment in unit price will be used. The lot is represented by 2 sieve analysis tests. Deviations of gradation will be calculated for each test and the deviations will be averaged for determination of adjustment in unit price.

(c) Pavement Density: Upon completion of compaction, 5 pavement samples per contract shall be obtained in accordance with Subsection 501.09 from each lot within 24 hours after placement of the lot. If this falls on a day the contractor's crews are not working, the sampling will be done the following working day. The lot will be divided into 5 sublots of approximately equal length and 1 sample shall be obtained from each sublot. In no event will the number of samples representing a

lot be less than 5. Acceptance testing for pavement density will be conducted by the Department. The density requirement for the average of 5 samples will be as shown in Table 1 of this Section, determined in accordance with DOTD Designation: TR 304. Payment will be made in accordance with Table 2 of this Section.

If the sampling location as determined by random sampling indicates obvious bad spots that are to be replaced or falls within 2 feet of the pavement edge, another random sampling location will be used. Asphaltic mixtures placed in layers less than 1 1/4 inches thick will not be sampled for density testing; however, such layers shall be compacted by approved methods.

(d) **Surface Tolerance:** Acceptance testing for surface tolerance will be required for each lot only on the final wearing surface excluding friction course. The surface will be tested with a 10-foot rolling straightedge in the longitudinal direction of the pavement within the time period prescribed in Heading (c) of this Subsection. The rolling straightedge shall be furnished by the contractor and shall be calibrated and used by the Department in accordance with DOTD Designations: TR 603 and TR 618. Surface corrections shall be made in accordance with Subsection 501.10.

The requirements for surface tolerance shall be as shown in Table 1 of this Section. Whenever 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 2 of this Section.

501.13 METHOD OF MEASUREMENT. Measurements will be made by one of the following methods as indicated. Asphaltic tack coat, prime coat or curing membrane required will not be measured for payment.

(a) **Weight Measurement:** Asphaltic concrete will be measured by the ton of 2,000 pounds from printed weights as provided in Section 503.

Stamped printer tickets will be issued for each truck load of material delivered. That portion of material lost, wasted, rejected or applied contrary to these specifications will not be measured for payment.

The estimated quantities of asphaltic concrete shown on the plans are based on 110 pounds per square yard per inch thickness. The measured quantities will be multiplied by the appropriate factor given below to determine the pay quantities.

Gravel, Slag, Sandstone or Clam Shell	1.00
Reef Shell	1.04
Expanded Clay	1.33
Limestone, or Limestone and Sand	0.97

When a combination of these aggregate types is used, the multiplier factor will be based on the weight ratio of the coarse aggregates set at the cold feed.

(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 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 the horizontal dimensions and compacted thickness of the completed course shown on the plans.

501.14 BASIS OF PAYMENT. Asphaltic concrete will be paid for at the contract unit price per unit of measurement on a lot basis. Whenever the mix does not conform to the acceptance requirements, payment will be made at an adjusted price per unit of measurement in accordance with Section 1002 and Table 2 of this Section.

(a) General: Payment for asphaltic concrete will include furnishing all required materials, producing the mixtures at the plant, preparing the surfaces on which the mixtures are placed, hauling the mixtures from the plant to the work site, and placing and compacting the mixtures.

(b) Wearing Course Mixes: The lowest percentage of contract price will be used for final adjustment in unit price for deficiencies in Marshall stability, pavement density, surface tolerance, aggregate gradation, anti-strip additive and asphalt cement properties (Section 1002).

(c) Base, Binder and Shoulder Mixes: The lowest percentage of contract price will be used for final adjustment in unit price for deficiencies in Marshall stability, pavement density, aggregate gradation, anti-strip additive and asphalt cement properties (Section 1002).

(d) Erected Stringline: If the use of an erected stringline is not specified, but is ordered by the engineer, an additional payment of 1 percent of the contract unit price will be made for that quantity placed by the erected stringline method; however, if the use of an erected stringline is specified, no additional payment will be made.

Payment will be made under:

Item No.	Pay Item	Pay Unit
501(1)	Asphaltic Concrete	Ton
501(2)	Asphaltic Concrete	Cubic Yard
501(3)	Asphaltic Concrete (__" Thick)	Square Yard

TABLE 1
REQUIREMENTS FOR ASPHALTIC CONCRETE MIXTURES

A. Mixture Requirements

U. S. Sieve	Type 1		Type 2	Type 3		Type 4	Type 5 Base		Shoulder Mix	Mix Tolerances %
	WC	BC	WC & BC	WC	BC	WC & BC	A	B	WC & BC (2)	
1 1/2"	—	—	—	—	—	—	100			±6
1 1/4"	—	100	—	—	100	—	—			±6
1"	100	90-100	100	100	90-100	—	80-100			±6
3/4"	85-100	75-100	90-100	85-100	75-100	100	—			±6
1/2"	70-100	55-95	80-100	70-100	55-95	80-100	—			±9
3/8"	—	—	—	—	—	—	—			±7
No. 4	40-70	35-70	50-80	40-70	35-70	55-85	35-75			±7
No. 10	25-55	20-50	35-65	25-55	20-50	45-75	—			±6
No. 40	8-33	8-33	15-40	8-33	8-33	20-55	10-55			±5
No. 80	5-20	5-20	5-20	5-20	5-20	10-25	—			±4
No. 200	2-10	2-10	2-10	2-10	2-10	2-12	2-15			±2
Extracted Asphalt %	—	—	—	—	—	—	—			±0.4
Mix Temperature										±25°F
% Crushed Ret. on No. 4 (8)	75 Min.	60 Min.	—	80 Min.	60 Min.	—	As Needed		60 Min.	
Coarse Aggregate (1)	A,B,C	A,B,C, D,E	E	A,B,C	A,B,C, D,E	F	A,B,C,D,E,F,G		A,B,C,D,E,F	
Marshall Stab. (lbs.)										
No. of Blows	75	75	75	75	75	75	75	50	50	
Avg. of 4 Tests										
Design (3)	1400	1400	1400	1900	1600	1400	1400	1100	1200	
Minimum	1200	1200	1200	1700	1400	1200	1200	900	1000	
Individual Test (min.)	1000	1000	1000	1400	1200	1000	1000	800	800	
Mar. Flow (1/100")	15 Max.	15 Max.	15 Max.	15 Max.	15 Max.	15 Max.	15 Max.	15 Max.	8-18	
%Voids	3-5	3-6	3-5 3-6	3-5	3-6	3-7	3-6	3-5	2-5	
%VFA	70-80	65-75	70-80 65-75	70-80	65-75	65-80	65-75	70-80	75-85	−3

B. Pavement Requirements

Density: Roadway 95.0%, Shoulder 94.0%

Surface Finish Variation, inches	Longitudinal (7)	Transverse	Cross Slope (4)	Grade (5)
Roadway Wearing Course	1/8 (6)	1/8	3/8	1/2
Binder Course	1/4	1/4	1/2	1/2
Shoulder Wearing Course	3/16	3/16	3/4	3/4

(1) A - Crushed gravel, B - Crushed slag, C - Crushed stone approved for wearing surface, D - Crushed stone, E - Crushed clam or reef shell, F - Expanded clay, G - Pit run sand clay gravel. Crushing not required in base mixtures.
(2) Requirements not shown are same as shown for applicable type mix.
(3) The contractor shall design a mixture at a stability value based on historical plant performance that will ensure compliance with 100 percent payment requirements for the average of 4 samples. Values listed may be used as guide.
(4) Based on 10 feet.
(5) Applicable only when grade is specified.
(6) To be used for acceptance testing.
(7) Based on a 10-foot rolling straightedge.
(8) Determined in accordance with DOTD Designation: TR 306.

TABLE 2
PAYMENT ADJUSTMENT SCHEDULES

Percent of Contract Unit Price/Lot (1)

	100	98	90	80	50 or Remove (2)
Marshall Stability:					
Type 1, 2 or 4 WC & BC, and Type 5A Base					
Lot (Average)	1200 & Above		1100 to 1199	1000 to 1099	Below 1000
Individual Test Within Lot	1000 & Above	Below 1000			
Type 3 WC					
Lot (Average)	1700 & Above		1550 to 1699	1350 to 1549	Below 1350
Individual Test Within Lot	1400 & Above	Below 1400			
Type 3 BC					
Lot (Average)	1400 & Above		1300 to 1399	1150 to 1299	Below 1150
Individual Test Within Lot	1200 & Above	Below 1200			
Shoulder Mix					
Lot (Average)	1000 & Above		900 to 999	800 to 899	Below 800
Individual Test Within Lot	800 & Above	Below 800			
Type 5B Base					
Lot (Average)	900 & Above		850 to 899	800 to 849	Below 800
Individual Test Within Lot	800 & Above	Below 800			
Pavement Density:					
Av. of 5 Samples (% of Laboratory Density)					
95.0	95.0 & Above		94.0 to 94.9	92.0 to 93.9	Below 92.0
94.0	94.0 & Above		93.0 to 93.9	91.0 to 92.9	Below 91.0
Surface Tolerance:					
Linear % of Pavement Exceeding 1/8" Surface Tolerance	0.0 to 1.0		1.1 to 1.5	1.6 to 2.5	Over 2.5
Aggregate Gradation:					
Deviations From Job Mix Formula Limits for Extracted Aggregate					
No. 4 Sieve	0 to 1.0	1.1 to 4.0	4.1 to 8.0		Over 8.0
No. 40 & 80 Sieves	0 to 1.0	1.1 to 3.0	3.1 to 6.0		Over 6.0
Anti-Strip Additive			Failure to Add		

(1) Portion of lot placed on the project.
(2) At the option of the engineer.

Section 502

Asphaltic Concrete Friction Course

502.01 DESCRIPTION. This work consists of furnishing and constructing a thin asphaltic concrete friction course (ACFC) on a prepared surface in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer.

All equipment and processes shall conform to Section 503.

502.02 MATERIALS. The contractor shall keep accurate records, including proof of deliveries of all materials for use in the asphaltic concrete friction course mixtures. Copies of these records shall be furnished to the engineer upon request. Materials shall conform to the following Subsections.

Asphalt	1002.01
Additives	1002.02
Aggregates	1003.06(b)

Friction course shall be composed of asphalt cement with anti-stripping additive and either slag, expanded clay or crushed stone at the contractor's option in accordance with Table 3 of this Section.

(a) **Asphalt:** Asphalt cement Grade AC 30 shall be used. Processing shall conform to Subsections 502.06 and 503.09.

(b) **Additives:** Silicone and anti-stripping additives shall be approved products listed on the Qualified Products List. Processing shall conform to Subsection 503.09.

(1) **Silicone:** Silicone additives, when needed, shall be dispersed into the asphalt by methods and in concentrations given in the Qualified Products List.

(2) **Anti-Stripping:** An anti-strip additive, added at the minimum rate of 0.5 percent by weight of asphalt, shall be thoroughly mixed with the asphalt cement at the plant. Pay adjustments will be applied in accordance with Table 4 of this Section for failure to add required anti-strip additive.

(c) **Aggregates:** All aggregates will be sampled and approved at the

plant site prior to incorporation in the mixture. Processing shall conform to Subsections 502.06 and 503.08.

502.03 DESIGN AND QUALITY CONTROL OF MIXTURES.

(a) General: The contractor shall have responsibility for the design, production and laydown of asphaltic concrete mixtures. All phases of this work shall meet the requirements of this Section and be subject to inspection and acceptance by the Department.

The contractor shall exercise quality control over materials and their assembly, design, processing, production, hauling, laydown and all associated equipment. Quality control is defined as the constant monitoring of equipment, materials and processes to ensure that asphaltic concrete mixtures produced and laid are uniform, are within control limits, and meet all requirements in Table 3 of this Section and other specification requirements. If these specifications are not being met and satisfactory control adjustments are not immediately made, operations shall be discontinued until proper adjustments and uniform operations are established. Control shall be accomplished by a program independent of, but correlated with, the Department's acceptance testing and shall verify that all requirements of the job mix are being achieved and that necessary adjustments provide specification results.

The contractor shall conduct such tests as are necessary in addition to the required tests to design, control and place mixtures within the limits of the specifications for the type mix produced.

At all times when the plant is in operation, the contractor shall have a Certified Asphaltic Concrete Technician present who is capable of designing the asphaltic concrete mixes at the plant, conducting any test or analysis necessary to put the plant into operation and producing a mixture meeting the specifications. The Asphaltic Concrete Technician certification will be awarded by the Department upon satisfactory completion of an examination.

(b) Job Mix Formula: The contractor will be required to design the mixtures for optimum asphalt content and comply with all requirements of DOTD Designation: TR 303. The job mix formula shall be submitted for approval to the District Laboratory Engineer on an Asphaltic Concrete Job Mix Release Form properly completed and supported by appropriate design data. No mixture shall be produced until the contractor's job mix formula has been approved. The extracted asphalt content shall reasonably verify the design asphalt content in the approved job mix formula. The job mix formula will allow the full range of gradation mix tolerances within the mix type specification limits.

The plant shall be so operated as to produce on a continuing basis a

mixture conforming to the approved job mix formula, the requirements of Table 3 of this Section and other specification requirements. When this is not the case, the contractor shall begin making satisfactory adjustments or cease operations. The District Laboratory Engineer may permit the contractor to submit a new Asphaltic Concrete Job Mix Release Form for approval.

502.04 WEATHER LIMITATIONS. The ACFC shall only be placed during the months of May, June, July, August and September. Mixtures shall not be placed on a wet surface or when the air temperature in the shade and away from artificial heat is below 70°F, except that material in transit or in surge bins at the time plant operation is discontinued may be placed; however, the mixtures placed shall perform satisfactorily and meet specification requirements.

502.05 SURFACE PREPARATION: The surface to be covered shall be prepared and approved prior to placing asphaltic concrete friction course. The contractor shall maintain the prepared surface until covered.

(a) **Cleaning:** The surface to be covered shall be swept clean of dust, dirt, caked clay and loose foreign material by revolving brooms or other mechanical sweepers supplemented with hand equipment as directed.

(b) **Pavement Surfaces:** Before constructing this course, an approved asphaltic tack coat shall be applied in accordance with Section 504 with the following exceptions. Tack coat application rate shall be as directed, but not less than 0.05 nor more than 0.10 gallon per square yard. The tack coat shall be applied on the same day that the ACFC is placed and shall be uniformly spread over the entire surface by means of any pneumatic-tire roller acceptable to the engineer. The engineer may waive the pneumatic-tire roller requirement if emulsified asphalt is used and the spread is uniform and complete. The contractor shall protect the tack coat and spot patch as required.

502.06 PREPARATION OF ASPHALT AND AGGREGATES. The asphalt cement shall be heated to the temperature specified in the job mix formula in a manner that will avoid local overheating and provide a continuous supply of asphalt to the mixer at a uniform temperature.

Aggregates shall be dried and heated to the required temperature. The moisture content of the aggregates shall be uniform and shall not exceed 12 percent by weight at the time they are placed in the dryer. Burners used for drying shall be properly adjusted to avoid contamination with soot or oil. Aggregates thus contaminated will be rejected.

Aggregates shall be mixed with asphalt cement to produce a mixture with a job mix temperature not exceeding 280°F, except that the job mix temperature may be increased to a maximum of 300°F when expanded clay

aggregate is used. Mixing of asphalt and aggregates shall continue until aggregates are uniformly and thoroughly coated with asphalt.

502.07 HAULING, SPREADING AND FINISHING. Asphaltic mixtures shall be transported from the plant to the project site in vehicles conforming to Section 503. All loads shall be covered during transit unless placed within 30 minutes after mixing; however, the engineer may require that all loads be covered in transit regardless of the time interval between mixing and placing. Spreading and finishing shall be in accordance with Subsection 501.07 with the following amendments.

The temperature of the mixture at time of placement shall be no cooler than 25°F below the lower limit of the approved job mix formula and in no case shall be lower than 200°F; however, for expanded clay aggregate mixtures the temperature of the mixture shall not be less than 240°F. The friction course shall be transported and placed with a minimum of separation of asphalt and aggregates. Excessive haul distances and haul times may result in separation and consequent rejection.

Spreading and finishing machines, equipped with approved automatic screed and slope control devices, shall be used with the 30-foot traveling stringline. Hand spreading shall not be used unless permitted.

Longitudinal joints shall be offset 3 to 6 inches from the centerline of pavement if the roadway comprises two lanes of width, or offset 3 to 6 inches from the lane lines if the roadway is more than two lanes. Transverse joints shall be in accordance with Subsection 501.06.

502.08 COMPACTION. Immediately after placement, friction course shall be uniformly compacted to the satisfaction of the engineer with a tandem steelwheel roller of such weight as to accomplish acceptable density without excessive breakage of the aggregate, followed by uniform coverage with a pneumatic-tire roller conforming to Section 503.

Sections of newly finished friction course shall be protected from traffic until it has sufficiently hardened.

502.09 SURFACE TOLERANCES. Due to the composition and nature of friction course, no fixed surface tolerances will be established; however, the mixture shall be placed by approved methods that will provide uniform thickness and texture of the friction course layer.

502.10 ACCEPTANCE. Acceptance testing for aggregate gradation will be conducted by Department personnel. Two samples will be taken by Department personnel from each lot of mixture produced. A lot will be considered as one day's production of a given mixture. One sample will be taken during the first half of the workday and another during the second half using random sampling techniques described in the Department's Materials Sampling Manual. Each sample will be tested by the

Department in accordance with DOTD Designations: TR 308 and TR 309; however, when permitted, testing may be performed by the contractor's technician and observed by Department personnel. Results of tests made by the Department will be available for the contractor's use at the convenience of the Department.

If the results obtained from acceptance testing of a lot are outside the control limits for aggregate gradation given in Table 3 of this Section, an adjustment in unit price for the lot will be made in accordance with Table 4 of this Section. This adjustment in unit price will be determined by percent deviation from control limits for the No. 4 and No. 10 sieves, and only the sieve with the greater adjustment in contract unit price will be used in assessing the price adjustment. The lot is represented by 2 sieve analysis tests. Deviation of gradation will be calculated for each test and the 2 deviations will be averaged for determination of adjustment in unit price. If the cessation of operations results in only 1 sieve analysis test, the mixture will be accepted on the basis of the 1 test.

502.11 METHOD OF MEASUREMENT. Quantities 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.

The design areas of asphaltic concrete friction course are based on the horizontal dimensions shown on the plans. Asphaltic tack coat will not be measured for payment.

502.12 BASIS OF PAYMENT. Asphaltic concrete friction course will be paid for at the contract unit price per square yard subject to the price adjustment provisions of Table 4 of this Section for aggregate gradation deviations and anti-strip additive, and Section 1002 for specification deviations of asphaltic materials. The lowest percentage of contract unit price will be used for final payment adjustment.

Payment will be made under:

Item No.	Pay Item	Pay Unit
502(1)	Asphaltic Concrete Friction Course	Square Yard

TABLE 3
REQUIREMENTS FOR ASPHALTIC CONCRETE FRICTION COURSE MIXTURES

U.S. Sieve	Type A	Type B	Mix Tolerances
3/4"	- - -	100	- - -
1/2"	100	90-100	- - -
3/8"	90-100	50-80	± 7%
No. 4	20-50	10-30	± 7%
No. 10	5-15	5-20	± 5%
No. 200	2-6	2-6	- - -
Mix Temperature	- - -	- - -	± 25°F
Design Asphalt Content:			
Expanded Clay	14-17	- - -	- - -
Slag or Crushed Stone	6-12	6-12	- - -

TABLE 4
PAYMENT ADJUSTMENT SCHEDULES

	Percent of Contract Unit Price/Lot			
	100	95	90	50 or Remove (1)
Aggregate Gradation: Deviations from Job Mix Formula Limits for Extracted Aggregate				
No. 4 Sieve	0.0 to 1.0	1.1 to 4.0	4.1 to 8.0	Over 8.0
No. 10 Sieve	0.0 to 1.0	1.1 to 3.0	3.1 to 6.0	Over 6.0
Anti-Strip Additive			Failure to Add	

(1) 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 used in producing, placing and compacting asphaltic concrete mixtures, and includes methods and equipment for handling and storing materials and transporting asphaltic concrete to the job site.

503.02 PLANT EQUIPMENT.

(a) General: All plants furnishing asphaltic concrete mixtures in accordance with Section 501, 502 and 508 shall be certified in accordance with current Departmental procedures.

Asphaltic concrete shall be mixed at a central mixing plant by either batch or dryer-drum mixing process. Aggregates, additives and asphalt shall be proportioned in a manner satisfactory to the engineer.

The complete process, including plant with necessary auxiliary equipment and controls, operating procedures, and testing and sampling methods during operation must be approved by the Department prior to use. Such approval will require a verification that the hardening properties of asphalt recovered from samples of mixture taken at the plant shall not exceed the absolute viscosity value obtained on residue from thin film oven test of the original asphalt by more than 2,000 poises. When samples of the mixture are taken from the roadway, the absolute viscosity of the recovered asphalt shall not exceed 12,000 poises (adjusted as necessary for aging). The asphalt shall be extracted from the mixture in accordance with DOTD Designation: TR 308 and recovered in accordance with AASHTO Designation: T 170. The absolute viscosity at 60°C (140°F) of the recovered asphalt shall be tested in accordance with AASHTO Designation: T 202.

The contractor shall have a plant site laboratory conforming to Subsection 722.04 as a part of his plant facilities.

(b) Asphalt Preparation Equipment: The asphalt working tank shall be capable of uniformly heating the material by approved methods, under positive control, to the required temperature. The asphalt circulating system shall be of adequate size to insure proper and continuous circulation (except while asphalt is being measured) during

the entire operation period. All pipelines and fittings shall be heated or insulated. Proper mixing temperature of asphalt shall be maintained. A sampling spigot shall be provided in each tank or the supply line.

(c) **Anti-Stripping Additive Equipment:** Anti-stripping 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 process for accomplishing this must be approved by the Department and shall provide that (1) the required quantity of anti-stripping material is uniformly proportional to the quantity of asphalt and (2) the process has means by which such uniformity can be easily verified. The equipment shall be calibrated and certified every 90 days, and more often when directed, by an approved independent scale service. The equipment shall include a positive displacement accumulating meter which accumulates and displays materials used which reads to the nearest 0.25 gallon. The 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.

(d) **Cold Aggregate Feeder:** The plant shall be provided with accurate mechanical means for uniformly feeding aggregate into the dryer. Feeders shall be capable of 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 and the individual controls shall be integrated with a total master control.

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 above the top of the bins. 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 1 dimension adjustable by positive mechanized adjustment. Indicators shall be provided on each gate to show the gate opening in inches.

The calibration of gate openings shall be based on the weight of samples taken from bin material. Material shall be fed from a bin through the individual orifice and bypassed to a container to be weighed. Material from each bin shall be calibrated separately. Weight calibration curves shall be developed and kept on file. The calibration process shall be part of the contractor's quality control and shall be shown as a function of belt speed and gate opening. The method and frequency shall be as directed.

When a cold feed system is the only system used to control the proportioning of aggregates, an automatic plant shutoff shall be provided

to operate when any aggregate bin becomes empty or flow is interrupted.

(e) Screening System: Plant screens as required for proportioning, capable of screening aggregates to the required sizes and having normal capacity in excess of the full capacity of the mixer or dryer, shall be provided. The screens shall be exposed for inspection at the engineer's request.

All plants shall have scalping screens with maximum size openings of 6 x 6 inches on the fine sand cold bin and other cold bins as necessary to insure removal of objectionable materials from the stockpiled materials prior to the cold bins being loaded.

In any process using a belt scale, an additional vibrating scalping screen will be required between cold feed discharge and belt scale. Other processes will require a vibrating scalping screen between cold feed discharge and mixing process.

(f) Dryer: The plant shall include one or more dryers that will 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. The dryer shall be equipped with automatic burner controls. Slope of the dryers shall be in accordance with approved recommendations of the dryer manufacturer.

(g) Hot Bins: Bin sizes shall be adequate for continuous operation of the plant at rated capacity. Bins shall be so arranged to insure 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.

(h) Thermometers: The plant will not be permitted to operate with faulty thermometers, and the thermometers listed herein shall be immediately repaired or replaced when faulty operation is detected.

(1) Asphalt: A thermometer graduated in 5°F increments and having an accuracy of ±5°F 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 the asphalt from storage.

(2) Anti-Stripping Additive: A thermometer graduated in 5°F increments and having an accuracy of ±5°F shall be placed at an approved point near the anti-stripping tank discharge point.

(3) **Heated Aggregates or Asphaltic Mixture:** The plant shall be equipped with an approved recording thermometer graduated in maximum 10°F increments and having an accuracy of ±5°F and a sensitivity which will provide an indication of temperature change at the rate of not less than 10°F per minute. It shall be placed at the dryer discharge chute to register automatically the temperature of heated aggregates for batch plants, and at an approved location for dryer-drum plants to register automatically the temperature of the asphaltic mixture at discharge.

(i) **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 dryer-drum process, baghouse fines shall be added near the asphalt 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.

(j) **Asphalt Measuring Equipment:** Asphalt may be introduced either by weight or volumetric measurement.

(1) **Weight Measurement:** Scales shall conform to Heading (m) of this Subsection and shall read to the nearest pound.

(2) **Volumetric Measurement:** Measurement by volume shall be by means of a positive displacement pump and shall be recorded in digital form to the nearest gallon. Provisions shall be made to periodically check by weight the quantity of asphalt delivered. The rate of asphalt delivered shall be continuously displayed in digital form corrected for 60°F and the quantity totalized. The quantity of asphalt shall be corrected to the job mix temperature. Measurement shall be continuous and accurate to 1.0 percent. Metering equipment shall be calibrated and certified every 90 days, and more often when directed, by an approved independent scale service.

(k) **Mixer Unit:** The mixer unit shall produce a uniform blend, with rapid and complete coating of asphalt that will give a minimum coating of 95 percent of the coarse aggregate particles retained on the No. 4 sieve when tested in accordance with AASHTO Designation: T 195, at the specified production rate.

(1) **Batch Plants:** Batch plants shall have an approved pugmill and spray bar. The pugmill shall have an approved rated capacity and shall be operated at an approved capacity. The mixer shall have an approved timing device to prevent entrance of additional material during mixing; discharge gates shall be locked to insure proper mixing. The device shall also lock the asphalt bucket throughout the dry mixing period.

(2) **Dryer-Drum Plants:** Dryer-drum plants shall have an approved drying and mixing operation. Aggregate and asphalt shall be fed into the dryer-drum in such manner that aggregates are dried, uniformly mixed and adequately coated with asphalt. Production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of materials with minimum oxidation of asphalt at the temperature of the approved job mix formula. Moisture content of the mixture shall be minimized and uniformly controlled.

(l) **Weigh Hoppers:** Weigh hoppers used in weighing aggregates, asphalt and mixtures shall be constructed to prevent leakage and shall be suspended from scales conforming to this Subsection.

In batch plants, asphalt and aggregate hoppers shall be of sufficient size to weigh the total batch in one operation.

Hoppers for weighing a mixture from a storage or surge bin shall be constructed and used in such manner as to prevent segregation of mixture loaded into the haul truck.

(m) **Scales and Printer Systems:**

(1) **Scales:** Scales shall be accurate to ±0.5 percent of the indicated load. They shall be designed, constructed and installed in such manner that operations do not affect their accuracy. The contractor shall have the scales certified every 90 days by the Weights and Measures Division, Louisiana Department of Agriculture or by an approved independent scale service, and more often when directed.

To determine the total weight of mix loaded in trucks, the contractor shall provide springless dial scales or load cell scales for weigh hoppers, and truck platform scales when weigh hoppers are not used. The contractor shall provide belt scales for conveyor systems when the dryer-drum process is used.

(2) **Printer System for Batch Plants Without Storage or Surge Bins:** For the purpose of determining pay weights for the mix, the contractor shall provide an approved printer system which will print separately the weight of aggregate and asphalt. Printing equipment purchased after July, 1981 shall also print zero weight for each batch and total weight of mixture loaded in the trucks.

In the event of a breakdown of the printing mechanism, the contractor will be permitted to operate for a maximum of 48 consecutive hours from the time of breakdown, provided an accurate weight of mixture can be determined and provided repeated breakdowns do not occur.

(3) **Printer System for Plants Using Storage or Surge Bins:** When storage or surge bins are used, the contractor shall provide

truck-platform scales or weigh hopper to determine pay weights for the mix. The weigh hopper shall conform to Heading (l) of this Subsection and shall be equipped with an approved automatic printer system that will print zero weight, batch weight and total weight of mixture loaded into the truck.

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 tare weight as well as total weight of unit and mix.

Scales with electronic digital readout displays, that do not automatically reset to zero after the tare is weighed, shall print the tare weight, zero weight and either the total weight of mix loaded into the unit or the total weight of the unit and mixture. Scales with electronic digital readout displays, that automatically return to zero after the tare is weighed, shall print the tare weight and either the total weight of mix loaded into the unit or the total weight of the unit and mixture.

If scales are located such that a truck must leave the scales between empty weighing and loaded weighing, the printer must print the tare weight, zero weight before loaded weighing, and total weight of the unit and mix. In the event of a breakdown of the printing mechanism, the contractor will be permitted to operate for a maximum of 48 consecutive hours from the time of breakdown, provided an accurate weight of mixture can be determined and provided repeated breakdowns do not occur.

503.03 STORAGE SILOS AND SURGE BINS. Storage silos or surge bins for storing asphaltic concrete mixtures may be used with prior approval.

(a) Conditions of Use: Use of silos or bins shall conform with all 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 visible to the loading operator. Mixtures shall be maintained above this level during production, except for extended periods of shut-down. Bins shall be such that the mixtures drawn from the bins meet the requirements of Heading (d) of this Subsection.

(b) Heated Silos: The atmosphere within the silo may be air or inert gas. The storage silo heating system shall be capable of uniformly maintaining mix temperature without localized heating (hot spots). If inert gas is used, the inert gas system must be capable of purging the

silo with an oxygen-free (inert) atmosphere and then sealing the silo to prevent loss of inert gas.

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.

(c) **Unheated Surge Bins:** The maximum allowable storage time for unheated surge bins is 2 hours. The Department may grant the contractor permission to exceed the above storage time, provided test results and other data indicate that the additional storage time is not detrimental to the mix.

(d) **Loading and Unloading Mixtures:** The system shall be capable of conveying the mixture from plant to bin or silo by a drag slat conveyor system or other approved system. The conveyor shall be of a continuous type designed to prevent spillage and to remove the mix from the plant as fast as it is produced.

The mix shall be transported directly from plant to silos or bins by means of the conveyor system and shall remain within ± 15°F of plant discharge temperature.

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 gates operating under gravity feed or other approved gates that will not cause segregation or be detrimental to the mix.

(e) **Approval Procedure:** An evaluation of a surge or storage unit will determine the degree of composition uniformity, temperature characteristics, and degree of asphalt hardening of mixture processed through the unit. Approval will be granted for silo or bin usage that consistently results in mixtures having gradation and temperature properties of no less quality than specified mixtures discharged directly from the plant's mixing operation and resulting in asphalt hardening properties not exceeding specified limits. Materials for use as open graded coarse material shall not be stored over 2 hours because of the likelihood of asphalt migration. Mixtures which the engineer determines visually to be segregated will be rejected.

503.04 HAULING EQUIPMENT: Vehicles used for transporting asphaltic mixtures shall have tight, clean, smooth metal beds, painted or sprayed at least once a day or as often as required with limewater, soap solution or an approved asphalt release agent on the Qualified Products List. Diesel fuel will not be allowed as a release agent.

Each vehicle shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather. When job conditions necessitate, the covers shall be used in accordance with Departmental policy.

The hauling unit shall discharge the mixture in a continuous manner so the spreader apron of the paver will not be overloaded. The truck bed shall not rest directly on the apron of spreader. Trucks that are to be pushed by paver shall be of such size and capacity that the paver will push them without affecting surface smoothness or edge line of the mixture. Any distortions in surface finish resulting from improper unloading of the mixture shall be corrected immediately.

When size, speed and condition of trucks are such as to interfere with orderly paving operations, the engineer may order suitable substitution to be made. Load restrictions shall be in accordance with Subsection 105.14.

503.05 PAVING EQUIPMENT: Pavers shall be equipped with automatic screed and slope control devices for use with a 30-foot (minimum) traveling stringline or erected stringline, as directed.

(a) General: Pavers shall be capable of laying mixtures within the tolerances specified. A screed or strike-off assembly shall be used, distributing the mixture over the entire lane width and such partial lane widths as may be approved. Pavers, including extensions, shall place mixtures uniform in appearance and quality. The assembly shall be adjustable to provide the required cross section. The screed assembly shall be equipped with a heater and either a vibrator or tamping bars. In hilly terrain, a positive connection shall be provided between the paver and the hauling unit.

Pavers shall be equipped with hoppers adequately designed and maintained to prevent spillage, and distributing screws to place the mix evenly in front of the screed, including extensions. They 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, modified pavers or widener spreaders may be provided when permitted.

(b) Pavers with Automatic Screed Control: This type paver shall meet the requirements in Heading (a) of this Subsection and shall be equipped with automatic screed and adjustable slope control devices capable of laying 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 2 grade sensors when required.

Pavers shall be equipped to work from an erected stringline, shoe device or a traveling stringline that will accurately reflect, for a minimum 30-foot length, the average grade of the surface on which it is to be operated.

If a malfunction occurs in the automatic screed control device during laydown operations, work may continue for the balance of that day on any course other than the final wearing course and friction course. Any overrun resulting from placing material without the automatic screed control device shall be borne by the contractor. If a screed control device malfunctions during final surface course paving operations, plant operations shall be discontinued immediately and shall not be resumed until the screed malfunction has been remedied. Material in transit may be placed; however, surface and grade tolerances must be met.

503.06 ROLLERS. Rollers shall be self-propelled and shall be in good condition, capable of reversing without backlash.

Vibratory rollers shall be especially designed for asphaltic concrete compaction and shall have separate controls for vibratory energy and propulsion. Pneumatic-tire rollers shall have tires of the same size and ply rating, and with uniform pressure adjusted to the highest contact pressure that will result in the required density. Rollers shall have suitable equipment for keeping rollers or tires clean and efficiently dispensing water to the contact surfaces to prevent mixture pickup.

The Department reserves the right to reject poorly performing rollers and require that they be replaced with suitable equipment or supplemented as necessary to accomplish the desired results.

503.07 MISCELLANEOUS EQUIPMENT AND HAND TOOLS. Power revolving brooms or power blowers and distributors shall be provided and maintained in a satisfactory working condition.

Tamping tools shall be approved types. Satisfactory mechanical equipment may be used instead of tamping tools.

The asphalt distributor shall be equipped with suitable manifold appliances so designed as to distribute material within the specified temperature range with positive controlled temperature at all times, and shall be equipped with thermometers to indicate temperature of material in the tank. The distributor shall be so designed as to maintain a constant uniform pressure on asphaltic material as it passes through nozzles, and to apply asphaltic material at the required rate. The distributor shall be equipped with devices and charts to provide for accurate, rapid determination and control of the amount of asphaltic materials being applied per square yard of surface under operating conditions, and shall have a tachometer, reading speeds in feet per minute.

503.08 HANDLING OF AGGREGATES. Aggregates shall be

stored at the plant site in such manner that no intermixing will occur. When stockpiling, the material shall be placed to minimize segregation. Stockpiles shall be well drained.

Blending of aggregates shall be done with 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.

Proportioning of material at the cold feed will be established by the contractor to meet the job mix gradation requirements. This shall be done in such manner that when plants operate with only cold feed control, further manipulations will not be necessary to meet job mix requirements.

(a) **Drying:** For all plants, aggregate shall be heated and dried to produce a mixture meeting specification requirements. The quantity of material fed through the dryer shall be held to an amount which can be adequately heated and dried. If proper drying is not achieved and the quality of the mix is impaired, the contractor shall adjust the rate of production of the dryer as required to obtain satisfactory results. The burner fuel used must be clean burning so there is no contamination of aggregates. Contaminated aggregates or mixtures will be rejected.

(b) **Hot Aggregate Storage:** In batch plants, hot aggregate shall be stored in bins. Storage shall be accomplished in such manner as to minimize segregation and loss of temperature of aggregates. If plant operation is interrupted and the temperature of material in hot storage cools to 25°F or more below the specified mixing temperature, bins shall be pulled and the material discarded. When a plant changes type of mix and the change requires a change of materials, bins shall be pulled and the material discarded.

503.09 PROCESSING OF ASPHALT, ADDITIVES AND AGGREGATES: Aggregates shall be combined, either before or after drying, depending on the type of plant used, to meet the approved job mix formula. Asphalt shall be measured and introduced into the mixer or dryer in the quantities specified in the approved job mix formula.

The aggregate, asphalt and the mixture shall be processed at the temperature specified in the job mix formula. The temperature of the mixture at discharge from the mixer shall be within ± 25°F of the temperature approved in the job mix formula. If the mixing, coating, placing and 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.

When the automatic asphalt adjustments or other critical control and

shutoff devices are not functioning, the plant will not be permitted to operate.

(a) **Conventional Plants with Pugmills:** Prior to adding asphalt, the combined aggregate shall be thoroughly mixed dry, after which the proper amount of asphalt shall be sprayed over aggregates and mixed to produce a homogeneous mixture in which all particles of aggregate are uniformly coated. Mixing times shall be in accordance with the approved job mix formula.

(b) **Dryer-Drum Plants:** The system shall provide positive weight 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 particles of aggregate are uniformly coated. Approved means shall be provided to waste the first and last output of the plant after each interruption that results in a change in mix quality.

Moisture content of the mixture shall be minimized and uniformly controlled to insure that placing and density requirements are met. The contractor's technician shall measure the moisture content of the cold feed aggregates daily when starting the plant. Adequate 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 of the engineer.

Provision shall be made for introducing the latest moisture content of the cold feed aggregates into the belt weighing signal, thereby correcting wet aggregate weight to dry aggregate weight. Dry or wet weight of the aggregate flow shall be displayed digitally in appropriate units of weight and time, and the quantity used totalized. The rate of flow of asphalt used shall also be digitally displayed and the quantity used totalized.

For mineral filler, a separate bin and feeder shall be furnished with its drive interlocked with the aggregate feeders. Mineral filler shall be introduced directly into the drum near the asphalt discharge.

Section 504

Asphaltic Tack Coat

504.01 DESCRIPTION. This work consists of preparing and treating an existing asphaltic or concrete surface with asphaltic material in accordance with these specifications and in conformity with the lines shown on the plans or established by the engineer.

504.02 ASPHALTIC MATERIAL. The tack coat shall be either cutback asphalt (Grade RC-70 or RC-250) or emulsified asphalt (Grade SS-1h, SS-1 or CSS-1h) and shall conform to Section 1002.

504.03 EQUIPMENT. The contractor shall provide equipment for heating and applying the asphaltic material and for proper preparation of the surface to be tacked. The equipment shall conform to Subsection 503.07.

504.04 SURFACE PREPARATION. The existing surface shall be cleaned by sweeping or by other approved methods. Edges of existing pavements adjacent to new pavement shall be cleaned to permit adhesion of the asphalt.

504.05 APPLICATION. The asphalt shall be uniformly applied with a pressure distributor at a rate not to exceed 0.05 gallon per square yard, except as otherwise specified in Subsection 502.05, based on gallonage converted to 60°F in accordance with Section 509. The tack coat shall not be applied on a wet surface or when the air temperature is below 40°F. The rate of application, temperature of the asphalt and areas to be treated shall be approved prior to application.The tack coat shall be applied the same day as the pavement mixture laydown in such manner as to cause the least inconvenience to traffic.

504.06 MEASUREMENT AND PAYMENT. Asphaltic tack coat will not be measured for payment; however, payment under the contract will be subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Section 505

Asphaltic Prime Coat

505.01 DESCRIPTION. This work consists of preparing and treating an existing surface with asphaltic material in accordance with these specifications and in conformity with lines shown on the plans or established by the engineer.

505.02 ASPHALTIC MATERIAL. The prime coat shall be cutback asphalt Grade MC-30 or MC-70 conforming to Section 1002.

505.03 WEATHER LIMITATIONS. Asphaltic materials shall not be applied on a wet surface nor when the air temperature is less than 45°F in the shade.

505.04 EQUIPMENT. The contractor shall provide all necessary equipment for proper construction of this work. The equipment shall have been approved before construction begins and shall be maintained in satisfactory working condition. The equipment shall conform to Subsection 503.07.

505.05 SURFACE PREPARATION. The surface to be primed shall be shaped to the required grade and section, shall be free from ruts, corrugations, segregated material or other irregularities and shall be compacted to the required density. Delays in priming may necessitate reprocessing or reshaping to provide a smooth compacted surface. Payment for surface preparation will be made under other items.

505.06 APPLICATION. The primer shall be applied to the prepared surface and shall extend 6 inches beyond the width of surfacing shown on the plans. The prime coat shall not be applied until the surface has been satisfactorily swept and is dry.

The prime coat shall be applied at the rates and temperatures shown in Table 5 of this Section. Quantities of prime coat shall not vary from that shown in Table 5 by more than 5 percent.

The volume of asphalt shall be corrected for temperature as described in Section 509.

The prime coat shall be maintained intact and, if required, the primed

TABLE 5
PRIME COATS

Asphalt Grade	Application (Gal.@ 60°F per Sq. Yd.)		Temperature of Application (°F)	
	Min.	Max.	Min.	Max.
MC-30	0.25	0.3	60	120
MC-70	0.25	0.3	100	180

surface shall be thoroughly cleaned prior to the application of any subsequent course.

Where the prime coat has failed or depressions have occurred, the failure shall be swept clean, brushcoated with cutback asphalt and refilled with a satisfactory asphaltic mixture. If the prime coat is generally unsatisfactory, the contractor shall reprime the unsatisfactory surface.

505.07 PROTECTION. After the prime coat has been applied, the contractor shall keep all traffic off the surface until the asphalt has properly cured, unless otherwise permitted.

If traffic is permitted, the contractor may be required, at his expense, to spread approved granular material as directed over the prime coat.

505.08 MEASUREMENT AND PAYMENT. Asphaltic prime coat will not be measured for payment; however, payment under the contract will be subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Section 506
Asphaltic Curing Membrane

506.01 DESCRIPTION. This work consists of the application and maintenance of an asphaltic curing membrane to cement or lime treated materials.

506.02 ASPHALTIC MATERIALS. Asphalt for curing membrane shall be an emulsified asphalt conforming to Section 1002.

506.03 WEATHER LIMITATIONS. Unless otherwise permitted, the weather limitations of Subsection 301.10 for mixing shall also apply to the application of asphaltic curing membrane.

506.04 EQUIPMENT. The contractor shall provide and satisfactorily maintain all necessary equipment for proper construction of this work. The equipment shall have been approved before construction begins. The distributor shall conform to Subsection 503.07.

506.05 SURFACE PREPARATION. The surface to which curing membrane is to be applied shall be shaped to the required grade and section, shall be free from ruts, corrugations, loose material or other irregularities and shall be compacted to the required density. Payment for surface preparation will be made under other items.

506.06 APPLICATION. The asphaltic curing membrane shall be applied immediately upon completion of smooth rolling of the final lift of the surface. The curing membrane shall be uniformly applied at the minimum rate of 0.10 gallon per square yard based on gallonage converted to 60°F in accordance with Section 509. Any additional applications required shall be placed by the contractor at his expense. When emulsified asphalt is diluted with water and applied in multiple passes of the distributor, the total amount of asphaltic material applied shall be increased accordingly. All extraneous material which has collected on the completed base shall be removed before additional application of asphaltic curing membrane.

506.07 PROTECTION. After the curing membrane has been applied, the contractor shall keep traffic off the surface until the asphalt has properly cured, unless otherwise directed.

506.08 MEASUREMENT AND PAYMENT. Asphaltic curing membrane will not be measured for payment; however, payment under the contract will be subject to the price adjustment provisions of Section 1002 for specification deviations of the asphaltic materials.

Section 507

Asphaltic Surface Treatment

507.01 DESCRIPTION. This work consists of furnishing and constructing a wearing surface of aggregate and asphalt on a prepared base course or on an existing pavement, in accordance with these specifications in conformity with the lines, grades and typical cross sections shown on the plans or established by the engineer.

Asphaltic surface treatment shall consist of the number of applications of each of the specified sizes of aggregate and the specified asphalt.

507.02 MATERIALS. The asphalt shall be asphalt cement Grade AC-5 or AC-10, or emulsified asphalt Grade CRS-2, conforming to Section 1002. Aggregates shall be uncrushed gravel, crushed gravel, crushed slag, crushed stone or expanded clay, and shall conform to Subsection 1003.05.

507.03 EQUIPMENT. The contractor shall provide and satisfactorily maintain all necessary equipment for proper construction of this work. The equipment shall have been approved before construction begins.

Storage tanks, piping, retorts, booster tanks, distributors and other equipment used in delivering, storing or handling asphaltic materials shall be kept clean and in good operating condition and shall be operated in such manner as to avoid contamination of the contents with foreign materials.

Equipment shall consist of the following units:

(a) A piece of 2-inch diamond mesh chain link fence approximately 10 x 15 feet used for dragging operation or broom dragging equipment capable of covering 1/3 to 1/2 the width of treatment.

(b) Power distributor conforming to Subsection 503.07.

(c) Self-propelled steel wheel rollers or self-propelled pneumatic-tire rollers.

Steel wheel rollers may be 3-wheel type, but tandem type is preferred. The weight of rollers shall not be less than 5 tons nor more than 10 tons.

Pneumatic-tire rollers shall be self-propelled with wheels mounted on 2 axles in such manner that the rear tires will not follow in the tracks of

the forward group. Rollers shall be capable of applying a minimum of 50 psi contact pressure under each tire and shall be of such weight that no damage is caused to the base course or surface treatment.

(d) Power revolving broom or a power blower.

(e) Self-propelled, pneumatic-tire power spreader so designed, equipped and operated that aggregate will be spread uniformly at the designated rate with the application being defined at the edges, or other approved spreading equipment.

507.04 WEATHER LIMITATIONS. Asphalt shall not be applied on a wet base nor when the air temperature in the shade is less than 60°F.

Asphalt shall not be applied during the months of November, December, January and February, unless otherwise approved in writing by the Chief Engineer. When approved, one of the following requirements shall be met during these months.

(a) All aggregates to be spread shall be mechanically dried and placed in a surface dry condition.

(b) If asphalt is placed during the above referenced months without mechanically drying aggregates, the contractor shall be responsible for the work, and the final inspection will not be made until such time after March 1st equal to the time required to place the surface treatment.

507.05 APPLICATION. After the prime coat, when required, has satisfactorily cured, asphalt and aggregates shall be applied in the amounts and sequence herein specified.

Application temperatures and sequence of application and spreading for asphaltic surfacing as specified shall be as shown in Table 6 of this Section.

The quantities of materials shown in Table 6 are approximate. The quantities to be used shall be as directed. Aggregates spread in excess of 5 percent over the quantity per square yard directed by the engineer will not be measured for payment.

The quantities of asphalt per square yard of treated surface as shown in Table 6 are based on a temperature of 60°F. Volumetric measurements shall be converted to this temperature in accordance with Section 509.

The length of spread of asphalt shall not exceed that which can be covered immediately with aggregate.

Asphalt for each application shall be applied uniformly for the full width of treatment unless, due to the impracticality of detouring highway traffic, the engineer directs that the material be applied to 1/2 the roadway at a time. If the contractor is unable to keep the application of asphalt consistently within ±5 percent of the quantity directed, he shall discon-

TABLE 6
QUANTITIES OF MATERIAL PER SQUARE YARD

	Gals. of Asphaltic Material at 60°F		Cubic Yards of Aggregate		
	Emulsified Asphalt	Asphalt Cement	Size 1	Size 2	Size 3
3-Application Treatment					
1st Application	0.5	0.4	0.0200		
2nd Application	0.4	0.3		0.0111	
3rd Application	0.3	0.2			0.0075
2-Application Treatment					
1st Application	0.5	0.4		0.0111	
2nd Application	0.3	0.2			0.0075
Temperature of Application		Minimum		Maximum	
Asphalt Cement		275°F		350°F	
Emulsified Asphalt		125°F		175°F	

tinue operations until he can provide an operator of greater experience or a better distributor, or both, or shall provide such precautions as necessary to keep the application within allowable variations.

If any nozzles become blocked during application of asphalt, the distributor shall be stopped immediately and the nozzles cleaned out. When the engineer directs that application be made over 1/2 the roadway at a time, all nozzles except the one towards the outside of the roadway shall have the same size opening, and care shall be taken to see that there is a slight longitudinal overlapping of the 2 applications along the centerline of the road. The distributor shall be operated along a marked edge to keep the surface treatment in proper alignment.

To secure uniform distribution at the junction of 2 applications, the distributor shall be promptly stopped when the flow decreases, indicating the tank is nearly empty. Building paper or other suitable material shall be placed over the end of the previous application, and the joining application shall start on the building paper. Building paper so used shall be removed and satisfactorily disposed of; however, burning of building paper will not be permitted on areas that have been recently seeded or sodded, or on other grassy areas within the right-of-way.

During application of asphalt, care shall be taken to prevent spattering adjacent pavements, structures and trees. The distributor shall not be cleaned or discharged into ditches, borrow pits, on shoulders or along the right-of-way.

Any excess asphalt at the junction between distributor loads shall be removed and satisfactorily corrected, and any parts of the surface to be treated which are not covered with asphalt directly from the distributor shall be covered by means of a hand hose equipped with nozzles or a hand pouring pot.

Aggregate shall be uniformly spread over the full width of asphalt with one or more passes of spreading equipment with the application being sharply defined at edges. Equipment shall not be driven on uncovered asphalt. If necessary to obtain uniform coverage, the surface shall be dragged or broomed.

Hand spreading will be permitted in conjunction with the self-propelled spreaders over areas inaccessible to the spreaders.

507.06 ROLLING COVER MATERIAL. Immediately after spreading and brooming or dragging the cover material, the entire surface shall be rolled with a power roller. Rolling shall proceed in a longitudinal direction, beginning at outer edges of treatment, each trip overlapping the previous trip 1/2 the width of the roller. The first rolling shall be completed within 1/2 hour after cover material has been spread. During rolling, previously spread cover material shall be uniformly broomed or dragged and placed where necessary to completely cover the asphalt. Rolling, dragging or brooming, and spotting of additional cover material shall be continued until uniform coverage has been obtained. The remaining courses shall be rolled as specified for the first course and shall not be placed until the previous course is surface dry.

507.07 PROTECTION. Traffic shall not be allowed on the surface until the final application has been placed and thoroughly rolled.

After application of Size 3 material, the surface where directed shall be lightly broomed or otherwise maintained for a period of 4 days or as directed. Maintenance of the surface shall include the distribution of Size 3 material over the surface to absorb any free asphalt, covering any area deficient in Size 3 material, and an additional rolling as directed at no additional cost to the Department. Maintenance shall be conducted so as not to displace imbedded material. Excess material shall be swept from the entire surface by means of rotary brooms at the time determined by the engineer.

507.08 METHOD OF MEASUREMENT. Quantities of aggregate and asphalt incorporated in completed and accepted asphaltic surface treatment will be measured separately. Aggregate will be measured by the cubic yard and asphalt will be measured by the gallon.

Aggregates will be measured in vehicles in accordance with Subsection 109.01 at the point of placing on the surface.

Asphalt will be measured in the distributor by the gallon of 231 cubic inches and converted to gallonage at 60°F in accordance with Section 509.

507.09 BASIS OF PAYMENT. Asphalt and aggregates will be paid for at the contract unit prices, subject to the price adjustment provisions of Section 1002 for specification deviations of asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
507(1)	Asphalt	Gallon
507(2)	Aggregates	Cubic Yard

Section 508

Asphalt Treated Drainage Blanket

508.01 DESCRIPTION. This work consists of furnishing and constructing an asphalt treated drainage blanket of the plant mix type in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by the engineer.

All equipment and processes shall conform to Section 503, except that rolling equipment shall consist of only a 10-ton tandem roller.

508.02 MATERIALS. The contractor shall keep accurate records, including proof of deliveries of all materials for use in the asphaltic mixtures. Copies of these records shall be furnished to the engineer upon request. Materials shall conform to the following Subsections:

Asphalt	1002.01
Additives	1002.02
Aggregates	1003.06 (a)

(a) Asphalt: Asphalt cement Grade AC 30 shall be used. Processing shall conform to Subsection 503.09.

(b) Additives: Silicone and anti-stripping additives shall be approved products listed on the Qualified Products List. Processing shall conform to Subsection 503.09.

(1) Silicone: Silicone additives, when needed, shall be dispersed into the asphalt by methods and in concentrations given in the Qualified Products List.

(2) Anti-Stripping: An anti-strip additive, added at the minimum rate of 0.5 percent by weight of asphalt, shall be thoroughly mixed with the asphalt at the plant when siliceous gravel aggregate is used. Pay adjustments will be applied in accordance with Table 2 of Section 501 for failure to add required anti-strip additive. Anti-strip additive will not be required when shell, limestone or expanded clay aggregate is used.

508.03 COMPOSITION OF MIXTURE. The mixture shall consist of coarse aggregate and asphalt proportioned as directed to produce suitable water permeability and meet the following requirements.

U.S. Sieve	% Passing
1″	100
3/4″	90 - 100
1/2″	70 - 100
3/8″	50 - 80
No. 4	10 - 35
No. 10	0 - 20
No. 80	0 - 5
% Crushed (Retained on No. 4)	60 min.
%Asphalt by Weight	2 1/2 - 4

508.04 CONSTRUCTION REQUIREMENTS. The weather limitations shall be as specified in Subsection 501.04.

Asphalt and aggregate shall be heated to a temperature that will produce a mix having a discharge temperature of 200-275°F, or as directed.

Prior to placement of the mixture, the surface shall be prepared in accordance with Subsection 501.05.

The asphaltic mixture shall be placed in 1 layer and rolled as directed. Sections of newly finished blanket shall be protected from traffic for a period of 24 hours, or until sufficiently hardened. Subsequent construction activities that will impair the drainage characteristics of the layer will not be permitted.

508.05 METHOD OF MEASUREMENT. Asphalt treated drainage blanket will be measured by the ton of 2,000 pounds from printed weights as provided in Section 503.

508.06 BASIS OF PAYMENT. Asphalt treated drainage blanket will be paid for at the contract unit price per ton, subject to the price adjustment provisions of Table 2 of Section 501 for anti-strip additive and Section 1002 for specification deviations of the asphalt cement. Payment will be made under:

Item No.	Pay Item	Pay Unit
508(1)	Asphalt Treated Drainage Blanket	Ton

Section 509

Temperature-Volume Conversion for Asphaltic Materials

509.01 DESCRIPTION. This Section describes the method of converting volume measurements of asphalts at field temperatures to corresponding volumes at 60°F. The number of gallons of asphalt cement, cutback asphalt, or emulsified asphalt placed and accepted shall be measured in the distributor by the gallon of 231 cubic inches and the temperature observed. The measurement shall be converted to gallonage at 60°F in accordance with the applicable table.

509.02 CONVERSION TABLES. The measured volume shall be converted to gallonage at 60°F by multiplying it by the conversion factor (M) corresponding to the observed temperature (t) in degrees Fahrenheit.

TABLE 7
TEMPERATURE-VOLUME CONVERSION
CUTBACK ASPHALT

t	M	t	M	t	M	t	M	t	M
0	1.0241	20	1.0160	40	1.0080	60	1.0000	80	0.9921
1	1.0237	21	1.0156	41	1.0076	61	0.9996	81	0.9917
2	1.0233	22	1.0152	42	1.0072	62	0.9992	82	0.9913
3	1.0229	23	1.0148	43	1.0068	63	0.9988	83	0.9909
4	1.0225	24	1.0144	44	1.0064	64	0.9984	84	0.9905
5	1.0221	25	1.0140	45	1.0060	65	0.9980	85	0.9901
6	1.0217	26	1.0136	46	1.0056	66	0.9976	86	0.9897
7	1.0213	27	1.0132	47	1.0052	67	0.9972	87	0.9893
8	1.0209	28	1.0128	48	1.0048	68	0.9968	88	0.9889
9	1.0205	29	1.0124	49	1.0044	69	0.9964	89	0.9885
10	1.0201	30	1.0120	50	1.0040	70	0.9960	90	0.9881
11	1.0197	31	1.0116	51	1.0036	71	0.9956	91	0.9877
12	1.0193	32	1.0112	52	1.0032	72	0.9952	92	0.9873
13	1.0189	33	1.0108	53	1.0028	73	0.9948	93	0.9869
14	1.0185	34	1.0104	54	1.0024	74	0.9944	94	0.9865
15	1.0181	35	1.0100	55	1.0020	75	0.9940	95	0.9861
16	1.0177	36	1.0096	56	1.0016	76	0.9936	96	0.9857
17	1.0173	37	1.0092	57	1.0012	77	0.9932	97	0.9854
18	1.0168	38	1.0088	58	1.0008	78	0.9929	98	0.9850
19	1.0164	39	1.0084	59	1.0004	79	0.9925	99	0.9846

TABLE 7 (continued)
CUTBACK ASPHALT

t	M	t	M	t	M	t	M	t	M
100	0.9842	148	0.9655	196	0.9471	244	0.9290	292	0.9113
101	0.9838	149	0.9651	197	0.9467	245	0.9286	293	0.9109
102	0.9834	150	0.9647	198	0.9463	246	0.9283	294	0.9105
103	0.9830	151	0.9643	199	0.9460	247	0.9279	295	0.9102
104	0.9826	152	0.9639	200	0.9456	248	0.9275	296	0.9098
105	0.9822	153	0.9635	201	0.9452	249	0.9272	297	0.9094
106	0.9818	154	0.9632	202	0.9448	250	0.9268	298	0.9091
107	0.9814	155	0.9628	203	0.9444	251	0.9264	299	0.9087
108	0.9810	156	0.9624	204	0.9441	252	0.9260	300	0.9083
109	0.9806	157	0.9620	205	0.9437	253	0.9257	301	0.9080
110	0.9803	158	0.9616	206	0.9433	254	0.9253	302	0.9076
111	0.9799	159	0.9612	207	0.9429	255	0.9249	303	0.9072
112	0.9795	160	0.9609	208	0.9425	256	0.9245	304	0.9069
113	0.9791	161	0.9605	209	0.9422	257	0.9242	305	0.9065
114	0.9787	162	0.9601	210	0.9418	258	0.9238	306	0.9061
115	0.9783	163	0.9597	211	0.9414	259	0.9234	307	0.9058
116	0.9779	164	0.9593	212	0.9410	260	0.9231	308	0.9054
117	0.9775	165	0.9589	213	0.9407	261	0.9227	309	0.9050
118	0.9771	166	0.9585	214	0.9403	263	0.9223	310	0.9047
119	0.9767	167	0.9582	215	0.9399	264	0.9219	311	0.9043
120	0.9763	168	0.9578	216	0.9395	264	0.9216	312	0.9039
121	0.9760	169	0.9574	217	0.9391	265	0.9212	313	0.9036
122	0.9756	170	0.9570	218	0.9388	266	0.9208	314	0.9032
123	0.9752	171	0.9566	219	0.9384	267	0.9205	315	0.9029
124	0.9748	172	0.9562	220	0.9380	268	0.9201	316	0.9025
125	0.9744	173	0.9559	221	0.9376	269	0.9197	317	0.9021
126	0.9740	174	0.9555	222	0.9373	270	0.9194	318	0.9018
127	0.9736	175	0.9551	223	0.9369	271	0.9190	319	0.9014
128	0.9732	176	0.9547	224	0.9365	272	0.9186	320	0.9010
129	0.9728	177	0.9543	225	0.9361	273	0.9182	321	0.9007
130	0.9725	178	0.9539	226	0.9358	274	0.9179	322	0.9003
131	0.9721	179	0.9536	227	0.9354	275	0.9175	323	0.9000
132	0.9717	180	0.9532	228	0.9350	276	0.9171	324	0.8996
133	0.9713	181	0.9528	229	0.9346	277	0.9168	325	0.8992
134	0.9709	182	0.9524	230	0.9343	278	0.9164	326	0.8989
135	0.9705	183	0.9520	231	0.9339	279	0.9160	327	0.8985
136	0.9701	184	0.9517	232	0.9335	280	0.9157	328	0.8981
137	0.9697	185	0.9513	233	0.9331	281	0.9153	329	0.8978
138	0.9693	186	0.9509	234	0.9328	282	0.9149	330	0.8974
139	0.9690	187	0.9505	235	0.9324	283	0.9146	331	0.8971
140	0.9686	188	0.9501	236	0.9320	284	0.9142	332	0.8967
141	0.9682	189	0.9498	237	0.9316	285	0.9138	333	0.8963
142	0.9678	190	0.9494	238	0.9313	286	0.9135	334	0.8960
143	0.9674	191	0.9490	239	0.9309	287	0.9131	335	0.8956
144	0.9670	192	0.9486	240	0.9305	288	0.9127	336	0.8952
145	0.9666	193	0.9482	241	0.9301	289	0.9124	337	0.8949
146	0.9662	194	0.9478	242	0.9298	290	0.9120	338	0.8945
147	0.9659	195	0.9475	243	0.9294	291	0.9116	339	0.8942

TABLE 7 (continued)
CUTBACK ASPHALT

t	M	t	M	t	M	t	M	t	M
340	0.8938	372	0.8823	404	0.8710	436	0.8599	468	0.8488
341	0.8934	373	0.8820	405	0.8707	437	0.8595	469	0.8485
342	0.8931	374	0.8816	406	0.8703	438	0.8592	470	0.8481
343	0.8927	375	0.8813	407	0.8700	439	0.8588	471	0.8478
344	0.8924	376	0.8809	408	0.8696	440	0.8585	472	0.8474
345	0.8920	377	0.8806	409	0.8693	441	0.8581	473	0.8471
346	0.8916	378	0.8802	410	0.8689	442	0.8578	474	0.8468
347	0.8913	379	0.8799	411	0.8686	443	0.8574	475	0.8464
348	0.8909	380	0.8795	412	0.8682	444	0.8571	476	0.8461
349	0.8906	381	0.8792	413	0.8679	445	0.8567	477	0.8457
350	0.8902	382	0.8788	414	0.8675	446	0.8564	478	0.8454
351	0.8899	383	0.8784	415	0.8672	447	0.8560	479	0.8451
352	0.8895	384	0.8781	416	0.8668	448	0.8557	480	0.8447
353	0.8891	385	0.8777	417	0.8665	449	0.8554	481	0.8444
354	0.8888	386	0.8774	418	0.8661	450	0.8550	482	0.8440
355	0.8884	387	0.8770	419	0.8658	451	0.8547	483	0.8437
356	0.8881	388	0.8767	420	0.8654	452	0.8543	484	0.8433
357	0.8877	389	0.8763	421	0.8656	453	0.8540	485	0.8430
358	0.8873	390	0.8760	422	0.8647	454	0.8536	486	0.8427
359	0.8870	391	0.8756	423	0.8644	455	0.8533	487	0.8423
360	0.8866	392	0.8753	424	0.8640	456	0.8529	488	0.8420
361	0.8863	393	0.8749	425	0.8637	457	0.8526	489	0.8416
362	0.8859	394	0.8746	426	0.8633	458	0.8522	490	0.8413
363	0.8856	395	0.8742	427	0.8630	459	0.8519	491	0.8410
364	0.8852	396	0.8738	428	0.8626	460	0.8516	492	0.8406
365	0.8848	397	0.8735	429	0.8623	461	0.8512	493	0.8403
366	0.8845	398	0.8731	430	0.8619	462	0.8509	494	0.8399
367	0.8841	399	0.8728	431	0.8616	463	0.8505	495	0.8396
368	0.8838	400	0.8724	432	0.8612	464	0.8502	496	0.8393
369	0.8834	401	0.8721	433	0.8609	465	0.8498	497	0.8389
370	0.8831	402	0.8717	434	0.8605	466	0.8495	498	0.8386
371	0.8827	403	0.8714	435	0.8602	467	0.8492	499	0.8383

TABLE 8
TEMPERATURE-VOLUME CONVERSION
ASPHALT CEMENT

t	M	t	M	t	M	t	M	t	M
0	1.0211	6	1.0190	12	1.0169	18	1.0148	24	1.0126
1	1.0208	7	1.0186	13	1.0165	19	1.0144	25	1.0123
2	1.0204	8	1.0183	14	1.0162	20	1.0141	26	1.0119
3	1.0201	9	1.0179	15	1.0158	21	1.0137	27	1.0116
4	1.0197	10	1.0176	16	1.0155	22	1.0133	28	1.0112
5	1.0194	11	1.0172	17	1.0151	23	1.0130	29	1.0109

TABLE 8 (continued)
ASPHALT CEMENT

t	M	t	M	t	M	t	M	t	M
30	1.0105	77	0.9941	124	0.9778	171	0.9618	218	0.9459
31	1.0102	78	0.9937	125	0.9775	172	0.9614	219	0.9456
32	1.0098	79	0.9934	126	0.9771	173	0.9611	220	0.9452
33	1.0095	80	0.9930	127	0.9768	174	0.9607	221	0.9449
34	1.0091	81	0.9927	128	0.9764	175	0.9604	222	0.9446
35	1.0088	82	0.9923	129	0.9761	176	0.9601	223	0.9442
36	1.0084	83	0.9920	130	0.9758	177	0.9597	224	0.9439
37	1.0081	84	0.9916	131	0.9754	178	0.9594	225	0.9436
38	1.0077	85	0.9913	132	0.9751	179	0.9590	226	0.9432
39	1.0074	86	0.9909	133	0.9747	180	0.9587	227	0.9429
40	1.0070	87	0.9906	134	0.9744	181	0.9584	228	0.9426
41	1.0067	88	0.9902	135	0.9740	182	0.9580	229	0.9422
42	1.0063	89	0.9899	136	0.9737	183	0.9577	230	0.9419
43	1.0060	90	0.9896	137	0.9734	184	0.9574	231	0.9416
44	1.0056	91	0.9892	138	0.9730	185	0.9570	232	0.9412
45	1.0053	92	0.9889	139	0.9727	186	0.9567	233	0.9409
46	1.0049	93	0.9885	140	0.9723	187	0.9563	234	0.9405
47	1.0046	94	0.9882	141	0.9720	188	0.9560	235	0.9402
48	1.0042	95	0.9878	142	0.9716	189	0.9557	236	0.9399
49	1.0038	96	0.9875	143	0.9713	190	0.9553	237	0.9395
50	1.0035	97	0.9871	144	0.9710	191	0.9550	238	0.9392
51	1.0031	98	0.9868	145	0.9706	192	0.9547	239	0.9389
52	1.0028	99	0.9864	146	0.9703	193	0.9548	240	0.9385
53	1.0024	100	0.9861	147	0.9699	194	0.9540	241	0.9382
54	1.0021	101	0.9857	148	0.9696	195	0.9536	242	0.9379
55	1.0017	102	0.9854	149	0.9693	196	0.9533	243	0.9375
56	1.0014	103	0.9851	150	0.9689	197	0.9530	244	0.9372
57	1.0010	104	0.9847	151	0.9686	198	0.9526	245	0.9369
58	1.0007	105	0.9844	152	0.9682	199	0.9523	246	0.9365
59	1.0003	106	0.9840	153	0.9679	200	0.9520	247	0.9362
60	1.0000	107	0.9837	154	0.9675	201	0.9516	248	0.9359
61	0.9997	108	0.9833	155	0.9672	202	0.9513	249	0.9356
62	0.9993	109	0.9830	156	0.9669	203	0.9509	250	0.9352
63	0.9990	110	0.9826	157	0.9665	204	0.9506	251	0.9349
64	0.9986	111	0.9823	158	0.9662	205	0.9503	252	0.9346
65	0.9983	112	0.9819	159	0.9658	206	0.9499	253	0.9342
66	0.9979	113	0.9816	160	0.9655	207	0.9496	254	0.9339
67	0.9976	114	0.9813	161	0.9652	208	0.9493	255	0.9336
68	0.9972	115	0.9809	162	0.9648	209	0.9489	256	0.9332
69	0.9969	116	0.9806	163	0.9645	210	0.9486	257	0.9329
70	0.9965	117	0.9802	164	0.9641	211	0.9483	258	0.9326
71	0.9962	118	0.9799	165	0.9638	212	0.9479	259	0.9322
72	0.9958	119	0.9795	166	0.9635	213	0.9476	260	0.9319
73	0.9955	120	0.9792	167	0.9631	214	0.9472	261	0.9316
74	0.9951	121	0.9788	168	0.9628	215	0.9469	262	0.9312
75	0.9948	122	0.9785	169	0.9624	216	0.9466	263	0.9309
76	0.9944	123	0.9782	170	0.9621	217	0.9462	264	0.9306

TABLE 8 (Continued)
ASPHALT CEMENT

t	M	t	M	t	M	t	M	t	M
265	0.9302	312	0.9148	359	0.8995	406	0.8845	453	0.8696
266	0.9299	313	0.9145	360	0.8992	407	0.8841	454	0.8693
267	0.9296	314	0.9141	361	0.8989	408	0.8838	455	0.8690
268	0.9293	315	0.9138	362	0.8986	409	0.8835	456	0.8687
269	0.9289	316	0.9135	363	0.8982	410	0.8832	457	0.8683
270	0.9286	317	0.9132	364	0.8979	411	0.8829	458	0.8680
271	0.9283	318	0.9128	365	0.8976	412	0.8826	459	0.8677
272	0.9279	319	0.9125	366	0.8973	413	0.8822	460	0.8674
273	0.9276	320	0.9122	367	0.8969	414	0.8819	461	0.8671
274	0.9273	321	0.9118	368	0.8966	415	0.8816	462	0.8668
275	0.9269	322	0.9115	369	0.8963	416	0.8813	463	0.8665
276	0.9266	323	0.9112	370	0.8960	417	0.8810	464	0.8661
277	0.9263	324	0.9109	371	0.8957	418	0.8806	465	0.8658
278	0.9259	325	0.9105	372	0.8953	419	0.8803	466	0.8655
279	0.9256	326	0.9102	373	0.8950	420	0.8800	467	0.8652
280	0.9253	327	0.9099	374	0.8947	421	0.8797	468	0.8649
281	0.9250	328	0.9096	375	0.8944	422	0.8794	469	0.8646
282	0.9246	329	0.9092	376	0.8941	423	0.8791	470	0.8643
283	0.9243	330	0.9089	377	0.8937	424	0.8787	471	0.8640
284	0.9240	331	0.9086	378	0.8934	425	0.8784	472	0.8636
285	0.9236	332	0.9083	379	0.8931	426	0.8781	473	0.8633
286	0.9233	333	0.9079	380	0.8928	427	0.8778	474	0.8630
287	0.9230	334	0.9076	381	0.8924	428	0.8775	475	0.8627
288	0.9227	335	0.9073	382	0.8921	429	0.8772	476	0.8624
289	0.9223	336	0.9070	383	0.8918	430	0.8768	477	0.8621
290	0.9220	337	0.9066	384	0.8915	431	0.8765	478	0.8618
291	0.9217	338	0.9063	385	0.8912	432	0.8762	479	0.8615
292	0.9213	339	0.9060	386	0.8908	433	0.8759	480	0.8611
293	0.9210	340	0.0957	387	0.8905	434	0.8756	481	0.8608
294	0.9207	341	0.9053	388	0.8902	435	0.8753	482	0.8605
295	0.9204	342	0.9050	389	0.8899	436	0.8749	483	0.8602
296	0.9200	343	0.9047	390	0.8896	437	0.8746	484	0.8599
297	0.9197	344	0.9044	391	0.8892	438	0.8743	485	0.8596
298	0.9194	345	0.9040	392	0.8889	439	0.8740	486	0.8593
299	0.9190	346	0.9037	393	0.8886	440	0.8737	487	0.8590
300	0.9187	347	0.9034	394	0.8883	441	0.8734	488	0.8587
301	0.9184	348	0.9031	395	0.8880	442	0.8731	489	0.8583
302	0.9181	349	0.9028	396	0.8876	443	0.8727	490	0.8580
303	0.9177	350	0.9024	397	0.8873	444	0.8724	491	0.8577
304	0.9174	351	0.9021	398	0.8870	445	0.8721	492	0.8574
305	0.9171	352	0.9018	399	0.8867	446	0.8718	493	0.8571
306	0.9167	353	0.9015	400	0.8864	447	0.8715	494	0.8568
307	0.9164	354	0.9011	401	0.8861	448	0.8712	495	0.8565
308	0.9161	355	0.9008	402	0.8857	449	0.8709	496	0.8562
309	0.9158	356	0.9005	403	0.8854	450	0.8705	497	0.8559
310	0.9154	357	0.9002	404	0.8851	451	0.8702	498	0.8556
311	0.9151	358	0.8998	405	0.8848	452	0.8699	499	0.8552

TABLE 9
TEMPERATURE-VOLUME CONVERSION
EMULSIFIED ASPHALT

t	M	t	M	t	M	t	M	t	M
60	1.00000	84	.99400	107	.98825	130	.98250	153	.97675
61	.99975	85	.99375	108	.98800	131	.98225	154	.97650
62	.99950	86	.99350	109	.98775	132	.98200	155	.97625
63	.99925	87	.99325	110	.98750	133	.98175	156	.97600
64	.99900	88	.99300	111	.98725	134	.98150	157	.97575
65	.99875	89	.99275	112	.98700	135	.98125	158	.97550
66	.99850	90	.99250	113	.98675	136	.98100	159	.97525
67	.99825	91	.99225	114	.98650	137	.98075	160	.97500
68	.99800	92	.99200	115	.98625	138	.98050	161	.97475
69	.99775	93	.99175	116	.98600	139	.98025	162	.97450
70	.99750	94	.99150	117	.98575	140	.98000	163	.97425
71	.99725	95	.99125	118	.98550	141	.97975	164	.97400
72	.99700	96	.99100	119	.98525	142	.97950	165	.97375
73	.99675	97	.99075	120	.98500	143	.97925	166	.97350
74	.99650	98	.99050	121	.98475	144	.97900	167	.97325
75	.99625	99	.99025	122	.98450	145	.97875	168	.97300
76	.99600	100	.99000	123	.98425	146	.97850	169	.97275
77	.99575	101	.98975	124	.98400	147	.97825	170	.97250
78	.99550	102	.98950	125	.98375	148	.97800	171	.97225
79	.99525	103	.98925	126	.98350	149	.97775	172	.97200
80	.99500	104	.98900	127	.98325	150	.97750	173	.97175
81	.99475	105	.98875	128	.98300	151	.97725	174	.97150
82	.99450	106	.98850	129	.98275	152	.97700	175	.97125
83	.99425								

PART VI

RIGID PAVEMENT

Section 601

Portland Cement Concrete Pavement

601.01 DESCRIPTION. This work consists of constructing portland cement concrete pavement, with or without reinforcement as specified, 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 control requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Control Specifications for Portland Cement Concrete Pavement and Structures".

601.02 MATERIALS. Materials shall conform to the following Sections or Subsections.

Portland Cement Concrete	901
Joint Materials	1005
Mesh Reinforcement	1009.01
Load Transmission Devices	1009.04
Curing Materials	1011.01

The contractor will be permitted to furnish either Type B, C, D or E concrete; however, the same Type shall be used throughout the project, unless otherwise authorized by the engineer in writing. The contractor will also be permitted to furnish Class A concrete in lieu of the mixtures listed above.

601.03 EQUIPMENT. Equipment and tools necessary for handling materials and performing the work will be subject to approval. The equipment must be at the job site sufficiently ahead of the start of operations to be examined for approval.

(a) Vibrators: Vibrators for full width vibration of concrete paving slabs shall be the 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 24 inches. The first vibrator shall be approximately 12 inches from the edge of slab. They shall not be allowed to come in contact with joints, load transfer devices, subgrade or forms. 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 so interlocked with the forward travel mechanism as to automatically start and stop vibrating as that machine starts and stops.

(b) **Concrete Saw:** When sawing joints is elected or specified, the contractor shall provide adequate equipment to complete the sawing to required dimensions.

(c) **Forms:** Straight side forms shall be made of metal at least 7/32 inch thick and shall be furnished in sections at least 10 feet long. On curves with a radius greater than 150 feet, straight forms of shorter lengths will be permitted. 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. Flexible or curved forms of proper radius shall be used on curves of 150-foot radius or less and shall be of an approved design. Materials used for keyway forms will be subject to approval. 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. When approved, built-up forms may be used; however, the buildup shall not exceed 2 inches. 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. Top face of forms shall not vary from a true plane more than 1/8 inch in 10 feet and the upstanding leg shall not vary more than 3/8 inch from the vertical. Forms shall contain provisions for locking ends of abutting sections together tightly.

601.04 PREPARATION OF GRADE. After the roadbed has been graded and compacted, the subgrade shall be trimmed to correct elevation, extending the work at least 1.0 foot beyond each pavement edge, and to a 30-inch width when slipform paving is used. Extensions in excess of 1.0 foot will not be measured for payment.

If the subgrade or base course is cement or lime treated (or stabilized) or asphaltic concrete, high places in the grade shall be cut or planed down. The subgrade or base course shall be cleaned of loose material.

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 specified grade. Variations in grade shall be corrected as necessary.

(b) Form Setting: After forms have been set to correct grade, the base or subgrade shall be thoroughly tamped, mechanically or by hand, at both inside and outside edges of forms. On asphaltic concrete base, or cement or lime treated (or stabilized) base, each 10-foot section of forms shall be staked into place with at least 2 pins installed in full-size drilled holes. On other type base or subgrade, at least 3 pins will be required in each 10 foot section. A pin shall be placed at each side of every joint. Pins shall be of sufficient length to provide adequate anchorage. Form sections shall be tightly locked, free from movement in any direction. Form sections shall not deviate from required alignment by more than 3/8 inch. No excessive settlement or springing of forms under the finishing machine will be tolerated. Face and top of forms shall be cleaned and oiled prior to placing concrete.

