

ACEC-DOT BRIDGE SUBCOMMITTEE

Minutes of February 5, 2007 Meeting

Attendees:

Greg Perfetti, NCDOT (Co-Chair)
Allen Raynor, NCDOT
Lonnie Brooks, NCDOT
Tom Tallman, WSA (Co-Chair)
Tim Rountree, RWA
Domenic Coletti HDR Engineering
Rodney Money, TY Lin
David Simpson (Simpson Engineering)
Dwain Hathaway (LPA)

I. Training

- a. NCDOT has scheduled their NHI LRFD Substructure design course for late April 30 – May 2, 2007. Due to limited seating, there will not be any available slots for the PEF's.
- b. The latest bridge design workshop on “Spliced Precast Prestressed Girder Design” was once again deemed to be a success.
- c. Several new workshop topics were discussed. One was a continued discussion from our last meeting regarding NCDOT's new policy on non-composite dead load deflection computations for steel girders. ACEC polled its membership and determined that 48 persons were interested in attending a seminar to provide information regarding the background and details concerning the new policy. Because of the good response, it was determined by the committee that the next workshop will be the dead load deflection seminar. Domenic Coletti and Greg Perfetti will coordinate potential speakers for this event which is tentatively scheduled for April 27, 2007. More details will follow when they become available.

In looking ahead, it was determined that the next workshop would include discussions on HPS steel. This workshop will occur in late spring or early summer.

II. Update on conversion to LRFD

Allen Raynor gave us a brief update on the LRFD conversion. He stated that Program Development is continuing to progress and are currently reviewing the changes to the Design Manual. In-house squads are doing some double designs (LFD and LRFD) on

some projects. As of now, Box Culvert designs and standards will remain the same utilizing LFD design. There is still no definitive date as to the changeover to LRFD design.

Domenic Colletti, Dwain Hathaway, and Peter Graf assembled and provided a handout of various DOT modifications to the AASHTO LRFD Bridge Design Specifications. The handout is attached as a pdf file to these minutes. The committee will continue to address this issue and provide additional information and discussion at the next meeting.

Also, Greg Perfetti provided a google link for other DOT's Design Manuals:
<http://www.google.com/coop/cse?cx=006511338351663161139%3Acnk1qdck0dc>

III. Bridge Policy Changes

The following policy memo has been issued since the November meeting:

Top of Rail Elevations – Requires the addition of a note on the bridge plans.

This memo is available on the Structure Design Web Page at:

<http://www.doh.dot.state.nc.us/preconstruct/highway/structur/polmemo/>

IV. Status of Potential PEF Advertisements

The following projects were provided by Lonnie Brooks as potential future projects for PEF's;

- May '07 advertisement; May '09 let
U-2519DA (Fayetteville Outer Loop) – 1 grade separation
- July '07 advertisement; June '10 let
R-4047 (NC 209 at Lake Junaluska) – 1 railroad underpass
- November '07 advertisement; October '10 let
R-2527B (Montgomery Co.) – 1 railroad underpass

Lonnie also informed us that the following Design Build projects that were listed as “to be advertised” have been removed from that list:

- I-3819
- B-3637

V. Next Meeting

The next bridge subcommittee meeting will be on **Monday, May 14, 2007** at 9:00 a.m. in Structure Design Conference Room B.

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Listed below are some exceptions to, adaptations from, modifications to, or simplifications of the AASHTO LRFD Bridge Design Specifications that have been adopted by some state DOTs. These are provided as ideas for similar modifications that NCDOT may want to incorporate as part of their implementation of the LRFD specifications.

This listing is far from complete. It represents only a cursory survey of practices in other states, as reported by some PEF offices in those states. Not all LRFD-compliant states are represented below.

Note that some of these revisions/exceptions are more restrictive than what is proposed in the AASHTO LRFD Specifications. It is very possible that many of those more restrictive or more prescriptive provisions were adopted by the noted state due to local considerations (local conditions, local practices, local history, etc.). Careful consideration should be given before adopting any of these other states' revisions/exceptions. This listing is provided more to provide ideas and stimulate discussion about what NCDOT might want to do in terms of local implementation of the AASHTO LRFD specifications.

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: South Carolina (SCDOT)

Some of Their Modifications with SCDOT Bridge Design Manual Section:

- For bridge project not on the State Highway system and locally funded (not SDCOT or Federal Funds) SCDOT encourages the use of LRFD Specifications but does not require it.
- SCDOT allows the use of AASHTO Standard Specification (seventeenth edition) for widening and rehabilitation projects using an HS-25 Live Load Vehicle with approval of the State Bridge Design Engineer.
- The LRFD specification allows the structural contribution of structurally continuous railing to resist transient loads at the service and fatigue limits states as part of the cross section of the exterior girder. SCDOT only allows this for rehabilitation if the contribution is significant. SCDOT does not allow this consideration for new structures.
- The tables of distribution factors given in LRFD Article 4.6.2.2 include a column entitled "Range of Applicability." The *LRFD Specifications* suggests that bridges with parameters falling outside the indicated ranges be designed using the refined analysis requirements of LRFD Article 4.6.3. These ranges of applicability do not necessarily represent limits of usefulness of the distribution-factor equations, but the ranges represent the range over which bridges were examined to develop the equations. Other State DOTs have conducted parametric studies to extend these ranges for typical bridges in their States that have demonstrated that the factors can be used far outside of the range of parameters that were specifically studied. Therefore, SCDOT policy is to use a refined analysis only with the approval of the State Bridge Design Engineer prior to any preliminary design and only with bridges where the parameters fall outside of the "Range of Applicability."
- SCDOT *Seismic Design Specifications for Highway Bridges* supersedes the LRFD Specifications (11.3.3.2)

Structural Systems and Dimensions:

- Requires the use of the optional deflection criteria. (11.3.1.1.3, 12.2.2.1)

Loads and Load Factors:

- Uses load modifier, η_i , values of 1.00 for all limit states (13.1.3.2)
- Does not specify a Permit Load, therefore, Strength II Load Combination is not needed unless a specific need is identified. (13.1.4.1)
- Extreme Event I Load Combination is not applicable, must follow *SCDOT Seismic Design Specifications for Highway Bridges*. (13.1.4.3)

Structural Analysis and Evaluation:

- Refined analysis methods, either grid or finite-element, shall be used for the analysis of horizontally curved steel bridges. LRFD Article 4.6.2.2.4 states that approximate analysis methods may be used for the analysis of curved steel bridges but then highlights the deficiencies of these analyses, specifically the V-load method for I-girders and the M/R method for boxes. Therefore, SCDOT does not allow the use of approximate analysis methods for curved steel bridges.

