CHAPTER 4 – STRUCTURAL ANALYSIS AND EVALUATION

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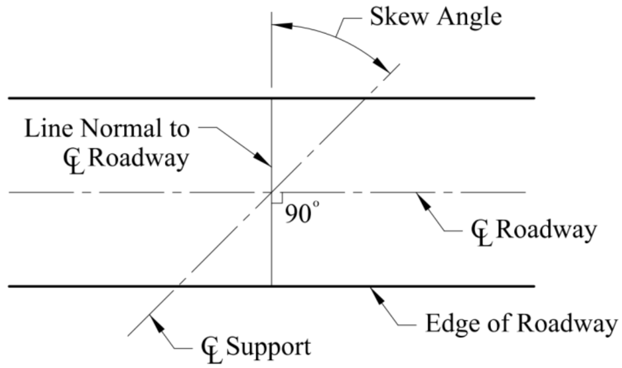
LIST OF FIGURES

4.2—DEFINITIONS

The following shall supplement *A 4.2*.

Skew Angle—Angle between centerline of support and a line normal to roadway centerline as shown.

(Special note: LADOTD historically showed skew angle as the angle between center of roadway and centerline of support; this has been modified as indicated above to conform with the definition in *AASTHO LRFD Specifications*.)



Definition of Skew Angle

4.4—ACCEPTABLE METHODS OF STRUCTURAL ANALYSIS

The following shall supplement *A4.4*.

LADOTD only allows use of pre-approved computer programs in design and load rating of bridges. A list of pre-approved software is posted on LADOTD Bridge Design website.

If any other software is needed, a synopsis of the software shall be submitted to the Bridge Design Engineer Administrator for approval prior to use. Synopsis shall include name of software and developer, a general description of functions, a certification from software developer stating that it is maintained in accordance with the latest *AASHTO LRFD Bridge Design Specifications*, and an account of requester's experience and experience of other organizations or agencies that use the software. Data/results from in-house software will not be accepted as part of the deliverable. The cost of software shall be included in overhead cost of the firm and not be a direct expense for projects.

Use of computer programs does not relieve

EOR's responsibilities to ensure the correctness of the results.

4.5—MATHEMATICAL MODELING

4.5.1—General

The following shall replace the second paragraph of *A4.5.1*.

For new bridges, analysis based on continuous composite barriers is not permitted. Consideration of continuous composite barriers, if needed, shall be only limited to structural evaluations and bridge rehabilitations with prior approval of the Bridge Design Engineer Administrator.

4.6—STATIC ANALYSIS

4.6.2—Approximate Methods of Analysis

4.6.2.1—Decks

4.6.2.1.1—General

The following shall replace the last paragraph of *A4.6.2.1.1*.

Where strip method is used, extreme positive moment in any deck panel between girders shall be assumed to apply to all positive moment regions. Similarly, the extreme negative moment over any interior beam or girder shall be assumed to apply to all interior negative moment regions.

The extreme negative moment over exterior girders and deck overhangs shall be determined per *A9* and *A13* for the wheel load and vehicle collision load. Reinforcing steel in the overhang portion of the deck shall also meet the crash tested and approved bridge railing details. In situations where such details vary from the dimensions or shapes of crash tested barriers and deck combination, the amount of reinforcing steel in the deck shall produce equal or greater strength than those produced in the crash test.

C4.6.2.1.1

The following shall supplement *AC4.6.2.1.1*.

Equivalent strip method may be used for skewed deck layouts. The span length is always to be taken perpendicular to the supporting girder lines. Detailing requirements in *A9.7.1.3* should be applied to skewed decks.

4.6.2.1.2—Applicability

The following shall replace *A4.6.2.1.2*.

Decks containing prefabricated elements must be designed and use of any design aids in lieu of analysis is not permitted.

For slab bridges and concrete slabs spanning more than 15.0 ft. in which the span is primarily in the direction parallel to traffic, provisions of *A4.6.2.3* and *A4.6.2.1.4b* shall apply to the design of interior strips and edge strips, respectively. Otherwise, provisions of *A4.6.2.1.3* and *A4.6.2.1.4* shall apply.

4.6.2.1.3—Width of Equivalent Strip

C4.6.2.1.3

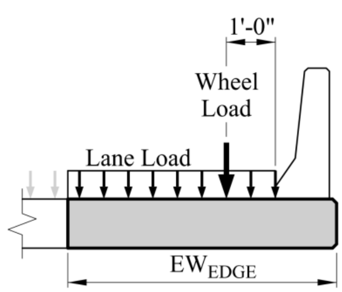
The following shall supplement *AC4.6.2.1.3.*

All decks with lines of support normal to traffic are considered to span in the direction parallel to traffic, such as decks that are supported by transverse floor beams. All decks with lines of support parallel to traffic are considered to span in the transverse direction, such as decks supported by girders parallel to traffic.

4.6.2.1.4b—Longitudinal Edges

The following shall replace the second paragraph of *A4.6.2.1.4b*.

Where decks span primarily in the direction of traffic, the effective width of the longitudinal edge strip, EW_{EDGE}, as shown in the diagram below, may be taken as the sum of the distance between the edge of the deck and inside face of the barrier, plus 12.0 in., plus one-quarter of the strip width, specified in either *A4.6.2.1.3*, *A4.6.2.3*, or *A4.6.2.10*, as appropriate. EW_{EDGE} shall not exceed one-half of the full strip width or 72.0 inches, whichever is smaller.