(c) Grade and Alignment: Alignment and elevation of forms shall be checked and corrections made by the contractor prior to placing concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

601.06 CONDITIONING OF SUBGRADE OR BASE COURSE. The subgrade or base course shall be graded to proper cross section. High areas shall be trimmed to proper elevation. 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 subgrade or base course shall be uniformly moist when concrete is placed. If directed, the subgrade or base course shall be sprinkled but the method of sprinkling shall not be such as to form mud or pools of water.

601.07 PLACING CONCRETE. Concrete shall be deposited on the grade in such manner as to require as little rehandling as possible. Equipment shall be so designed and operated as to assure placing and spreading of concrete without segregation. 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, excluding rakes. Workmen shall not be allowed to walk in freshly mixed concrete with boots or shoes coated with earth or foreign substances.

If concrete is to be placed adjoining previously constructed pavement and mechanical equipment will be operated on existing pavement, the pavement shall have attained an age of 10 days or a compressive strength of 3,000 psi in accordance with AASHTO Designation: T 22. If only finishing equipment is carried on existing pavement, paving in adjoining pavement will be permitted after 3 days, exclusive of days when temperature is below 40°F. The contractor shall protect the finish from damage.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them.

Concrete shall be thoroughly consolidated for its full width, and along the faces of forms and along the full length and on both sides of joint assemblies with internal vibrators or other acceptable methods. When hand-held vibrators are used, care shall be taken to avoid excessive vibration.

601.08 TEST SPECIMENS. The contractor shall, at his expense, furnish concrete for casting test specimens as required. Test specimens will be made and cured as specified in DOTD Designation: TR 226.

601.09 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT. After placement, concrete shall be struck off to conform to the specified cross section and to an elevation such that when concrete is properly consolidated and finished, the pavement surface will be at the established elevation. When reinforced concrete is placed in 1 layer, the reinforcing may be placed by mechanical or vibratory means. When reinforced concrete pavement is placed in 2 layers, the entire width of the bottom layer shall be struck off to such length and depth that the fabric reinforcing may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed on the concrete, after which the top layer of concrete shall be placed within 1/2 hour. If, due to conditions beyond the control of the contractor, more than 1/2 hour but not more than 1 hour has elapsed before the top layer of concrete is placed, the location by stations, temperature and other weather conditions and other pertinent data will be recorded on the Concrete Inspector's Daily Report. At such locations, core borings will be taken at a later date to determine if the slab is monolithic.

Any portion of the bottom concrete layer which has been in place for more than 1 hour shall be removed and replaced with fresh concrete at the contractor's expense prior to placing the top layer.

When the top layer of concrete is placed after the initial 1/2 hour period and before the expiration of 1 hour and core borings indicate a monolith has not been attained, the concrete shall be removed and replaced at the contractor's expense.

At the time concrete is placed, reinforcement shall be free of mud, oil or other materials that may adversely affect bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory provided the minimum dimensions and weight of a hand wire-brushed test specimen are not less than the tolerance allowed.

601.10 JOINTS.

(a) Longitudinal Joint: The transverse joint shall be 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. 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 or, in lieu of bent tie bars, approved 2-piece connectors may be used. Tie bars which break or show evidence of fracture upon straightening shall be replaced when directed by drilling 1-inch holes to a depth of 12 inches and epoxy-grouting the tie bars in the holes by approved methods.

(1) The groove for the longitudinal joint shall be formed by using a "T" iron wheel or other device that will insure a groove that is true in both vertical and horizontal alignment. Grooves shall be cut to the specified minimum depth in such manner that the surface of freshly placed concrete will not be depressed or otherwise disturbed. Re-tempering of concrete adjacent to joints will not be permitted.

Strips of preformed joint filler material of specified dimensions shall be inserted in the groove. After insertion, the top edge of the strip shall be flush with the surface or slightly below. In no case shall the distance between the top of the insert and surface of concrete exceed 1/8 inch. The joint shall then be aligned and the surface of pavement floated and checked with a 10-foot straightedge. These fillers shall conform to Subsection 1005.01 (a)(1); (a)(2), Type I or III; or (e), and no sealer is required. Fillers conforming to Subsection 1005.01(c) may be used with sealers conforming to Subsection 1005.02(a), (b), (c) or (d)(2).

(2) Flexible joint-forming devices of the specified types may be used. Such joints shall be formed in accordance with plan details and the manufacturer's recommendations. When the contractor desires to use a joint forming device not specified, the device and method of installation must be approved in writing. These joint-forming devices shall conform to Subsection 1005.01(d).

(b) **Transverse Expansion Joints:** Any concrete disturbed during expansion joint installation shall be replaced with fresh concrete and vibrated with a surface vibrator. The expansion joint filler shall be one of the following types:

(1) **Fillers Requiring Sealing:** If wood filler conforming to Subsection 1005.01(b) or preformed nonbituminous cellular filler (for sawed joints) conforming to Subsection 1005.01(c) is used to form the joint, it shall be sealed as specified. When wood filler is used, it shall

be immersed in water for at least 24 hours before installation. Boards shall be kept thoroughly wet until installed. The sealer shall be one of the following materials:

a. Preformed elastomeric compression seal conforming to Subsection 1005.03.

b. PVC extended hot poured elastic joint sealer conforming to Subsection 1005.02(a).

c. Polyurethane sealant conforming to Subsection 1005.02(b).

(2) Fillers Not Requiring Sealing: Fillers not requiring sealing shall conform to Subsection 1005.01 (a)(2), Type I or III, or Subsection 1005.01(e). The expansion joint filler shall be continuous between forms and shaped to the subgrade. Preformed joint fillers shall be furnished in lengths equal to the pavement width or equal to the width of one lane, except that when polyethylene conforming to Subsection 1005.01(e) is used, a minimum length of 9 feet is acceptable. Damaged or repaired joint fillers shall not be used unless approved.

Load transfer devices shall provide bracing adequate to hold the expansion joint filler in a vertical position. An expansion installing bar or other device shall be used if required to secure preformed expansion joint filler at proper grade and alignment during placing, vibrating and finishing of concrete. Care shall be taken to prevent indentations, deformations or punctures of the filler. Finished joints shall not deviate more than 1/4 inch 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.

(c) Transverse Contraction Joints (Dummy Joints): Transverse contraction joints shall consist of planes of weakness created in cross section of pavement. The joints shall include load transfer devices and shall be constructed by one of the following methods:

(1) Install a nonbituminous preformed filler board in a groove in the pavement formed as outlined under Heading (a)(1) of this Subsection and then sawed to the dimensions specified with one pass of the saw.

(2) Install an approved removable joint device to form a joint to the required width and depth. This device shall be vibrated in place and raised 1/2 to 3/4 inch while concrete is workable, with all laitance removed along side of insert. 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. They shall be reused only with prior approval.

(3) Install an approved permanent joint device as described in Sub-

section 1005.04 to form a joint in fresh concrete to assure proper bond and alignment. The sequence of operations shall be as follows.

a. Paving and Surface Preparation: Paving and finishing equipment shall be moved ahead as required to provide plastic concrete for joint installation. The pavement surface shall be finished, except for texturing, to specified grade prior to installation of sealer.

b. Forming of Joint: A vertical plane shall be established for installation of the sealer by working a blade into the fresh concrete perpendicular to the surface at the specified joint location to a depth 1/4 inch greater than the depth of the sealer. The blade portion of the forming device shall have a thickness of 1/4 to 3/8 inch and shall be flanged or marked so that when inserted to proper depth, the bottom of the flanged portion is flush with the concrete surface and may be used to visually control depth. Vertical vibration may be used to force the blade into the concrete. Movement of the blade in a direction that widens the joint shall be avoided. The blade shall be removed with minimum disturbance to the surface.

c. Insertion of Sealer: The sealer shall be inserted with the side strips held closed and perpendicular to the concrete surface. The top of the sealer cap shall be flush with the concrete surface. Connections between lengths of sealer shall be made at longitudinal joints with the connecting guides supplied with the sealer. At joint intersections the longitudinal joint material shall be cut as directed.

d. Vibrations: An approved vibrating bull float shall be placed directly over the installed sealer and moved along the top of the seal to cause concrete to flow up both sides of sealer simultaneously. The vibrating float shall be moved along the entire joint length twice or until the concrete is properly consolidated against both sides of the seal. After vibration, the top edges of the top cap shall be visible across the entire joint length. Should any portion of the top edges of the top cap not be visible, the sealer shall be raised to proper depth and revibrated.

e. Subsequent Operations: No subsequent operations shall be permitted to move the sealer. Texturing shall be discontinued within 2 inches of the seal.

f. Removal of Top Cap: Top caps shall be removed within 15 days from installation of sealer. If a 1/16 to 1/8 inch thickness of grout has hardened above the top cap, a topper shall be used to crack off this thin overlay prior to top cap removal to avoid spalling of the joint edges.

g. Treatment of Spalled Areas at Joints: Joints shall be free of spalls, fractures, breaks and voids. If the extent of spalling is severe enough to enable tire traffic to contact the seal, the contact areas shall be chipped back to sound concrete and repaired with an approved patching compound in accordance with the manufacturer's recommendations. When spalling adjacent to the joint exceeds 2 feet in length and the depth of spalling exceeds 1/2 inch, the sealer shall be removed by sawing and replaced with preformed elastomeric compresson joint seal or other approved pourable joint sealer.

h. Limitations on Use: This material shall be used only in transverse contraction joints. This sealer shall not be used in skewed joints or joints in which the concrete has set to such extent that the sealer cannot be properly installed.

i. Storage: The materials shall be stored flat in the shipping containers.

(d) Transverse Construction Joints: 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 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 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 construction joints. Joints shall include dowel bar assembly type load transfer devices.

(e) Load Transfer Devices: Load transfer devices shall be either dowel bar assemblies or cantilever-type devices conforming to Subsection 1009.04.

Dowels shall have a uniformly round cross section and shall be saw-cut, smooth and free of burrs, projections and deformations. Dowels shall be coated with 1 coat of an approved paint and thoroughly coated with an approved lubricant. In lieu of painted and lubricated dowels, plastic-coated dowel bars may be used. Plastic-coated dowel bars may be placed by approved mechanical devices equipped with suitable means to control proper depth and alignment of the dowel bars; bars shall be positioned parallel to the pavement centerline and surface; bars shall be firmly held in position by the mechanical device until concrete has been thoroughly consolidated around the bars. Painted and greased dowel bars shall be placed in approved metal dowel assemblies. An approved sleeve shall be furnished with each dowel bar used in expansion joints. The sleeve shall fit the dowel bar tightly and the closed end shall be watertight.

Cantilever device assemblies shall be of the specified type or approved equal.

(f) Overlaid Pavement: If concrete pavement is to be overlaid with asphaltic concrete, sawing and sealing of longitudinal and transverse joints will not be required.

601.11 FINAL STRIKE-OFF, CONSOLIDATION AND FINISHING.

(a) Sequence: The sequence of operations shall be: strike-off and consolidation, floating and removal of laitance, straightedging and final surface finish.

In general, addition of water to the surface of concrete to assist in 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 finish operations, areas that are improperly finished shall be refloated and refinished as required.

(b) Finishing at Joints:

(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 adjacent to joints shall be consolidated as required in Subsection 601.07.

(2) After concrete has been placed and vibrated adjacent to joints, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine to, over and beyond the joint causes segregation of concrete, damage to or misalignment of joints, the finishing machine shall be stopped when the front screed is approximately 8 inches from the joint. Segregated concrete shall be removed from in front of and off the joint; the front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screed, provided there is no segregated concrete between the joint and screed or on top of the joint.

(c) Machine Finishing: Vibrators for full width vibration of concrete paving slabs shall conform to Subsection 601.03(a). Vibrators shall not be operated longer than 15 seconds in one location. If uniform and satisfactory density of concrete is not obtained, the contractor shall furnish equipment and use methods which will produce pavement conforming to specifications.

(d) Hand Finishing: Hand finishing methods will not be permitted except under the following conditions:

(1) In the event of breakdown of mechanical equipment, hand methods may be used to finish concrete already deposited on the grade when the breakdown occurs.

(2) Pavement widths not exceeding 16 feet or areas of irregular dimensions where operation of mechanical equipment is impractical may be finished by hand methods.

Concrete, as soon as placed, shall be struck off and screeded with an approved portable screed. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used. The screed for the surface shall be at least 2 feet longer than the slab width and shall be of approved design, sufficiently rigid to retain its shape and constructed either of metal or other suitable material shod with metal.

Consolidation shall be attained by the use of suitable vibrators or other approved equipment.

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.

(e) Floating: After concrete has been struck off and consolidated, it shall be further smoothed, trued and consolidated by means of a float.

The contractor may use a machine composed of cutting and smoothing floats suspended from and guided by a rigid frame. The frame shall be carried by 4 or more visible wheels riding on, and constantly in contact with, side forms.

If necessary, following the preceding method of floating, long-handled floats having blades at least 5 feet long and 6 inches wide may be used to smooth and fill open-textured pavement areas. Longhandled floats shall not be used to float the entire pavement surface in lieu of or supplementing the preceding method of floating. When strike-off and consolidation are done by hand and the pavement crown will not permit use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the pavement surface by a straightedge at least 10 feet long. Successive drags shall be lapped 1/2 the length of the blade.

(f) Straightedge Testing and Surface Correction: After floating has been completed and excess water removed but while concrete is still plastic, the concrete surface shall be tested for trueness with an accurate 10-foot straightedge swung from handles approximately 3 feet longer than 1/2 the slab width. 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 and the whole area 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 straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is free from departures from the straightedge and the slab conforms to required grade and cross section.

(g) Final Finish and Texture: Final finish and texture shall be obtained by using a fabric drag in accordance with Heading (h) of this Subsection followed by a metal tine texturing device. Approved methods other than the tine finish shall be used for final finish on crossovers, parking areas, turnouts, drives and other such areas.

Final texturing with the metal tine shall produce grooves uniform in appearance and transverse to pavement centerline and a continuously textured surface. Tines shall be approximately 0.025 x 0.126 inch steel flat wire, 4 to 5 inches in length spaced on 1/2 inch centers. Grooves produced in the concrete shall be 3/16 inch in depth with a minimum depth of 1/8 inch. The metal tine device shall be operated by approved mechanical means when texturing main roadway pavement lanes. Manual methods may be used for texturing ramps, split slab construction or other pavement sections when approved.

Depth of final finish will be checked in accordance with DOTD Designation: TR 229. Texturing operations must be satisfactory to the engineer. Texturing equipment other than that specified may be approved for use provided it produces a texture equivalent to that produced by the specified metal tine.

(h) Drag Finish: When permitted, the surface texture shall be a drag finish. The drag shall consist of a seamless strip of damp burlap or cotton fabric which produces a uniform surface of gritty texture after dragging it longitudinally along the full pavement width. For pavement 16 feet or more in width, the drag shall be mounted on a bridge which travels on forms. Dimensions of the drag shall be such that a strip of burlap or fabric at least 4 feet wide is in contact with the full width of pavement surface while the drag is used. The drag shall consist of at

least 2 layers of burlap with the bottom layer approximately 6 inches wider than the upper layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1/16 inch deep. Drags that cannot be cleaned shall be replaced.

(i) Broom Finish: When permitted, the surface texture shall be a broom finish. It shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the pavement center to the edge with adjacent strokes slightly overlapping. Brooming operations shall be so executed that surface corrugations produced shall be uniform in appearance and not more than 1/16 inch deep. Brooming shall be completed before concrete is in such condition that the surface will be torn or unduly roughened by the operation. The surface shall be free from rough and porous areas, irregularities and depressions resulting from improper broom handling. Brooms shall be of such quality, size and construction and be so operated as to produce a satisfactory surface finish. Subject to satisfactory results being obtained, the contractor will be permitted to use mechanical brooming in lieu of manual brooming.

(j) Edging At Forms and Joints: After final finish but before concrete has taken its initial set, the edges on each side of pavement and each side of transverse expansion joints, formed joints and transverse construction joints 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 obtained. The pavement surface shall not be unduly 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 corner of the slab shall not be disturbed. Concrete on top of joint filler shall be removed. Joints shall be tested with a straightedge before the concrete has set and corrections made as necessary.

(k) Finish for Concrete to be Overlaid: If concrete pavement is to be overlaid with asphaltic concrete, final strike-off and surface finishing as hereinbefore specified will not be required and the pavement shall be satisfactorily finished in conformity with the 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.

601.12 CURING. Immediately after completion of finishing operations and as soon as marring of concrete will not occur, the entire surface of newly placed concrete shall be cured by covering with a white pigmented impervious membrane. Concrete shall not be left exposed for more than 1/2 hour during the curing period. Curing shall be maintained continuously for 72 hours.

The contractor shall have available at the job site sufficient covering material to properly protect the last hour's pour against the effects of rain. Covering material may be burlap mats, waterproof paper or combined burlap and white polyethylene sheeting. Failure to provide sufficient cover material or adequately take care of curing shall be cause for immediate suspension of concreting operations.

Other curing methods may be used when approved in writing.

(a) White Pigmented Impervious Membrane: The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after completion of surface finishing as soon as surface water evaporates. If the pavement is cured initially with burlap mats and mats are removed prior to expiration of 72 hours, curing compound shall be applied immediately. 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 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 odd 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 reinforcing steel.

Should the film become damaged within the curing period, the damaged portions shall be repaired immediately with additional compound.

Upon removal of side forms, exposed sides of slabs shall be protected immediately with a curing treatment equal to that provided for the surface.

(b) Waterproof Paper: The pavement surface shall be thoroughly wet prior to placing paper. The pavement surface and sides shall be entirely covered with waterproof paper. Units shall be lapped at least 18 inches. Paper shall be so placed and weighted down as to cause it to remain in contact with the surface. The paper shall have such dimensions that each unit will extend beyond pavement edges at least twice the pavement thickness, or of pavement width and 2-foot strips of paper for edges. If laid longitudinally, paper not manufactured in sizes providing this width shall be sewed or cemented together in such manner that they do not separate during the curing period. After removal of side

forms, materials shall be folded down over pavement edges and secured by a continuous bank of earth.

(c) **Burlap Mats:** The pavement surface shall be entirely covered with mats of such length or width that they will extend at least twice the pavement thickness beyond the slab. Mats shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, mats shall be saturated thoroughly with water. After removal of side forms, material shall be folded down over pavement edges and secured by a continuous bank of earth. Mats shall be so placed and weighted down as to cause them to remain in contact with the surface.

(d) **White Polyethylene Sheeting:** The pavement surface and sides shall be entirely covered with polyethylene sheeting. Units shall be lapped at least 18 inches. Sheeting shall be so placed and weighted down as to cause it to remain in contact with the surface. Sheeting shall have such dimension that each unit will extend beyond pavement edges at least twice the pavement thickness. After removal of side forms, the material shall be folded down over pavement edges and secured by a continuous bank of earth.

(e) **Combined Burlap and White Polyethylene Sheeting:** The burlap portion of each sheet shall be thoroughly wet down before use. After completion of finishing operations and immediately following the disappearance of surface water, the pavement surface shall be completely covered, with the polyethylene side of the material up. Sheets of material shall be so placed and weighted as to cause it to remain in contact with the surface and separate sheets shall be lapped at least 6 inches. After removal of side forms, the material shall be folded down over pavement edges and secured by a continuous bank of earth.

(f) **Cold Weather Curing:** When concrete is being placed and the air temperature is expected to drop below 35°F, a sufficient supply of straw, hay, grass, approved curing paper or other blanketing material shall be provided along the work, and any time the temperature is expected to reach the freezing point during the day or night, the material shall be spread over the pavement to a sufficient depth to prevent freezing of concrete. Any concrete damaged by frost action shall be removed and replaced at the contractor's expense.

601.13 SURFACE FINISH REQUIREMENTS. As soon as concrete has hardened sufficiently, the contractor shall conduct tests as are necessary to determine whether the paved surface is within specification limits. The pavement surface will be tested by the Department with an approved 10-foot rolling straightedge capable of marking the deficient areas by suitable means. The rolling straightedge shall be furnished by the

contractor and shall be calibrated and used by the Department in accordance with DOTD Designations: TR 603 and TR 618.

Surface tolerance measurements will be conducted for each pavement lot. If surface deviations in a lot exceed 6.0 percent, paving operations shall be discontinued and shall not be resumed until satisfactory corrective action is taken by the contractor.

All testing will be made longitudinally for the full length of each traffic lane. Each section will be tested as early as possible in a longitudinal direction in both wheel paths of each travel lane.

Pavement areas with surface deviations over 1/2 inch shall be satisfactorily removed and replaced by the contractor at his expense with pavement meeting these specifications.

Pavement areas with surface deviations of 1/4 to 1/2 inch will be isolated by the engineer and shall be corrected by the contractor at his expense by approved grinding methods to within a 1/8-inch deviation; except for ramps, turnouts and other irregular sections which shall be corrected by approved grinding methods to within a 1/4-inch deviation. Pavement surfaces which have been corrected by grinding shall be textured consistent with adjacent pavement. Surface deviations of 1/8 to 1/4 inch will be subject to the price adjustments given in Table 1 of this Section.

601.14 REMOVING FORMS. Forms shall not be removed from freshly placed concrete until it has set for at least 12 hours, except auxiliary forms used temporarily in widened areas. 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 601.12. Minor honeycombed areas shall be filled with mortar composed of 1 part cement and 2 parts fine aggregate. Major honeycombed areas shall be removed and replaced. Any area or section so removed shall not be less than 10 feet in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to joints that is less than 10 feet long shall also be removed and replaced.

601.15 SEALING JOINTS.

(a) General Requirements: Each joint will be subject to inspection and approval for proper width, depth, alignment and preparation before sealing is allowed. Sealing of joints will not 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 backup material immediately after sawing or removal of insert. When poured sealers are used, the concrete shall be 7 days old prior to sealing joints.

Joints shall be thoroughly cleaned immediately prior to sealing. Poured sealers require that joint faces 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 shall not be permitted while sealing and until after sealant is cured. When a liquid poured sealant in accordance with Subsection 1005.02 is used, the pavement shall be closed to all traffic for at least 1 day after sealing. When elastomeric compression seal is used, the pavement may be opened to traffic immediately following completion of sealing.

Joints shall be reasonably 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 sealant shall be installed in accordance with the manufacturer's recommendations. Sealant shall be installed to a depth of 1/4 to 3/8 inch below the pavement surface. Sealants shall conform to the following:

(1) **Longitudinal joints** — as specified in Subsection 601.10.

(2) **Transverse expansion joints** — as specified in Subsection 601.10.

(3) **Transverse contraction and construction joints** — shall be sealed with joint sealers conforming to Subsection 1005.02 or 1005.03.

(b) Elastomeric Polymers and Preformed Compression Seals: The following additional requirements apply to the installation of elastomeric polymers and preformed compression seals conforming to Subsections 1005.02 and 1005.03.

(1) **Hot Poured Sealants:**

a. Joint Preparation: Joints shall be either formed or cut in accordance with Subsection 601.10. Removal of joint-forming devices or sawing operations shall not commence until immediately before cleaning and application of sealant material. Joints shall be thoroughly cleaned by commercial sandblasters capable of effectively removing all concrete curing membrane, laitance and other foreign matter from the joint. Sandblasting operations shall continue until the joint exhibits a uniform etched surface. Upon com-

pletion of sandblasting, the joint and adjacent areas shall be cleaned of all dust and sand.

b. Application: Poured sealers conforming to Subsections 1005.02(a) and 1005.02(d)(2) shall be installed in accordance with the following requirements:

The sealant shall not be installed until the joint has been inspected and approved. A backing material shall be placed as shown on the plans and shall be nonadhesive to concrete or sealant material. The material shall be upholstery roving cord. The joint sealant shall be applied uniformly solid from bottom to top. The joint shall be filled without formation of entrapped air or voids. Air temperature at the time of installation shall be 50°F or above.

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 range of 240° to 280°F will be required. Kettles shall have easy access to facilitate cleaning and shall be thoroughly cleaned of any foreign substances or previously used compounds and shall be flushed daily with flushing oil. This equipment shall be provided with 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 and shall be satisfactorily maintained in satisfactory condition.

(2) Polyurethane Polymers, Subsection 1005.02(b): Care shall be taken that the material's shelf life is not exceeded and that application is accomplished at a temperature of 70°F or above.

(3) Preformed Elastomeric Compression Seals, Subsection 1005.03: Dilution of lubricant-adhesive is discouraged; however, a maximum of 10 percent dilution with a material recommended by the manufacturer will be allowed when application is by pump and the viscosity is such that the lubricant-adhesive will not flow through a pump. The lubricant-adhesive shall be applied just prior to installation of the seal and shall be sufficient to completely cover the seal's sidewalls.

Sealers shall be machine installed on projects requiring 3,000 feet or more of joint sealing. Stretching of the compression seal shall not exceed 5 percent. Prior to beginning installation, a length of sealer equal to the pavement width shall be cut and installed so that

stretching may be measured. Random checks for stretching shall then be made throughout the project as deemed necessary by the engineer. If the lubricant-adhesive has chemically set and maximum stretch limits are exceeded, the seal shall be removed and cleaned, the joint recleaned and reinstallation made. Field splicing will not be allowed. Sizes of compression seals shall be as indicated on the plans.

(4) **Silicone Polymers, Subsection 1005.02(c):** Care shall be taken that joint faces are dry and dust-free prior to seal installation.

601.16 PROTECTION OF PAVEMENT. The contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen 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.

601.17 SPLIT SLAB CONSTRUCTION. Split slab construction methods will only be permitted when required for traffic maintenance, or for short pavement sections (generally, less than 400 linear feet), or for turnouts, crossovers and other irregular sections.

There will be no additional payment for split slab construction. When the use of the split slab method is requested by the contractor, written authority shall be obtained.

Longitudinal joints in pavement constructed by the split slab method shall conform to Subsection 601.10. 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 601.18.

The use of split slab construction methods will not preclude the use of approved paving equipment as specified elsewhere herein.

601.18 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 601.06 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 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 1 pass of the machine in such manner that a

minimum of hand finish will be necessary to provide a dense, homogenous pavement in conformance with plans and specifications. The machine shall be equipped with vibrators conforming to Subsection 601.03(a) and concrete shall be vibrated for the full pavement width and depth. Sliding forms shall be rigidly held together laterally to prevent spreading of forms. Jointed concrete paving shall use trailing forms except in confined areas where deemed impractical by the engineer. Forms shall trail behind the paver for such distance that no appreciable slumping of concrete will occur. All vibration of concrete and vibratory placement of load transfer devices shall occur within trailing forms.

Concrete shall be held at a uniform consistency. The contractor shall take all steps necessary to avoid noncompliance of the physical mix requirements of concrete delivered for paving. If such noncompliance is a recurring problem, and the contractor's corrective measures are deemed by the engineer to be inadequate, paving operations shall be discontinued until adequate corrective measures have been taken. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress. Concrete mix 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 per minute. If it is necessary to stop forward movement of the paver, the vibrator and tamping elements shall also be stopped immediately. 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 601.11. Surface tolerances shall be as specified in Subsection 601.13 with the following modifications. In addition to longitudinal testing, edges of slabs placed without conventional forms shall meet the following tolerances when tested transversely with the straightedge.

(1) **Edges not along Longitudinal Joints:** The surface within the 6-inch width adjacent to the edge shall not vary more than 1/4 inch when tested transversely with the straightedge.

(2) **Edges at Longitudinal Joints:** Approved conventional metal forms will be required at slab edges along longitudinal joints within travel lanes. The top of forms shall be set to required pavement grade and forms shall be adequately supported to maintain the required line and grade during concrete placing and finishing operations. Conventional forms will not be required at slab edges along longitudinal joints outside of travel lanes, provided the surface within the 6-inch width adjacent to the edge does not vary more than 1/8 inch when tested transversely with the straightedge.

(d) **Curing:** Curing shall be done in accordance with Subsection 601.12.

(e) **Joints:** Joints shall be constructed and sealed in accordance with Subsections 601.10 and 601.15.

(f) **Protection Against Rain:** The contractor shall have available at all times materials for protection of edges and surface of unhardened concrete from damage due to rain. Such protective materials for pavement edges shall consist of standard metal forms or wood plank having a nominal thickness of not less than 2 inches and a nominal width of not less than the pavement thickness. Protective materials for pavement surfaces shall be burlap mats, curing paper or plastic sheeting. 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 protective covering.

601.19 OPENING TO TRAFFIC. The pavement shall not be opened to traffic until standard test specimens conforming to Subsection 601.08 have attained a compressive strength of 3,000 psi when tested in accordance with AASHTO Designation: T 22. If such 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 601.15.

601.20 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.

A lot is 3,000 linear feet of pavement when a single traffic lane is placed, 1,500 linear feet when two lanes are placed concurrently, or 1,000 linear feet when three lanes are placed concurrently. The last unit in each slab shall constitute a lot in itself when its length is at least 1/2 the normal lot length. A shorter length will be included in the previous lot. Other areas such as intersections, entrances, crossovers, ramps, etc., will be grouped together to form lots not exceeding 4,000 square yards. Small irregular areas may be included with other unit areas to form a lot.

(b) **Thickness and Compressive Strength:** Strength and thickness of pavements will be determined from hardened concrete cores in accordance with DOTD Designation: TR 225. Each lot will be divided into 5 equal segments and 1 core will be obtained from each segment after the pavement has met all surface tolerance requirements.

(1) **Thickness:** The average thickness of the pavement lot shall not be less than specified thickness by more than 0.10 inch. Un-

derthickness deficiencies in excess of 0.10 inch will be subject to the price adjustments shown in Table 1 of this Section. Overthickness will be waived at no cost to the Department.

In calculating average pavement thickness, individual measurements in excess of specified thickness by more than 0.25 inch will be considered as specified thickness plus 0.25 inch.

Individual areas found deficient in thickness by more than 1.00 inch will be evaluated by the engineer, and if in his 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 will be made at 50 percent of the contract unit price for that fraction of the lot with greater than 1.00 inch underthickness. Payment for the remainder of the lot will be made in accordance with Table 1 of this Section based on the average thickness of the entire lot.

(2) Compressive Strength: Average compressive strength for the lot shall not be less than 4,000 psi (3,600 psi when air entrainment is used).

When the average strength for the lot is less than 4,000 psi (3,600 psi when air entrainment is used), the contract unit price will be adjusted in accordance with Table 1 of this Section.

When an individual core indicates compressive strength less than 3,000 psi, and if in the judgment of the engineer the concrete may be left in place, the quantity of concrete represented by the deficient core will be paid for at 50 percent of the contract unit price. If removal is warranted, the entire section shall be replaced with concrete of the specified quality.

The compressive strength of cores will be determined after a minimum of 28 days.

(c) Surface Tolerance: The surface of each pavement lot will be tested longitudinally with a 10-foot rolling straightedge as described in Subsection 601.13. 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 1 of this Section.

601.21 METHOD OF 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 pavement.

Reinforcement, except for tie bars, load transfer devices and joint materials, will be measured by the pound.

601.22 BASIS OF PAYMENT. Portland cement concrete pavement will be paid for on a lot basis at the contract unit price per square yard, which includes furnishing and placing all materials including tie bars, load transfer devices and joint material. If the pavement does not conform to the acceptance requirements, payment will be made at an adjusted unit price in accordance with Table 1 of this Section. The lowest percentage of contract unit price will be used for final adjustment in unit price for deficiencies in pavement thickness, compressive strength and surface tolerance.

Fabric reinforcing will be paid for at the contract unit price per pound.

Payment will be made under:

Item No.	Pay Item	Pay Unit
601(1)	Portland Cement Concrete Pavement (__" Thick)	Square Yard
601(2)	Portland Cement Concrete Pavement (__" Thick) (Crossovers and Turnouts)	Square Yard
601(3)	Fabric Reinforcing	Pound

TABLE 1
PRICE ADJUSTMENT SCHEDULE

	Payment (Percent of Contract Unit Price/Lot)			
	100	95	80	50 or Remove (1)
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
Surface Tolerance, linear percent	0 to 6.0	6.1 to 8.0	8.1 to 10.0	Over 10.0

(1) At the option of the engineer.

PART VII

INCIDENTAL CONSTRUCTION

Section 701

Culverts and Storm Drains

701.01 DESCRIPTION. This work consists of furnishing and installing pipe culverts, pipe arch culverts, storm drains and sewers, herein referred to as "conduit," in accordance with these specifications and in conformity with lines and grades shown on the plans or established by the engineer.

701.02 MATERIALS. Materials shall conform to the following Subsections and these additional requirements:

Granular Material	1003.07
Concrete Sewer Pipe	1006.02
Reinforced Concrete Pipe	1006.03
Reinforced Concrete Pipe Arch	1006.04
Gasket Materials	1006.06
Vitrified Clay Pipe	1006.08
Asbestos-Cement Pipe	1006.09
Plastic Yard Drain Pipe	1006.11
Corrugated Steel Pipe and Pipe Arch	1007.01
Bituminous Coated Corrugated Steel Pipe and Pipe Arch	1007.02
Asbestos Bonded Corrugated Steel Pipe and Pipe Arch	1007.03
Structural Plate for Pipe and Pipe Arch	1007.05
Corrugated Aluminium Pipe and Pipe Arch	1007.06
Polymeric Coated Corrugated Steel Pipe and Pipe Arch	1007.08
Cast Iron Soil Pipe	1007.11
Geotextile Fabric (Plastic Filter Cloth)	1018.15

(a) General: At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

(b) Side Drain Pipe or Pipe Arch: When the item "Side Drain Pipe" or "Side Drain Pipe Arch" is included in the contract, the contrac-

tor has the option of furnishing conduit of reinforced concrete, asbestos bonded corrugated steel, bituminous coated corrugated steel, polymeric coated corrugated steel, or corrugated aluminum, unless otherwise specified.

(c) Pipe Conduit or Pipe Arch Conduit: When the item "Pipe Conduit" or "Pipe Arch Conduit" is included in the contract, the contractor has the option of furnishing conduit of reinforced concrete, bituminous coated corrugated steel, polymeric coated corrugated steel, asbestos bonded corrugated steel, or corrugated aluminum, unless otherwise specified.

(d) Corrugated Metal Pipe or Corrugated Metal Pipe Arch: When the item "Corrugated Metal Pipe" or "Corrugated Metal Pipe Arch" is included in the contract, the contractor has the option of furnishing conduits of bituminous coated corrugated steel, polymeric coated corrugated steel, asbestos bonded corrugated steel or corrugated aluminum, unless otherwise specified.

(e) Material Type Abbreviations:

RCP	Reinforced Concrete Pipe
RCPA	Reinforced Concrete Pipe Arch
CMP	Corrugated Metal Pipe, Steel or Aluminum
CMPA	Corrugated Metal Pipe Arch, Steel or Aluminum
RCB	Reinforced Concrete Box Culvert
CSP	Corrugated Steel Pipe
CSPA	Corrugated Steel Pipe Arch
CAP	Corrugated Aluminum Pipe
CAPA	Corrugated Aluminum Pipe Arch
BCCSP	Bituminous Coated Corrugated Steel Pipe
BCCSPA	Bituminous Coated Corrugated Steel Pipe Arch
PCCSP	Polymeric Coated Corrugated Steel Pipe
PCCSPA	Polymeric Coated Corrugated Steel Pipe Arch
ABBCCSP	Asbestos Bonded Bituminous Coated Corrugated Steel Pipe
ABBCCSPA	Asbestos Bonded Bituminous Coated Corrugated Steel Pipe Arch
SL	Smooth Lined
T1	Type 1 Joint
T2	Type 2 Joint
T3	Type 3 Joint

701.03 EXCAVATION. Trenches shall be excavated to a width sufficient for proper joining of conduit sections and thorough compaction of bedding and backfill material under and around conduits. Excavated material that is not satisfactory for backfill or is surplus material shall be satisfactorily disposed of.

701.04 FORMING CONDUIT BED. Rock encountered shall be removed below grade and replaced with satisfactory materials in such manner as to provide a compacted earth cushion having a thickness under the conduit of at least 1/2 inch per foot of fill height over the top of conduit with a minimum thickness of 8 inches.

If conduit is not laid in a trench, a uniformly firm bed shall be made as specified for the bottom of the trench.

When specified, additional excavation shall be performed below established grade and bedding material placed. This work shall be performed and paid for in accordance with Section 726.

When it is determined by the engineer that a suitable foundation cannot be obtained at established grade and the item for bedding material has not been included in the contract, unstable soil below established grade shall be removed and replaced with satisfactory soil materials compacted as directed or bedding material conforming to Section 726, as the engineer elects. The additional excavation will not be measured for payment; however, the additional materials furnished and placed for the conduit foundation will be measured and paid for as follows:

(a) **Soil 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. If the contract does not include a pay item for embankment, payment will be made in accordance with Subsection 104.02.

(b) **Bedding Material:** Measurement and payment will be made in accordance with Section 726. If the contract does not include a pay item for bedding material, payment will be made in accordance with Subsection 104.02.

701.05 LAYING CONDUIT. Conduit laying shall begin at the downstream end of the line. The conduit shall be reasonably in contact with the foundation throughout its length. Bell or groove ends of concrete conduit and outside circumferential laps of flexible conduit shall be placed facing upstream. Metal conduit shall be placed with longitudinal laps at sides. Conduits in each continuous line shall have the same wall thickness. Metal conduits provided with lifting lugs shall be handled only by these lugs.

701.06 JOINING CONDUIT.

(a) Types of Joints:

(1) Type 1 joints shall be used for side drains under drives.

(2) Type 2 joints shall be used for cross drains under roadways, including turnouts.

(3) Type 3 joints shall be used for closed sanitary and storm sewer systems, flumes and siphons.

(b) **Concrete Conduit:** Concrete conduit may be either bell and spigot, or tongue and groove. The method of joining conduit 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 conduits over 36-inch diameter.

Joints shall conform to Subsection 1006.05, and shall be sealed with gasket material conforming to Subsection 1006.06 installed in accordance with the manufacturer's recommendations.

Types 2 and 3 joints shall be wrapped with plastic filter cloth for a minimum of 12 inches on each side of joint. Ends of the cloth shall be lapped at least 10 inches and edges and ends of cloth shall be suitably secured.

(c) **Metal Conduit:** Metal conduit shall be firmly joined by coupling bands conforming to Subsection 1007.10. Bands shall lap over an equal portion of each conduit section.

For Type 1 joints, flexible plastic gasket material shall be placed in 1 corrugation recess on each side of the joint at the coupling band and on each band connection in such manner to prevent leakage. Gasket material shall be placed in accordance with the manufacturer's recommendations.

When Type 2 or 3 joints are specified, joining of metal conduit sections shall conform to the following provisions:

(1) **General:** Band joints shall be sealed with gasket material conforming to Subsection 1006.06. Plastic gasket material shall be placed in the first 2 corrugation recesses on each side of conduit connections. Plastic gasket material shall also be placed on each band connection in such manner to prevent leakage. Gasket material shall be placed in accordance with plan details. The joint shall be wrapped with plastic filter cloth for a minimum of 12 inches on each side of the connecting band. Ends of cloth shall be lapped at least 10 inches, and edges and ends of cloth shall be suitably secured.

(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 12 inches wide for pipe arch up to a 30-inch round equivalent diameter, and 24 inches wide for 36-inch 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-inch round equivalent diameter pipe arch and above shall be 2-piece bands.

(d) **Cast Iron:** Cast iron pipe sections shall be connected with approved joining materials and methods that provide watertight connections. Joints shall not be located within drainage structures.

(e) Approved connections shall be used when joining new to existing conduits, and no direct payment will be made therefor.

701.07 RELAYING CONDUIT. If specified or directed, existing conduits shall be removed and all suitable sections relaid as specified for new conduits.

701.08 BACKFILLING.

(a) **General:** Conduits shall be inspected before backfill is placed and any found to be damaged or out of required alignment or grade shall be removed and relaid or replaced, at the contractor's expense; and any conduits damaged or out of the required alignment or grade due to backfill operations or other cause shall be removed and relaid, or replaced, at the contractor's expense. At the time of final acceptance, all conduits installed or extended by the contractor shall be cleaned of all debris and soil to the invert elevation of the conduit.

(b) **Side Drain Conduits:** Backfill for side drain conduits for drives, field roads and similar installations shall conform to the following.

(1) **Nonpaved Areas:** Conduit backfill shall be usable embankment material as defined in Subsection 203.06, placed by approved methods and uniformly compacted to the satisfaction of the engineer.

(2) **Paved Areas:** Conduit backfill material, placement and compaction shall be as specified in Heading (c).

(c) **Conduits other than Side Drains:** Backfill for conduits other than side drains for drives, field roads and similar installations shall be either selected soils as defined in Subsection 203.06 or granular materials conforming to Subsection 1003.07.

When the top of conduit is even with or below the top of the trench, backfill material shall be brought up evenly on both sides of conduit for its full length to an elevation of 1 foot above the top of conduit (or to subgrade if less than 1 foot) or to natural ground elevation, whichever is greater.

When the top of conduit is above the top of trench, backfill material shall be brought up evenly on both sides of conduit for its full length to an elevation 1 foot above the top of conduit (or to subgrade if less than 1 foot). Material in the trench and above the top of trench for a distance on each side of conduit equal to the horizontal outside diameter and to 1 foot above the top of conduit (or to subgrade if less than 1 foot) shall be backfill material.

The embankment shall be constructed to a minimum of 2 feet over the

conduit before heavy construction equipment is allowed to cross the installation. Where practical, installations with less than 2 feet of cover over the top of the conduit shall be constructed after all heavy hauling is completed over the conduit location. After completion of hauling operations, the contractor shall remove excess cover material. Any conduit damaged by hauling operations shall be removed and relaid, or replaced, at the contractor's expense.

(1) **Backfill Methods:**

a. Selected Soils: Backfill shall be placed at or near optimum moisture content in layers not exceeding 6 inches compacted thickness and each layer shall be compacted by approved methods to at least 95 percent of maximum density prior to placement of a subsequent layer.

b. Granular Material: Backfill may be placed and compacted by either conventional methods or flooding methods. Granular backfill materials loosened due to subsequent operations shall be recompacted by approved methods to required density. Exposed slopes of conduit ends shall be covered by at least a 12-inch compacted thickness of plastic soil material conforming to Subsection 203.06.

1. Conventional Methods: Backfill shall be placed at or near optimum moisture content. Backfill material shall be thoroughly compacted under haunches and then compacted in layers not exceeding 12 inches. Each layer shall be compacted by approved methods to at least 95 percent of maximum density prior to placement of a subsequent layer.

2. Flooding Methods: The compacted thickness of the first layer of backfill shall be equal to 1/2 the outside diameter of the conduit, but not exceeding a compacted thickness of 3 feet. The remainder of backfill shall be placed in layers not exceeding 3 feet compacted thickness. During placement, backfill materials shall be thoroughly saturated with water and satisfactory drainage of backfill materials shall be provided. Each layer of backfill shall be compacted to at least 95 percent of maximum density by approved mechanical compaction equipment prior to placing a subsequent layer.

(2) **Density Requirements:** Maximum density will be determined in accordance with DOTD Designation: TR 418 and in-place density determined by DOTD Designation: TR 401. The frequency of density tests will be in accordance with Departmental policy, and

additional tests will be made at the discretion of the engineer during backfilling to determine that required density is being obtained.

701.09 STUBBING AND PLUGGING CONDUITS. When it is required that conduits be plugged, such plugs shall be constructed of Class R concrete conforming to Section 902. Thickness of plug and method of construction shall be as directed.

When new conduits are to be stubbed into new or existing conduits or other structures, the connection shall be made with approved mortar.

Such plugging and stubbing of conduits will not be measured for payment.

701.10 METHOD OF MEASUREMENT. The length of conduit, both new and relaid, will be measured in linear feet by the following methods: (1) conduit not confined by fixed structures will be measured by the number of joints at the nominal length of each joint; (2) conduit confined by fixed structures will be measured along the conduit between the termini of conduit in structure walls; (3) conduit confined by a fixed structure on one end and unconfined at the other end will be measured along the conduit from the terminus of conduit in the structure wall to the unconfined end of conduit.

Fabrication of conduit tees, elbows and other fittings will be measured per each fitting, and the length of conduit in such fittings will be included in the pay length measurement of conduits of which they form a part.

Excavation required for installation of conduits will not be measured for payment, except as otherwise specified in Subsection 203.11.

When the contract does not include a pay item for "Conduit Backfill", furnishing and placing backfill material for conduits will not be measured for payment. Backfill material needed to complete backfill above natural ground and around conduits that extend above natural ground will be measured and paid for under applicable earthwork items.

Furnishing and placing backfill material for installation of conduits for drive entrances and similar installations will not be measured for payment.

When the contract contains a pay item for "Conduit Backfill," the quantity to be measured will be the number of cubic yards (net section) in final position in the trench up to the top of the original ground; except when original ground is less than 1 foot above the top of conduit, measurement will include backfill material to a height of 1 foot above conduit (or to subgrade if less than 1 foot), but will not include material placed outside of vertical planes 18 inches outside of and parallel to the outside wall of conduit at its greatest horizontal dimension.

701.11 BASIS OF PAYMENT. Conduit will be paid for at the contract unit price per linear foot of the types and sizes specified.

Fabrication of conduit tees, elbows and other fittings will be paid for at the contract unit price per each fitting.

When an item for "Conduit Backfill" is included in the contract, backfill will be paid for at the contract unit price per cubic yard.

Payment will be made under:

Item No.	Pay Item	Pay Unit
701(1)	Structural Plate Pipe (Size)	Linear Foot
701(2)	Structural Plate Pipe Arch (Size)	Linear Foot
701(3)	Corrugated Steel Pipe (Size)	Linear Foot
701(4)	Corrugated Steel Pipe Arch (Size)	Linear Foot
701(5)	Bituminous Coated Corrugated Steel Pipe (Size)	Linear Foot
701(6)	Bituminous Coated Corrugated Steel Pipe Arch (Size)	Linear Foot
701(7)	Polymeric Coated Corrugated Steel Pipe (Size)	Linear Foot
701(8)	Polymeric Coated Corrugated Steel Pipe Arch (Size)	Linear Foot
701(9)	Asbestos Bonded Corrugated Steel Pipe (Size)	Linear Foot
701(10)	Asbestos Bonded Corrugated Steel Pipe Arch (Size)	Linear Foot
701(11)	Asbestos Bonded Corrugated Steel Pipe (Size) (Smooth Lined)	Linear Foot
701(12)	Asbestos Bonded Corrugated Steel Pipe Arch (Size) (Smooth Lined)	Linear Foot
701(13)	Corrugated Aluminum Pipe (Size)	Linear Foot
701(14)	Corrugated Aluminum Pipe Arch (Size)	Linear Foot
701(15)	Reinforced Concrete Pipe (Size)	Linear Foot
701(16)	Reinforced Concrete Pipe Arch (Size)	Linear Foot
701(17)	Concrete Sewer Pipe (Size)	Linear Foot
701(18)	Plastic Yard Drain Pipe	Linear Foot
701(19)	Vitrified Clay Pipe (Size)	Linear Foot
701(20)	Asbestos Cement Pipe (Size)	Linear Foot
701(21)	Cast Iron Pipe (Size)	Linear Foot
701(22)	Side Drain Pipe (Size)	Linear Foot
701(23)	Side Drain Pipe Arch (Size)	Linear Foot
701(24)	Pipe Conduit (Sizes and Types)	Linear Foot
701(25)	Pipe Arch Conduit (Sizes and Types)	Linear Foot
701(26)	Corrugated Metal Pipe (Size)	Linear Foot

Item No.	Pay Item	Pay Unit
701(27)	Corrugated Metal Pipe Arch (Size)	Linear Foot
701(28)	Relaying Conduit	Linear Foot
701(29)	Conduit Backfill	Cubic Yard
701(30)	Fabricating Conduit Fittings	Each

Section 702

Manholes, Junction Boxes and Catch Basins

702.01 DESCRIPTION. This work consists of the construction and adjustment of manholes, junction boxes and catch basins in accordance with these specifications, and in conformity with lines and grades shown on the plans or established by the engineer.

702.02 MATERIALS. Materials shall conform to the following Section or Subsections:

Cast-in-Place Concrete (Class A)	902
Brick	1004.01
Asphaltic Varnish	1008.07
Reinforcing Steel	1009.01
Precast Reinforced Concrete Units	1016
Manhole Steps, Frames, Grates and Covers	1018.04

The contractor shall have the option of furnishing structures of either cast-in-place concrete or precast concrete units; however, design and installation procedures for precast concrete units will be subject to Department approval.

Mortar shall consist of 1 part portland cement, 2 parts approved sand, and water as required for proper consistency. Mortar shall be used within 30 minutes after mixing.

At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

702.03 CONSTRUCTION REQUIREMENTS: Concrete construction shall conform to Section 805. Joints shall be full mortar joints not more than 1/2 inch wide. When specified, the outside faces of structures shall be plastered with 1/2 inch thick cement-sand mortar. Exposed surfaces of concrete and masonry shall be cured by approved methods for at least 48 hours.

Precast concrete units shall be cast with the specified number and size of pipe openings to incorporate the unit into the drainage system; however, if additional pipe is required during construction for which no holes have been provided, the contractor may make such holes provided any damaged units are replaced or satisfactorily repaired. Precast units shall be set to established grade ± 1/2 inch on bedding material as shown on the plans or approved by the engineer. Joints for sectional precast units shall be sealed with flexible plastic gasket material conforming to Subsection 1006.06(b) so installed as to form a watertight seal.

Metal frames shall be set in full mortar bed. Conduit sections shall be flush on the inside of structure wall and project outside sufficiently for proper connection with the next pipe 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 by the foregoing method, the contractor may adjust structures by means of approved metal adjustment rings.

At the time of final acceptance, new structures shall be cleaned of silt, debris or other foreign matter, and metal parts of new or adjusted structures shall be coated with asphaltic varnish..

After inspection of completed structures and when directed, excavated areas not occupied by structures shall be refilled to required elevations. Backfilling shall conform to Subsection 701.08.

Excavated material not satisfactory for backfill, and surplus material, shall be satisfactorily disposed of.

702.04 METHOD OF MEASUREMENT. New and adjusted junction boxes, manholes and catch basins will be measured by the unit.

Excavation required for installation of these units will not be measured for payment.

When the contract does not contain a pay item for "Conduit Backfill," furnishing and placing backfill material will not be measured for payment.

When the contract contains a pay item for "Conduit Backfill," quantities of backfill for payment will be the design volumes 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 volumes are based on plan depths of the structure and vertical planes 18 inches outside of and parallel to neat lines of the structure.

702.05 BASIS OF PAYMENT. New and adjusted junction boxes, manholes and catch basins will be paid for at the contract unit price per each.

When the contract includes an item for "Conduit Backfill", payment for backfill will be made in accordance with Subsection 701.11.

Payment will be made under:

Item No.	Pay Item	Pay Unit
702(1)	Junction Boxes	Each
702(2)	Manholes	Each
702(3)	Catch Basins	Each
702(4)	Adjusting _____	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 by the engineer.

703.02 MATERIALS. Materials shall conform to the following Section and Subsections:

Asphaltic Concrete	501.02
Portland Cement Concrete	902
Aggregate Backfill (Size 3)	1003.05
Granular Material	1003.07
Perforated Concrete Pipe	1006.07
Asbestos-Cement Pipe	1006.09
Perforated and Nonperforated Plastic Pipe	1006.10
Perforated Bituminous Coated Corrugated Steel Pipe	1007.04
Perforated Corrugated Aluminum Pipe	1007.07
Reinforcing Steel	1009.01
Geotextile Fabric (Plastic Filter Cloth)	1018.15

Polyethylene Film: Polyethylene sheeting shall be an approved 6-mil thick polyethylene film.

Rodent Screen and Hardware: Rodent screens shall be mesh hardware cloth as specified on the plans, heavily galvanized in accordance with ASTM Designation: A 153. Bolts, nuts and washers shall conform to ASTM Designation: A 307 galvanized in accordance with ASTM Designation: A 153. Galvanizing may be performed by an approved mechanical galvanizing method that provides the same thickness of coating.

When an item for "Shoulder Underdrains" or "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 types listed above.

When an item for "Nonperforated Pipe Underdrains" is included in the

contract, the contractor will be permitted to furnish any of the nonperforated types listed above or other approved types.

At the Department's discretion, plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

703.03 CONSTRUCTION REQUIREMENTS.

(a) Shoulder Underdrain Systems: Installation of filter cloth, pipe, backfill and replacement of shoulder base shall follow immediately behind trenching operations. If traffic is permitted on the roadway, all trenches shall be backfilled at the end of each day's operations. Operations shall be performed in such manner that existing roadway pavement, shoulder surfacing and base course outside the limits of underdrain trenches are not damaged. The contractor shall satisfactorily restore vegetation on grassed areas affected by his operations.

(1) Trenching: If 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. Trenches shall be excavated with suitable mechanical equipment that will produce a trench of uniform width and depth. Removed materials considered unacceptable for spreading on slopes shall be disposed of by the contractor outside the right-of-way. Excess and accepted excavated materials may be wasted on embankment slopes or disposed of outside the right-of-way at the contractor's option.

(2) Filter Cloth: Completed trenches for perforated pipe shall be lined with plastic filter cloth. Adjoining sheets of cloth shall be spliced by lapping at least 18 inches and satisfactorily securing, or by use of sewn or heat-bonded splices. A sufficient width of cloth 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 filter cloth, pipe and backfill to avoid damaging filter cloth. The contractor shall satisfactorily repair or replace any damaged filter cloth.

(3) Underdrain Pipe: Plastic underdrain pipe shall be installed in trenches using approved joints. Perforated pipe shall be placed with perforations down.

(4) Backfill: After installation of pipe, the trench shall be backfilled in a manner that will not cause displacement of pipe. Soil

backfill for nonperforated pipe shall be uniformly compacted by approved methods to the satisfaction of the engineer. Aggregate backfill for perforated pipe shall be uniformly compacted with approved vibratory equipment to the satisfaction of the engineer, after which filter cloth shall be lapped over the full width of trench and secured by an approved method.

(5) **Base Course and Surfacing:** Portland cement concrete or asphaltic concrete for replacement of removed shoulder base course and surfacing shall be placed in accordance with Section 724. If portland cement concrete is used for the base course, the top of the backfilled trench shall be covered with one layer of polyethylene film, and the concrete used shall conform to the requirements for Class A concrete, except that the minimum cement content shall be 7.0 sacks (94 lbs. each) per cubic yard of concrete.

(6) **Headwalls:** Portland cement concrete headwalls for underdrain outlet pipe shall be Class A concrete constructed in accordance with Section 706.

(7) **Restoring Vegetation:** Existing grassed areas that are disturbed due to the contractor's operations shall be satisfactorily repaired.

(b) **Other Underdrain Systems:** Trenches shall be excavated to the specified dimensions and grade or as directed. When specified, a minimum 3-inch thick bedding layer of granular material shall be placed and compacted in the bottom of the trench for its full width and length. Underdrain pipe shall be embedded firmly in the bedding material.

Perforated pipe shall be placed with perforations down and pipe sections shall be joined securely with appropriate coupling fittings or bands. When specified, perforated pipe shall be wrapped with plastic filter cloth in accordance with plan details or as directed.

Nonperforated pipe shall be laid with bell end upgrade and open joints, either wrapped with suitable material to permit entry of water, or unwrapped as specified.

Upgrade ends of pipe shall be closed with a suitable plug to prevent entry of soil materials.

After pipe installation has been inspected and approved, granular backfill shall be placed as shown on the plans or as directed. Care shall be taken not to displace the pipe or covering at open joints. The contractor shall satisfactorily dispose of excess excavated material.

703.04 METHOD OF MEASUREMENT. Completed and accepted underdrains will be measured as follows.

(a) **Shoulder Underdrain Systems:**

(1) Shoulder Underdrains: Shoulder underdrains will be measured by the linear foot of underdrain pipe. Required excavation, plastic filter cloth, aggregate backfill, polyethylene sheeting, restoration of shoulder base course and surfacing, restoration of vegetation 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, which includes all required excavation, underdrain pipe and fittings, backfill, restoration of shoulder base course and surfacing, concrete headwalls and hardware, restoration of vegetation and disposal of excavated materials.

(b) **Other Underdrain Systems:** Other perforated and nonperforated pipe underdrains will be measured by the linear foot of underdrain pipe. Required excavation, bedding, backfill and plastic filter cloth will not be measured for payment.

703.05 BASIS OF PAYMENT. Payment for underdrains will be made at the contract unit prices under:

Item No.	Pay Item	Pay Unit
703(1)	Perforated Pipe Underdrains (Size)	Linear Foot
703(2)	Nonperforated Pipe Underdrains (Size)	Linear Foot
703(3)	Shoulder Underdrains	Linear Foot
703(4)	Shoulder Outlet Underdrains (Single)	Each
703(5)	Shoulder Outlet Underdrains (Double)	Each

Section 704

Guard Rail

704.01 DESCRIPTION. This work consists of furnishing and constructing beam type highway guard rail in accordance with these specifications, and in conformity with lines and grades shown on the plans or established by the engineer.

704.02 MATERIALS. Materials shall conform to the following Section or Subsections.

Cast-in-Place Concrete (Class A)	902
Metal Beam Guard Rail	1010.08
Posts and Spacer Blocks	1010.09
Hardware	1010.10
Wire Rope and Fittings	1010.11

At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

704.03 POSTS. Posts shall be set plumb. When driving of posts is permitted, the manner of driving shall be such as to avoid damaging posts. Post holes shall be backfilled with acceptable material placed and compacted as directed. Where posts are to be placed within existing surfaced areas, surface material shall be replaced in kind immediately upon completion of the installation.

704.04 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.

Galvanized surfaces that are damaged shall be repaired in accordance with Subsection 811.16.

704.05 METHOD OF MEASUREMENT. Quantities of guard rail,

anchor sections 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.

704.06 BASIS OF PAYMENT. Guard rail, anchor sections and transitions will be paid for at the contract unit prices under:

Item No.	Pay Item	Pay Unit
704(1)	Guard Rail	Linear Foot
704(2)	Guard Rail (Double Faced)	Linear Foot
704(3)	Blocked Out Guard Rail	Linear Foot
704(4)	Blocked Out Guard Rail (Double Faced)	Linear Foot
704(5)	Guard Rail Anchor Sections (BCT)	Linear Foot
704(6)	Guard Rail Anchor Sections (Trailing End)	Linear Foot
704(7)	Guard Rail Bridge Attachments	Linear Foot
704(8)	Guard Rail Transitions	Linear Foot

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 conform to the following Section or Subsections:

Portland Cement Concrete (Class R)	902
Barbed Wire	1010.01
Mesh (Woven) Wire	1010.02
Posts and Braces for Field and Line Type Fence	1010.03
Staples	1010.04
Metal Fasteners for Steel Posts	1010.05
Gates	1010.06
Chain Link Fence, Gates and Appurtenances	1010.07

The same type chain link fencing shall be used throughout the project.

At the Department's discretion, manufacturing plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots.

All materials will be subject to inspection for acceptance as to condition at any time during the work.

705.03 GENERAL CONSTRUCTION REQUIREMENTS. Clearing and grubbing necessary for fence installation shall be performed in accordance with 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, or 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 until 3 days after placing concrete.

Tops of posts shall be set to required grade and alignment. Cutting of post tops will be allowed only with the approval of the engineer. 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 intervals. Ground rods and connections shall conform to plan details. Ground rod installation will not be measured for payment.

705.04 REBUILT FENCE. When specified, the contractor will be required to 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. Hand mixing of concrete will be permitted for small quantities of concrete. No hand mixed batch shall exceed 1/2 cubic yard.

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 shall be placed promptly and without segregation after mixing. The contractor shall consolidate concrete satisfactorily by tamping or vibrating. Excess excavation from footings shall be satisfactorily disposed of.

(b) Fence Erection: Pull posts shall be placed not more than 200 feet apart in straight runs and at each vertical angle more than 20 degrees. Corner posts shall be placed at each horizontal angle more than 20 degrees. Corner and pull posts shall have a horizontal brace and tie rod on each side of posts, connected to adjacent line posts.

Posts shall be permanently positioned, anchorages firmly set and top

rail or top tension wire 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 mesh 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 all fittings as specified or required for complete installation.

Clamps for attaching hardware shall be made up tight. Bottom of gates shall clear the ground at least 3 inches 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, so placed as to prevent damage to gate or fence by overswing. Unless otherwise directed, stops shall be provided also to arrest the swing of a closed gate at the centerline of fence.

(d) Repair of Protective Coatings: After completion of fence and gate installation, any damaged protective coatings shall be satisfactorily repaired by approved methods.

705.07 METHOD OF MEASUREMENT.

(a) New Fence and Gates: New fence will be measured by the linear foot 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 between outside of end posts for each continuous run of fence, inclusive of 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.

705.08 BASIS OF PAYMENT. Fence and gates will be paid for at the contract unit prices under:

Item No.	Pay Item	Pay Unit
705(1)	Barbed Wire Fence	Linear Foot
705(2)	Combination Mesh and Barbed Wire Fence	Linear Foot
705(3)	Single Swinging Walk Gates	Each
705(4)	Single Swinging Driveway Gates	Each
705(5)	Double Swinging Driveway Gates	Double Gate
705(6)	Chain Link Fence (__-Foot Height)	Linear Foot
705(7)	__-Foot Single Gates for Chain Link Fence (__-Foot Height)	Each
705(8)	__-Foot Double Gates for Chain Link Fence (__-Foot Height)	Double Gate
705(9)	Rebuilt Fence	Linear Foot

Section 706

Concrete Walks, Drives and Incidental Paving

706.01 DESCRIPTION. This work consists of furnishing and constructing portland cement concrete walks, drives and incidental paving slabs in accordance with these specifications and in conformity with lines and grades shown on the plans or established by the engineer.

706.02 MATERIALS. Materials shall conform to the following Section or Subsections.

Portland Cement Concrete (Class A)	902
Joint Filler	1005.01
Reinforcing Steel	1009.01
Curing Materials	1011.01

706.03 CONSTRUCTION REQUIREMENTS.

(a) Excavation: Excavation shall be made to required depth and width. The subgrade shall be shaped and compacted to a firm, even surface conforming to the section shown on the plans. Unstable material shall be removed and replaced with approved material at the contractor's expense.

(b) Forms: Forms shall be of wood or metal and shall extend for 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.

At the contractor's option, 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 1 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, and after passing there shall be no noticeable slumping of concrete.

Air entrainment admixture in accordance with Subsection 901.08(b) will be required in slip-formed concrete.

(c) **Subgrade:** The subgrade shall be thoroughly moistened immediately prior to placing concrete.

(d) **Depositing and Finishing:** Concrete shall be deposited 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 radius.

(e) **Joints:** Expansion joints shall be filled with 1/2-inch thick preformed expansion joint filler. Expansion joints shall be installed at maximum 100-foot intervals, and between intersecting paving and any fixed structure such as a building, bridge or curbing. Expansion joint material shall extend for the full depth of paving.

Dummy joints shall be formed by a jointing tool or other acceptable means. Dummy joints shall extend into concrete for at least 1/4 of the depth and shall be approximately 1/8 inch wide.

Construction joints shall be formed around manholes, utility poles, etc., extending into paving and 1/4-inch thick preformed expansion joint filler shall be installed in these joints.

(1) **Walks:** Spacing of dummy joints for walks shall be equal to the width of walk.

(2) **Drives:** A longitudinal dummy joint shall be formed along the centerline of drives more than 16 feet wide, and transverse dummy joints shall be formed at not more than 16-foot intervals.

(3) **Incidental Paving:** Dummy joints for incidental paving shall be formed at intervals not exceeding 20 feet in length or width, and incidental paving poured adjacent to jointed concrete shall be jointed to match existing joints, with intermediate joints formed as necessary not to exceed the 20-foot maximum joint spacing.

(f) **Curing:** Concrete shall be cured in accordance with Subsection 601.12.

706.04 METHOD OF 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 plan 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.

706.05 BASIS OF PAYMENT. Concrete walks, drives and inciden-

tal paving will be paid for at the contract unit price per square yard, subject to the price adjustment provisions of Section 902.

Payment will be made under:

Item No.	Pay Item	Pay Unit
706(1)	Concrete Walk (__" Thick)	Square Yard
706(2)	Concrete Drive (__" Thick)	Square Yard
706(3)	Incidental Concrete Paving (__" Thick)	Square Yard

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 by the engineer.

707.02 MATERIALS. Materials shall conform to the following Section or Subsections:

Asphaltic Concrete	501.02
Portland Cement Concrete (Class A)	902
Joint Fillers	1005.01
Joint Sealers	1005.02, 1005.03

(a) Concrete Curbs and Gutters: If slip-formed methods are used, concrete shall have not more than 1½-inch slump and an air entraining admixture conforming to Subsection 901.08(b) will be required.

(b) Asphaltic Curbs: Mixtures for these curbs shall be asphaltic concrete wearing course shoulder mix.

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. Unstable material shall be removed and replaced with approved material at the contractor's expense.

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 springing. Forms shall be cleaned thoroughly and greased or soaped 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 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 prescribed filler.

Other types of curbing shall be provided with 1/4-inch joints at maximum intervals of 20 feet formed by using steel plates 1/4-inch thick, cut to section and set vertically in forms until concrete has set sufficiently to permit removal of plates.

707.06 DEPOSITING 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 deposited and thoroughly tamped within 30 minutes after pavement has been finished and care shall be taken to secure monolithic construction. Concrete shall be spaded or vibrated sufficiently to eliminate all 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 with an approved finishing tool to the specified radius.

At the option and expense of the contractor, integral curb type may be placed after completion of pavement, provided steel dowels are placed in the pavement of the size, type and spacing shown on the plans.

(b) **Non-Integral Types:** Concrete shall be placed on the prepared subgrade, struck off and compacted to required thickness. Concrete shall be spaded or vibrated sufficiently to eliminate all 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 1 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, and after passing there shall be no noticeable slumping of concrete. Finished concrete shall be free from voids and any additional finishing required shall be performed immediately after placement.

707.07 FINISHING. Forms shall be removed within 24 hours after concrete has been placed, and honeycombed areas and other minor defects shall be filled with mortar composed of portland cement and sand, mixed in the same proportion as used in the concrete. Plastering will not be permitted on faces of curb or gutter, and rejected curb or gutter shall be removed and replaced without additional compensation. Top and face of curb or gutter shall be finished while concrete is green with 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 conforming to Section 504.

707.09 CURING CONCRETE CURB OR GUTTERS. After finishing, curb or gutter shall be cured in accordance with Subsection 601.12.

707.10 BACKFILLING. After curb or gutter has set sufficiently, the contractor shall backfill adjacent to curb or gutter with approved material thoroughly tamped in layers of not over 6 inches compacted thickness.

707.11 METHOD OF 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 plan 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 BASIS OF PAYMENT. Curbs and/or gutters will be paid for at the contract unit price per linear foot, subject to the following provisions:

(a) **Asphaltic Mixtures:** Asphaltic curbs will be subject to the price adjustment provisions of Section 501 for deviations in Marshall stability, aggregate gradation, anti-strip additive and asphalt cement specifications. Asphaltic tack coat will not be measured for payment.

(b) **Portland Cement Concrete:** Portland cement concrete curbs and/or gutters will be subject to the price adjustment provisions of Section 902.

Payment will be made under:

Item No.	Pay Item	Pay Unit
707(1)	Concrete Curb	Linear Foot
707(2)	Concrete Gutter	Linear Foot
707(3)	Combination Curb and Gutter	Linear Foot
707(4)	Asphaltic Curb	Linear Foot

R/W 1. every 1500' on a tangent
2. at each break
3. every 1000' on a curve
4. at PC & PT of each curve

Section 708

Right-of-Way Markers

708.01 DESCRIPTION. This work consists of furnishing and erecting concrete right-of-way markers in conformity with the design, dimensions and locations shown on the plans.

708.02 MATERIALS. Materials shall conform to the following Section or Subsection:

Portland Cement Concrete (Class A)	902
Reinforcing Steel	1009.01

708.03 FABRICATION. Markers shall be precast reinforced concrete posts cast, finished and cured in accordance with Sections 805 and 806 in the following manner:

(a) Casting: Concrete posts shall be cast in mortar-tight forms. Care shall be exercised to puddle and tamp concrete around reinforcing steel and avoid formation of aggregate pockets. Concrete shall be placed continuously in each post.

(b) Finishing: Forms shall be removed as soon as concrete has hardened sufficiently to prevent damage to marker. Markers shall be given a Class 1 Finish in accordance with Subsection 805.13 and shall present a neat and uniform appearance.

(c) Curing: As soon as finished, markers shall be cured by an approved method at least 3 days.

708.04 INSTALLATION. Marker posts shall be erected on right-of-way lines at points designated on the plans or as directed. Posts shall be set to the depth indicated on the plans or as directed. Post holes shall be backfilled and thoroughly tamped as directed.

708.05 METHOD OF MEASUREMENT. Right-of-way markers will be measured by the marker.

708.06 BASIS OF PAYMENT. Markers will be paid for at the contract unit price per each, which includes concrete and reinforcing steel.

Payment will be made under:

Item No.	Pay Item	Pay Unit
708(1)	Right-of-Way Marker	Each

Section 709

Steel Rail Cattle Guards

709.01 DESCRIPTION. This work consists of furnishing and constructing welded steel rail 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. Steel rails shall be at least the minimum unit weight specified. Pipe wings shall be 2-inch diameter standard strength black or galvanized steel pipe conforming to ASTM Designation: A 53 or A 120. Black pipe shall be painted in accordance with Section 1008.02. Galvanized pipe will not require painting.

Concrete shall be Class A conforming to Section 902. Reinforcing steel shall be deformed bars conforming to Section 1009. Treated timber shall be creosoted pine or Douglas fir and shall be Dense No. 1 structural grade conforming to Section 1014.

Hardware shall be acceptable standard quality galvanized, of the size and dimensions recommended by the cattle guard fabricator.

709.03 CONSTRUCTION REQUIREMENTS. Excavation shall extend a minimum of 1 foot outside neat lines of concrete walls or footings. Backfill shall be deposited in layers not exceeding 6 inches compacted thickness and each layer shall be thoroughly compacted with mechanical tampers.

Concrete and reinforcing steel shall be placed in accordance with Sections 805 and 806.

Rails shall be placed in accordance with plan details, welded in an approved manner.

709.04 METHOD OF MEASUREMENT. Steel rail cattle guards will be measured as a unit.

Excavation, backfill, concrete and reinforcing steel will not be measured for payment.

709.05 BASIS OF PAYMENT. Steel rail cattle guards will be paid for at the contract unit price per each, subject to the price adjustment provisions of Section 902.

Payment will be made under:

Item No.	Pay Item	Pay Unit
709(1)	Steel Rail Cattle Guard	Each

Section 710

Removing, Relocating and Demolishing Structures

710.01 DESCRIPTION. Removing and relocating structures consists of the removal, preparation for moving and relocation of buildings or other structures, hereinafter referred to as "structure," with all existing service connections, appurtenances and accessories; and reconstruction of all foundations and appurtenances; all in accordance with the plans and these specifications.

Moving of structures consists of moving the structures specified under the item "Removing and Relocating Structures" from original to final location. This item includes extension of existing water, gas, sewer and other service lines and utilities and all materials necessary therefor.

Demolishing structures consists of demolishing and disposing of all parts of the structure indicated on the plans, including foundations, basements, cisterns, underground tanks, walks, drives or other appurtenances.

710.02 GENERAL REQUIREMENTS. The Department reserves the right to eliminate the removal of any or all structures under these items. Such elimination shall not affect contract unit prices on remaining structures to be moved or unit prices on other items of the contract, and the contractor will not be entitled to compensation due to such elimination.

The contractor shall conduct his operations in accordance with Section 107.

710.03 REMOVING AND RELOCATING STRUCTURES. Structures shall be prepared for moving, removed and placed in their new locations as shown on the plans or as designated, and left in as good condition as originally found. Structures removed and relocated shall be placed on foundations of the same type and character as original foundations.

Steps, outside stairways, canopies, porches, block or post supports, sills, chimneys on brackets and other appurtenances forming an integral part of the structure are considered part of the structure and shall be removed and relocated accordingly. Cellars, cellar steps, concrete or masonry porches,

concrete floors, solid or semi-solid concrete and masonry foundations and supports, septic tanks, wells, fireplaces and chimneys standing on the ground, and other appurtenances attached or connected to the structure shall be removed, relocated or replaced with foundations or appurtenances of the same size, type and character as existed before the structure was moved.

Sanitary sewers, water, gas, electric or telephone service lines connected to structures being removed and relocated shall be disconnected without unnecessarily discommoding the occupants of structures being moved. The contractor shall be responsible for all notices to public utility companies and for all fees charged by them.

Privies, washhouses, garages, other outbuildings, cisterns and other appurtenances used in conjunction with a structure shall be removed and relocated. The contractor shall also remove and rebuild 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 to the structures indicated on the plans to be removed and relocated.

Relocated wells shall conform to the Sanitary Code of the State of Louisiana as prepared and promulgated by the Louisiana State Board of Health.

Removal and relocation of a structure, any part of which is used as a filling station, shall include the removal and relocation of all gasoline pumps, tanks, pipes, signs and other accessories appurtenant to the filling station. Tanks shall be placed the same depth below the ground as existed before moving.

Material in existing foundations, concrete or masonry floors, chimneys and other appurtenances, where not used in reconstruction of appurtenances, shall be removed and disposed of as directed.

New material required in performing any of the above operations shall be furnished by the contractor at his expense.

Contents of structures shall be removed and relocated with the structure to its new site. If not feasible to remove structures with contents therein, the contents shall be removed from the structure at its original location and replaced in the relocated structure. Precautions shall be taken to prevent damage or loss to contents.

Cattle pens, cane derricks, cattle guards or other structures shall be removed and relocated or reconstructed on or beyond right-of-way line as directed. Materials in structures considered 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 his expense.

Prior to removal of fuel tanks, the contractor shall notify and obtain approval of the Louisiana Liquefied Petroleum Gas Commission in order that said Commission may have a representative present at time of removal should they desire. Should their representative require that a new tank be furnished, the contractor shall replace the old tank with such new tank as required. The contractor will be reimbursed for the cost of the new tank upon presentation of the original receipted bill. If the removed tank is not to be reused, it shall be destroyed by the contractor, but in doing so, the contractor is warned of danger from accumulated gas in the tank. A suggested method is first filling the tank with water and cutting off the neck; however, the Department will not be liable for damage or loss from such operations.

The contractor shall furnish the engineer a certificate of release from each property owner, and in case of separate ownership of structure and property, a certificate of release from each owner shall be furnished. This certificate shall state that the structures removed and relocated are in an acceptable condition and that said owner waives all claims for damages to his property and structures removed.

710.04 MOVING OF STRUCTURES. The limits of moving of a structure unit shall be the distance from the center of the principal structure in its original location, measured along the shortest practical route of moving, to the center of the principal structure in its new location. Appurtenances to the principal structure will not be considered in the measurement, but shall be moved with the principal structure as a unit and re-established at the new location.

710.05 DEMOLISHING STRUCTURES. All materials in the designated structure shall become the property of the contractor and shall be removed from the right-of-way.

710.06 METHOD OF MEASUREMENT. Removing and relocating structures will be measured by the unit. Each principal structure with its appurtenances and appliances will be considered a separate unit.

Moving of structures will be measured along the shortest practical route in units of principal structure, including appurtenances, moved one foot which shall be designated a "structure foot".

Demolishing structures will be measured by the unit and shall include appurtenances, foundations, etc.

710.07 BASIS OF PAYMENT. Structures acceptably removed, moved, relocated and demolished will be paid for at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
710(1)	Removing and Relocating Structures	Unit
710(2)	Moving Structures	Structure Foot
710(3)	Demolishing Structures	Unit

If a structure is included as a unit under Item 710(1) for removal and relocation and the contractor enters into an agreement with a property owner for demolishing or other disposition; 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 said agreement to the engineer for approval.

The contractor will be paid for demolishing or other handling of the structure at the contract amount for the unit as listed under Item 710(1).

If the 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 of said unit under Item 710(1), an allowance will be made in such amount as the engineer deems equitable.

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 his property and structure that has been demolished or otherwise handled to the owner's satisfaction. No measurement or payment will be made under Item 710(2) for any such structure handled as provided herein.

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. Riprap shall consist of stone that will 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 Designation: T 85, the solid weight of stone shall be at least 150 pounds per cubic foot (based on bulk specific gravity) and the absorption shall not exceed 2 percent. Samples of stone from a source not previously approved shall be taken under supervision of the engineer and submitted for testing and approval prior to delivery to the project. The least dimension of an individual stone shall be at least 1/3 its maximum dimension, and each shipment of stone shall be reasonably well graded within the specified limits.

Broken concrete conforming to these material and gradation requirements may be used as riprap, provided its solid weight is at least 130 pounds per cubic foot (based on bulk specific gravity) and it is free of protruding reinforcement.

Control of gradation will be by visual inspection either at the source or project site or both, at the engineer's option.

Any difference of opinion between the engineer and contractor shall be resolved by checking the gradation of 2 random truckloads (or equivalent size samples). Equipment, labor and sorting site shall be furnished by the contractor at his expense.

(a) **Random Riprap:** Individual stones shall be not more than 18 inches in any dimension and at least 50 percent of the weight of material shall consist of stones weighing at least 35 pounds. Riprap shall contain not more than 5 percent of material by dry weight passing a 1/2 inch sieve.

(b) **Riprap for Sinking Mattresses:** Riprap for ballast for sinking mattresses shall be graded as follows:

Individual Stone Weight (Pounds)	Percent by Weight
75 to 100	0 to 20
25 to 74	60 to 100
10 to 24	0 to 20
Less than 10	15 Max.