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: South Carolina (SCDOT) *(Continued)*

Structural Concrete:

- Prohibits the use of four-bundled bars. (15.3.1.8)
- Does not permit partial prestressing of strands. (15.5.1)

Bridge Decks:

- Does not allow the use of the empirical deck design (17.2.2)

Substructures:

- Requires the dynamic load allowance to be considered in the design of bent caps, interior bent columns, and all piles, drilled shafts, and footings, if any portions of these elements are above ground.

Joints and Bearings:

- Prohibits the use of holes in steel-reinforced elastomeric bearings.

References:

Bridge Design Manual, April 2006 Edition

Available online: http://www.scdot.org/doing/bridge/pdfs/BD_manual/bd_manual.pdf

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: Pennsylvania DOT (PennDOT)

Some of Their Modifications:

- There is a state specific live load called PHL-93
- Deflection criteria must be met
- No inelastic analysis allowed.
- PA Traffic factor for fatigue design
- Nominal seismic loads defined for superstructure bearings and beam seats
- Numerous special guidelines for rebar detailing
- Prestressed and post-tensioned allowable stresses different
- Composite section properties in girder bridges assume a haunch = 0" for design
- Curved girders designed using AASHTO standard specs.
- Many fatigue details restricted
- No uplift allowed in steel piles
- All lateral loads to be resisted by battered piles
- Foundation resistance factors all different
- Single bearing at substructure unit must carry all lateral loads

References:

Design Manual, Part 4, Structures (Pub 15M, DM-4).

Available online: <http://www.dot.state.pa.us/Internet/BQADStandards.nsf/home?OpenFrameset>

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: Texas DOT (TxDOT)

Some of Their Modifications:

- The major thing that TxDOT is changing is the new Braking Force calculation which can be on the order of 10 times the old Longitudinal Force from the Standard Spec. They felt that the new provisions were just excessive.

References:

TxDOT LRFD Bridge Design Manual covers this and may cover some other exceptions.

Available online: <ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/lrf.pdf>

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: Ohio DOT (ODOT)

Some of Their Modifications:

- The Ohio Dept. of Transportation's move to LRFD is still a work in progress. But one major carry-over from the past will be that all bridges designed under LRFD must still be load rated for HS-20 inventory and operating loads using the BARS-PC program and the LFD factored loadings. They require this in the ODOT Bridge Design Manual because they use the analysis for future permitting of heavy loads. A bridge submittal will not be accepted that does not rate HS-20 or greater using BARS-PC in the Stage II submittal. This process won't change until they go to LRFR (which they won't do until they have to).

References:

ODOT's Office of Structural Engineering has a website, from which their manuals can be downloaded:
<http://www.dot.state.oh.us/se/>

They have a specific page for LRFD, but it is mostly schedule of implementation information:
<http://www.dot.state.oh.us/se/LRFD/Implementation/LRFDmain.htm>

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: Minnesota DOT (MnDOT)

Some of Their Modifications:

- LRFD 4.6.2.2.2e and 4.6.2.2.3c, LRFD Correction for Skew: As skews increase over 45 degrees the moment skew reduction factor for live load distribution can exceed 10%. Several LFD load ratings have shown a significant capacity shortfall since the current rating methods do not account for this reduction with skew. Designers shall no longer utilize the moment reduction for skew. The shear magnification for skew should still be used.
- Ultimate Capacity of Prestressed Concrete Beams: For most prestressed concrete beam designs, service limit state checks control the design. As sections become more lightly prestressed, the ultimate capacity (Strength Limit State) of the member begins to control the design. Bridges with lightly prestressed beams have resulted in very low operating ratings. To ensure an adequate minimum load rating level, designers must provide moment capacity in excess of 1.30 of the required moment, that is:

$$\phi M_n > 1.30 M_u$$

- Longitudinal Steel Check (LRFD 5.8.3.5) The longitudinal steel check requires adequate transfer length of prestressing steel to resist the applied shear and moment. The LRFD Specifications allow designers to ignore the moment component of the equation at simply supported beam ends. MnDOT agrees with this allowance for our typical prestressed beams. Our design guidance states that strands should be placed from bottom up in the cross section, filling one row before filling rows higher in the beam. This method keeps the center of gravity of the strands as low as possible. It also limits the moment component for the longitudinal check. If this guidance for placing strands as low as possible is not followed, designers must also verify the longitudinal capacity with the equation including the moment component at the section.
- Design Live Load for Continuous Bridges. Over the last year we have noted several LRFD continuous girder designs that exhibited low load ratings over sections at the piers. To ensure that these load ratings are at acceptable minimum levels, designers shall consider the following amplified double truck plus lane load case (in place of the double truck plus lane load case required by LRFD 3.6.1.3) when designing continuous beams for the Strength I Limit State. This load is for moment and reaction only.

For bridges with longest span below 100 feet:

90% of the HL-93 double truck with DLA plus lane load (same as LRFD 3.6.1.3)

For bridges with longest span between 100 and 200 feet:

(90+(span – 100)*0.2)% of the HL-93 double truck with DLA plus lane load

For bridges with longest span above 200feet:

110% of the HL-93 double truck with DLA plus lane load

References:

MnDOT LRFD Bridge Design Manual and associated memos.

Available online: <http://www.dot.state.mn.us/bridge/Manuals/LRFD/index.html>

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: Oregon DOT (ODOT)

Some of Their Modifications:

- ODOT has fully implemented LRFD for 5 years now ... except for foundation design. That section is being phased in through 2007 and, at that point, will be fully implemented. Since 4/06, both design approaches are considered acceptable. For the foundation section, ODOT allows the *Standard Specifications for Highway Bridges*. Lack of confidence in the load factors associated with the foundation loads based on "Oregon specific" soil properties (although I do not see a meaningful reason to prohibit the recent version of LRFD's foundation design approach).