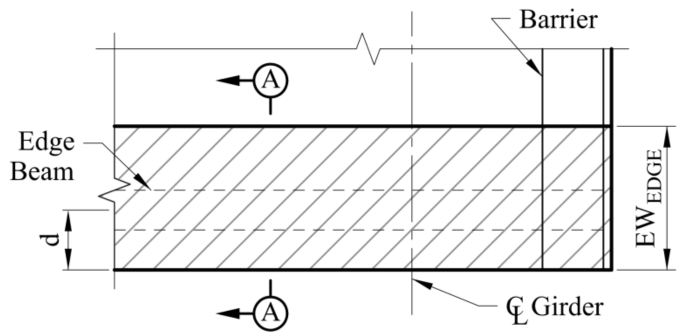


<u>Longitudinal Edge Strip</u>

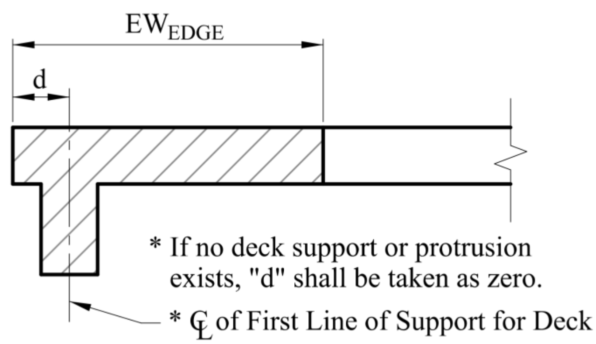
4.6.2.1.4c—Transverse Edges

The following shall replace the second paragraph of *A4.6.2.1.4c*.

Effective width of the transverse edge strip, EW_{EDGE}, as shown in the Plan View and Section A-A below, may be taken as sum of distance "d" between the transverse edge of the deck and the centerline of first line of support for the deck, plus one-half of strip width as specified in *A4.6.2.1.3*. EW_{EDGE} shall not exceed the full strip width specified in *A4.6.2.1.3*.



Plan View



Section A-A

Transverse Edge Strip

4.6.2.1.9—Inelastic Analysis

The following shall replace *A4.6.2.1.9*.

Inelastic finite element analysis or yield line theory is not allowed for deck design. Exceptions must be approved by the Bridge Design Engineer Administrator.

4.6.2.2—Beam Slab Bridges

4.6.2.2.1—Applications

The following shall supplement *A4.6.2.2.1*.

C4.6.2.2.1

The following shall supplement *AC4.6.2.2.1*.

For bridges with variable or flared girder spacing, the girder spacing, "S", used to determine the live load distribution factors shall be as follows:

S_{max} = maximum girder spacing

S_{min} = minimum girder spacing

When $S_{max}/S_{min} \leq 1.4$,

$S = (2/3)S_{max} + (1/3)S_{min}$

When $S_{max}/S_{min} > 1.4$, refined analysis shall be used.

For Louisiana precast/prestressed concrete quad-beam sections, calculate the distribution factor based on Type k as defined in *A4.6.2.2.1, Table 4.6.2.2.1-1*.

Where design parameters exceed the limits specified in *A4.6.2.2.1*, *Table 4.6.2.2.2b-1*, the distribution factors shall be calculated based on refined analysis.

The most commonly used refined analysis models are the 2-D grillage model and the 3-D finite element (FE) model. One of the conclusions of NCHRP study 12-26 (*NCHRP Report 592*) is that 3-D (FE model) analyses provide no additional value over less rigorous 2-D (grillage model) analyses. Therefore, it is recommended to use the 2-D grillage model unless the 3-D FE model is deemed necessary.

4.6.2.2.4—Curved Steel Bridges

The following shall replace *A4.6.2.2.4*.

Approximate analysis methods for curved steel bridges such as those referred to in *A4.6.2.2.4* are not permitted.

C4.6.2.2.4

The following shall replace *AC4.6.2.2.4*.

The main effect of horizontal curvature on steel superstructures is twofold. First, steel girders that are fabricated on horizontal curves tend to overturn under their own self weight. This tendency causes dead and live loads to be transferred transversely, which translates into some girders carrying a larger portion of the applied loads than others. Second, curvature of superstructures subjects the steel girders to torsional moments that are mainly resisted by horizontal shear in the flanges. Horizontal shear generates moments in the flanges, which increases, or reduces, the stresses from vertical bending. Both effects should be considered in the design of horizontally curved steel bridges using refined analysis methods.

4.6.2.3—Equivalent Strip Width for Slab-Type Bridges

The following shall supplement *A4.6.2.3*.

Equivalent strip width given in *A4.6.2.3* shall be used for typical interior strips only and is not to be used for edge strips. Width of edge strips shall be taken as specified in *A4.6.2.1.4b and D4.6.2.1.4b*.

4.6.4—Redistribution of Negative Moments in Continuous Beam Bridges

The following shall replace *A4.6.4*.

Negative moment redistribution is not allowed in design or load rating of continuous bridges without prior approval of the Bridge Design Engineer Administrator.

4.7—DYNAMIC ANALYSIS

4.7.1—Basic Requirements of Structural Dynamics

4.7.1.1—General

The following shall supplement *A4.7.1.1*.

Dynamic analysis may be required at the request of the Bridge Design Engineer Administrator in cases of flexible continuous bridges which may be especially susceptible to vibrations.

4.7.4—Analysis for Earthquake Loads

4.7.4.4—Minimum Support Length Requirements

The following shall supplement *A4.7.4.4.*

Minimum support length, "N", shall be measured from end of the elements to be supported, such as beams, girders or slabs, to edge of the top most supporting element, such as risers or bent caps if no risers.

4.8—ANALYSIS BY PHYSICAL MODELS

4.8.1—Scale Model Testing

The following shall supplement *A4.8.1*.

The Bridge Design Engineer Administrator may require scale model testing for complex structures or where refined or dynamic methods of analysis were used.

4.9—REFERENCES

NCHRP Report 592, Simplified Live Load Distribution Factor Equations, Transportation Research Board, Washington, DC, 2012.