(c) Heavy Deposited Riprap: Heavy deposited riprap shall be graded as follows:

Individual Stone Weight (Pounds)	Percent by Weight
250 to 350	10 to 20
150 to 249	60 to 90
50 to 149	0 to 25
Less than 50	15 Max.

711.03 CONSTRUCTION REQUIREMENTS.

(a) Random Riprap: Random riprap shall be dumped or rolled into place in such manner that smaller stones will be uniformly distributed throughout the mass. Sufficient hand work shall be done to procure a neat and uniform surface.

(b) Riprap for Sinking Mattresses: Riprap for ballast in sinking mattresses shall be uniformly distributed over the mattress by methods that will avoid damaging the mattress.

(c) Heavy Deposited Riprap: Areas on which heavy deposited riprap is to be placed shall be graded to required sections. Heavy deposited riprap shall be placed and uniformly distributed over the areas. If 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.

711.04 METHOD OF MEASUREMENT. Random riprap will be measured by the cubic yard in vehicles at the point of delivery on the project in accordance with Subsection 109.01.

Riprap for sinking mattresses and heavy deposited riprap will be measured by the ton (2,000 pounds). If riprap is delivered by vehicles or railroad cars, measurement will be based on certified weight tickets furnished to the engineer by the contractor. If riprap is delivered by barge, measurement will be made by calculation from barge displacement, based on water weighing 62.4 pounds per cubic foot.

No measurement will be made for necessary excavation or backfilling.

711.05 BASIS OF PAYMENT. Riprap will be paid for at the contract unit prices under:

Item No.	Pay Item	Pay Unit
711(1)	Random Riprap	Cubic Yard
711(2)	Riprap for Sinking Mattresses	Ton
711(3)	Heavy Deposited Riprap	Ton

Section 712

Revetments

712.01 DESCRIPTION. This work consists of furnishing and constructing revetments for protection of embankment slopes, stream channels 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.

Cellular Concrete Block on Plastic Filter Cloth
Sacked Concrete on Plastic Filter Cloth
Stone on Plastic Filter Cloth

When an item for "Flexible Revetments" is included in the contract, the contractor has the option of furnishing revetments of either cellular concrete blocks, sacked concrete or stone; however, the same type revetment shall be used throughout the project, unless otherwise approved in writing.

712.02 MATERIALS.

(a) Concrete: Concrete for cast-in-place revetment shall be Class R conforming to Section 902.

(b) Geotextile Fabric (Plastic Filter Cloth): Plastic filter cloth shall conform to Subsection 1018.15.

(c) Cellular Concrete Blocks: Cellular concrete blocks shall conform to Subsection 1004.04.

(d) Sacked Concrete: Sacks shall conform to Subsection 1018.21. Concrete shall be Class R concrete conforming to Section 902. 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 to 6 inches. Other sacked concrete revetment systems will be permitted when approved by the Department's Hydraulics Engineer.

(e) Stone: Stone shall conform to Subsection 711.02 and shall be graded within the following limits. If not otherwise specified, Type A stone shall be furnished.

Percent By Weight	Stone Weight (Pounds)		
	Type A	Type B	Type C
10 maximum	26 to 36	88 to 122	190 to 230
40 to 60	9 to 14	28 to 46	65 to 100
20 to 40	4 to 9	14 to 28	35 to 65
15 maximum	Spalls under 4	Spalls under 12	Spalls under 30

Spalls will include all quarry chips and fines weighing less than the specified minimum which are retained on a rock fork whose tines are spaced 1 inch in the clear.

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 to be revetted and the areas filled and graded to cross sections shown on the plans. Approved soil shall be used to bring areas to grade and shall be compacted to the engineer's satisfaction before final grading.

(a) Concrete Cast-in-Place Revetment: Before placement, preformed 1/4 inch thick expansion material conforming to Subsection 1005.01 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 surface of revetment shall be cured in accordance with Subsection 601.12.

(b) Plastic Filter Cloth Placement: Ends of filter cloth shall be buried for anchorage as shown on the plans. Adjacent strips of filter cloth shall be lapped at least 10 inches and the laps pinned at 5-foot maximum intervals. Care shall be taken to prevent damage to filter cloth during placement of revetment material.

(c) Cellular Concrete Block Placement: Placing of blocks shall commence in a trench or against suitable anchorage at the downslope end of the area to be revetted and shall progress upslope. Each block shall be laid perpendicular to the slope and shall be bedded firmly against adjoining blocks. Cement grout will be required to fill unaligned joints or breaks at slope changes if directed. Individual blocks shall not be grouted to each other.

At the contractor's option, in lieu of placing filter cloth and blocks separately, revetment may be constructed of mattresses consisting of concrete blocks preset on the filter cloth with an adhesive; however, both blocks and filter cloth shall be approved products. If mattresses are

used, the foregoing placement requirements may be modified as required to permit proper placement of mattress panels; however, the 10-inch overlap between adjacent panels shall apply.

After completion of cellular block revetment, topsoil conforming to Section 715 shall be loosely spread over the revetment to partially fill cell openings. Topsoil shall be seeded and fertilized in accordance with Sections 717 and 718 at the time seeding operations are conducted on the project.

(d) **Sacked Concrete Placement:** Sacks of wet-batched concrete shall be placed in one layer in contact with adjacent sacks and tamped into position by approved methods. Sacks shall be completely filled with concrete, with only a small portion at the top remaining unfilled to permit sealing or folding down of the sack. Placement of sacked concrete shall begin at the toe of revetment and progress upslope. Sacked concrete revetment for stream channels and other relatively level areas shall be placed as directed.

(e) **Stone Placement:** Toe and end walls shall be constructed by placing stone in the trench lined with filter cloth. 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 above or below the specified thickness will be allowed. Openings between stones exposing more than 4 square inches of filter cloth will not be permitted.

712.04 METHOD OF MEASUREMENT. Quantities of revetments for payment will be the design revetment areas as specified on the plans and adjustments thereto. Design quantities are based on surface areas shown on the plans to be revetted. Site preparation, plastic filter cloth, expansion joint filler and toewalls will not be measured for payment. 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.

712.05 BASIS OF PAYMENT. Revetments will be paid for at the contract unit price. Payment for concrete cast-in-place revetment will be subject to the price adjustment provisions of Section 902.

Payment will be made under:

Item No.	Pay Item	Pay Unit
712(1)	Concrete Cast-in-Place Revetment	Square Yard
712(2)	Cellular Concrete Block Revetment	Square Yard
712(3)	Sacked Concrete Revetment	Square Yard
712(4)	Stone Revetment	Square Yard
712(5)	Flexible Revetment	Square Yard

Section 713

Temporary Signs, Barricades and Pavement Markings

713.01 DESCRIPTION. This item consists of furnishing, installing and maintaining temporary construction barricades, lights, signals, pavement markings and signs; providing flagmen; and complying with all other requirements regarding the protection of the work, workmen and safety of the public. Signs, barricades, temporary pavement markings, etc., shall conform to the details shown on the plans, the MUTCD and these specifications.

Signs and barricades, and arrangements thereof, as shown on the plans, are minimum requirements. Appropriate signs for special conditions shall be furnished and installed as directed. Requirements as to proper signs, barricades or other safety precautions promulgated by the contractor's insurers are not negated by these specifications. These specifications shall not be construed as relieving the contractor of any of his responsibilities for the safety of the traveling public, for any liability in connection therewith, or compliance with State and local laws or ordinances.

713.02 MATERIALS AND FABRICATION. Materials and fabrication for temporary signs, barricades and related devices shall conform to Section 729, the plans and the following:

Backing material for construction signs shall conform to Subsection 1015.04(b).

Barricade warning lights shall conform to Subsection 1018.12.

Temporary pavement markings shall conform to Subsection 1015.08.

713.03 CONSTRUCTION REQUIREMENTS. 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 but the traveled portion of the road is not in a safe condition for the traveling public. During such times that barricades are not in place, appropriate regulatory signs shall be erected and maintained by the contractor.

If a partial Notice to Proceed is issued, the contractor shall immediately

begin erection of signs and barricades over the affected portions of the project to the extent necessary to comply with the requirements herein. When the full Notice to Proceed is issued, barricades shall be erected at the beginning and end of the project, and signing throughout the remainder of the project shall be completed.

If a full Notice to Proceed is issued, the contractor shall immediately begin erection of appropriate signs and barricades over the entire project.

In no event shall construction work under the contract begin until signs, barricades and other traffic control devices, as provided above, have been erected and approved.

When all signs to be furnished and erected by the contractor are in place and approved, the Department's forces will remove or cover any standard signs that are in conflict with temporary signs.

The contractor shall cooperate with the engineer in placing of signs, as well as the Department's forces responsible for 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 life of the contract.

Signs placed by the contractor shall not be removed until the contract is completed and the Department's forces have re-erected standard highway signs along the project. However, it shall be the responsibility of the Department to see that all Departmental signs are in place upon completion and acceptance of the project.

Signs, barricades and related devices furnished and placed by the contractor shall, upon removal, remain his property.

On projects where the surface course is constructed with asphaltic concrete or portland cement concrete pavement, the permanent centerline striping shall be completed by the Department's forces prior to removal of barricades.

713.04 PAVEMENT MARKINGS. Color, width, type and material requirements of markings shall be in accordance with the MUTCD, Subsection 1015.08 and plan requirements. Temporary centerline and/or lane line markings shall be placed on each lift of asphaltic concrete surfacing subjected to traffic during construction. Temporary markings shall be in place at the end of each day's asphaltic concrete surfacing or cold planing operations on all lanes that are open to traffic. Roadway centerlines and/or lane lines shall be marked with 4 foot long stripes placed on approximate 40-foot centers. On the final surface, temporary markings shall be placed with sufficient accuracy to avoid conflict with permanent

striping. Markings may be either Type I or II. The contractor shall satisfactorily remove all temporary pavement markings by approved methods after completion of permanent striping.

713.05 METHOD OF 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 necessary for the protection of the public 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 necessary for the protection of the public will be measured on a lump sum basis.

(b) Temporary Pavement Markings: When the contract does not include an item for "Temporary Pavement Markings", the providing 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 on a lump sum basis.

713.06 BASIS OF PAYMENT. Temporary construction signs, barricades and related devices will be paid for at the contract lump sum price in accordance with the following schedule:

Percent of Total Contract Amount Earned	Allowable Percent of Lump Sum Price for Temporary Signs and Barricades
Initial Erection	20
25	40
50	60
75	80
100	100

Temporary pavement markings will be paid for at the contract lump sum price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
713(1)	Temporary Signs and Barricades	Lump Sum
713(2)	Temporary Pavement Markings	Lump Sum

Section 714

Slab 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. Slab sod shall be either field grown grass or approved nursery grown grass.

Field grown grass sod shall be Bermuda grass, carpet grass, or other approved grass native to the area.

Nursery grown grass sod shall be centipede, tiffway Bermuda, nomow Bermuda, common Bermuda or Bahia grass.

Sod shall be free from noxious weeds or other vegetation.

Water may be obtained from any source, except brackish or oily water shall not be used.

714.03 GENERAL CONSTRUCTION REQUIREMENTS. Slab sod shall be cut with approved mechanical or manual sod cutters. The designated area shall be mowed when necessary, and sod shall be cut to a minimum soil depth of 1 1/2 inches for field grown grass and 1 inch for nursery grown grass, and to a uniform width and in convenient lengths for handling. Care shall be exercised to retain soil on roots of sod during excavating, hauling and planting.

Sod cut more than 48 hours before placing shall not be used unless authorized.

Sod taken from bare areas that may produce inferior growth will not be accepted.

Watering required in connection with digging, storing or hauling sod will not be paid for.

714.04 HANDLING SOD. The contractor may use either hand or machine methods for handling sod.

(a) Hand Method: Sod cut in the field shall be placed flat, grass side up on boards of convenient lengths and hauled to planting site with soil intact. Only one layer of sod shall be placed on each board and boards

shall be of sufficient thickness to prevent excessive bending and sufficient width to prevent sod from hanging over edges. Slabs shall be placed without excessive spaces between them. Sod shall not be loaded in bulk on vehicles or dumped in bulk on planting sites.

(b) Machine Method: The contractor may use mechanical devices to load, haul and plant sod. Sod stacked shall be kept moist and satisfactorily protected from the elements. When the machine method is used, final acceptance will not be made until a satisfactory growth of healthy, growing grass turf has been obtained.

714.05 PLANTING. Areas to receive slab sod shall be thoroughly pulverized to a depth of approximately 3 inches and dressed to a reasonable grade. If an item for agricultural lime is included in the contract, liming shall be done when the area is being pulverized. If an item for fertilizer is included in the contract, approximately 90 percent shall be broadcast over the area to receive slab sodding, and the remaining 10 percent shall be broadcast over sod after placing and rolling. Fertilizer and agricultural lime shall conform to Section 718. Upon delivery to the planting site, slab sod shall be transferred onto the surface of the soil. Areas to be sodded shall be watered as directed. Slabs of sod shall be placed with a minimum amount of space between slabs. Slabs which do not fit closely shall be pulled together with suitable tools and pegged when necessary.

714.06 ROLLING. Slab sod shall be rolled as soon after planting as practicable with plain rollers or cultipackers. Where rolling is impracticable, sod shall be tamped by approved hand methods.

714.07 WATERING. Slab sodding shall be watered as directed. If nursery grown grass sod is used, particular attention shall be paid to watering.

714.08 METHOD OF MEASUREMENT.

(a) Slab Sodding: Slab sodding will be measured by the square yard along the surface of completed and accepted sodding.

(b) Water: Water will be measured in units of 1,000 gallons in approved tanks.

(c) Fertilizer and Agricultural Lime: Any required fertilizer and agricultural lime will be measured for payment in accordance with Section 718.

714.09 BASIS OF PAYMENT. Slab sodding and water will be paid for at the contract unit prices under:

Item No.	Pay Item	Pay Unit
714(1)	Slab Sodding	Square Yard
714(2)	Water	M Gallons

Section 715

Topsoil

715.01 DESCRIPTION. This work consists of furnishing and placing topsoil on areas designated on the plans or as directed which will be seeded, fertilized and limed (when required) in accordance with Sections 717 and 718.

715.02 MATERIALS. Topsoil shall be approved natural, workable, loamy soil, free of debris, refuse and similar foreign matter, and reasonably free of subsoil, hard lumps, gravel and other such materials. Topsoil shall have a minimum Plasticity Index of 4 and shall be capable of supporting adequate vegetation. Approved existing topsoil within construction limits may be used in accordance with Subsection 106.02.

715.03 CONSTRUCTION REQUIREMENTS. Areas to receive topsoil shall be scarified to a satisfactory depth and dressed to grade. If agricultural lime is required, it shall be spread prior to scarifying the areas. Topsoil shall be uniformly spread over the areas to a depth of 6 inches and rolled to a uniform surface with a cultipacker or other suitable equipment. Any damage to completed topsoil shall be satisfactorily repaired prior to beginning seeding and fertilizing operations.

715.04 METHOD OF MEASUREMENT. Topsoil furnished, placed and accepted will be measured by the cubic yard in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

715.05 BASIS OF PAYMENT. Topsoil will be paid for at the contract unit price per cubic yard under:

Item No.	Pay Item	Pay Unit
715(1)	Topsoil	Cubic Yard

Section 716

Vegetative Mulch

716.01 DESCRIPTION. This work consists of furnishing and placing an asphalt-tacked mulch of straw or hay on areas that have been seeded.

716.02 MATERIALS.

(a) Mulch: Mulch shall conform to Subsection 1018.19. The contractor shall notify the engineer at least 7 days in advance of commencing operations so that the mulch can be inspected and approved prior to use.

Mulching material shall be delivered in bales of uniform size. Storage of mulching materials shall be in accordance with Subsection 106.08. Mulch stockpiles shall be suitably protected from weather.

(b) Asphalt: Asphalt for mulching shall be approved emulsified asphalt conforming to Section 1002.

716.03 GENERAL CONSTRUCTION REQUIREMENTS. Mulching shall closely follow seeding operations. Mulch shall be placed with mechanical equipment which will distribute mulch uniformly by blowing it onto the area. Equipment shall be provided with jet nozzles spaced in the muzzle of the blower through which asphalt is ejected simultaneously with mulch, thus coating mulch uniformly with asphalt as mulch is blown through the nozzle.

Spreading mulch manually and after-spraying with asphalt will be permitted only in areas inaccessible to equipment or where asphalt may deface a structure.

716.04 SPREADING RATES. Mulch shall be applied at a rate of 1 1/2 to 2 tons per acre simultaneously with asphalt at a rate of 125 to 175 gallons per ton of mulch.

When required, emulsified asphalt shall be diluted with water as directed.

Specific rates of application of mulch and asphalt will be determined by the engineer.

716.05 MANUAL SPREADING. Where manual spreading is permitted, mulch shall be placed in such manner that a loose, shredded

condition will prevail, after which asphalt shall be sprayed over the mulch at the specified rate.

716.06 MULCHING OPERATIONS. Mulching operations shall begin within 48 hours after completion of seeding.

The asphalt-tacked 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 slopes and extend downward. Particular attention shall be given to the top of cut slopes so that such areas will be covered at the junction with the natural ground. Extensions to the blower pipe shall be supplied where slopes are encountered that cannot be reached by the blower under normal conditions. During windy conditions, the contractor shall make adjustments in his operations to obtain uniform spreading.

Care should be taken not to spray asphalt on structures within mulching area. Unsightly asphalt stains shall be removed and the surface left in a condition acceptable to the engineer.

716.07 METHOD OF MEASUREMENT. Vegetative mulch will be measured by the ton. The weight for measurement will be the product of the number of bales used and the average weight per bale as determined on certified scales provided by the contractor.

Emulsified asphalt placed and accepted will be measured by the gallon at application temperature. No measurement for payment will be made for water used in emulsion.

716.08 BASIS OF PAYMENT. Vegetative mulch and emulsified asphalt will be paid for at the contract unit prices, subject to the price adjustment provisions of Section 1002 for specification deviations of emulsified asphalt.

Payment will be made under:

Item No.	Pay Item	Pay Unit
716(1)	Vegetative Mulch	Ton
716(2)	Emulsified Asphalt	Gallon

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.

717.02 MATERIALS. Seed shall conform to Subsection 1018.18. The contractor shall furnish the engineer with a copy of the laboratory test report as described in Subsection 1018.18(b).

Water shall conform to Subsection 714.02.

717.03 SOIL AREAS. Seed shall be selected on the basis of 5 general soil areas shown 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 shall be thoroughly pulverized to a minimum depth of 3 inches and leveled as directed. Hardpan areas shall be rototilled if necessary to insure that soil is in condition to receive and sprout seed. If the contract requires topsoil, fertilizer or agricultural lime, they shall be incorporated at this time. Topsoil, fertilizer and agricultural lime shall conform to Sections 715 and 718. Slopes shall be smoothed to grade and rolled prior to seeding.

717.05 SEEDING. Seed shall be planted within the dates shown in Table 1, unless otherwise permitted in writing.

The contractor will be allowed to apply seed by use of a hydroseeder. Under this method, the seed, fertilizer and agricultural lime shall be distributed over the area in one operation. The same rates for seed, fertilizer and agricultural lime will apply as in the conventional method.

717.06 WATERING. After seed has been planted, area shall be wa-

TABLE 1

Mixture	Seed Mixture	Pounds per Acre	Soil Area	Planting Dates
A	Hulled Bermuda Pensacola Bahia	15 15	1,2,3,5	March thru Sept.
B	Hulled Bermuda Carpet	10 20	2,3,4,5	March thru Sept.
C	Hulled Bermuda Crimson clover (1)	10 20	1,2,3,5	Feb. thru March
D	Kentucky 31 Fescue Pensacola Bahia	30 10	1,2,3,5	Sept. thru Feb.
E	Kentucky 31 Fescue Crimson Clover (1)	30 10	1,2,3,4,5	Sept. thru Feb.
F	Kentucky 31 Fescue Crimson Clover (1) Pensacola Bahia	20 10 10	1,2,3,5	Sept. thru Feb.
G	Hulled Bermuda	30	1,2,3,4,5	March thru Sept.
H	Kentucky 31 Fescue	40	1,2,3,4,5	Sept. thru Feb.
I	Crimson Clover (1)	40	1,2,3,4,5	Sept. thru Feb.
J(2)	Hulled Bermuda Centipede	15 10	1,2,3,5	Feb. thru Sept.

Note: (1) Inoculated prior to planting with proper bacterial culture.

Note: (2) For rest areas, urban areas and multiple-use projects.

tered immediately with approved watering tanks. Other waterings shall follow as directed.

Prior to planting, the engineer will contact the Department's roadside development personnel to select the varieties of seed to be used.

717.07 METHOD OF MEASUREMENT. Seeding will be measured by the pound. Water, fertilizer and agricultural lime will be measured for payment in accordance with Sections 714 and 718; however, water used in hydroseeding slurry will not be measured for payment.

717.08 BASIS OF PAYMENT. Seeding will be paid for at the contract unit price.

Payment will be made under:

Item No.	Pay Item	Pay Unit
717(1)	Seeding	Pound

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 in accordance with these specifications.

718.02 MATERIALS.

(a) Commercial Fertilizer: Fertilizer shall be an approved brand conforming to requirements of the Louisiana Department of Agriculture. Fertilizer shall be either 8-8-8, 12-12-12, 13-13-13 or 16-16-16, and shall conform to Subsection 1018.16.

(b) Agricultural Lime: Agricultural lime shall conform to Subsection 1018.17. The material may 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 approximate rate of fertilizer application shall be as follows:

Type	Pounds Per Acre
8-8-8	1,000
12-12-12	667
13-13-13	615
16-16-16	500

The rate per acre shall be increased or decreased as directed.

Fertilizer applied after surface dressing shall be thoroughly incorporated in the soil by light disking or harrowing. Fertilizer may be applied before final disking or harrowing during surface dressing or if dressed by hand, it may be applied before final raking and leveling.

(b) Agricultural Lime: Agricultural lime shall be spread uniformly at the rate of 2 tons per acre with a spreader. Lime must be applied prior to seeding, topsoil placement and slab sodding and may be applied in conjunction with fertilizer. Several passes may be required to obtain the desired application rate. After application, the areas shall be disked, harrowed, or rototilled to incorporate lime or lime-fertilizer into the top 3 to 6 inches of soil.

(c) **Hydroseeding:** If hydroseeding methods are used, the contractor will be permitted to include fertilizer and lime in the seeding slurry for application during hydroseeding operations.

718.04 METHOD OF MEASUREMENT.

(a) **Fertilizer:** Fertilizer will be measured by the pound. 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 following factors to determine pay quantities:

Type	Factor
12-12-12	1.5
13-13-13	1.625
16-16-16	2.0

(b) **Agricultural Lime:** Agricultural lime will be measured by the ton.

718.05 BASIS OF PAYMENT. Fertilizer and agricultural lime will be paid for at the contract unit prices under:

Item No.	Pay Item	Pay Unit
718(1)	Fertilizer	Pound
718(2)	Agricultural Lime	Ton

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 LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC. The contractor shall conduct his operations in accordance with Section 107 and the requirements of the Louisiana Horticulture Law and Regulations.

719.03 QUALITY AND EXTENT OF WORK. All work shall be done in accordance with accepted landscaping practices. Plant materials approved for planting shall be dug, loaded, moved, unloaded, planted, fertilized, pruned, watered and maintained in such manner as to insure their healthy growth in their new location.

719.04 PLANT MATERIALS. Plants will be subject to approval at the job site before planting. Plant materials damaged en route to planting sites will be subject to rejection.

(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 valid copy of the certificate of inspection shall accompany each delivery.

(b) Plant Names: Scientific and common plant names shall conform to the current edition of "Hortus". Plants shall be true to name and legibly tagged. There shall be no substitutions for the kinds, quantities or sizes of materials specified without written permission, and then only when sufficient evidence has been presented by the contractor 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 conform to the

latest "Grades and Standards for Landscape Materials" prepared by the Louisiana Association of Nurserymen, Inc., and to other contract requirements.

(d) **Plant List:** A complete list of plants will be shown on the plans in regard to botanical name, common name, quantity, height, caliper, etc. Sizes of stock shown thereon are minimum acceptable sizes.

(e) **Quality and Source of Plant Materials:** Plant materials shall be nursery grown, unless written permission is obtained to use selected native stock. This permission will be granted only if contractor demonstrates that it is impracticable to obtain nursery grown plant material or if, in the opinion of the engineer, selected native stock will be better suited or superior in quality to that obtained from a nursery.

If permission is given to use selected native stock, the engineer will inspect the materials before digging and the contractor shall tag each plant selected and dig plants as directed. Plants not showing a sufficient root system will be rejected. Requirements of collected native plants will be as described for nursery grown stock.

Plants shall be root pruned, heavily caned for shrubs and have a single trunk for trees, and typical of the species. They must possess a healthy, normal and fibrous root system of sufficient size to insure plant growth. The branch system shall be of normal development free from disfiguring knots, sun scald, injuries, bark abrasions, dead wood, broken terminal growth or other objectionable disfigurations. Trees shall have reasonably straight trunks and shall be well branched and symmetrical in accordance with their natural growth.

(f) **Balled and Burlapped Plants:** Plants designated as "B & B" condition shall be carefully dug with balls of soil sufficiently large to include enough roots at sides and bottom of the plant to insure proper growth. Balls shall be dug by cutting. Burlap shall be securely fastened around the ball by an approved method. Balls 1 1/2 feet or more in diameter shall be tied with small rope to insure against settling or cracking. Plants shall be handled by the balls of soil.

(g) **Container Grown Plants:** Container grown stock which has become "potbound" or for which the top system is out of proportion (larger) to the size of the container or has roots growing out 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 exercised to prevent root system damage.

(h) **Bare Root Plants:** Soil shall be placed in the plant pit to required depth. Bare rooted plants shall be placed in the center of the

plant pit and roots spread out in a natural position. Broken or damaged roots shall be cleanly cut back to sound root growth.

Backfill soil shall be worked around and over roots and settled by tamping. Thorough watering shall accompany backfill around bare root plants. Earth saucers at least 4 inches deep for trees and 3 inches deep for shrubs shall be formed around plants with a diameter equal to that of the plant pit.

Backfill soil shall consist of 4 parts topsoil and 1 part peat moss or peat humus.

(i) **Handling and Storage:** During handling and storage, the contractor shall protect plants from drying out by covering the root system with suitable materials or wetting foliage. B & B materials shall have earth balls covered with sawdust, woodchips or other suitable materials and kept moist. Bare root materials in bundles shall have bundles opened, plants separated, and then heeled-in in trenches. Container grown plants shall be kept sufficiently moist to insure their livability.

(j) **Delivery and Receipt of Plant Materials:** The contractor shall notify the engineer at least 24 hours before making delivery of plant materials to the project. Each shipment shall be accompanied by an invoice showing sizes and varieties in the shipment.

(k) **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 objectionable features 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 removed from the site and replaced with new plant material of the same kind, meeting requirements, at the expense of the contractor.

719.05 CONSTRUCTION METHODS.

(a) **Seasonal Operations:** Unless otherwise authorized in writing, planting operations shall be performed between November 1 and April 15.

Work shall be suspended when the ambient temperature falls below 32°F, wind velocity exceeds 25 mph, ground is frozen or too wet, or continuation of prevailing weather would likely cause unsatisfactory

results. The contractor shall complete planting as early as practicable in the planting season.

If 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 and weather and ground conditions are suitable for planting.

(b) **Pruning:** If necessary, plant material shall be pruned at the site in accordance with standard practice. Cuts over 1-inch diameter shall be painted with approved tree paint.

(c) **Location of Plants:** Planting stakes will be set by the engineer at designated plant locations. Each stake will bear an item number or color code as designated to coincide with a particular item number.

(d) **Planting Pits:** Planting pits may be machine or hand dug. Square or circular pits with vertical or slanted sides shall be dug to plan dimensions.

(e) **Setting Plants:** Plants shall be planted in pits. Deep planting shall be avoided and, unless otherwise directed, plants shall be set at such level that, after settlement, a normal relationship of the crown of the plant with the ground surface will be established. Each plant in an individual pit shall be in the center of the pit, unless otherwise directed. When B & B plants are set, topsoil shall be tamped under and around the base of each ball to fill all voids. Plants shall be planted in topsoil thoroughly settled by watering and tamping to eliminate settling and leaning of plant material.

When plants are grouped together in a plant bed or in a line less than 5 feet apart, the area shall be loosened and lumps broken to a minimum depth of 6 inches prior to excavating plant pits.

(f) **Topsoil:** Topsoil shall be fertile, friable, natural surface soil obtained from a well drained area and free of stones, brush, weeds, shale, roots and other organic litter. Topsoil shall have 1 to 2 percent organic matter and an acidity range betweeen pH 5.0 to 6.5 inclusive. Topsoil shall be sampled and subject to approval prior to placement.

(g) **Fertilizer:** The contractor shall furnish and place commercial fertilizer (8-8-8) conforming to Subsection 1018.16 at the specified rate. Fertilizer shall be spread uniformly on the excavated material in a circle at the outer edge of planting pit. Fertilizer shall be mixed with excavated soil before backfilling.

(h) **Backfilling:** Plants shall be plumb and set at proper depth. Suitable material removed from the excavation shall be mixed with fertilizer and the pit shall be backfilled as directed. Care shall be exercised in placing backfill under the sides and over the ball so as not to

disturb same. Backfill shall be placed to 3/4 the depth of the ball on all sides, then watered uniformly on all sides of ball to allow settlement of the plant. Plants which settle or lean, before or after watering, shall be straightened, raised, replaced or the condition otherwise remedied. Excavated material considered unsuitable shall not be used in the backfill, but shall be replaced with topsoil by the contractor at no additional cost to the Department.

Excavated material not used as backfill shall be spread on areas of the project as directed.

(i) **Water:** The contractor shall furnish and apply water conforming to Subsection 714.02 in sufficient quantities for proper irrigation of plants. Plants shall be watered during planting operations, immediately after planting and at intervals as directed until final acceptance.

(j) **Bed Preparation:** For bedded plants, planting bed areas shall be scraped, removing all grass, weeds, sticks, stones, and other debris. Beds shall then be tilled with a rototiller to required depth. Peat moss, or satisfactory organic matter, and 8-8-8 fertilizer shall be added to the soil at the following minimum rates: peat moss or organic matter, 3 pounds per square yard; and fertilizer, 1/2 pound per square yard. Beds shall be tilled again to thoroughly mix all components. Beds shall then be raked smooth and dirt lumps, concrete, sticks, grass and other foreign matter shall be removed. Finish grade of beds shall be 1 to 2 inches below finish grade of adjoining surfaces.

(k) **Mulching:** Any material suitable for mulch may be used. Mulching shall be accomplished within 24 hours after plants are set. Mulch shall be placed uniformly on all sides of the plant and watered as soon as possible. When plants are planted in a row less than 5 feet apart, the entire row shall be mulched solid. Bed areas shall also be mulched solid.

When pine bark mulch is specified, mulch shall consist of 1-inch minimum size chipped pine bark. Excessively decomposed pine bark will be rejected. If fresh pine bark is used, the contractor shall add 1/2 pound of nitrogen per 10 cubic feet of mulch.

(l) **Weeding:** Weeds shall be kept removed from the planting basin of each plant, including basin walls. The contractor shall mow around plant materials not planted in beds for a distance of 5 feet. Use of selective herbicide will be permitted, provided it is an approved contact type compatible with plants and provided the grass in the 10-foot circle has been cut to a satisfactory height. These areas shall be weeded by hand. Weeding shall be performed as directed to maintain a neat appearance.

719.06 PERIOD OF ESTABLISHMENT AND REPLACEMENTS. 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.

The contractor shall care for planted areas for a period of establishment, which shall be one growing season, after provisional acceptance is made. A growing season shall begin April 16 and extend to October 31. During this period of establishment, the contractor shall preserve plants in a healthy, growing condition. Such plant establishment work shall include cultivation, watering, pruning, controlling insect pests and disease and other work necessary to insure healthy plant growth. Unsatisfactory plants shall be promptly removed from the project and replaced in kind at proper planting time.

The contractor shall contact the engineer every week and outline activities which he will perform on the project. 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.

A semifinal inspection by the contractor and the engineer will be held 2 weeks prior to the end of the growing season to determine the acceptability of plants. Replacement planting, as required, shall be performed in the upcoming planting season.

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 if approved. These replacement plantings shall be made at the contractor's expense. Replacements made at this time will not require a period of establishment.

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.

Final inspection of plant material will be held approximately 2 weeks after replacement planting has been completed. Final acceptance will be made only if all plants are in place, alive and are in conformance with plans and specifications.

If landscape work consists only of shrub planting at dead end road installations, no period of establishment will be required; however, all 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 if approved by the engineer. These replacement plantings shall be made at the contractor's expense.

719.07 METHOD OF 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 pit preparation, topsoil, fertilizer, mulching, peat moss, watering, plant maintenance or plant replacement.

Bed preparation and pine bark mulch for beds will be measured by the square yard.

If 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.

719.08 BASIS OF PAYMENT. Bed preparation, pine bark mulch for beds and plant materials will be paid for at the contract unit prices.

If an item for "Landscaping" is included in the contract, payment will be made at the contract lump sum price.

Partial payment will be limited to 75 percent of the contract price for landscaping items until the end of the growing season. At the end of the growing season, if plants have been properly maintained and replacement planting has been accomplished, the remaining contract price for landscaping items will be paid.

Payment will be made under:

Item No.	Pay Item	Pay Unit
719(1)	Plants (Type, Size)	Each
719(2)	Pine Bark Mulch (__" Depth)	Square Yard
719(3)	Bed Preparation (__" Depth)	Square Yard
719(4)	Landscaping	Lump Sum

Section 720

Fiber Glass Roving and Erosion Control Matting

720.01 DESCRIPTION. This work consists of furnishing and placing fiber glass roving or erosion control matting where shown on the plans or as directed.

720.02 MATERIALS.

(a) **Fiber Glass Roving:** Fiber glass roving shall conform to Subsection 1018.20.

(b) **Asphaltic Materials:** Asphaltic materials shall conform to Subsection 1002.01 and shall be approved grades of either asphalt cement or emulsified asphalt.

(c) **Erosion Control Matting:** Erosion control matting shall conform to Subsection 1018.24. Either paper or excelsior matting shall be used, at the contractor's option.

720.03 EQUIPMENT. Equipment necessary to satisfactorily perform the work shall be furnished and maintained by the contractor. Equipment for applying fiber glass roving and asphalt shall include the following:

(a) Pneumatic ejector capable of applying fiber glass roving at the rate of 2 pounds per minute (approximately 8 square yards per minute).

(b) Air compressor capable of supplying 40 cfm at 80 to 100 psi and acceptable air hoses for supplying air to areas inaccessible to compressor.

(c) Asphalt distributor with hoses and hand spray bar for areas inaccessible to distributor.

720.04 CONSTRUCTION REQUIREMENTS. Fiber glass roving or erosion control matting shall be applied within 24 hours after completion of seeding operations.

(a) **Fiber Glass Roving:** Fiber glass roving shall be spread uniformly to form a random mat of continuous glass fibers at the rate of 0.25 to 0.35 pound per square yard or as directed.

Fiber glass roving shall be anchored to the ground with asphalt applied uniformly over the glass fibers at the rate of 0.35 to 0.45 gallon per square yard or as directed. A light coat of asphalt shall be applied to the soil surface prior to applying fiber glass roving. When required, emulsified asphalt shall be diluted with water as directed.

Upgrade ends of roving shall be buried to a depth of 1 foot.

(b) Erosion Control Matting:

(1) Paper Matting: Matting shall be draped loosely over the ground surface without stretching. On slopes steeper than 3:1, the matting shall be applied with the paper strips oriented parallel to the slope.

A 4-inch deep check slot shall be dug 1 foot back from the slope crown or at the beginning of the ditch to be lined. The end of the paper matting shall be folded, placed in the check slot and stapled at maximum 12-inch centers in the check slot. The slot shall then be covered with soil. The paper matting shall then be placed on the slope or in the ditch. Intermediate check slots for ditch lining shall be provided in accordance with the manufacturer's recommendations. The check slot shall be repeated at the bottom of the slope or end of the ditch.

When 2 or more lengths of paper matting are installed side-by-side to cover an area, they shall overlay 4 inches (minimum). Paper matting installed end-to-end shall overlap 4 inches (minimum) with upgrade section on top.

Each length of fabric shall be stapled in 3 rows, each edge and center, with staples placed on 3-foot centers (maximum). Overlap ends shall be stapled on maximum 12-inch centers across the fabric overlay.

(2) Excelsior Matting: The netting shall be on top and the fibers in contact with the soil. In ditches, the matting shall be applied in the direction of flow, tightly butted at ends and sides, and stapled. Butt joints along the ditch bottom shall be located at least 1 foot from the centerline of ditch. On slopes, the blankets shall be applied either transverse or parallel to the slope, with ends and sides butted tightly and stapled. Check slots will not be required; however, a row of staples spaced on 6-inch centers, running at right angles to the ditch line, shall be placed at 50-foot centers for ditch grades of 4 percent or less. On ditch grades greater than 4 percent, such rows of staples shall be placed at 25-foot centers.

720.05 MAINTENANCE. The contractor shall maintain the areas on which fiber glass roving or erosion control matting have been placed until final acceptance of the project. This shall consist of the repair of

damage by erosion, wind, fire or any other cause. Such areas shall be repaired to reestablish the condition that existed prior to placing the roving or matting and may include fertilizer, seeding, mulching or sodding as required, and shall be at the contractor's expense.

720.06 METHOD OF MEASUREMENT.

(a) Fiber Glass Roving: Fiber glass roving will be measured by the pound. The number of pounds will be determined as the product of the number of spools or packages of fiber glass roving used and the average weight of spools or packages. The average weight will be determined by weighing and averaging random samples of at least 3 percent of the total number of spools or packages required. In no case shall the number of samples be less than 3.

(b) Asphaltic Material: Asphaltic material will be measured by the gallon at application temperature. No measurement for payment will be made for water used in the emulsion.

(c) Erosion Control Matting: Erosion control matting will be measured by the square yard along the surface of the completed matting.

720.07 BASIS OF PAYMENT. Fiber glass roving, asphaltic material and erosion control matting will be paid for at the contract unit prices, subject to the price adjustment provisions of Section 1002 for specification deviations of asphaltic materials. Payment will be made under:

Item No.	Pay Item	Pay Unit
720(1)	Fiber Glass Roving	Pound
720(2)	Asphaltic Material	Gallon
720(3)	Erosion Control Matting	Square Yard

Section 721

Asphalt Mulch

721.01 DESCRIPTION. This work consists of furnishing and placing asphalt mulch for erosion control on seeded areas as shown on plans or as directed.

721.02 MATERIALS. Asphalt mulch shall be an approved emulsified asphalt conforming to Subsection 1002.01.

721.03 GENERAL CONSTRUCTION REQUIREMENTS. Asphalt mulching shall follow seeding operations as soon as possible. Areas to receive asphalt mulch that have not been sufficiently moistened by rainfall shall be watered as directed. Asphalt shall be spread with a mechanical spreader equipped with boom or hand spray nozzles.

721.04 SPREADING RATES. Asphalt shall be spread over seeded areas at the rate of 0.4 to 0.5 gallon per square yard. When required, asphalt shall be diluted with water as directed.

721.05 METHOD OF MEASUREMENT. Asphalt mulch will be measured by the gallon at application temperature. No measurement for payment will be made for water used in the emulsion.

721.06 BASIS OF PAYMENT. Asphalt mulch will be paid for at the contract unit price, subject to the price adjustment provisions of Section 1002 for specification deviations of asphaltic materials.

Payment will be made under:

Item No.	Pay Item	Pay Unit
721(1)	Asphalt Mulch	Gallon

Section 722

Field Laboratories

722.01 DESCRIPTION. This work consists of furnishing laboratory buildings at the project site, and asphaltic concrete and portland cement concrete plant sites, for exclusive use of the engineer and other personnel in performing the necessary inspection, sampling and testing of the work during construction.

722.02 GENERAL REQUIREMENTS. Field laboratories shall be constructed of wood or metal of an approved type for the purpose of housing and using testing equipment, keeping records of tests made and making reports. The buildings shall be adequately maintained during their use and 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.

Each building shall have minimum outside dimensions of 10 x 16 feet or other approved dimensions that provide equivalent floor space; at least 2 tables or work benches having a minimum size of 30 x 48 inches, or as directed; at least one outside door; and sufficient windows to provide satisfactory light in daytime. If the contractor's operations are conducted at night, adequate lighting shall be provided. Roof, floor and walls shall be weather-tight. Outside doors shall be provided with locks, and all keys shall be under control of the engineer. The building shall be moved to various locations on the project as directed.

Field laboratory buildings shall remain the property of the contractor and shall be removed upon completion of the project.

722.04 PLANT SITE LABORATORY. The laboratory at each asphaltic concrete and portland cement concrete plant shall consist of a building or room at an acceptable location at the plant site; shall have a minimum floor space of 140 square feet; shall be suitably weatherproofed, air conditioned, heated and ventilated; shall contain a sink with running water; and shall be provided with electric lights and power outlets as directed. Electric exhaust fans shall be provided in such size and location

to insure continuous removal of fumes from chemicals used in testing operations. The laboratory shall be equipped with sturdily constructed benches and tables as required, shall have at least one outside door, and its contents shall be secured by suitable locks and catches. The engineer shall be afforded access to the plant site laboratory at all times.

722.05 METHOD OF MEASUREMENT.

(a) Project Site Laboratory: Project site laboratories furnished, satisfactorily maintained, moved as directed, and subsequently removed from the project will be measured per each building.

(b) Plant Site Laboratory: Plant site laboratories provided at asphaltic concrete and portland cement concrete plants will not be measured for payment.

722.06 BASIS OF PAYMENT. Project site laboratories will be paid for at the contract unit price per each under:

Item No.	Pay Item	Pay Unit
722(1)	Project Site Laboratory	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 conform to Subsection 1003.07.

723.03 CONSTRUCTION REQUIREMENTS. Materials shall be placed, properly shaped and uniformly compacted to the satisfaction of the engineer. 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 Designation: 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 the contractor's expense.

(a) Thickness: Underthickness shall not exceed 3/4 inch. Overthickness will be waived at no additional cost to the Department.

(b) Width: Underwidth shall not exceed 6 inches. Overwidth will be waived at no additional cost to the Department.

723.05 METHOD OF 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 in approved hauling vehicles at the point of delivery in accordance with Subsection 109.01.

723.06 BASIS OF PAYMENT. Granular material will be paid for at the contract unit price per cubic yard under:

Item No.	Pay Item	Pay Unit
723(1)	Granular Material (Net Section)	Cubic Yard
723(2)	Granular Material (Vehicular Measurement)	Cubic Yard

Section 724

Pavement Patching, Widening and Joint Repair

724.01 DESCRIPTION. This work consists of patching, widening and joint repair of existing pavements in accordance with these specifications and in conformity with the lines, grades and typical sections shown on the plans or as directed.

The contractor has the option of using either portland cement concrete or asphaltic concrete for patching and widening. Joints in existing asphaltic concrete overlays shall be repaired with asphaltic concrete.

724.02 MATERIALS. Portland cement concrete shall be Class A or any type of pavement concrete, and shall conform to Section 901.

Asphaltic concrete shall be any type mixture listed in Section 501, except Types 2 and 5B.

Asphaltic tack coat shall conform to Subsection 1002.01.

Granular material shall conform to Subsection 1003.07.

724.03 EQUIPMENT. Equipment furnished shall meet the specification requirements for the types of material used.

724.04 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 replacing of pavement, 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, unless otherwise directed.

For joint repair, contact surfaces of existing pavement shall be cleaned and painted with a thin, uniform asphaltic tack coat prior to placing asphaltic mixture in the joint.

724.05 PATCHING AND WIDENING WITH PORTLAND CEMENT CONCRETE. Patching and widening with portland cement concrete shall conform to Section 601, except that either machine or hand

finishing methods may be used. If granular material subbase is specified, the granular material shall be placed in accordance with Section 723.

724.06 PATCHING AND WIDENING WITH ASPHALTIC CONCRETE. Patching and widening with asphaltic concrete shall conform to Section 501, except that priming of the subgrade will not be required. Contact surfaces of pavement shall be cleaned and painted with a uniform coat of asphaltic tack coat before asphaltic concrete is placed against them.

Spreading, finishing and compaction of asphaltic concrete shall leave the surface reasonably smooth and level with, or slightly above, the edge of existing pavement. Sampling and testing for density shall be of the top 4 inches of finished sections. One sample will be taken per 100 tons (or portion thereof) per day up to a maximum of 5 samples per day.

To provide lateral support, the contractor will be permitted to construct temporary berms of excavated material against outside edge of widening strips prior to rolling.

724.07 METHOD OF MEASUREMENT.

(a) Patching: Patching of pavement will be measured by the square yard of existing pavement designated to be removed and replaced. Removal of existing surfacing and base course and required excavation for patching 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, or 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 of asphaltic mixture used to backfill the joint. Measurement will be made in accordance with Subsection 501.13(a).

724.08 BASIS OF PAYMENT.

(a) Patching and Widening: Pavement patching and widening will be paid for at the contract unit prices per square yard, subject to the following provisions:

Price adjustments for deficiencies in portland cement concrete, asphaltic concrete and asphaltic materials will be applied to 1/2 the contract unit price for pavement patching.

If 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 thickness will be determined by dividing the contract unit price per square yard by the plan thickness. Payment for the additional thickness will be made at 50 percent of the value per inch thus determined.

(1) **Portland Cement Concrete:** Portland cement concrete will be paid for on a lot basis. A lot will be a completed section or an identifiable pour completed in 1 day.

Two random batches will be sampled for each lot, and 3 cylinders molded for each batch. The 6 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 3 cylinders will constitute a lot.

Acceptance and payment for each lot will be as specified in Subsection 601.20(b)(2).

(2) **Asphaltic Concrete:** Asphaltic concrete will be subject to the price adjustment provisions of Section 501 for deficiencies in Marshall stability, pavement density, aggregate gradation, anti-strip additive and asphaltic materials.

(b) Joint Repair: Pavement joint repair will be paid for at the contract unit price per ton, subject to the following provisions:

Asphaltic concrete for joint repair will be subject to the price adjustment provisions of Section 501 for deficiencies in Marshall stability, aggregate gradation, anti-strip additive and asphaltic material; however, price adjustments will be applied to 1/3 the contract unit price for joint repair.

(c) Payment will be made under:

Item No.	Pay Item	Pay Unit
724(1)	Pavement Patching	Square Yard
724(2)	Pavement Widening	Square Yard
724(3)	Pavement Joint Repair	Ton

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 at the locations shown on the plans or as directed, in conformance with plan details and these specifications.

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 conform to 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.

(b) Detour Bridges: Timber shall be sound, new or used, treated or untreated. Splits, rot, unsound knots or other defects which, in the opinion of the engineer, materially affect the strength of the timber will not be permitted. Timber shall conform to species, grade and stress rating requirements of Subsection 1014.01.

Piles shall be pine, fir, cypress or oak of any grade which will satisfactorily withstand driving and shall be reasonably straight. Lumber and piling, in addition to meeting requirements herein, shall be satisfactory to the engineer. Peeling of bark from piles will not be required.

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 and warning devices in accordance with Section 713 shall be placed for detours prior to being opened to traffic. The contractor shall maintain detours in a condition satisfactory to the engineer.

(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. If 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 conforming to Section 713 shall be placed on detours surfaced with asphaltic concrete or portland cement concrete, and these markings shall be in place at the time the detour is opened to traffic.

Low profile runaround type detour roads shall be surfaced with aggregate approved by the engineer. Aggregate surfacing shall be placed to a minimum depth of 4 inches and a minimum width of 20 feet. Alignment and grade of runaround type detour roads shall be acceptable to the engineer. When directed, the contractor shall provide temporary culverts for low profile detours. No direct payment will be made for low profile runaround type detour roads.

(c) **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 will not be permitted to post temporary bridges against passage of loads up to and including maximum legal loads. Temporary bridge construction shall be performed in accordance with applicable Sections of these specifications.

725.04 REMOVAL OF DETOURS. Upon completion of permanent construction and diversion of traffic thereto, the contractor shall remove detour roads and bridging, and temporary fencing and culverts, and eliminate construction scars.

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 outside the right-of-way, unless reuse of these materials on the project is permitted.

725.05 METHOD OF MEASUREMENT.

(a) **Detour Roads:** Temporary detour roads will be measured either by the linear foot or square yard, as specified, in accordance with the following provisions:

(1) **Linear Foot:** Measurement will be made along the centerline of detour roads. Detours with temporary bridging will be measured between the edge of surfacing and temporary bridging. Detours without temporary bridging will be measured between edges of surfacing.

(2) **Square Yard:** Measurement will be made along the surface of completed detour road surfacing.

(b) **Detour Bridging:** Temporary detour bridging will be measured by the linear foot along the centerline of completed bridging in accordance with the following:

(1) If 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) If 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.

(c) **Incidentals:** Additional clearing and grubbing, temporary fencing and culverts, and temporary pavement markings will not be measured for payment.

725.06 BASIS OF PAYMENT. Temporary detour roads and bridging furnished, constructed, maintained and subsequently removed will be paid for at the contract unit prices under:

Item No.	Pay Item	Pay Unit
725(1)	Temporary Detour Roads	Linear Foot
725(2)	Temporary Detour Roads	Square Yard
725(3)	Temporary Detour Bridging	Linear Foot

Section 726

Bedding Material

726.01 DESCRIPTION. This work consists of furnishing and placing bedding material for drainage structures in accordance with these specifications and in conformity with the lines, grades and sections shown on the plans or established by the engineer.

Bedding material may be any type of material listed herein. Unless otherwise approved in writing, the same type material shall be used throughout the project.

726.02 MATERIALS. Materials shall conform to the following Subsections:

Plastic Soil	203.06
Stone	1003.03(d) or 1003.04(a)
Shell	1003.04(c)
Stone and Sand	1003.08
Shell and Sand	1003.08
Gravel and Sand	1003.08

Materials shall be properly proportioned and mixed prior to being placed in the foundation.

726.03 PLACEMENT OF BEDDING MATERIAL. Materials shall be placed, shaped and uniformly compacted to the satisfaction of the engineer.

Excavation below the established grade of the structure for placement of bedding material shall be disposed of in accordance with Section 203.

A layer of compacted plastic soil material 12 inches thick shall be placed at structure ends when bedding material is exposed.

726.04 METHOD OF MEASUREMENT. Bedding material, including plastic soil material, completed and accepted, will be measured by the cubic yard (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.

Necessary excavation and disposal of excess excavated materials will not be measured for payment.

726.05 BASIS OF PAYMENT. Bedding material will be paid for at the contract unit price per cubic yard. Payment will be made under:

Item No.	Pay Item	Pay Unit
726(1)	Bedding Material	Cubic Yard

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 BASIS OF 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 following schedule up to a maximum of 10 percent of the original total contract amount, including this item, and payment of any remaining amount will be made upon completion of all work under the contract.

Percent of Total Contract Amount Earned	Allowable Percent of the Lump Sum Price for the Item
1st Partial Estimate	25
10	50
25	75
50	100

No price adjustments will be made for this item due to changes in the work in accordance with Section 109.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided by the contract.

Payment will be made under:

Item No.	Pay Item	Pay Unit
727(1)	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 shall conform to Subsection 701.02. Corrugated metal pipe to be jacked or bored shall have corrugated bands a minimum of 24 inches wide with 4 lines of approved gasket material. These bands shall be secured by a minimum of 4 galvanized steel rods and lugs in accordance with the plans.

728.03 CONSTRUCTION REQUIREMENTS. In general, pipes 30-inch diameter and greater shall be jacked, and pipes less than 30-inch diameter shall be bored.

The work shall begin at the outfall end of pipe whenever possible. If 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, pipe shall be either cased or pressure grouted for 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 to the engineer for approval a plan showing his 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 his 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 properly designed jacking head. The jacking head shall be so designed 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 oakum or 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 2 feet beyond the forward end of pipe, and if the character of embankment material dictates, the distance shall be reduced to prevent the embankment from being damaged.

Excavation on the underside of pipe, for at least 1/3 the circumference of pipe shall conform to contour and grade of pipe. A clearance of not more than 2 inches may be provided for the upper 1/2 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, so constructed that it will transmit pressures uniformly around the ring of the pipe.

Once begun, jacking shall continue without interruption, insofar as is practical, to prevent pipe from becoming firmly set in the embankment.

Pipe shall not vary laterally or vertically by more than 1 inch in 10 feet 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 his expense.

(b) **Boring:** Boring shall be done mechanically, using a pilot hole approximately 2 inches 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 l inch shall be remedied by pressure grouting the entire length of the installation.

Pipe shall be joined as specified in Section 701.

728.04 METHOD OF 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 and grouting will not be measured for payment.

728.05 BASIS OF PAYMENT. Jacked or bored pipe will be paid for at the contract unit price per linear foot under:

Item No.	Pay Item	Pay Unit
728(1)	Jacked or Bored Pipe (Size, Type, Class or Thickness)	Linear Foot

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 conformity with the requirements shown on the plans and contained in these specifications.

In general, the work and materials shall conform to the MUTCD as modified by these specifications or as shown on the plans.

Signs shall be fabricated in a properly equipped plant, and the contractor shall show evidence of successful experience in fabrication and erection of quality reflectorized multipanel signs.

The term "legend" shall mean border strip, letters, numerals and symbols which convey the message on signs.

729.02 GENERAL REQUIREMENTS. The contractor has 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. Sign panels shall be aluminum. Before beginning work, the contractor shall notify the engineer in writing as to the combination of signing materials he proposes to furnish, and the same combination of signing materials shall be used throughout the project.

The contractor shall furnish fabrication and erection drawings of all sign mountings except standard roadside mounted supports, and any sign face details not provided by the Department, all in accordance with Subsection 801.03. Approval of sign face details must be given before approval of sign structure drawings will be made. Fabrication or construction shall not be started until drawings have been approved and distributed.

Fabrication of sign mountings shall conform to Section 807. An approved damper will be required for each aluminum overhead 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. Posts for ground mounted small

signs, markers and delineators shall be driven with a suitable protective driving cap and shall be vertical.

Welding shall conform to Section 815.

729.03 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 conform to Section 1015. Reflective sheeting material shall be either Type I, Enclosed Lens Material or Type II, Encapsulated Lens Material, as specified; if not specified, either Type I or II may be furnished.

(b) Ferrous Metal: Ferrous metals shall conform to Subsection 1015.02(a). Reinforcing steel shall conform to Section 1009. All ferrous metal, except reinforcing steel, shall be galvanized in accordance with Section 811.

(c) Aluminum: Aluminum alloys for structural members shall conform to Subsection 1015.02(b). Aluminum sign panels shall conform to Subsection 1015.04(a).

(d) Fittings: Structural bolts, nuts and washers and miscellaneous hardware shall conform to Subsection 1015.02.

(e) Guard Rail: Guard rail materials for dead end road installations shall conform to Section 1010.

(f) Timber: Piling and planks for barricades in dead end road installations shall be treated timber (noncoastal treatment) conforming to Section 1014.

(g) Concrete: Concrete shall be Class A conforming to Section 902.

(h) Flexible Sign Posts: Flexible posts for small signs, markers and delineators shall conform to Subsection 1015.03.

729.04 FABRICATION OF SIGN PANELS AND MARKERS.

(a) General: The completed product shall show careful finished workmanship free from cracks, blisters and other blemishes, and shall be reasonably free of wrinkles.

Unless otherwise permitted, 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.

Aluminum panels shall be 0.080 inch thick.

(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 trichloroethylene or perchloroethylene. 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: Etch in a 6 to 8 percent phosphoric acid solution at 100°F; rinse 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:** Dry panels 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 sign face and legend sheeting shall be in accordance with approved recommendations of the reflective sheeting manufacturer. Unless otherwise approved in writing, reflective sheeting shall be applied to panels in such manner that there are no horizontal splices.

Sign faces comprising 2 or more pieces of reflective sheeting must 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 must be reversed and consecutive to insure 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 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 adhesive coated reflective sheeting as specified in Subsection 1015.05, permanently adhered to a 0.032 inch thick flat aluminum backing, except that route marker shields shall be 0.080 inch thick aluminum. Aluminum shall be treated in accordance with Heading (b) herein. 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.

(d) Paint Screening Process: Paint screening of sign faces shall be in accordance with Subsection 1015.07. 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) Hazard Markers, Milepost Markers and Delineators:

(1) Hazard Markers: Hazard markers shall be silver reflectorized material conforming to Subsection 1015.05 and low gloss black nonreflectorized material conforming to Subsection 1015.06 or 1015.07 mounted on 0.080 inch thick aluminum panels.

(2) Milepost Markers: Milepost markers shall be reflectorized green background sheeting and reflectorized silver white numerals in accordance with Subsection 1015.05 mounted on 0.080 inch thick aluminum panels.

(3) Delineators: Delineators shall be Type II reflective sheeting (silver, red or yellow, as specified) conforming to Subsection 1015.05 applied to properly treated base panels, punched or sheared to specified dimensions for rigid steel posts; or applied directly to flexible posts.

(f) Packaging: Before being packed, signs shall be allowed to stand for at least 12 hours after completion of paint screening. Signs shall be

slip-sheeted and packed in such manner as to insure their arrival at destination in an undamaged condition. Packaged signs shall not be permitted to become wet in storage or shipment.

729.05 CONSTRUCTION REQUIREMENTS. If removal of existing signs is required, the contractor's sign removal operations shall be coordinated as directed with new sign construction to provide adequate signing in place at all times.

(a) **Construction Stakes:** Sign support locations will be determined and staked by the engineer. 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 determine elevations for post length determinations at the established sign support location.

Required information relating to lines and grades will be furnished by the Department; however, the contractor will be responsible for orientation, elevation, offset and leveling of signs.

(b) **Sign Positioning:**

(1) **Overhead Signs:** Signs shall be constructed so that the sign face is tilted back 2 or 3 degrees (approximately 1 inch in 2 feet) 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 from the edge of travel lane shall be placed at a 93-degree angle from the center of travel lane, and sign faces located 30 feet or more from the edge of travel lane shall be placed at an 87-degree angle from the center of travel lane. Where lanes divide or on curves or grades, sign faces shall be oriented so as to be most effective both day and night and avoid specular reflection.

(3) **Delineator, Hazard Marker and Milepost Assemblies:** These assemblies shall be placed at least 2 feet beyond the outer edge of roadway shoulder, 2 feet beyond the face of curb, or in the line of guard rail.

(4) **Vertical and Horizontal Clearances:** In ground installations, signs shall be constructed to a minimum height of 6 feet above the edge of pavement to the bottom of signs. If, however, a secondary sign is mounted below another sign, the secondary sign shall be at least 4 feet above pavement edge. Overhead sign mountings shall provide a minimum clearance of 18 feet over the entire width of pavement and shoulders.

Minimum horizontal clearance from edge of roadway to any ground

sign or the nearest vertical member of an overhead sign structure shall be as shown on the plans or as directed.

(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 sign shall be placed on an existing sign. If 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. All raised legend shall be removed from the existing sign face prior to placing the overlay panel. Size of overlay panel shall not exceed the size of existing sign panel by more than 3 inches on any side. Overlay panel shall be attached to existing panel with 3/16 inch solid core rivets. Rivets shall be placed on 12-inch centers (maximum) along the perimeter of panel and at panel splices, and on 24-inch centers (maximum) both vertically and horizontally in interior portions of each panel. Rivets shall be centered horizontally on panels less than 24 inches wide. A 4 x 4-inch shim of 0.080 inch 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). Existing sign panel shall be kept reasonably flat during installation of overlay panel. 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 conform to Sections 804, 805, 806 and 807.

Posts for ground mounted delineator, hazard 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 minimum bolt tension in accordance with Subsection 807.20. 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 base connection will be checked by the engineer, and bolt tensioning shall be corrected as 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 installation of signs is complete, the Department's Sign Inspection Team along with the engineer or his authorized representative will inspect the signs, both day and night. The inspection will consist of a review of sign faces, mounts, installations, hardware and all matters relating to the requirements of this Section along with applicable plans, standards and special provisions. Color match, uniformity and spacing of legend, specular glare, and sign type and design will be inspected for conformance to plans and specifications. If 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 and 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.

In lieu of removing and replacing new sign faces that have been rejected, sign overlay panels conforming to Subsection 729.05(c) may be used to correct the deficiencies at the expense of the contractor.

729.08 METHOD OF MEASUREMENT.

(a) Sign Faces and Overlay Panels: Quantities for payment will be the design areas in square feet 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, Hazard Marker and Milepost Assemblies: Delineator, hazard 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.

729.09 BASIS OF PAYMENT.

(a) Sign Faces and Overlay Panels: Sign faces and overlay panels will be paid for at the contract unit price per square foot, which includes furnishing, fabricating and constructing the signs and furnishing all necessary attaching devices.

(b) Post Mountings: Post sign mountings will be paid for 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 for the sign mounting.

(c) Overhead Mountings: Overhead sign mountings, including bridge fascia mountings, will be paid for at the contract unit price per each, which includes furnishing, fabricating and erecting the structure complete, ready for affixing signs.

(d) Delineator, Hazard Marker and Milepost Assemblies: Delineator, hazard marker and milepost assemblies will be paid for at the contract unit prices per each, which includes posts.

(e) Dead End Road Installations: Dead end road installations will be paid for at the contract unit price per each, which includes piling, posts, barricades, sign materials, reflectors, and any required guard rail.

(f) Footings: Footings for overhead sign mountings will be paid for at the contract unit price per each, which includes excavation, piling, concrete, reinforcing steel, anchor bolt assemblies and backfill.

Payment will be made under:

Item No.	Pay Item	Pay Unit
729(1)	Sign (Type A)	Square Foot
729(2)	Sign (Type B)	Square Foot
729(3)	Sign (Type C)	Square Foot
729(4)	Sign (Type D)	Square Foot
729(5)	Sign (Type E)	Square Foot
729(6)	Sign (Overhead Mounted)	Square Foot
729(7)	Sign (Overlay Panel)	Square Foot
729(8)	Mounting (____ Size Post)	Each
729(9)	Mounting (Overhead Truss) (Ground Mounted)	Each
729(10)	Mounting (Overhead Truss) (Structure Mounted)	Each

Item No.	Pay Item	Pay Unit
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)	Hazard 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

Section 730

Electrical Systems

730.01 DESCRIPTION. This work consists of furnishing and installing all electrical equipment, apparatus, conduit, wire, junction boxes, secondary power control units, transformers, control stations and incidentals necessary for complete electrical control and power systems for buildings, roadway and structure lighting and other electrical systems, except for movable bridges.

The work also includes furnishing and installing all electrical equipment and materials required to connect to electrical systems all other appurtenances not classified as electrical equipment, such as air conditioning equipment and controls, thermostats, pumps, etc.

The installation shall be constructed in conformity with plans and specifications, and upon completion shall present a neat and finished appearance.

730.02 GLOSSARY OF TERMS.

AA	Aluminum Association
IEEE	American Institute of Electrical and Electronics Engineers
AWG	American Wire Gage
EIA	Electronic Industries Association
IES	Illuminating Engineering Society
IPCEA	Insulated Power Cable Engineer's Association
MSG	Manufacturer's Standard Gage
NEC	National Electrical Code
UL	Underwriters Laboratories, Inc.

730.03 CODES, PERMITS AND INSPECTIONS. Materials furnished and work performed shall be in accordance with the latest revisions of the NEC, the National Electrical Safety Code, requirements of the local power and telephone companies, and codes, regulations and rules prevailing in the area in which the work is being performed.

730.04 DRAWINGS, BROCHURES AND DESCRIPTIVE DATA. The contractor shall furnish drawings, brochures and other descriptive data in accordance with Subsection 801.03.

730.05 MATERIALS. Materials shall conform to the following Sections and Subsections:

Backfill	701.08
Portland Cement Concrete	902
Reinforcing Steel	1009
Timber	1014
Anchor Bolts, Nuts and Washers	1015.02 (c)(1)
Conduit	1018.09
Conductors	1018.10
Aluminum Plate for Electrical Boxes	1018.11

All materials shall be of the best quality and workmanship and shall be new and of the most advanced proven design available. Throughout the project, all units of any one item, such as lighting standards, luminaires, lamps, transformers, controllers, photoelectric relays, ballasts, circuit breakers, transformer bases, panel boards, switches and starters, shall be products of the same manufacturer.

Reference to any name, make or manufacturer's number for an article, material or equipment indicates the quality of materials that will be acceptable. The contractor may propose the use of other manufactured materials on a basis of equality for the purpose intended. The contractor shall submit detailed specifications and descriptions of such materials, which will be subject to approval.

730.06 GUARANTY. The contractor guarantees, by his signing of the contract, all electrical equipment, apparatus, materials and workmanship for a period of 1 year after the date of final acceptance of the project.

Prior to final acceptance of the project, the contractor shall furnish warranties and guarantees as specified in Subsection 104.05.

730.07 GENERAL CONSTRUCTION REQUIREMENTS. The contractor shall remove excess material, reshape and resod or otherwise repair to the satisfaction of the engineer any portion of the construction area disturbed due to his operations.

Trenching and backfilling for underground cable installation shall be performed in accordance with Section 701; "plowing-in" of cables will not be permitted.

730.08 POWER SUPPLY. The contractor shall make all arrangements with the utility company, and shall furnish and install the service pole and/or service riser and all equipment, apparatus, conduit, wire, hardware and incidentals necessary to bring in the service either overhead or underground as shown on the plans. The service shall be 480-volt, 3-wire, single-phase 60-Hertz, AC grounded for lighting systems; and

120/240-volt, 3-wire, single-phase, 60-Hertz, AC for buildings. Metering shall be provided as required by the utility company.

No direct payment will be made for power used prior to final inspection.

730.09 GROUNDING. The entire system shall be grounded and bonded in accordance with the NEC. All equipment shall be grounded. Ground wire for service poles shall be a minimum AWG No. 6, bare, solid, soft-drawn copper, attached to a 3/4-inch nominal diameter copperweld steel 10-foot long ground rod with a bronze clamp.

730.10 WIRING. All conductors shall be stranded copper, per IPCEA specifications. Conductors smaller than AWG No. 12 shall not be used. Conductors shall conform to Subsection 1018.10.

Splices in copper conductors at light standards shall be made by use of Y or straight splice with fused or unfused disconnect tap, as required, and shall be made with approved, field applied, waterproof connector kits.

Connector kits not requiring a light tap shall be unfused.

Connector kits at the last standard of a circuit or run or remote ballast shall be of the straight type with fuse.

Connector kits for double luminaire standards shall be unfused Y connectors in feeders and fused straight connectors in taps.

Splices for pole type ballasts shall be made with pressure type connectors and approved insulating caps.

All other conductor connections shall be made on high pressure, box lug, barrier type terminals. Splices other than those specified above will not be permitted.

730.11 CONDUIT. Conduit above ground or exposed on structures shall be rigid aluminum. Fittings and covers shall be cast aluminum and covers shall be sealed with neoprene gaskets. Hardware shall be stainless steel.

Underground conduit shall be galvanized rigid steel or approved PVC plastic conduit.

Conduit for buildings shall be galvanized rigid steel, rigid aluminum, or galvanized or aluminum electrical metallic tubing. Electrical metallic tubing shall not be placed in the slab, underground, in moist areas or other hazardous locations.

Fittings and covers for steel conduit shall be cast or malleable iron with neoprene gaskets.

Conduits entering disconnects, starters and panel boards shall have union hubs or bolt-on hubs. Conduits entering standards, equipment, etc., shall have insulated grounding bushings, except where bolted hubs are

used. Bushings shall be installed prior to pulling wire. Each circuit shall be run into the controller in a separate conduit.

Conduit on structures shall be surface-mounted, strapped at intervals not greater than 5 feet with galvanized malleable iron clamps, clamp backs and nest backs, so that the minimum clearance between conduit and structures will be 1/2 inch. Each conduit run on structures, from roadway to bent cap for understructure lights, for understructure crossings, and for understructure runs shall contain a short length of liquid-tight flexible metal conduit with bonding strap for expansion deflection.

Conduit on service poles shall be clamped at approximately 5-foot intervals with heavy duty galvanized 2-hole pipe clamps and stainless steel lag bolts with flat washers, except when channels or Z bars are used for mounting.

Cut threads on steel conduit shall be given an approved protective coating before assembly and joints shall be made up tight. Aluminum conduit joints shall be treated with an oxide inhibiting compound before assembly and made up tight.

Expansion joints with bonding straps and clamps shall be used when conduit runs across expansion joints in structures.

Maximum length of structure mounted conduit run between pull points shall be 100 feet. Drain holes of 1/8-inch diameter shall be drilled at low points of surface conduit runs, including expansion joints, before pulling conductors.

730.12 HARDWARE. Hardware on structures shall be stainless steel. Hardware in buildings shall be galvanized steel. Bolts shall be hex-headed with hex nuts, and shall be fitted with a flat washer and external tooth lockwasher. Stainless steel hardware shall be Type 18-8. Galvanized steel hardware shall be galvanized in accordance with ASTM Designation: A 153 or by an approved mechanical galvanizing method that provides the same thickness of coating. Galvanized bolts shall be ASTM Designation: A 307.

730.13 JACKING OR BORING CONDUIT. Conduit under roadways shall be rigid steel or Schedule 80 PVC plastic conduit, 2-inch diameter minimum size, installed by jacking or boring. The method of jacking or boring shall not use water jetting and shall be subject to approval prior to beginning the installation. A separate conduit shall be installed for each circuit.

730.14 TESTING. Completed electrical systems shall be given a performance test for at least 3 weeks. The system shall remain in operation during the test period. Any loose connections or defective equipment, material and workmanship shall be immediately corrected. The contractor

shall conduct a resistance test on all circuits, and the engineer shall be provided with a copy of the readings. All circuits with low resistance readings shall be checked for ground faults or other deficiencies, and any deficiencies shall be corrected prior to final inspection. Minimum resistance, phase-to-phase or phase-to-ground, on any circuit shall be 50 megohms when measured with a 1,000-volt DC insulation tester. Any equipment subject to damage by these tests shall be disconnected prior to testing.

730.15 METHOD OF MEASUREMENT.

(a) Trenching and Backfilling: Trenching and backfilling will be measured by the linear foot.

(b) Conduit with Conductors: Conduit with conductors will be measured by the linear foot of conduit. No measurement will be made for clamps, fittings, junction boxes, flexible metal conduit and miscellaneous hardware required for a complete conduit installation.

(c) Underground Cable: Underground cable will be measured by the linear foot.

(d) Jacking or Boring Conduit: Jacking or boring conduit will be measured by the linear foot of conduit jacked or bored. No measurement will be made for fittings, excavation and backfilling required for installing the conduit.

(e) Light Standard: Light standards installed and accepted will be measured per each standard, which includes the standard, bracket, base assembly, concrete foundation, concrete apron, reinforcing steel, conduits in foundation, ground rod, ground wires, ground clamp, conductors, connectors, fuses, hardware, connections to circuit conductors, excavation, backfill, grout, oxide-inhibiting compound and disposal of excess excavated material.

(f) Lighting Tower: Lighting towers installed and accepted will be measured per each tower, which includes the tower, luminaire ring, lowering assembly, drive assembly, conduit, grounding, wiring, electrical connections, fuses, washers, hex nuts, anchor bolts, grout, and all hardware and appurtenances required for a complete installation.

(g) Lighting Tower Foundation: Lighting tower foundations completed and accepted will be measured per each foundation, which includes excavation, reinforcing steel, conduit in foundations, anchor bolts, concrete, backfilling and disposal of excess excavated material.

(h) Luminaire: Luminaires installed and accepted will be measured per each luminaire, which includes the luminaire, ballast, lamp, fuse, lightning arrestor, mounting, connections and hardware.

(i) Electrical Service Poles and Service Points: Electrical service poles and service points will be measured per each assembly, which includes pole, controller assembly ane all equipment as shown on the plans, footing, anchor bolts, grounding electrode, conduits in footing, rigid steel conduit and conductors on utility company pole, and all connections and hardware required.

(j) Electrical Systems: When electrical systems are specified to be paid for on a lump sum basis, payment will include furnishing and installing all equipment and apparatus, and performing all work required for a complete system.

730.16 BASIS OF PAYMENT. Electrical work will be paid for at the contract unit prices under:

Item No.	Pay Item	Pay Unit
730(1)	Trenching and Backfilling	Linear Foot
730(2)	Conduit with Conductors (Size and Type)	Linear Foot
730(3)	Underground Cable (Size and Type)	Linear Foot
730(4)	Jacking or Boring Conduit (Size and Type)	Linear Foot
730(5)	Light Standard (__-Foot Mounting Height)	Each
730(6)	Lighting Tower (__-Foot Mounting Height)	Each
730(7)	Lighting Tower Foundation	Each
730(8)	Luminaire (Size and Type)	Each
730(9)	Electrical Service Pole	Each
730(10)	Electrical Service Point	Each
730(11)	Electrical System	Lump Sum

Section 731

Raised Pavement Markers

731.01 DESCRIPTION. This work consists of furnishing and placing reflectorized and nonreflectorized raised pavement markers at the locations shown on the plans or as directed, and in conformance with plan details and these specifications.

731.02 MATERIALS.

(a) Markers: Markers shall conform to 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: Adhesive for placing raised markers shall be a 2-component epoxy adhesive conforming to Subsection 1017.02. The components shall be mixed in equal parts by volume. Mixing and dispensing of adhesive shall be by mechanical methods, unless hand methods are permitted.

731.03 CONSTRUCTION REQUIREMENTS.

(a) Weather Limitations: Application of markers will not be permitted when there is moisture on the surface. If a normal set adhesive is used, application of markers will not be permitted at ambient air temperatures less than 50°F. If a rapid set adhesive is used, application of markers will be permitted at ambient air temperatures between 35°F and 50°F, 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.

(b) Cleaning of Surfaces: Surfaces on which markers are to be applied shall be cleaned of all materials that would reduce the bond of adhesive. Surfaces shall be cleaned by blast cleaning or other approved methods; however, blast cleaning equipment used on asphaltic surfaces must be provided with positive cutoff controls and cleaning operations shall be performed by approved methods that satisfactorily clean the surface without damaging pavement. Surfaces shall be maintained in a clean 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. Adhesive bed area shall be equal to the bottom area of marker, and 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 during placement.

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 thick from the extrusion nozzle shall not exceed 4 percent by volume. Machine mixer and applicator must be capable of accurately and uniformly proportioning the 2 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 containers placed before the mixing chamber and the actual volume of each component measured. Equipment shall be arranged so it is possible to bypass the mixer to perform these periodic checks. Temperature of adhesive shall be maintained at 70 to 110°F before mixing, with this temperature adjusted such that there shall be no excessive flow of epoxy from the marker when installed.

(d) Construction Sequence: Markers shall be placed prior to permanent striping.

731.04 METHOD OF MEASUREMENT. Raised pavement markers will be measured by counting the number of markers furnished, placed and accepted.

731.05 BASIS OF PAYMENT. Raised pavement markers will be paid for at the contract unit prices per each under:

Item No.	Pay Item	Pay Unit
731(1)	Nonreflectorized Raised Pavement Markers (Class)	Each
731(2)	Reflectorized Raised Pavement Markers (Class)	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 applied plastic at the locations shown on the plans or as directed, and in conformance with the MUTCD, plan details and these specifications.

732.02 MATERIALS.

(a) Thermoplastic Markings: Thermoplastic marking material shall be a plastic compound reflectorized by internal and external application of glass spheres, all conforming to Subsection 1015.10. 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. Glass spheres used in drop-on application to molten plastic shall be shipped in bags of multi-ply paper or burlap with a polyethylene liner, strong enough to permit handling without damage, and having a capacity of 50 pounds of spheres. Bags shall be sufficiently water-resistant so that spheres will not become wet or caked in transit.

(b) Preformed Plastic Markings: Preformed plastic markings shall conform to Subsection 1015.11.

732.03 CONSTRUCTION REQUIREMENTS.

(a) Equipment for Thermoplastic Markings: Materials shall be applied to pavement by either spray or extrusion methods. Equipment shall provide continuous mixing and agitation of material. Conveying parts of equipment between main material reservoir and discharge mechanism shall prevent accumulation and clogging. Parts of equipment which come in contact with the material shall be easily accessible for cleaning and maintaining. Mixing and conveying parts shall maintain material at the plastic temperature. Equipment shall be capable of

producing continuous uniformity in dimensions of stripes. Equipment shall produce varying widths of traffic markings. Glass spheres shall be applied to the surface of completed stripes by an automatic sphere dispenser attached to the striping machine in such manner that beads are dispensed almost simultaneously at a controlled rate of flow on installed lines. Glass sphere dispenser shall be equipped with an automatic cutoff control synchronized with cutoff of thermoplastic material. Kettles to hold a minimum of 1,000 pounds of material shall be provided for melting and heating thermoplastic material. Kettles must be equipped with automatic thermoplastic control devices so that heating can be done by controlled heat transfer liquid rather than direct flame, to provide positive temperature control and prevent overheating of material. Applicators and kettles must 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 applicating unit so that only one lane of traffic will be occupied during installation.

In the extrusion method, one side of shaping die shall be the pavement and other sides shall be formed by suitable equipment for heating and controlling flow of material. Extrusion applicators shall produce sharply defined lines and provide means for cleanly cutting off square stripe ends and applying broken lines. Use of pans, aprons or similar appliances will not be permitted.

(b) **Weather Limitations:** Application of markings will not be permitted when there is moisture on pavement surface nor when the surface temperature is below 50°F.

(c) **Cleaning of Surfaces:** Surfaces on which markings are to be applied shall be cleaned of all materials that would reduce adhesion of plastic marking compound to pavement. Cleaning shall be done by approved methods and surfaces shall be kept clean until placement of markings.