References:

Direction for this approach may be found in Section 1.1.1 and 1.1.5 of the ODOT BDDM.

Available online: http://www.oregon.gov/ODOT/HWY/BRIDGE/standards_manuals.shtml

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: Florida DOT (FDOT)

Some of Their Modifications:

- Since FDOT has not tested the latest AASHTO LRFD “unified” steel bridge specs, they do not allow use of the current LRFD specifications for curved steel plate and box girders. Instead they use the 2003 AASHTO guide spec with HS 25 live load.
- In LRFD Article 5.4.2.6, FDOT changed the modulus of rupture equation from $0.37\sqrt{f_c}$ to $0.24\sqrt{f_c}$ for normal weight concrete.
- FDOT replaces the LRFD Resistance Factors for drilled shafts Table 10.5.5-3 with the following values:

Table 3.5 Resistance Factors for Drilled Shafts (Bridge Foundations)

Loading	Design Method	Construction QC Method	Resistance Factor, ϕ	
			Redundant	Non-redundant ⁶
Compression	For soil: FHWA alpha or beta method ¹	Std Specifications	0.60	0.50
	For rock socket: McVay's method ² neglecting end bearing	Standard Specifications	0.60	0.50
	For rock socket: McVay's method ² including 1/3 end bearing	Standard Specifications	0.55	0.45
	For rock socket: McVay's method ²	Statnamic Load Testing	0.70	0.60
	For rock socket: McVay's method ²	Static Load Testing	0.75	0.65
Uplift	For soil: FHWA alpha or beta method ¹	Std Specifications	Varies ¹	Varies ¹
	For rock socket: McVay's method ²	Std Specifications	0.50	0.40
Lateral ³	FBPier ⁴	Std Specifications or Lateral Load Test ⁵	1.00	0.90

1. Refer to FHWA-IF-99-025, soils with $N < 15$ correction suggested by O'Neill.

2. Refer to *FDOT Soils and Foundation Handbook*.

3. Extreme event.

4. Or comparable lateral analysis program.

5. When uncertain conditions are encountered.

6. As defined in SDG 3.6.9.

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: Florida DOT (FDOT) (Continued)

- FDOT replaces the LRFD Resistance Factors for piles Table 10.5.5-2 with the following values:

Loading	Design Method	Construction QC Method	Resistance Factor, ϕ
Compression	Davisson Capacity	PDA and CAPWAP	0.65
		Static Load Testing	0.75
		Statnamic Load Testing	0.70
Uplift	Skin Friction	PDA	0.55
		Static Load Testing	0.65
Lateral (Extreme Event)	FBPier ¹	Standard Specifications	1.00
		Lateral Load Test ²	1.00

1. Or comparable lateral analysis program.

2. When uncertain soil conditions are encountered.

- Deck design - In lieu of the reinforcing requirements of **LRFD [9.7.2.5]**, use no. 5 bars at 12-inch centers in both directions in both the top and bottom layers. Place two additional No. 5 bars between the primary transverse top slab bars (4-inch nominal spacing) in the slab overhangs to meet the TL-4 loading requirements for the FDOT standard barriers. Extend one of the additional bars to the mid-point between the exterior beam and the first interior beam; extend the second additional bar 36-inches beyond this mid-point. The maximum deck overhang is 6 feet, measured from the centerline of the exterior beam.
- Prestressing Strand Couplers: Strand couplers as described in **LRFD [5.4.5]** are not allowed.
- Add the following additional Principal Tensile Stress Limits to **LRFD [5.9.4.2.2]** (using HL-93 loading at the Service III limit state regardless of environmental classification):

Principal web tension: $3\sqrt{f'_c}$, psi ($0.095\sqrt{f'_c}$, ksi).

References:

Direction for this approach may be found in the FDOT Structures Design Guidelines .

Available online:

<http://www.dot.state.fl.us/structures/StructuresManual/CurrentRelease/FDOTBridgeManual.htm>

Various DOT Modifications to the AASHTO LRFD Bridge Design Specifications

Agency: California (CALTRANS)

Some of Their Modifications:

- Caltrans has posted several amendments to the LRFD specifications. The revisions will be printed on blue paper to be inserted into the AASHTO LRFD binder.

References:

Available online: <http://www.dot.ca.gov/hq/esc/lrfd/>

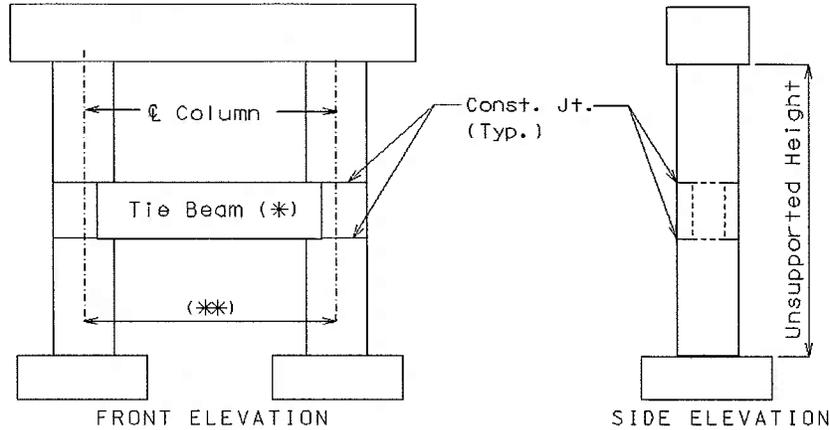
Caltrans Amendments to LRFD currently available as .PDF:

- Section 1 - [Introduction](#)
- Section 2 - [General Design and Location Features](#)
- Section 3 - [Loads and Load Factors](#)
- Section 4 - [Structural Analysis and Evaluation](#)
- Section 5 - [Concrete Structures](#)
- Section 6- [Steel Structures](#)
- Section 9 - [Decks and Deck Systems](#)
- Section 10 - [Foundations](#)
- Section 11 - [Abutments, Piers, and Walls](#)
- Quick Guide- [CA LRFD Quick Guide](#)

The "Quick Guide" is a handy summary of their revisions.