When plastic markings will replace painted markings, painted markings shall be removed to such extent that 75 percent of pavement surface is exposed. At the end of each day's operations, temporary markings conforming to Section 713 shall be placed in areas where existing painted markings have been removed and new stripes not placed. Temporary traffic markings shall be satisfactorily removed prior to resuming plastic striping operations.

(d) **Application of Markings:** Material shall be installed in specified widths from 4 to 24 inches. Finish lines shall have well defined edges and be free of waviness. Measurements shall be taken as an

average throughout any 36-inch section of line. Longitudinal lines shall be offset approximately 2 inches from construction joints of portland cement concrete pavement.

(1) **Thermoplastic Markings:** Thickness of material on pavement shall be not less than 90 mils for lane lines, edge lines and gore markings and not less than 125 mils for crosswalks, stop lines, and word and symbol marking. For thermoplastic applied on portland cement concrete pavement, the contractor shall apply a binder-sealer prior to thermoplastic installation. The binder-sealer shall be that product recommended by the thermoplastic material manufacturer. On other pavement surfaces, if recommended by the material manufacturer, a binder-sealer material shall be applied to the road surface prior to thermoplastic installation. Thermoplastic material shall be installed in a melted state at the temperature recommended by the manufacturer, but not less than 375°F nor more than 450°F. Material shall not scorch or discolor if kept at this temperature for 4 hours.

(2) **Preformed Plastic Markings:** Plastic material shall be applied by removing release paper and applying adequate pressure for approximately 30 seconds to assure proper adhesion to the pavement. Material not adhering properly shall be satisfactorily corrected.

732.04 METHOD OF MEASUREMENT.

(a) Plastic Pavement Striping: Plastic striping will be measured by the linear foot or mile, as specified.

(1) **Linear Foot:** Measurement will be made by the linear foot of striping, exclusive of gaps.

(2) **Mile:** Measurement will be made by the mile of single stripe per roadway. No deduction will be made for standard 30-foot 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.

732.05 BASIS OF PAYMENT. Plastic pavement markings will be paid for at the contract unit prices. Payment will be made under:

Item No.	Pay Item	Pay Unit
732(1)	Plastic Pavement Striping (__" Width)	Linear Foot
732(2)	Plastic Pavement Striping (Solid Line) (__" Width)	Mile
732(3)	Plastic Pavement Striping (Broken Line) (__" Width)	Mile
732(4)	Plastic Pavement Legends and Symbols	Each

Section 733

Median Roadway Barriers

733.01 DESCRIPTION. This work consists of furnishing and constructing concrete median barriers for roadways at locations shown on the plans and in conformity with plan details and these specifications. Barriers may be precast or cast in-place concrete, at the contractor's option.

733.02 MATERIALS. Materials shall conform to the following Sections and Subsections:

Portland Cement Concrete	902
Joint Materials	1005
Reinforcing Steel	1009
Curing Materials	1011.01
Special Surface Finish Materials	1011.03

Cast-in-place concrete shall be Class A. 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 2 or 2A finish.

The contractor shall perform necessary excavation and backfilling for barriers and shall satisfactorily dispose of excess excavated material.

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, 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 to 1 1/2 inch, unless otherwise approved. Air-entraining admixture in accordance with Subsection 901.08(b) will be required in slip-formed concrete.

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 dummy joints shall be formed at intervals not exceeding 20 feet. Vertical joints in barriers shall match joints in existing underlying concrete pavement, unless otherwise directed, with intermediate joints placed as required not to exceed 20 foot maximum spacing. Dummy joints shall be formed to a minimum depth of 1 1/2 inches by means of an approved jointing tool or sawing the plastic concrete.

733.04 METHOD OF 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 BASIS OF PAYMENT. Concrete barriers for roadways will be paid for at the contract unit price per linear foot under:

Item No.	Pay Item	Pay Unit
733(1)	Median Roadway Barrier (Type)	Linear Foot

Section 734

Breaking and Seating Pavement

734.01 DESCRIPTION. This work consists of rolling, breaking and seating existing pavements at locations indicated on the plans or as directed, in accordance with these specifications.

734.02 EQUIPMENT. Equipment necessary for satisfactorily breaking and seating pavements shall be furnished and maintained by the contractor and shall include the following:

(a) Roller: The roller shall be a 50-ton pneumatic-tire roller consisting of 4 rubber-tired wheels equally spaced across the full width and mounted in line on a rigid steel frame in such manner that all wheels carry equal loads, regardless of surface irregularities. Roller tires shall be capable of satisfactory operation at a minimum inflation pressure of 100 psi, and tires shall be inflated to the pressure necessary to obtain proper surface contact pressure to satisfactorily seat pavement slabs. At the contractor's option, tires may contain liquid. The roller shall have a weight body suitable for ballasting to a gross load of 50 tons, and ballast shall be such that gross roller weight can be readily determined and so controlled as to maintain a gross roller weight of 50 tons. The roller shall be towed with a rubber-tired prime mover capable of maintaining speeds of 2 mph and capable of turning 180 degrees within a 30-foot width.

(b) Impact Hammer: The impact hammer shall have a minimum striking area of 1 square foot and shall be capable of developing sufficient energy to satisfactorily break pavement slabs without excessive shattering or punching.

734.03 CONSTRUCTION REQUIREMENTS. Sequence of operations shall be as directed and shall generally be as follows: Locate moving pavement slabs with 1 coverage of roller; break moving slabs with impact hammer; apply seating coverage with the roller and locate additional or continuing rocking slabs with this coverage; accomplish additional breaking required with impact hammer; and seat pavement with the roller. Not less than 2 nor more than 3 coverages of the roller shall be used.

Slab breaking and seating shall be accomplished prior to placement of

any required widening course. Breaking and seating of pavements shall not be accomplished until trenches are cut on both sides of slab to a depth equal to pavement. Trenches shall be backfilled immediately after breaking and seating operations.

Unless otherwise directed, after completion of breaking and seating operations, the contractor shall place asphaltic tack coat conforming to Section 504 and a minimum of 1 inch thick asphaltic concrete leveling course. Leveling course shall consist of either binder or wearing course, at the contractor's option. Pavement areas that have been broken and seated shall not be left unsurfaced longer than 24 hours.

During operation of the roller, care must be taken to insure that no bridges or cross drains are displaced, overloaded or otherwise disturbed due to the loaded roller. The loaded roller shall not be operated outside of construction limits.

There shall be no application of the roller after placement of the leveling course.

734.04 METHOD OF MEASUREMENT.

(a) **Rolling and Seating:** Rolling and seating pavement will be measured by the square yard of area rolled and accepted, regardless of whether the area has received 2 or 3 coverages. The width for measurement will be as shown on the plans, and the length will be the centerline length measured along the surface.

(b) **Breaking:** Breaking of pavement will be measured by the hour, which includes the time required for moving the crew from location to location within the project during these operations. If more than one crew is employed in breaking pavement, the time of each crew will be measured. Idle time or time used in moving tools and equipment on or off the job will not be measured.

(c) **Asphaltic Concrete:** Asphaltic concrete leveling course will be measured and paid for under appropriate pay items. Asphaltic tack coat will not be measured for payment.

734.05 BASIS OF PAYMENT. Rolling and seating of pavement will be paid for at the contract unit price per square yard, and breaking of pavement will be paid for at the contract unit price per hour. Payment will be made under:

Item No.	Pay Item	Pay Unit
734(1)	Rolling and Seating Pavement	Square Yard
734(2)	Breaking Pavement	Hour

Section 735

Undersealing Pavement

735.01 DESCRIPTION. This work consists of undersealing pavements by drilling holes and pumping soil cement or flyash cement slurry under pavement slabs to fill cavities, seal the underside of slabs and, when required, correct vertical alignment of pavements, all in accordance with the plans and these specifications.

735.02 MATERIALS.

(a) Portland Cement: Cement shall be the following types conforming to Section 1001:

(1) Soil Cement Slurry — Type III

(2) Flyash Cement Slurry — Type I or I(B)

(b) Water: Water shall conform to Subsection 1018.01.

(c) Calcium Chloride: Calcium chloride shall be Type 2 conforming to Subsection 1018.02.

(d) Soil: Soil shall be Class A-4 conforming to DOTD Designation: TR 423, free of large clay lumps, rocks, sticks, roots, trash or other debris, grass roots and small clay lumps; and containing not more than 5 percent organic material.

(e) Flyash: Flyash shall be from an approved source and shall conform to the fineness and chemical requirements of ASTM Designation: C 618, Class C with the following modifications:

	Requirement
Calcium Oxide (CaO), % min.	18.0
Carbon (C), % max.	10.0
Magnesium Oxide (MgO), % max.	6.0

(f) Admixtures: Fluidifier and water-reducing agent shall be powdered ammonium lignin sulphonate.

735.03 EQUIPMENT. Equipment necessary to satisfactorily underseal pavements shall be furnished and maintained by the contractor, and shall include the following:

(a) Air Compressors and Drills: Air compressors shall be equipped with air-lift pneumatic drills capable of drilling 2 holes simultaneously through pavement.

(b) Measuring Equipment: Accurate measuring equipment for proportioning slurry components.

(c) Mixer: Mixer shall be capable of thoroughly mixing slurry ingredients and accurately adding required amounts of water.

(d) Pump: The pump shall be a positive action type capable of forcing cement slurry through drilled holes in pavements and into cavities below pavements. Pump shall be capable of supplying pressures varying from 1 to 50 psi at the end of discharge pipe. Discharge line of the pump shall be equipped with a positive cutoff valve and a pressure gage.

(e) Roller: Roller shall be a pneumatic-tire roller with a minimum weight of 9 tons and not exceeding 35 tons gross weight.

(f) Plugs: Wood plugs shall be provided for temporarily plugging slurry holes.

735.04 PROPORTIONING.

(a) General: Water shall be added in amounts that will produce a slurry of such consistency that the time of efflux from the flow cone is between 12 and 18 seconds when tested in accordance with DOTD Designation: TR 633.

(b) Soil Cement Slurry: The slurry shall consist of 1 part portland cement and 3 parts soil, by volume. Calcium chloride shall be added at a maximum rate of 2 percent by weight of cement; however, the use of calcium chloride shall be discontinued if, in the engineer's opinion, the slurry is setting too rapidly for satisfactory placement..

(c) Flyash Cement Slurry: The slurry shall consist of 1 part portland cement and 3 parts flyash, by volume. When directed or approved, a fluidifier and water-reducing admixture shall be added at the rate of 0.5 to 1.5 percent by weight of cement.

735.05 CONSTRUCTION REQUIREMENTS. Holes of 1 1/2-inch diameter or other approved size 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 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, unless otherwise directed.

After holes are drilled, a pipe connected to the discharge hose on the

pressure pump shall be lowered into the hole. Discharge end of the pipe shall not extend below the bottom of concrete pavement.

Pumping of slurry into a hole shall continue until the slab begins to rise, and if a grade raise in the slab is desirable, pumping shall continue until the desired grade raise in the slab has been attained. In most cases, pumping will be required in several holes across the full width of slab to accomplish a raise in grade. Raising of the slab or flowing of slurry out of an adjacent hole during pumping is sufficient evidence that all cavities are filled within range of the hole being pumped.

If stooling of slurry occurs, additional holes shall be provided in the slab as directed and a more fluid slurry shall be pumped through these new holes to fill voids between stools.

If back pressure forces slurry out of the hole onto the slab after withdrawal of discharge pipe, the hole shall be temporarily plugged with a wood plug until the slurry has set. After completion of pumping in a hole, the discharge pipe or wood plug shall be removed and the hole filled with slurry.

Pumping in an area shall be continued until, in the opinion of the engineer, all cavities beneath the pavement in that area have been filled. After at least 2 hours have elapsed after completion of pumping an area, the contractor shall proof roll the area with 1 to 3 passes of the pneumatic tire roller. If slab movement is detected during rolling, the area shall be repumped. Pumping and proof rolling shall be continued until no slab movement is detected during proof rolling.

Unless otherwise permitted, undersealed pavement areas shall be closed to all traffic for at least 1 hour after completion of pumping.

Construction methods outlined herein may be modified by the engineer as field conditions indicate.

735.06 METHOD OF MEASUREMENT. Undersealing pavement will be measured per hundred pounds (CWT) of portland cement used in the undersealing slurry. Holes for undersealing will be measured per each. Soil, flyash, admixtures, calcium chloride and water will not be measured for payment.

735.07 BASIS OF PAYMENT. Undersealing pavement and holes for undersealing will be paid for at the contract unit prices. Payment will be made under:

Item No.	Pay Item	Pay Unit
735(1)	Undersealing Pavement (Type)	CWT
735(2)	Holes for Underseal	Each

Section 736

Cold Planing Asphaltic Pavement

736.01 DESCRIPTION. This work consists of removing asphaltic concrete surfacing by cold planing methods to the specified depth, width and cross section.

736.02 EQUIPMENT. Equipment for planing asphaltic surfacing shall be self-propelled planing machines or grinders capable of removing a thickness of asphaltic concrete necessary to provide profile and cross slope uniformly across the surface. Equipment shall have sufficient power, traction and stability to maintain accurate depth of cut and slope. Equipment shall be capable of accurately and automatically establishing a profile grade along each edge of the machine by referencing from existing pavement by means of a ski or matching shoe or from an independent grade control and shall have an automatic system for controlling cross slope at a given rate. Adequate loading equipment shall be provided to immediately remove materials being cut from the surface and discharge cuttings into a truck. Adequate personnel shall be provided to insure that all cuttings are removed from the surface daily. The machine shall be equipped with means to adequately control dust created by the cutting action and shall have a manual system providing for uniformly varying the depth of cut while the machine is in motion.

736.03 CONSTRUCTION REQUIREMENTS.

(a) General: If 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 1 1/4 inches in height, this longitudinal face shall be sloped as directed. Transverse faces present at the end of a work period shall be beveled as directed. Satisfactory provisions shall be made at drives and turnouts to maintain local traffic.

Asphaltic concrete next to structures that cannot be removed by the planing machine shall be removed by other acceptable methods.

Pavement surfaces resulting from planing operations shall be uniform and free from loose material. It will be the contractor's responsibility to provide for surface drainage of planed areas.

On roadways that are open to traffic, pavement striping removed by planing shall be replaced with temporary pavement markings at the end of each day's planing operations. Payment for these temporary pavement markings will be included under Item 713(2).

All surfacing material removed by planing shall become the property of the contractor and shall be disposed of by him outside the right-of-way.

All required joint repairs shall be made after planing.

(b) One-Lift Construction: If the planed surface is to be the final wearing surface or is to be covered with only one lift of asphaltic concrete (excluding friction course), pavement patching shall be completed before planing; however, if additional areas requiring patching are exposed by planing operations, such additional patching shall be performed after planing.

(c) Multi-Lift Construction: If the planed surface is to be covered with at least 2 lifts of asphaltic concrete (excluding friction course), any required patching may be performed either before or after planing; however, if the pavement is patched before planing and additional areas requiring patching are exposed by planing operations, such additional patching shall be performed prior to placing asphaltic concrete.

736.04 METHOD OF MEASUREMENT. Measurement will be made by the square yard of asphaltic concrete surfacing satisfactorily removed.

736.05 BASIS OF PAYMENT. Cold planing asphaltic pavement will be paid for at the contract unit price, which includes removal of asphaltic concrete surfacing and disposal of removed materials. Payment will be made under:

Item No.	Pay Item	Pay Unit
736(1)	Cold Planing Asphaltic Pavement	Square Yard

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. All structures shall be constructed in conformity with the lines, grades, dimensions and designs shown on the plans and in accordance with the project specifications.

Work within wetlands, navigable waters or adjacent areas shall conform to Subsection 107.09.

801.02 BORINGS. Soil borings and other soil investigations and soil analyses will be made by the Department for development of subsurface information for bridge foundations. This data will be included in the plans for informational purposes. Soil samples may not be available for inspection and bidders should make such additional investigations as they consider necessary to determine soil conditions. No additional compensation will be allowed the contractor if soil material is of a different character from that shown on the plans.

801.03 SHOP AND WORKING DRAWINGS. The contractor shall submit shop drawings, working drawings and other submittals for approval. No work shall be started until final approval of shop and working drawings has been obtained. No additional 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 his responsibility under the contract.

(a) General: Two prints of required shop or working drawings shall be submitted to the Bridge Design Engineer for checking, 1 of which will be returned with either approval or required revisions noted thereon. For final approval and distribution, 9 prints of each checked drawing shall be submitted to the Bridge Design Engineer. For movable bridges, the original tracings or photographic reproductions of original shop and working drawings shall be delivered to the Bridge Design Engineer upon completion of fabrication or erection, as follows:

(1) Original Tracings: Original tracings shall be ink drawings on either Imperial tracing cloth or polyester translucent matte film.

Original matte film drawings may have a matte surface on either or both sides and shall be 0.003 to 0.004 inch thick.

(2) **Reproductions:** Photographic reproductions shall be on cloth or 0.004-inch translucent polyester film which incorporates a silver halide emulsion image of a permanent type, from which satisfactory prints can be made. Additions or changes shall be made with a permanent type or waterproof black ink manufactured for this purpose.

For all other structures, 1 set of the final corrected shop and working drawings suitable for microfilming shall be delivered to the Bridge Design Engineer upon completion of fabrication or erection. Changes on drawings shall be noted and dated to show that a revision has been made. Tracings and subsequent reproductions shall be 22 x 36 inches overall with 1/2-inch margins at top, right and bottom edges and a margin of at least 1 1/2 inches at the left edge. No trim lines are necessary. Each sheet shall have a title block in the lower right hand corner with the State project number, project name, parish, fabricator's and contractor's name, fabricator's plant location, sheet number, date and revision block.

(b) **Shop and Working Drawings Checked by Consulting Engineers:** When specified, the contractor shall furnish the consulting engineers shop and working drawings for checking, approval and distribution.

Two prints of required shop or working drawings shall be submitted for checking to the consulting engineers. After all corrections required by the consulting engineers are made, 9 prints of each checked drawing shall be submitted to the consulting engineers for final approval. Final checked prints shall be stamped "Approved" and dated by the consulting engineers; 1 print of each shall be retained by the consulting engineers; and the remaining 8 prints of each drawing shall be sent to the Bridge Design Engineer for distribution.

Upon completion of fabrication or erection, 1 set of prints of the final corrected shop and working drawings shall be delivered to the consulting engineers for transmittal to the Department.

During the process of approval, a copy of each transmittal letter from contractor to the consulting engineers shall be sent to the Department's Bridge Design Engineer and the consulting engineers shall send a copy of each letter of reply.

All other requirements of this Subsection shall apply.

(c) **Falsework:** The term "falsework" shall mean 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. The contractor shall prepare and submit to the engineer for review, plans for all falsework. This requirement shall also apply to falsework required for changes in an existing structure for maintenance of traffic.

(d) Form Drawings: When requested, the contractor shall prepare and submit to the engineer for review, plans for his proposed forming system for all 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.

(e) Steel Fabrication and Erection: Detail drawings shall be furnished by the contractor for approval. The type, size and procedures for submittal and approval of these drawings shall be as described in Headings (a) and (b) of this Subsection.

(1) Shop Drawings: The contractor shall furnish shop drawings for all steel work for approval and 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, and 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 he proposes to use, which shall be subject to review. He shall prepare and submit for review 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. Drawings shall outline the erection procedure and equipment to be used.

(3) Shipping Statements and Shop Bills: The contractor shall

furnish the engineer 1 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 3 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.

(f) **Movable Bridge Equipment:** Detail drawings shall be furnished by the contractor for approval as follows:

(1) **Shop Drawings and Erection Drawings:** The contractor shall furnish a complete conduit and wire layout, elementary wiring diagram, detailed working drawings of the switchboard, control desk, junction boxes, machinery houses, operating house, counterweight, including calculations, and machinery and traffic barrier parts and assembly layouts of all items he is to furnish. 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 for 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 9 copies of certified dimension sheets and detailed manufacturer's description of each piece of equipment and apparatus to the Bridge Design Engineer, 1 of which will be returned approved or with required revisions noted thereon. If revisions are required, the contractor shall submit 9 corrected copies for final approval. The name of the project, State project number and parish shall be shown on each sheet of every submittal, with indication of any changes noted on the drawings.

The contractor will not be required to submit single conductor wire, but all multiple conductor cables shall be submitted for review.

The description for cables shall include construction layout sketch, size and number of conductors, type and thickness of sheath, type and

size of armor, type and thickness of jacket, diameter of core, diameter under jute bedding and overall diameter of cable. The above descriptions shall be shown on shipping tags of wires and cables delivered to the bridge site. If the information on shipping tags does not conform to the description approved by the Bridge Design Engineer or if there is reason to believe that the construction and materials of wires and cables do not conform to the approved descriptions, the engineer reserves the right to obtain samples of wires and cables delivered to the bridge site and have these samples tested.

The conduit and wire layout shall show size and approximate length of all conduits, and number, size, type and identification of all conductors in each conduit run. Identification of conductors shall be with the same symbols used in the elementary wiring diagram.

Drawings for control desk and switchboard shall be complete and shall include cabinet dimensions, layout of equipment, nomenclature of equipment, the rating, description, catalog number and name of manufacturer of equipment and complete wiring diagrams. Sizes of all conductors larger than No. 12 AWG shall be shown on all drawings, and each conductor and piece of equipment shall be identified with the same symbol wherever shown.

Drawings for counterweights shall show all dimensions, method of construction and all calculations.

A detailed list of all electrical equipment and devices, 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 Headings (a) and (b) 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 he notifies the Bridge Design Engineer in writing that the work is to be performed as shown on design drawings, but the contractor shall be responsible for any errors which may be on the plans, and will not be relieved of any responsibility placed upon him by his contract. Shop drawings will be required for all fabricated items.

(2) Maintenance and Operation Instruction Booklets: The contractor shall furnish to the Chief Maintenance and Operations Engineer 6 bound copies of a booklet, 8 1/2 x 11 inches in size,

containing descriptive leaflets and drawings covering all items of the electrical equipment, with 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 all 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 to the Chief Maintenance and Operations Engineer 6 bound copies of a similar booklet for mechanical and traffic barrier equipment which shall include lubricating charts showing locations of all 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.

All booklets 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 all non-standard 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.

(g) Precast-Prestressed Concrete Girder Spans: The contractor shall furnish complete fabrication drawings and erection diagrams, and no girders shall be cast prior to final approval of these plans. When

precast stay-in-place concrete deck panels are used, the following requirements will also apply to fabrication drawings. Precast panels shall conform to Subsection 805.14(k).

Fabrication drawings shall include complete details and dimensions of girders, details of proposed casting bed layout and stressing data and, in pretensioned members, method of holding draped strands in place and method and schedule of release of hold-downs and cable strands.

If girders are detailed so completely that design drawings may serve as working drawings, the contractor will not be required to submit drawings for that part of the work, provided he notifies the Bridge Design Engineer in writing that the work is to be done as shown on design drawings; however, the contractor shall submit corrections to plan dimensions due to elastic shortening, shrinkage, girder slope and other causes. The use of such design drawings will not relieve the contractor of any responsibility placed on him by his contract.

Erection diagrams shall show the location of each girder in each span and shall be coordinated with identifying marks on the girders. Identifying girder marks showing the location and span for which the girder is cast and 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 Headings (a) and (b) of this Subsection.

(h) Illumination Systems: Detail drawings, brochures and descriptive data shall be furnished by the contractor for approval as follows:

(1) Shop and Working Drawings: The contractor shall furnish a lighting standard and conduit layout, detailed working drawings of all standards and brackets, mounting details of service equipment and a complete equipment listing. The lighting standard or high mast tower details shall include details of all connections, bases, welds, anchor bolts, handhole reinforcement and erection procedure. The lighting standard and conduit layout shall show location of each standard or luminaire by station, circuit number and number of the service pole. Locations of service poles, trenches and conduit runs and sizes and number of cables in each trench or conduit run shall be indicated. Types and sizes of wires and cables shall be clearly identified.

At the option of the contractor, design drawings may serve as working drawings, provided he notifies the Bridge Design Engineer in writing that the work is to be performed as shown on the design drawings, but the contractor will be held responsible for any errors that may be on the plans, and he will not be relieved of any responsibility placed upon him by his contract. However, shop drawings will

be required for all standards, brackets, high mast towers and other fabricated items.

The type, size and procedures for submittal and approval of these drawings shall be as described in Headings (a) and (b) of this Subsection.

(2) Equipment and Apparatus: The contractor shall submit 9 copies each of required brochures and descriptive data to the Bridge Design Engineer for approval. This information shall include type of cables and wire and other equipment and apparatus he proposes to furnish in order to establish that such material is equivalent to that specified. All submittals shall be originals or copies equal to originals. Each copy of every submittal shall be identified with State project number, project name, parish, contractor and date.

The contractor will not be required to submit single conductor wire for approval. Multiple conductor cables and cable duct systems shall be submitted. The description shall include manufacturer's name, marking on insulation, size and stranding of conductor, thickness and type of insulation, thickness and type of sheath and overall diameter of cable.

One copy of each original submittal will be returned with approval, rejection or required revisions marked thereon. If submittal is marked approved, no additional copies will be necessary. If submittal was rejected, the contractor shall submit 9 copies of acceptable data for final checking and approval. If original submittal is marked for revisions, 9 copies of the revised submittal shall be returned to the Bridge Design Engineer for final checking and approval.

(i) Traffic Signs and Devices: Detail drawings for overhead and 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 Headings (a) and (b) of this Subsection.

Detailed drawings for fabrication and erection of aluminum and steel parts for overhead and 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.

All 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 Interstate Engineer for approval. Details shall be submitted on legal size sheets of acceptable quality for all 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.

(j) Buildings: Detail drawings, brochures and samples for architectural, mechanical and electrical 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 Headings (a) and (b) 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.

Section 802

Structural Excavation and Backfill

802.01 DESCRIPTION. This work consists of removal of all materials necessary for construction of retaining walls, foundations and substructures. It shall include furnishing all necessary equipment and the construction of all cribs, cofferdams, caissons, dewatering, etc. necessary for execution of the work. It shall also include subsequent removal of cofferdams and cribs and placement of all necessary backfill. It shall also include wasting of excess excavated material, in a manner and in locations so as not to affect the carrying capacity of the channel and not be unsightly, all as directed. All work shall be performed in accordance with these specifications and in conformity to the lines, grades and dimensions shown on the plans or established by the engineer.

802.02 GENERAL CONSTRUCTION REQUIREMENTS. Excavations for substructures shall be shored, braced or protected by cofferdams where necessary. When footings can be placed in the dry without cribs or cofferdams, backforms may be omitted with the approval of the engineer and the entire excavation filled with concrete to the required elevation of the top of footing. The additional concrete required shall be placed at the expense of the contractor.

802.03 PRESERVATION OF CHANNEL. Unless otherwise permitted, no excavation shall be made outside of caissons, cribs, cofferdams or sheeting, and the natural stream bed adjacent to the structure shall not be disturbed. If any excavation or dredging is made at the site of the structure before caissons, cribs or cofferdams are sunk or in place, the contractor shall, without extra charge, after the foundation base is in place, backfill all such excavation to the original ground surface or river bed with satisfactory material. Material deposited within the stream area from foundation or other excavation or from the filling of cofferdams shall be removed and the stream area freed from obstruction. The contractor's attention is also directed to Subsection 107.09.

802.04 DEPTH OF FOOTINGS. Elevations of the bottoms of footings as shown on the plans shall be considered as approximate and the engineer may order, in writing, such changes in dimensions or elevation of footings as may be 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 surface, either level, stepped or roughened, as directed. Seams shall be cleaned out 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 and final removal of foundation material to grade shall not be made until just before the concrete is placed.

802.06 COFFERDAMS AND CRIBS.

(a) **General:** Cofferdams and cribs for foundation construction shall be carried to adequate depths and heights, safely designed and constructed and made as watertight as necessary for proper performance of the work which must be done inside them. In general, 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 are tilted or moved laterally during sinking shall be righted, reset or enlarged to provide the necessary clearance at the expense of the contractor.

When conditions are encountered which render it 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 then be pumped out 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 entire weight of the crib into the foundation seal. During placing of a foundation seal, elevation of the water inside the cofferdam shall be controlled to prevent flow through the seal and if the cofferdam is to remain in place, it shall be vented or ported at low water level.

(b) **Protection of Concrete:** Cofferdams or cribs shall be constructed so as to protect foundations from damage caused by a sudden rising of the stream eroding green concrete. Timber from cofferdams or cribs shall not be left embedded in substructure concrete.

(c) **Required Drawings:** Drawings for substructure work shall be furnished in accordance with Subsection 801.03.

(d) **Removal:** Cofferdams or cribs with all sheeting and bracing shall be removed after completion of the substructure, care being taken not to damage concrete. No sheet piling used as forms shall be removed prior to 7 days after placement of concrete.

802.07 PUMPING. 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 placing of concrete or for a period of 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.

802.08 INSPECTION. After each excavation is completed, the contractor shall notify the engineer, and no concrete shall be placed until the engineer has approved the depth of the excavation and the 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 refilled with earth 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 earth cover shall be provided over reinforced concrete box culverts before heavy construction equipment may cross the installation. The fill shall be approved by the engineer.

(c) Backfill for structures other than (a) and (b) above shall be placed in horizontal layers not exceeding 9 inches thick (loose) and uniformly compacted by approved methods to the satisfaction of the engineer. Jetting of backfill behind abutments and wing walls will not be permitted. The excavation shall be pumped as dry as possible before beginning backfilling.

(d) No backfill shall be placed against a concrete abutment, wing wall or reinforced concrete box culvert until concrete has been in place 14 days, or until test cylinders show a compressive strength of 3000 psi as determined under Subsection 805.10, Method 1.

802.10 METHOD OF MEASUREMENT. The quantity of structural excavation for payment shall be the number of cubic yards, measured in its original position, of material acceptably excavated in conformity with the plans or as directed. No yardage shall be included in the measurement outside of a volume bounded by vertical planes 18 inches 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 required for box culvert construction will not be measured for payment, except as specified in Subsection 203.11.

When the contract does not contain a pay item for "Conduit Backfill", backfill of box culverts will not be measured for payment.

When the contract contains a pay item for "Conduit Backfill", backfill for box culverts and attached headwalls will be measured in accordance with Subsection 701.10.

(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.

802.11 BASIS OF PAYMENT. Structural excavation will be paid for at the contract unit price per cubic yard, which includes constructing and removing cribs and cofferdams, required excavation and backfill, and disposing of excess excavated material; except when the contract contains a pay item for "Conduit Backfill", backfill for box culverts will be paid for in accordance with Subsection 701.11.

If the engineer orders foundations to be lower than the specified elevation, payment for the additional excavation required will be made in accordance with the following table:

Depth of Foundation Below Specified Elevation (Feet)	Percent of Contract Unit Price for the Excavation Item
0 to 2.0	100
2.1 to 4.0	125
4.1 to 6.0	150
6.1 to 8.0	175
8.1 to 10.0	200
Over 10.0	Extra Work

When an item for "Cofferdams" is included in the contract, cofferdams will be paid for at the contract lump sum price, which includes furnishing and installing all materials, dewatering, maintenance, removal and satisfactory clean-up of the areas.

Payment will be made under:

Item No.	Pay Item	Pay Unit
802(1)	Structural Excavation	Cubic Yard
802(2)	Structural Excavation for Intermediate Bents	Cubic Yard
802(3)	Structural Excavation for Piers (Dry)	Cubic Yard
802(4)	Structural Excavation for Piers (Wet)	Cubic Yard
802(5)	Cofferdams	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.

803.02 MATERIALS. Materials shall conform to the following Sections and Subsections.

Concrete	901
Coal Tar Epoxy-Polyamide Paint	1008.08
Reinforcing Steel	1009
Steel 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) Steel Sheet Piles: Steel sheet piles shall be fabricated in accordance with Section 807.

(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 3 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) Untreated Timber: Timber shall conform to Section 812, but may consist of any species which will satisfactorily withstand driving. It shall be sawn or hewn with square corners and shall be free from work holes, loose knots, wind shakes, decayed or unsound portions, and other defects which might impair its strength or tightness.

(3) Treated Timber: Treated timber shall be either Southern Pine or Douglas Fir conforming to 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. To facilitate closure, it may be advantageous to set up piles for a complete length of wall before initial driving; piles thus set up can be progressively driven in short increments of penetration.

803.04 JETTING SHEET PILES.

(a) Use of jets will not be permitted at locations where stability of embankments or other improvements would be endangered.

(b) The contractor may supply and operate one or more high pressure water jetting systems to erode material adjacent to the pile when needed and permitted to facilitate driving sheet piles to desired penetration. The pumping capacity provided shall deliver a minimum of 150 psig pressure at each jet nozzle.

(c) Jetting may be done either ahead of or simultaneously with driving operations. If jets and hammer are used simultaneously, jets shall be withdrawn and final penetration of sheet piles obtained by driving with the hammer alone for at least the last foot of penetration.

(d) Payment for jetting sheet piles will not be made.

803.05 CUTOFFS.

(a) Tops of sheet piling shall be cut off or driven down 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 the contractor's expense.

(c) Tops of timber sheet piles after cut-off shall be treated in accordance with Subsection 812.07, except that galvanized metal coverings shall be bent down at least 3 inches 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 the contractor's expense.

803.06 PAINTING. Before driving, surfaces of steel sheet piling to be backfilled or immersed shall be cleaned and painted from a point 10 feet below stream bed to cut-off level with a 2-coat coal tar epoxy-polyamide paint system in accordance with Section 811.

803.07 METHOD OF MEASUREMENT. Quantities of sheet pile wall for payment will be the design wall area as specified on the plans and adjustments thereto. Design quantities will be adjusted if the engineer

makes changes to adjust to field conditions, or if plan errors are proven, or if design changes are made.

803.08 BASIS OF PAYMENT. Sheet pile wall will be paid for at the contract unit prices. Payment will be made under:

Item No.	Pay Item	Pay Unit
803(1)	Untreated Timber Sheet Pile Wall	Square Foot
803(2)	Treated Timber Sheet Pile Wall	Square Foot
803(3)	Concrete Sheet Pile Wall	Square Foot
803(4)	Steel Sheet Pile Wall	Square Foot

Section 804

Bearing Piles

804.01 DESCRIPTION. This work consists of furnishing and driving piles of the kind and size designated, to the required penetration in accordance with these specifications and in conformity with the lines and spacings shown on the plans or established by the engineer.

Piling furnished under items for "Concrete Piles" and "Unloaded Concrete Test Piles" shall be either precast concrete piles or cast-in-place concrete piles, at the contractor's option; however, the same type pile shall be furnished under both these items for a project.

804.02 MATERIALS. Materials shall conform to the following Sections and Subsections.

Precast Concrete Piles	805.14
Concrete	901
Coal Tar Epoxy-Polyamide Paint	1008.08
Reinforcing Steel	1009
Steel Bearing Piles	1013.09
Steel Pipe Piles	1013.11
Timber	1014

804.03 ORDER LISTS FOR PILING. The contractor shall furnish piles in accordance with an itemized list furnished by the engineer showing the number, size, length and location of all permanent piles. No permanent piles shall be driven prior to receipt of this order list. When test piles are driven to determine the lengths of piling, the order list will not be furnished the contractor until loading is completed and order lengths approved. The engineer may require that permanent piles be driven to a tip elevation below that of the test pile even though the test pile satisfactorily held the test load. In determining lengths of piles for ordering, the lengths given in the order list will be based on the lengths which are assumed to remain in the completed structure. The contractor shall, at his own expense, increase the lengths given to provide such additional length as necessary to suit the contractor's method of operation. The order length may be revised by the engineer when driving conditions deviate from test pile results.

804.04 PREPARATION FOR DRIVING. If, in the opinion of the engineer, pile driving operations may cause damage to recently placed concrete, the contractor will be required to alter his operations to prevent such damage.

(a) Excavation: Piles shall not be driven until after excavation is complete. Any material forced up between piles shall be removed to correct elevation without cost to the Department before foundation concrete is placed.

(b) Embankment: Embankment at bridge ends shall be constructed to the bottom of the abutment bent cap and compacted as provided in Section 203 prior to driving the piles affected.

(c) Driving Caps: When the nature of driving requires protection for heads of concrete and timber piles, pile driving heads shall be cushioned by an approved cap. The approved cap shall have a rope or other suitable cushion next to the pile head and fitting into a casting which supports a timber shock block. When the area of the head of a timber pile is greater than that of the face of the hammer, a suitable cap shall be provided to distribute the blow of the hammer throughout the cross section of the pile.

Special driving heads, mandrels or other devices shall be provided as recommended by the manufacturer for special types of piling so the pile may be driven without damage.

Heads for steel piling shall be cut squarely. A driving cap shall be provided during driving to hold the axis of the pile in line with the axis of the hammer.

(d) Collars: Collars, bands or other approved devices to protect timber piles against splitting or brooming shall be provided where necessary or as required by the engineer.

(e) Splicing Piles:

(1) Precast concrete piles shall be furnished and driven in full lengths, unless otherwise specified. When splicing of piling is specified, there will be no direct payment for splicing.

(2) Cast-in-place concrete pile shells may be field spliced, but sections which, 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 conform to Section 815, except that the prequalification test for field welders will not be required unless directed.

(3) Steel bearing piles shall be furnished and driven in full lengths unless splices are authorized. When authorized, splices shall be lim-

ited to not more than 2 per pile. Splicing of steel bearing piles shall be made by welding in accordance with Section 815.

(4) Timber piles shall be furnished and driven full length where possible. Splicing of timber piles may be made only by written permission and in accordance with the splicing detail approved by the engineer.

(f) Painting of Piling: Foundation piling need not be painted. When specified, that area of steel piles, or the exterior surface of the steel shell of cast-in-place concrete piles, above the ground line or stream bed shall be cleaned and painted with a 2-coat coal tar epoxy-polyamide paint system in accordance with Section 811.

(g) Transporting Precast Concrete Piling: Precast prestressed concrete piles shall be transported with supports at each of the pick-up points shown on the plans. Supports shall not be more than 1 foot from the theoretical position of each support, nor shall the distance between the 2 supports be more than 1 foot from the theoretical required distance between supports, unless otherwise approved.

(h) 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 for piles up to 50 feet long, or more than 20 percent of the designated penetration of the piles for piles over 50 feet 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 material acceptable to the engineer.

804.05 METHODS OF DRIVING.

(a) Description: Piles shall be driven with an approved hammer that will obtain required penetration without damaging piles, except that gravity hammers will be permitted only when driving timber piles. The minimum energy developed by the hammer shall be as specified herein for the various type piles. The adequacy of diesel hammers in meeting the 1 foot-pound of energy for each pound of pile criteria will be determined by rating the diesel hammer at 85 percent of the maximum rating specified by the manufacturer.

(b) Hammers for Timber Piles: Gravity hammers for driving timber piles shall weigh not less than 2,000 pounds, preferably 3,000 pounds, but in no case shall the weight of the hammer be less than the combined weight of the driving head and pile. The fall shall be so regulated as to avoid damaging piles and in no case shall it exceed 10 feet. When timber piles are driven with steam, air or diesel hammers, either single or double acting, the total energy developed by the ham-

mer shall not be less than 7,200 nor more than 20,000 foot-pounds per blow.

(c) Hammers for Concrete Piles: Precast concrete piles or shells for cast-in-place concrete piles shall be driven with an approved hammer which shall develop an energy at each full stroke of the piston of not less than 1 foot-pound for each pound of weight driven, except when the weight of the pile exceeds 48,000 pounds, the minimum size hammer shall be one developing 48,000 foot-pounds of energy. In no case shall the total energy developed by the hammer be less than 15,000 foot-pounds per blow. When there is little resistance to driving, a hammer of less energy than specified above may be required to prevent damage to piling.

(d) Hammers for Steel Piles: Steel piles shall be driven with an approved hammer developing an energy of not less than 1 foot-pound for each pound of weight driven. The minimum energy shall be developed at each full stroke of the piston. Total energy developed by the hammer shall be no less than 15,000 foot-pounds per blow.

(e) Additional Equipment: If required penetration of the pile is not obtained by the use of a hammer complying with the above requirements, the contractor shall, with approval, use pilot holes or water jets or both with the hammer.

(f) Leads and Templates: Equipment shall be constructed in such manner as to afford freedom of movement of the hammer and to drive piles to the tolerances specified without damaging piles. Either fixed leads or swinging leads may be used. Swinging leads shall be used in combination with a rigid template providing pile support meeting the approval of the engineer. Inclined leads shall be used in driving batter piles.

(g) Followers and Underwater Hammers: The use of followers or underwater hammers for driving piling will only be permitted by written approval. When a follower or underwater hammer is used, 1 pile in each group of 10 shall be furnished sufficiently long to permit being driven without a follower or underwater hammer and shall be used to determine the average bearing capacity of the group. The safe bearing capacity of piles will be determined by blow count in accordance with Subsection 804.08(c). Any required loading of piles will be paid for under Item 804(15), Loading Permanent Piles. No direct payment will be made for cut-off of these piles.

(h) Pilot Holes: Pilot holes will be required when piles are driven in compacted embankments and when bridge borings indicate impenetrable material above minimum tip elevation. Maximum diameter of pilot holes will be the dimension of the pile diagonal. Depth of pilot holes

in embankment shall be equivalent to the embankment height. Depth of pilot holes in impenetrable soils will be that dimension necessary to obtain required penetration with the pilot holes a minimum of 2 feet above pile tip elevation, unless otherwise directed. Pilot holes will not be permitted for tapered piles. The annular space around piles shall be filled with granular material acceptable to the engineer at the contractor's expense.

(i) **Water Jets:** When water jets are required or allowed, 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. The pump shall have sufficient capacity to deliver at least 150 psig pressure at 2 jet nozzles of 3/4 inch diameter located at opposite sides of 24-inch or larger piles. One jet nozzle may be used with piles smaller than 24 inches. Before desired penetration is reached, jets shall be withdrawn and the piles shall be driven with the hammer to final penetration. Jetting will not be permitted within 5 feet of pile tip elevation unless authorized. The use of jets where stability of embankments or other improvements would be endangered will not be permitted.

(j) **Accuracy of Driving:** 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 measured perpendicular to the bent, nor more than 6 inches measured along the centerline of the bent, and piles shall be driven with a variation of not more than 1/4 inch per foot from vertical or from the batter shown on the plans. For foundation piling, the centroid of a pile at cut-off shall be within a 12-inch diameter circle having the plan location as its center.

(k) **Interrupted Driving:** When driving is interrupted before the pile reaches final penetration, the record for resistance shall not be taken until after at least 12 inches of penetration has been obtained after driving is resumed.

(l) **Extent of Driving:** Driving shall be continued until plan cut-off is reached or until satisfactory penetration and resistance are obtained. If desired resistance to driving is not obtained at plan cut-off, the engineer has the option of either loading a permanent pile to determine the capacity or driving may be continued until satisfactory resistance is obtained. The additional length of pile required shall be supplied by splicing. Precast concrete piles shall be extended in accordance with Subsection 804.11.

(m) **Loading Permanent Piles:** A permanent pile which does not attain the desired resistance to driving shall be loaded when directed. The loading procedure shall be in accordance with Subsection 804.10(b).

804.06 CAST-IN-PLACE CONCRETE PILES. Cast-in-place concrete piles shall be steel encased. Steel shells shall be of the specified diameter and type. After shells are driven to required penetration 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 required penetration. The shell shall be cleaned of debris and pumped dry before placing concrete.

Class A concrete shall be placed in the shell in accordance with Section 805. Piles shall be filled with concrete to the cut-off elevation. Reinforcing steel conforming to Section 806 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. 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 of the shell shall be vibrated. Driving of additional piles within a radius of 10 feet of the completed pile will not be permitted until concrete has been allowed to set for at least 36 hours.

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 and the driving mandrel withdrawn. It shall be the contractor's responsibility to determine the wall thickness of shell required.

804.07 DEFECTIVE PILES. The procedure used in driving piles shall not subject them to excessive abuse producing cracking, crushing or spalling of concrete, splitting, splintering and brooming of timber or deformation of steel. Manipulation of 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 the contractor's expense by one of the following methods approved by the engineer:

1. The pile shall be withdrawn and replaced by a new and, if necessary, a longer pile.

2. A second pile shall be driven adjacent to the defective pile.

3. The pile shall be spliced or built up as otherwise provided herein or a sufficient portion of the footing extended to embed the pile. Timber piles shall not be spliced without permission. Piles pushed up by driving adjacent piles or other cause shall be redriven to desired elevation.

4. The cap or footing shall be redesigned at no cost to the Department and shall be approved by the engineer. Additional compensation will

not be allowed the contractor for increased quantities in a bent or footing due to driving additional piles to correct defective piles.

804.08 DETERMINING PILE BEARING CAPACITY.

(a) **General:** A pile's bearing capacity will normally be determined by comparing penetration, theoretical bearing values, loading conditions and soil borings with similar conditions known from a representative test pile previously driven. Where results are obtained through variation in soil conditions and other factors which make the pile bearing capacity questionable or do not offer a ready comparison to available information, test loading will be required. The test shall consist of applying a static test load placed on a suitable platform supported by the pile. The platform must be equipped to accurately measure the test load and settlement of the pile under each increment of load. In lieu thereof, hydraulic jacks with suitable yokes and pressure gages may be used.

The test load shall be applied in the various increments as specified. If hydraulic jacks are used to apply the load, the entire hydraulic system will be calibrated by the Laboratory provided the transporting and assembly of jacks to and from the Laboratory is furnished by the contractor and that the Laboratory has the necessary equipment to conduct the tests; otherwise, the contractor shall have the jacks calibrated by a reputable commercial laboratory, in which case, certified laboratory reports of calibration tests shall be furnished to the Department Laboratory. After the system is calibrated, no replacement parts will be permitted (except the pump) without recalibration of the system. 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. This gage shall be calibrated to give a direct reading in tons of the total load placed on the test pile.

(b) When required, the contractor shall make load tests to determine the bearing capacity of piling. Anrhor piles shall be at least 5 feet from the test pile.

The contractor shall submit to the engineer for approval his proposed method to test load the required piles.

(c) **Pile Formulas:** If the safe bearing capacity of permanent piles is to be determined by formulas, the following shall be used as a guide and shall be correlated with test pile driving and loading data.

$$P = \frac{2WH}{S + 1.0}$$ for gravity hammer,

$$P = \frac{2WH}{S + 0.1}$$ for single-acting steam or air hammers,

Where

P = safe bearing power in pounds,
W = weight in pounds of striking parts of hammer,
H = height of fall in feet,
S = the average penetration in inches per blow for the foot involved

The above formulas are applicable only when:

(1) The hammer has a free fall.
(2) The head of the pile is not broomed or crushed.
(3) The penetration is reasonably quick and uniform.
(4) There is no appreciable bounce after the blow.
(5) A follower is not used.

Twice the height of the bounce shall be deducted from "H" to determine its value in the formula. The safe bearing capacity of permanent piles is 1/2 of that value at which the test pile was loaded before failure, or 1/2 of the bearing obtained under the hammer by the foregoing formula for test piles which were not required to be loaded.

Diesel hammers will be permitted. The hammer must be equipped with an attached measuring rod calibrated in 0.5 foot increments to determine the height of fall of the ram. The safe bearing capacity will be calculated by the formula above for single-acting steam or air hammers.

804.09 TEST PILES.

(a) When required, the contractor shall drive test piles of the length, number, size and type specified at the location and penetration shown on the plans or as directed.

If water jets are used in connection with driving, the bearing capacity will be determined by the applicable formulas from the results obtained by driving after jets have been withdrawn or by static load testing in accordance with Subsection 804.10.

Test piles shall be driven using the same type of hammer, the same energy, methods and procedures as intended for permanent piles.

(b) When test piles are driven to determine the length of foundation piles required, it will be necessary to excavate to the elevation of the bottom of footing and to keep this excavation open during driving and loading of test piles so that driving and loading conditions will be representative of actual conditions of load on permanent piles. In lieu of the above, the contractor will be permitted to drive the test pile within an approved casing. The casing shall extend to the bottom of footing or the elevation shown on the plans. The contractor shall, at his own expense, provide any bracing of the test pile required during loading or driving operations.

(c) Cast-in-place concrete test piles shall be filled with concrete in accordance with Subsection 804.06 and the concrete allowed to set for at least 48 hours before the first increment of test load is applied.

(d) The plans or project specifications will designate whether or not permanent piles are to serve as test piles. Should a permanent pile so designated fail under the test load, and should redriving be required, the following requirements shall apply:

1. Precast concrete piles shall not be spliced and redriven unless permitted. If directed, the contractor shall remove the failing pile and drive a new test pile to the designated depth at the approved location.

2. Steel bearing piles shall have an additional length spliced, if necessary, and the pile redriven to such further depth as directed.

3. Timber piles shall not be spliced and redriven. If directed, the contractor shall remove the failing pile and drive a new test pile to the designated depth at the approved location.

4. Cast-in-place concrete piles shall not be redriven. If ordered, the contractor shall drive a new test pile to the designated depth and at the approved location.

(e) If test piles are not to be utilized as permanent piles, they shall be removed to a minimum of 1 foot below natural ground or stream bed and disposed of as directed.

(f) If permanent piles are used for anchor piles, permanent piles will be no lower than the tip elevation of the test pile and, after completion of test pile installation, permanent piles shall be reseated.

804.10 LOADING PILES.

(a) **Loading Test Piles:** A test pile will be loaded when the bearing capacity of the pile is less than 2 times the design load as determined by the formulas specified in Subsection 804.08 or when directed. Test piles shall be allowed to remain undisturbed for at least 14 days after driving to required penetration before beginning loading operations. Test piles shall be loaded to failure or until 2 1/2 times the design load is reached. The test pile will be considered to have failed when the permanent settlement, measured at the top of the pile, is greater than 1/4 inch.

The first increment of load to be placed on the test pile shall be the pile design load. The load on the pile shall be increased to 2 times the design load by adding load in 4 equal increments. A period of 2 hours shall intervene between each increment of load, except that if the pile is still settling at the end of the 2-hour period, the interval may be extended at the discretion of the engineer.

Upon attaining 2 times the design load on the pile or finding a gross settlement 1/4 inch greater than the elastic deformation, loading shall

be halted and the pile allowed to stand under this load for a period of 2 hours or until settlement stops or failure is reached. The load shall then be removed and the pile allowed to stand for at least 2 hours without any load. Readings will be taken to determine the amount of rebound and net settlement.

After completion of the above loading test, 2 times the design load shall be replaced on the pile as the first increment and loading continued in 2 increments as described above until 2 1/2 times the design load is reached. Loading then shall be halted and the pile allowed to stand under this load for a period of 2 hours or until settlement stops or failure is reached. The load shall then be removed and the pile allowed to stand for at least 2 hours without any load. Readings will be taken to determine the amount of rebound and net settlement.

The safe allowable load of any pile so tested shall be considered equal to 1/2 the maximum load reached before failure occurs.

(b) Loading Permanent Piles: When the driving resistance of a permanent pile is less than that of the test pile and will not correlate with the test pile data, the engineer may direct the contractor to either drive permanent piles to a greater depth or load a permanent pile at the driven tip elevation. When loading of permanent piles is directed, the loading shall be conducted in accordance with the following procedure. The pile shall be allowed to stand undisturbed for at least 14 days before beginning loading operations. Permanent piles shall be loaded to failure or until a load equal to 2 times the design load is reached. The pile will be considered to have failed when the permanent settlement, measured at the top of the pile, is greater than 1/4 inch.

The first increment of load to be placed on the pile shall be the pile design load. The load on the pile shall be increased to 2 times the design load by adding the additional load in 3 equal increments. A period of 1 hour shall elapse between each increment of load, except that if the pile is still settling at the end of the 1-hour period, the interval shall be extended. Upon attaining 2 times the design load on the pile or finding a gross settlement 1/4 inch greater than the elastic deformation, loading shall be halted and the pile allowed to stand under this load for a period of 1 hour.

The safe allowable load of any pile so tested shall be equal to 1/2 the maximum load reached before failure occurs.

804.11 EXTENSION OF PRECAST CONCRETE PILES.

(a) Extending by Casting in Place: 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 of the same quality as that used in the pile. 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.

(b) Extending by Splicing a Precast Section: When permitted or specified on the plans, a precast concrete pile may be extended by the addition of a precast section with splicing to be done by an approved method or as shown on the plans. The section added shall meet all requirements of these specifications.

804.12 CUT-OFFS.

(a) 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.

(b) Steel Bearing Piles: Steel bearing piles shall be cut off at right angles to the axis of the pile and to the elevation shown on the plans or as directed. The cuts shall be made in clean straight lines and any irregularity due to cutting or burning shall be corrected by deposits of weld material prior to placing bearing caps.

(c) Timber Piles:

(1) Tops of timber piling which support concrete footings or caps shall be sawed off at right angles to their axis at the required elevation.

(2) Piles which support timber caps shall be sawed to a horizontal plane, or to the slope specified, in such manner as to fit the superimposed structure.

(3) Shimming on tops of piles will not be permitted.

(4) Treatment of pile heads shall conform to Section 812.

(d) Cast-in-Place Concrete Piles: When pile shells are fully driven, inspected and approved, they shall be cut off at right angles to the axis of the pile at the required elevation.

804.13 METHOD OF MEASUREMENT.

(a) Pilings: Piling will be measured by the linear foot of pile below pile cut-off elevation. Redriving permanent piles used for anchor piles in accordance with Subsection 804.09 will not be measured for payment.

(b) Cut-offs: Cut-offs made as directed will be measured by the linear foot. Payment will not be made for cut-off of a pile unless the length of such cut-off is in excess of one linear foot, nor will payment for

cut-offs be made where they have been necessitated by crushing, brooming, splitting or other damage resulting from careless driving.

No payment will be made for required cut-offs of steel bearing piling and cast-in-place concrete pile shells. Such cut-offs will remain the property of the contractor.

(c) **Concrete Pile Extensions:** Measurement of extensions on precast concrete piles including test piles will be made by the linear foot, complete in place and accepted. 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 3 to determine the quantity for measurement, which includes any additional driving required. This additional driving includes any moving back and redriving of permanent piles as directed. No deduction will be made from the ordered length of pile driven due to cut-back for splicing.

Measurement of extensions on all other type piles will be made by the linear foot complete in place and accepted for that portion of the pile added to the original length of pile driven, which includes any additional driving required.

No measurement will be made for extensions necessitated by damage to the pile during driving.

(d) **Redriving Test Piles:** Redriving of test piles will be measured for each test pile for which redriving is required.

(e) **Splices:**

(1) **Concrete Piles:** Splices for precast concrete piles will not be measured as a splice.

(2) **Timber Piles:** Measurement of splices on timber piles will be by the linear foot. The total number of linear feet of piling driven will be determined by adding 10 feet to the net length of piling for each splice in place in the finished structure. No measurement will be made for splices except those made as directed.

(3) **Steel Bearing Piles:** Measurement of splices on steel bearing piles will be made by the linear foot. The total number of linear feet of piling driven will be determined by adding 2 feet to the net length of piling for each splice in place in the finished structure. No measurement will be made for splices except those made as directed.

(4) **Cast-in-Place Concrete Piles:** Splices for cast-in-place concrete piles will not be measured as a splice.

(f) **Test Piles:** The number of test piles to be paid for will be the number of individual piles of each type furnished and driven as directed.

Cut-offs of test piles will not be included in any pay footage. Test piles pulled and reused as permanent piles will be measured as provided under Heading (a) of this Subsection.

(g) Loading Test Piles: The number of load tests to be paid for will be the number of load tests ordered and completed.

(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.

804.14 BASIS OF PAYMENT.

(a) Piling: Piling will be paid for at the contract unit price per linear foot, 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) Cut-offs: Payment for cut-offs will be made at the rate of 2/3 the contract unit price per linear foot for the type of pile cut-off.

(c) Extensions: Payment for cast-in-place extensions will be made at the contract unit price per linear foot for the type and size of pile extended.

(d) Splices: Payment for splices will be made at the contract unit price per linear foot for the type of pile splices.

(e) Test Piles: Test piles will be paid for at the contract unit price per each.

(f) Loading Test Piles: Loading test piles will be paid for at the contract unit price per each.

(g) Reloading Test Piles: Reloading test piles will be paid for at the contract unit price per each.

(h) Loading Permanent Piles: Loading permanent piles will be paid for at the contract unit price per each.

(i) Redriving Test Piles: Redriving test piles will be paid for at the contract unit price per each.

Payment will be made under:

Item No.	Pay Item	Pay Unit
804(1)	Precast Concrete Piles (Size)	Linear Foot
804(2)	Untreated Timber Piles	Linear Foot
804(3)	Treated Timber Piles	Linear Foot
804(4)	Steel Bearing Piles (Size)	Linear Foot
804(5)	Cast-in-Place Concrete Piles (Size)	Linear Foot

Item No.	Pay Item	Pay Unit
804(6)	Concrete Piles (Size)	Linear Foot
804(7)	Precast Concrete Test Piles	Each
804(8)	Timber Test Piles	Each
804(9)	Steel Bearing Test Piles	Each
804(10)	Cast-in-Place Concrete Test Piles	Each
804(11)	Concrete Test Piles	Each
804(12)	Loading Test Piles	Each
804(13)	Reloading Test Piles	Each
804(14)	Redriving Test Piles	Each
804(15)	Loading Permanent Piles	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 in accordance with these specifications and conforming to the lines, grades and dimensions shown on the plans.

Quality control requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Control Specifications for Portland Cement Concrete Pavement and Structures" or "Application of Quality Control Specifications for Precast-Prestressed Concrete Plants".

Structural excavation and backfill shall conform to Section 802.

805.02 MATERIALS. Materials shall conform to the following Sections or Subsections:

Portland Cement Concrete	901,902
Joint Fillers	1005.01
Joint Sealers	1005.02-1005.06
Waterstops	1005.08
Box Culvert Joint Materials	1006.06
Reinforcing Steel	1009
Curing Materials	1011.01
Special Surface Finish Materials	1011.03
Precast Box Culvert Units	1016
Adhesives	1017.02
Elastomeric Bearing Pads	1018.14

Classes of concrete furnished shall be as follows:

Concrete Class	Use
A or A(M)	Concrete exposed to sea water, and all other concrete except as listed herein.
AA or AA(M)	Poured-in-place bridge superstructure
D	Pier footings
P or P(M)	Precast bridge members
R	Nonreinforced sections

Concrete Class	Use
S	Underwater sections
X	When specified

805.03 HANDLING AND PLACING CONCRETE.

(a) General: In preparation for placing concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces serving temporarily to hold forms in correct shape and alignment pending placing of concrete shall be removed from the forms when concrete placing has reached an elevation rendering their service unnecessary.

Concrete shall be placed as 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 inferior concrete is produced by the use of such devices, the engineer may order discontinuance of their use and the institution of a satisfactory method of placing.

Unless otherwise permitted, 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. No aluminum alloy material will be allowed.

When placing operations involve dropping concrete more than 5 feet, it shall be deposited through sheet metal or other approved tremie except where deemed impractical by the engineer. After initial set of the concrete, forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project from freshly poured concrete.

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 not less than 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.

(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 withdrawn from the concrete slowly. Vibration shall be of sufficient duration and intensity to thoroughly compact concrete but shall not be continued so as to 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 transport concrete in forms.

(7) Vibration shall be supplemented by such spading as necessary to insure 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 piling, concrete cribbing and other precast members except that, if approved, the manufacturer's methods of vibration may be used.

Concrete shall be placed in horizontal layers not more than 12 inches 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.

When placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. The top surface of concrete adjacent to forms shall be finished to a 2-inch grade strip.

Where a featheredge might be produced at a construction joint, as in the sloped top surface of a wingwall, an inset form work 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 in the succeeding layer. Work shall not be discontinued within 18 inches of the top of any face, unless provision has been made for a coping less than 18 inches thick, in which case, if permitted, the construction joint may be made at the underside of the coping.

Immediately following the discontinuance of placing concrete, accumulations of mortar splashed on reinforcement steel and forms shall be removed. Dried mortar chips and dust shall not be mixed in fresh concrete. If accumulations are not removed prior to the concrete reaching initial set, care shall be exercised not to damage or break the concrete-steel bond while cleaning reinforcement steel.

(b) Reinforced Concrete Box Culvert: When specified, the contractor shall have the option of furnishing structures of either cast-in-place concrete or precast concrete units. 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 thoroughly cleaned of shavings, sticks, sawdust or other extraneous material and the surface carefully chipped or roughened in accordance with the method of bonding construction joints specified in Subsection 805.06.

In construction of box culverts 4 feet or less in height, walls and top slab may be constructed as a monolith. When this method of construction is used, necessary construction joints shall be vertical and at right angles to the axis of the culvert.

In construction of box culverts more than 4 feet in height, concrete in walls shall be placed and allowed to set in accordance with strength or curing time requirements of Subsection 805.10 before the top slab is placed.

If possible, each wingwall shall be constructed as a monolith. Construction joints shall be horizontal and so located 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 be sealed with flexible plastic gasket material so installed as to form a watertight seal. Joints shall be wrapped with plastic filter cloth for a minimum of 12 inches on each side of the joint; ends of cloth shall be lapped at least 10 inches, and edges and ends of cloth shall be 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 high shall be placed at the same time as that in the girder stem, and 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 or more, the abutment or columns, haunch and girder shall be placed in 3 stages: (1) up to the lower side of haunch, (2) to the lower side of girder and (3) to completion. For haunched continuous girders, the girder stem (including haunch) shall be placed to the top of stem. Where the size of pour is such that it cannot be made in one continuous operation, vertical construction joints shall preferably be located within the area of contraflexure.

Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise directed.

Floors and girders of through girder superstructures shall be placed in one continuous operation, unless otherwise specified, in which case special shear anchorage shall be provided to insure monolithic action between girder and floor.

Concrete T-beam or deck girder spans may be placed in one continuous operation, or in 2 separate operations, each of which shall be continuous: (1) to the top of girder stems and (2) to completion. In the latter case, the bond between stem and slab shall be positive and mechanical and may be secured by suitable shear keys or roughening the top of girder stem. Suitable keys may be formed by use of timber blocks approximately 2 x 4 inches in cross section and having a length 4 inches less than the width of girder stem, spaced along girder stems as required, but not greater than 1 foot center to center. Blocks shall be beveled and oiled to facilitate their removal, and shall be removed as soon as concrete has set sufficiently to retain its shape.

Concrete columns shall be placed in one continuous operation, unless otherwise directed. 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 compressive strength before caps are placed.

Unless otherwise permitted, no concrete shall be placed in the superstructure until column forms have been stripped sufficiently to determine the character of concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until test cylinders representing the bents have attained at least 3,000 psi compressive strength but in no case in less than 7 curing days.

(d) Arches: Concrete in arch rings shall be placed in such manner as to load the centering uniformly.

Arch rings shall be cast in transverse sections of such size that each section can be cast in a continuous operation. Arrangement of sections and sequence of concrete placement shall be as approved and shall be such as to avoid creation of initial stress in reinforcement. Sections shall be bonded together by suitable keys or dowels. When permitted, arch rings may be cast in a single continuous operation.

(e) 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 herein. If the contractor fails to meet the minimum placement rate, the engineer may reject the pour, and further placement of similar nature and size will not be permitted until corrective measures have been taken to assure the engineer that the minimum placement rate can be met.

Pour Size Cubic Yards	Minimum Placement Rate Cubic Yards Per Hour
0-25	15
26-50	20
51-75	25
76-125	30
Over 125	40

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. Aluminum piping will not be permitted.

A grout mortar, or concrete with coarse aggregate omitted, 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 pipeline, 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 UNDERWATER CONCRETE. Concrete shall not be deposited in water except on approval. If approved, the method of placing shall be as follows:

To prevent segregation, concrete shall be placed in its final position by means of a tremie or other approved method, and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit and forms under water shall be watertight.

For underwater parts of structures, concrete seals shall be placed in one continuous operation. Surface of concrete shall be kept as nearly horizontal as possible.

A tremie shall consist of a tube at least 10 inches in diameter, and if constructed in sections, it shall have watertight couplings. Tremies shall be supported so as to permit free movement of discharge end over the entire top surface of the work and rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of work to prevent water from entering the tube and shall be entirely sealed.

When a batch is dumped into the hopper, flow of concrete shall be induced by slightly raising the discharge end, always keeping it in deposited concrete. Flow shall be continuous 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 placing concrete. 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.

If 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) Mortar 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, thoroughly cleaned of foreign matter and laitance, and saturated with water. To insure an excess of mortar at the juncture of hardened and newly deposited concrete, the surfaces, including vertical and inclined surfaces, shall be thoroughly coated with mortar or neat cement grout. 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 Joints:** Vertical surfaces of deck construction joints and other construction joints shall be coated prior to each succeeding pour with an approved Type II, Grade B epoxy adhesive applied according to manufacturer's recommendations. Surfaces of hardened concrete to which new concrete is to be bonded shall be cleaned of foreign material and loose and unsound concrete by sandblasting, hammers or wire brushes. Grease or oil present 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.

805.07 CONCRETE EXPOSED TO SEA WATER. Concrete shall be mixed for 2 minutes and the water content of the mixture shall be carefully controlled to produce concrete of maximum impermeability. 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 as determined by the engineer. Between these levels sea water shall not come in contact with concrete for at least 30 days. Concrete surfaces shall be left undisturbed after form removal.

805.08 FALSEWORK AND CENTERING. Detailed plans for falsework and centering shall be furnished in accordance with Section 801.

For designing falsework and centering, a weight of 150 pounds per cubic foot shall be assumed for green concrete and a minimum of 30 pounds per square foot for construction load. Falsework shall be designed and constructed to provide necessary rigidity and support loads without appreciable settlement or deformation. The engineer may require the contractor to employ screw jacks, hardwood wedges or other approved methods to take up settlement in formwork before or during placing of concrete.

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.

Arch centering shall be constructed according to approved centering plans. Provisions shall be made by means of suitable wedges, sand boxes or other devices for gradual lowering of centers to render the arch self-supporting. When directed, centering shall be placed on approved jacks to correct slight settlement after placing of concrete has begun.

805.09 FORMS.

(a) **Construction:** Forms shall be of wood, metal or other approved material, built mortartight and of sufficient rigidity to prevent distor-

tion 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 or discolor concrete, 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 insure easy removal.

When possible, forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit free access for inspecting, working and spading the concrete.

(c) **Metal Ties:** Metal ties or anchorages within forms shall be constructed to permit their removal to a depth of at least 1/2 inch from the face without damage to concrete. If ordinary wire ties are permitted, upon removal of the forms, wires shall be cut back at least 1/4 inch from the face of concrete with chisels or nippers; only nippers shall be used for green concrete. 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.

(d) **Setting and Maintaining:** Forms shall be set and maintained reasonably true to required line and grade until concrete is sufficiently hardened. When forms appear 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 practicable, 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 extraneous material immediately before placing concrete.

(e) **Re-Used Forms:** Shape, strength, rigidity, mortartightness and surface smoothness of re-used forms shall be maintained. Any warped or bulged lumber must be resized before being re-used. Unsatisfactory forms shall not be re-used.

(f) **Surface Treatment:** Forms shall be treated with a form release agent and saturated with water immediately before placing concrete.

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 immediately prior to placing concrete.

Cleanout ports shall be provided at the top surface of concrete where a stoppage of placing occurs.

805.10 CURING. Concrete in substructures for grade separation structures, superstructures of major structures, and railroad underpasses shall be cured with wet burlap or other approved material. Precast concrete shall be cured in accordance with Subsection 805.14(f).

A Type 1-D curing compound conforming to Section 1011.01 may be used for curing concrete in minor drainage structures and bridge substructures and diaphragms when surfaces do not require a Class 2 or 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 and this curing shall begin 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 1 gallon per 100 square feet of surface area. The compound shall be applied in 1 or 2 applications. If the compound is applied in 2 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 2 thicknesses of wet burlap. Burlap shall be kept continuously and thoroughly wet for at least 5 curing days as defined in Subsection 805.11 after concrete is placed.

In bridge deck construction, exposed surface of decks shall be sprayed uniformly with a Type II curing compound immediately after final texturing as an interim curing measure in accordance with Subsection 601.12(a). Exposed reinforcing steel and joints shall be covered or shielded to prevent contact with curing compound. The moist curing methods stated herein shall then be used on the deck.

805.11 REMOVAL OF FALSEWORK AND FORMS. Except as otherwise specified herein, forms for surfaces requiring a Class 2 or 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 2 or 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.

Method 1: Forms and falsework may be removed as soon as concrete has attained a compressive strength, as determined by cylinder tests, indicated in the following table:

Concrete Class	Compressive Strength (psi)
A	3,000
A(M)	3,600
AA	3,200
AA(M)	3,600
D	2,500
P (nonprestressed)	3,000
P(M) (nonprestressed)	3,600
X (nonprestressed)	2,500
Precast Minor Structure Units (nonprestressed)	2,500

Test specimens will be made in accordance with DOTD Designation: 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 AASHTO Designation: T 22.

Method 2: Forms and falsework may be removed when concrete has aged for the minimum number of curing days in the following table:

Under slabs, beams or pile caps with span lengths of 10 feet and less	7 days
Under slabs, beams or pile caps with span lengths over 10 feet and less than 17 feet	7 days plus 1 day for each foot of span over 10 feet
Under slabs, beams or pile caps with span lengths over 17 feet	14 days
Under portion of slabs that cantilever more than one foot	7 days
Walls, columns, side forms for beams, pile caps and slabs that cantilever one foot or less	1 day

Caissons	1 day
Precast nonprestressed bridge units (side forms)	1 day
Precast nonprestressed minor structure units	7 days (2,000 psi min.)

The term "curing day" will be interpreted as a calendar day on which the temperature is above 50°F for at least 19 hours. Colder days may be counted if satisfactory provision is made to maintain air temperature adjacent to concrete above 50°F 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 2 times the number of curing days stated above. In determining the time for removal of forms and falsework and discontinuance of heating, consideration will be given to location and character of the structure, weather and other conditions influencing setting of concrete.

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.

Arch centering shall be struck and the arch made self-supporting before railing or coping is placed. For filled spandrel arches, such portions of spandrel walls shall be left for construction subsequent to striking of centers as necessary to avoid jamming of expansion joints.

Centers shall be gradually and uniformly lowered in such manner as to avoid damaging stresses in any part of the structure. In arch structures of 2 or more spans, the sequence of striking centers shall be as specified or approved.

Traffic shall not be permitted on bridge decks until concrete has been in place for 14 days or has attained 3,200 psi compressive strength.

Precast nonprestressed bridge units shall be held at the plant a minimum of 10 days after casting. After expiration of the 10 days, the units may be shipped, provided the required 28-day compressive strength has been attained.

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 or preformed compression 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.

(1) **Liquid Poured:** Before application of the seal, joint faces must be sandblasted. Joints shall be thoroughly dry at the time of installation. Seals shall be installed in accordance with the manufacturer's recommendations. Care shall be taken that the material's shelf life is not exceeded and that application is accomplished at 70°F or above. Application shall be done by a machine with a powered mixing device with an accurate method of proportioning and mixing the components.

Primers, if 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 seals.

Joints shall be backed with closed cell polyethylene foam joint fillers to obtain correct depth of seal. The filler may be cast into the joint or compressed into the joint such that it adheres tightly to sides of the joint providing a stable backing for the seal. This backing material must not adhere to seal material and must be of a character recommended by the seal manufacturer.

(2) **Preformed Elastomeric Compression Joint Seal:** Joints shall be thoroughly cleaned and free of loose rust. Where armored joints are welded for alignment during construction, weld spots shall be ground smooth prior to seal placement. Joints shall be smooth-faced and thoroughly clean and dry at the time of installation. Joint seals shall be installed in accordance with the manufacturer's recommendations.

The lubricant-adhesive shall be applied just prior to installation and shall be sufficient to completely cover the seal's sidewalls. Installation shall be done in a manner that least disturbs the lubricant-adhesive on joint walls. Dilution of the lubricant-adhesive will not be allowed.

Stretching of the seal shall be minimal. When installation procedures appear to cause stretching, random checks shall be made. Frequency and thoroughness of checks shall be as directed. Maximum allowable stretch of the compression seal is 5 percent. When maximum limits are exceeded, and the lubricant-adhesive has chemically set, the seal shall be completely removed and cleaned, the joint recleaned and reinstallation made.

One manufacturer's shop splice per 48-foot length will be allowed provided field performance and laboratory tests indicate satisfactory performance. Field splicing will not be allowed.

(d) Premolded Expansion Joint Filler: Premolded fillers shall be furnished when specified and installed as directed.

(e) Steel Joints: Plates, angles or other structural shapes shall be accurately fabricated to conform to the section of the concrete floor. Care shall be taken to insure that the surface in the finished plane is 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 and care shall be taken to avoid impairment of the required clearance by accurately setting the joint 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 casting adjacent pours.

(f) Waterstops: Adequate waterstops of metal, rubber or plastic shall be placed as shown on the plans. Where movement at the joint is provided, waterstops shall be of a type permitting such movement without damage. They shall be spliced, welded or soldered to form continuous watertight joints.

(g) Bearing Devices: Masonry surfaces on which bearings are to be set shall be finished to insure uniform bearing at required grade and elevation. Rockers or other expansion devices shall be accurately set considering temperature effects and stage of construction at the time of installation.

(h) Elastomeric Bridge Bearing Pads: Elastomeric bearing pads shall be either plain (consisting of elastomer only) or laminated (consisting of layers of elastomer separated by nonelastic laminates) as specified. 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.

805.13 CONCRETE SURFACE FINISHES. Surface finishes shall be classified as follows:

Class 1	Ordinary Surface Finish
Class 2	Rubbed 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. If not otherwise specified, the following surfaces shall be given a Class 2, Rubbed Finish: exposed faces of wingwalls, retaining walls, railings and parapets; outside faces of girders, slabs, brackets, curbs, headwalls, and parapets. Wingwalls shall be finished from the top to one foot below finish slope lines on the exposed face and shall be finished on top for a depth of one foot below the top on backfill sides.

Bridge roadway 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 all other holes, honeycombed spots, broken corners or edges and other defects shall be thoroughly 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 one hour old. Concrete shall then be cured as specified under Subsection 805.11. Construction and expansion joints in the completed work shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

The resulting surfaces shall be true and uniform. All surfaces which cannot be satisfactorily repaired shall be rubbed as specified for Class 2, Rubbed Finish.

Exposed surfaces not protected by forms shall be struck off with a straightedge and finished with a wood float to a true and even surface. Use of additional mortar to provide a grout finish will not be permitted.

(b) **Class 2, Rubbed Finish:** After removal of forms, rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, concrete shall be kept thoroughly saturated with water. Sufficient time shall elapse before the wetting down to allow mortar used in pointing rod holes and defects to thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone using a small amount of mortar on its face. Mortar shall be composed of cement and fine sand mixed in proportions used in the concrete being finished.

Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface obtained. Paste produced by this rubbing shall be left in place.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water until the entire surface is of a smooth texture and uniform color.

After final rubbing is completed, the surface shall be left free from all unsound patches, paste, powder and objectionable marks.

(c) **Class 2A, Special Surface Finish:** The Class 2A Special Surface Finish will be allowed as an alternate to the Class 2, Rubbed Finish. When the Special Surface Finish is used, it shall be used throughout the project in lieu of the Class 2, Rubbed Finish.

Application of the Special Surface Finish shall not be started until all other work which might mar the surface finish is complete and until 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.

(d) **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.

(e) **Class 6, Bridge Deck Finish:**

(1) **Striking Off:** After concrete is placed and consolidated according to Subsection 805.03, bridge floors 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 floors or slabs 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 50 feet or less in length. These screeds shall be mechanically operated for finishing spans over 50 feet in length and may not be used to strike off spans in excess of 75 feet without permission.

Spans over 50 feet 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 roadway 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 floor as many times as required to obtain required profile and cross section. A slight excess of concrete shall be kept in front of cutting edge by the screed. This excess of concrete shall be carried to the edge of the pour or form and shall not be worked into the slab, but 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.

In general, addition of water to the surface of concrete to assist in finishing operations will not be permitted. If application of water to the surface is permitted, it shall be applied as a fog spray by means of approved equipment.

(2) **Straightedging:** After striking off, the entire surface shall be checked by the contractor with an approved 10-foot metal straightedge operated parallel to the centerline of bridge and shall show no deviation in excess of 1/8 inch 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 Finishing:** 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 x 0.126 inch steel flat wire, 4 to 5 inches in length spaced on 1/2 inch centers. Grooves produced in concrete shall be 3/16 inch in depth with a minimum depth of 1/8 inch. Grooves shall be transverse to the centerline of roadway and shall extend to within 1 foot 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 Designation: TR 229. Texturing equipment other than that specified herein may be approved provided it produces an equivalent texture.

During final surface finishing operations, areas that are improperly finished shall be refloated and refinished as required.

(f) 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 under a 10-foot straightedge. The surface shall have a granular or matte texture.

(g) Class 8, Precast-Prestressed Concrete Finish: Concrete for precast-prestressed bridge members shall be given Class 1, Ordinary Surface Finish at the plant as soon as possible after casting and before delivery. The manufacturer of precast members will be required to adopt measures to reduce the number and size of trapped air cavities to a reasonable minimum and an excessive number of these cavities will be cause for rejection of the precast member. Precast-prestressed bridge members shall be given Class 1, Ordinary Surface Finish by the manufacturer.

After completion of the structure, all 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 clean by washing and shall remove any materials that adhere to the surface and mar the finish of girders.

805.14 PRESTRESSED CONCRETE.

(a) Supervision and Inspection: Unless otherwise permitted, the contractor or fabricator shall provide a technician skilled in the use of the system of prestressing 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. Free access to all parts of the plant engaged in fabrication of prestressed concrete bridge members shall be afforded the engineer at all times while prestressed members are being fabricated. Areas where inspection is required shall be kept free of debris so as to provide safe access to the work.