Agency: Missouri DOT (MoDOT)

2.3 General Design Assumptions



- * Use only if specified on the Design Layout or as stated by the guidelines in this section.
- ** For column spacings greater than 30'-0", tie beams are not to be used, unless the web supports the beam.

Figure 3.71.2.3.1 Elevations for General Intermediate Bent

General

The following are general design guidelines for the design of intermediate bents.

Rigid frame design is to be used for designing Intermediate Bents and Piers.

The joint between the beam and column, and web or tie beam and column, shall be assumed to be integral for all phases of design and must be analyzed for reinforcement requirements as a "Rigid Frame".

The joint between the column and footing is assumed to be "fixed", unless foundation flexibility needs to be considered as required by the Structural Project Manager.

Beam

Beams shall be designed for vertical loads, including a dynamic load allowance (impact) and components of horizontal forces.

LRFD 5.4.2.6, 5.7.3.4

The gross concrete section, without contribution from reinforcement, shall not rupture under service dead loads. In addition, longitudinal reinforcement shall be distributed to control cracking at the Service-I limit state.

Fatigue design should not control the size of reinforcement in the beam. LRFD 5.5.3.2 may be ignored for open concrete intermediate bents.

LRFD 5.7.3.3.2

The minimum reinforcement shall be such that the factored flexural resistance, M_r , is greater than or equal to the lesser of:

LRFD 3.6.5

Vehicular Collision Force, CT

Abutments and piers located within a distance of 30 feet to the edge of roadway or within a distance of 50 feet to the centerline of a railway track, shall be designed for an equivalent static force of 400 kip, which is assumed to act in any direction in a horizontal plane, at a distance of 4 feet above ground.

Design for vehicular collision force of 400 kip is not required if abutment or pier is protected by:

- An embankment
- A 54 inch TL5 barrier located within 10 feet from the pier or abutment.
- A 42 inch TL5 barrier located more than 10 feet from the pier or abutment
- A collision wall meeting the standards provided in these guidelines. See LRFD DG Sec. 3.71.
- A guardrail or barrier that is consistent with the department's roadway standards. See LRFD DG Sec. 3.32.

Note: TL5 refers to a "Test Level Five" crash test. See LRFD 13.7.2 for more specifics.

LRFD Bridge Design Guidelines

LRFD A13.4.2, A13.2

Collision Loads

Collision loads applied to the safety barrier curb (SBC) shall be transferred to the slab overhang. The design forces from SBC consist of lateral and vertical components that are to be considered separately. Because of MoDOT's experience with the collision survivability of bridge decks that utilize the standard barriers given in LRFD DG Sec. 3.32, MoDOT does not require the deck overhang to be designed for forces in excess of those resulting from the design loads for Traffic Railings shown in LRFD Table A13.2-1. The standard slab cross-sections presented in LRFD DG Sec. 3.30.1.7 reflect this design philosophy.

ATTACHED FOR
YOUR REFERENCE

Design Case 1

The collision force and moment shall be considered.

Slab Overhang Design Collision Moment

The design collision moment at the base of the curb is the barrier curb moment capacity about the curb longitudinal axis. For SBC design with either failure mechanism 1 or 2 controlling:

$$M_{ct} = M_c \text{ (averaged over height of SBC)}$$

Slab Overhang Design Collision Force

A refined analysis may be performed. In this case the design collision moment at the base of the curb, M_{ct} , is to be taken as the average moment over the theoretical distribution length ($L_c + 2H$ for continuous sections), when the TL-4 collision load is applied to the top of the curb. (Refer to LRFD DG Sec. 3.32)

LRFD A13.4.2

For continuous sections of safety barrier curbs:

$$T = \frac{R_w}{L_c + 2H}$$

Where:

R_w = total transverse resistance of curb (k)

L_c = critical length of yield line failure pattern (ft)

H = height of curb (ft)

T = tensile force per unit of deck length at base of curb (k/ft)

For discontinuous safety barrier curb sections:

$$T = \frac{R_w}{L_c + H}$$

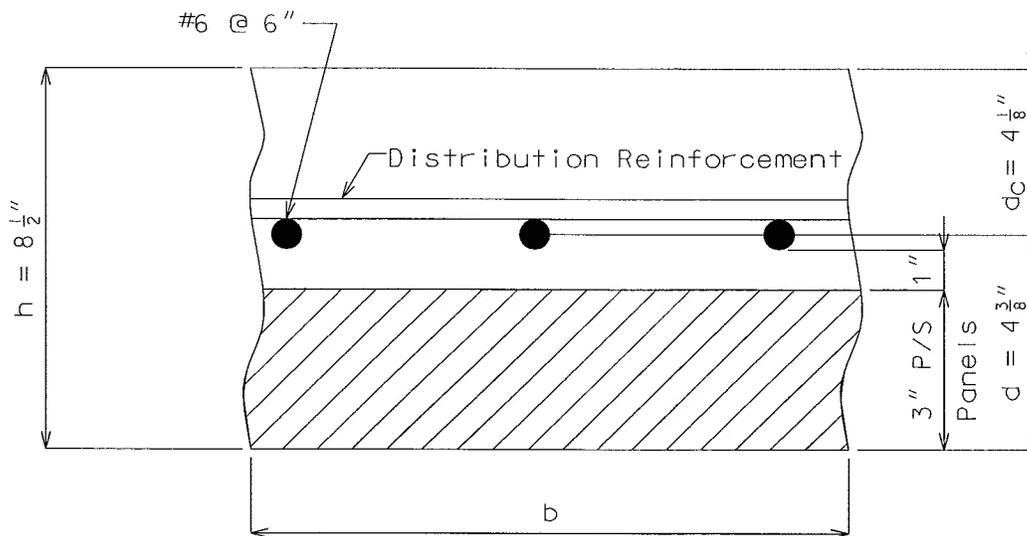


Figure 3.30.1.6 Example Slab Cross Section for Cracking Check

LRFD 9.7.1.3

Reinforcing Placement

Although LRFD Specifications allow slab primary reinforcing to be skewed with the bridge under certain cases, MoDOT Bridge practice is to place transverse reinforcing perpendicular to roadway.