Inspection of prestressed concrete bridge members shall be in accordance with the AASHO Interim Manual for inspection of prestressed concrete bridge members as modified by the Department's addendum modifying tolerance requirements. Required finishing, repairs and cur-

ing shall be accomplished immediately after casting and before placing members in permanent storage.

The contractor or fabricator shall furnish the engineer an office with at least 140 square feet of floor space to perform necessary work. Additional space as deemed necessary by the engineer shall be provided. This office shall contain desk, chair, 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 be in good condition, located where there is not excessive noise and restricted to the Department's inspectors only. Convenient and adequate reserved parking space shall be provided.

The contractor or fabricator shall furnish a concrete cylinder breaking machine of minimum 250,000 lbs. capacity conforming to ASTM Designation: C39 for use by the inspector. Suitable facilities for use of this machine shall also be furnished. These testing machines shall be calibrated by an approved laboratory or calibration service at the manufacturer's expense prior to initial use and at 1 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 contractor or 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.

Prior to use in manufacture of prestressed members under these specifications, all jacks to be used, with their gages, shall be calibrated by an approved laboratory or calibration service. For jacks up to 200 tons capacity which can be placed within the available testing machine, the calibration may be performed without charge by the Department's Materials Laboratory, provided jacks are delivered and assembled by the contractor. For larger jacks, calibration by proving ring or other acceptable method, performed by an established laboratory or calibration service at the expense of the contractor, will be required. During progress of 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 entire 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 by the engineer, but such approval shall not relieve the contractor 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 and prestressing tendons and given his 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 approximately the time of initial set, the entire 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 2 bolted joints or seams. Bolted joints or seams shall be thoroughly sealed to minimize bleeding.

Prior to placement of concrete, forms shall be thoroughly cleaned and uniformly coated with an approved form release agent listed on the Qualified Products List. 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 pouring 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(g).

(e) **Curing:** To establish adequacy of curing methods used and to determine whether concrete has attained the required compressive strength, 7 test cylinders will be made and cured under the same condition as the members. Two cylinders will be tested at the end of 28 days. The remaining 5 cylinders will be tested at any time requested by the contractor. If all 5 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 brochure entitled "Application of Quality Control Specifications for Precast-Prestressed Concrete Plants." Curing methods other than steam curing shall be according to Subsection 805.11. Hot weather concrete limitations as stipulated in Subsection 901.12(b) shall not be applicable for steam curing; however, precautions such as cooling of forms will be required.

Steam Curing: 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. If 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 to prevent loss of moisture and to provide excess moisture for proper hydration of cement. 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 per hour until a uniform temperature not exceeding 160°F is reached. This temperature shall be held until concrete has reached required release strength. At this time, the steam curing may be discontinued. Concrete shall remain covered for 2 hours minimum 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 effects to members. Recording thermometers showing time-temperature relationship shall be furnished at the rate of 1 for each 200 feet of bed.

(f) **Transportation and Storage:** Precast girders shall be transported in an upright position, and 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, hoisting and handling of precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the contractor at his expense.

Members may be handled immediately after detensioning. If stressing is not done in a continuous operation, members shall not be handled before sufficiently stressed as determined by the engineer 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 may be installed at any time after completion of stressing and grouting, providing concrete has attained the specified minimum 28-day compressive strength, except for prestressed piling.

Prestressed concrete piling shall be held at the plant until one of the following criteria is met:

(1) 10 days after the specified minimum 28-day compressive strength is attained or

(2) 14 days after casting, provided the specified minimum 28-day compressive strength has been attained.

(g) Pretensioning Method: Prestressing elements shall be accurately held in position and stressed by jacks. A record shall be kept of the jacking force and tendon elongation produced. Several units may be cast in one continuous line and stressed at one time. Sufficient space shall be left between ends of units to permit access for cutting after concrete has attained required strength. No bond stress shall be transferred to concrete nor shall end anchors be released until concrete has attained the specified release strength as shown by standard cylinders made and cured identically with members. Elements shall be cut or released in such order that lateral eccentricity of prestress will be a minimum in accordance with approved shop drawings.

All strands to be prestressed in a group shall be brought to a uniform initial tension prior to being given full pretensioning. This uniform initial tension of 1,000 to 2,000 pounds 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 this initial tensioning, the group shall be stressed until required elongation and jacking pressure are attained and confirmed within the specified limits.

With the cables stressed in accordance with the plan requirements and the foregoing specificatons and with all other reinforcing in place, the concrete shall be cast to the desired lengths. Strands shall not be spliced within the casting length of any girder.

(h) Posttensioning Method: The tensioning process shall be conducted so that the tension being applied to the tendon and its elongation may be measured at all times. The friction loss shall be estimated as

provided below. A record shall be kept of gage pressures and elongations at all times and submitted to the engineer for approval. Loads shall not be applied to concrete until it has attained the compressive strength specified in Heading (f) of this Subsection.

Posttensioning tendons of straight members may be tensioned from one end. Posttensioning tendons of curved members shall be stressed by simultaneous jacking from both ends of the stressing element.

Friction Losses: Friction losses in posttensioned steel shall be based on experimentally determined wobble and curvature coefficients, and shall be verified during stressing operations. Values of coefficients assumed for design, and acceptable ranges of jacking forces and steel elongations shall be as shown on the plans. These friction losses shall be calculated as follows:

$$T_o = T_x \, e^{(KL + \mu\alpha)}$$

When $(KL + \mu\alpha)$ is not greater than 0.3, the following equation may be used:

$$T_o = T_x (1 + KL + \mu\alpha)$$

in which

T_o = Steel stress at jacking end.

T_x = Steel stress at any point x.

e = Base of Naperian logarithms.

K = Friction wobble coefficient per foot of prestressing steel.

L = Length of prestressing steel element from jacking end to point x, in feet.

μ = Friction curvature coefficient.

α = Total angular change of prestressing steel element in radians for jack to point x.

The following values for K and μ may be used when experimental data from the materials used are not available:

Type of Steel	Type of Duct	K	μ
Wire or ungalvanized strand	Bright Metal Sheathing	0.0020	0.30
	Galvanized Metal Sheathing	0.0015	0.25
	Greased or asphalt - coated and wrapped	0.0020	0.30
	Galvanized rigid	0.0002	0.25

Type of Steel	Type of Duct	K	μ
High-strength bars ..	Bright Metal Sheathing	0.0003	0.20
	Galvanized Metal Sheathing	0.0002	0.15

Friction losses occur prior to anchoring but should be estimated for design and checked during stressing operations. Rigid ducts shall have sufficient strength to maintain their correct alignment without visible wobble during placement of concrete. Rigid ducts may be fabricated with either welded or interlocked seams. Galvanizing of welded seam will not be required.

(i) **Grouting of Bonded Steel:** Posttensioning 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 if approved by the engineer. Portland cement shall be Type I, II or III conforming to Subsection 1001.01.

Cement used for grouting shall be fresh and shall not contain any lumps or other indications of hydration or "pack set". Water used in the grout shall conform to Subsection 1018.01.

Admixture, if used, shall impart the properties of low water content, good flowability, minimum bleed and expansion if desired. Its formulation shall contain no chemicals in quantities that may have a harmful effect on the prestressing steel or cement. Admixtures containing chlorides in excess of 0.5 percent by weight of admixture, assuming 1 pound of admixture per sack (94 pounds) of cement, fluorides, sulphites and nitrates, shall not 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 3000 psi prior to transfer of bond stress or end anchor release. Preparation and testing of grout cubes shall be in accordance with ASTM Designation: C 109.

(j) Prestressing Reinforcement: Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile-strength 7-wire strand or high-tensile-strength alloy bars, as specified.

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.

Should the contractor desire to substitute a different size strand than specified or to substitute ASTM Designation: A 416 Grade 270 strand for Grade 250 strand, he shall submit complete details to the Bridge Design Engineer for review and approval. The design submitted shall correspond in total prestressing force and location of prestressing force in all essential requirements to the design drawings.

(k) Precast-Prestressed Concrete Deck Forms: When permitted on the plans, 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 all reinforcing bars shall be as detailed on the plans.

b. Reinforcing steel shall be provided in the concrete panel transverse to the prestressing strands. Area of steel to be a minimum of 0.22 square inch per foot of length and shall be deformed reinforcing steel.

c. Panels shall be fabricated with 3/8 inch strands only, unless otherwise permitted by the Bridge Design Engineer. The minimum panel length parallel to strands shall be 60 inches.

d. Shear reinforcing steel of 0.40 square inch per 10 square feet 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 deep to insure 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 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 sealed with grout or 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. 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 and maximum height of 1 1/2 inches. The strips shall be placed in approximate 4-foot lengths using an approved adhesive. Openings of 1/2 inch 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 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 of the engineer.

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 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 bar deformed reinforcement shall be provided to carry required loads.

(2) Materials: Materials for use in the panels shall conform to 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.
c. Deformed reinforcing steel may be Grade 40 or 60.
d. Welded deformed steel wire fabric shall conform to ASTM Designation: A 497.
e. Panels with elements less than 3 1/2 inches thick shall require Grade F aggregate. For all other panels, either Grade A or Grade F aggregate may be used.

f. Continuous high (CHC) bar chairs shall conform to ASTM Designation: A 108, Grade 1008.

(3) **Construction:** Forms shall be installed in accordance with approved fabrication and erection plans. To insure full bond between the precast panel and cast-in-place concrete, this interface shall be free of all foreign material during cast-in-place concreting operations. After erection of panels and prior to pouring cast-in-place concrete, all laitance or flakes shall be removed from the entire 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 and a fan nozzle pressure of approximately 1,500 psig. 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. All controls for lines and grades above bent caps will be the responsibility of the contractor.

Only the outer 3 inches of the top flange of girders shall be smoothed for purposes of seating the panels. The remaining area of the top girder flange shall be left rough.

Panels shall be so placed as to obtain the minimum slab thickness shown in the plans within a tolerance of +3/8 inch. The tolerance on the cast-in-place concrete cover for the top reinforcing steel will be +1/4 to −1/8 inch.

(4) **Panel Tolerances:**

	Inches
Panel Depth (Thickness)	+1/4, −1/8
Panel Length (Parallel to strands)	± 1
Panel Width	+1/8, −1/2
Position of Strands (Vertical)	± 1/8
Position of Strands (Horizontal)	± 1/2

(5) **Payment:** Payment will be based on the plan quantities for full depth cast-in-place concrete construction, regardless of the method of deck construction used.

805.15 PLACING ANCHOR BOLTS. Anchor bolts in piers, bents, abutments or pedestals shall be set in portland cement mortar 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 insure proper setting of bolts. Any 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 to allow for adjustment and

sufficient in depth to admit the anchor bolt. The holes may be formed by the insertion in fresh concrete of oiled wooden plugs, metal sleeves or other approved devices which are subsequently withdrawn after concrete has partially set. All 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 the preformed holes sufficiently with grout so that when anchor bolts are placed to required depth, the grout will completely fill the 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 larger than the bolt diameter.

805.16 METHOD OF 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, expansion joints, and embedded structural steel and piling. Volumes deducted for embedded piling are based on 12-inch 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, 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:** Design quantities of expansion joint seal are based on lengths shown on the plans.

(e) **Bridge Superstructure and Substructure:** Bridge superstructure and substructure will be measured per span.

805.17 BASIS OF PAYMENT.

(a) **Structural Concrete:** Structural concrete will be paid for at the contract unit price per cubic yard, 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 of concrete. A pour of 200 to 400 cubic yards will be divided into 2 lots as equal in size as possible while maintaining identifiability. A pour exceeding 400 cubic yards will be represented by 3 lots.

Two random batches will be sampled for each lot, and 3 cylinders molded from each batch. The 6 specimens per lot will be tested for compressive strength in 28 to 31 days.

In the event of sudden cessation of operation, a minimum of 3 cylinders will constitute a lot.

Acceptance and payment for each lot will be made in accordance with Table 2 of Section 901.

Concrete that is classified as minor structure concrete will be accepted under these specifications and in accordance with Table 3 of Section 902.

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:** Precast-prestressed girders will be paid for at the contract unit price per linear foot, 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:** Expansion joint seal will be paid for at the contract unit price per linear foot.

(d) **Bridge Superstructure and Substructure:** Bridge superstructure and substructure will be paid for 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.

Payment will be made under:

Item No.	Pay Item	Pay Unit
805(1)	Class A Concrete	Cubic Yard
805(2)	Class A(M) Concrete	Cubic Yard
805(3)	Class AA Concrete	Cubic Yard
805(4)	Class AA(M) Concrete	Cubic Yard
805(5)	Class D Concrete	Cubic Yard
805(6)	Class R Concrete	Cubic Yard
805(7)	Class S Concrete	Cubic Yard
805(8)	Precast-Prestressed Concrete Girders (Type)	Linear Foot
805(9)	Expansion Joint Seal	Linear Foot
805(10)	Bridge Superstructure and Substructure	Span

Section 806

Reinforcement

806.01 DESCRIPTION. This work consists of furnishing and placing reinforcing steel for portland cement concrete in conformity with the plans and specifications.

806.02 MATERIALS. All materials shall conform to Section 1009. Unless otherwise specified, reinforcing steel may be either Grade 40 or Grade 60.

806.03 STEEL LISTS. Before placing reinforcing steel, 2 copies of a list of all reinforcing steel showing location, mark number, size and type bend shall be furnished to the engineer. Furnishing such lists shall not be construed to mean that the lists will be reviewed for accuracy. 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 2 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 4 bar diameters for No. 5 or smaller bars, and at least 5 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 the following Table 1:

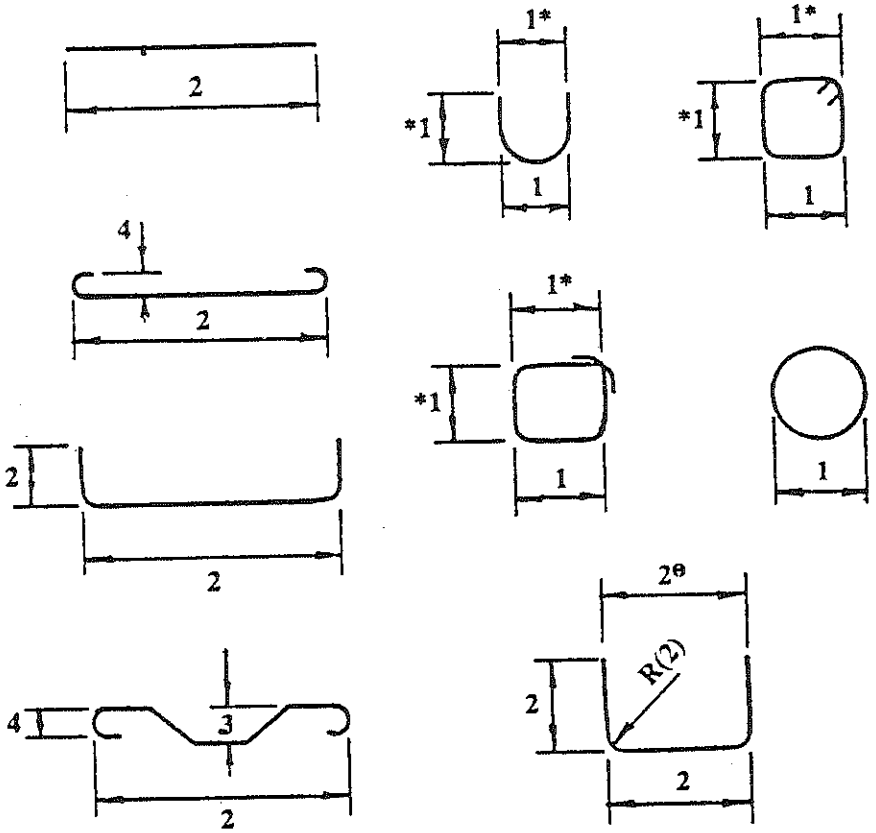
TABLE 1
PINS FOR BAR BENDS

Bar Size	Minimum Pin Diameter
Nos. 3 through 8	6 bar diameters
Nos. 9, 10 and 11	8 bar diameters
Nos. 14 and 18	10 bar diameters

Special fabrication will be required for bending Nos. 14 and 18 bars more than 90 degrees, and all bends of Grade 50 bars.

(b) Tolerances: Bars shall be fabricated in accordance with the tolerances specified in Table 2 of this Section. All dimensions given in the table are out-to-out of bars.

TABLE 2
FABRICATION TOLERANCES



Symbol	Tolerance (Inches)
1	± 1/2
2	± 1
3	+0, −1/2
4	+0, −1

*Not to differ for opposite parallel dimension by more than 1/2″.
θNot to differ for opposite parallel dimension by more than 1″.

(c) **Shipping:** Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the Code of Standard Practice of the Concrete Reinforcement Steel Institute (CRSI).

806.05 PROTECTION OF MATERIAL. From its delivery to the job until used, reinforcing steel shall be stored above the ground surface 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.

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 or other foreign material. Thin powdery rust and light rust need not be removed. Bars shall be tied with No. 14 or 16 gage wire at all intersections, except where spacing is less than 1 foot 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. 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 except as follows: bottom of slab, 1 inch; stirrups and ties in T-Beams, 1 1/2 inches. 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 of concrete begins.

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. Bars shall be lapped 30 bar diameters when Grade 40 is specified, and 45 bar diameters when Grade 60 is specified. When Grade 60 is used as a substitute for Grade 40, bars shall be lapped 30 bar diameters. 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 by the engineer in writing. Welding shall conform to Section 815.

When permitted in the plans or specifications, reinforcing steel splices may be made by an approved mechanical butt splicing device listed on the Qualified Products List 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.

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.

806.09 METHOD OF 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 of nominal size plain round bars as follows:

Bar No.	Weight Lbs./Lin. Ft.	Bar No.	Weight Lbs./Lin. Ft.
3	0.376	9	3.400
4	0.668	10	4.303
5	1.043	11	5.313
6	1.502	14	7.650
7	2.044	18	13.600
8	2.670		

Measurement and payment of structural shapes used as reinforcement will be made in accordance with Section 807.

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.

806.10 BASIS OF PAYMENT. Reinforcing steel will be paid for at the contract unit price per pound. Payment will be made under:

Item No.	Pay Item	Pay Unit
806(1)	Deformed Reinforcing Steel	Pound

Section 807

Structural Metals

807.01 DESCRIPTION. This work consists of furnishing and placing structural metals for structures in accordance with the details shown on the plans and these specifications.

807.02 MATERIALS. All materials shall conform to Section 1013. If the type of structural steel to be used is not specified, steel conforming to ASTM Designation: A 36 shall be used.

807.03 DRAWINGS. Shop drawings and working drawings shall be furnished in accordance with Subsection 801.03.

807.04 INSPECTION. The Department will inspect all structural metal.

The engineer will examine the material before it is worked in the shop and will have authority to reject materials or workmanship not in conformity with the plans and specifications. The contractor or fabricator shall give the Chief Construction Engineer at least 10 days notice before commencing fabrication. Heat number markings shall be shown 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 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 fabricating shop, the transferring of heat numbers shall be steel die stamped for all pieces of main material. In case of doubt as to the grade of metal being used, samples will be taken by the inspector for submittal to the Department's Laboratory for tests to establish the grade. A color code system in accordance with the latest AASHTO requirements 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.

Identification Color Codes

A 242	Blue	
A 440-77	Brown	
A 441	Yellow	
A 514	Red	
A 517	Red and Blue	
A 572	Grade 42	Green and White
	Grade 45	Green and Black
	Grade 50	Green and Yellow
	Grade 55	Green and Brown
	Grade 60	Green and Gray
	Grade 65	Green and Blue
A 588	Blue and Yellow	
A 36	White	

Metals not covered above nor included in ASTM Designation: A 6 shall have an individual color code established and on record for the engineer. The contractor shall furnish means and assistance for testing materials and workmanship. The engineer shall 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 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 as required by the engineer. The office shall be provided with adequate heating, ventilation and air conditioning and convenient sanitary facilities with running water. 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.

(a) Mill Inspection: Mill inspection of structural metals will not be made; however, 5 copies of certified and notarized certificates of analysis (mill test reports) on chemical and physical tests, properly identified as to intended use, are required and shall be submitted to the Chief Construction Engineer for approval and distribution.

(b) Shop Inspection: Shop inspection of fabrication and assembly of structural steel, castings and other metal items will be performed by

the Construction Section. A schedule of fabrication for the metal items required for the project, including location of the shop and the dates inspection service 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 or pattern making for castings.

(c) Qualifications of inspectors for Quality Assurance (QA) and Quality Control (QC) will be determined by, and be satisfactory to, the engineer.

807.05 QUALITY OF WORKMANSHIP. Workmanship and finish shall be equal to the best general practice in modern fabrication shops as interpreted by the engineer.

807.06 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.

807.07 STRAIGHTENING MATERIAL AND CURVING ROLLED BEAMS AND WELDED GIRDERS.

(a) Straightening Material: Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not damage the metal. Heat straightening of ASTM A514 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. Sharp kinks and bends will be cause for rejection of the material.

(b) Curving Rolled Beams and Welded Girders:

(1) Materials: Steels that are manufactured to a specified yield point greater than 50,000 psi shall not be heat curved.

(2) Type of Heating: Beams and girders may be curved by either continuous or V-type heating, as approved. For the continuous method, a strip along edges of top and bottom flanges shall be heated simultaneously. The strip shall be of sufficient width and temperature to obtain required curvature.

For V-type heating, top and triangular or wedge-shaped bottom flanges shall be heated in truncated areas having their base along the flange edge and spaced at regular intervals along each flange. The spacing and temperature shall be as required to obtain required

curvature, and heating shall progress along the top and bottom flange at approximately the same rate. The apex of the truncated triangular area applied to the inside flange surface shall terminate just before the juncture of the web and flange is reached. To avoid unnecesary web distortion, care shall be taken when heating the inside flange surfaces (the surfaces that intersect the web) so that heat is not applied directly to the web. When the radius of curvature is 1,000 feet or more, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend to the juncture of the flange and web. When the radius of curvature is less than 1,000 feet, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend past the web for a distance equal to 1/8 of the flange or 3 inches, whichever is less. The truncated triangular pattern shall have an included angle of approximately 15 to 30 degrees, but the base of the triangle shall not exceed 10 inches. Variations in the patterns prescribed above may be made with approval of the engineer.

For both types of heating, the flange edges to be heated are those that will be on the inside of the horizontal curve after cooling. Heating both inside and outside flange surfaces is only mandatory when the flange thickness is 1 1/4 inches or greater, in which case the two surfaces shall be heated concurrently. The maximum temperature shall be as prescribed below.

(3) Temperature: The heat-curving operation shall be conducted in such manner that the temperature of steel does not exceed 1150°F as measured by temperature-indicating crayons or other suitable means. The girder shall not be artificially cooled until after naturally cooling to 600°F; the method of artificial cooling will be subject to approval of the engineer.

(4) Position for Heating: The girder may be heat-curved with the web in either a vertical or horizontal position. When curved in the vertical position, the girder must be braced or supported in such manner that the tendency of the girder to deflect laterally during the heat-curving process will not cause the girder to overturn.

When curved in the horizontal position, the girder must be supported near its ends and at intermediate points, if required to obtain a uniform curvature. The bending stress in flanges due to dead weight of the girder must not exceed the usual allowable design stress. When the girder is positioned horizontally for heating, intermediate safety catch blocks must be maintained at midlength of the girder within 2 inches of flanges at all times during heating to prevent sudden sag due to flange buckling.

(5) Sequence: The girder shall be heat-curved in the fabrication shop before it is painted. The heat-curving operation may be conducted either before or after welding of transverse intermediate stiffeners. However, unless provisions are made for girder shrinkage, connection plates and bearing stiffeners shall be located and attached after heat-curving. If longitudinal stiffeners are required, they shall be heat-curved or oxygen-cut separately and then welded to the curved girder. When cover plates are to be attached to rolled beams, they may be attached before heat curving if the total thickness of one flange and cover plate is less than 2 1/2 inches and the radius of curvature is greater than 1,000 feet. For other rolled beams with cover plates, the beams must be heat-curved before the cover plates are attached. Cover plates must be either heat-curved or oxygen-cut separately and then welded to the curved beam.

(6) Camber: Girders shall be cambered before heat-curving. For plate girders, the web shall be cut to the prescribed camber with suitable allowance for shrinkage due to cutting, welding and heat-curving. The heatcurving process may tend to change the vertical camber present before heating. This effect will be most pronounced when the top and bottom flanges are of unequal widths on a given transverse cross section. However, subject to approval of the engineer, moderate deviations from specified camber may be corrected by a carefully supervised application of heat.

(7) Measurement of Curvature and Camber: Horizontal curvature and vertical camber will not be measured for final acceptance before all welding and heating operations are completed and flanges have cooled to a uniform temperature. Horizontal curvature shall be checked with the girder in the vertical position by measuring offsets from a stringline or wire attached to both flanges or other suitable means. Camber shall be checked by adequate means.

807.08 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.

807.09 RIVET AND BOLT HOLES.

(a) Holes for Rivets and High Strength Bolts: Holes for rivets or bolts shall be either punched or drilled. Material forming parts of a member composed of not more than 5 thicknesses of metal may be punched 1/16 inch larger than the nominal diameter of rivets or bolts whenever the thickness of metal is not greater than 3/4 inch for structural carbon steel or 5/8 inch for alloy steel.

When there are more than 5 thicknesses or when any main material is thicker than 3/4 inch in structural carbon steel or 5/8 inch in alloy

steel or when required under Subsection 807.12, holes shall either be drilled full size or subdrilled.

When required under Subsection 807.12, holes shall be either subpunched or subdrilled (subdrilled if thickness limitation governs) 3/16 inch smaller and, after assembling, reamed 1/16 inch larger or drilled full size to 1/16 inch larger than the nominal diameter of rivets or 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 and larger in diameter except as hereinafter restricted:

(1) Oversize holes shall be 3/16 inch larger than bolts 7/8 inch and less in diameter, 1/4 inch larger than bolts 1 inch in diameter, and 5/16 inch larger than bolts 1 1/8 inch 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 wider than the bolt diameter and have a length which does not exceed the oversize diameter provisions of Heading (1) by more than 1/16 inch. 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 wider than the bolt diameter and have a length more than allowed in Heading (2) but not more than 2 1/2 times the bolt diameter.

In friction-type connections, they 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 maybe 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 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 smaller than the nominal diameter of bolt and reamed assembled or to a steel template or, after assembling, drilled from the solid.

807.10 PUNCHED HOLES. Diameter of the die shall not exceed diameter of the punch by more than 1/16 inch. Holes that must be enlarged to admit rivets or bolts shall be reamed. Holes must be clean-cut without torn or ragged edges. Poor matching of holes will be cause for rejection; any repair shall be subject to approval of the engineer.

807.11 REAMED OR DRILLED HOLES. Reamed holes shall be cylindrical, perpendicular to the member and not more than 1/16 inch larger than the nominal diameter of rivets or bolts. Where practicable, reamers and drills shall be directed by mechanical means. Drilled holes shall be 1/16 inch larger than the nominal diameter of rivet or bolt. All burrs shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist reamers or twist drills. 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.

807.12 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 807.09 and subsequently reamed while assembled or to a steel template, as required by Subsection 807.16. 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 the template has been located for position and angle and firmly 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 matchmarking.

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 807.12(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 807.14 and 807.16.

The contractor shall submit to the engineer for approval a detailed outline of his proposed procedures in accomplishing 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.

807.13 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 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 smaller in diameter than the nominal size of punched holes will be cause for rejection.

807.14 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 between adjacent thicknesses of metal.

Steel templates shall have hardened steel bushings in holes accurately dimensioned from centerlines of the connection as inscribed on the template. Centerlines shall be used in locating the template from milled or inscribed ends of members.

807.15 FITTING FOR RIVETING AND BOLTING. Contact surfaces of metal shall be prepared as specified in Subsection 807.20(d). Parts of a member shall be assembled, well pinned and firmly drawn together with bolts before reaming or riveting. 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.

Before shop riveting of full-size punched material, rivet holes, if necessary, shall be spear-reamed for admission of rivets. Reamed holes shall not be more than 1/16 inch larger than the nominal diameter of rivets.

End connection angles, stiffener angles and similar parts shall be adjusted to correct position and bolted, clamped or otherwise firmly held in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts to prevent damage in shipment and handling.

807.16 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 subsize holes reamed to specified size while connections are assembled. Assembly shall be Full 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 the engineer by the fabricator showing camber at each panel point of trusses or arch ribs, and at 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 Truss or Girder Assembly consists of assembling initially for each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at least 3 contiguous shop sections or all members in at least 3 contiguous panels but not less than the number of panels associated with 3 contiguous chord lengths (i.e., length between field splices) and at least 150 feet for structures longer than 150 feet. At least one shop section or panel, or as many panels as are associated with a chord length, shall be added at the advancing end of the assembly before any member is removed from the rearward end, so that the assembled portion of the structure is never less than that specified above.

(c) **Full Chord Assembly:** Full Chord Assembly consists 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 lines.

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 fitting 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 and shall consist of at least 3 contiguous shop sections or, in a truss, all members in at least 3 contiguous panels but not less than the number of panels associated with 3 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 for which there shall be no additional cost to the Department.

(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.

807.17 DRIFTING OF HOLES. Drifting done during assembling 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 or rivets shall be reamed.

807.18 MATCH-MARKING. Connecting parts assembled in the shop for reaming holes in field connections shall be match-marked with steel stencils and a diagram showing such marks shall be furnished to the engineer.

807.19 BOLTS AND BOLTED CONNECTIONS. All bolts shall conform to the requirements of this Subsection, except for high strength bolts. Bolted connections fabricated with high strength bolts shall conform to Subsection 807.20.

(a) General: Bolts shall be unfinished, turned or ribbed bolts conforming to ASTM Designation: 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. 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 the holes. A washer shall be provided under the nut.

(c) Ribbed Bolts: The body of ribbed bolts shall be of 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 greater than the nominal diameter of the specified bolt.

Ribbed bolts shall be furnished with round heads conforming to ANSI Designation: B 18.5. 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.

807.20 CONNECTIONS USING HIGH STRENGTH BOLTS.

(a) General: This specification covers the assembly of structural joints using ASTM Designation: A 325 or A 490 high strength steel bolts tightened to a high tension. Bolt holes shall be 1/16 inch larger than the nominal bolt size.

All fasteners within a connection shall be of the same type, and all bolts and nuts within each connection shall be from the same manufacturer.

Construction shall conform to the specifications for riveted or welded structures of wrought iron, 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 conforming to Subsection 1013.08(c) may be used. Installation of lock-pin and collar fasteners shall be by approved procedures.

(c) Bolts, Nuts and Washers: Bolts, nuts and washers shall conform to ASTM Designation: A 325 or A 490, as specified.

(1) Bolt dimensions shall conform to requirements for heavy hex structural bolts of ANSI Designation: B 18.2.1.

(2) Nut dimensions shall conform to requirements for heavy hex nuts of ANSI Designation: B 18.2.2.

The minimum bolt length shall be determined by adding the appropriate length given in the following table to the grip (total thickness of all connected material, excluding washers):

BOLT LENGTH

Bolt Size (inches)	Length to Add to Grip (inches)
1/2	1-1/16
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

Add 5/32 inch for each hardened flat washer, and add 5/16 inch for each beveled washer. The minimum bolt length thus determined shall be increased to the nearest 1/4 inch to obtain the required bolt length, but in no case shall the bolt have less than 2 threads beyond the nut after final torque.

Washers shall conform to ASTM Designation: F 436.

(d) 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 in excess of the nominal bolt diameter.

When assembled, joint surfaces, including those adjacent to the bolt-heads, nuts or washers, shall be cleaned with high cycle wire brush sander or disc grinder and shall be free of scale, burrs and other defects that would prevent solid seating of the parts.

Contact surfaces within joints shall be free of contaminants and shall be prepared as follows:

(1) When steel is to be painted, contact surfaces within joints shall be cleaned in accordance with Subsection 811.06(b) and painted with the first prime coat of the specified paint system. At the contractor's option, the second prime coat may also be applied to contact surfaces.

(2) When the plans specify the steel as unpainted ASTM A588, contact surfaces within joints shall be thoroughly cleaned by Commercial Blast Cleaning in accordance with Section 811 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, contact surfaces within joints shall be scored by wire brushing or blasting after galvanizing and prior to assembly. 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 bolts are specified to connect galvanized parts, the bolts shall be painted to prevent possible electrolytic action. ASTM A 490 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 C2.2, except that subsequent sealing treatments described in Section IV therein shall not be used.

(e) **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 bolts shall have 2 hardened washers. ASTM A 490 and ASTM A 325 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 tightened to give the bolt tension values shown in Table 3 on completion of the joint. Tightening shall be done with properly calibrated wrenches; however, the "turn-of-nut" method may be used in lieu of calibrated wrenches when permitted by the engineer.

(f) **Calibrated Wrenches:** The setting of calibrated wrenches shall be such as to induce a bolt tension slightly in excess of the bolt tension specified in Table 3. These wrenches shall be calibrated (at least once each working day for each bolt diameter being installed) by tightening, in a device capable of indicating actual bolt tension, at least 3 typical bolts from the lot to be installed. Power wrenches shall be adjusted to stall or cut-off at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened which may have been loosened by the tightening of subsequent bolts.

(g) **Turn-of-Nut Method:** When the turn-of-nut method is permitted by the engineer to provide the bolt tension specified in Table 3, there shall first be enough bolts brought to a snug tight condition to insure that parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table 4 with tightening progressing systemati-

TABLE 3 - BOLT TENSION

Bolt Size (inches)	Recommended Bolt Tension for Calibrated Wrenches (Lbs.)**	Minimum Bolt Tension (Lbs.)*	Approx. Torque for Minimum Bolt Tension (Ft. Lbs.)***
	ASTM A 325 BOLTS		
1/2	12,500	12,050	100
5/8	20,000	19,200	200
3/4	30,000	28,400	350
7/8	41,000	39,250	570
1	54,000	51,500	860
1 1/8	59,000	56,450	1,060
1 1/4	75,000	71,700	1,490
1 3/8	89,500	85,450	1,960
1 1/2	109,000	104,000	2,600
	ASTM A 490 BOLTS		
1/2	15,500	14,900	120
5/8	25,000	23,700	240
3/4	37,000	35,100	440
7/8	51,000	48,500	700
1	67,000	63,600	1,060
1 1/8	84,000	80,100	1,500
1 1/4	107,000	101,800	2,120
1 3/8	127,500	121,300	2,780
1 1/2	155,000	147,500	3,690

* Equal to 70% of specified minimum tensile strength of bolt.
** Approximately 5% in excess of the minimum bolt tension.
*** Values given are for experimental approximates for nonlubricated bolts and nuts and are based on 0.0167 ft.-lb. per inch bolt diameter per lb. minimum bolt tension. The actual value shall be determined during calibration of inspection wrenches.

cally from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

(h) **Inspection:** When the calibrated wrench method of tightening is used, the engineer shall have full opportunity to witness the calibration tests prescribed in Heading (f) of this Subsection.

The engineer shall observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and that all bolts are tightened.

Bolts will be inspected by applying a properly calibrated manual torque wrench in the tightening direction to 10 percent of the bolts, but not less than 2 bolts, selected at random in each connection. If no nut or bolt head is turned by application of the job inspecting torque, the connection shall be accepted as properly tightened. If a nut or bolt head is turned by the application of less than the specified torque, this torque shall be applied to all bolts in the connection, 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 4
Nut Rotation from Snug Tight Condition[1]

Bolt Length (measured from underside of head to extreme end of point)	Disposition of Outer Faces of Bolted Parts		
	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°; for bolts installed by 2/3 turn and more, the tolerance is ± 45°.

[2] When bolt lengths exceed 12 diameters, the required rotation must be determined by actual tests 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 by the engineer.

The contractor, in the presence of the engineer, shall perform the inspection specified herein and shall provide the personnel and required manual torque wrench, which will be calibrated by the Laboratory.

807.21 RIVETS AND RIVETING. The specified size of rivets shall be the size before heating. Rivet heads shall be of standard shape and

uniform size for the same diameter of rivet. They shall be in full contact with the surface of the member.

Except as otherwise provided herein, rivets shall be heated uniformly to a light cherry red color and driven hot. A rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale and other adhering matter.

Rivets that are loose, burned, badly formed or otherwise defective shall be removed and replaced with satisfactory rivets. A rivet whose head is defective in size or whose head is driven off center shall be removed. Stitch rivets that are loosened by driving of adjacent rivets shall be removed and replaced with satisfactory rivets. Caulking, recupping or double gunning of rivet heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines when practical. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required when the size and length of rivets warrant their use.

Rivets may be driven cold provided their diameter is not over 3/8 inch.

807.22 PLATE CUT EDGES.

(a) Edge Planing: Sheared edges of plates more than 5/8 inch thick and carrying calculated stress shall be planed to a depth of 1/4 inch. Reentrant corners shall be filleted to a minimum radius of 3/4 inch before cutting.

(b) Visual Inspection and Repair of Plate Cut Edges: Visual inspection and repair of plate cut edges shall be in accordance with the latest AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

807.23 SHOP WELDING. Shop welding of metal structures shall conform to 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 or curvature and which is in contact with the element at 2 other points. The term "element" as used herein refers to the 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 boundaries of 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 whenever 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 or curvature of a panel shall not exceed the greater of:

$$3/16 \text{ inch or } \frac{D}{144\sqrt{T}} \text{ inch}$$

where

D = least dimension in inches along boundary of panels, and
T = minimum thickness in inches of plate comprising the panel.

(2) **Straightness of Longitudinal Stiffeners Subject to Calculated Compressive Stress, Including Orthotropic-Deck Ribs:** The 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:

$$\frac{L}{480}$$

where

L = length of stiffener or rib between cross members, webs or flanges, in inches.

(3) **Straightness of Transverse Web Stiffeners and Other Stiffeners not Subject to Calculated Compressive Stress:** The

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:

$$\frac{L}{240}$$

where

L = length of stiffener between cross members, webs or flanges, in inches.

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 conform to the following surface finish of ANSI B 46.1, Surface Roughness, Waviness and Lay, Part 1:

	Surface Finish
Steel slabs	2,000
Heavy plates in contact in shoes to be welded	1,000
Milled ends of compression members, stiffeners, and fillers	500
Bridge rollers and rockers	250
Pins and pin holes	125
Sliding bearings	125
All other surfaces	500

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.

807.27 END CONNECTION ANGLES. Floor beams, stringers and girders having end connection angles shall be built to specified length (+0, −1/16 inch) 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 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 the following table:

Plate Thickness (t) (inches)	Minimum Bend Radius
Up to 1/2	2t
Over 1/2 to 1	2 1/2t
Over 1 to 1 1/2	3t
Over 1 1/2 to 2 1/2	3 1/2t
Over 2 1/2 to 4	4t

Low alloy steel over 1/2 inch thick may require hot bending for small radii.

Allowance for springback of A514 steel should be about 3 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 radius is essential, plates shall be bent hot at a temperature not greater than 1200°F, except for A514 steel. If A514 steel plates to be bent are heated to a temperature greater than 1125°F, 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 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 fit sufficiently tight to exclude water after being painted. 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 at each end. Welding transversely across tension flanges of beams or girders will not be permitted.

807.32 EYEBARS. Fabrication of eyebars shall conform to the latest AASHTO specifications.

807.33 ANNEALING AND STRESS RELIEVING. Structural members to be annealed or normalized shall have finished machining, boring and straightening done subsequent to heat treatment. Normalizing

and full annealing shall be as specified in ASTM Designation: E 44. Temperatures shall be maintained uniformly throughout the furnace during heating and cooling so that the temperature at no 2 points on the member shall differ by more than 100°F at any time.

Members of A514 steel shall not be annealed or normalized and shall be stress-relieved only with approval of the engineer.

A record of each furnace charge shall identify pieces in the charge and show temperatures and schedule used. Proper instruments, including recording pyrometers, shall be provided for determining at any time the temperatures of members in the furnace. Records of the treatment operation shall be available to, and meet approval of the engineer. Holding temperature for stress relieving A514 steel shall not exceed 1125°F.

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 the latest AWS Structural Welding Code.

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 in diameter shall be forged and annealed. Pins and rollers 9 inches or less in diameter may be either forged and annealed or cold-finished carbon-steel shafting.

In pins larger than 9 inches in diameter, a hole not less than 2 inches 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. 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 for pin diameters of 5 inches or less, and 0.03125 inch for larger pins.

807.37 SCREW THREADS. Threads for bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC/ANSI B 1.1, Class 2A for external threads and Class 2B for internal

threads, except that pin ends having a diameter of 1 3/8 inches or more shall have 6 threads to the inch.

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.

Beams may be cambered cold or may be heated. If 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 to 1250°F) 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 OTHER MEMBERS. No quenching process shall be permitted without permission of the engineer.

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 section of the concrete deck. Fabrication and painting shall conform to the specifications covering those items. Care shall be taken to insure 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 or 7/8-inch studs. Stud shear connectors shall conform to the following:

(a) Construction Requirements:

(1) Stud shear connectors shall be end welded to beams or girders with automatically timed stud welding equipment. Adequate provision shall be made in the fabrication of structural members to compensate for loss of camber due to welding of shear connectors.

(2) If 2 or more stud welding guns are operated from the same power source, they shall be interlocked so that only 1 gun can operate at a time and so that the power source has fully recovered from making one weld before another weld is started. The power source shall be adequate for the size stud being welded.

(3) Studs shall not be painted or galvanized. At the time of welding, studs shall be free from excessive rust, scale, rust pits and oil. The beam surface to which studs are welded shall be free from excessive mill scale, rust, dirt, paint, grease or other material which might impair the quality of the weld. When necessary to obtain satisfactory welds, the areas on the beam, girder or plate to which studs are to be welded shall be wire-brushed, peened, prick-punched or ground free of scale or rust.

(4) Welding shall not be done when the ambient temperature is below 0°F or when the surface is wet or exposed to rain or snow.

(5) While in operation, the welding gun shall be held in position without movement until weld metal has solidified.

(6) Longitudinal and lateral spacings of studs with respect to each other and to edges of beam or girder flanges shall not vary more than 1/2 inch from specified dimensions, except that a variation of 1 inch will be permitted where required to avoid obstruction with other attachments on the beam or where a new stud is being welded to replace a defective one. The minimum distance from the edge of a stud to the edge of a beam shall be 1 inch, but preferably at least 1 1/2 inches.

(7) The first 2 studs welded on each beam or girder, after being allowed to cool, shall be bent 45° by striking each stud with a hammer. If failure occurs in the weld of either stud, the procedure shall be corrected and 2 successive studs welded and tested before any more studs are welded. The engineer shall be promptly informed of any changes in the welding procedure.

(8) When the temperature of the base metal is below 0°F, preheating will be required in accordance with Section 815 and 2 studs in each 100 studs welded shall be bent 45° in addition to the first 2 bends as specified in Heading (a)(7) of this Subsection. Preheating must be to 70°F and temperature of the preheated base metal shall be maintained between 32°F and 70°F during welding.

(9) Studs on which a full 360° weld is not obtained may be repaired by adding a 3/16-inch fillet weld in place of the lack of weld, using the shielded metal-arc process with low-hydrogen welding electrodes.

(10) If the reduction in the height of studs as they are welded becomes less than normal, welding shall be stopped immediately and not resumed until the cause has been corrected.

(11) Before welding a new stud where a defective one has been removed, the area shall be ground smooth and flush or in the case of a pullout of metal, the pocket shall be filled with weld metal using the shielded metal-arc process with low-hydrogen welding electrodes and then ground flush. In compression areas of flanges, a new stud may be welded adjacent to the defective area in accordance with Heading (6) above in lieu of repair and replacement on existing weld area.

(b) **Inspection:**

(1) If a visual inspection reveals a stud shear connector that does not show a full 360° fillet weld, or that has been repaired by welding, or that shows an abnormal reduction in length due to welding, such stud shall be struck with a hammer and bent 15° from the correct axis of installation, and in the case of a defective or repaired weld, the stud shall be bent 15° in the direction that will place that defective portion of the weld in the greatest tension. Studs that crack either in the weld or shank shall be replaced.

Studs which are to be replaced for the above reasons or because they are otherwise unacceptable may be manually welded a full 360° 1/4 inch fillet weld for 3/4 inch studs, and a full 360° 5/16-inch fillet weld for 7/8-inch and 1-inch studs, as specified in Headings (a)(9) and (a)(11) of this Subsection.

(2) The engineer may select additional studs to be subjected to the bend test specified above.

(3) The studs tested that show no sign of failure may be left in the bent position.

(4) If inspection and testing indicates in the judgment of the engineer, that the shear connectors being obtained are not satisfactory, the contractor will be required at his expense to make such changes in welding procedure, welding equipment and type of shear connector as necessary to secure satisfactory results.

(5) At the expense of the contractor, the manufacturer of the studs may be required at any time to submit sample studs for requalification in accordance with established procedure.

807.43 MARKING AND SHIPPING. 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 3 tons 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.

Bolts and rivets of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts and packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed 300 pounds. 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 conform to Section 811.

807.45 FALSEWORK. Falsework shall be designed properly, constructed substantially and maintained for the loads which will come upon it.

807.46 BEARINGS AND ANCHORAGES. Bearings shall be set level, in exact position, and must have full and even bearing on the masonry.

Elastomeric bearing pads, if used, shall be set directly on the concrete masonry.

Cast iron or steel or rolled steel bearings shall be bedded on the masonry with alternate layers of red lead and canvas, or a single thickness of sheet lead, or preformed fabric bearing pad.

Anchor bolts shall be installed in accordance with Subsection 805.15.

Location of anchors and setting of rockers or rollers shall take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom chord or bottom flange due to dead load after setting; the intention being that, as near as practical, at mean temperature and under dead load, the rockers and rollers will set vertically and anchor bolts at expansion bearings will center their slots. Care shall be taken that full and free movement of the superstructure at movable bearings is not restricted by improper setting or adjustment of bearings or anchor bolts and nuts.

Bearings shall not be placed on masonry bearing areas which are irregular or improperly formed.

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 A514 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 A514 steel exceed 1125°F, nor shall the temperature exceed 950°F at weld metal or within 6 inches 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 1200°F (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 A514 steel shall be done only under rigidly controlled procedures, each application subject to approval of the engineer.

807.48 ASSEMBLING STEEL. Parts shall be accurately assembled and any matchmarks 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 larger.

Permanent field bolting shall be performed in accordance with Subsection 807.20.

807.49 RIVETING. Pneumatic hammers shall be used for field riveting except when the use of hand tools is permitted. Rivets larger than 7/8-inch diameter shall not be driven by hand. Cupfaced dollies fitting the head closely to insure good bearing shall be used. Connections shall be accurately and securely fitted up before rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled. In other respects, riveting shall conform to Subsection 807.21. Field rivets shall not be smaller than the heads of the shop rivets. In removing rivets, the surrounding metal shall not be damaged, and if necessary, they shall be drilled out.

807.50 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 screwed up tight and the threads burred at the face of the nut with a pointed tool.

807.51 FIELD WELDING: Field welding of steel structures, when authorized, shall conform to Section 815.

807.52 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 up of parts by moderate use of drift pins or reaming and slight chipping or cutting, shall be reported immediately to the inspector and his approval of the method of correction obtained. The correction shall be made in his presence. The contractor shall be responsible for all misfits, errors and damages and shall make the necessary corrections and replacements.

807.53 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 x 5/8 inch threaded galvanized bolt. It shall be located on the downstream side at the end of the bridge on the right descending bank. If the bridge has a concrete deck, the bench mark plate shall be set at the end of the curb. No permanent plates or markers other than those furnished or specified will be permitted on any structure.

807.54 WEATHERING STEEL. When ASTM A 588 weathering steel is specified to be left unpainted,the following modifications in the requirements of this Section shall apply.

(a) **Materials:** Steel to be completely embedded in concrete shall be either ASTM A36 or A588 steel. Anchor bolt assemblies and other steel partially embedded in concrete shall be A588 steel.

(b) **High Strength Bolts:** High strength bolts shall be ASTM A325, Type 3.

(c) **Stiffeners:** To facilitate drainage adjaent to stiffeners, the lower end of transverse stiffeners shall be clipped at least 1 1/2 inch, and longitudinal stiffeners shall be terminated at least 1 inch 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(c). Blast cleaned surfaces shall be kept free of grease, oil, markings, paint or other soilage; and all such soilage of blast cleaned surfaces shall be removed by approved methods. Concrete splatter shall be washed off immediately.

At the contractor's option, any other weathering steel surface may be blast cleaned.

(e) **Restoration of Concrete Finish:** After all weathering steel has been in place for at least 30 days, the contractor shall remove all discolorations of concrete surfaces due to weathering of the steel and shall restore the finish of these concrete surfaces.

807.55 METHOD OF MEASUREMENT.

(a) **Weight Basis:** Structural steel will be measured by the weight of metal in pounds 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 rivets, bolts, nuts, washers or welds and no deductions will be made for rivet holes, 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 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.

Steel (A 36) 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, wrought iron sheets, 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.

Steels (A 440-77), (A 441), (A 572) and (A 588) include all steel classified as such in the plans or specifications.

Metal weights will be computed on the following basis:

Metal	Unit Wt. (Lbs./Cu. Ft.)
Aluminum, cast or wrought	173.0
Bronze, cast	536.0
Copper-alloy	536.0
Copper, sheet	558.0
Iron, cast	445.0
Iron, malleable	470.0
Iron, wrought	487.0
Lead, sheet	707.0
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490.0
Zinc	450.0

(b) Lump Sum Basis: When payment is specified to be made by the lump sum, no weight measurement of metal will be made. Any estimate of the weight of structural metalwork shown on the plans is approximate and no guarantee is made that it is the correct weight to be furnished. It will be the contractor's responsibility to determine the correct weight of each grade of metal to be furnished. No adjustment in

contract price will be made due to errors in the estimated weight shown on the plans. Shop bills will not be required.

807.56 BASIS OF PAYMENT.

(a) Weight Basis: The various classifications of structural metals will be paid for at the respective contract unit prices per pound.

(b) Lump Sum Basis: The completed and accepted items will be paid for 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 and other hardware; and the performance of all work necessary to complete the item.

If changes in the work are ordered by the engineer, which vary the weight of steel to be furnished, the lump sum payment will be adjusted as follows:

The value per pound of the increase or decrease in the weight of structural steel involved in the change will be determined by dividing the contract lump sum amount by the estimated weight 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(1)	Steel (A 36)	Pound
807(2)	Steel (A 440)	Pound
807(3)	Steel (A 441)	Pound
807(4)	Steel (A 572)	Pound
807(5)	Steel (A 588)	Pound
807(6)	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 conform to Subsection 1013.21.

Concrete in filled steel grid floors shall be Class A conforming to Section 901, except Grade F coarse aggregate shall be used.

Upper edges of members forming the wearing surface of open type grid flooring shall be fabricated or treated to give maximum skid resistance.

808.03 FABRICATION. Deviations from these specifications to conform to manufacturer's specifications will not be permitted without approval of the Bridge Design Engineer.

808.04 NOTICE OF BEGINNING OF WORK. The contractor shall give the 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. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before shop drawings have been approved and before the 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 Subsection 807.04.

808.06 STORAGE OF MATERIALS. Steel grid flooring shall be stored as specified in Subsection 807.06.

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, but in every case the units shall extend over at least 3 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 full continuity.

Where main elements are parallel to centerline of roadway, sections shall extend over not less than 3 panels, and ends of abutting units shall be welded over their full cross-sectional area or otherwise connected to provide full 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 or riveting bars. Connections will be subject to approval of the engineer. Rivets may be cold driven.

808.11 CONNECTION TO SUPPORTS. The floor shall be connected to its steel supports by welding. Before any welding is done, 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 conform to Section 815. Field welding shall conform to the approved method and location as shown on the shop drawings.

808.13 PAINTING. The open steel grid floor shall be cleaned and painted in accordance with Section 811. Cleaning shall be done by the Near-White Blast Cleaning Method. For filled type grid flooring, only the

underside of the bottom plate and the other faces of headers, trim bars and end bars shall be painted.

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 or wood to retain the concrete filler without excessive leakage.

If metal forms are used, they shall fit tightly on bottom flanges of floor members and be placed in short lengths so as to extend only about 1 inch onto the edge of each support, but in all cases forms shall provide for adequate bearing of the slab on the support.

Concrete shall be thoroughly consolidated by vibrating the steel grid floor. The vibrating device and the manner of operating it will be subject to approval.

808.15 METHOD OF 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 BASIS OF PAYMENT. Steel grid flooring will be paid for at the contract price per square foot, which includes furnishing and fabricating all steel materials, including base plates, trim angles, trim plates, painting or other coating (if required) and all welding and riveting, 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(1)	Steel Grid Flooring	Square Foot

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, power plant and machinery houses.

The requirements for fixed span bridges, as given in these specifications, shall apply to movable bridges except as herein provided.

809.02 GUARANTEES. The contractor guarantees, by his signing of the contract, all machinery, operating houses, traffic barriers and power plant equipment, materials and workmanship for a period of one year after the date of final acceptance of the project.

Prior to final acceptance of the project, the contractor shall furnish warranties and guarantees as specified in Subsection 104.05.

If it should be found that parts failed due to defective material or faulty workmanship and if such parts should, within the said one year, cause any breakdown or accident, the contractor will not only be required to furnish and install the defective part but will also be held pecuniarily responsible to the Department for all expense to the latter due to such failure. The contractor shall insert 1 copy of all warranties and guarantees into the maintenance manuals specified. Routine maintenance during the guarantee period will be performed by the Department.

809.03 BOND. As a guarantee to cover the replacement of warranted equipment and apparatus as stated above, the contractor will be required to furnish satisfactory bonding in full amount of the contract price for machinery, operating houses, traffic barriers and power equipment. This bond shall remain in effect for a period of one year from date of final acceptance of the project and must be filed in the offices of the Department before payment of the final estimate will be made.

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.

809.06 INSTRUCTION TO OPERATORS. The contractor shall notify the engineer when the span, including the power plant, operating house, traffic barriers and machinery, is sufficiently complete to be operable in order that the permanent bridge operators may be assigned for instruction. At this time, the contractor shall furnish a competent person, experienced in operation of equipment of this character, for a period of 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 of the Department's electrical, mechanical and bridge maintenance personnel in proper operation, maintenance, lubrication and adjustment of equipment. This 5-day period of instruction shall be prior to final inspection.

809.07 METALS. Structural and miscellaneous metals to be used in the manufacture of parts for movable bridges shall be as listed in Part X, Materials, current AASHTO Standard Specifications for Movable Highway Bridges, the project specifications and as shown in the plans.

809.08 WIRE ROPE AND ATTACHMENTS. Wire rope and attachments shall be as specified in Section 1009, the project specifications and as shown on the plans.

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 machinery and traffic barrier parts shall be in accordance with the current and best practice of modern foundries and machine shops. The manufacture of machined parts shall be in accordance with ANSI standards for the various items. All surface finish requirements in this Section refer to ANSI B 46.1.

(b) Inspection: The contractor shall give the 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 Subsection 807.04. 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: Allowances which should be made for different kinds of fits are tabulated hereinafter. They are based on the use of the hole as the nominal size and give the amounts by which the shaft should be less than (minus) or greater than (plus) the nominal hole size. If the shaft is selected as the base, the allowances for the hole will be of the same magnitude but of opposite sign. The permissible tolerance is the difference between the minimum and maximum allowances.

(d) Classifications of Fits and Surface Finishes:

Classifications	ANSI Surface Finish
Loose Fit (Class 1), Large Allowance. This fit provides for considerable freedom and embraces certain fits where accuracy is not essential. Suitable for ordinary bearings on shafts which are subject to journal pressures of 600 psi or less.	Bearings—16 Journals—8
Free Fit (Class 2), Liberal Allowance. For running fits with speeds of 600 rpm or over and journal pressure of 600 psi or over, and for heavily loaded journals on shafts and trunnions.	Bearings—16 Journals—8
Medium Fit (Class 3), Medium Allowance. For running fits under 600 rpm and journal pressures less than 600 psi, and for sliding fits.	Bearings—16 Journals—8
Snug Fit (Class 4), Zero Allowance. This is the closest fit which can be assembled by hand and necessitates work of considerable precision.	125
Wringing Fit (Class 5), Zero to Negative Allowance. This is also known as a tunking fit and is practically metal to metal.	125
Tight Fit (Class 6), Slight Negative Allowance. Light pressure is required to assemble these fits.	125
Medium Force Fit (Class 7), Negative Allowance. Considerable pressure is required to assemble these fits, and the parts are considered permanently assembled.	125
Heavy Force and Shrink Fit (Class 8), Considerable Negative Allowance. These fits are used for steel holes where the metal can be highly stressed without exceeding its elastic limit.	125
Shafts Outside Bearings:	250

Allowances for the various classifications of fits shall be in accordance with the following tables.

ALLOWANCES FOR VARIOUS TYPES OF FIT

(Allowances, Tolerances and Interference are given in ten-thousandths of an inch)

Size, Inches	Loose Fit (Class 1)		Free Fit (Class 2)		Medium Fit (Class 3)		Snug Fit (Class 4)		Wringing Fit (Class 5)		Tight Fit (Class 6)	Medium Force Fit (Class 7)	Heavy Force or Shrink Fit (Class 8)
	Tightest fit	Loosest fit	Tightest fit	Loosest fit	Tightest fit	Loosest fit	Tightest fit	Loosest fit	Tightest fit	Loosest fit	Selected fit	Selected fit	Selected fit
	Allowance	Allowance plus Tolerances	Allowance	Allowance plus Tolerances	Allowance	Allowance plus Tolerances	Allowance	Allowance plus Tolerances	Allowance	Allowance plus Tolerances	Average Interference	Average Interference	Average Interference
	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(−)	(−)	(−)
1 1/16–1 3/16	30	90	15	43	10	26	0	10	4	6	3	6	11
1 3/16–1 3/8	30	90	16	44	10	28	0	10	4	6	3	6	13
1 3/8–1 5/8	30	90	18	48	12	30	0	12	4	7	4	8	15
1 5/8–1 7/8	40	100	20	52	13	33	0	12	5	7	5	9	18
1 7/8–2 1/8	40	100	22	54	14	34	0	13	5	8	5	10	20
2 1/8–2 3/8	40	100	24	58	15	35	0	13	5	8	6	11	23
2 3/8–2 3/4	50	110	26	62	17	39	0	13	5	8	6	13	25
2 3/4–3 1/4	50	130	29	67	19	43	0	15	6	9	8	15	30
3 1/4–3 3/4	60	140	32	72	21	45	0	15	6	9	9	18	35
3 3/4–4 1/4	60	140	35	77	23	49	0	16	6	10	10	20	40
4 1/4–4 3/4	70	150	38	80	25	51	0	17	7	10	11	23	45
4 3/4–5 1/2	70	150	41	85	26	54	0	17	7	10	13	25	50
5 1/2–6 1/2	80	180	46	94	30	60	0	18	7	11	15	30	60
6 1/2–7 1/2	90	190	51	101	33	63	0	19	8	11	18	35	70
7 1/2–8 1/2	100	200	56	108	36	68	0	20	8	12	20	40	80

(+) denotes clearance or amount of looseness
(−) denotes interference of metal or negative allowance

For larger than 8 1/2 inch diameter, use following:

Formulas for Recommended Allowances and Tolerances

Class of Fit	Method of Assembly	Allowance	Selected Average Interference of Metal	Hole Tolerance	Shaft Tolerance
(1) Loose	Strictly Interchangeable	$0.0025\sqrt[3]{d^2}$		$0.0025\sqrt[3]{d}$	$0.0025\sqrt[3]{d}$
(2) Free	Strictly Interchangeable	$0.0014\sqrt[3]{d^2}$		$0.0013\sqrt[3]{d}$	$0.0013\sqrt[3]{d}$
(3) Medium	Strictly Interchangeable	$0.0009\sqrt[3]{d^2}$		$0.0003\sqrt[3]{d}$	$0.0003\sqrt[3]{d}$
(4) Snug	Strictly Interchangeable	0.0000		$0.0006\sqrt[3]{d}$	$0.0004\sqrt[3]{d}$
(5) Wringing	Selective Assembly		0.0000	$0.0006\sqrt[3]{d}$	$0.0004\sqrt[3]{d}$
(6) Tight	Selective Assembly		0.00025d	$0.0006\sqrt[3]{d}$	$0.0006\sqrt[3]{d}$
(7) Medium force	Selective Assembly		0.0005d	$0.0006\sqrt[3]{d}$	$0.0006\sqrt[3]{d}$
(8) Heavy force or shrink	Selective Assembly		0.001d	$0.0006\sqrt[3]{d}$	$0.0006\sqrt[3]{d}$

d = diameter of fit in inches.
The formulas for allowance values give the ideal condition of fit for Classes 1 to 4.
The formulas for selected average interference of metal give the ideal condition of fit for Classes 5 to 8.

809.11 SHAFTS, TRUNNIONS AND JOURNALS. Shafts and trunnions shall be made with fillets where abrupt changes in section occur.

Journals of shafts and trunnions shall be polished to ANSI No. 8 surface finish after being machined. For shafts and trunnions more than 8 inches 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 No. 125 surface finish and holes bored in pairs.

809.13 HUBS. Hubs of wheels, pulleys, gears and couplings shall be bored true to center for Class 7 fit upon their shafts or axes. 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 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 bushing after boring will be uniform.

809.15 BEARING HOUSING. Rubbing and bearing surfaces shall have an ANSI No. 16 surface finish and the joints between cap and base of bearings shall have an ANSI No. 125 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 and bolts turned 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. Teeth of gears 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. Teeth of the rack may be either cast or cut and finished, as specified.

809.17 BEVEL GEARS. Teeth of bevel gears 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.

809.18 WORMS AND WORM WHEELS. Threads on worms shall be machine cut and teeth of worm wheels shall fit the worm accurately with surface or line contact.

809.19 KEY AND KEYWAYS. Keys shall be planed and keyways machine cut. The finish of keys and keyways shall be such as to give the key a Class 7 fit on all the sides. Tapered keys shall bear on the top, bottom and sides; parallel faced keys on the sides only.

809.20 CASTINGS. Castings shall be cleaned and all fins and other irregularities removed so that they will have clean, smooth, uniform surfaces suitable for this class of work. Contact surfaces of castings to be attached to structural steel or other castings shall have an ANSI No. 250 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 No. 2000 finish.

809.21 BOLT HOLES AND TURNED BOLTS. Holes for unfinished bolts shall be drilled or reamed not more than 1/16 inch larger in diameter than the bolt. Diameter of the shank of turned bolts shall be of such size as to make a Class 6 fit for the holed parts.

809.22 AIR BUFFERS. Workmanship on air buffers shall be so accurate that the weight of the cylinder and its attachments will be sustained by the confined air for 6 minutes, with the cylinder lubricated

with a light oil and with a piston travel not more than that which occurs during closure of the bridge. Valves must be closed and buffers balanced so that the whole weight is carried by the piston rod.

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 preferably be attached to the shoes by means of 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 No. 250 finish. The track centerline shall be scribed on the surface.

Tooth segments forming the rack shall be fitted accurately. Care shall be taken to have the pitch of the 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 No. 1000 finish. Surfaces which bear on masonry shall have an ANSI No. 2000 finish.

809.25 PIVOT PEDESTALS. Disc seats shall be so finished as to insure a horizontal position of the span.

809.26 DISCS. 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 No. 8 finish. Disc centers shall be assembled, fitted accurately and match-marked.

809.27 BALANCE WHEELS. The periphery and faces of balance wheels shall be turned to an ANSI No. 250 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 No. 250 finish.

809.29 TREAD PLATES AND TRACK SEGMENTS. Contact surfaces of tread plates and track segments shall be given an ANSI No. 250 finish.

809.30 OIL OR GREASE GROOVES IN TRUNNIONS. Oil or grease grooves in the surfaces of trunnions and similar large bearings shall be machine cut. After machining, small inequalities may be removed by chipping and filing. Grooves shall be smooth, especially the rounded corners.

809.31 BORING AND ASSEMBLY OF TRUNNION BEARINGS. When trunnion bearings are to be mounted on flexible supports, they shall be so bored that when 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.

Sheaves shall have an ANSI Class 8 fit on shafts up to and including 10 inches, and an ANSI Class 7 fit on shafts over 10 inches.

Both ends of hub shall be finished as specified.

809.33 HOLES FOR SHEAVES FOR VERTICAL LIFT BRIDGES. In vertical lift bridges, holes in girders and columns for bolts connecting main sheave bearings to their supporting girders 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 and the 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 smaller and reamed to size after erection.

809.35 HYDRAULIC PIPING. Inside of hydraulic piping shall be bright, clean and free from grease, drawing 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 or with benzine. Welding of hydraulic pipe shall conform to Section 815.

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 thoroughly protected by boxes or crates. Electric motors not designed to be operated fully exposed to the weather shall be protected by waterproof coverings.

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 which are protected from weather in the completed structure or during shipment from the shop shall be likewise protected during unloading, field storage and erection. Care shall be exercised in protecting electrical parts. Wire ropes shall be stored at least 16 inches above ground and free from conditions likely to produce corrosion of wires or decay of hemp cores. While being unwound or otherwise handled during installation, they 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.

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 3/1000 of an inch. 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. To prevent localization of stresses in machinery and traffic barrier parts, shims shall not be less in dimensions than the bearing area being shimmed.

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 cleaned and well lubricated during erection. All parts shall be properly lubricated before operating machinery is tested. Counterweight and operating ropes shall be given 1 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, rivets in all main truss connections shall have been driven or joints 100 percent pinned and bolted so that no slip 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 following requirements:

1. When blocking is removed and the span allowed to swing free under full dead load at normal temperature, the elevations at the span ends shall be at a distance below grade equal to the specified end lift.

2. When wedges are fully driven and the structure is acting under full dead load including the deck, the elevation at all panel points shall conform to the specified grade lines.

The above method involves superimposing 2 cambers. The first is equal to deflection of the structure as a cantilever under full dead load and the second is equal to deflection when acting as a continuous or partially continuous span under full dead load and dead load end reactions.

(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 insure correct closing and locking.

(h) **Alignment and Trunnion Bearings:** Care shall be taken in alignment of trunnion bearings by means of beveled shims or other means provided so that when full deflection of trunnion girder or bearing support occurs under full dead load, the axes of trunnions will be coincident.

(i) **Alignment of Vertical Lift Spans:** Care shall be taken to assure proper spacing and alignment of towers so that towers and guides will be vertical when the dead load of the span and counterweight has been applied.

(j) **Service Test of Machinery:** A service test of power operation of the span shall be made by moving the span through a number of complete open and close cycles. 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, so that any tendency of the operating parts to become heated may be discovered. All defects found in the operation of the span shall be corrected.

809.38 COUNTERWEIGHTS. Counterweights shall be sufficient to balance the moving span and its attachments in any position, except that in vertical lift bridges, the counterweight ropes shall not be balanced.

Prior to final acceptance but after all work is completed, the contractor shall balance the span with the counterweights. For lift spans, balancing shall be accomplished by noting the traction motor currents required to raise and to lower the span. Each traction motor shall be balanced with the corresponding counterweight and for lift spans both traction motors shall be balanced with each other. During balancing operations, the power selsyns shall be cut out.

When correctly balanced, span motors shall require approximately the same current throughout the span operation. The current should be highest when starting the span from the full seated position and lowest at the fully raised position in the opening operation and the opposite in the closing operation.

When the span and counterweights are at equal elevations and the span controller is placed in the "Drift" position, the span should drift slightly and then stop in either the raise or lower operation. If the span and counterweights are stopped at equal elevations and the span controller placed in the "Drift" position, the span should not drift in either direction.

Bascule spans shall be balanced by noting the span pump motor currents required to raise and to lower each span. Counterweight blocks shall be added or removed until opening and closing currents are approximately equal.

When the spans and counterweights have been properly balanced, balance blocks shall be removed from each counterweight to give the spans a small positive reaction in the closed position, as directed. All balancing shall be accomplished in the presence of the engineer.

Counterweights shall be of concrete supported in a steel box or by a steel frame. They 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. Concrete blocks weighing not over 100 pounds each shall be used and they shall be provided with eye or ring bolts to facilitate handling. Space for 5 percent under and over the calculated weight shall be provided. Movable blocks shall be provided as specified. Pockets shall be provided with drain holes at least 6 inches in diameter. If the 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 when the bridge is fully open. 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 weighing approximately 145 pounds per cubic foot. Steel punchings or scrap metal may be used when necessary to increase concrete unit weight. If steel punchings are used, they shall be placed in layers and grouted with a cement mortar composed of 1 part portland cement and 2 parts sand. The maximum available total weight shall not be taken as more than 315 pounds per cubic foot. Such a mixture shall not be used as a counterweight which revolves above a horizontal axis, unless retained in place by surrounding steel box or by walls of reinforced concrete.

The fabricator of the structural steel shall determine the weight and where 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 computed from approved shop plans and these weights 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 of concrete for counterweights.

Determination of the proper mixture for counterweights to give the desired unit weight is especially important and 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 not less than one cubic foot shall

be made and a record kept showing the weight of blocks when cast and when 1, 2, 3 and 7 days old. The engineer shall be notified at least 3 days prior to casting of test blocks, and the casting and weighing of the blocks shall be done in the presence of the engineer. This record of test blocks must be submitted to the engineer for approval before concreting is to begin and 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 the counterweights.

The unit weight of materials entering into construction of the deck is an important factor in the determination of the volume of the counterweights and the contractor shall furnish the engineer and fabricator with the unit weight of materials used in the deck. The determination of unit weights 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 of the deck slab as constructed.

The contractor shall assume responsibility for the correctness of the center of gravity calculations. He shall also be responsible for the detail drawings of counterweights and construction of counterweights of correct unit weight so that the completed bridge will be in proper balance. The contractor shall be responsible for the balancing of the bridge and shall make free of charge, all necessary adjustments and alterations required to obtain a proper balance.

809.39 POWER PLANT.

(a) **General:** The power plant shall be as provided in current AASHTO Standard Specifications for Movable Highway Bridges, and as specified in the plans and project specifications, except as provided herein.

(b **Power Supply:** On electrically operated bridges, the contractor shall make all necessary arrangements with the power company for electrical service. The contractor shall furnish and install the service pole and shall bring the electrical power service to the switchboard in the operating house. The electrical service shall be 110/220 volt, 4 wire delta, 3-phase, 60 Hertz A.C. and shall be brought into the operating house underground in rigid metal conduit.

No direct payment will be made for power used prior to final acceptance.

(c) **Inspection of Switchboard and Control Desk:** Before shipment, the control desk and switchboard shall be tested for operation sequence of devices, grounds and ability to withstand operating voltages and currents in accordance with NEMA standards. The contractor shall give the engineer ample notice before making final tests so that the engineer may inspect the switchboard and control desk and witness these tests. Witnessing of the tests shall be at the option of the Depart-

ment and shall not relieve the contractor of any responsibility placed upon him by his contract.

(d) Grounding and Bonding: The entire system shall be grounded and bonded in accordance with the National Electric Code (NEC). Conduit runs shall be bonded at the control desk and switchboard as well as throughout the system.

(e) Wiring: Conductors shall be copper and have a rated 600 volt moisture and heat resistant NEC Type XHHW, XLPE insulation, and shall conform to Subsection 1018.10.

All conductors, except spares, shall be terminated on high pressure connector barrier type terminal blocks. Conductors shall be identified with adhesive type wire markers with proper identification stamped thereon.

Conductors smaller than AWG No. 12 shall not be used. Conductors shall be stranded in accordance with IPCEA specifications.

(f) Conduit: The entire conduit system shall be rigid metal conduit, except that a short length of flexible conduit shall be provided at connections to motors, brakes, limit switches and other equipment as shown on the plans. Underground conduit, and conduit embedded in concrete, shall be galvanized, sherardized or metallized rigid steel. Conduit exposed on structures shall be rigid aluminum. Conduit fittings shall be cast aluminum, with cast covers and solid neoprene gaskets. Conduit clamps, clamp backs and nest backs shall be heavy duty malleable iron, galvanized, and shall be held with stainless steel hex head bolts with hex nuts and external tooth lockwashers. Insulated throat metal bushings shall be used at ends of conduits to prevent damage to conductors. Drain holes of 1/8 inch diameter shall be drilled at the low point of all conduit runs before wire is pulled in the conduit. Cut threads on steel conduit shall be given an approved protective coating before assembly. Threads on aluminum conduit shall be painted with an approved oxide inhibiting compound. Conduit shall conform to Subsection 1018.09.

Stainless steel hardware shall conform to Subsection 1018.08.

(g) Junction Boxes: Junction boxes shall be made of welded aluminum plate with a minimum wall thickness of 1/4 inch. Corners and edges shall be well-rounded and welds shall be ground smooth. Junction boxes shall have drain and breather fittings, located top and bottom.

Junction boxes shall have sufficient terminal blocks to terminate all conductors except spares. Mounting terminal blocks on the sides, top or bottom of boxes will not be permitted. A clear distance of at least 6 inches shall be provided between rows of terminal blocks and at least 6 inches between terminal blocks and sides of the box. The minimum

depth of junction box shall be twice the diameter of the largest conduit entering the box plus 2 inches, but in no case less than 6 inches. Junction boxes shall have hinged covers, equipped with neoprene gaskets to form watertight seals, and held closed with stainless steel hinged bolts with winged nuts.

Cast aluminum hubs shall be used for conduit attachment to the junction box.

All hardware shall be stainless steel.

Junction boxes shall conform to Subsection 1018.11.

Hardware shall be in accordance with Subsection 1018.08.

(h) Terminal Blocks: Terminal blocks shall be provided for the termination of all conductors, except spares, which do not terminate at devices equipped with terminals. Terminal blocks shall be of the barrier type equipped with high pressure connectors. Black over white plastic marking strips shall be provided and each connector shall be identified by engraving the marking strip with the same identification as the elementary wiring diagram.

(i) Internal Combustion Engines: Internal combustion engines shall be as shown on the plans.

(j) Fuel Tank: Fuel tanks shall be a minimum of 100 gallons capacity and constructed of steel sheet metal not less than 1/8 inch thick. Approved fiber glass tanks may be used underground. The tank shall be labeled by the Underwriters Laboratory and shall be equipped with drain, vent and filler pipes. The filler pipe shall be so constructed as to permit gaging of the tank with a calibrated stick gage to be furnished by the contractor.

809.40 OPERATING AND MACHINERY HOUSES. The operating house and machinery house shall be constructed in accordance with the plans. All obviously necessary parts or fittings not shown or specified shall be furnished by the contractor without extra charge.

809.41 METHOD OF MEASUREMENT.

(a) Movable Bridge Machinery: Movable bridge machinery will be measured for payment 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 for payment on a lump sum basis, which includes furnishing all materials and erecting the traffic barriers.

(c) **Power Plant:** Power plant will be measured for payment on a lump sum basis, which includes all electrical motors, internal combustion engines and all incidental parts, electrical generator sets, electrically operated brakes, switchboard and control desk with their attachments and electrical parts, controllers, resistors, limit switches, transformers, circuit breakers, electric navigation lights, navigation and sound signals, storage batteries, battery chargers, electrically operated position indicators, service lighting, traffic warning signals, electrically operated roadway traffic gates, floodlights, wiring, conduits and their fittings, junction boxes, submarine cables, flexible cables, collector rings, contactors, switches, instructors, pit pumps, name plates for each operating element, and all other items and equipment required for the installation for a complete power plant and all items classified as "Power Plant" on the plans.

(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) Class A concrete in counterweights will be measured by the cubic yard in accordance with Subsection 805.16.

Deformed reinforcing steel or structural steel used in counterweights will be measured as provided in Sections 806 and 807.

809.42 BASIS OF PAYMENT. Machinery, traffic barriers, power plant, operating house and machinery houses will be paid for at the respective lump sum contract prices, complete in place and accepted.

Concrete and reinforcing steel or structural steel used in counterweights will be paid for as provided in Sections 805, 806 and 807.

Payment will be made under:

Item No.	Pay Item	Pay Unit
809(1)	Movable Bridge Machinery	Lump Sum
809(2)	Traffic Barriers	Lump Sum
809(3)	Power Plant	Lump Sum
809(4)	Operating House	Lump Sum
809(5)	Machinery Houses	Lump Sum

Section 810

Bridge Railings and Barriers

810.01 DESCRIPTION. This work consists of furnishing and constructing bridge railings and barriers of the type specified in accordance with these specifications and in reasonably close conformity to the lines, grades and dimensions shown on the plans or established by the engineer.

810.02 MATERIALS. Materials shall conform to Section 1012. Concrete shall be Class AA.

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 1600 psi before placing of reinforcing steel and forms for concrete railings. The deck slab shall attain a minimum compressive strength of 3200 psi before pouring concrete railings. 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 to 1 1/2 inches unless otherwise approved. The contractor's proposed slip-form procedures and equipment shall be approved prior to beginning slip-form concrete placement. 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 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 all work is completed,

loose or thin shells or mortar likely to spall under movement shall be removed.

810.06 PLACING RAILING. Concrete barrier or railing shall not be placed until centering of falsework for the span has been released, rendering the span 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 fixing in place to insure 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 METHOD OF MEASUREMENT. Quantities of railings and barriers for payment will be the design lengths as specified on the plans and adjustments thereto. Design quantities of railing include all work constructed above the roadway curb, sidewalk or sidewalk curb; and design quantities of barriers include all work constructed above the roadway.

Reinforcing steel and hardware for railings and barriers will not be measured for payment.

810.09 BASIS FOR PAYMENT: Railing and barriers will be paid for at the contract unit price per linear foot, subject to the following provisions.

Concrete railing will be paid for on a lot basis. A lot will be a completed unit or an identifiable pour that is completed in one day.

Two random batches shall be sampled for each lot, and 3 cylinders molded for each batch. The 6 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 3 cylinders will constitute a lot.

Acceptance and payment for each lot will be in accordance with Table 2 of Section 901.