Note:

Due to the depth of cover and location of primary reinforcement, the cracking check shown on the previous page does not appear to be accurate for Missouri's bridge decks shown above.

1.6 Slab Overhang Section Design

LRFD 4.6.2.2.1

Girder Layout

In order to use distribution factors provided in LRFD Table 4.6.2.2.2 for girder design, the roadway overhang shall not exceed 3 ft.

LRFD 13.7.3.1.2

Slab Thickness

The slab overhang shall be 8 1/2" slab thickness.

LRFD A13.4

Design Cases

Four design cases shall be considered for each design condition.

Design Case 1 EXTREME EVENT II load combination with transverse and longitudinal collision force components

Design Case 2 EXTREME EVENT II load combination with vertical collision force components (Does not control slab for TL-4).

Design Case 3 STRENGTH I load combination

Design Case 4 SERVICE I load combination for cracking check

Design Conditions

Three design conditions may exist for slab overhang design.

Design Condition 1 – Continuous Slab & Continuous SBC

Design Condition 2 – Continuous Slab & Discontinuous SBC

Design Condition 3 – Discontinuous Slab & Discontinuous SBC

LRFD 4.6.2.1.6

Critical Sections

The critical design section for slab overhang shall be at the following two locations:

- At roadway face of safety barrier curb
- At exterior girder:
 - For steel girders –the design negative moment should be taken at 1/4 of the flange width from the centerline of the web.
 - For P/S-I girders -the design negative moment should be taken at 1/3 of the flange width, but not exceeding 15" from the centerline of the web

LRFD 4.6.2.1.3

Width of Equivalent Strip at Continuous Slab Section

The equivalent strip width for a continuous section of slab overhang shall be:

$$E = 45 + 10x$$

Where:

E = equivalent width (in)

x = distance from load to point of support (ft)

LRFD 4.6.2.1.4a &
LRFD 4.6.2.1.4c

Width of Equivalent Strip at Discontinuous Slab Section

The effective strip width shall be taken as $\frac{1}{2}$ of the equivalent strip width for a continuous slab section plus the distance between the transverse edge of slab and the edge beam (if any). This shall not be taken to be greater than equivalent strip width for continuous slab section.

Assumed Load Distribution

To determine the load effect at slab overhang critical sections, the slab shall be assumed as fixed at the exterior girder. This assumption is intended for slab design only, not the distribution of slab loads to girder.

For the purpose of determining the collision load effect at slab critical sections, the load may be assumed to fan out at 30 degrees on each side from the point of load.

Determining Top Reinforcing

The top (negative) reinforcing steel may be determined by assuming the section to be either singly- or doubly-reinforced, as needed. For slab overhang lengths equal to or less than 3'-10", the reinforcement shown in the standard slab details is adequate (see LRFD DG Sec. 3.30.1.7). For overhang lengths greater than 3'-10", further analysis is required for top transverse steel design.

LRFD Bridge Design Guidelines

General Superstructure – Section 3.30

Page: 1.7-1

1.7 Standard Slab Details

Slab on Girder

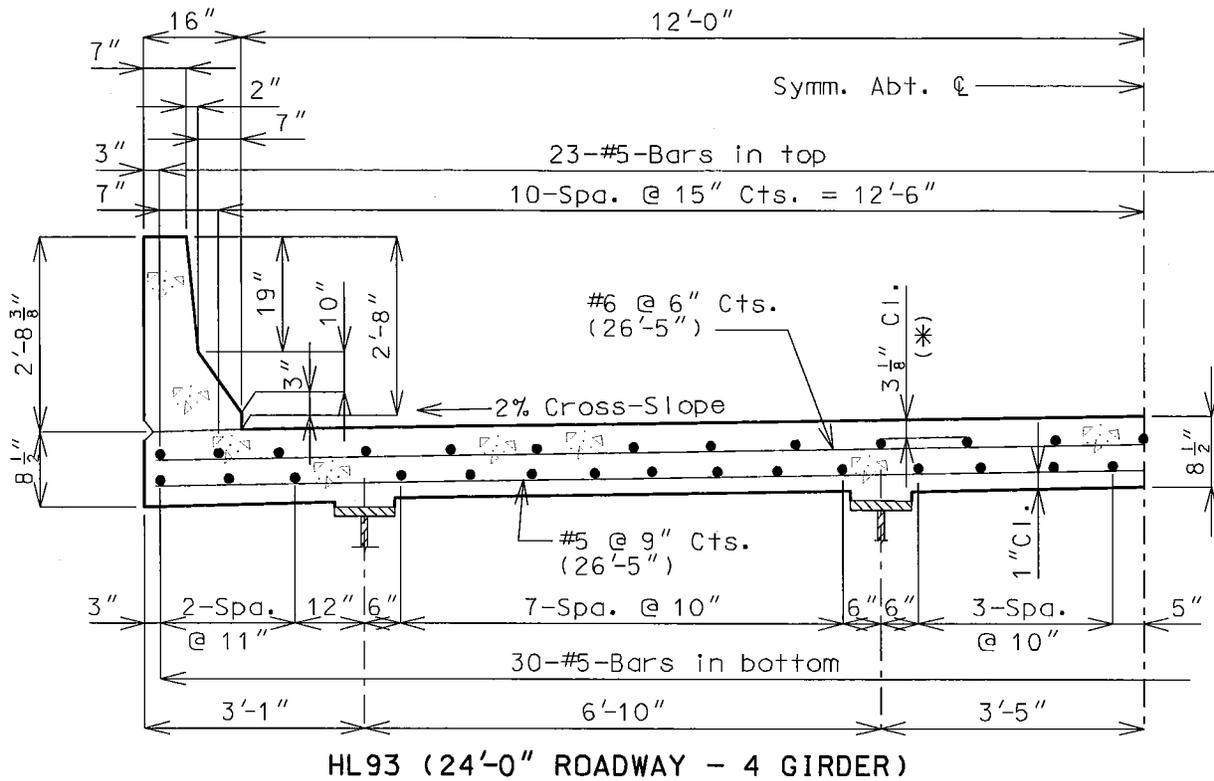
GENERAL INFORMATION:

- (A) Although P/S panel slabs are the standard, C.I.P. cross section are shown for information.
- (B) This slab design includes an allowance for 35 psf future wearing surface.
- (C) Slab design is based on ultimate strength design, $f'_c = 4$ ksi, and grade 60 reinforcing steel.
- (D) Haunching diagrams shall be provided for only the P/S panel slab.
- (E) Quantities for haunching are estimated by taking 4% of slab quantities for steel structures and 2% for prestressed structures.
- (F) When the flange width exceeds the bottom longitudinal reinforcement spacing over the girder, reduce the bar spacing between the girders and increase the bar spacing over the girder to clear the flange edges.
- (G) When the structure is on grade, determine lengths of the longitudinal reinforcement in the slab and safety barrier curb from the actual length.
- (H) For slab design, the centerline of wheels is located 1 foot from face of curbs.
- (I) The standard slabs were designed assuming 12" minimum flanges.
- (J) When median barrier curb or safety barrier curb is permanently required on the structure, other than at the edge of slab, P/S panels will not be allowed in the bay underneath the curb. Check reinforcement in the C.I.P bay for collision and wheel loads on opposite faces of the curb and provide suitable anchorage of the reinforcing steel.
- (K) The bridge roadway width, from gutter line to gutter line, shall be the same as the roadbed width (from outside edge of shoulder to outside edge of shoulder).
- (L) The P/S panels must be used in at least two consecutive bays.
- (M) Standard slabs do not include the effect of features not shown (i.e. sidewalk, fence, utilities, etc...) except for future wearing surface.
- (O) Minimum concrete cover for slab top bars is 2 ¾" for #8 longitudinal bars.

Note: Generally, when the deck is bid in Sq. Yd., curbs are bid in linear Ft., and when the deck is bid in Cu. Yd., curbs are bid in Cu. Yd.

Details of Concrete Slab on Girder (Cont.)

Slab on Girder

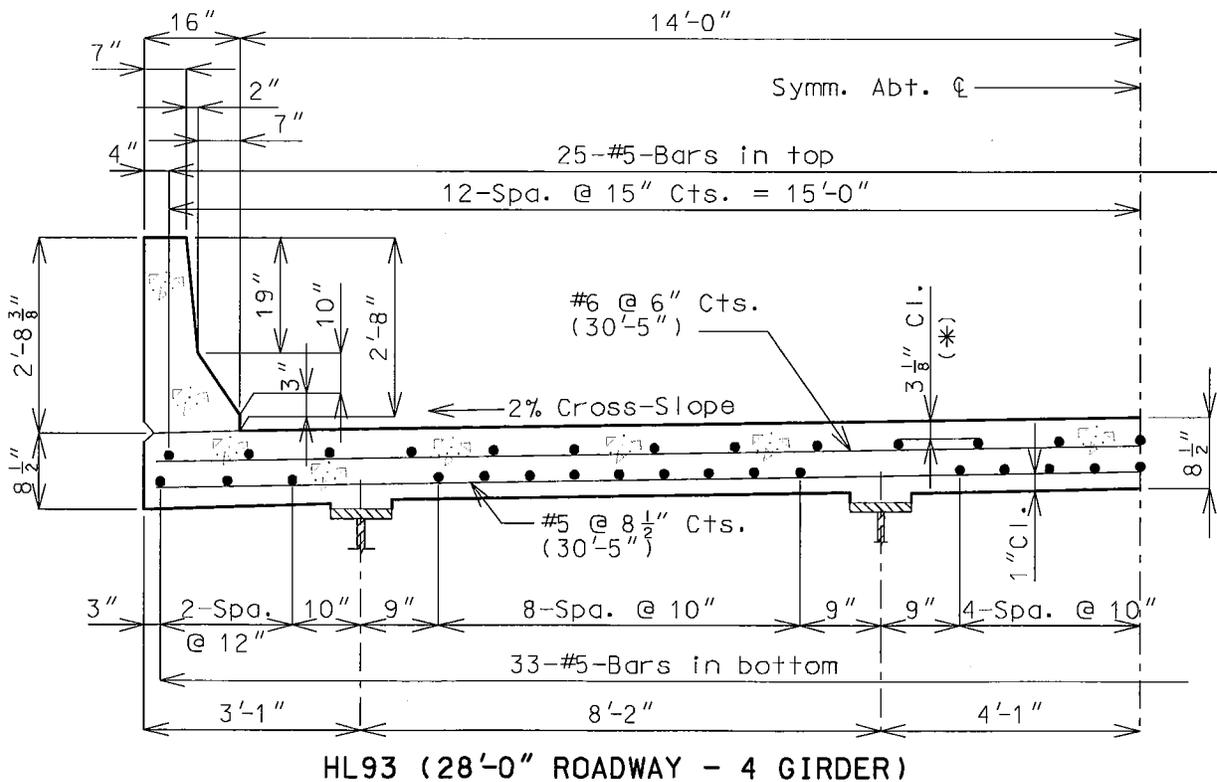
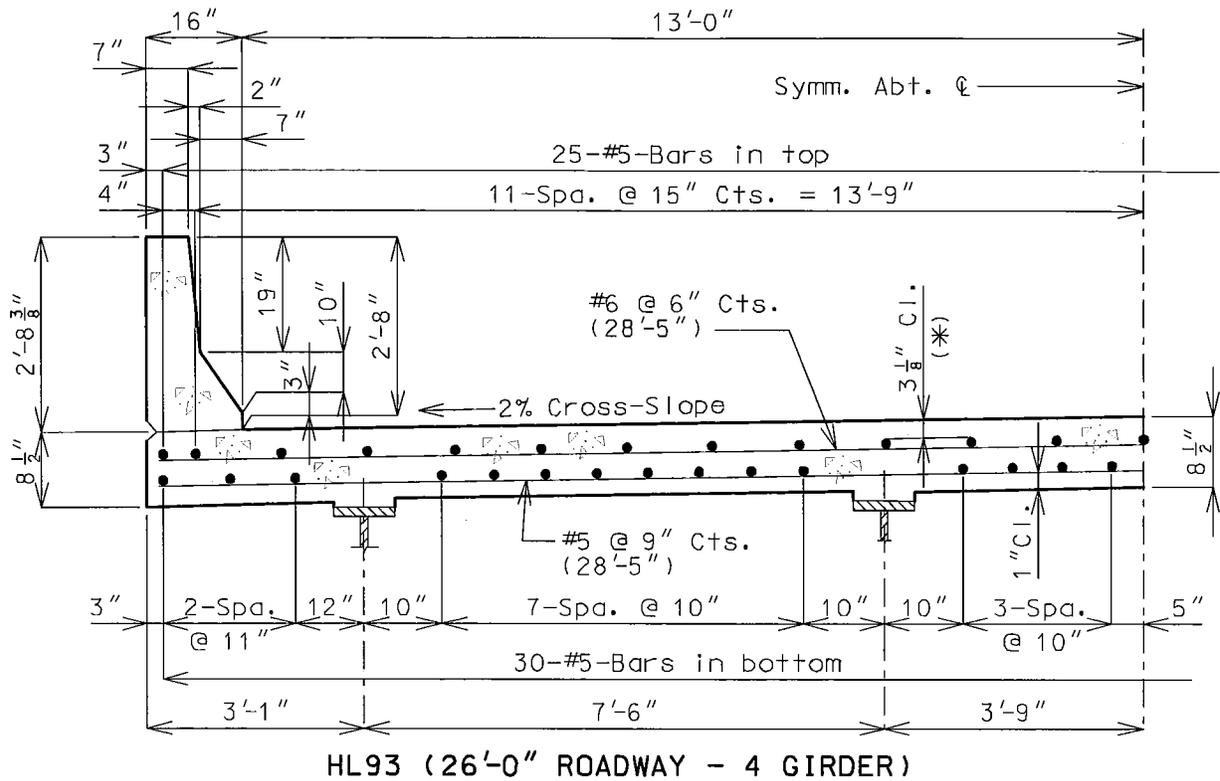