Payment will be made under:

Item No.	Pay Item	Pay Unit
810(1)	Concrete Railing (Type)	Linear Foot
810(2)	Steel Railing	Linear Foot
810(3)	Pipe Railing	Linear Foot
810(4)	Steel and Concrete Railing	Linear Foot
810(5)	Pipe and Concrete Railing	Linear Foot

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, in accordance with the plans, project specifications and as directed.

Unless otherwise specified, an approved 3-coat organic zinc paint system as specified under Subsection 811.03(a) shall be used for coating all metal surfaces requiring painting.

The contractor shall notify in writing the Department's Bridge Design Engineer, and the Consulting Engineer if one is involved, of the approved paint system that will be used on the project prior to submitting required shop drawings. This paint system must be shown on all shop or working drawings.

Requirements for galvanizing and metallizing of metal surfaces are also included in this Section.

Metal surfaces to be painted shall be cleaned in accordance with the Near-White Blast Cleaning Method described in Subsection 811.06.

811.02 SAFETY STANDARDS. The contractor's attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. Appropriate respiratory protective devices must be provided by the contractor and must 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.

(a) The 3-Coat Organic Zinc Primer and Topcoat System shall conform to Subsection 1008.02 and shall be an approved system on the Qualified Products List. The contractor has the option of using any one of these systems; however, no modification or combining of systems will be permitted and the same system shall be used throughout the project.

(b) The 2-Coat Organic Zinc Primer and Topcoat System shall conform to Subsection 1008.03.

(c) **The Basic Lead Silico Chromate Paint System** shall conform to Subsection 1008.04. Colors of the coats shall be in accordance with standard color samples available upon request from the Department's Materials Section.

(d) **The Red Lead and Aluminum Paint System** shall conform to Subsections 1008.05 and 1008.06.

(e) **The Coal Tar Epoxy-Polyamide Paint System** shall conform to Subsection 1008.08.

811.04 PAINTING METAL. All metal surfaces shall be painted with the 3-coat organic zinc paint system unless painting would interfere with proper operation of movable metal parts.

When field weld 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.

Preassembled and precoated parts shall be treated with 1 coat of wash primer conforming to Military Specification MIL-P-15328C at a dry film thickness of 0.5 to 1.0 mil prior to application of topcoat.

When required, galvanized, sherardized or metallized surfaces of sheet metal, electrical conduit, and water, air and gas pipes that are exposed and visible shall be painted. Surfaces to be painted shall be treated with 1 coat of wash primer conforming to Military Specifications MIL-P-15328C at a dry film thickness of 0.5 to 1.0 mil prior to application of topcoat. Other galvanized, sherardized or metallized surfaces shall not be painted.

Metal surfaces to be encased in concrete shall not be painted. Painting of aluminum surfaces will not be required.

(a) **3-Coat Organic Zinc Primer and Topcoat Systems:** Each coat shall be applied in one application and the minimum dry film thickness of each coat shall be as follows:

1st Prime Coat (Tinted Red)	3.0 mils
2nd Prime Coat (Tinted Green)	1.5 mils
Vinyl Aluminum Topcoat	3.0 mils

Minimum dry film thickness of the 3-coat system shall be 7.5 mils.

(b) **2-Coat Organic Zinc Primer and Topcoat System:** Each coat shall be applied in 1 application to a minimum dry film thickness of 3.0 mils per coat.

(c) Basic Lead Silico Chromate System:

(1) New Structures: A 4-coat system shall be used and the minimum dry film thickness of coatings shall be as follows:

1st Coat (Brown)	1.5 mils
2nd Coat (Maroon)	1.5 mils
3rd Coat (Gray)	1.5 mils
Final Coat (Cement Gray)	1.0 mil

Minimum dry film thickness of the 4-coat system shall be 5.5 mils.

(2) Existing Structures: A 3-coat system shall be used on existing steel surfaces and any new steel being placed in the existing structure, and the minimum dry film thickness of coatings shall be as follows:

1st Coat (Brown)	2.0 mils
2nd Coat (Gray)	2.0 mils
Final Coat (Cement Gray)*	2.0 mils

* If only portions of a structure are to be repainted, the color of the final coat shall match the topcoat color of the existing structure.

Minimum dry film thickness of the 3-coat system shall be 6.0 mils.

(d) Red Lead and Aluminum System: The minimum dry film thickness of coatings shall be as follows:

1st Coat (Red Lead)	1.5 mils
2nd Coat (Red Lead with 1 oz. of lampblack paste per gallon of paint)	1.5 mils
3rd Coat (Red Lead)	1.5 mils
Final Coat (Aluminum)	1.0 mil

Minimum dry film thickness of the 4-coat system shall be 5.5 mils.

(e) Coal Tar Epoxy-Polyamide System: The minimum dry film thickness of coatings shall be as follows:

1st Coat	8.0 mils
Final Coat	8.0 mils

Minimum dry film thickness of the 2-coat system shall be 16.0 mils.

811.05 WEATHER LIMITATIONS. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather with the relative humidity being below 85 percent. Painting will not be permitted when the ambient air temperature is below 45°F in the shade and away from artificial heat except as provided in this Subsection for enclosures. If fresh paint is damaged by the elements, it shall be replaced by the contractor at his expense.

Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

Subject to approval of the engineer, in writing, the contractor may provide suitable enclosures to permit painting during inclement weather. Provisions shall be made to control atmospheric conditions artificially inside the enclosure within limits suitable for painting throughout the painting operation. No additional compensation will be allowed for providing and maintaining the enclosures.

811.06 CLEANING OF SURFACES.

(a) General: Metal surfaces to be painted or coated shall be cleaned by blast cleaning in accordance with the Near-White Blast Cleaning Method.

When shot blasting is used, the abrasive mixture shall have a minimum of 25 percent by volume of approved grit material. The grit size shall be G-25 (SAE) with a minimum hardness of 45, Rockwell "C" Range and the abrasive mixtures shall produce an anchor pattern from 1 to 3 mils.

All surfaces of a casting shall be blast cleaned before the casting is machined.

Structural steel to be encased in concrete shall be blast cleaned, hand tool cleaned or power tool cleaned.

Weld spatter and other undesirable materials shall be removed and sharp edges ground smooth for metal surfaces prior to blast cleaning.

(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 finish 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 from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides or slight, tight residues of paint or coating that may remain. At least 95 percent of each square inch 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 the requirements of Specification SSPC-SP 10 with the following modifications. The anchor pattern shall be 1 to 3 mils. Rate of blast cleaning may vary from one area to the next in order to achieve the desired pattern. The use of recycled shot blasting materials will be permissible, provided anchor pattern requirements are met and adhesion is not compromised. Blast cleaned surfaces shall be painted

before any rusting occurs, preferably within 8 hours after blasting. The 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 the requirements of Specification SSPC-SP 10.

(c) **Commercial Blast Cleaning Method:** This method prepares metal surfaces for painting or coating 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 oil 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 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 Specification SSPC-SP 6.

(3) **Safety Precautions:** Safety precautions shall be in accordance with Specification SSPC-SP 6.

811.07 PROTECTION OF THE PUBLIC AND WORK. The contractor shall protect all parts of the work against disfigurement by spatters, splashes and smirches of paint materials. The contractor shall be responsible for any damage caused by his operations to vehicles, persons or property, including plants and animals; he shall provide protective measures at his expense to prevent such damage.

Paint stains which might result in an unsightly appearance shall be removed or obliterated by the contractor at his expense.

If traffic causes an objectionable amount of dust, the contractor shall, at his own expense, allay the dust for the necessary distance on each side of the work and take any 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 MIXING OF PAINT. Except as otherwise specified in Section 1008, paint shall be premixed at the factory. Paint shall also be thoroughly field-mixed mechanically before applying and shall be stirred sufficiently while being used to keep pigments in uniform suspension.

811.09 THINNING PAINT. Paint as delivered in containers, when thoroughly mixed, shall be ready for use. If it is necessary in cool weather

to thin the paint in order that it shall spread more freely, this shall be done only by heating in hot water or on steam radiators and liquid shall not be added nor removed unless permitted.

811.10 APPLICATION.

(a) **3-Coat Organic Zinc Primer and Topcoat System:** Primer and topcoat paint shall be applied with airless or conventional spray equipment. The spray equipment shall apply paint in a fine and even spray without addition of thinner, unless approved by the engineer. If thinning of paint is allowed, it shall be done in accordance with the paint manufacturer's recommendations, but shall not exceed the limitations specified in Subsection 1008.02. A 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 brushes or approved daubers to insure coverage.

Film thickness measurements will be made with an approved dry film thickness tester. Measurement of dry film thickness will be made by adjusting the approved measuring device to read 3 mils on a 3-mil shim placed on the blast surface. Since different readings will be obtained at various places, the devices will be adjusted so that the average reading for a particular section is 3 mils.

(1) **Primer:** Primer for new steel shall be applied after fabrication and the 2 prime coats must be applied at the shop.

Each prime coat must be cured at least 72 hours before the next coat of primer or topcoat is applied. The maximum time between application of the first and second prime coats is 7 days. The curing times shall be the cumulative time that the ambient air temperature is 45°F or above.

Potlife of the primer shall not exceed limits specified by the manufacturer, but in no case shall the potlife exceed 12 hours. When the limit is reached, the spray pot must be emptied, material discarded, and new material mixed.

(2) **Field Spot Priming:** Damaged areas or other surfaces to be field primed shall be blast cleaned and painted with the approved organic zinc primer to a minimum dry film thickness of 4.5 mils. Surface preparation shall be the same as required under Subsection 811.06. Primer shall be allowed to cure 72 hours prior to application of topcoat.

(3) **Topcoat:** Topcoat paint for new steel shall be applied after field erection and after required field spot priming and cleaning of primer surfacing has been accomplished.

Dust film or other residue shall be removed prior to painting. The use of sandpaper for cleaning is acceptable, provided the minimum dry film thickness of primer remains.

Maximum time between application of the second prime coat and topcoat shall be 4 months. If more than 4 months have elapsed after application of the second prime coat, a vinyl wash primer shall be sprayed on surfaces to be topcoated to a dry film thickness of 0.3 to 0.7 mil not more than 72 hours prior to application of topcoat. The vinyl wash primer shall conform to Federal Military Specification MIL-P-15328A with this requirement: In Table I, Formula 117, use the Ethyl Alcohol as described in Note 4 - no water.

Topcoat shall be applied at the specified minimum film thickness. Where members are inspected and found low in film thickness, the entire member shall be recoated to eliminate lap marks. The contractor shall exercise the necessary controls to eliminate laps, sags, overspray patterns and other undesirable characteristics.

(b) **2-Coat Organic Zinc Primer and Topcoat System:** Primer and topcoat paint shall be applied with airless or conventional spray equipment. The spray equipment shall apply the paint in a fine and even spray without the addition of thinner, unless approved by the engineer. If thinning of paint is allowed, it shall be done in accordance with the paint manufacturer's recommendations. A moisture trap shall be placed between air supply and pressure pot, and regulators and gauges 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 brushes or approved daubers to insure coverage.

Film thickness measurements will be made with an approved dry film thickness tester. Measurement of dry film thickness will be made by adjusting the approved measuring device to read 3 mils on a 3-mil shim placed on the blast surface. Since different readings will be obtained at various places, the devices will be adjusted so that the average reading for a particular section is 3 mils.

(1) **Color Contrast:** Primer coat shall be so tinted as to provide a color contrast from the blast cleaned metal and the topcoat. The coloring may be included in the zinc dust or the vehicle.

(2) **Primer:** Primer for new steel shall be applied after fabrication and before erection, and must be applied at the shop.

Potlife of the primer shall not exceed the limits specified by the manufacturer. When the limit is reached, the spray pot must be emptied, material discarded, and new material mixed.

(3) **Field Spot Priming:** Damaged areas or other surfaces to be field primed shall be blast cleaned and painted with the approved organic zinc to a minimum dry film thickness of 3.0 mils. Surface preparation shall be the same as required under Subsection 811.06. These requirements for field touch-up priming shall apply to the applicable parts of Subsection 811.12.

(4) **Topcoat:** Topcoat paint for new steel may be applied either before or after erection.

Dust film or other residue shall be removed prior to painting to assure that the coating achieves a tight bond to the primer. The use of sandpaper for cleaning is acceptable, provided the minimum dry film thickness of primer remains.

Topcoat shall be applied at the specified minimum film thickness, as described in Subsection 811.04. Where members are inspected and found low in film thickness, the entire member shall be recoated to eliminate lap marks. The contractor shall exercise the necessary controls to eliminate laps, sags, overspray patterns and other undesirable characteristics.

(c) Basic Lead Silico Chromate System: Basic lead silico chromate paint shall be applied by airless or conventional spray.

Spray equipment shall apply the paint in a fine, even spray. The coating of paint applied shall be smooth and uniform, producing no sags or runs, with no heavy deposit of wet coat requiring excessive curing time.

On surfaces inaccessible to spray equipment, the paint shall be applied with approved brushes or daubers to insure thorough coverage.

No portions of the paint films shall be less than the specified film thickness; however, the film thickness shall not be so great that either the appearance or service life of the paint will be detrimentally affected.

At least 72 hours shall elapse between paint applications.

(d) Red Lead and Aluminum System: Shop and field coats may be applied with hand brushes or rollers or a combination of these methods. Aluminum topcoat may also be applied by sprayer; however, spray application of red lead paint will not be permitted. The coating of paint applied shall be smoothly and uniformly spread so that no excess paint will collect at any point. The right is reserved to require the use of hand brushing should the results of spraying be unsatisfactory.

When brushes are used, the paint shall be so manipulated under the brush as to produce a smooth, uniform and even coating in close contact with the metal or with previously applied paint and shall be well worked into all corners and crevices.

Power spraying equipment shall apply the paint in a fine, even spray without the addition of thinner. Paint applied with spray equipment shall immediately be followed by hand brushing when necessary to secure uniform coverage and to eliminate airholes, blistering, splotches or wrinkling.

No portion of paint films shall be less than the specified film thickness; however, the film thickness shall not be so great that either the appearance or service life of paint will be detrimentally affected.

No less than 72 hours shall elapse between applications of coats of paint.

(e) **Coal Tar Epoxy-Polyamide System:** Coal tar epoxy-polyamide paint shall be applied in accordance with the paint manufacturer's recommendations. At least 72 hours shall elapse between paint applications.

811.11 SHOP PAINTING.

(a) **Surfaces to be Painted:** When fabrication and cleaning are completed, surfaces not previously painted during assembly shall be painted with 1 coat of the specified paint before any damage occurs to the cleaned surface from weather or other exposure. Shop and field contact surfaces shall be prepared as specified in Subsection 807.20(d). Surfaces to be in contact with concrete shall not be painted. 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 paint of contrasting color.

(c) **Loading:** Material shall not be loaded for shipment until the paint is dry.

(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 material 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.

811.12 FIELD PAINTING. As soon as field cleaning has been done to the satisfaction of the engineer, the 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 2 coats of the same paint as was used in the shop in accordance with Subsection 811.10(a)(1). When the paint applied for touching up rivet or bolt heads and abraded surfaces has become dry, the field coat may be applied. In no case shall a coat be applied until the previous coat has dried throughout the full thickness of paint film.

Small cracks and cavities which have not been sealed watertight by the field coat shall be filled.

The field coat of paint shall not be applied to the steel work below the highway floor level until the concrete roadway slab has been completed and metal work carefully cleaned. If concreting operations have damaged the paint, the surface shall be cleaned and spot painted as directed.

811.13 SPECIAL STENCILING. The date (month and year) of painting and type of paint system used shall be stenciled at 2 locations determined by the engineer on all bridge structures in block letters 2 1/2 inches high. The paint used shall form a contrast with the background and shall be compatible with the paint system used.

811.14 PAINTING LUMBER AND TIMBER. New lumber and timber requiring painting shall be cleaned to the satisfaction of the engineer and painted with 3 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.

811.15 PAINTING GALVANIZED SURFACES. Galvanized surfaces shall be prepared for painting by applying a vinyl wash primer coat as specified in Subsection 811.10(a)(3) or by deferring the painting as long as possible to allow the surface to weather.

811.16 GALVANIZING OF METAL PARTS AND SURFACES.

The following criteria shall be properly controlled and shall meet standards that are satisfactory to the engineer 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 plugged to the satisfaction of the engineer.

Galvanizing of products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips, 1/8 inch thick and heavier, shall conform to ASTM Designation: A 123. Galvanizing shall be performed after fabrication into the largest practicable 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 conform to ASTM Designation: A 123 and A 153 or shall be accomplished by an approved mechanical galvanizing method that provides the same thickness of coating, and when specified, shall conform to the following quenching requirements. Parts that are hot-dip galvanized shall be quenched immediately after removal from the kettle. The quenching solution shall contain 0.1 to 1.0 percent chromic acid by volume and shall be maintained at a temperature of 150 to 160°F, with a maximum allowable temperature of 180°F. 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 the application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be repaired by the application of a low temperature galvanizing repair compound, in the shape of a bar or rod, to the preheated 600°F repair surface. The bar or stick shall be rubbed over the preheated surface with the melted repair material being brushed over the bare area with a wire brush. The low temperature galvanizing repair compound shall be submitted for approval and shall be in accordance with Federal Specification O-G-93, 29 November 1949. Zinc coating by the metallizing process may be allowed when approved by the engineer.

811.17 METALLIZING OF METAL PARTS AND SURFACES. When specified, metallizing shall be performed in accordance with the AWS Specification C 2.2 and thickness of the sprayed zinc coat shall be a

minimum of 5 mils. The method of applying the zinc coating shall be approved by the engineer prior to application.

811.18 MEASUREMENT AND PAYMENT. No measurement or direct payment will be made for painting or any protective coating.

Section 812

Untreated and 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 or untreated, and of preparing, framing, assembling and erecting the same, including painting where specified, and all hardware specifications, all in accordance with the specifications and in conformity with the plan details.

812.02 MATERIALS. Materials shall conform to the following Subsections:

Castings	1013.05(a), 1013.06(a)
Structural Timber and Lumber	1014.01
Piling	1014.02
Preservatives	1014.03
Treatment	1014.04
Connectors	1018.07
Hardware and Structural Shapes	1018.08
Pitch	1018.13

812.03 SPECIES OF WOOD.

(a) **Permanent Structures:** Lumber and timber used in construction of permanent bridges, bridge fenders and bulkheads may be either Douglas Fir or Southern 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. Lumber and timber shall not be used in exposed structures without preservative treatment.

(b) **Temporary Structures:** Temporary bridging shall conform to Section 725. All other temporary structures may be any satisfactory species and grade of timber.

812.04 HARDWARE FOR TIMBER.

(a) **Structural Shapes:** Rods, plates and shapes shall be of structural steel. Eyebars shall conform to the requirements for structural steel eyebars.

812.04 HARDWARE, STRUCTURAL SHAPES AND CASTINGS.

(a) **Structural Shapes:** Rods, plates and shapes shall be of structural steel. Eyebars shall conform to the requirements for structural steel eyebars.

(b) **Castings:** Castings shall be cast steel or gray iron, as specified.

(c) **Bolts, Dowels and Other Hardware:** All hardware, except malleable iron connectors, for treated timber shall be galvanized.

812.05 STORAGE OF MATERIAL. Lumber and timber stored on the site shall be kept in orderly piles or stacks. Untreated material shall be open-stacked on supports at least 12 inches above ground to avoid absorption of ground moisture and permit air circulation and it shall be so stacked and stripped as to permit free circulation of air between the tiers and courses. When directed, protection from the weather by suitable covering will be required.

On laminated structural members that are not to be preservatively treated, approved end sealer shall be applied after end trimming of each completed member.

812.06 TREATED TIMBER. Treated timber shall be interpreted to mean timber of the specified species and stress grade treated as stipulated in Subsection 1014.04.

(a) **Workmanship:** Workmanship shall be first class throughout. Only competent carpenters shall be employed and all framing shall be true and exact.

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. Workmanship on metal parts shall conform to the requirements specified for metal structures.

(b) **Surfacing:** All lumber and timber, except bulkhead planks and sway bracing, shall be surfaced on 4 sides (S4S).

(c) **Handling:** Treated timber shall be carefully handled without dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant hooks, peaveys, pikes or hooks shall not be used.

(d) **Framing and Boring:** All cutting, framing and boring of treated timbers shall be done before treatment insofar as practicable. When treated timbers are to be placed in waters infested by marine borers, untreated cuts, borings or other joint framings below highwater elevation shall be avoided.

(e) **Installation of Timber Connectors:** Timber connectors shall be of the specified types. The split ring and the shear plate shall be

installed in precut grooves of dimensions as given herein 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. All connectors of this type at a joint shall be embedded simultaneously and uniformly. Fabrication of structures using connectors shall be done prior to treatment. Bolt holes shall not be more than 1/16 inch larger than bolt diameter and shall be bored perpendicular to the face of the timber.

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 otherwise specified shall meet with the approval of the engineer.

(f) Cuts and Abrasions: All cuts in creosoted piles or timbers and all abrasions, after having been carefully trimmed, shall be covered with 2 applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch or brush-coated with at least 2 applications of hot creosote oil and covered with hot roofing pitch.

Cuts and abrasions in timbers treated with waterborne preservatives or pentachlorophenol 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: Whenever, 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.

812.07 TREATMENT OF PILE HEADS.

(a) General: Pile heads, after cutting to receive caps and prior to placing caps, 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 2 liberal applications of preservative followed by a heavy application of coal-tar 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 sawn surface shall be thoroughly brush coated with 2 applications of hot creosote oil, after which there shall be placed 2 layers of heavy canvas (14 ounces minimum per

square yard) conforming to Subsection 1018.05, size 20 x 20 inches saturated with hot asphalt, followed by 24 x 24 inches number 28 gage galvanized metal cover. The cover shall be bent down over the pile at an angle of approximately 45°.

(c) **Fabric Covering:** Heads of treated piles shall be covered with alternate layers of hot pitch and loosely woven fabric conforming to AASHTO Designation: M 117, using 4 applications of pitch and 3 layers of fabric. The cover shall measure at least 6 inches 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 7 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.

Heads of untreated piles shall be thoroughly brush-coated with 2 applications of hot creosote oil.

812.08 HOLES FOR BOLTS, DOWELS, RODS AND LAG SCREWS. Holes for round drift-bolts and dowels shall be bored with a bit 1/16 inch less in diameter than bolt or dowel to be used. Diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of bolt or dowel.

Holes for machine bolts shall be bored with a bit the same diameter as the bolt.

Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

812.09 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 and bolts shall not project more than 1 inch beyond the nut on work securely tightened. Long bolts shall be saw-cut or clipped, ground smooth and repaired as specified in Subsection 811.16.

Nuts of bolts shall be effectually locked after they have been finally tightened.

812.10 COUNTERSINKING. Countersinking shall be done wherever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil and, after bolt or screw is in place, filled with hot pitch.

812.11 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 entire 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.

812.12 PILE BENTS. Piles shall be driven in accordance with Section 804.

812.13 FRAMED BENTS.

(a) Mud Sills: Timber mud sills shall be of heart cedar, heart cypress, heart redwood, treated southern pine, treated fir or other durable timber. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

(b) Concrete Pedestals: Concrete pedestals for support of framed bents shall be finished so that sills or posts will take an even bearing on them. Dowels of at least 3/4-inch diameter and projecting at least 6 inches above the tops of pedestals shall be set in them when they are cast for anchoring sills or posts.

(c) Sills: Sills shall have true and even bearing on mud sills, piles or pedestals. They shall be drift-bolted to mud sills or piles with bolts of at least 3/4-inch diameter and extending into mud sills or piles at least 6 inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

(d) Posts: Posts shall be fastened to pedestals with dowels of at least 3/4-inch diameter, extending at least 6 inches into the post. Posts shall be fastened to sills by one of the following methods, as specified:

(1) By dowels of at least 3/4-inch diameter, extending at least 6 inches into posts and sills.

(2) By drift-bolts of at least 3/4-inch diameter driven diagonally through the base of post and extending at least 9 inches into sill.

812.14 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 diameter extending at least 9 inches into posts or piles. Drift-bolts shall be approximately in center of the post or pile.

812.15 BRACING. Ends of bracing shall be bolted through pile, post or cap with a bolt of at least 5/8-inch diameter. Intermediate intersections shall be bolted or spiked with wire or boat spikes. In all cases, spikes shall be used in addition to bolts.

812.16 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. Lapped ends of untreated stringers shall be separated at least 1/2 inch for circulation of air and shall be securely fastened by drift-bolting where specified. When stringers are 2 panels in length, joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least 2 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.

812.17 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 openings between them for seasoned material and with light 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 2 adjacent planks vary in thickness by more than 1/16 inch.

Two-ply timber floors shall consist of 2 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. 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.

812.18 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 intervals, with the spikes driven alternately near the top and bottom edges. Spikes shall be of sufficient length to pass through 2 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.

812.19 COMPOSITE WOOD-CONCRETE DECKS.

(a) Slab Spans: Where wood and concrete are to be used compositely, the joining of the 2 materials shall be such as to resist all horizontal shear at that plane and provision shall be made to prevent separation of materials.

Horizontal shear may be resisted by metal devices set into and projecting above the top of laminated strips or by fabricating the upper edge of strips in a serrated manner.

Separation of materials may be resisted by nails driven at an angle in the upper edge of strips or by other suitable devices, or by grooves or other working of upstanding strips.

(b) T Beams: Spans consisting of concrete slabs placed on wood stringers may be designed as T beams when the 2 materials are suitably joined to resist horizontal shear at their junction and materials are bonded permanently together.

A horizontal shear joint may be made using metal devices or by serrating tops of stringers.

Separation of concrete from stringers may be prevented by driving nails in top of stringers at an angle or by other suitable metal devices or by grooving sides of stringers near the top or other working of the wood and then forming the concrete into patterns worked in the wood.

812.20 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 long.

812.21 TRUSSES. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection and, in vertical projection, shall show a smooth curve through panel points conforming to correct camber. All bearing surfaces shall fit accurately.

812.22 TRUSS HOUSING AND RAILINGS. Unless otherwise directed, housing and railings shall be built after removal of falsework and adjustment of trusses to correct alignment and camber. Workmen wearing shoes with cleats will not be permitted on the roof.

812.23 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.

Where timber decks are provided, top flanges of stringers and floor beams shall be protected by a covering composed of a heavy layer of asphaltic material (tar, asphalt or pitch) applied hot and one thickness of 2-ply tar paper wide enough to project 3 inches beyond edges of members. These edges shall be bent down at an angle of approximately 45°.

812.24 METHOD OF 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 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.

812.25 BASIS OF PAYMENT. Timber will be paid for at the contract unit price per thousand board feet (MFBM).

Payment will be made under:

Item No.	Pay Item	Pay Unit
812(1)	Untreated Timber	MFBM
812(2)	Treated Timber	MFBM

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 conform to the following Sections and Subsection:

Portland Cement Concrete	901
Joint Materials	1005
Deformed Reinforcing Steel	1009.01

813.03 CONCRETE. Concrete for pile-supported approach slabs shall be Class AA. Concrete for all other approach slabs, and bolster blocks under approach slabs, shall be Class A or one of the concrete pavement Types. The slabs shall be constructed in accordance with Sections 601 and 805.

Curing shall be in accordance with Subsection 601.12. Surface tolerances shall meet the requirements of Subsection 601.13.

813.04 REINFORCING STEEL. Reinforcing steel shall be placed in accordance with Section 806.

813.05 BEARING PILES. When shown in the plans, the approach slab shall be supported on bearing piles. Piling shall be driven at the locations shown on the plans and in accordance with Section 804.

813.06 BOLSTER BLOCKS. Bolster blocks, when required, shall be constructed in accordance with these specifications and as indicated on the plans. The contractor shall place 3 layers of approved tar paper or 1 coat of paint or heavy grease between bolster block and pavement slab and expansion joint adjacent to the approach slab.

813.07 ROADWAY FINISH. The roadway shall be given a metal tine texture finish. All surface finishing operations shall be performed in accordance with Subsection 601.11.

813.08 RELIEF JOINTS. Relief joints of premolded joint filler or poured filler shall be constructed in accordance with plan details.

813.09 SUBGRADE. When specified, the approach slab subgrade shall consist of aggregate material placed in accordance with plan details. Aggregate material shall be either shell or gravel or stone conforming to Subsection 1003.08. Aggregate shall be placed and compacted as directed and covered with approved polyethylene film of at least 6-mil thickness.

813.10 METHOD OF 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, concrete bolster blocks, joint materials, aggregate subgrade materials and polyethylene film will not be measured for payment.

813.11 BASIS OF PAYMENT. Concrete approach slabs will be paid for at the contract unit price per square yard 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. Concrete in bolster blocks will be considered minor structure concrete. Two random batches will be sampled for each lot, and 3 cylinders molded for each batch. The 6 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 3 cylinders will constitute a lot. Acceptance and payment for each lot will be made in accordance with Table 2 of Section 901. If one of the Types of pavement concrete is used, price adjustments as specified for Class A concrete will be applied.

Payment will be made under:

Item No.	Pay Item	Pay Unit
813(1)	Concrete Approach Slabs	Square Yard
813(2)	Concrete Approach Slabs (Pile Supported)	Square Yard

Section 814

Drilled Shaft Foundations

814.01 DESCRIPTION. This work consists of furnishing and constructing foundations of reinforced concrete shafts with or without bell type concrete footings. Concrete shafts shall be placed in drilled excavation when shafts are without bell type footings and in drilled and underreamed excavation when shafts are with bell type footings. Such foundations shall be constructed in reasonably close conformity with plan details and these specifications.

814.02 MATERIALS. Concrete shall be Class D conforming to Section 901, except as otherwise specified herein.

Reinforcing steel shall conform to Section 1009.

814.03 CONSTRUCTION REQUIREMENTS.

(a) Experience Requirements: Prior to beginning drilled shaft construction, the contractor shall submit in writing to the Bridge Design Engineer for approval information showing his experience in constructing the type of shafts required and the equipment he proposes to use in constructing the shafts.

(b) Excavation: The contractor shall perform all excavation required for shafts and bell footings, through whatever substances are encountered and to the dimensions and elevations shown on the plans or as directed. Shafts shall be bored plumb to a tolerance of 1 1/2 inches for depths not over 10 feet plus an additional tolerance of 0.05 inch per foot for depths over 10 feet. The center of drilled shaft at the top shall lie within a 3-inch diameter circle with the theoretical center of the shaft as its center. Bells, when required, shall be excavated to form a bearing area of the size and shape shown on the plans. Shafts and bells shall be excavated by mechanical methods. Blasting methods will not be permitted.

If satisfactory foundation materials are not encountered at plan elevations, footings may be raised or lowered as determined by the engineer.

Casings will be required for shaft excavations when necessary to prevent caving of material or to shut off seepage water. Casings shall be

metal of ample strength to withstand handling stresses and the pressure of concrete and surrounding earth or backfill materials, and shall be watertight. Inside diameter of casing shall not be less than the nominal size of shaft; otherwise, size of casing and drilled excavation in which the casing is to be placed will be at the discretion of the contractor, except as noted below. No extra compensation will be allowed for concrete required to fill oversize casings or excavations.

If caving occurs or excess ground water is encountered, no further drilling will be allowed until a construction method is employed which will prevent caving. Drilling in a mud slurry without removal of cuttings or other construction methods which will control the size of excavation will be permitted. Drilling mud, if used, shall be removed from the shaft hole prior to pouring concrete.

If the elevation of the top of shaft is below ground level at the time of concrete placement, an oversize casing from ground elevation to a point below the top of shaft will be required to prevent caving of material into freshly placed concrete.

Excavation for footing bells or shafts beyond the lines required by plan dimensions, where casings are not required, shall be backfilled with Class D concrete at the contractor's expense. Where casings are used, the contractor will be permitted to backfill around the upper portion of casing with pea gravel or approved granular material. Where a double casing is required for a portion of the shaft, the area between casings shall be filled with Class D concrete.

Under normal operations when the casing is to be removed, removal shall not be started until concrete placement is completed in the shaft. Movement of the casing for short pulls of a few inches or rotating the casing to insure the breaking of bond of concrete to casing will be permitted. When conditions warrant, the casing may be pulled in stages. A sufficient head of concrete shall be maintained at all times above the bottom of casing to overcome hydrostatic pressure. Extraction of the casing shall be at a slow, uniform rate and the pull shall be in a vertical direction. If upward movement of concrete or steel inside the casing occurs during the pulling operation, the following criteria shall govern:

(1) If the upward movement is 1 inch or less, the casing may be left in place and the shaft used if concrete is vibrated or rodded to reconsolidate it. Vibration or rodding shall not be used to break the casing loose for extraction unless the entire shaft is to be replaced.

(2) If the upward movement is greater than 1 inch, all material shall be removed and the drilled shaft redone.

Drilled shaft concrete shall not be placed under water without permission. If such permission is granted, underwater concrete shall be placed in accordance with Subsection 805.05.

Material excavated from shafts and bells and not used elsewhere on the project shall be disposed of as directed.

At the time concrete is placed, the excavation shall be free from accumulated seepage water and all loose material shall be removed from the base. The contractor shall provide suitable access and lighting for the engineer to inspect the completed excavation and check the dimensions and alignment of drilled shafts and the underreamed excavation when underreaming is required.

Provisions shall be made for pumping fresh air to workmen and inspectors in the excavated hole. Any required lighting shall be by electric lights. Mechanical equipment used in the excavation shall be operated by air or electricity. The use of gasoline driven engines placed in the excavation for pumping or drilling will not be permitted.

If directed, the contractor shall make soundings or take cores at his expense to determine the character of supporting materials. The depth of such soundings or cores will not be required to exceed 5 feet below proposed footing grade.

When the plans require drilled shafts in end bents, the embankment at bridge ends shall be made to grade as shown and thoroughly compacted as provided in the governing specifications prior to drilling for end bent shafts.

(c) **Reinforcing Steel:** Fabrication and placement of reinforcing steel shall conform to Section 806. The reinforcing steel cage shall be completely assembled and placed into the shaft as a unit. Subject to the engineer's approval, the reinforcing steel cage may be fabricated in 2 sections, an upper and a lower section. The upper section shall be lap-spliced to the lower section while the lower section is partially lowered into the shaft hole. The completely assembled reinforcing steel cage shall then be lowered into final position as a unit. The reinforcing steel unit shall not be placed until immediately before concreting operations are to be started.

Each longitudinal bar shall be tied or tack-welded to the spiral hooping at intervals not to exceed 12 inches on centers and shall be tack-welded to lateral tie plates at each intersection.

For cased shafts where the reinforcing steel cage is over 30 feet long, longitudinal bars shall be tied or tack-welded at each intersection of spiral hooping for a distance of L/5 from the bottom of the cage, where L is the length of the spiral cage.

The reinforcing steel cage shall be supported from the top by positive method to prevent slumping downward during concrete placement or extraction of the casing. Dowel bars in the top of shaft which are not tied together with a cage may be inserted immediately after completion of concrete placement.

In uncased shafts, side spacer blocks of concrete shall be used at intervals along the shaft to insure concentric spacing for the entire length of shaft. In cased shafts, concrete spacer blocks shall not be used. Metal chair-type spacers shall be placed vertically at intervals around the steel cage to insure concentric spacing inside the casing.

(d) **Concrete:** The work shall be performed in accordance with Section 805 and the requirements herein.

The bottom of the shaft hole shall be cleaned with a cleanout bucket or other appropriate tool. At the time concrete is placed, all loose material shall be removed from the base of the shaft hole.

Concrete placing shall be continuous from the beginning of placing in the shaft or footing bell to the top of shaft or to construction joint as may be indicated on the plans. Time intervals will be allowed for pulling casings, placing forms and other necessary operations in sequence with placing operations.

Concrete shall be placed through a suitable tube to prevent segregation of concrete materials and unnecessary splashing on reinforcing steel. The tube shall be made in sections to permit raising as placement progresses.

Concrete for underwater placement shall be Class S and shall be placed in accordance with Subsection 805.05.

Casings shall be smooth and well-oiled and shall extend sufficiently above the grade of finished shaft to provide for excess concrete to be placed for the anticipated slump due to casing removal. Where a casing is to be pulled, concrete placed in the casing shall be of such workability as to require no vibrating or rodding.

Where a cap block or groundline strut is to be placed at the top of shaft and the cap or strut is shown to be monolithic with the shaft, a time interval will be allowed for placing the required form and reinforcing after any necessary casing removal. When the drilled shaft is continued by means of a column, the contractor must make provisions for adequately holding the column form at the top of the drilled shafts either by means of inserts or by forming and pouring a stub the size of the column.

After a concrete pour is completed, the top surface shall be cured and any construction joint area shall be treated as specified in Section 805.

Core samples will be required in any shaft that shows indication of improper procedures which may have caused seepage, infiltration or entrapment of air within the shaft. Core samples will be at the contractor's expense and core holes shall be filled with grout by the contractor after acceptance of the shaft.

814.04 TEST HOLES. Where shown on the plans or ordered by the engineer in writing, test holes will be required to establish elevations for belling to determine soil characteristics or elevation of ground water. Diameter and depth of test holes shall be as shown on the plans or as directed.

814.05 TEST BELLS. When shown on the plans or when ordered by the engineer in writing, underreaming of bells on test holes will be required to establish the ability to underream in the soil strata present. Diameter and shape of test bells shall be as shown on the plans or as directed.

814.06 METHOD OF MEASUREMENT.

(a) Drilled Shafts: Drilled shafts of the specified diameter will be measured by the linear foot. At interior bents and piers, shafts will be measured from a point 6 inches below ground elevation at the center of shaft after clearing operations are completed. At highway grade separations and railroad underpasses, the ground elevation will be the completed roadway section under the structure. At stream crossings and railroad overpasses, the ground elevation will be the elevation existing at the time drilling begins. At abutment bents, the lengths of shaft will be measured from the top of shaft elevation shown on the plans.

(b) Bell Footings: Bell footings will be measured by the cubic yard. The volume for measurement will be the authorized footing volume outside the dimensions of the drilled shaft, which will be considered as extending to the bottom of bell.

(c) Test Holes and Test Bells: Test holes will be measured from the elevation of the ground at the time drilling begins by the linear foot of acceptable test hole drilled. Test bells will be measured per each test bell acceptably underreamed.

814.07 BASIS OF PAYMENT.

(a) Drilled Shafts: Drilled shafts will be paid for at the contract unit price per linear foot, subject to the following limitations for authorized overruns. Payment will include all required excavation, pumping, furnishing and placing casings, furnishing and placing concrete and reinforcement, removing casings, casings left in place, and disposal of excess excavated material.

(1) Payment for shaft lengths up to and including 5 feet in excess of plan length shaft will be made at the contract unit price per linear foot.

(2) Payment for that portion of shaft length in excess of 5 feet and up to and including 15 feet more than plan length shaft will be made at 115 percent of the contract unit price per linear foot.

(3) Payment for shaft lengths over 15 feet in excess of the maximum plan length shafts as defined herein will be in accordance with Subsection 109.04.

(4) Payment for additional reinforcement required, including splices, for the extra shaft length will be made at the contract unit price per pound for deformed reinforcing steel.

(b) Bell Footings: Bell footings will be paid for at the contract unit price per cubic yard. Payment for authorized increases in footing bell diameters beyond 3 times the nominal shaft diameter will be in accordance with Subsection 109.04.

(c) Test Holes and Test Bells: Test holes will be paid for at the contract unit price per linear foot. Test bells will be paid for at the contract unit price per each.

Test holes or test bells required by the engineer but not specified by the plans will be paid for in accordance with Subsection 109.04.

Payment will be made under:

Item No.	Pay Item	Pay Unit
814(1)	Drilled Shaft (Diameter)	Linear Foot
814(2)	Bell Footing	Cubic Yard
814(3)	Test Hole (Diameter)	Linear Foot
814(4)	Test Bell (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 conform to these specifications.

815.02 QUALIFICATION OF PROCEDURES, WELDERS AND WELDING OPERATORS.

(a) General:

(1) The Department's Construction Section shall be the sole 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 of each qualifying welder and welding operator shall be furnished and recorded on the required reports, and the qualified welder shall have his social security card in his 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: Welding procedures, welders and welding operators shall be qualified in accordance with AWS D 1.1-80 Structural Welding Code as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges (Third Edition-1981).

(c) Reinforcing Steel: Welding qualification for reinforcing steel shall conform to AWS D 1.4-79, Structural Welding Code-Reinforcing Steel.

(d) **Aluminum:** Welding qualification for aluminum alloys shall conform to the DOTD Welding Procedures Manual.

(e) **Electrodes:** All electrodes shall be qualified in accordance with AWS D 1.1-80 Structural Welding Code as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges (Third Edition-1981).

815.03 WELDING. Size, type and length of welds shall be as shown on the plans. The use of electroslag and electrogas welding processes or self-shielded flux cored arc welding electrodes will not be permitted.

(a) **Structural Steel and Steel Pipe:** Welding of structural steel and steel pipe shall conform to AWS D 1.1-80 Structural Welding Code as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges (Third Edition-1981).

(b) **Reinforcing Steel:** Welding of reinforcing steel shall conform to AWS D 1.4-79, Structural Welding Code-Reinforcing Steel.

(c) **Aluminum:** Welding of aluminum alloys shall conform to the DOTD Welding Procedures Manual.

815.04 NONDESTRUCTIVE TESTING.

(a) **Structural Steel, Steel Pipe and Tubular Members:** Nondestructive testing shall conform to AWS D 1.1-80 Structural Welding Code as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges (Third Edition-1981).

(b) **Reinforcing Steel:** Nondestructive testing shall conform to AWS D 1.4-79, Structural Welding Code-Reinforcing Steel.

(c) **Aluminum:** Nondestructive testing shall conform to the DOTD Welding Procedures Manual.

(d) **Magnetic Particle Testing:** When magnetic particle testing is used, the procedure and technique shall be in accordance with the dry powder magnetic particle examination of welds using the prod method.

(e) **Personnel Qualification:** Persons performing ultrasonic testing shall be qualified by tests administered by the Department's Construction Section, unless otherwise approved by the Department.

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 any weld metal deposited; however, there will be no deduction made for removal of the metal to be welded due to edge preparation.

PART IX

PORTLAND CEMENT CONCRETE

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.

Portland cement concrete shall be a mixture of portland or portland-pozzolan cement, fine aggregate, coarse aggregate, water and, when specified or allowed, approved admixtures.

Trucks and plants furnishing, transporting and placing portland cement concrete, except concrete for minor structures in accordance with Section 902, shall be certified by the Department. The design, control and transportation of concrete mixtures in accordance with these specifications shall be the responsibility of the contractor.

All required laboratory facilities at portland cement concrete plants, including a plant site laboratory conforming to Section 722, shall be furnished by the contractor. These facilities will not be paid for directly.

Quality control requirements shall be as specified in the latest edition of the Department's publication entitled "Application of Quality Control Specifications for Portland Cement Concrete Pavement and Structures" or "Application of Quality Control Specifications for Precast-Prestressed Concrete Plants".

901.02 MATERIALS. Materials shall conform to the following Subsections:

Portland Cement	1001.01
Portland-Pozzolan Cement	1001.02
Masonry Cement	1001.03
Aggregates	1003.02
Admixtures	1011.02
Water	1018.01

Coarse and fine aggregates for concrete that will be subject to wetting, extended exposure to humid atmosphere or contact with moist ground shall not contain materials deleteriously reactive with alkalies in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, except that if such materials are present in injurious amounts,

the aggregate may be used with a cement containing 0.6 percent or less alkalies calculated as sodium oxide equivalent.

901.03 TRANSPORTATION AND STORAGE OF CEMENT. Cement shall be transported in watertight conveyances and stored in watertight buildings, silos or other approved facilities in such manner that cement will be protected from dampness or water intrusion. Cement which has become contaminated, partially set or which contains lumps of caked cement will be rejected. Cement from discarded or used bags shall not be used.

On small projects, open storage of bagged cement may be permitted when approved by the engineer in writing, in which case a raised platform and ample waterproof covering shall be provided.

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 in the work. Copies of these records shall be supplied to the engineer in such form as required.

Different brands or types of cement, or the same brand or type of cement from different mills, shall not be mixed or used alternately unless authorized by the Materials Engineer. This requirement can be waived in case of concrete plant breakdown during a pour to allow concrete to be furnished from another plant to finish pour 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.

When specified, coarse aggregate shall be separated into 2 or more sizes to secure greater uniformity of the concrete mixture. Different grades of aggregates shall be stored in separate stockpiles sufficiently removed from each other to prevent material at edges of piles from becoming intermixed. Aggregates of the same grade and mineral type whose specific gravities vary by not more than 0.03 may be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batch plant in such manner as to secure uniform grading of material. Aggregates that have become segregated or contaminated shall not be used. Aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for adequate drainage. Transport containers will be accepted as adequate binning when adequate drainage is provided. Drainage of aggregates shall meet the approval of the engineer prior to batching.

901.05 SAMPLING AND TESTING. Sampling and testing will be done in accordance with the Department's Materials Sampling and Testing Procedures Manuals. The contractor shall furnish, at his expense, all necessary concrete for testing.

901.06 QUALITY CONTROL OF CONCRETE. The contractor will be responsible for quality control of materials during handling, blending, mixing and pouring operations; for initial determination and necesary 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 and temperature.

A qualified Concrete Batcher shall perform all batching operations. A qualified Concrete Technician shall be present at the plant or job site whenever the plant is in operation. The Concrete Technician shall design concrete mixes, make adjustments in batch weights for moisture content, perform necessary adjustments in proportioning of materials to produce the specified concrete, and shall perform tests necessary for control of the concrete mix within specification requirements. If a Concrete Technician is not available at the job site, a qualified Concrete Tester (Field) will be allowed to perform control tests for slump and air content and report results to the Concrete Technician. The use of a Concrete Tester (Field) will not relieve the Concrete Technician from performing the remaining duties as outlined in these specifications.

Testing and analysis of the mix for quality control purposes, and the setting of dials, gages, scales or meters shall be the responsibility of the contractor.

(a) Mix Design: The contractor shall submit for approval on a form provided by the Department his intended source of materials and the mix design for concrete he proposes to furnish. No work shall be started until the Portland Cement Concrete Job Mix Release has been approved by the Department. When unusual material conditions necessitate tests on trial mixes, such testing will be performed by the Department and will require 45 days.

Gradation, unit weight, specific gravity and absorption factor of aggregate intended for use will be determined by the Department if requested by the contractor.

The job mix shall be such as to produce concrete conforming to Subsection 901.08 and Table 1 of this Section.

(b) Control Tests: The contractor will be responsible for determining gradation and moisture content of fine and coarse aggregate used in the concrete mixture and for testing the mixture at the job site for

slump, temperature and air content (when used). He shall so conduct his operations as to produce a mix conforming to the approved design, except that variations will be permitted within specified control limits for individual samples. Results shall be charted on control charts for individual samples.

Times at which to obtain control test samples will be set by the contractor using random number tables in accordance with DOTD Designation: S 605 or by random selection. Gradation control limits of aggregates shall be as shown in Subsection 1003.02. When deemed necessary by the engineer, additional test samples shall be taken as directed for slump and air content (when used).

The minimum number of control tests shall be as follows:

	Aggregate Gradation (Fine and Coarse)	Slump	Air Content
Structural Concrete	1 per Lot(1)	2 per Lot(1)	2 per Lot(1)
Pavement Concrete	2 per Day(2)	2 per 1/2 Day	2 per 1/2 Day

(1) As defined in Subsection 805.17

(2) For an all-day pour, 1 test shall represent morning control and the other afternoon control.

When tendency of individual slump, air content or gradation measurements, as plotted on control charts, indicates that the mix will fall outside tolerance limits, the contractor shall immediately make adjustments to bring the mix within specified limits. If the contractor fails to make proper adjustments, or if the mix is obviously defective, the mix will be rejected.

If it is necessary to make adjustments in mix design to obtain desired workability, such changes in mix proportions will be permitted, provided the water-cement ratio is not exceeded, minimum cement factor is obtained and prior notification is given to the engineer.

No changes in source of materials shall be made until a new Job Mix Release form using the new material has been submitted by the contractor and approved by the Department.

901.07 CLASSES AND TYPES OF CONCRETE. Structural concrete is designated by class and pavement concrete by type. Each class or type concrete shall be used where specified.

901.08 COMPOSITION OF CONCRETE. Type of cement and composition of concrete shall be in accordance with the requirements of this Subsection and Table 1 of this Section.

(a) Cement and Aggregates: Allowable types of cement are as follows:

Use	Allowable Cement Types
General Construction (including paving and structural concrete)	Type I(B) or II portland cement Type IP portland-pozzolan cement
Minor Structure Concrete	Type I,I(B) or II portland cement Type IP portland-pozzolan cement
Prestressed or Precast Concrete	Type I,I(B), II or III portland cement Type IP portland-pozzolan cement

The contractor may vary, without charge, the ratio of fine to coarse aggregate as approved, but in no case shall it be varied so as to materially affect the volume of cement per unit volume of concrete as determined by original proportions designed to obtain a cement factor of not less than that specified in Table 1 of this Section.

Specified cement contents indicated in Table 1 are the minimum permitted, but are not assured by the Department since the cement content required is dependent upon gradation of aggregates.

(b) Admixtures: Admixtures shall be mechanically dispensed in a liquid state with the mixing water. A separate dispensing device shall be provided for each admixture.

An air-entraining admixture will be required in paving concrete when a central mixing plant or slip-form paver is used.

Air-entraining and water-reducing admixtures will be required in Class AA or AA(M) concrete.

The use of admixtures in other classes or types of concrete will be optional with the contractor. If the contractor desires to use air-entraining or water-reducing admixtures, it will be at his expense without reducing the cement content, and written approval must be obtained.

When an air-entraining admixture is used, total air content of the concrete mix, when tested in accordance with DOTD Designation: TR 202, shall be as specified in Table 1 of this Section.

If both air-entraining and water-reducing admixtures are used, the 2 materials must be manufactured by the same company and must be compatible.

When air temperature in the shade and away from artificial heat is above 70°F, the water-reducing admixture shall be the set-retarding

type; when air temperature is 70°F or below, the water-reducing admixture shall be the normal set type. Set-retarding admixture shall be used in an amount sufficient to produce the necessary retardation; however, the amount used shall not be less than is necessary to conform to Subsection 1011.02.

(c) Water: The amount of water, including admixtures and free water for the mixture, shall not exceed the quantity specified in Table 1 of this Section. Free water shall include all water entering the mix with the aggregate, 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 X concrete. The consistency requirement will be the governing factor in determining maximum allowable water.

(d) Coarse Aggregate: Coarse aggregate shall be the grade specified in Table 1 of this Section.

(e) Consistency: Composition of mixtures shall be such as to produce concrete of suitable workability with not less than the specified cement content and not more than the specified amount of water.

Consistency of mixtures shall be such as to have slumps within the ranges shown in Table 1 of this Section when tested in accordance with DOTD Designation: TR 207; however, the engineer may authorize an increase in maximum limits for construction of walls and diaphragms less than 8 inches thick, provided the water-cement ratio is not exceeded.

(f) Compressive Strength:

(1) Structural Concrete: Class concrete mixes shall be formulated to produce concrete which, when molded and cured in accordance with DOTD Designation: TR 226 and tested as prescribed in DOTD Designation: TR 230, shall show an average compressive strength not less than as shown in Table 1 of this Section.

Cylinders by which strength of Class P and Class P(M) concrete is to be determined shall be cured by the same methods used in curing the members they represent.

If the required strength is not secured with the minimum cement content specified, additional cement shall be used or other aggregate provided at the contractor's expense.

From the concrete being placed, the engineer may require additional samples for compression tests to determine that mix proportions being used produce the specified strength.

(2) **Pavement Concrete:** Compressive strength of Type concrete and Class A concrete used for pavement, determined from hardened concrete cores taken in place in accordance with Subsection 601.20 and tested in accordance with DOTD Designation: TR 225, shall meet the requirements in Table 1 of this Section.

901.09 BATCH PLANT AND EQUIPMENT.

(a) General: Batch plants shall include storage bins, weigh hoppers and measuring devices. Fine aggregate and each size of coarse aggregate shall be weighed on scales, separately or cumulatively, in the weigh hopper from separate bins. If cement is used in bulk, a separate silo, weigh hopper and scales system shall be used. Equipment shall be properly sealed and vented to minimize dusting.

An approved device shall be provided between weigh hopper and transporting unit to minimize dusting and loss of material.

Batch plants may be equipped to proportion materials by approved automatic weighing devices.

(b) Storage Bins and Weigh Hoppers: Bins with adequate separate compartments for fine aggregate and each size of coarse aggregate shall be provided in the batch plant. Each compartment shall be designed to discharge efficiently and freely into weigh hopper. 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 so 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.

(c) Measuring Devices: Materials shall be measured by weighing except where other methods are authorized.

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 tell-tale device shall be in view of the operator. Measuring devices shall be subject to approval and shall be tested, inspected and certified by a qualified independent scale service at no cost to the Department every 90 days and as often as the engineer deems necessary to assure their accuracy.

Individual aggregates shall be batched within 2 percent, and the total weight of aggregate shall be within 1 percent of the required weight.

Cement shall be within 1 percent of the required weight. Cement in standard packages (sacks) need not be weighed; however, when sack cement is used, the quantities of aggregates for each batch shall be

sufficient for 1 or more full sacks of cement and no batch requiring fractional sacks of cement will be permitted. Mixing water shall be measured by volume or weight. 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.

When volumetric measurements are authorized for small amounts of concrete, weight proportions shall be converted to equivalent volumetric proportions and suitable allowance shall be made for variations in the moisture of aggregates, including bulking effect in fine aggregate.

Approval methods and equipment for adding air-entraining agents 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.

(d) Ticket Printer System: Certified concrete plants may be equipped with an approved automatic ticket printer system for recording required batching information. If an automatic ticket printer system is not used, quantities and batching information shall be determined by visual observation, recorded and certified correct by the plant's Concrete Batcher or Concrete Technician.

The approved ticket printer system shall be tamper-proof and shall print time of batching, water content, batch weights, moisture content of aggregate and quantities of admixtures, if used. Moisture content of aggregate or quantities of admixtures may be added to the printed ticket by the Concrete Batcher 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 job site shall be shown on the batch ticket. The engineer shall be provided with a legible copy of all batch records.

901.10 DRY BATCHING. Batch plant site, layout, equipment and provisions for transporting materials shall be such as to assure a continuous supply of material to the work.

When mixing at the site of work, materials shall be transported from batching plant to mixer in batch boxes, vehicle bodies or other containers of adequate capacity and construction to properly carry the volume required. Partitions separating batches shall be adequate to prevent spilling from one compartment to another while in transit or being dumped. When bulk cement is used, the contractor shall use a suitable method of handling cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer with chute, boot or other approved

device to minimize loss of cement and arranged to provide the specified cement content in each batch.

Bulk cement shall be transported to the mixer in tight compartments carrying cement required for the batch or between fine and coarse aggregate. Cement in original shipping packages may be transported on top of aggregates, each batch containing the number of bags required by the job mix.

901.11 WET BATCHING.

(a) General: Mixing operations shall begin within 30 minutes after cement has been added to aggregate. When cement is charged into a mixer drum containing surface-wet aggregate and ambient temperature is above 90°F, or when high early strength cement is used, this limit shall be reduced to 15 minutes.

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 the mixer except that a portion of mixing water shall enter in advance of cement and aggregates. No mixer having a rated capacity of less than 1 cubic yard shall be used nor shall a mixer be charged in excess of its rated capacity.

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.

(b) Mixing at Site: Concrete shall be thoroughly mixed in a batch mixer of an approved size and type which will insure uniform distribution of materials throughout the mass.

The mixer shall be equipped with adequate water storage and a device for accurately measuring and automatically controlling the amount of water used in each batch. 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.

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. 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.

If mixing operations are interrupted, the mixer shall be thoroughly cleaned.

(c) **Truck Mixing:** Unless otherwise authorized, truck mixers shall be the revolving drum type, watertight and so constructed that concrete can be mixed to insure uniform distribution of materials throughout the mass. Solid materials for concrete shall be measured in accordance with Subsection 901.09 and charged into the drum at the proportioning plant. Except as subsequently provided, the truck mixer shall be equipped with a tank for carrying mixing water. Only the prescribed amount of water shall be placed 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 by which the number of revolutions of drum or blades may be verified. Counters shall also be located as to provide safe and convenient inspection. The delivery ticket shall show the amount of water added.

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 manufacturer's guaranteed capacity of the drum in terms of concrete volume, and rotation speed of mixing drum or blades for both agitating and mixing speeds.

Size of batch in truck mixers shall not exceed the maximum rated capacity of mixer as stated by the manufacturer and stamped on a metal plate on the mixer. Minimum size batch shall be 1 cubic yard. 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 drum or blades at the rate of rotation designated as 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 agitating speed. All materials, including mixing water, shall be in the mixer drum before actuating the revolution counter.

When the prescribed water is added at the batch plant and slump is on the low side at the delivery site, 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, in no case shall the total of 130 revolutions be exceeded. Truck mixers shall be equipped with means for accurately measuring the amount of water used in each batch. Water added at the job site shall not cause the maximum allowable water-cement ratio of the batch to be exceeded.

(d) **Partial Mixing at Central Plant:** When a truck mixer or agitator provided with adequate mixing blades is used for transportation,

mixing time at the stationary mixer may be reduced to 30 seconds and mixing completed in a truck mixer or agitator. Mixing time in the truck mixer or agitator shall be as specified for truck mixing.

(e) Central Plant Mixing: Mixing at a central plant shall conform to the requirements of Heading (b) above.

(f) Transit Mix: When a batch plant is provided on the project and job conditions permit, on written request by the contractor, the engineer may approve mixing in transit.

(g) Time of Hauling and Placing Mixed Concrete: Wet batches of concrete may be transported in a truck mixer, agitator or other approved equipment. Nonagitator 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 and agitation speed shall be in accordance with the manufacturer's specified rating. Bodies of nonagitating hauling equipment shall be smooth, mortartight, metal containers and shall be capable of discharging concrete at a satisfactorily controlled rate without segregation. Covers shall be provided when directed.

When agitator trucks are used, elapsed time between addition of cement to the mix and depositing concrete in place shall not exceed 90 minutes. When hauling in nonagitator trucks, such elapsed time shall not exceed 45 minutes. When dry batching cement and aggregates, elapsed time shall not exceed 90 minutes from the time cement comes in contact with aggregates until depositing concrete in place. In hot weather or under other conditions contributing to quick stiffening of concrete, maximum allowable time may be reduced by the engineer.

(h) Hand Mixing: When hand mixing is authorized, it shall be done on a watertight platform and in such manner as to insure a uniform distribution of materials throughout the mass. Mixing shall be continued until a homogeneous mixture of required consistency is obtained.

(i) 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 rehandling and without damage to the structure or concrete.

(j) Retempering: Concrete shall be mixed only in such quantities required for immediate use and material which has developed initial set shall not be used.

901.12 LIMITATIONS OF MIXING.

(a) General: No concrete shall be mixed, placed or finished when natural light is insufficient, unless an approved artificial lighting system is provided.

Air temperature shall be determined at the point of pour.

A Job Mix Release using approved materials may be approved at the plant at the time it is ready to start production on a project, provided 24 hours notice is given to the engineer.

(b) Hot Weather Limitations: Hot weather limitations will only apply to concrete for bridge decks.

Hot weather concreting practices will be required when the job site temperature in the shade and away from artificial heat is 80°F and rising. When internal temperature of plastic concrete reaches 85°F, the contractor shall prevent the temperature of succeeding batches from going beyond 90°F by approved methods. If necessary, forms shall be precooled by approved methods immediately prior to concrete placement.

(c) Cold Weather Limitations: Unless authorized in writing, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F, and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

When concreting is authorized at lower air temperatures, 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 so arranged as to prevent occurrence of overheated areas. If the air temperature is less than 35°F at the time of placing concrete, the engineer may require water or aggregates to be heated to not less than 70°F nor more than 150°F. No concrete shall be placed on a frozen subgrade nor shall frozen aggregates be used in concrete.

901.13 ACCEPTANCE AND PAYMENT SCHEDULE. Acceptance and payment schedules in Table 2 of this Section will apply to all cast-in-place portland cement concrete, except minor structure concrete and portland cement concrete pavement. Portland cement concrete pavement acceptance and payment schedules are contained in Section 601. Minor structure concrete acceptance and payment schedules are contained in Section 902. These schedules do not apply to precast concrete.

TABLE 1
MASTER PROPORTION TABLE

Class or Type of Concrete	Average Compressive Strength psi at 28 days	Grade of Coarse Aggregate	Minimum Bags of Cement (94 lbs.) per Cu.Yd. of Concrete	Maximum Water per Bag of Cement[a] (Gallons)	Total Air Content (Percent by volume)[d]	Slump Range (Inches)		
						Non-Vibrated	Vibrated	Slip form Paving[b]
Structural Class								
AA(M)	4,400	A	6.5	5.4	5 ± 1	2-5	2-4	N.A.
AA	4,200	A	6.5	5.4	5 ± 1	2-5	2-4	N.A.
A(M)	4,400	A	6.0	6.0	5 ± 2	2-5	2-4	N.A.
A	3,800	A, F[h][i]	6.0[h]	6.0	5 ± 2	2-5	2-4	1-2.5
D	3,300	A, B, D	5.0	6.6	5 ± 2	2-5	1-3	N.A.
P(M)	6,000[e]	A, F[i]	7.0	5.0	5 ± 2	N.A.	2-6[g]	N.A.
P	5,000[e]	A, F[i]	6.5	5.0	5 ± 2	N.A.	2-6[g]	N.A.
R	2,000	A, B, D	4.0	8.0	5 ± 2	2-5	1-3	N.A.
S	3,800	A	7.0	6.0	5 ± 2	6-8	N.A.	N.A.
X	3,800	Y	6.5	(c)	6.9	N.A.	1-3	N.A.
Pavement Type								
B	4,000[f]	B	5.8	6.0	5 ± 2	N.A.	2-4	1-2.5
C	4,000[f]	B(Crushed Slag)	6.0	6.0	5 ± 2	N.A.	2-4	1-2.5
D	4,000[f]	D	5.4	6.0	5 ± 2	N.A.	2-4	1-2.5
E	4,000[f]	E	5.0	6.5	5 ± 2	N.A.	2-4	1-2.5

N.A.—Not Applicable

(a) Except for Class AA or AA(M) concrete, the maximum water-cement ratio (gal./sack) 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.
(b) Also slump range for other concrete placed by extrusion methods.
(c) Refer to Subsection 901.08(c).
(d) Total air content ranges when air entrainment is allowed or specified. Air content shall be designed at midrange.
(e) Minimum compressive strength required.
(f) Average compressive strength for Pavement Type concrete shall be 3,600 psi when air entrainment is used.
(g) No more than a 2-inch slump differential for any designated pour.
(h) For minor structure concrete, either Grade A or B coarse aggregate may be used and minimum cement content shall be 5.8 bags per cubic yard of concrete.
(i) Grade F coarse aggregate shall be used only when specified or permitted.

TABLE 2
ACCEPTANCE AND PAYMENT SCHEDULES
CAST-IN-PLACE STRUCTURAL CONCRETE

Average Compressive Strength per Lot, psi (28 to 31 days)

Class A[1]	Class AA	Class A(M) or AA(M)	Class D	Class S	Percent of Contract Price[3]
3800 & above	4200 & above	4400 & above	3300 & above	3800 & above	100
3400 - 3799	3800 - 4199	4000 - 4399	3000 - 3299	3400 - 3799	98
3000 - 3399	3200 - 3799	3600 - 3999	2500 - 2999	3000 - 3399	90
below 3000	below 3200	below 3600	below 2500	below 3000	50 or remove and replace[2]

(1) Use these values when "Type" concrete is used in approach slab.

(2) When the average compressive strength of any batch in a lot is less than 3600 psi for Class A(M) or AA(M), less than 3200 psi for Class AA, less than 3000 psi for Class A and Class S, or less than 2500 psi for Class D, 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.

When the average compressive strength for a lot is less than 3600 psi for Class A(M) or AA(M), less than 3200 psi for Class AA, less than 3000 psi for Class A and Class S, or less than 2500 psi for Class D, 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.

When cores are obtained in these investigations, values obtained from these cores will be used for evaluation purposes only and payment will be based on original acceptance samples.

(3) 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 805.17. The value for each cubic yard required will be assessed at 150 dollars for the purpose of applying price adjustment percentages. The amount of price adjustment for the quantity of concrete involved will be deducted from payment as required.

Acceptance and payment schedules shall apply to the contract item itself for cast-in-place piling.

Section 902

Portland Cement Concrete for Minor Structures

902.01 GENERAL. Portland cement concrete in minor structures shall be in accordance with Section 901 as modified herein.

Concrete furnished under these specifications may be furnished from either a certified or non-certified plant.

The following structures will be considered as minor structures:

1. Manholes, junction boxes and catch basins.
2. Curbs, gutters, walks, drives and incidental paving.
3. Paved ditches, revetments and medians.
4. Headwalls.
5. Embedments for posts.
6. Foundations for light standards and sign structures.
7. Cattle guards.
8. Other structures designated by the engineer, except bridges, box culverts and portland cement concrete pavement.

902.02 MIX DESIGN, INSPECTION AND TESTING.

(a) Mix Design: The contractor will not be required to submit mix designs to the engineer for approval unless the total quantity of each class of concrete for the project exceeds 50 cubic yards; however, complete records of mixes being used shall be maintained by the contractor and made available to the engineer at all times. Requirements shall be in accordance with Table 1 of Section 901.

(b) Inspection and Testing: Inspection and sampling of concrete will be performed at the point of delivery. The contractor will be responsible for proper batching, mixing and transporting of concrete. Concrete obviously improperly batched, mixed or transported will be rejected. Concrete of each class will be test sampled by molding sets of 3 cylinders, with a minimum of one set per 50 cubic yards.

902.03 ACCEPTANCE AND PAYMENT. Acceptance and payment schedules in Table 3 of this Section apply to all cast-in-place portland cement concrete for minor structures. These schedules do not apply to precast concrete.

TABLE 3
ACCEPTANCE AND PAYMENT SCHEDULES
CAST-IN-PLACE MINOR STRUCTURE CONCRETE

Average Compressive Strength, psi (28 to 31 days)		Percent of Contract Price(2)
Class A	Class R	
3000 & Above	1800 & Above	100
Below 3000	Below 1800	50 or Remove(1)

(1) When the average compressive strength is less than 3,000 psi for Class A and 1,800 psi 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.

When cores are obtained in these investigations, values obtained from these cores will be used for evaluation purposes only and payment will be based on original acceptance samples.

(2) 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 of concrete required will be assessed at 150 dollars for the purpose of applying price adjustment percentages. The amount of price adjustment for the quantity of concrete involved will be deducted from payment as required.

PART X
MATERIALS

PART X
MATERIALS

PREFACE

SAMPLING, TESTING AND CERTIFICATION: Except as otherwise specified herein, all sampling and certification shall be in accordance with the following documents; precedence shall be in the order as written:

Louisiana Department of Transportation and Development (DOTD) Materials Sampling Manual and Testing Procedures Manual.

Standards published by the American Association of State Highway and Transportation Officials (AASHTO).

Standards published by the American Society for Testing and Materials (ASTM).

Minor materials for which sampling and testing procedures are not specified will be accepted on the basis of visual inspection by the engineer.

QUALIFIED PRODUCTS LIST: When specified, materials shall be approved products listed on the Department's Qualified Products List as described in Subsection 101.50.

Section 1001

Hydraulic Cement

1001.01 PORTLAND CEMENT. Portland cement shall be from an approved source on the Qualified Products List and shall conform to AASHTO Designation: M 85 with the following exceptions:

(a) Type I(B) cement is defined as Type I cement with fineness requirements modified as follows to provide a coarser grind:

Turbidimeter Test	**Fineness (sq. cm./g.)**
Average value, max.	2000
Max. value, any one sample	2100
Air Permeability Test	**Fineness (sq. cm./g.)**
Average value, max.	3600
Max. value, any one sample	3800

(b) Alkali content calculated as sodium oxide equivalent shall not exceed 0.85 percent by weight for all types of cement.

1001.02 PORTLAND-POZZOLAN CEMENT. Portland-pozzolan cement shall be from an approved source on the Qualified Products List, shall conform to ASTM Designation: C 595, Type IP, and shall contain 20 ± 5 percent by weight 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 0.85 percent by weight. Fly ash or bottom ash shall conform to ASTM Designation: C 618, Class F, except that loss on ignition shall not exceed 6 percent by weight.

1001.03 MASONRY CEMENT. Masonry cement shall conform to AASHTO Designation: M 150.

Section 1002

Asphaltic Materials

1002.01 GENERAL. Asphalt shall be prepared by the refining of petroleum. It shall be uniform in character, free from water, and shall not foam when heated to 350°F. Asphalt shall be from an approved source on the Qualified Products List.

Storage tanks, piping, retorts, booster tanks, distributors and other equipment used in delivering, storing or handling asphaltic materials shall be kept clean and in good operating condition and shall be operated in such manner as to avoid contamination of the contents with foreign materials.

Final test results for asphaltic materials will be applied to the proper table in this Section for conformance to specifications. Any deviation from the specifications will result in a payment adjustment as specified.

The adjustment in pay for asphaltic materials shall be applied only to samples taken at the point of delivery. Samples taken at the refinery shall conform to specification requirements, and should the refinery sample fail to meet these requirements, the material will be rejected and shall not be shipped to the job site.

If asphaltic materials sampled at the point of delivery do not conform to requirements for 100 percent pay, and in the opinion of the engineer have resulted in an unsatisfactory product, the materials shall be removed and replaced or otherwise corrected at the expense of the contractor. If test results are such that a price adjustment would result from more than 1 test value, the price adjustment for the greatest reduction shall apply.

1002.02 ADDITIVES.

(a) Anti-Stripping: Additives used to inhibit stripping of asphaltic concrete shall conform to DOTD Designation: TR 317 and shall be approved products on the Qualified Products List.

(b) Silicone: Silicone additives shall be approved products on the Qualified Products List.

TABLE 1
ASPHALT CEMENT, MODIFIED AASHTO GRADES AC-20 AND AC-30

Applicable to Asphaltic Concrete		AC-20[1]			AC-30[1]		
		Percent of Contract Unit Price/Unit of Measurement of Asphaltic Concrete					
		Specifications	Deviations		Specifications	Deviations	
		100	95	90 or Remove[2]	100	95	90 or Remove[2]
Applicable to Asphalt Cement As a Separate Item		Percent of Contract Unit Price/Unit of Measurement of Asphalt Cement/Shipment					
		Specifications	Deviations		Specifications	Deviations	
	Test Method	100	80	50 or Remove[2]	100	80	50 or Remove[2]
Penetration, 25°C (77°F), 100g, 5 Sec.	AASHTO T 49	65+[3]		59−	55+[4]		49−
Viscosity, 135°C (275°F), SSF[5]	ASTM E 102	150+			175+		
Viscosity, 135°C (275°F), cSt	AASHTO T 201	300+	250-299	249−	350+	300-349	299−
Viscosity, 60°C (140°F), poises	AASHTO T 202	2000 ± 400		1599− 2401+	3000 ± 600		2399− 3601+
Solubility in Trichloroethylene, %	AASHTO T 44	99.0+			99.0+		
Flash Point, COC, °C (°F)	AASHTO T 48	232(450)+		231(449)−	232(450)+		231(449)−
Tests on Residue from Thin Film Oven Test:							
Viscosity, 60°C (140°F), poises	AASHTO T 202	8000−		8001+	12000−		12001+
Ductility, 25°C (77°F), 5 cm/min.	AASHTO T 51	100+	70-99	69−	100+	70-99	69−
Spot Test (Standard Naphtha Solvent)	AASHTO T 102	Neg.		Pos.	Neg.		Pos.

(1) All values are inclusive.
(2) At the option of the engineer.
(3) For samples obtained at point of delivery, the penetration requirement shall be 60 +.
(4) For samples obtained at point of delivery, the penetration requirement shall be 50+.
(5) For samples obtained at point of delivery, the viscosity @ 275°F may be determined using ASTM E 102.

TABLE 2
ASPHALT CEMENT, MODIFIED AASHTO GRADES AC-5 AND AC-10

		Percent of Contract Unit Price/Unit of Measurement/Shipment					
		AC-5[1]			AC-10[1]		
		Specifications	Deviations		Specifications	Deviations	
	Test Method	100	80	50 or Remove[2]	100	80	50 or Remove[2]
Penetration, 25°C (77°F), 100g, 5 sec.	AASHTO T 49	140+[3]		129−	85+[4]		79−
Viscosity, 135°C (275°F), SSF[5]	ASTM E 102	88+			125+		
Viscosity, 135°C (275°F), cSt	AASHTO T 201	175+	125-174	124−	250+	200-249	199−
Viscosity, 60°C (140°F), poises	AASHTO T 202	500 ± 100		399−	1000 ± 200		799−
				601+			1201+
Solubility in Trichloroethylene, %	AASHTO T 44	99.0+			99.0+		
Flash Point, COC, °C (°F)	AASHTO T 48	177(350)+		176(349)−	218(425)+		217(424)−
Tests on Residue from Thin Film Oven Test:							
Viscosity, 60°C (140°F), poises	AASHTO T 202	2000−		2001+	4000−		4001+
Ductility, 25°C (77°F), 5 cm/min.	AASHTO T 51	100+	70-99	69−	100+	70-99	69−
Spot Test (Standard Naphtha Solvent)	AASHTO T 102	Neg.		Pos.	Neg.		Pos.

(1) All values inclusive.
(2) At the option of the engineer.
(3) For samples obtained at the point of delivery, the penetration requirements shall be 130+.
(4) For samples obtained at the point of delivery, the penetration requirement shall be 80+.
(5) For samples obtained at point of delivery, the viscosity at 275°F may be determined using ASTM E 102.

TABLE 3
ANIONIC EMULSIFIED ASPHALT

	AASHTO Test Method	Percent of Contract Unit Price/Gallon/Shipment[2]					
		SS-1			SS-1h		
		Specifications	Deviations		Specifications	Deviations	
		100	80	50 or Remove[1]	100	80	50 or Remove[1]
Viscosity, 25°C (77°F), SSF	T 59	20-100	10-19 101-150	9− 151+	20-100	10-19 101-150	9− 151+
Residue by Distillation, % by wt.	T 59	57 Min.	52-56	51−	57 Min.	52-56	51−
Sieve Test (Retained on No. 20)	T 59	0.1 Max.	No Penalty		0.1 Max.	No Penalty	
Cement Mixing	T 59	2.0 Max.	No Penalty		2.0 Max.	No Penalty	
Settlement, 5 days, %	T 59	5 Max.	No Penalty		5 Max.	No Penalty	
Tests on Residue Penetration, 25°C (77°F), 100g, 5 sec.	T 49	100-200	88-99 201-212	87− 213+	40-90	30-39 91-100	29− 101+
Solubility in Trichloroethylene, %	T 44	97.5 Min.	No Penalty		97.5 Min.	No Penalty	
Ductility, 25°C (77°F), 5 cm/min.	T 51	40 Min.	26-39	25−	40 Min.	26-39	25−

(1) At the option of the engineer.
(2) If material is incidental to pay item, use invoice price per gallon.

TABLE 4
CATIONIC EMULSIFIED ASPHALT (CRS-2, CMS-2 AND CSS-1h)

		Percent of Contract Unit Price/Gallon/Shipment[1]								
		CRS-2			CMS-2			CSS-1h		
		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations	
	Test Method	100	80	50 or Remove[2]	100	80	50 or Remove[2]	100	80	50 or Remove[2]
Viscosity, 50°C (122°F), SSF	AASHTO T 59	100-400	56-99 401-444	55 – 445 +	50-450	26-49 451-499	25 – 500 +			
Viscosity, 25°C (77°F), SSF	AASHTO T 59							20-100	10-19 101-150	9 – 151 +
Residue by Distillation, % by wt.	AASHTO T 59	65 Min.	61-64	60 –	65 Min.	61-64	60 –	57 Min.	52-56	51 –
Oil Distillate by Volume, %	AASHTO T 59	3 Max.	No Penalty		12 Max.	No Penalty				
Particle Charge	DOTD TR 311	Pos.		Neg.	Pos.		Neg.	Pos.		Neg.
Sieve Test (Retained on No. 20)	AASHTO T 59	0.1 Max	No Penalty		0.1 Max.	No Penalty		0.1 Max.	No Penalty	
Settlement, 5 Days, %	AASHTO T 59	5 Max.	No Penalty		5 Max.	No Penalty		5 Max.	No Penalty	
Tests on Residue										
Penetration, 25°C (77°F), 100g, 5 Sec.	AASHTO T 49	100-250	84-99 251-266	83 – 267 +	100-250	84-99 251-266	83 – 267 +	40-90	30-39 91-100	29 – 101 +
Solubility in Trichloroethylene, %	AASHTO T 44	97.5 Min.	No Penalty		97.5 Min.	No Penalty		97.5 Min.	No Penalty	
Ductility, 25°C (77°F), 5 cm/min.	AASHTO T 51	80 Min.	66-79	65 –	40 Min.	26-39	25 –	40 Min.	26-39	25 –
Viscosity, 135°C (275°F), cSt	AASHTO T 201	175 Min.	125-174	124 –						

(1) If the unit of pay is not based on the gallon, the deduction will be converted to an equivalent deduction in terms of unit of pay.
(2) At the option of the engineer.