LRFD Bridge Design Guidelines

General Superstructure - Section 3.30

Details of Concrete Slab on Girder (Cont.)

Slab on Girder



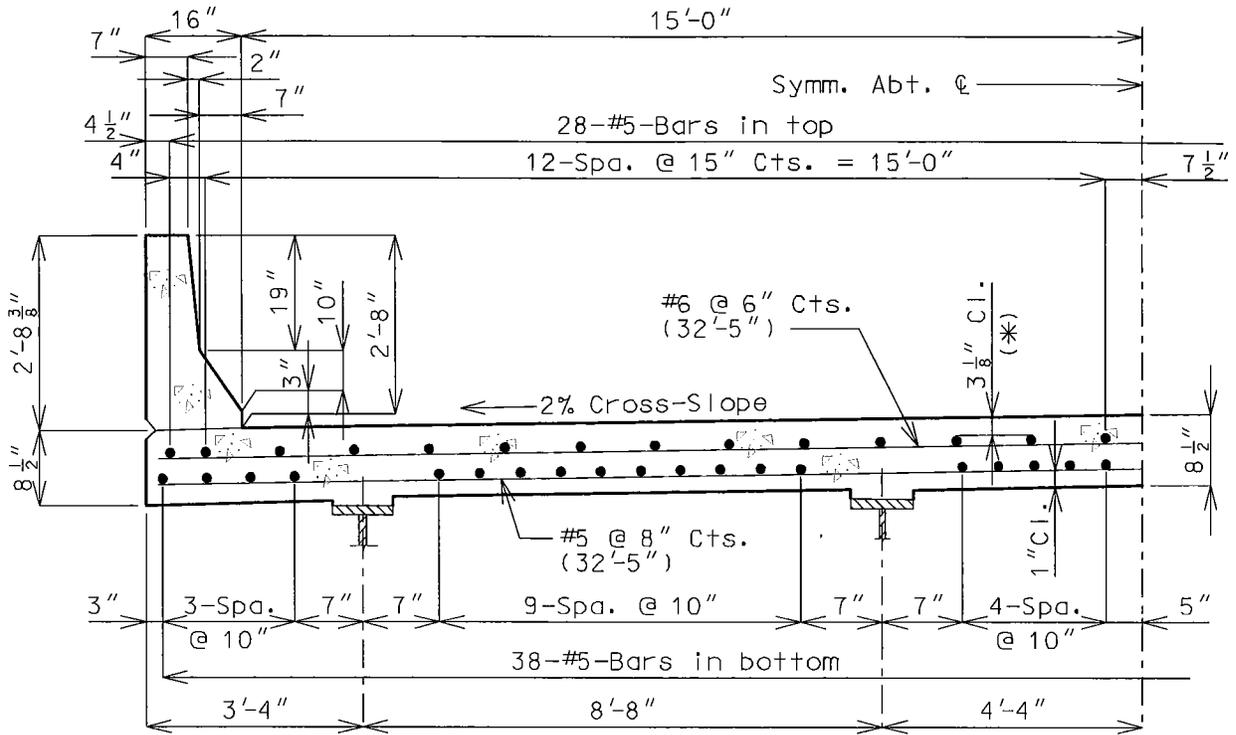
(*) Cover will be less for other than #5 longitudinal bars.