TABLE 5
CATIONIC EMULSIFIED ASPHALT (CQS-1h)

	Test Method	Percent of Contract Unit Price/Gallon/Shipment[1]		
		Specifications	Deviations	
		100	80	50 or Remove[2]
Viscosity, 25°C (77°F), SSF	AASHTO T 59	15-100	10-14 101-150	9− 151+
Residue by Distillation, % by wt.	AASHTO T 59	57 Min.	52-56	51−
Particle Charge	DOTD TR 311	Pos.		Neg.
Sieve Test (Retained on No. 20)	AASHTO T 59	0.1 Max.	No Penalty	
Settlement, 5 days, %	AASHTO T 59	5 Max.	No Penalty	
Mixing and Setting Properties	DOTD TR 315			
Mixing Test		Pass	No Penalty	
Setting Test		Pass	No Penalty	
Test on Residue				
Penetration, 25°C (77°F) 100g, 5 Sec.	AASHTO T 49	40-90	30-39 91-100	29− 101+
Solubility in Trichloroethylene, %	AASHTO T 44	97.5 Min.	No Penalty	
Ductility, 25°C (77°F), 5 cm/min.	AASHTO T 51	40 Min.	26-39	25−

(1) If payment is not based on the gallon, the deduction shown will be converted to the equivalent deduction in terms of the unit of pay.
(2) At the option of the engineer.

TABLE 6
MC CUTBACK ASPHALT

		Deduction in Contract Unit Price/Square Yard of Base Course[1]								
		MC-30			MC-70			MC-250		
	AASHTO Test Method	Specifications No Deductions	Deviations $0.08	$0.22	Specifications No Deductions	Deviations $0.08	$0.22	Specifications No Deductions	Deviations $0.08	$0.22
Flash Point, Open Tag, °C (°F)	T 79	38(100) Min.	No Penalty		38(100)Min.	No Penalty		66 (150) Min.	No Penalty	
Viscosity, SSF	T 72									
25°C (77°F)		75-150	58-74	57–						
			151-167	168+						
60°C (140°F)					35-70	24-34	23–	125-250	100-124	99–
						71-81	82+		251-275	276+
Distillation Test, Distillate Percentage by Volume of Total Distillate to 360°C (680°F)	T 78		No Penalty			No Penalty			No Penalty	
to 225°C (437°F)		0-25			0-20			0-10		
to 260°C (500°F)		40-70			20-60			15-55		
to 316°C (600°F)		75-93			65-90			60-87		
Residue from Distillation to 360°C (680°F), Percentage Volume by Difference		50 Min.	46-49	45–	55 Min.	51-54	50–	67 Min.	63-66	62–
Tests on Residue										
Penetration 25°C (77°F), 100g, 5 Sec.	T 49	120-250	102-119	101–	120-250	102-119	101–	120-250	102-119	101–
			251-268	269+		251-268	269+		251-268	269+
Solubility in Trichloroethylene, %	T 44	99.0 Min.	98.6-98.9	98.5–	99.0 Min.	98.6-98.9	98.5–	99.0 Min.	98.6-98.9	98.5–
Ductility, 25°C (77°F) for Residues to 200 Penetration, 5 cm/min.	T 51	100 Min.	76-99	75–	100 Min.	76-99	75–	100 Min.	76-99	75–
Ductility, 15.5°C (60°F) for Residues of 200-300 Penetration, 5 cm/min.	T 51	100 Min.	76-99	75–	100 Min.	76-99	75–	100 Min.	76-99	75–

(1) If the unit of pay is not based on the square yard, the deduction will be converted to an equivalent deduction in terms of the unit of pay.

TABLE 7
RC CUTBACK ASPHALT

	AASHTO Test Method	Percent of Contract Unit Price/Gallon/Shipment(1)								
		RC-70			RC-250			RC-800		
		Specifications	Deviations		Specifications	Deviations		Specifications	Deviations	
		100	80	50	100	80	50	100	80	50
Flash Point, Open Tag, °C (°F)	T 79				27(80) Min.	No Penalty		27(80) Min.	No Penalty	
Viscosity, SSF 60°C (140°F)	T 72	35-70	24-34	23−	125-250	100-124	99−	400-800	No Penalty	
			71-81	82+		251-275	276+			
Distillation Test, Distillate Percentage by Volume of Total Distillate	T 78		No Penalty			No Penalty			No Penalty	
to 360°C (680°F)		10 Min.								
to 190°C (374°F)		50 Min.			35 Min.			15 Min.		
to 225°C (437°F)		70 Min.			60 Min.			45 Min.		
to 260°C (500°F)		85 Min.			80 Min.			75 Min.		
to 316°C (600°F)										
Residue from Distillation to 360°C (680°F); Percentage Volume by Difference		55 Min.	51-54	50−	65 Min.	61-64	60−	75 Min.	71-74	70−
Tests on Residue										
Penetration 25°C (77°F), 100g, 5 Sec.	T 49	80-120	66-79	65−	80-120	66-79	65−	80-120	66-79	65−
			121-134	135+		121-134	135+		121-134	135+
Solubility in Trichloroethylene, %	T 44	99.0 Min.	98.6-98.9	98.5−	99.0 Min.	98.6-98.9	98.5−	99.0 Min.	98.6-98.9	98.5−
Ductility, 25°C (77°F), 5 cm/min.	T 51	100 Min.	76-99	75−	100 Min.	76-99	75−	100 Min.	76-99	75−

(1) If payment is not based on the gallon, the deduction shown will be converted to the equivalent deduction in terms of the unit of pay.

Section 1003

Aggregates

1003.01 GENERAL. All aggregates shall be from an approved source. For a source to be approved, each sample submitted shall pass all tests specified in the appropriate Subsection; thereafter, periodic tests will be performed, except that when the material is questionable tests will be performed. Acceptance and control testing shall be as listed in the Department's Materials Sampling Manual. When submitting samples of aggregates for testing, the geographical source of the material shall be furnished.

Coarse aggregates listed on the Qualified Products List, including expanded clay, shall show an abrasion loss of not more than 40 percent and a soundness loss of not more than 15 percent when subjected to 5 cycles of the magnesium sulfate test. Slag shall contain not more than 10 percent by weight of glassy particles.

The following test methods shall be used in approving aggregates:

AASHTO T 19	Dry Rodded Unit Weight
AASHTO T 21	Organic Impurities in Sands
AASHTO T 71	Mortar Strength Test
AASHTO T 96	Abrasion Test
AASHTO T 104	Soundness Test
AASHTO T 112	Clay Lumps
AASHTO T 113	Coal and Lignite
AASHTO T 189	Soft Fragments
DOTD TR 102	Gradation of Mineral Filler
DOTD TR 107	Lightweight Coarse Aggregate
DOTD TR 109	Foreign Matter in Shell
DOTD TR 110	Percent of Clam Shell in Shell Mixture
DOTD TR 112	Material Passing No. 200 Sieve
DOTD TR 113	Gradation of Aggregates
DOTD TR 116	Polish Value of Coarse Aggregate
DOTD TR 117	Glassy Particles in Slag
DOTD TR 118	Flat or Elongated Particles
DOTD TR 313	Index of Retained Marshall Stability
DOTD TR 413	Organic Matter in Binders
DOTD TR 428	Liquid Limit and Plasticity Index

1003.02 AGGREGATES FOR PORTLAND CEMENT CONCRETE AND MORTAR.

(a) **General:** Coarse and fine aggregates for use in concrete that will be subject to wetting, extended exposure to humid atmosphere, or contact with moist ground shall not contain any materials that are deleteriously reactive with the alkalies in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, except that if such materials are present in harmful amounts, the aggregate may be used with a cement containing 0.6 percent or less alkalies calculated as sodium oxide equivalent.

The alkali reactivity of the aggregate will be determined in accordance with ASTM Designation: C 33, Appendix XI.

(b) **Fine Aggregate:** Sand shall be from a source listed on the Qualified Products List. The percentages of foreign matter shall not exceed the following values:

	Percent
Coal or Lignite	0.25
Clay Lumps	0.50

Fine aggregate subjected to the colorimetric test for organic impurities which produces a color darker than the Reference Standard Color Solution shall be subjected to the mortar strength test before acceptance. When subjected to the mortar strength test, fine aggregate shall show a minimum strength of 95 percent of the reference mortar.

Fine aggregate shall conform to the following gradation:

Sieve Size	Percent Passing
Concrete Sand	
3/8″	100
No. 4	95-100
No. 16	45-90
No. 50	7-30
No. 100	0-7
No. 200	0-3
Mortar Sand	
No. 4	100
No. 8	95-100
No. 100	0-25
No. 200	0-10

(c) **Coarse Aggregate:** Coarse aggregate shall be from a source listed on the Qualified Products List, and the maximum amounts of foreign matter shall be as follows:

	Percent
Clay Lumps	0.25
Soft Fragments	5.0
Flat or Elongated Particles	15.0
Iron Ore (Included in Soft Fragments)	
Max. Retained on 3/4″ Sieve	1.5
Max. Passing 3/4″ Sieve	0.5
Coal and Lignite	1.0(1)
Sticks (Wet)	0.25
Total Clay Lumps, Soft Fragments, Coal and Lignite, and Sticks	5.0

Note (1) Aggregate used in railings shall be free from lignites.

Coarse aggregate shall conform to the following gradation:

	Percent Passing				
U.S. Sieve	**Grade A**	**Grade B**	**Grade D**	**Grade E**	**Grade F**
2-1/2″	—	—	100	100	
2″	—	100	90-100	—	
1-1/2″	100	85-100	—	60-75	
1″	90-100	—	40-80	—	See
3/4″	—	40-88	—	20-40	Note (1)
1/2″	25-60	—	—	—	
3/8″	—	—	—	—	
No. 4	0-10	0-6	0-6	0-5	
No. 8	0-5	—	—	—	
No. 200	0-1	0-1	0-1	0-1	

Note (1) Small coarse aggregate for special designs. Grade F aggregate shall be used only when specified or permitted and shall conform to the following gradation:

U. S. Sieve	Percent Passing
3/4″	100
1/2″	90-100
No. 4	15-60
No. 8	0-15
No. 16	0-5
No. 200	0-1

1003.03 BASE COURSE AGGREGATES.

(a) Sand Clay Gravel: This aggregate shall be composed of a mixture of sand, clay and gravel or stone.

The mixture, as determined by visual inspection, shall be free from

vegetable or other foreign matter, and shall conform to the following gradation:

U. S. Sieve	Percent Passing
1 1/2″	95-100
No. 4	40-65
No. 40	20-50
No. 200	12-25

Material passing the No. 40 sieve shall conform to the following requirements:

	Untreated	Cement Treated
Liquid Limit (Max.)	25	35
Plasticity Index (Max.)	6	12

Stone in the mixture shall be from a source listed on the Qualified Products List.

(b) **Shell:** This aggregate shall be either reef shell or a mixture of clam and reef shell; however, not more than 70 percent by weight of the mixture shall be clam shell. The material shall contain not more than 5 percent foreign matter.

(c) **Sand-Shell:** This aggregate shall be a mixture of 65 percent shell and 35 percent sand as verified by proof of material deliveries.

(1) **Shell:** Shell in the mixture shall be either clam shell or reef shell or any combination thereof. The material shall contain not more than 5 percent foreign matter.

(2) **Sand:** Sand in the mixture shall be siliceous or other approved material containing not more than 4 percent organic matter and conforming to the following gradation:

U. S. Sieve	Percent Passing
No. 4	85-100
No. 40	65-100
No. 200	0-60

Sand shall conform to the following requirements:

Liquid Limit (Max.)	25
Plasticity Index (Max.)	6

(d) **Stone:** This material shall be from a source listed on the Qualified Products List and shall conform to the following gradation:

U. S. Sieve	Percent Passing
1 1/2″	100
1″	90-100
3/4″	70-100
No. 4	35-65
No. 40	12-32
No. 200	5-12

The fraction of stone passing the No. 40 sieve shall conform to the following requirements:

Liquid Limit (Max.)	25
Plasticity Index (Max.)	6

1003.04 SURFACE COURSE AGGREGATES.

(a) Stone: This material shall be from a source listed on the Qualified Products List and shall conform to the following gradation:

U. S. Sieve	Percent Passing
1 1/2″	100
3/4″	50-100
No. 4	25-65
No. 40	10-32
No. 200	3-12

The fraction of stone passing the No. 40 sieve shall conform to the following requirements:

Liquid Limit (Max.)	25
Plasticity Index (Max.)	6

(b) Sand Clay Gravel: This material shall be a mixture of sand, clay and gravel or stone. The mixture shall be free from foreign matter as determined by visual inspection.

The mixture prior to treatment shall conform to the following gradation:

	Percent Passing		
U.S. Sieve	Untreated	Lime Treated	Asphalt Treated
1 1/2″	95-100	95-100	95-100
No. 4	40-65	40-75	40-75
No. 40	20-50	—	20-45
No. 200	12-25	12-25	8-20

The fraction passing the No. 40 sieve shall conform to the following requirements:

	Untreated	Lime Treated	Asphalt Treated
Liquid Limit (Max.)	35	40	35
Plasticity Index	4-12	4-20	0-4

Stone in the mixture shall be from a source listed on the Qualified Products List.

(c) **Shell:** This material shall be either reef shell or a mixture of clam and reef shell, except that not more than 50 percent by weight of the mixture shall be clam shell. The material shall contain not more than 15 percent foreign matter and shall meet the following gradation:

U. S. Sieve	Percent Passing
2″	100
No. 4	30-75

1003.05 ASPHALTIC SURFACE TREATMENT AGGREGATES. Aggregates for asphaltic surface treatment shall be from a source listed on the Qualified Products List and shall be either uncrushed gravel, crushed gravel, crushed stone or crushed slag, a combination of crushed and uncrushed gravel, or expanded clay, and shall conform to the gradation requirements in Table 8 of this Section.

The maximum amounts of foreign matter shall be as follows:

	Percent
Clay Coating	0.0
Clay Lumps	0.25
Soft Fragments	5.0
Flat or Elongated Particles	15.0
Iron Ore (Included in Soft Fragments)	
Max. Retained on 3/4″ Sieve	1.5
Max. Passing 3/4″ Sieve	0.5
Coal and Lignite	1.0
Sticks (Wet)	0.25
Totals: Clay Lumps, Soft Fragments, Coal and Lignite, and Sticks	5.0

1003.06 AGGREGATES FOR ASPHALTIC CONCRETE MIXTURES.

(a) **Asphaltic Concrete:** All aggregates, except crushed shell and fine sand, shall be from a source listed on the Qualified Products List.

(1) **Gravel, Stone and Slag:** These aggregates shall be clean, free of an excess of flat or elongated particles, free of an excess of soft or disintegrated pieces, and free of foreign matter.

TABLE 8
ASPHALTIC SURFACE TREATMENT AGGREGATES
PERCENT PASSING

	Size 1		Size 2		Size 3
U. S. Sieve	Uncrushed Gravel or Crushed Aggregate	Expanded Clay Aggregate	3-Application Surface Treatment	2-Application Surface Treatment	
1 1/2″	100	100	—	—	—
1″	85-100	95-100	—	—	—
3/4″	40-80	70-90	100	100	—
5/8″	—	—	95-100	95-100	—
1/2″	0-15	—	—	60-90	100
3/8″	—	—	—	—	90-100
No. 4	—	0-5	0-7	0-10	15-60
No. 10	—	—	—	—	0-15
No. 16	—	—	—	—	0-5

(2) Coarse Sand: Coarse sand shall be graded from coarse to fine and shall be free from vegetable and other foreign matter.

(3) Fine Sand: Fine sand shall be free from vegetable and other foreign matter. The plasticity index of the fine sand shall not exceed 4, and no clay balls shall be incorporated into the asphaltic mixture.

(4) Crushed Shell: Shell material shall consist of clam or reef shell free from objectionable material such as sticks or a coating of mud. Foreign matter such as sand, silt and clay shall not exceed 5 percent, and such material shall be dispersed throughout the mass.

(5) Screenings: Screenings, when used, shall be made by crushing aggregates which, prior to crushing, conformed to the requirements for coarse aggregates in Subsection 1003.01.

(6) Expanded Clay: Expanded clay shall consist of angular fragments of uniform density free from an excess of foreign matter.

(7) Sand Clay Gravel: Pit run sand clay gravel may be used in Type 5 mixes provided the material is separated into 2 sizes prior to final mixing. The separation shall be done by using a No. 4 screen or other approved size. For batch plants, the screening process must be adequate to satisfy this requirement. The plasticity index shall not exceed 4, and no clay balls shall be incorporated into the asphaltic mixture.

(8) Mineral Filler: Mineral filler shall consist of limestone dust, pulverized hydrated lime, silica dust, shell dust, portland cement,

cement stack dust or other approved material. 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 conform to the following gradation:

U. S. Sieve	Percent Passing
No. 30	100
No. 80	95-100
No. 200	70-100
No. 270	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 of at least 85 percent, and a maximum of 1.0 percent volumetric swell.

(b) Asphaltic Concrete Friction Course: Aggregates shall be from a source listed on the Qualified Products List, and shall demonstrate the ability to achieve a polish value of at least 35. Aggregates shall be clean, shall have not more than 15 percent flat or elongated particles, shall have not more than 5 percent soft or disintegrated pieces, and shall be free of other foreign matter. Mineral filler, when used, shall conform to Heading (a)(8) of this Subsection.

1003.07 GRANULAR MATERIAL. Granular material shall be nonplastic siliceous or other approved material and shall conform to the following gradation:

U. S. Sieve	Percent Passing
1/2″	100
No. 10	75-100
No. 200	0-10

1003.08 BEDDING MATERIAL. Bedding materials shall be a mixture of either gravel, stone or shell with 35 ± 5 percent sand as verified by proof of material deliveries, conforming to the following requirements:

(a) Gravel: Gravel shall be from a source listed on the Qualified Products List and shall conform to the following gradation:

U. S. Sieve	Percent Passing
1 1/2″	95-100
No. 4	0-15
No. 200	0-2

(b) Stone: Stone shall be from a source listed on the Qualified Products List and shall conform to the following gradation:

U. S. Sieve	Percent Passing
1 1/2″	95-100
3/4″	40-85
No. 4	0-15

(c) Shell: Shell may be either whole or crushed or a combination thereof, and shall consist of clam or reef shell or any combination thereof. Foreign matter content of the shell shall not exceed 10 percent.

(d) Sand: Sand shall conform to Subsection 1003.07.

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 conform to AASHTO Designation: M 91, Manhole Brick Grade MM.

Concrete brick shall conform to ASTM Designation: C 139, except that the minimum thickness of each unit shall be 3 5/8 inches.

1004.02 BUILDING BRICK.

(a) Building brick made from clay or shale for use in brick masonry shall conform to AASHTO Designation: M 114, Grade SW.

(b) Concrete building brick for use in masonry buildings shall conform to ASTM Designation: C 55, Grade N-II.

1004.03 CONCRETE BUILDING BLOCK. Concrete hollow load-bearing building block shall conform to ASTM Designation: 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 conform to ASTM Designation: C 145, Grade N-II, except the oven-dry weight of concrete shall be at least 130 pounds per cubic foot based on bulk specific gravity. Permissible block dimension variations shall be as directed.

Section 1005

Joint Materials for Pavements and Structures

1005.01 JOINT FILLERS.

(a) Preformed Expansion Joint Fillers for Concrete Paving and Structures:

(1) Nonextruding and Resilient Bituminous Types: Fillers shall consist of preformed strips which have been formed from cane or other cellular fibers 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 2 layers of felt.

The type shall be as specified and shall conform to AASHTO Designation: M 213.

(2) Nonextruding and Resilient Nonbituminous Types: Fillers shall consist of preformed expansion joint fillers of the following types conforming to AASHTO Designation: M 153.

Type I	Sponge Rubber
Type II	Cork
Type III	Self-Expanding Cork

(3) Bituminous Type: Bituminous preformed expansion joint filler shall consist of bituminous (asphalt or tar) mastic composition, formed and encased between 2 layers of bituminous impregnated felt. The preformed filler shall conform to ASTM Designation: D 994.

(b) Wood Fillers: Boards shall be clear heart redwood, clear all heart western red cedar, Idaho white pine, western white spruce, northern white pine, sugar pine, western hemlock or white fir. All species, other than redwood or cedar, shall be treated with preservatives. Occasional medium surface checks will be permitted provided the board is free of defects that will impair its usefulness. No board less than 6 feet long shall be used and separate pieces shall be held securely to form a straight line.

Preservative treatment for wood shall be chromated copper arsenate (CCA) conforming to AWPA P5 with a minimum net retention of 0.40 lb./cu.ft.

Boards shall not vary from specified dimensions in excess of the following tolerances:

	Tolerance(Inches)
Thickness	−0, +1/16
Depth	−0, +1/8
Length	±1/4

The load required to compress the material in an oven-dry condition to 50 percent of its original thickness shall not exceed 1800 psi.

(c) Preformed Nonbituminous Cellular Filler (For Sawed Joints): This filler shall consist of preformed strips which have been formed from cane or other cellular fibers, or laminated fiberboards built up to specified thickness. The material forming these strips shall be securely bound together with a suitable nonbituminous binder and formed to specified dimensions.

The preformed strips shall conform to the following:

(1) Water Absorption: When tested in accordance with AASHTO Designation: T 42, the sample shall not absorb more than 15 percent by volume in 4 hours.

(2) Permissible Variation in Dimensions: The preformed filler shall not vary from specified thickness by more than ± 1/16 inch.

(d) Preformed Polyvinyl Chloride or Asphalt Ribbon:

(1) Polyvinyl Chloride: This filler shall be an approved preformed extruded insert material (with or without removable cap as required) composed of polyvinyl chloride of required depth and thickness. It shall be sufficiently rigid to enable it to form a straight joint.

(2) Asphalt Ribbon: This filler shall consist of preformed strips of bitumen and inert filler material conforming to the following requirements:

Thickness, inches	1/8 to 3/16
Depth tolerance, inches	± 1/8
Weight, lbs./hundred sq. ft., min.	60
Tensile Strength, lbs./inch width, min.	50
Bitumen, % by wt. (ASTM D 147), min.	60

The tensile strength is determined by pulling a 1 x 6 inch sample at a 20-inch/minute 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: This material is primarily used in pavements and structure joints whose slabs are tied together with steel. It is also used in pressure relief joints for concrete pavement approaches and bridge approach slabs as shown on the plans.

The joint filler shall be formed by the expansion of polyethylene base resin, extruded as a multicellular, closed cell, homogeneous section of foamed polyethylene. This material shall be used with an adhesive. Joint fillers and adhesives shall be approved products on the Qualified Products List.

The joint filler shall conform to the following requirements:

Property	ASTM Test Method	Requirement
Density, pcf	D 3574	2.0 - 3.0
Water Absorption, % by volume, max.	C 272 (1)	1.0
Compression, psi	D 1056	
@ 20% deflection, min.		3.0
@ 80% deflection, max.		125.0
Extrusion @ 80% deflection, inches, max.	D 545	0.12

Note (1) The requirement that materials which trap water in flutes be dipped in absolute alcohol shall be omitted. Instead, the joint filler shall be dried quickly by blotting with absorbent paper.

1005.02 POURED AND EXTRUDED JOINT SEALERS.

(a) PVC Extended Coal Tar: This material shall be an approved pourable single-component polymer type elastomeric compound conforming to the following physical requirements:

Property	Test Method	Requirement
Penetration, max.	AASHTO T 187	130
Flow, inches, max.	AASHTO T 187 (1)	0.2
Bond, inches separation, max.	AASHTO T 187	0.25
Resilience, %, min.	DOTD TR 623	60
Ball Penetration	DOTD TR 623	5-20
Artificial Weathering	DOTD TR 623	Pass

Note (1) The flow test will be conducted according to AASHTO T 187 with the following exception: The samples shall be placed in an oven maintained at 150 ± 2°F for 24 hours.

Back-up material and elastomeric polymers shall be approved products on the Qualified Products List.

(b) Polyurethane Polymers: This joint sealer shall be a 1- or 2-component, pourable or extrudable material. It shall set up as a solid rubber-like material able to withstand both tension and compression.

Primers, back-up materials and elastomeric polymers shall be approved products on the Qualified Products List.

Shelf life shall be specified by the manufacturer and the expiration date shall be shown on the container.

The material shall conform to the following requirements.

Property	Test Method	Requirement
Flow, inches, max.	AASHTO T 187 (1)	0.2
Tack-Free Time, hrs., max.	Fed. Spec. TT-S-00227E	72
Bond, in. sep., max.	AASHTO T 187	0.25
Resilience, %, min.	DOTD TR 623	75
Ball Penetration	DOTD TR 623	5-20
Resilience (after heat aging), %, min.	DOTD TR 623	75
Weatherometer, 600 hrs., min.	DOTD TR 611	Pass
Ozone Resistance (Exposure to 100pphm ozone for 100 hrs. @ 104°F, sample under 20% strain or bent loop)	ASTM D 1149	No Cracks
Weight loss, %, max.	Fed. Spec. TT-S-00227E	10
Infrared Charts	DOTD TR 610	
Activator		Pass
Base		Pass

Note (1) The flow test will be conducted according to AASHTO T 187 with the following exception: The samples shall be placed in an oven maintained at 150 ± 2°F for 24 hours.

(c) Silicone Polymers: This joint sealer shall be a 1-component, extrudable material. It shall set up as a solid rubber-like material able to withstand both tension and compression. The material shall be forced against the joint walls by approved methods that will insure proper adhesion.

Primers, back-up materials and elastomeric polymers shall be approved products on the Qualified Products List.

Containers shall be marked as to material, identity, batch number, manufacture date and expiration date.

Silicone sealants shall conform to Federal Specification TT-S-001543 for Class A Sealants except as modified by the following test requirements:

Property	Test Method	Requirement
Flow, inches, max.	AASHTO T 187 (1)	0.2
Tack-Free Time at 77°F and 45-55% R.H., minutes	Fed. Spec. TT-S-00227E	35-75
Density, pcf	ASTM D 545	90.5-94.5

Property	Test Method	Requirement
Resilience, %, min.	DOTD TR 623	75
Ball Penetration	DOTD TR 623	5-20
Resilience (after heat aging), %, min.	DOTD TR 623	75
Durometer, Shore A	ASTM D 2240(2)	10-25
Tensile Stress at 150% Elongation, psi, max.	ASTM D 412, Die C(2)	45
Elongation, %, min.	ASTM D 412, Die C(2)	1200
Bond, inches separation, max.	DOTD TR 635	0.25
Peel, lbs., min.	DOTD TR 635	20

Note (1) The flow test will be conducted according to AASHTO T 187 with the following exception: The samples shall be placed in an oven maintained at 150 ± 2°F for 24 hours.

Note (2) Cured 7 days at 75-90°F and 45-55% R.H.

(d) Hot Poured Asphaltic Types:

(1) Asphalt Mineral Filler: Asphalt mineral filler shall be homogeneous and shall be composed of asphalt and mineral filler. The asphalt shall be free from impurities. Asphalt mineral filler shall conform to the following requirements:

Property	AASHTO Test Method	Requirement Min.	Max.
Softening Pt., °F	T 53	125	145
Penetration at 32°F, 200g, 60 sec.	T 49	15	—
Penetration at 77°F, 100g, 5 sec.	T 49	50	70
Ductility at 77°F, cm.	T 51	15	—
Asphalt, %	T 44	45	55
Mineral Filler, %	T 44	45	55
Water, %	T 55	—	2

(2) Elastic Asphaltic Type: This sealer shall conform to AASHTO Designation: M 173, except the pour point test will be performed only as deemed necessary. Materials shall be applied in accordance with the sealer manufacturer's recommendations.

(3) Catalytically Blown Asphalt: Catalytically blown asphalt shall be uniformly blended with 10 percent diatomaceous earth filler which passes the No. 325 sieve. It shall form a suitable joint and crack sealer which may be melted to pouring consistency in a regular asphalt kettle at a temperature of 400 to 485°F. The material shall conform to the following requirements:

Property	AASHTO Test Method	Requirement Min.	Max.
Penetration, 77°F, 100g, 5 sec.	T 49	68	88
Penetration, 32°F, 200g, 60 sec.	T 49	38	—
Penetration, 115°F, 50g, 5 sec.	T 49	—	160
Softening Pt., R & B, °F	T 53	175	200

Property	AASHTO Test Method	Requirement Min.	Max.
Flash, C.O.C., °F	T 48	500	—
Specific Gravity, 77/77°F	—	1.02	—
Ductility, 77°F, 5 cm/min., cm.	T 51	5	—
Flow, 140°F, cm.	T 187	—	0.5
Ash Weight, %	T 111	8	20
Shock Test, 30°F	M 190-5.3.1	No cracking	

1005.03 PREFORMED ELASTOMERIC COMPRESSION JOINT SEALS. The joint seal shall be an approved product on the Qualified Products List.

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 Designation: TR 612.

(a) Pavement Use: The material shall conform to ASTM Designation: D 2628 with the following exceptions:

(1) The test for ozone resistance may, at the option of the Department, be determined by the bent loop test method.

(2) The seal shall exert a minimum pressure of 3.0 psi (4.0 psi for pressure relief joints) at 80 percent of nominal width and a maximum of 25.0 psi at 50 percent of nominal width.

(3) The lubricant-adhesive shall conform to ASTM Designation: D 2835.

(b) Bridge Use: The seal shall conform to ASTM Designation: D 3542 with the following exceptions:

(1) The seal shall exert a minimum pressure of 4.0 psi at 80 percent of nominal width.

(2) Lubricant-Adhesive: The material shall be as recommended by the sealant manufacturer and listed on the Qualified Products List.

It shall exhibit a viscosity of 16,000 to 450,000 centipoises and a minimum shear ratio of 2.5. It shall have a minimum lubricating life of 2 hours at 100°F and shall cure within 48 hours without sagging.

No material shall be used which has skinned over or which has settled in the container to the extent that it cannot be easily dispersed by hand stirring to form a smooth, uniform product.

The material shall be uniform, homogeneous, contain no lumps or agglomerates, and there shall be no settlement in the container. Minimum solids shall be 65 percent and shall be determined by oven drying at 230 ± 5°F for 3 hours.

The lubricant-adhesive shall be delivered in containers marked with manufacturer's name or trademark, lot number, manufacture date and storage stability.

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 2 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 conform to the following requirements:

Property	ASTM Test Method	Requirement
Tensile Strength, psi, min.	D 412	1800
Elongation at Break, %, min.	D 412	200
Hardness, Shore A, pts.	D 2240	65 ± 10
Properties after Aging, 70 hrs. @ 212°F	D 573	
Tensile Strength, % loss, max.		20
Elongation, % loss, max.		25
Hardness, pts. increase, max.		10
Ozone Resistance, 20% strain, 300 pphm in air , 70 hrs. @ 104°F	D 518	no cracks
Oil Swell, ASTM Oil #3, 70 hrs. @ 212°F, max. wt. change, %	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 pounds per linear inch of sealer when tested in accordance with DOTD Designation: TR 636.

(3) Bond of Plastic to Cement Mortar: This bond shall be evaluated subjectively and shall meet the following requirements:

The force required to separate the cement mortar from the plastic shall be a minimum of 5 pounds per linear inch of sealer when tested in accordance with DOTD Designation: TR 636.

1005.05 ARMORED JOINT WITH NEOPRENE STRIP. The armored joint with neoprene strip seal shall be an approved system listed

on the Qualified Products List. The neoprene strip seal shall be an extruded neoprene material conforming to ASTM Designation: D 2628 modified to omit the recovery test.

1005.06 REINFORCED ELASTOMERIC JOINT SEALS. This material shall consist of integrally molded units of elastomer and bonded metal components so arranged as to provide for expansion and contraction movements. Metal components bridging the joint gap shall be of sufficient strength to carry wheel loads across the joint. The total system with components shall be an approved product on the Qualified Products List.

1005.07 JOINT MATERIALS FOR APPROACH SLABS AND PRESSURE RELIEF JOINTS.

(a) Preformed Closed Cell Polyethylene Joint Filler: This material shall conform to Subsection 1005.01(e).

Lubricant-adhesive shall be used and applied according to the manufacturer's instructions.

(b) Preformed Urethane Foam Joint Filler: The material shall be made with a semi-open, flexible polyurethane foam which is molded to such cross-sectional shape that it can be easily installed in the pavement joint with parallel sides and which will be sufficiently self-locking to prevent the material from floating out of the joint. 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.

The properties of the urethane foam when determined on skin-free specimens shall conform to the following requirements:

Property	Test Method	Requirements
Density, pcf	ASTM D 3574	7-11
Compression, psi	ASTM D 3574	
25% Deflection		3-7
65% Deflection		8-16
Recovery, % of original, min.	65% deflection, after 1 minute relaxation from deflection return	95
Tensile Strength, psi, min.	ASTM D 3574	25
Water Absorption, % Vol., max. (1" thick specimen)	AASHTO T 42	30
Chemical Resistance	Immerse specimen approximately 0.5 cubic inch in volume in a 50% by volume mixture of mineral spirits and linseed oil for 24 hours. Remove and visually examine specimen for evidence of deterioration.	

A lubricant-adhesive recommended by the manufacturer shall be provided with the joint filler and liberally used according to the manufacturer's instructions.

(c) Preformed Elastomeric Compression Joint Seal: This material shall conform to Subsection 1005.03(b).

1005.08 WATERSTOPS.

(a) Copper waterstops shall conform to ASTM Designation: B 370, soft temper.

(b) Polyvinyl chloride waterstops shall conform to Corps of Engineers Specification CRD-C 572.

(c) Rubber waterstops shall conform to Corps of Engineers Specification CRD-C 513.

Details of installation and splicing, when not shown on the plans, shall be submitted to the Materials Engineer for approval. Copper and rubber waterstops shall be sampled in accordance with the Department's Materials Sampling Manual. When polyvinyl chloride waterstops are used, the contractor shall submit a certificate of analysis indicating conformance to these specifications.

Section 1006
Concrete, Clay, Asbestos-Cement and Plastic Pipe

1006.01 GENERAL.

(a) Portland-pozzolan cement conforming to Subsection 1001.02 may be used in the manufacture of concrete pipe and pipe arch.

(b) Any admixture for portland cement concrete listed on the Qualified Products List is allowed for use in concrete pipe manufacture.

(c) Compressive strength specimens for concrete pipe shall be made and cured in accordance with DOTD Designation: TR 227 and tested in accordance with DOTD Designation: TR 230.

(d) Concrete pipe shall be cured by one of the methods listed in ASTM Designation: C 76 as approved by the Department's Materials Section.

1006.02 CONCRETE SEWER PIPE. Nonreinforced (plain) concrete sewer pipe shall conform to ASTM Designation: C 14. Joints shall conform to Subsection 1006.05.

1006.03 REINFORCED CONCRETE PIPE. Reinforced concrete pipe shall conform to ASTM Designation: C 76, amended as follows:

(a) Unless otherwise specified, Class III pipe, Wall A, B or C shall be furnished.

(b) When extra strength pipe is required, either Class IV or Class V Reinforced Concrete Pipe shall be furnished as specified. Either Wall A, B or C may be furnished.

(c) The pipe shall be tested for permeability as specified in ASTM Designation: C 497. Frequency of testing shall be a minimum of 1 pipe section per lot of sizes up to and including 48-inch diameter and not to exceed 1 test per 1000 sections of pipe manufactured.

(d) The absorption test specified in ASTM Designation: C 76 will be conducted if the pipe exhibits visual porosity.

(e) For pipe sizes not included in ASTM Designation: C 76, the area of reinforcement shall be approved in accordance with ASTM Designation: C 655.

(f) No modified designs will be allowed.

(g) Joints shall conform to Subsection 1006.05.

1006.04 REINFORCED CONCRETE PIPE ARCH. Reinforced concrete pipe arch shall conform to ASTM Designation: C 506, amended as follows:

(a) Unless otherwise specified, Class III pipe arch shall be furnished.

(b) No modified designs will be allowed.

(c) Basis of Acceptance is expanded to include the following: Random testing, as established by Departmental policy, will be made to assure proper placement of reinforcement.

(d) For pipe arch sizes not included in ASTM Designation: C 506, the area of reinforcement shall be approved in accordance with ASTM Designation: C 655. The producer shall provide fabrication drawings reflecting conformance to these specifications prior to pipe inspection.

(e) Joints shall conform to Subsection 1006.05.

1006.05 CONCRETE PIPE JOINTS. Joints for concrete pipe and pipe arch shall conform to AASHTO Designation: M 198 with the following modifications. Gasket material shall conform to Subsection 1006.06.

(a) Type 3 Joints:

(1) Pipe for Type 3 joints shall have a maximum taper of 12° and a maximum differential between the joint taper of the bell and the spigot (tongue and groove) of 1° with the following exception. A maximum allowable differential between the tongue and groove may be 2° provided the taper is 6° or less and it will pass the 10-psi hydrostatic pressure test. The 10-psi hydrostatic test requirement will apply to pipe with diameters greater than 15 inches when the groove (bell) depth or tongue (spigot) length is less than 2 1/2 inches, and will apply to pipe with diameters of 15 inches or less when the groove depth or tongue length is less than 2 inches.

(2) Joints for use with rubber gaskets which have a taper less than 6° will not require hydrostatic pressure test except as provided in paragraph (1) above. If the joint taper is 6° to 8°, its use will be permitted provided the joint will pass the 10-psi hydrostatic pressure test.

(3) Joints for use with flexible plastic gaskets which have a taper less than 10° will not require the hydrostatic pressure test except as provided in paragraph (1). If the joint taper is 10° to 12°, its use will be permitted provided the joint will pass the 10-psi hydrostatic pressure test.

(b) **Type 2 Joints:** Pipe for Type 2 joints shall have joints qualified by the Department's Materials Section, shall use approved rubber or flexible plastic gaskets and shall pass the 5-psi hydrostatic pressure test.

(c) **Type 1 Joints:** Pipe for Type 1 joints shall have joints qualified by the Department's Materials Section and shall use approved rubber or flexible plastic gaskets.

(d) **Repair of Joints:** Joint repairs shall conform to ASTM Designation: C 443.

1006.06 GASKET MATERIALS. Gasket material sizes shall be as approved by the Department's Materials Section.

(a) **Rubber Gaskets:** Rubber gaskets for pipe joints shall conform to AASHTO Designation: M 198, Type A. The lubricant shall be the type recommended by the gasket manufacturer.

(b) **Flexible Plastic Gaskets:** Flexible plastic gaskets for pipe joints shall conform to AASHTO Designation: M 198, Type B. Flexible plastic gasket material and primer shall be from a source listed on the Qualified Products List.

1006.07 PERFORATED CONCRETE PIPE. Perforated concrete pipe shall conform to ASTM Designation: C 444.

1006.08 VITRIFIED CLAY PIPE AND JOINTS. Vitrified clay pipe shall be extra strength pipe conforming to ASTM Designation: C 700 and shall have compression joints conforming to ASTM Designation: C 425. The manufacturer shall supply certificates of analysis to the Department's Materials Section covering the jointing materials.

1006.09 ASBESTOS-CEMENT NONPRESSURE SEWER PIPE AND JOINTS. Asbestos-cement nonpressure sewer pipe shall conform to ASTM Designation: C 428 and shall have rubber ring joints conforming to ASTM Designation: D 1869. The manufacturer shall supply certificates of analysis to the Department's Materials Section covering the pipe and joint materials.

1006.10 PLASTIC UNDERDRAIN PIPE. Plastic pipe for underdrains shall be perforated or nonperforated, as specified.

(a) Perforated plastic pipe shall have either slot or circular perforations conforming to AASHTO Designation: M 252.

(b) The pipe shall be one of the following:

(1) Acrylonitrile-Butadiene-Styrene (ABS): ASTM Designation: D 2751, SDR 35.

(2) Corrugated Polyethylene (PE): AASHTO Designation: M 252.

(3) Polyvinyl Chloride (PVC): AASHTO Designation: M 278 or ASTM Designation: D 2729. Pipe stiffness shall conform to AASHTO Designation: M 278.

1006.11 PLASTIC YARD DRAIN PIPE.

(a) Plastic pipe for yard drains shall be one of the following:

(1) Acrylonitrile-Butadiene-Styrene (ABS): ASTM Designation: D 2680 for composite-wall pipe or ASTM Designation: D 2751, SDR 23.5 for solid-wall pipe.

(2) Polyvinyl Chloride (PVC): AASHTO Designation: M 278.

(b) Joints: Elastomeric gaskets for joining plastic pipe shall conform to the physical requirements of ASTM Designation: F 477.

Section 1007
Metal Pipe

1007.01 CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits shall conform to the requirements of Type I (culvert pipes, circular section) and Type II (culvert pipes, other than circular section) of AASHTO Designation: M 36 amended as follows:

(a) Pipe and pipe arch shall be galvanized (zinc coated) in accordance with AASHTO Designation: 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) When smooth-lined pipe is specified, the inside circumference of the pipe shall be fully lined with bituminous material in accordance with AASHTO Designation: M 190, Type D.

(e) Helical pipe shall have annular ends and shall have the ends of seams welded a minimum of 2 inches. Helical pipe ends shall be rerolled a minimum of 2 full standard corrugations to the same corrugation depth as the pipe when used with the appropriate jointing system.

(f) Pipe Arch Dimensions: Refer to Table 9 of this Section.

(g) Pipe joints shall conform to Subsection 1007.10 and shall be as shown on the plans.

(h) When Type 2 or 3 joints are specified, a minimum of 2 approved lifting lugs shall be provided on pipe larger than 30-inch diameter and pipe arch larger than 30-inch equivalent diameter.

(i) All welds and damaged zinc coatings shall be repaired by an approved method with a cold galvanizing repair compound listed on the Qualified Products List.

1007.02 BITUMINOUS COATED CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits shall be coated in accordance with AASHTO Designation: M 190 amended as follows:

(a) AASHTO Designation: M 36 is amended in accordance with Subsection 1007.01.

(b) Coating shall be Type A, fully bituminous coated.

(c) Pipe joints shall conform to Subsection 1007.10 and shall be as shown on the plans.

1007.03 ASBESTOS BONDED CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits shall be fabricated from asbestos bonded steel sheets. Base metal and fabrication of conduits and coupling bands shall conform to Subsection 1007.01.

Steel sheets shall be coated on both sides with a layer of asbestos fibers applied by pressing a sheet of asbestos fiber into the molten metallic bonding medium. Immediately after the metallic bond has solidified, the asbestos fibers shall be thoroughly impregnated with a bituminous saturant. Finished sheets and fabricated pipe shall be free from blisters, unsaturated spots, cracks in the bonding, unbonded areas and other defects.

After fabrication, asbestos bonded pipe and pipe arch shall be fully bituminous coated with a Type A coating in accordance with AASHTO Designation: M 190.

Asbestos bonded corrugated steel pipe and pipe arch shall be fabricated by the riveting process.

1007.04 BITUMINOUS COATED CORRUGATED STEEL UNDERDRAIN PIPE. Pipe and coupling bands shall conform to the requirements of Type III (underdrain pipes) of AASHTO Designation: M 36. The pipe shall be coated with a bituminous material in accordance with AASHTO Designation: M 190, Type A coating, except the minimum coating thickness shall be 0.03 inch. The specified minimum diameter of perforations shall apply after coating. Minimum sheet thickness shall be 0.064 inch (16 gage).

1007.05 STRUCTURAL PLATE FOR PIPE, PIPE ARCH AND ARCH. This material shall conform to AASHTO Designation: M 167 for steel, and AASHTO Designation: M 219 for aluminum.

1007.06 CORRUGATED ALUMINUM PIPE AND PIPE ARCH. These conduits shall conform to AASHTO Designation: 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. Helical pipe ends shall be rerolled a minimum of 2 full standard corrugations to the same corrugation depth as the pipe when used with the appropriate jointing system.

(b) Pipe Arch Dimensions: Refer to Table 9 in Subsection 1007.09.

(c) Pipe joints shall conform to Subsection 1007.10 and shall be as shown on the plans.

(d) When Type 2 or 3 joints are specified, a minimum of 2 approved lifting lugs shall be provided on pipe larger than 30-inch diameter and pipe arch larger than 30-inch equivalent diameter.

1007.07 CORRUGATED ALUMINUM UNDERDRAIN PIPE. Pipe and coupling bands shall conform to the requirements of Type III (underdrain pipes) of AASHTO Designation: M 196. Minimum sheet thickness shall be 0.060 inch (16 gage).

1007.08 POLYMERIC COATED CORRUGATED STEEL PIPE AND PIPE ARCH. These conduits shall conform to the requirements of Type I (culvert pipes, circular section) and Type II (culvert pipes, other than circular section) of AASHTO Designation: M 245 amended as follows:

(a) Pipe and pipe arch shall be galvanized (zinc coated) in accordance with AASHTO Designation: M 218.

(b) Polymeric coated pipe fabrication shall only be allowed with helical lock seam pipe.

(c) Thickness of polymeric coating on the finished pipe shall be 0.010 inch on the interior and exterior surfaces.

(d) Helical pipe shall have annular ends and shall have the ends of the seams welded a minimum of 2 inches. Helical pipe ends shall be rerolled a minimum of 2 full standard corrugations to the same corrugation depth as the pipe when used with the appropriate jointing system.

(e) Pipe Arch Dimensions: Refer to Table 9 of this Section.

(f) Pipe joints shall conform to Subsection 1007.10 and shall be as shown on the plans.

(g) Polymeric coated steel and approved repair materials shall be from a source listed on the Qualified Products List.

(h) When Type 2 or 3 joints are specified, a minimum of 2 approved lifting lugs shall be provided on pipe larger than 30-inch diameter and pipe arch larger than 30-inch equivalent diameter.

(i) All welds and damaged zinc coating shall be repaired by an approved method with a cold galvanizing repair compound listed on the Qualified Products List. Exposed edges and damaged polymeric coating shall be repaired with an approved material to a minimum thickness of 0.010 inch.

(j) Elbows, tees and other in-line filling 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.

1007.09 PIPE ARCH DIMENSIONS. If the plans specify the old standard pipe arch span and rise dimensions, the contractor shall furnish conduits meeting the new dimensional requirements of the latest

AASHTO Designations: M 36, M 196 and M 245. Table 9 shall be used to correlate the old and new dimensions.

TABLE 9
METAL PIPE ARCH DIMENSIONS
(Inches)

Round Equiv.	Steel Pipe Arch				Aluminum Pipe Arch	
	2 2/3 x 1/2 Corr.		3 x 1 or 5 x 1 Corr.		2 2/3 x 1/2 Corr.	
	OLD	NEW	OLD	NEW	OLD	NEW
15	18 x 11	17 x 13			18 x 11	17 x 13
18	22 x 13	21 x 15			22 x 13	21 x 15
21	25 x 16	24 x 18			25 x 16	24 x 18
24	29 x 18	28 x 20			29 x 18	28 x 20
30	36 x 22	35 x 24			36 x 22	35 x 24
36	43 x 27	42 x 29	43 x 27	40 x 31	43 x 27	42 x 29
42	50 x 31	49 x 33	50 x 31	46 x 36	50 x 31	49 x 33
48	58 x 36	57 x 38	58 x 36	53 x 41	58 x 36	57 x 38
54	65 x 40	64 x 43	65 x 40	60 x 46	65 x 40	64 x 43
60	72 x 44	71 x 47	72 x 44	66 x 51	72 x 44	71 x 47
66	79 x 49	77 x 52	73 x 55	73 x 55	—	77 x 52
72	85 x 54	83 x 57	81 x 59	81 x 59	84 x 56	83 x 57
78			87 x 63	87 x 63		
84			95 x 67	95 x 67		
90			103 x 71	103 x 71		
96			112 x 75	112 x 75		
102			117 x 79	117 x 79		
108			128 x 83	128 x 83		
114			137 x 87	137 x 87		
120			142 x 91	142 x 91		

1007.10 PIPE JOINTS. Coupling bands for joining metal conduit shall conform to AASHTO Designation: M 36 for steel conduit and AASHTO Designation: 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. Coating shall be the same as used on the conduit. Minimum band width shall be 12 inches.

(b) Rubber Gaskets: Rubber gaskets shall conform to Subsection 1006.06(a). Gasket cross section shall be as shown on the plans.

(c) Flexible Plastic Gaskets: Flexible plastic gaskets shall conform to Subsection 1006.06(b). Gasket material shall be a minimum of 1

inch for 1/2-inch corrugation depth, and a minimum of 1 1/2 inches for 1-inch corrugation depth.

(d) **Hardware** shall be galvanized in accordance with ASTM Designation: A 153 or B 633, Class Fe/Zn 25 or an approved mechanical galvanizing process that provides the same coating thickness.

(e) **Steel banding rods** shall conform to ASTM Designation: A 36. Welding of rods will not be permitted. No more than 2 splices will be allowed.

(f) **Angle and strap connections** shall be approved by the Department's Materials Section.

(g) **Type 3 Joints:** These joints must pass the 10-psi hydrostatic pressure test before being approved. Joint details shall be as shown on the plans.

(h) **Type 2 Joints:** These joints must pass the 5-psi hydrostatic pressure test before being approved. Joint details shall be as shown on the plans.

(i) **Type 1 Joints:** These joints shall be a Type 2 or 3 joint or other approved joint system. At least 1 line of approved gasket material will be required under the band on each pipe end.

1007.11 CAST IRON SOIL PIPE AND FITTINGS. Cast iron soil pipe and fittings shall conform to ASTM Designation: A 74, and joints shall be made with rubber gaskets conforming to ASTM Designation: C 564.

1007.12 DUCTILE-IRON PIPE. Ductile-iron pipe shall conform to ANSI Designation: A 21.51.

1007.13 BLACK AND GALVANIZED WELDED AND SEAMLESS STEEL PIPE. Steel pipe for ordinary uses shall conform to ASTM Designation: A 120.

Section 1008

Paints

1008.01 GENERAL.

(a) Packaging: Paints shall be delivered in 5-gallon, full lid, metal shipping containers conforming to Interstate Commerce Commission (ICC) 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 thereon: name and address of manufacturer, trade name or trademark, kind of paint, color of paint, number of gallons, batch number and date of production.

(c) Storage: After 1 year storage, the material shall not show skinning, settling, color change, thickening or livering that cannot be eliminated by normal mixing procedures.

1008.02 3-COAT ORGANIC ZINC PRIMER AND TOPCOAT SYSTEM. This 3-coat paint system (2 primer coats and 1 topcoat) shall be an approved system on the Qualified Products List. Each system shall be tested for a minimum of 1500 hours in a Salt Spray (Fog) apparatus, a Fluorescent UV-Condensation Exposure apparatus and/or an Operating Light-Exposure apparatus (Carbon Arc Type) with water in accordance with DOTD Designation: TR 503. The paint system shall show no rusting, blistering, checking, cracking, delamination, or undercutting and only slight chalking or discoloration. Each paint system shall conform to the following requirements.

(a) Organic Zinc Primer (2 Coats): Generic type vehicle-epoxy polyamide (catalyzed):

(1) Base Composition:

	% By Weight
Pigment, min.	80
Zinc Dust, ASTM D 520, Type I, min.	98
Thixatropes and Tinting Pigments, max.	2
Purity of Zinc Dust, min.	95
Vehicle, max.	20
Epoxy Resin (Epoxy Equ. 450-550)	18-26

Film Forming Additives, max.	1.1
Solvent Blend	72.9-82.0
Ethylene Glycol Monoethyl Ether 10% max. of Solvent Blend	
Sp. Gravity: 3.10 min.	

Material must not settle to the point that it cannot be stirred back in easily, and must not show any signs of gassing.

(2) **Curing Agent:** The curing agent shall be a clear, nonpigmented solution consisting of the following:

	% By Weight
Polyamide (amine value, 200-250)	25-29
Solvent Mixture:	
Cellosolve, max.	25
Xylene, min.	36
Sp. Gravity: 0.9	
Solids (wt.): 25-29%	

(3) **Mixed Primer:**

Property	Requirement
% Solids (by wt.), min.	80
% Volatiles by wt., max.	20
Wt./gallon, lbs., min.	21.0
Dry to touch, minutes, max.	30.0
Dry through, hours, max.	8

The manufacturer has the option to produce the primers as a 3-component system consisting of a base, cure and pigment. Thinning shall be in accordance with the manufacturer's recommendations, but not exceeding 12 percent.

(4) **Tinting:** Primer shall be tinted for color contrast as follows:

1st Coat - Red
2nd Coat - Green

(b) Vinyl Aluminum Topcoat:

(1) **Composition:**

	% By Weight
Vinyl Resin (VAGH & VMCH equal parts), min.	15.00
Epoxy resin (Epon 828), max.	0.07
Dioctylphthalate (DOP), max.	3.83
Aluminum powder, Fed. Spec. TT-P 320 Type 1 Class 2/leafing, max.	6.52
N Butyl Acetate	55-65
Toluene	10-20

(2) Properties:

Property	Requirement
% Solids by wt., min.	24
% Volatiles by wt., max.	76
Wt./gallon, lbs.	7.8-8.5
Dry to touch, minutes, max.	30
Dry through, hours	3-4
Viscosity	60-100
Storage, yrs., min.	1

Thinning shall be in accordance with manufacturer's recommendations, but not exceeding 10 percent.

1008.03 2-COAT ORGANIC ZINC PRIMER AND TOPCOAT SYSTEM. This 2-coat paint system shall be an approved system on the Qualified Products List. The system shall consist of 1 coat of organic zinc primer and 1 coat of topcoat to be used in painting metal surfaces. Each system shall be tested for a minimum of 1500 hours in a Salt Spray (Fog) apparatus, a Fluorescent UV-Condensation Exposure apparatus and/or an Operating Light-Exposure apparatus (Carbon Arc Type) with water in accordance with DOTD Designation: TR 503. The paint system shall show no rusting, blistering, checking, cracking, delamination or undercutting, and only slight chalking or discoloration.

1008.04 BASIC LEAD SILICO-CHROMATE PAINT. The 4-coat paint system will use Coats A, B, C and D coats of paint. The 3-coat system will use Coats A, C and D coats of paint.

(a) Coat A(1) Brown (First prime coat for steel on new construction):

(1) Pigment: The pigment shall be well ground and be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM D 1648)	93.2	....
Siliceous Red Iron Oxide (85% Fe_2O_3)	5.0	6.1
Organo Montmorillonite (Bentone 38)	0.5	0.7

(2) Liquid: The liquid shall consist of at least 52 percent nonvolatile vehicle, the balance to be combined drier and thinner. Nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in approximate proportions of 1:1 by weight and shall contain a minimum of 15 percent phthalic anhydride. Alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type III. Small quantities of grinding and wetting aids may be used.

(3) The paint shall consist of:

	Min.	Max.
Pigment	57.0%	....
Vehicle	....	43.0%
Weight/Gallon, Pounds @ 77°F	13.5	....
Water	....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	....	1.0%
Fineness of Grind (North Standard)	4	....
Viscosity (Stormer-Krebs Units) @ 77°F	72	83
Drying Time:		
Set to Touch, Hours	....	4
Dry Through, Hours	....	16

The following is a suggested batching formulation that will conform to the required composition.

	% By Weight
Pigment	58.4
Basic Lead Silico-Chromate (ASTM D 1648)	93.5
Siliceous Red Iron Oxide (85% Fe_2O_3)	5.9
*Organo Montmorillonite	0.6

*Prewet with 30% by weight of methyl alcohol: water (95:5) before adding to grind.

	% By Weight
Vehicle	41.6
Raw Linseed Oil (AASHTO M 125-60)	26.7
Alkyd Resin (Fed. Spec. TT-R-266, Type III)	52.3
Mineral Spirits	18.7
6% Zirconium Catalyst	1.2
6% Manganese Naphthenate	0.4
6% Cobalt Naphthenate	0.2
Anti-Skinning Agent	0.2
Methyl Alcohol: Water (95:5)	0.3

PV (% pigment by volume in nonvolatile portion of paint): 39.7.
Volatile and drier in vehicle: 44.9%.

(b) Coat A(2) Brown (First prime coat for existing steel structures):

(1) Pigment: The pigment shall be well ground and composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM D 1648)	94.0	....
Siliceous Red Iron Oxide (85% Fe_2O_3)	4.0	5.5
Organo Montmorillonite (Bentone 38)	0.5	0.7

(2) Liquid: The liquid shall consist of at least 69 percent nonvolatile vehicle, the balance to be combined drier and thinner. Nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in approximate proportions of 2.3:1 respectively by weight and shall contain a minimum of 7.0 percent phthalic anhydride. Alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type I, Class A or B. A drier combination of 0.14 percent zirconium, 0.04 percent manganese, and 0.02 percent cobalt metals furnished in soluble form based on the nonvolatile vehicle of the paint shall be used. Small quantities of grinding and wetting aids may be used.

(3) The paint shall consist of:

	Min.	Max.
Pigment	64.0%	....
Vehicle	....	36.0%
Weight/Gallon, Pounds @ 77°F	15.0	....
Water	....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	....	1.0%
Fineness of Grind (North Standard)	4	....
Viscosity (Stormer-Krebs Units) @ 77°F	72	80
Dry Firm, Hours	18	....

The following is a suggested batching formulation that will conform to the required composition.

	% By Weight
Pigment	64.58
Basic Lead Silico-Chromate (ASTM D 1648)	94.43
Siliceous Red Iron Oxide (85% Fe_2O_3)	4.97
*Organo Montmorillonite	0.60

*Prewet with 30% by weight of methyl alcohol: water (95.5) before adding to grind.

	% By Weight
Vehicle	35.42
Raw Linseed Oil (AASHTO M 125-60)	48.46
Alkyd Resin (Fed. Spec. TT-R-266, Type I, Class A)	30.81
Mineral Spirits	17.94
6% Zirconium Catalyst	1.58
6% Manganese Naphthenate	0.47
6% Cobalt Naphthenate	0.24
Anti-Skinning Agent	0.18
Methyl Alcohol: Water (95:5)	0.32

PV (% pigment by volume in nonvolatile portion of paint): 38.1. Volatile and drier in vehicle: 29.9%.

(c) **Coat B Maroon:**

(1) **Pigment:** The pigment shall be well ground and be composed of:

	Min.%	Max.%
Basic Lead Silico-Chromate (ASTM D 1648)	64.0	....
Siliceous Red Iron Oxide (85% Fe_2O_3)	....	35.5
Organo Montmorillonite (Bentone 38)	0.5	0.7

(2) **Liquid:** The liquid shall consist of at least 72 percent nonvolatile vehicle, the balance to be combined drier and thinner. Nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in approximate proportions of 2:1 respectively by weight and shall contain a minimum of 7.6 percent phthalic anhydride. Alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type I, Class A or B. A drier combination of 0.14 percent zirconium and 0.04 percent manganese metals furnished in soluble form based on nonvolatile vehicle of the paint shall be used. Small quantities of grinding and wetting aids may be used.

(3) **The paint shall consist of:**

	Min.	Max.
Pigment	62.0%	....
Vehicle	....	38.0%
Weight/Gallon, Pounds @ 77°F	14.8	....
Water	....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	....	1.0%
Fineness of Grind (North Standard)	4	....
Viscosity (Stormer-Krebs Units) @ 77°F	74	84
Dry Firm, Hours	18	....

The following is a suggested batching formulation that will conform to the required composition.

	% By Weight
Pigment	62.26
Basic Lead Silico-Chromate (ASTM D 1648)	4.62
Siliceous Red Iron Oxide (85% Fe_2O_3)	34.79
*Organo Montmorillonite	0.59

*Prewet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

	% By Weight
Vehicle	37.74
Raw Linseed Oil (AASHTO M 125-60)	47.56
Alkyd Resin (Fed. Spec. TT-R-266, Type I, Class A)	34.44
Mineral Spirits (Hv)	14.76
Anti-Skinning Agent	0.16
6% Zirconium Catalyst	1.80
6% Manganese Naphthenate	0.49
Methyl Alcohol:Water (95:5)	0.30
Soya Lecithin	0.49

PV (% pigment by volume in nonvolatile portion of paint): 34.8. Volatile and drier in vehicle: 27.84%.

(d) Coat C Gray:

(1) Pigment: The pigment shall be well ground and be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM D 1648)	65.6	....
Chalk Resistant Rutile Titanium Dioxide	....	16.6
Acicular Zinc Oxide	....	5.8
Fibrous Magnesium Silicate and Tinting Colors (Lampblack and Phthalocyanine Blue) No Iron Blue Permitted	....	11.5
Organo Montmorillonite (Bentone 38)	0.5	....

(2) Liquid: The liquid shall consist of at least 69 percent nonvolatile vehicle, the balance to be combined drier and thinner. Nonvolatile vehicle shall be composed of raw linseed oil and alkyd resin combined in approximate proportions of 2:1 respectively by weight and shall contain a minimum of 7.5 percent phthalic anhydride. Alkyd resin, furnished as a solution, shall conform to Federal Specification TT-R-266, Type I, Class A or B. Small quantities of grinding and wetting aids may be used.

(3) The paint shall consist of:

	Min.	Max.
Pigment	56.5%	....
Vehicle	....	43.5%
Weight/Gallon, Pounds @ 77°F	13.5	....
Water	....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	....	1.0%
Fineness of Grind (North Standard)	4	....
Viscosity (Stormer-Krebs Units) @ 77°F	72	82
Dry Firm, Hours	18	....

The following is a suggested batching formulation that will conform to the required composition.

	% By Weight
Pigment	57.7
Basic Lead Silico-Chromate (ASTM D 1648)	67.80
Titanox RANC	15.52
Zinc Oxide	5.13
Magnesium Silicate	9.77
Lampblack	0.81
Phthalocyanine Blue	0.36
*Organo Montmorillonite	0.61

*Prewet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

	% By Weight
Vehicle	42.3
Raw Linseed Oil (AASHTO M 125-60)	46.83
Alkyd Resin (Fed. Spec. TT-R-266, Type I, Class A)	33.33
Mineral Spirits	18.00
6% Zirconium Catalyst	1.17
6% Manganese Naphthenate	0.23
Anti-Skinning Agent	0.16
Methyl Alcohol: Water (95:5)	0.28

PV (% pigment by volume in nonvolatile portion of paint): 32.5. Volatile and drier in vehicle: 30%.

(e) Coat D(1) Bright Green:

(1) Pigment: The pigment shall be well ground and be composed of:

	Min. %	Max. %
Basic Lead Silico-Chromate (ASTM D 1648)	64	....
Titanium Dioxide, Rutile Nonchalking	18	....
Organo Montmorillonite (Bentone 38)	0.8	1.0
Tinting Colors (C.P. Chrome Yellow Light Phthalocyanine Green)	Balance	

(2) Liquid: The liquid shall consist of at least 47.0 percent nonvolatile vehicle, the balance to be combined drier and thinner. Nonvolatile vehicle shall be an alkyd resin conforming to Federal Specification TT-R-266, Type I, Class A or B. Thinner shall be essentially mineral spirits conforming to Federal Specification TT-T-291a, Grade 1. Small quantities of grind and wetting aids may be used.

(3) The paint shall consist of:

	Min.	Max.
Pigment	30.5%	....
Vehicle	....	69.5%
Weight/Gallon, Pounds	9.8	....
Water	....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	....	1.0%
Fineness of Grind (North Standard)	5	....
Viscosity (Stormer-Krebs Units)	65	75
Dry Firm, Hours	....	8

The following is a suggested batching formulation that will conform to the required composition.

	% By Weight
Pigment	31.0
Basic Lead Silico-Chromate (ASTM D 1648)	64.2
Titanox RANC	18.4
Chrome Yellow, Light	11.0
Phthalocyanine Green	5.5
*Organo Montmorillonite	0.9

* Prewet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

	% By Weight
Vehicle	69.0
Alkyd Resin (Fed. Spec. TT-R-266, Type I, Class A)	67.2
Mineral Spirits	30.7
Zirconium Catalyst, 6%	1.2
Cobalt Naphthenate, 6%	0.3
Manganese Naphthenate, 6%	0.3
Anti-Skinning Agent	0.2
Methyl Alcohol:Water (95:5)	0.1

PV (% pigment by volume in nonvolatile portion of paint): 20.1.
Volatile and drier in vehicle: 53.0%

(f) Coat D(2) Cement Gray:

(1) **Pigment:** The pigment shall be composed of:

	Min. %	Max.%
Basic Lead Silico Chromate (ASTM D 1648)	39.0	....
Titanium Dioxide, Rutile Nonchalking	57.0	....
Organo Montmorillonite (Bentone 38)	0.7	0.9
Phthalocyanine Blue and Lampblack	Balance	

(2) Liquid: The liquid shall consist of at least 50 percent nonvolatile vehicle, the balance to be combined drier and thinner. Nonvolatile vehicle shall be an alkyd resin conforming to Federal Specification TT-R-266, Type I, Class A or B. Thinner shall be essentially mineral spirits conforming to Federal Specification TT-T-291a, Grade 1. Small quantities of grind and wetting aids may be used.

(3) The paint shall consist of:

	Min.	Max.
Pigment	33.0%	....
Vehicle	....	67.0%
Weight/Gallon, Pounds @ 77°F	10.0	....
Water	....	0.5%
Coarse Particles and Skins (Total Residue Retained on 325 Sieve Based on Paint)	....	1.0
Fineness of Grind (North Standard)	5	....
Viscosity (Stormer-Krebs Units) @ 77°F	68	75
Dry Firm, Hours	....	8

The following is a suggested batching formulation that will conform to the required composition.

	% By Weight
Pigment	33.6
Basic Lead Silico-Chromate (ASTM D 1648)	39.10
Titanox RANC	58.66
*Organo Montmorillonite	0.84
Phthalocyanine Blue	1.40

*Prewet with 30% by weight of methyl alcohol:water (95:5) before adding to grind.

	% By Weight
Vehicle	66.4
Alkyd Resin (Fed. Spec. TT-R-266, Type I, Class A)	71.9
Mineral Spirits (AASHTO M 128-60)	24.9
6% Zirconium Catalyst	1.4
6% Cobalt Naphthenate	0.3
6% Manganese Naphthenate	0.3
Anti-Skinning Agent	0.2
Methyl Alcohol:Water (95:5)	1.0

PV (% pigment by volume in nonvolatile portion of paint): 20.8.
Volatile and drier in vehicle: 49.1%.

(g) Application: Coating must be capable of being applied to required film thickness by brush, roller or spray application without difficulty at temperatures above 40°F and shall exhibit no running, streaking, sagging, wrinkling or other defects.

(h) Color: Paint colors shall be as specified. Color chips are available upon request from the Department's Materials Section.

(i) Hiding Power: Paints shall be sufficient to obtain complete hiding when applied at normal spreading rates.

1008.05 RED LEAD PAINT. Red lead paint shall conform to AASHTO Designation: M 72, Type II, except that the first field coat shall be tinted with 1 ounce of lampblack, paste form, to 1 gallon of paint. Lampblack shall conform to ASTM Designation: D 209 and shall be incorporated by the manufacturer.

1008.06 ALUMINUM PAINT. Aluminum paint shall conform to AASHTO Designation: M 69, Type I.

1008.07 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 for suitable solvents with the necessary amount of drier.

(b) Appearance: The film shall be smooth and homogeneous when examined by pouring some of the thoroughly mixed sample on a clean, clear, glass plate and standing in a vertical position until the excess varnish has drained off. Examine the film 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.

(e) Drying of film:

(1) Set to Touch: Film shall set to touch in not more than 8 hours.

(2) Dry Firm: Film shall dry firm in not more than 36 hours.

(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.

1008.08 COAL TAR EPOXY-POLYAMIDE PAINT. This paint shall conform to Corps of Engineers Specification C-200.

Section 1009

Reinforcing Steel and Wire Rope

1009.01 REINFORCING STEEL. Reinforcing steel for concrete shall conform to the following. Unless otherwise specified, deformed bars may be either Grade 40 or 60. No. 2 bars need not be deformed, and shall conform to Headings (a), (b) or (c) below. Wire conforming to Heading (d) below may be used in lieu of No. 2 bars when furnished in size W 5.

(a) Billet-Steel Deformed and Plain Bars: ASTM Designation: A 615 and its Supplementary Requirements.

(b) Rail-Steel Deformed and Plain Bars: ASTM Designation: A 616.

(c) Axle-Steel Deformed and Plain Bars: ASTM Designation: A 617.

(d) Cold-Drawn Steel Wire: ASTM Designation: A 82 with the following amendment: for material testing over 110,000-psi 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 increment of tensile strength exceeding 110,000 psi.

(e) Welded Steel Wire Fabric: ASTM Designation: A 185.

1009.02 SPIRAL REINFORCING. Spiral reinforcing shall conform to Subsection 1009.01(a), (b), (c) or (d).

1009.03 TIE BARS. Tie bars shall conform to Subsection 1009.01 (a), (b) or (c). Tie bars to be bent and restraightened during construction shall be Grade 40.

1009.04 LOAD TRANSFER DEVICES. Load transfer devices shall consist of approved dowel bar assemblies or cantilever-type devices.

(a) Dowel Bars: Dowel bars shall be plain bars conforming to 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.

Paint for dowel bars shall conform to AASHTO Designation: M 72.

Plastic coated dowel bars shall be undercoated with an adhesive and given an outer coat of extruded polyethylene plastic in accordance with the coating requirements of AASHTO Designation: M 254 and the following:

Adhesive Undercoating:	
Adhesive Thickness	3 to 10 mils
Outer Coating:	
Coating Material	High Density Polyethylene
Coating Thickness	14 to 20 mils
Total Thickness of Adhesive Undercoating and Outer Coating	20 to 30 mils

(b) Cantilever-Type Devices: Cantilever-type devices shall be fabricated of cast malleable iron conforming to details shown on the plans. Castings forming each of the 2 sections shall be of material conforming to ASTM Designation: A 47, Grade No. 35018. Each load transfer unit of the cantilever type shall consist of 2 identical castings providing a cantilever arm on which the other 1/2 of the unit shall bear, and each casting shall have an upper tension anchor and a lower compression anchor, all constructed in accordance with the general dimensions shown on the plans. Castings shall be cleaned and ground to the required dimensions and assembled into a complete unit providing coincidence of bearing on both vertical and horizontal sliding faces. Castings shall be sufficiently smooth so that there will be no interference with smooth sliding operations.

1009.05 STEEL STRAND FOR PRETENSIONING. Strand for pretensioning shall conform to ASTM Designation: A 416. The strand manufacturer shall submit to the Department's Construction Section 3 copies of certificates of analysis of all test results as stipulated in ASTM Designation: 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.

1009.06 BARS FOR POST-TENSIONING. Bars shall be steel conforming to ASTM Designation: A 722 having a minimum modulus of elasticity of 25,000,000, 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 minimum diameter. Wire shall conform to ASTM Designation: 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 conforming to the physical requirements specified above for wedge-type anchorages will be considered. All 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 3,000,000 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 Department's Materials Sampling Manual and submitted to the Department's Construction Section for approval by evaluation or testing.

1009.10 WIRE ROPE. Wire rope shall conform to Federal Specification RR-W-410C and the following requirements.

Wire rope shall be improved plow steel, uncoated, preformed, 6 x 19 filler wire construction with hard fiber core and right regular lay.

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.

(a) **Type and Classification:** The type and classification of wire rope shall conform to one shown in Table 10.

(b) **Breaking Strength and Dimensions:** Diameter, circumference, pitch and breaking strength shall be as specified in Table 11. For other types and classifications, refer to Federal Specification RR-W-410C.

No splicing of wire rope or its component strands will be permitted.

When wire joints are necessary, they shall be electrically butt-welded; and in the stranding operation, no 2 joints in any strand shall be closer than 25 feet apart, except for filler wires.

Wire rope shall be shipped on reels, the minimum diameter of which shall be not less than 25 times the nominal diameter of the wire rope. If shipped in coils, the inside diameter of coils shall be not less than 25 times the nominal diameter of the wire rope.

1009.11 COUNTERWEIGHT ROPES. Counterweight ropes shall conform to Subsection 1009.10 and the following. 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.

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, and the prestressing load shall be 35 percent of the listed breaking strengths of the wire ropes, and such loading shall be applied 3 times to the wire ropes. The cycle of loading shall be between the limits of 5 to 35 percent, and 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, and 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. Rope number shall be stamped on each socket, counterweight and span lifting point.

Lengths of wire rope in excess of 100 feet shall not vary from specified length by more than 0.0002 times the specified length. For wire rope lengths of 100 feet or less, the tolerance from specified length shall be ± 1/4 inch.

Sockets and socket pins used with wire ropes shall be forged, without welds, from solid steel and shall conform to ASTM Designation: A 668, Class D, normalized. The socket shall be attached to the wire rope by using zinc of a quality not less than defined for Intermediate Grade in ASTM Designation: B 6, and wire rope must not slip appreciably in its connection.

TABLE 10
General Wire Rope Classification and Usage

Type	Classification	Usage
I	1. (6 x 7)	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. (6 x 19)	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. (6 x 37)	For hoisting rope where maximum flexibility is required; for instance, hoisting rope on dragline that runs over small sheave.
II	2. (8 x 19)	High speed elevator rope.
III (Marine)	1. (6 x 6)	Deck lashing ropes.
	2. (6 x 12)	Running ropes.
	3. (6 x 24)	Mooring lines.
	4. (6 x 3 x 7)	Spring lay.
	5. (6 x 3 x 19)	Spring lay.
	6. (6 x 42)	Tiller or hand control rope.
IV (Special)	2. (18 x 7)	Nonrotating (for drill rigs).

Full-sized specimens of rope shall be fitted with sockets, attached not less than 25 rope diameters but not more than 12 feet apart, and shall be tested to destruction.

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 should occur, the method of attachment shall be changed until a satisfactory one 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 2 specimens taken from each original length of rope.

The manufacturer shall provide proper facilities for making the tests and shall make them at his expense. The contractor shall furnish the engineer with certified test reports for all required tests.

If a socket should break during tests of the wire rope, 2 others 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 10 percent or more of the sockets tested break at a load less than the specified minimum strength of the rope, the entire lot shall 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 shall be rejected and replaced.

Wire ropes shall be suitably marked or tagged for identification for proper erection.

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 11

Type I, General Purpose, Class 2, 6 x 19
Improved Plow Steel, Fiber Core

Rope Diameter Nominal (ordered) (Minimum) Inches	Maximum Inches	Approximate Circumference Inches	Maximum Strand Pitch		Approximate Weight Lbs./Ft.	Minimum Breaking Strength on Bright (uncoated) Wire Ropes Pounds
			Regular Lay Inches	Lang Lay Inches		
1/4	9/32	3/4	1 11/16	1 13/16	0.105	5343
5/16	11/32	1	2 1/8	2 9/32	0.164	8307
3/8	13/32	1 1/8	2 17/32	2 23/32	0.236	11895
7/16	15/32	1 3/8	2 31/32	3 3/16	0.32	16127
1/2	17/32	1 5/8	3 3/8	3 5/8	0.42	20865
9/16	19/32	1 3/4	3 13/16	4 3/32	0.53	26325
5/8	21/32	2	4 7/32	4 17/32	0.66	32565
3/4	25/32	2 3/8	5 1/16	5 7/16	0.95	46410
7/8	59/64	2 3/4	5 29/32	6 11/32	1.29	62790
1	1 3/64	3 1/8	6 3/4	7 1/4	1.68	81510
1 1/8	1 11/64	3 1/2	7 19/32	8 5/32	2.13	102570
1 1/4	1 5/16	3 7/8	8 7/16	9 1/16	2.63	125970
1 3/8	1 7/16	4 3/8	9 9/32	9 31/32	3.18	151515
1 1/2	1 9/16	4 3/4	10 1/8	10 7/8	3.78	179400
1 5/8	1 23/32	5 1/8	10 31/32	11 25/32	4.44	208650
1 3/4	1 27/32	5 1/2	11 13/16	12 11/16	5.15	241800
1 7/8	1 31/32	5 7/8	12 21/32	13 19/32	5.91	274950
2	2 3/32	6 1/4	13 1/2	14 1/2	6.72	312000
2 1/8	2 7/32	6 5/8	14 11/32	5 13/32	7.59	349050
2 1/4	2 11/32	7 1/8	15 3/16	16 5/16	8.51	390000
2 1/2	2 5/8	7 7/8	16 7/8	18 1/8	10.5	475800
2 3/4	2 7/8	8 5/8	18 9/16	19 15/16	12.7	569400

Section 1010

Fence and Guard Rail

1010.01 BARBED WIRE. Barbed wire shall be aluminum alloy or steel.

(a) General Requirements: Average spacing of barbs, based on a minimum sample length of 25 feet, shall not exceed the specified spacing and no individual spacing shall exceed the specified spacing by more than 3/4 inch.

(b) Steel Barbed Wire: Steel barbed wire shall conform to ASTM Designation: A 121 except that the coating weight shall be a minimum of 0.30 ounce/square foot of uncoated wire surface area regardless of wire gage.

(c) Aluminum Alloy Barbed Wire: Aluminum alloy barbed wire shall conform to ASTM Designation: B 211, Alloy 5052-O for line wire and Alloy 5052-H38 for barbs.

1010.02 WOVEN WIRE. Woven wire shall conform to ASTM Designation: A 116. Spelter coating shall be Class 1.

1010.03 POSTS AND BRACES FOR FIELD AND LINE TYPE FENCE. Posts and braces shall be either steel or treated timber; however, the same type, shape and treatment of posts shall be used throughout a section of fence.

(a) Treated Timber Posts and Braces: Posts and braces shall be treated Southern Pine. Posts and braces shall be either round or square. Posts and bracing 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 bracing shall be free from decayed wood, rot and red heart. Ring shakes and season checks which penetrate more than 1/4 inch will be cause for rejection. Posts and bracing shall show at least 4 annual rings per inch and at least 1/3 summer wood.

Posts and braces 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 post nor at any point be more than 2 inches from the geometric center of the post. Posts and bracing shall be free from short or reverse bends. Butts and tips shall be sawed square.

Posts and braces shall be air or artificially seasoned prior to treatment. After seasoning, posts and braces shall be treated with one of the following preservatives in accordance with Subsection 1014.03.

(1) Creosote.
(2) Pentachlorophenol-Petroleum Solution.
(3) Chromated Copper Arsenate (CCA).

(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 conform to ASTM Designation: 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 Designation: A 123.

Excessive bow, camber, twist or other such defects in posts and braces will be cause for rejection.

1010.04 STAPLES. Staples shall be made of galvanized steel wire. Minimum spelter coating shall be not less than 0.20 ounce per square foot when tested in accordance with ASTM Designation: 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 diameter. Spelter coating shall not be less than 0.20 ounce per square foot when tested in accordance with ASTM Designation: A 90.

1010.06 GATES FOR FIELD AND LINE TYPE FENCE.

(a) Gates: If the contractor proposes to furnish gates of a design other than that shown on the plans, he shall submit for approval, specifications covering the design and fabrication of the type gates he contemplates furnishing. Steel sheets used in fabricating gates shall be galvanized in accordance with ASTM Designation: A 525, G 90 Coating Designation (1.25 Commercial).

(b) **Posts:**

(1) **Treated Timber:** Treated timber posts shall conform to Subsection 1010.03(a).

(2) **Metal:** Metal posts shall be made of galvanized steel pipe, standard weight, conforming to ASTM Designation: A 120.

(c) **Hardware:** Hinges, washers, nails, staples, well chains and latches shall be 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 conforming to 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 conforming to Subsection 1010.03(a).

1010.07 CHAIN LINK FENCE, GATES AND APPURTENANCES.

(a) Chain link fence may be fabricated of any of the following:

(1) Type I - Zinc-coated steel fabric, posts, hardware and fittings.

(2) Type II - Aluminum-coated steel fabric and zinc-coated steel posts, hardware and fittings.

(3) Type III - Aluminum alloy fabric, posts, hardware and fittings.

(4) Type IV - Green vinyl-clad steel fabric and zinc-coated steel posts, hardware and fittings.

(b) All materials furnished, except as specified herein, shall conform to AASHTO Designation: M 181.

(1) **Zinc-coated Steel Fabric:** Zinc coating for steel fabric shall be a Class I coating (1.2 oz. of zinc per square foot, minimum, of uncoated wire surface) in accordance with ASTM Designation: A 392.

(2) **Zinc-coated Steel Members:** Zinc coating of posts, rails, expansion sleeves and gate frames shall be an average of 1.8 oz. of zinc per square foot of uncoated surface in accordance with ASTM Designation: A 120.

(3) **Wire Ties and Tension Wire:** Wire fabric ties, wire ties, hog rings and tension wire for use with zinc-coated steel fabric or with aluminum-coated steel fabric shall be zinc-coated steel wire or aluminum-coated steel wire, and those for use with aluminum alloy fabric shall be aluminum alloy wire.

a. Wire Ties: Wire ties, wire fabric ties and hog rings shall be either ductile steel or aluminum alloy having a minimum tensile strength of 42,000 psi, a minimum yield strength of 35,000 psi, and a minimum elongation of 10 percent. Steel shall be coated with a minimum of 0.70 oz. of zinc or 0.40 oz. of aluminum alloy per square foot of uncoated wire surface.

b. Tension Wire: Tension wires shall be minimum 9 gage wire.

1. Zinc-coated and aluminum-coated steel tension wire shall have a minimum tensile strength of 80,000 psi coated with a minimum of 0.80 oz. of zinc or 0.40 oz. of aluminum alloy per square foot of uncoated wire surface.

2. Aluminum alloy tension wire shall have a minimum tensile strength of 42,000 psi, a minimum yield strength of 35,000 psi, and a minimum elongation of 10 percent. The minimum allowable gage shall be such that the aluminum alloy wire will develop ultimate tensile force equivalent to that of a 9 gage steel wire under an 80,000-psi tensile stress.

(c) Barbed wire used with chain link fence shall conform to Subsection 1010.01.

(d) Padlocks shall be solid jacket, extruded brass metal with interchangeable cores and 1 3/4-inch 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. 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 conform to AASHTO Designation: M 180.

The fabricator shall file a Brand Registration and Guarantee with the Department's Materials Engineer in accordance with AASHTO Designation: M 180. Certificates of analysis shall be furnished for each heat per shipment covering all tests and measurements required by AASHTO Designation: M 180.

1010.09 GUARD RAIL POSTS AND SPACER BLOCKS. Railing posts shall be of wood 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 of the same material as the post.

When required depth of penetration cannot be achieved for wood posts, steel posts may be allowed or required. Spacer blocks for these steel posts shall be of the same material as the guard rail posts at the installation.

(a) Wood posts and spacer blocks shall be treated timber of Southern Pine No. 1 S.R. or Douglas Fir Dense Construction quality. Posts and spacer blocks shall be fabricated before treatment. Timber and treatment shall conform to Section 1014.

(b) Steel posts and spacer blocks shall conform to ASTM Designation: A 36 or A 769 (Grade 40) galvanized in accordance with ASTM Designation: A 123.

(c) Concrete and reinforcement for anchorages shall conform to Sections 902 (Class A) and 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 conform to ASTM Designation: A 307 and nuts shall conform to ASTM Designation: A 563, Grade A.

Fittings, bolts, washers and other accessories for steel guard rail shall be galvanized after fabrication in accordance with ASTM Designation: A 123 or A 153, or by an approved mechanical galvanizing process 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 conform to AASHTO Designation: M 30.

Flexible rail elements composed of multiple wires in any arrangement other than rope form shall conform to the strength requirements for the item.

1010.12 TIMBER RAIL. Timber rails shall be cut from dry, well-seasoned and dressed timber conforming to Subsection 1014.01. Preservative treatment shall conform to Subsection 1014.04.

Section 1011

Concrete Curing Materials, Special Finishes and Admixtures

1011.01 CURING MATERIALS.

(a) Liquid Membrane-Forming Compounds: This material shall conform to AASHTO Designation: M 148, except that specimens tested for drying time shall be maintained at a temperature of 100 ± 2°F and a relative humidity of 32 ± 2 percent. When so tested, the membrane-forming compound shall dry to touch in not more than 2 hours.

(b) Burlap Cloth made from Jute or Kenaf: AASHTO Designation M 182, Class 3.

(c) Waterproof Paper: AASHTO Designation: M 171.

(d) White Polyethylene Sheeting: AASHTO Designation: M 171.

(e) Combined Burlap and White Polyethylene Sheeting: AASHTO Designation: M 171.

1011.02 ADMIXTURES. Concrete admixtures shall be from an approved source on the Qualified Products List and shall conform to the following requirements:

(a) Physical Requirements: Admixtures shall be of a water-reducing (normal set or set-retarding) or air-entraining type conforming to the requirements in Table 12 of this Section when tested in accordance with DOTD Designation: TR 224.

(b) Chemical Requirements: The contribution of chloride ion (Cl^-) resulting from the addition of admixtures to the concrete shall not exceed 0.02 pound/cubic yard of concrete.

(c) Tests: Tests to determine rate of hardening, compressive strength or other properties may be made at any time during the work to insure continued compliance with these specifications.

1011.03 SPECIAL SURFACE FINISH. This material shall be an approved product on Qualified Products List. The material shall provide a

TABLE 12
Physical Requirements For Admixtures

	Air-Entraining Admixtures	Water-Reducing Admixtures	
		Normal Set	Set-Retarding
Unit Water Content,			
Max. % of Control	90	95	95
Min. % of Control	—	88	88
Air Content, %, Total	5 ± 1	0 to 3	0 to 3
Time of Setting, Deviation from Control in Hours (1)			
Initial Set — Max.		± 1	+3
Min.		—	+1
Final Set — Max.		±1	+3
Min.		—	—
Compressive Strength, Min. % of Control			
7 Days	85	105	105
28 Days	85	105	105

Note (1) Time of setting requirements provide that, at the dosage rate used to approve the admixture, concrete containing:

1. A water-reducing, normal set admixture must reach both initial set and final set not more than 1 hour sooner or 1 hour later than the reference concrete.

2. A water-reducing, set-retarding admixture must reach initial set at least 1 hour later but not more than 3 hours later than the reference concrete and must reach final set not more than 3 hours later than the reference concrete.

uniform, fine-textured finish. 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.

When tested in accordance with DOTD Designation: TR 620, the material shall conform to the following requirements:

(a) The average number of cycles to failure shall be not less than 50 cycles when tested in accordance with DOTD Designation: TR 231. Test specimens shall show no flaking, cracking, spalling or loss of bond.

(b) The material shall show satisfactory appearance when exposed to 500 cycles of accelerated weathering in accordance with DOTD Designation: TR 611.

(c) Color of the material when applied to the test panel shall closely match that of the standard "Louisiana Gray" color chip on file at the Department's Materials Section.

Section 1012

Railings and Barriers

1012.01 CONCRETE. Concrete for bridge railings and barriers shall conform to Section 901. Concrete for roadway barriers shall conform to Section 902.

1012.02 REINFORCING STEEL. Reinforcing steel shall be deformed bars conforming to Subsection 1009.01.

1012.03 STRUCTURAL STEEL. Structural steel for railings and railing posts shall be A 36 steel conforming to Subsection 1013.01, except that the maximum tensile strength requirement will be waived.

1012.04 ALUMINUM PIPE RAILINGS.

(a) Aluminum Alloy Pipe: Aluminum alloy pipe shall be standard pipe ANSI Schedule 40, and shall conform to ASTM Designation: B 241, Alloy 6061-T6 or 6063-T6.

(b) Cast Aluminum Railing Posts: The chemical composition of castings shall conform to the limits listed in Table 13.

TABLE 13
Chemical Composition*
(Percent)

Cu	Fe	Si	Mn	Mg	Zn	Ti	Other (each)	Other (Total)
0.10	0.20	6.5-7.5	0.10	0.05	0.10	0.20	0.05	0.15

* All values maximum unless shown as a range.

Minimum mechanical properties of test bars machined either vertically or horizontally from the high stressed area of the post tension flange (lower 14 inches), but not at the junction of the rib and tension flange, shall be as shown in the following Table 14:

TABLE 14
Mechanical Properties

	Tension Flange
Ultimate Tensile Strength, psi	20,000
Elongation (% in 2 inches or 4D), Min.	20

(1) **Test Specimens:** Tension test specimens shall be machined from integrally cast test coupons extending from one side of the base of the posts sufficiently large to permit obtaining a 0.350-inch diameter test specimen as defined in ASTM Designation: E 8.

(2) **Number of Tests:** A minimum of 1 percent of the posts in any lot shall be sampled for tensile testing. A lot shall consist of not more than 1,000 pounds of clean castings when produced from a batch-type furnace charged with 1 heat of ingot of known analysis, or not more than 2,000 pounds of clean castings when produced from one continuous furnace in not more than 8 consecutive hours.

(c) **Aluminum Alloy Swedge Bolts and Nuts:** Swedge bolts and nuts shall be made from rods conforming to ASTM Designation: B 211, Alloy 6061-T6 or 2024-T4. Bolts shall conform to ANSI Designation: B 18.2.1, with threads conforming to the Unified Standard Class 2A. Nuts shall conform to ANSI Designation: B 18.2.2, with threads conforming to the Unified Standard, Class 2B. Finished bolts and nuts shall be supplied in either T6 or T4 temper and shall be given an anodic coating at least 0.0002 inch thick and dichromate sealed.

(d) **Aluminum Alloy Washers:** Washers shall be made of sheet conforming to ASTM Designation: B 209, Alloy 2024-T4.

(e) **Aluminum Alloy Shims:** Shims shall be made of sheet or plate conforming to ASTM Designation: B 209, Alloy 1100-O.

Access door cover and rail caps shall conform to ASTM Designation: B 221, Alloy 6061-T6 or B 108, Alloy A 444.0-T4 conforming to the chemical and physical requirements of Tables 13 and 14.

(f) **Set 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.

1012.05 GALVANIZED STEEL PIPE RAILINGS. Galvanized surfaces to be placed in contact with concrete shall be given a heavy coat of an approved alkali-resistant bituminous paint and allowed to dry before placing on concrete. However, a pad of opaque polyethylene film at least 6 mils thick may be placed between galvanized and concrete surfaces in lieu of paint and trimmed to the perimeter of the casting base after the casting has been bolted down.

Galvanized steel pipe shall be standard weight conforming to ASTM Designation: A 53.

Fittings and castings for steel pipe shall be malleable iron or cast steel conforming to ASTM Designation: A 47, Grade 35018 or A 27, Grade 70-36. Fittings and castings shall be galvanized in accordance with ASTM Des-

ignation: A 153. Repairs to galvanized surfaces shall be made in accordance with Subsection 811.16.

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 of zinc spelter coating applied.

Bolts, nuts and washers (except high strength bolts) shall conform to ASTM Designation: A 307, Grade A.

High strength bolts shall conform to ASTM Designation: A 325. Bolts, nuts and washers shall be galvanized in accordance with ASTM Designation: A 153 or by an approved mechanical galvanizing method that provides the same coating thickness.

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 Department's Construction Section 3 copies of the certificates of analysis.

Structural steel shall conform to the following ASTM specifications as amended by this Subsection.

Description	ASTM Designation
Structural Carbon Steel.	A 36
High-Strength, Low-Alloy Structural Steel.	A 242
High-Strength Structural Steel.	A 440-77
High-Strength, Low-Alloy Structural Manganese Vanadium Steel.	A 441
High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.	A 514
High-Strength, Low-Alloy Columbium-Vanadium Steel.	A 572
High-Strength, Low-Alloy Structural Steel (50,000 psi Minimum Yield Point to 4-inch thick).	A 588

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 test specified in Tables 15, 16 and 17. Sampling and testing procedures shall be in accordance with ASTM Designation: A 673 and the following requirements: the (H) frequency of heat testing shall be used for all steels except that for A 514 the (P) frequency of piece testing shall be used.

1013.02 RIVET STEEL.

(a) Structural Rivet Steel shall conform to ASTM Designation: A 502, Grade 1.

(b) High Strength Rivet Steel shall conform to ASTM Designation: 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 conform to ASTM Designation: A 668. Class C forgings shall be furnished except in cases specified below:

(1) **Forged Shafts:** ASTM Designation: A 668, Class F.

(2) **Forged Trunnions:** ASTM Designation: A 668, Class G.

(b) Alloy Steel Forgings for Pinions and Reduction Gears: Alloy steel forgings for pinions and reduction gears shall conform to ASTM Designation: A 291, Class 3 or 3A.

(c) Cold Finished Carbon Steel Shafting: Cold finished carbon steel shafting shall conform to ASTM Designation: A 108, Grade 1016-1030 inclusive.

TABLE 15
Types A 36, A 242, A 440-77 and A 441 Structural Steel

Thickness	Specified Minimum Average Energy Absorbed (Ft.Lbs.@ 70°F)
Up to 4″	15

TABLE 16
Types A 572 and A 588 Structural Steel*

Thickness	Specified Minimum Average Energy Absorbed (Ft.Lbs.@ 70°F)
Up to 4″ mechanically fastened	15
Up to 2″ welded	15
Over 2″ to 4″ welded (A 588 Steel only)	20

* If the yield point of the material exceeds 65 ksi, the temperature for the CVN value for acceptability shall be reduced by 15°F for each increment of 10 ksi above 65 ksi.

TABLE 17
Type A 514 Structural Steel

Thickness	Specified Minimum Average Energy Absorbed (Ft.Lbs. @ 30°F)
Up to 4″ mechanically fastened	25
Up to 2 1/2″ welded	25
Over 2 1/2″ welded	35

1013.05 STEEL CASTINGS.

(a) Steel Castings for Highway Bridges: ASTM Designation: A 486 (Class 70) or A 27 (Grade 70-36).

(b) High Strength Steel Castings: ASTM Designation: A 148.

(c) Chromium Alloy Steel Castings: ASTM Designation: A 743, 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 arises 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: ASTM Designation: A 48, Class 30.

(b) Malleable Castings: ASTM Designation: A 47, Grade 35018.

(c) Ductile Iron Castings: ASTM Designation: A 536, Grade 60-40-18. Castings weighing more than 1,000 pounds shall be ultrasonically tested for voids.

1013.07 BRONZE OR COPPER ALLOY BEARING AND EXPANSION PLATES.

(a) Bronze Bearing and Expansion Plates: ASTM Designation: B 22, Alloy C 91100.

(b) Rolled Copper-Alloy Bearing and Expansion Plates: ASTM Designation: B 100, Alloy C 51000.

1013.08 BOLTS, NUTS AND WASHERS.

(a) Bolts and nuts, except high strength bolts, shall conform to ASTM Designation: A 307, Grade A.

(b) High strength bolts, nuts and circular washers shall conform to ASTM Designation: A 325 or A 490, as specified. For A 325 bolts, Type 1 bolts shall be used; except that Type 3 bolts shall be used with unpainted A 588 steel.

(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 or A 490, 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 and 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 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 an approved standard product of an established manufacturer of lock-pin and collar fasteners.

1013.09 STEEL BEARING PILES. ASTM Designation: A 36.

1013.10 STEEL SHEET PILES. ASTM Designation: A 328.

1013.11 STEEL PIPE PILES. ASTM Designation:A 252, Grade 2.

1013.12 SHEET COPPER. ASTM Designation: B 152.

1013.13 SHEET LEAD. ASTM Designation: B 29.

1013.14 SHEET ZINC. ASTM Designation: B 69, Type II.

1013.15 COLD ROLLED STEEL. ASTM Designation: A 108.

1013.16 BRONZE.

(a) Center discs for movable bridges shall conform to ASTM Designation: B 22, Alloy C 91300.

(b) Trunnion and similar bearings for movable bridges shall conform to ASTM Designation: B 22, Alloy C 91100.

(c) Shafts and ordinary bearings shall conform to ASTM Designation: B 22, Alloy C 93700.

(d) Gears, nuts transmitting motion and other parts involving stresses other than compression shall conform to ASTM Designation: B 22, Alloy C 90500.

1013.17 BABBITT METAL. ASTM Designation: B 23, Alloy 3.

1013.18 STEEL FOR CENTER DISCS (Movable Bridges). ASTM Designation: A 668, Class F.

1013.19 STEEL FOR KEYS (Movable Bridges). ASTM Designation: A 668, Class D.

1013.20 SEAMLESS STEEL PIPE AND TUBING FOR HYDRAULIC LINES. Carbon steel pipe for hydraulic lines shall conform to ASTM Designation: A 106, Grade B. Fittings for hydraulic lines shall conform to ASTM Designation: A 105.

Stainless steel tubing shall be seamless austenitic stainless steel and shall conform to ASTM Designation: A 269.

1013.21 STEEL FOR OPEN GRID BRIDGE FLOORING. Steel shall conform to Subsection 1013.01. The contractor or fabricator shall furnish certificates of analysis of all applicable ASTM tests and submit 3 copies to the Department's Construction Section.

1013.22 DUCTILE CAST IRON BEARINGS. ASTM Designation: A 536.

1013.23 SHEAR CONNECTORS.

(a) General:

(1) Shear connector studs shall be of a design suitable for end welding to steel beams and girders with automatically timed stud welding equipment. See Figure 1 for dimensional tolerances.

(2) An arc shield (ferrule) of heat-resistant ceramic or other suitable material shall be furnished with each stud. The material shall not be detrimental to welds or cause excessive slag and shall have sufficient strength so as not to crumble or break due to thermal or structural shock before the weld is completed. Ferrules furnished with shop welded studs shall be removed in the shop prior to delivery, and ferrules furnished with field welded studs shall be removed before placing concrete.

(3) Flux for welding shall be furnished with each stud, either attached to the end of the stud or combined with the arc shield for automatic application in the welding operation.

(4) Only qualified studs shall be used. To be qualified, a stud shall pass the tests prescribed in DOTD Designation: TR 601. The arc shield used in production shall be the same as used in the qualification tests.

(5) Before placing orders for studs, the contractor shall submit the following information to the engineer for approval:

a. Name of manufacturer.

b. Detailed description of stud and arc shield.

c. Manufacturer's certification that stud is qualified as specified in Paragraph (4) above.

d. Copy of qualification test report certified by the Laboratory.

e. Notarized copies of certificates of analysis (mill test reports) showing conformance to material requirements of Headings (b)(1) and (b)(2) below.

(6) After welding, studs shall be free from any defect or substance which would interfere with their function as shear connectors.

(b) **Material Requirements:**

(1) Shear connector studs shall conform to ASTM Designation: A 108, Grades 1010 to 1020 inclusive, either semi- or fully-killed. If flux-retaining caps are used, steel for caps shall be a low carbon grade suitable for welding and shall conform to ASTM Designation: A 109.

(2) Tensile properties as determined by tests of bar stock after drawing, rolling or machining of finished studs shall conform to the following requirements:

Tensile Strength, Min.	60,000 psi
Yield Strength, Min.*	50,000 psi
Elongation, Min.	20% in 2 in.
Reduction of Area, Min.	50%

* As determined by a 0.2 percent offset method.

(3) Tensile properties shall be determined in accordance with ASTM Designation: A 370. Tensile tests of finished studs shall be made on studs welded to test plates using a test fixture similar to that given in DOTD Designation: TR 601. If fracture occurs outside of the middle 1/2 of the gage length, the test shall be repeated.

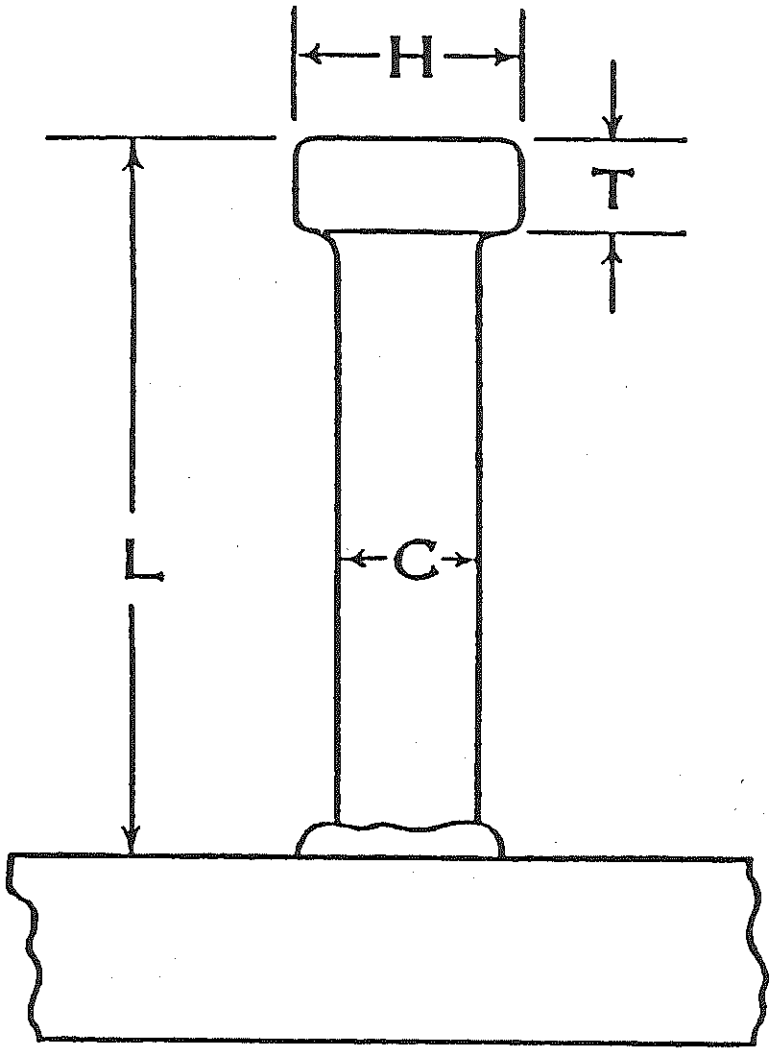
(4) Finished studs shall be of uniform quality and condition and free from injurious laps, fins, seams, cracks, twists, bends or other injurious defects. Finish shall be as produced by cold-drawing, cold-rolling or machining.

(5) The manufacturer shall certify that studs are in accordance with the material requirements of this Section. Certified copies of in-plant quality control test reports shall be furnished upon request.

(6) The engineer may select, at the contractor's expense, studs of each type and size used, as necessary for checking conformance with these specifications.

1013.24 CONCRETE ANCHOR STUDS. Concrete anchor studs used for end dam plates, bearing plates or other concrete anchorage shall conform to Subsection 1013.23 as modified by AWS D 1.1-80 Structural Welding Code.

Figure 1
DIMENSIONS AND TOLERANCES



Standard Dimensions—Inches

C	L*	H	T
3/4 − .015	4 + .062 − .125	1-1/4 ± 1/64	3/8 Min.
7/8 − .015	4 + .062 − .125	1-3/8 ± 1/64	3/8 Min.

*4-inch length is standard. Other lengths may be obtained by special order.

Section 1014

Timber and Timber Preservatives

1014.01 STRUCTURAL TIMBER AND LUMBER. Species and grade of structural timber and lumber shall conform to AASHTO Designation: M 168 and the following requirements.

(a) Southern Pine Timber: 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 Timber: 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 conform to 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 PILING. Timber piles shall be Southern Pine or Douglas Fir and shall conform to ASTM Designation: D 25, except that Table 18 herein shall be used in lieu of Tables I and II in ASTM Designation: D 25.

1014.03 TIMBER PRESERVATIVES. The type preservatives to be used are as follows:

(a) Creosote—AWPA P1 for regular treatment; AWPA P13 for coastal (marine) treatment.

TABLE 18
CIRCUMFERENCES AND DIAMETERS OF TIMBER PILES (1)

Length, feet	3 Feet from Butt (inches)				At Tip, Min. (inches)	
	Min.		Max.			
	Circumference	Diameter (Approx.)	Circumference	Diameter (Approx.)	Circumference	Diameter (Approx.)
Under 40	38 (2)	12 (2)	63	20	25	8
40 to 54 Incl.	38	12	63	20	22	7
55 to 74 Incl.	41	13	63	20	22	7
75 to 90 Incl.	41	13	63	20	19	6
Over 90	41	13	63	20	16	5

Note (1) All measurements shall be taken under bark. Diameter at 3 feet from butt shall not exceed 20 inches.

Note (2) A minimum circumference of 34 inches or diameter of 11 inches at a point 3 feet from butt may be specified for lengths of 25 feet and under.

(b) Creosote Coal-Tar Solution — AWPA P2, Grade A or B for regular treatment; AWPA P12 for coastal (marine) treatment.

(c) Pentachlorophenol-Petroleum Solution — AWPA P8 and P9.

(d) Chromated Copper Arsenate (CCA)—AWPA P5, Type B or C.

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 Sawn Posts ..... C1 and C2
Fire Retardant Lumber ..... C1 and C20

Air-dried timber shall be steamed prior to treatment for a minimum of 6 hours. 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 19 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 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.

a. Chromated Copper Arsenate (CCA) Type B or C — conforming to AWPA P5.

b. Pentachlorophenol — conforming to AWPA P8.

Hydrocarbon solvents for oil borne preservatives shall conform to AWPA P9, Type B (Volatile Petroleum Solvent, LPG) or Type D (Chlorinated Hydrocarbon Solvent-Inhibited Grade of Methylene Chloride).

(1) Minimum net retention of preservative by assay shall be 0.50 lb./cu.ft.

(2) Timber showing discoloration or bleeding due to treatment shall be repainted by the contractor at no cost to the Department.

1014.05 TIMBER CONNECTORS, HARDWARE AND STRUCTURAL SHAPES. Timber connectors, hardware and structural shapes shall conform to Subsections 1018.07 and 1018.08.

1014.06 INSPECTION. All inspection shall be in accordance with AWPA Standard M2 and quality control shall be in accordance with AWPA Standard M3.

TABLE 19
MINIMUM RETENTION OF PRESERVATIVE
Pounds per Cubic Foot of Wood (PCF)

Material and Usage	Creosote	Creosote-Coal Tar	Pentachlorophenol	CCA [1]
Timber & Lumber (General Use)	12.0	N/A	0.60	0.60
Bridge Timber & Lumber for Land and Fresh Water:				
Southern Pine or Douglas Fir	16.0	16.0	N/A	N/A
Bridge Timber & Lumber For Coastal Water:				
Southern Pine or Douglas Fir	20.0	20.0	N/A	N/A
Piles for Land or Fresh Water:				
Southern Pine	N/A	16.0	N/A	N/A
Douglas Fir	N/A	17.0	N/A	N/A
Piles for Coastal Water:				
Southern Pine or Douglas Fir	N/A	20.0	N/A	N/A
Foundation Piles Land or Fresh Water:				
Southern Pine	N/A	12.0	N/A	N/A
Douglas Fir	N/A	17.0	N/A	N/A
Foundation Piles, Coastal Water:				
Southern Pine or Douglas Fir	N/A	20.0	N/A	N/A
Poles: Southern Pine	12.0	12.0	0.60	N/A
Fence and Gate Posts	8.0	8.0	0.40	0.40
Guard Rail Posts and Spacer Blocks	12.0[2]	N/A	0.60	0.60
Bridge Rails and Dead End Road Installations	12.0[2]	N/A	0.60	0.60

Note (1) Material treated with Chromated Copper Arsenate (CCA) must be conditioned by kiln drying prior to treatment.

Note (2) Timber guard rail posts, spacer blocks, bridge rails and dead end road installations treated with creosote shall be steam flushed for a minimum of 1 hour at 240°F after treatment.

Section 1015

Signs and Pavement Markings

1015.01 GENERAL REQUIREMENTS. The materials shall conform to these specifications, the plans and the MUTCD. When directed, it shall be the responsibility of the contractor to 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 conform to ASTM Designation: A 36. Protective coating shall be in accordance with Subsection 729.03(b).

(2) Steel Pipe: Steel pipe or tubing for structures shall be Schedule 40 (STD) conforming to ASTM Designation: A 53, Type E or S, Grade B or hot formed tubing conforming to ASTM Designations: A 36 and 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 811.16. Before fabrication, posts shall be within 3.5 percent of the specified weight.

Tensile strength of steel determined from a 1/2 x 10-inch sample cut from one of the posts shall be 60,000 psi (minimum). Holes 3/8 inch in diameter shall be drilled or punched through the middle of each post on 1-inch centers for at least 36 inches from the top of each post.

(b) Aluminum Alloy: Structural members shall be aluminum alloy conforming to ASTM Designation: B 221 or B 429, 6061-T6. Miscellaneous aluminum shall conform to ASTM Designation: B 209, Alloy 6061-T6.

(c) Fittings:

(1) Structural Bolts, Nuts and Washers: High strength bolts shall be ASTM Designation: A 325, and other bolts shall be ASTM Designation: A 307, Grade A. Bolts shall have hexagonal heads and

be supplied with 2 flat and 1 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 Designation: A 153 or B 633, Class Fe/Zn 25, or by an approved mechanical galvanizing process that provides the same coating thickness.

Anchor bolts shall be ASTM Designation: A 36 galvanized in accordance with Subsection 811.16.

Stainless steel bolts shall conform to ASTM Designation: A 320, Grade B8, annealed or approved equal.

(2) **Fasteners:** Fasteners used in fabricating sign faces, including splice plates for joining 2 panels, sills and border angles, and attaching route marker shields shall be 3/16-inch solid-pin rivets, shall have brasier heads and shall be manufactured from aluminum alloy conforming to ASTM Designation: B 316, Alloy 2024-T4 or other approved aluminum alloy. Collars shall be of the type and alloy recommended by the manufacturer.

Fasteners used in attaching demountable legend to sign faces (except for shields) shall be 1/8-inch diameter blind rivets manufactured from aluminum alloy conforming to ASTM Designation: B 316, Alloy 1100-H14 or other approved aluminum alloy.

Fasteners for delineator, hazard marker and milepost assemblies shall be vandal-resistant and will be subject to approval prior to use.

1015.03 FLEXIBLE SIGN POSTS. Flexible posts for small signs, markers and delineators shall be approved products on the Qualified Products List.

1015.04 SIGN PANELS.

(a) Permanent Sign Panels: Panels shall be aluminum sheets or plates conforming to ASTM Designation: B 209, Alloy 6061-T6 or 5052-H38.

(b) Temporary Sign Panels: Panels shall be made from sheet aluminum, sheet steel or wood.

(1) **Aluminum:** Aluminum sheeting shall be 0.080-inch thickness conforming to ASTM Designation: B 209, Alloy 6061-T6 or 5052-H38 or other approved aluminum sheeting.

(2) **Steel:** Steel panels shall be 16-gage continuous coat galvanized steel sheeting conforming to ASTM Designation: A 525, Coating G 90.

(3) **Wood:** Plywood sheeting of exterior type Grades (1) High Density Overlay, (2) Medium Density Overlay and (3) Special Exterior

Grades A-A and A-B are acceptable for use provided the following requirements are met.

a. General: Panels shall conform to the latest American Plywood Association specifications and be identified with the DFPA 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 light to fine sandpaper, and wiped thoroughly clean with naphtha or other acceptable commercial solvent. Allow surface a minimum of 8 hours to dry prior to application of sheeting. Cut edges of plywood panels shall be sealed with an approved sealer.

b. Medium Density Overlay: Surfaces and edges shall be painted with an approved exterior enamel.

c. Special Exterior Grades A-A and A-B: Surfaces and edges shall be sealed with an approved sealer.

d. Plywood panels shall be a minimum of 5/8 inch thick.

1015.05 REFLECTIVE SHEETING. Reflective sheeting shall be Type I Enclosed Lens or Type II Encapsulated Lens, as specified. Reflective sheeting shall be approved products on the Qualified Products List.

(a) Description:

(1) Type I enclosed lens sheeting shall consist of spherical lens elements embedded within a flexible transparent weatherproof film having a smooth, flat outer surface.

(2) Type II encapsulated lens sheeting shall consist of spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface.

(b) Adhesive: Reflective sheeting shall include a precoated pressure-sensitive adhesive backing (Class 1) or a tack-free heat activated adhesive backing (Class 2) either of which may be applied without additional adhesive coats on either the sheeting or application surface.

Class 1 adhesive backing shall be a pressure-sensitive adhesive of the aggressive tack type requiring no heat, solvent or other preparation for adhesion to smooth clean surfaces. Class 2 adhesive backing shall be a tack-free adhesive activated by applying heat in excess of 175°F to the material as in the heat-vacuum process of sign fabrication.

Protective liner attached to adhesive shall be removed by peeling without soaking in water or other solvents without breaking, tearing or removing adhesive from the backing. Protective liner shall be easily removed following accelerated storage for 4 hours at 160°F under a weight of 2.5 psi.

Adhesive shall form a durable bond to smooth corrosion and weather-resistant surfaces and shall be tough enough to resist scuffing and marring during handling and elastic enough to resist shocking off when struck at low temperatures or sliding off at high temperatures. Adhesive shall be strong enough to resist peeling the reflective sheeting from the application surface when a 5 pounds per inch width force is applied as outlined in DOTD Designation: TR 624, Method A, or to support a 1 3/4-pound weight for 5 minutes, without the bond peeling for a distance of more than 2.0 inches when tested as outlined in DOTD Designation: TR 624, Method B.

Adhesive shall be sufficiently moisture-resistant to withstand a cycle of 8 hours at 100 percent relative humidity followed by an overnight drying without appreciable decrease in adhesion.

(c) Photometric Requirements:

(1) Reflective sheeting shall have minimum brightness values shown in Tables 20 and 21 at 0.2° and 0.5° divergence expressed as average candlepower per footcandle per square foot of material. Measurements shall be conducted in accordance with standard testing procedures for reflex reflectors in accordance with DOTD Designation: TR 625.

TABLE 20
TYPE I-ENCLOSED LENS REFLECTIVE SHEETING

	Silver-White		Yellow		Red		Blue		Green		Orange		Brown	
Div. Angle	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°
Inc. Angle														
−4°	70	30	50	25	14.5	7.5	4.0	2.0	9.0	4.5	25	13.5	1.0	0.35
+30°	30	15	22	13	6	3	1.7	0.8	3.5	2.2	7.0	4.0	0.3	0.2

TABLE 21
TYPE II-ENCAPSULATED LENS REFLECTIVE SHEETING

	Silver		Green		Yellow		Red		Orange		Blue	
Div. Angle	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°	0.2°	0.5°
Inc. Angle												
−4°	250	95	45	15	170	62	45	15	100	30	20	7.5
+30°	150	65	25	10	100	45	25	10	60	25	11	4.4

(2) Applied or Demountable Copy: Reflective sheeting for legend shall be Type I Silver-White or Type II Silver. No further matching shall be necessary.

(3) **Rainfall Performance:** Brightness of reflective sheeting totally wet by rain shall be at least 90 percent of values shown in Tables 20 and 21. Wet performance measurements shall be conducted in accordance with DOTD Designation: TR 625.

(d) **Color:** Color of sheeting shall be matched visually and be within the limits shown in Table 22 as determined in accordance with DOTD Designation: TR 626. Standards to be used for reference shall be the Munsell Papers designated in this table.

TABLE 22
COLOR SPECIFICATIONS LIMITS
AND REFERENCE STANDARDS

	Chromaticity Coordinates (Corner Points)								Reflectance Limit Y		Ref. Std. Munsell Papers
	1		2		3		4				
	x	y	x	y	x	y	x	y	Min.	Max.	
Silver-White	.303	.287	.368	.353	.340	.380	.274	.316	27.0	—	5PB 7/1
Green	.030	.380	.166	.346	.286	.428	.201	.776	3.0	8.0	10G 3/8
Yellow	.498	.412	.557	.442	.479	.520	.438	.472	15.0	40.0	1.25Y 6/12
Red	.613	.297	.708	.292	.636	.364	.558	.352	2.5	11.0	7.5R 3/12
Orange	.550	.360	.630	.370	.581	.418	.516	.394	14.0	30.0	2.5YR 5.5/14
Blue	.144	.030	.244	.202	.190	.247	.066	.208	1.0	10.0	5.8PB 1.32/6.8
Brown	.445	.353	.604	.396	.556	.443	.445	.386	3.8	7.7	5YR 3/6

(e) **Film:**

(1) **Flexibility:** Sheeting, with liner removed and conditioned for 24 hours at 72±2°F and 50±4 percent relative humidity, shall be sufficiently flexible to show no cracking when bent in one second's time around a 1/8-inch mandrel with adhesive contacting the mandrel.

(2) **Surface:** Sheeting surface shall be smooth and flat, facilitate cleaning and wet performance, and exhibit 85° glossmeter rating of not less than 40 when tested in accordance with DOTD Designation: TR 629. Sheeting surface shall be compatible with recommended transparent and opaque process colors and show no appreciable physical or handling changes with normal processing, cutting and application and shall permit cutting and color processing at temperatures of 60 to 100°F and relative humidity of 20 to 80 percent.

(3) **Cleanability:** The sheeting surface shall be solvent-resistant such that it may be cleaned with VM&P naphtha, mineral spirits, turpentine or water with no appreciable loss of reflective intensity or change in appearance.

(f) **Impact Resistance:** Sheeting, applied according to manufacturer's recommendations to a cleaned and etched 0.040 x 3 x 5-inch alumi-

num panel and conditioned for a minimum of 24 hours at room temperature, shall show no cracking when face of panel is subjected to impact of a 2-pound weight with 5/8-inch rounded tip at a 10 inch-pound setting on a Gardner Variable Impact Tester.

(g) Shrinkage: A 9 x 9-inch reflective sheeting specimen with liner shall be conditioned a minimum of 1 hour at 72±2°F and 50±4 percent relative humidity. Liner shall be removed and the specimen placed on a flat surface with adhesive side up. Ten minutes after liner is removed and again after 24 hours, specimen shall be measured to determine the amount of dimensional change. Reflective sheeting shall not shrink in any dimension more than 1/32 inch in 10 minutes nor more than 1/8 inch in 24 hours.

(h) Durability: Reflective sheeting, when processed, applied and cleaned in accordance with recommended procedures, shall perform outdoors satisfactorily for at least 7 years (5 years in the case of orange) for Type I sheeting and 10 years (3 years in the case of orange) for Type II sheeting and shall retain a minimum brightness as specified in Table 23. The contractor shall supply the Department with a statement of performance life for the minimum retained brightness required.

Reflective material exposed at an approved test facility for 24 months in Florida or Louisiana at 45° south facing shall not support fungus growth and accumulate dirt to the extent that reflective brightness before cleaning is less than 75 percent of reflective brightness after cleaning, when measured at 0.2° divergence and −4° incidence. Precoated adhesive shall have no staining effect on reflective sheeting.

Type I sheeting surface must be readily refurbishable by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

(i) Accelerated Weathering: Processed and applied in accordance with recommended procedures, reflective material shall be weather-resistant and following cleaning shall show no appreciable discoloration, cracking, blistering or dimensional change. Sheeting shall not have less than 50 percent of the specified minimum reflective intensity values listed in Table 20 for Type I enclosed lens sheeting and not less than 70 percent of the values listed in Table 21 for Type II encapsulated lens sheeting when subjected to accelerated weathering for 1,000 hours or 2,200 hours (500 hours for orange), respectively, in accordance with DOTD Designation: TR 611.

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

TABLE 23

Sheeting Type and Color	Average Min. Candlepower per Footcandle Per Sq. Ft. at 0.2° Divergence and −4° Incidence
Type I (Enclosed Lens)	
Silver-White	30
Yellow	20
Red	5
Blue	2
Green	3
Orange	10
Brown	0.4
Type II (Encapsulated Lens)	
Silver	175
Red	31
Blue	14
Green	31
Yellow	119
Orange	70

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 22 as determined in accordance with DOTD Designation: TR 626.

(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 conform to Subsection 1015.05(b).

(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, and the material shall have demonstrated its ability to withstand normal weathering without checking, cracking or excessive color loss. Sheeting surface shall be solvent-resistant such that it may be cleaned with VM&P naphtha, mineral spirits, turpentine or water with no appreciable change in appearance.

1015.07 SIGN ENAMELS AND PAINTS.

(a) **Sign Enamels and Paints:** These shall be applied in accordance with the sheeting manufacturer's recommendations, and 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 good film without running, streaking or sagging. 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 on silk screen equipment. The material shall produce the desired color and the same brightness 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.

1015.08 TEMPORARY PAVEMENT MARKINGS.

(a) General: Marking material shall be a striping tape having pressure-sensitive adhesive backing which shall not require a liner for protection from contamination, preadhesion or blocking within the roll, or require activation procedures and shall adhere to asphaltic or portland cement concrete surfaces when applied according to manufacturer's recommendations at surface temperatures above 35°F. Material shall be flexible and formable, and following application shall remain conformed to the texture of pavement surfaces. Minimum reflectivity for material shall be 0.18 candlepower per footcandle per square foot when tested at a divergence angle of 0.2° and an incidence angle of 86° following the procedure described in DOTD Designation: TR 625.

(b) Type I Striping Tape: Striping tape shall be removable from asphaltic and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device at temperatures above 40°F, and without the use of heat, solvents, grinding or blasting. This ease of removability shall have been demonstrated to the satisfaction of the Materials Engineer through actual field installation. There shall be no objectionable staining of pavement surface as a result of the removal procedure. Average thickness of material without backing, determined by 5 micrometer readings, shall be at least 22.0 mils.

(c) Type II Striping Tape: Average thickness of material, determined by 5 micrometer readings, shall be at least 9.0 mils. Striping tape shall be removable by following the manufacturer's recommendations as long as the material is substantially intact, and in no case shall removal require sandblasting, solvent or grinding methods and shall not result in objectionable staining of pavement surfaces.

1015.09 RAISED PAVEMENT MARKERS. Markers shall be either Class I (nonreflectorized) or Class IV (reflectorized), as specified.

Markers shall be approved products on the Qualified Products List. Infrared curves of materials used in markers shall match approved curves on file at the Department's Materials Section.

(a) Description:

(1) Class I markers shall consist of an acrylonitrile-butadiene-styrene polymer or other approved material, and shall be 4 inches wide x 6 inches long.

(2) Class IV markers shall consist of acrylonitrile-butadiene-styrene or methyl methacrylate body or shell filled with a mixture of an inert thermosetting compound and filler material, or other approved material. Reflecting system shall consist of prismatic reflector lens or spherical reflecting system with biconvex glass elements, or other approved material.

(b) Physical Requirements: Markers shall conform to the following requirements when tested in accordance with DOTD Designation: TR 621.

Property	Requirement
Heat Resistance	No change in shape or appearance
Impact Resistance	No break, chip or crack
Load Resistance	No break, chip, crack or permanent deformation

(c) Optical Requirements: Class IV markers shall conform to the following requirements when tested in accordance with DOTD Designation: TR 604.

	Footlamberts			
	Angle of Incidence			
Color	0°		20°	
	Average	Minimum	Average	Minimum
Crystal	125	100	60	50
Amber	80	65	35	25
Red	25	15	15	10

Reflectivity of markers shall be not less than 80 percent of the above minimum values after being subjected to the heat test required elsewhere herein.

(d) Adhesive: The adhesive shall be a Type V epoxy resin system conforming to Section 1017.

1015.10 THERMOPLASTIC PAVEMENT MARKINGS.

(a) Description: This specification covers hot-sprayed or hot-extruded reflective thermoplastic compound for pavement markings on asphaltic and portland cement concrete pavement. Material shall be so

manufactured as to be applied by spray 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.

(b) **General Characteristics:** The compound shall not deteriorate because of oil content of pavement materials or from oil droppings from traffic. In the plastic state, materials shall not give off fumes which are toxic or otherwise injurious to persons or property. Material shall not scorch, break down or deteriorate if held at the plastic temperature specified in Section 732 for 4 hours, or by reason of 4 reheatings to the plastic temperature. Temperature-versus-viscosity characteristics of plastic material shall remain constant throughout up to 4 reheatings, and shall be the same from batch to batch. There shall be no obvious change in color of material as the result of up to 4 reheatings or from batch to batch.

(1) **Material Composition:** Binder shall consist of a mixture of synthetic resins. Total binder content of the thermoplastic compound shall be not less than 18 percent. Pigmented binder shall be well dispersed and free from skins, dirt, foreign objects or such ingredients as will cause bleeding, staining or discoloration. Filler shall be a white calcium carbonate or equivalent with a compressive strength of 5,000 psi.

(2) **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. Marking shall have a uniform cross section. Pigment shall be evenly dispersed throughout the material. Density and character of material shall be uniform throughout its 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 surface without chipping or cracking.

(3) **Drying Time:** Drying time shall not exceed a characteristic straight line curve, the lower limits of which are 2 minutes at 50°F, the upper limits of which are 15 minutes at 90°F, both temperatures measured at a maximum relative humidity of 70 percent. After application and proper drying time, material shall show no appreciable deformation or discoloration under traffic conditions, and in air or pavement surface temperature ranging from 0 to 140°F.

(4) **Color:** White reflectorized thermoplastic material shall have a pigment containing 8 to 10 percent titanium dioxide and, after

setting, shall be pure white and free from dirt. Yellow reflectorized thermoplastic material shall be "Federal Yellow" in color (Federal Test Method Standard 141A, Method 4252). Material shall not change its color and brightness characteristics after prolonged exposure to sunlight.

(5) Reflectorization: During manufacture, reflectorizing glass spheres shall be mixed into material at the rate of 30 to 40 percent by weight of material. Glass spheres shall also be automatically applied to the surface of material at a uniform rate of a minimum of 5 pounds of glass spheres per 100 square feet of line. Glass spheres shall be dropped onto thermoplastic material while it is in a molten state immediately after it has been applied to the pavement.

(c) Physical Requirements:

(1) Color:

White: Initially, white as demonstrated by a standard color difference meter such as the Gardner Color Difference Meter standard not greater than the following:

Reflectance (Rd)	70% minimum
Redness — Greenness, a	0 ± 5%
Yellowness — Blueness, b	0 ± 10%

Yellow: Initially, yellow shall be equal to standard color chips, using Federal Test Method Standard 141A, Method 4252.

(2) Color Retention: Retention of initial color may be determined by testing. Specimens shall be prepared in accordance with ultraviolet light ASTM methods which shall be a 275-watt sunlamp bulb, Type RS, with built-in reflector. After 100 hours of exposure, specimens shall show no color change when compared visually with an unexposed specimen.

(3) Water Absorption: Materials shall have no more than 0.5 percent by weight of retained water when tested by ASTM Designation: D 570, Procedure 6.1.

(4) Softening Point: Materials shall have a softening point of not less than 90°C, as determined by ASTM Designation: E 28.

(5) Specific Gravity: Specific gravity of thermoplastic compound at 25°C shall be from 1.8 to 2.5.

(6) Impact Resistance: Impact resistance shall be not less than 10 inch-pounds at 77°F after material has been heated for 4 hours at 400°F and cast into bars of 1 square inch cross-sectional area 3 inches long and placed with 1 inch extending above the vise in a cantilever beam (Izod type) tester, using the 25 inch-pound scale described in ASTM Designation: D 256.

(7) Bond Strength: Bond strength shall be not less than 50 psi when tested in accordance with DOTD Designation: TR 622.

(8) Indentation Resistance: When tested in accordance with ASTM Designation: D 2240, material shall conform to the following requirements. After heating material for 4 hours at 400°F and cooling to test temperature, minimum durometer hardness using 2.205 lbs. weight for 15 seconds shall be:

Durometer Type	Hardness	Test Temperature
A	65	115 ± 3°F
D	95	77 ± 3°F

(d) Properties of Glass Spheres for Reflectorization:

(1) Refraction Index: Glass spheres used in the formulation shall have a refractive index of not less than 1.50 when tested by the liquid immersion method at 25°C. At least 70 percent by count shall be water-white true spheres free from air inclusions.

(2) Gradation: Spheres shall meet the following gradation requirements when tested in accordance with DOTD Designation: TR 634.

For compounding in the manufacture of thermoplastic material:

U.S. Sieve	Percent Passing
No. 40	80-100
No. 80	0-10

For application on molten thermoplastic material:

U.S. Sieve	Percent Passing
No. 20	90-100
No. 80	0-10

(3) Chemical Resistance: Glass spheres shall withstand immersion in water and acids without undergoing noticeable corrosion or etching and shall not be darkened or otherwise noticeably decomposed by sulfides. Tests for chemical resistance shall consist of 1 hour immersion in water and solutions of corrosive agents, followed by microscopic inspection. A 3 to 5 gram portion of the sample shall be placed in each of 3 pyrex-glass beakers or porcelain dishes; 1 sample shall be covered with distilled water, 1 with 3N solution of sulfuric acid and the other with a 50 percent solution of sodium sulfide. After 1 hour of immersion, glass spheres of each sample shall be examined microscopically for evidence of darkening and frosting.

(4) Packaging: Glass spheres for drop-on application to the molten stripe shall be shipped in bags of multi-ply paper or burlap with a polyethylene liner, strong enough to permit multiple handling with-

out damage, and having a capacity of 50 pounds of spheres. Bags shall be sufficiently water-resistant so that spheres will not become wet or caked in transit.

1015.11 PREFORMED PLASTIC PAVEMENT MARKINGS.

(a) Description: Marking material shall be preformed plastic consisting of white or yellow pigmented plastic with reflective glass spheres uniformly distributed throughout the entire cross-sectional area and shall be capable of being affixed to asphaltic or portland cement concrete pavement by either a pressure-sensitive precoated adhesive or a liquid contact cement. The material shall be provided complete in a form that will facilitate rapid application and protection during shipment and storage. Solvents, adhesives and necessary equipment for proper application shall be in accordance with marking manufacturer's instructions. The material shall be manufactured and packaged in such manner to permit storage at normal shelf temperatures for periods of up to 1 year after purchase. Contact elements, where used, shall have a shelf life of 6 months. The material shall mold itself to pavement contours, breaks, faults, and the like by action of traffic at normal pavement temperatures.

The pavement marking film shall be capable of use for patching worn areas of the same type film in accordance with marking manufacturer's instructions.

The product shall be from a manufacturer of reflectorized preformed pavement markings who can submit evidence of successful product use under similar climatic conditions present in Louisiana.

(b) Material Composition: The retroreflective pliant polymer pavement marking film shall consist of a mixture of high quality polymeric materials and pigments with 1.50 to 1.60 refractive index glass spheres uniformly distributed throughout its cross-sectional area, and with a reflective layer of beads bonded to the top surface. Composition shall be as follows:

Material	Min. % by Weight
Resins and Plasticizers	20
Pigments	30
Graded Glass Beads	33

The remaining percentage shall be comprised of the above materials in various proportions. This material shall be capable of adhering to asphaltic or portland cement concrete by means of a pressure-sensitive precoated adhesive or by a liquid contact cement applied at the time of installation.

(c) Physical Requirements:

(1) Bend Test: Plastic shall be of such structure that at a temperature of 80°F, a 3 x 6-inch piece (with backing) placed on a 1-inch diameter mandrel, may be bent over the mandrel until the end faces are parallel and 1 inch apart. There shall be no fracture lines apparent in the uppermost surface by visual inspection.

(2) Adhesive Backing Release Material Removal: Release material shall be completely removed when tested as specified. Cut a 1/2 x 6-inch specimen. Remove release material for 1 inch of the length and attach the nonadhesive side to a vertical surface with a suitable clamp at the point where release material was removed. Attach a clamp, which has a supported 1-pound weight attached to it, to the end of the partly removed release material. Release the weight. Examine the specimen for any remaining release material.

(3) Tensile Strength: The film shall have a minimum tensile strength of 40 psi of cross section when tested according to ASTM Designation: D 638. A 1 x 6-inch sample shall be tested at a temperature between 70 and 80°F using a jaw speed of 10 to 12 inches per minute.

(4) Elongation: The film shall have a minimum elongation of 75 percent at break when tested according to ASTM Designation: D 638, using the 1 x 6-inch sample at a jaw speed of 10 to 12 inches per minute.

(5) Pigmentation: Pigments shall be selected and blended to provide a marking film which is white or yellow conforming to standard highway colors through the expected life of the film.

(6) Glass Beads: Glass beads shall be colorless and have an index of refraction of 1.50 to 1.60 when tested using the liquid oil immersion method. Size and quality of beads shall be such that performance requirements for the retroreflective pliant polymer film will be met.

(7) Skid Resistance: The surface of the retroreflective pliant polymer shall provide a minimum skid resistance value of 35 BPN when tested according to ASTM Designation: E 303.

(8) Abrasion Resistance: The plastic marking shall have a maximum loss in weight of 0.25 gram in 500 revolutions when abraded according to Federal Test Method Standard No. 141A (Method 6192), using CS-10 calabrade wheels with a 500-gram load on each wheel.

(9) Photometric Requirements: The material shall have the minimum brightness values shown below at 0.2° and 0.5° divergence expressed as average candlepower per footcandle per square foot of

material. Measurements shall be conducted in accordance with DOTD Designation: TR 625.

Observation Angle	Entrance Angle	Reflective Intensity White	Reflective Intensity Yellow
0.2°	86°	0.04	0.03
0.5°	86°	0.03	0.02

(10) Thickness: The retroreflective pliant polymer film without adhesive shall be supplied in a minimum thickness of 60 mils.

(11) Adhesive Shear Strength: Specimens shall be tested according to the method described in ASTM Designation: D 638 as modified to test the adhesive shear strength. Specimens shall be prepared as follows: Plastic specimens cut to a dimension of 1 x 6 inches shall have applied to the adhesive face a 1 x 3-inch piece of carborundum extra coarse emery cloth, or its equivalent, so that there is 1 square inch overlap at one end of the plastic specimen. A pressure of 50 psi shall be applied over this area for 30 seconds. Load is applied by gripping each end of the test piece in a tensile test machine. The average load required to break the adhesive bond shall not be less than 7 pounds. The speed of testing shall be 0.25 inch per minute. The test shall be conducted at a temperature of 70 to 80°F.

(12) Adhesive Stability Test: The precoated adhesive backing shall be pressure-sensitive and shall remain stable with a controlled degree of flexibility and flow. The same specimen as described above shall withstand a static load of 4 pounds for 30 minutes, similar to the description of the testing in ASTM Designation: D 816, Method B. The slippage between the plastic panel and emery cloth shall not exceed 1 inch. This test shall be conducted at 70 to 80°F.

(d) Performance: The retroreflective pliant polymer, when applied according to the manufacturer's recommendations, shall provide a neat, durable marking that will not flow or distort due to temperature. The pliant polymer shall provide a cushioned resilient substrate that reduces bead crushing and loss. The film shall be weather-resistant, and through normal traffic wear shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking. It shall also show no significant tearing, roll back or other signs of poor adhesion.

Section 1016

Precast Reinforced Concrete Drainage Units

1016.01 GENERAL. These specifications cover the manufacture of precast reinforced concrete box culverts, manhole sections, junction boxes and catch basins.

(a) Portland-Pozzolan Cement: Portland-pozzolan cement conforming to Subsection 1001.02 may be used in the manufacture of precast units.

(b) Admixtures: Any admixture for portland cement concrete listed on the Qualified Products List is allowed for use in the manufacture of precast units.

(c) Strength: Compressive strength specimens for precast units shall be made and cured in accordance with DOTD Designation: TR 226 or TR 227, and tested in accordance with DOTD Designation: TR 230.

(d) Steps and Ladders: When steps are required, steps that are cast or mortared into walls shall be aligned in each section to form a continuous ladder with rungs equally spaced vertically in the assembled unit.

(e) Pipe Connections: For grout connections, each opening shall be $4 \pm 1/2$ inch 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; 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.

Other methods for connecting pipe to precast units using resilient connectors shall conform to ASTM Designation: C 923 and shall be approved by the Department's Materials Section.

(f) Marking: The name or trademark of the manufacturer, date of casting, and the structure number or station number as shown on the plans shall be stenciled on each unit in such manner as to be legible at time of delivery.

1016.02 PRECAST REINFORCED CONCRETE BOX CULVERTS. Precast reinforced concrete box culverts shall conform to ASTM Designation: C 789 or C 850, whichever is applicable, amended as follows:

(a) Table 1 shall be used.

(b) No modified designs will be allowed.

(c) Joints shall conform to Subsection 1006.05. Rubber gaskets will not be allowed.

(d) Approved shear connectors shall be cast into each end of box sections in accordance with ASTM Designation: C 850.

(e) Inside horizontal and vertical dimensions shall not vary by more than ± 1 percent with a maximum of ± 1/2 inch from design dimensions.

(f) Sides of each box section shall not vary from being perpendicular to the top and bottom by more than 1/2 inch when measured diagonally between opposite interior corners of each end.

(g) Culvert units shall be cured by one of the methods listed in ASTM Designation: C 789 or C 850. The method must be approved by the Department's Materials Section.

1016.03 PRECAST REINFORCED CONCRETE MANHOLE SECTIONS AND JUNCTION BOXES. Precast reinforced concrete manhole sections and junction boxes shall be of the type specified and shall conform to ASTM Designation: C 478, amended as follows:

(a) Units shall be tested for permeability as specified in ASTM Designation: C 497. The frequency of testing shall be a minimum of 1 section per 1000 sections manufactured.

(b) The absorption test specified in ASTM Designation: C 76 will be conducted if the section exhibits visual porosity.

(c) Joints shall conform to Subsection 1006.05(a).

(d) Steps, frames, grates and covers shall conform to Subsection 1018.04.

(e) Special designs will be subject to approval by the Department's Hydraulics Engineer and shall meet all the above requirements.

(f) No modified designs will be allowed.

1016.04 PRECAST REINFORCED CONCRETE CATCH BASINS. Precast reinforced concrete catch basins shall conform to the dimensions shown on the plans or other design approved by the Department's Hydraulics Engineer, and shall meet the following requirements:

(a) Materials: The materials shall conform to the following Sections and Subsection:

Portland Cement Concrete, Class A	902
Reinforcing Steel	1009
Steps, Frames, Grates and Covers	1018.04

Portland cement concrete shall attain a minimum compressive strength of 3800 psi before acceptance and shipping of the units.

(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, with the following permissible variations in position: Except at pipe connections, variations in the position of reinforcement shall not exceed 1/4 inch from the position shown in the design. Cover on reinforcement shall not be less than that shown on the plans.

(d) Curing: Units shall be cured in accordance with Subsection 805.11 or 805.14.

(e) Form Removal: Forms shall remain in place for 1 curing day in accordance with Subsection 805.10, Method 2.

(f) Workmanship: Units shall be true to shape, and surfaces shall be smooth, dense and uniform in appearance. 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 any approved patching material as soon as forms are removed.

(g) Testing and Inspection: Acceptability of units will be determined by results of compression tests on concrete cylinders and by inspection during manufacture to determine their conformance with the design and workmanship prescribed in these specifications and on the plans.

A minimum of 3 cylinders shall be made from each pour and cured in the same manner as the units. Additional cylinders shall be made in pairs and used to determine the strength for moving within the plant. Units shall attain a strength of 3,000 psi before moving within the plant and shall be held at the plant until they have met all requirements of this Subsection.

Section 1017

Epoxy Systems

1017.01 GENERAL. This Section covers the material requirements for epoxy resin systems and epoxy concrete.

1017.02 EPOXY RESIN SYSTEMS.

(a) General: Epoxy resin systems for applications as specified herein shall be an approved product on the Qualified Products List. Epoxy resin systems shall consist of 2 components which, when combined in accordance with the manufacturer's written instructions, shall conform to 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.

(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 sytems 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 and epoxy concrete.

Type IV — A 100 percent reactive, non-solvent-containing system formulated primarily for splicing precast concrete pile segments at ambient temperatures of 40 to 105°F. The epoxy bonding agent shall be relatively insensitive to dampness, and have low creep characteristics.

Type V — For use primarily in bonding raised pavement markers to portland cement concrete and asphaltic concrete surfaces. 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 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 non-sagging gel or non-sagging 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, III and IV 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 conform to the applicable physical requirements and the following general requirements:

(1) All fillers, pigments, and/or thixotropic agents in either component must 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 or Type IV epoxy resin system must be of such a nature as will not interfere with application by injection equipment or damage such equipment.

(2) The components must be free of lumps, skinning or foreign material.

(3) The viscosity of the individual components shall not change more than ± 15 percent after 14 days in closed containers at 115 ± 3°F.

(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, when tested in accordance with DOTD Designation: TR 627, shall conform to the following requirements:

PROPERTY	TYPE I MIN.	TYPE I MAX.	TYPE II MIN.	TYPE II MAX.	TYPE III MIN.	TYPE III MAX.
Consistency:						
Grade A, # 3 Spindle at 20 RPM, poises	—	20	—	20	—	20
Grade B, # 3 Spindle at 20 RPM, poises	20	—	20	—	20	—
Grade C, Sag, inches	—	0.25	—	0.25	—	0.25
Epoxide Equivalent of Comp. A, g/g mol.	160	275	160	275	160	275
Gel Time, minutes(1)	20	—	20	—	20	—
Water Absorption, 24 hr. Immersion, %	—	0.8	—	0.8	—	0.8
Compressive Strength, 24 hr., psi	5000	—	—	—	3000	—
Tensile Bond Strength, psi						
24 hours (dry cure)	350	—	—	—	250	—
72 hours (moist cure)	—	—	150	—	—	—
Diagonal Shear Strength, psi						
2 days (dry cure)	4000	—	—	—	1000	—
14 days (moist cure)	—	—	3000	—	—	—
Volatile Content, Cured System, %	—	5	—	5	—	—
Thermal Compatibility	—	—	—	—	Passes Test	
Property Retention After 5 Cycles from 30 to 110°F:						
Tensile Bond Strength, psi	350	—	150	—	250	—

Note (1) Specification limits apply to working life of Grade C material. The minimum gel time for Type 1 Grade A material used for crack injection is 15 minutes.

(2) Type IV epoxy resin systems shall conform to AASHTO Designation: M 235, Class II and additional tests as follows:

a. Compression strength of cured epoxy bonding agent: This test shall conform to ASTM Designation: D 695. Compressive strength at 77±3°F shall be 8,000 psi minimum after 24 hours curing at 105±3°F.

b. Elastic modulus in compression of cured epoxy bonding agent: This test shall conform to ASTM Designation: D 695. The modulus of elasticity at 77±3°F shall be 400,000 psi minimum after 24 hours curing at 105±3°F.

c. Temperature deflection of epoxy bonding agent: This test shall conform to ASTM Designation: D 648. A minimum deflection temperature of 122°F at a fiber stress loading of 264 psi is required on specimens cured 7 days at 77±3°F.

d. The consistency of the epoxy shall be such that it can be applied under pressure.

e. The maximum allowable tensile elongation will be 9 percent when tested in accordance with DOTD Designation: TR 627.

f. The gel time of the mixed epoxy when tested in accordance with DOTD Designation: TR 627 shall be 5 minutes, minimum.

(3) Type V epoxy resin systems shall be specified by the supplier as being either standard set or rapid set and shall conform to the following requirements when tested in accordance with DOTD Designation: TR 616.

Property	Requirement	
	Standard Set	Rapid Set
Pot Life at 77±2°F		
Mixture mixed and dispensed by machine, minutes, min.	6	6
Mixture mixed and dispensed by hand, minutes	7-13	Not Allowed
Set Time to reach 170 psi at 77±2°F, minutes, max.	210	40
Slant Shear Strength, (base area), min., psi		
24 hrs. at 77±2°F	2000	1000
24 hrs. at 77±2°F, Plus 7 day water soak	1500	800
Viscosity at 77±2°F		
Component A (resin), poises	1000 to 3500	1000 to 3500
Component B (hardener), poises	1000 to 3500	1000 to 3500
Shear ratio (each component), min.	2.0	2.0

1017.03 EPOXY CONCRETE. Epoxy resin systems for use in epoxy concrete shall conform to the requirements for Types I, II or III epoxy as shown in Subsection 1017.02. Fine and coarse aggregates shall conform to Subsection 1003.02 and shall be clean and moisture free. The contractor shall submit the proposed mix design and detailed method of mixing to the Materials Section for approval.

Connector grooves in timber shall be cut concentric with the bolt hole and shall be of the following dimensions, in inches:

Ring Size	Inside Diameter	Groove Width	Groove Depth
2 1/2	2.56	0.18	0.37
4	4.08	0.21	0.50
6	6.12	0.27	0.62

(b) Toothed-Ring Connectors: Toothed-ring connectors shall be stamped cold from 0.060 inch thick rolled sheet steel conforming to ASTM Designation: 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 and depth of fillet of 0.25 inch.

(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-inch diameter shall be manufactured from steel conforming to ASTM Designation: 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 having a central bolt hole and 2 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 diameter shall be manufactured according to ASTM Designation: A 47, Grade 35018. 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 having 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, 3 1/8 and 4-inch diameter shall be of malleable iron, manufactured according to ASTM Designation: A 47, Grade 35018. Each claw-plate shall consist of a perforated circular flanged plate with 3-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 Designation: A 47, Grade 35018. They shall consist of 4 rows of opposing spikes forming a 4 1/8-inch 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 Designation: A 307. Dowels shall conform to ASTM Designation: A 36. Washers shall be cast ogee gray iron or malleable castings. A standard circular washer shall be used under heads of lag screws.

Machine bolts shall have square 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 Designation: A 153.

(b) Structural Shapes: Structural shapes, rods and plates shall be of structural steel conforming to Section 1013.

(c) Electrical Apparatus: Hardware for electrical apparatus shall conform to ASTM Designation: A 193, Grade B8 (bolts and studs) and ASTM Designation: A 194, Grade 8 or 8A (nuts).

1018.09 RIGID METAL ELECTRICAL CONDUIT. ANSI Designation: C 80.1 or C 80.5.

1018.10 ELECTRICAL CONDUCTORS. IPCEA Pub. No. S-19-81, S-66-524 and S-61-402.

1018.11 ALUMINUM PLATE FOR ELECTRICAL BOXES. Aluminum plate for such items as junction boxes, etc., shall conform to ASTM Designation: 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 on the Qualified Products List.

(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 a notarized material certification (certificate of compliance) listing (1) the proposed number of warning lights to be used, (2) their type, (3) trade name and (4) manufacturer's name and model number as contained on the Qualified Products List. 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. AASHTO Designation: M 118.

1018.14 ELASTOMERIC BRIDGE BEARING PADS.

(a) **General:** 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 thickness rolled steel sheets conforming to either ASTM Designation: A 570 (33 or 40) or A 606.

Elastomeric bearing pads shall be an approved product on the Qualified Products List.

(b) **Physical Properties of Elastomer:** The elastomer compound for plain and laminated bearings shall meet the requirements in Table 24. Insofar as possible, all tests shall be made on the finished product. A deviation of −10 percent from the values in Table 24 will be allowed on the original tensile strength, original elongation and tear properties when tests are performed on samples taken from the finished product. Special molded or prepared specimens, where required, shall conform to the specimen preparation requirements of the test involved.

(c) **Manufacturing Requirements:** All components of a laminated bearing shall be molded into an integral unit. Edges of the nonelastic laminations shall be covered by a minimum of 1/8 inch 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.

Batch or lot number shall be marked on each bearing in such manner as to remain legible until the bearing is placed in the structure. A batch is

defined as the quantity of compound produced from each separate mixture of ingredients. A lot is defined as the quantity of compound resulting from the mixture of 2 or more batches.

(d) Appearance and Dimensions: Flash tolerance and appearance shall conform to Drawing Designation: 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 variation from specified dimensions and configuration shall be as follows:

	Tolerance Inches
Overall Vertical Dimensions	
Average Total Thickness 1 1/4 in. or less	−0, +1/8
Average Total Thickness over 1 1/4 in.	−0, +1/4
Overall Horizontal Dimensions	−0, +1/4
Thickness of Individual Layers of Elastomer (Laminated Bearings Only)	±1/8
Variation from Plane Parallel to Theoretical Surface	
Top	±1/8
Sides	±1/4
Individual Nonelastic Laminates (determined by measurements at edges of bearing)	±1/8
Position of Exposed Connection Members	±1/8
Edge Cover of Embedded Laminates or Connection Members	−0, +1/8
Size of Holes, Slots or Inserts	−0, +1/8
Position of Holes, Slots or Inserts	±1/8
Thickness of Nonelastic Laminates	−0, +1/16

(e) Load Testing: For laminated bearings, each bearing shall be subjected by the manufacturer to an average compression of 1,000 psi in the presence of the Department's inspector. 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.

1018.15 GEOTEXTILE FABRIC (PLASTIC FILTER CLOTH).

(a) General Requirements: The fabric shall be a pervious sheet of plastic yarn. Plastic yarn shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, amide or vinylidene-chloride, and when required shall contain stabilizers and/or inhibitors added to the base plastic to make filaments

TABLE 24
PHYSICAL PROPERTIES

	Grade (Durometer)		
	50	60	70
Original Physical Properties			
Hardness, ASTM D 2240	50 ± 5	60 ± 5	70 ± 5
Tensile Strength, Min. psi, ASTM D 412	2,500	2,500	2,500
Elongation at Break, Min. %	400	350	300
Accelerated Test to Determine Long-Term Aging Characteristics, Oven-aged, 70 Hrs.@212°F, ASTM D 573			
Hardness, Points Change, Max.	0 to +15	0 to +15	0 to +15
Tensile Strength, % Change, Max.	± 15	± 15	± 15
Elongation at Break, % Change, Max.	−40	−40	−40
Ozone — 100 ± 5 PPHM in Air by Volume 20% Strain or Bent Loop — 104°F, ASTM D 1149, 100 Hrs.(1)	No Cracks	No Cracks	No Cracks
Compression Set — 22 Hrs.@158°F, ASTM D 395, Method B, Max. %	25	25	25
Low Temperature Test Brittleness −40°F, ASTM D 746, Procedure B(2)	No Failure	No Failure	No Failure
Adhesion (for laminated bearings) Bond made during vulcanization, ASTM D 429, Method B, Lbs./in., Min.(2)	40	40	40

Note (1) Sample to be solvent wiped before test to remove surface impurities.

Note (2) Manufacturer's certification and testing may be waived at option of the Department.

resistant to deterioration due to ultraviolet and heat exposure. Fabric shall be so constructed that yarns will retain their relative position with respect to each other. Edges of fabric shall be finished to prevent the outer yarn from pulling away from the fabric. Length and width of sheets may be varied to suit manufacturer's standards. Seams meeting strength requirements of the fabric will be permitted. Fibers of other composition may be woven into the cloth for reinforcing purposes. Durability of these fibers must be equivalent to that of the fabric.

The fabric shall be an approved product on the Qualified Products List.

(b) Detailed Requirements: The fabric shall conform to the following requirements:

	Test Method	Bulkheads & Flexible Revetment	Riprap	Underdrain & Pipe Joints	Railroad Crossing
Weight, oz./sq. yd., min.	ASTM D 1910	—	—	3.0	4.0
EOS (U. S. Sieve)	DOTD TR 630	30-70	30+	50+	50+
Average Grab Tensile, lbs./in., min.	ASTM D 1682	—	—	90	90
Grab Tensile (any direction), lbs./in., min.	ASTM D 1682	95	190	75	75
Average Grab Elongation, %	ASTM D 1682	—	10-50	—	—
Burst Strength, lbs., min.	ASTM D 751	150	300	—	—
Permeability Factor, cm./sec., min.	DOTD TR 631 (revetment) (bulkhead)	35.0 8.0	8.0	8.0	4.0
Abrasion Resistance, min. cycles to failure	DOTD TR 637	2500	2500	—	—
Aged for 1000 hrs. in weatherometer:	DOTD TR 611				
Grab Tensile (any direction), lbs./in., min.	ASTM D 1682	95	190	—	—
Retained Grab Tensile (any direction), % min.	ASTM D 1682	75	75	—	—

Note: For weep holes in structures, any geotextile fabric on the Qualified Products List may be used.

1018.16 COMMERCIAL FERTILIZER. Fertilizer shall be a commercial type conforming to the commercial fertilizer laws in effect as regulated by the Louisiana Department of Agriculture. 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 shall be supplied in granulated or pelletized form and shall be packaged in suitable containers to prevent contamination by moisture.

1018.17 AGRICULTURAL LIME. Agricultural lime shall consist of ground limestone or seashells containing at least 90 percent calcium carbonate equivalent ($CaCO_3$). The material shall be ground so that a minimum of 90 percent passes a No. 10 sieve and 25 percent passes a No. 100 sieve.

1018.18 SEED. Seed shall conform to all requirements, rules and regulations of Louisiana Revised Statutes 3:1431, *et seq*. The minimum percentage of pure live seed and the maximum percentage of weed seed permitted shall be in accordance with Table 25 herein.

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 No. 6 standard shipping tag, minimum, containing all information required by the Louisiana Seed Law, arranged as shown in Illustration No. 1.

All 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.

TABLE 25
SEED REQUIREMENTS

Kind	Min. % of Pure Live Seed (Purity Times Germination Including Hard Seed)	Max. % of Weed Seed
Hulled Bermuda	83	1
Carpet Grass	76	2
Pensacola Bahia	81	2
Dixie Crimson Clover	78	1
Kentucky 31 Fescue	80	1
Centipede	82	1

(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.

Analysis tags shall be removed from each bag or container only by the engineer or his authorized representative.

(b) Test Report: A copy of the laboratory test report of an "official" sample for each lot of seed furnished as prepared by the State Seed Analyst of the Louisiana Department of Agriculture shall be submitted to the engineer by the contractor. The Department will accept test reports from other states provided the requirements of these specifications are met.

Illustration No. 1

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 _____

1018.19 VEGETATIVE MULCH. Mulch shall consist of stems or stalks of oats, rye, rice, wheat 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.

1018.20 FIBER GLASS ROVING.

(a) Description: This specification covers a continuous fiber glass roving used with asphalt to control erosion on newly seeded slopes and drainage channels.

(b) General Requirements: The material shall be formed from continuous fibers drawn from molten glass, coated with a chrome-complex sizing compound, collected into strands and lightly bound together into roving without the use of clay, starch or like deleterious substances. The roving shall be wound into a cylindrical package approximately 1 foot high in such manner that the roving can be continuously fed from the center of the package through an ejector driven

by compressed air and expanded into a mat of glass fibers on the soil surface. The material shall contain no petroleum solvents or other agents known to be toxic to plant or animal life.

(c) Detailed Requirements: Fiber glass roving shall conform to the following requirements:

Property	Test Method	Limits
Strands/Rove	End Count	20 minimum
Yards/lb. of Rove	ASTM D 578	175-250
Fiber Diameter, In. (Trade Designation)		
G	ASTM D 578	.00038 nominal
K	ASTM D 578	.00053 nominal
Organic Content, % Max.	ASTM D 578	2.0
Package Wt., lbs.	ASTM D 578	25-40

1018.21 SACKS FOR SACKED CONCRETE. Sacks for sacked concrete revetment shall be suitable new burlap bags, approved heavy duty reinforced kraft shipping sacks or other approved material.

1018.22 PLASTICIZED CEMENT. Plasticized cement for use in splicing precast concrete piles shall develop a minimum compressive strength of 6,500 psi in 1 1/2 hours when tested in the form of 2-inch cube specimens in accordance with the procedure given in AASHTO Designation: T 231 for sulfur mortars. Ingots of plasticized cement shall have a melting point in the range of 265 to 290°F and shall be capable of being poured easily to fill and seal all voids. Upon cooling, the cement shall resolidify to form a structurally sound splice and joint capable of withstanding continued redriving of pile.

1018.23 CONCRETE ANCHOR SYSTEMS. Concrete anchorage systems shall consist of mechanical anchor devices, epoxy systems or other approved methods for connections to hardened concrete. These systems shall be approved systems on the Qualified Products List.

1018.24 EROSION CONTROL MATTING.

(a) Paper Matting: The matting shall consist of a knitted construction of polypropylene yarn with uniform openings (0.5 square inch max.) interwoven with strips of biodegradable paper and furnished suitable protection for outdoor storage. Weight shall be 0.05 pound per square yard (minimum).

(b) Excelsior Matting: The matting shall consist of a machine produced mat of curled wood excelsior covered with a 3 x 1-inch weave of twisted kraft paper having a high wet strength, or a 2 x 1-inch biodegradable extruded plastic mesh, or other approved biodegradable mate-

rial. The matting shall be made smolder-resistant without the use of chemical additives. The wood fibers shall be of consistent thickness, with 80 percent of the fibers being at least 6 inches long, and shall be evenly distributed in the matting. The matting shall be furnished with suitable protection for outdoor storage.

(c) Staples: Staples shall be 11 gage wire, U shaped with a 1-inch crown and 6-inch legs, or other approved staple.

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