LRFD Bridge Design Guidelines

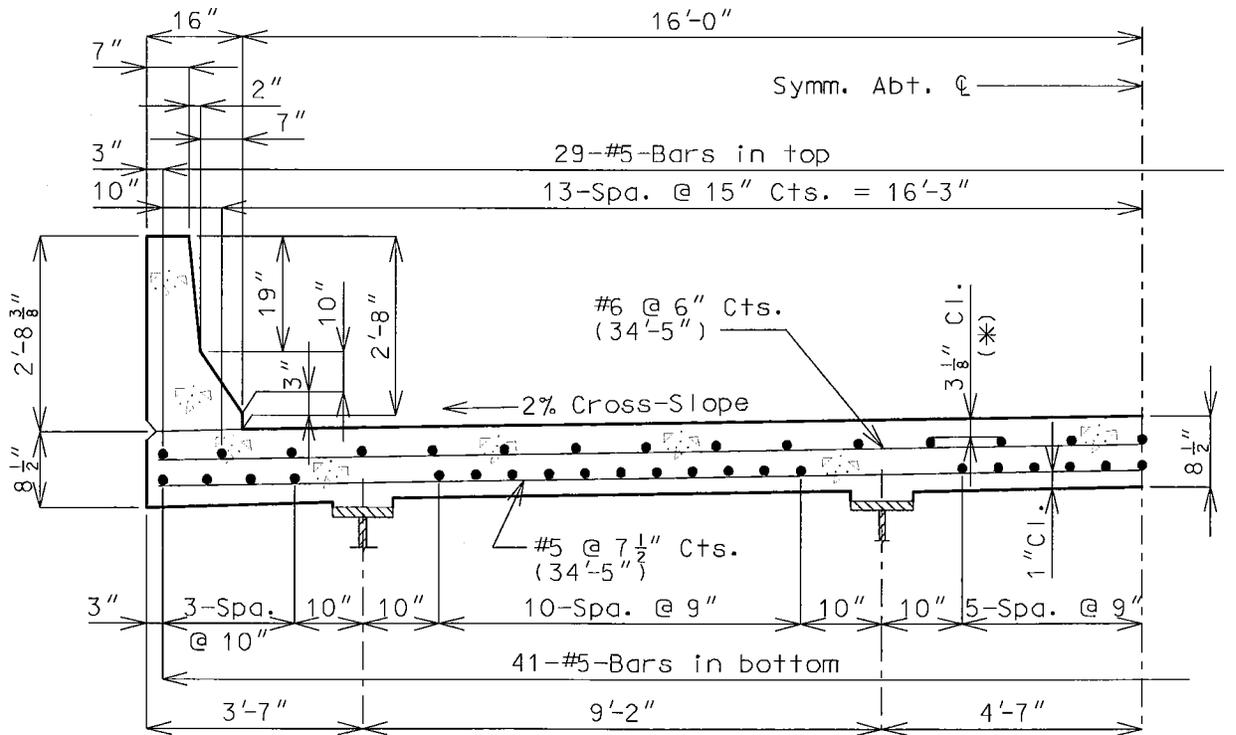
General Superstructure - Section 3.30

Details of Concrete Slab on Girder (Cont.)

Slab on Girder



HL93 (30'-0" ROADWAY - 4 GIRDER)



HL93 (32'-0" ROADWAY - 4 GIRDER)

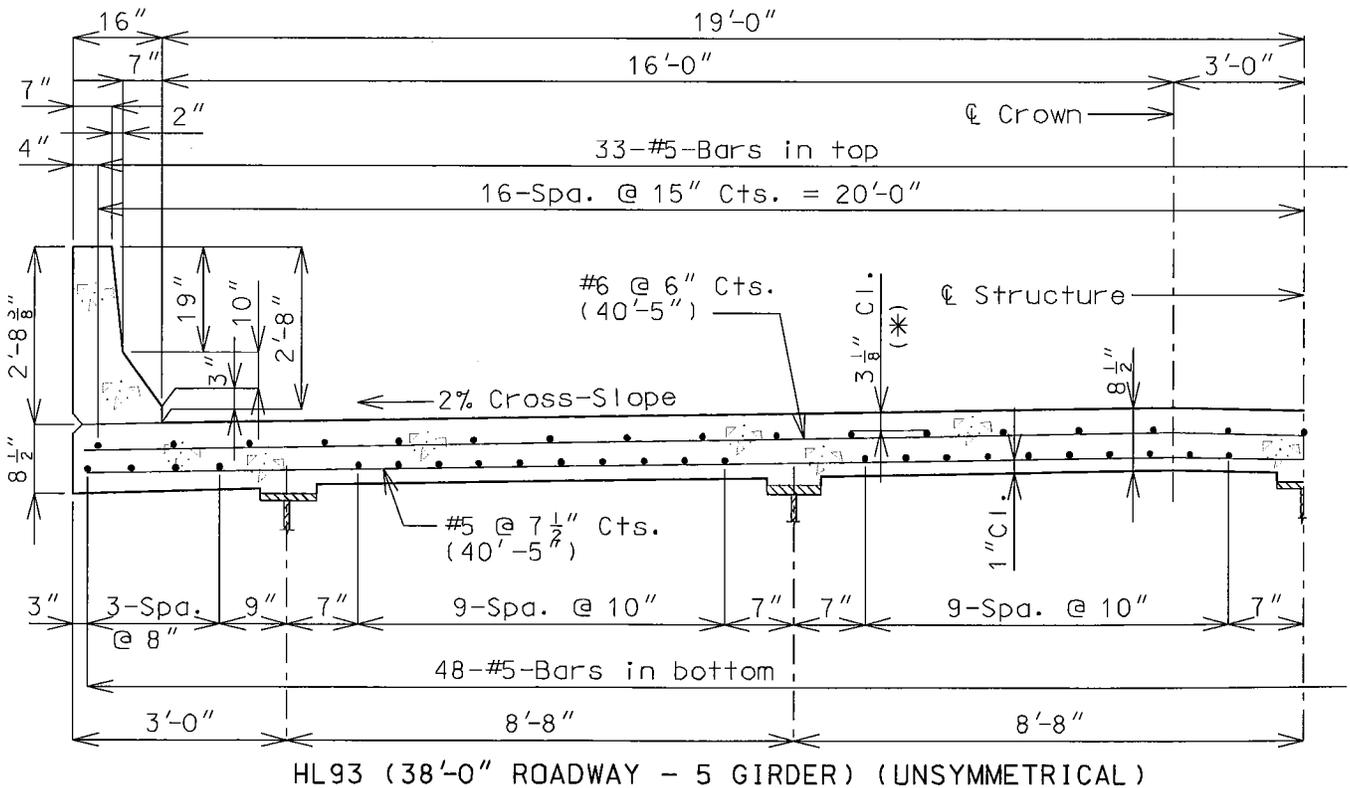
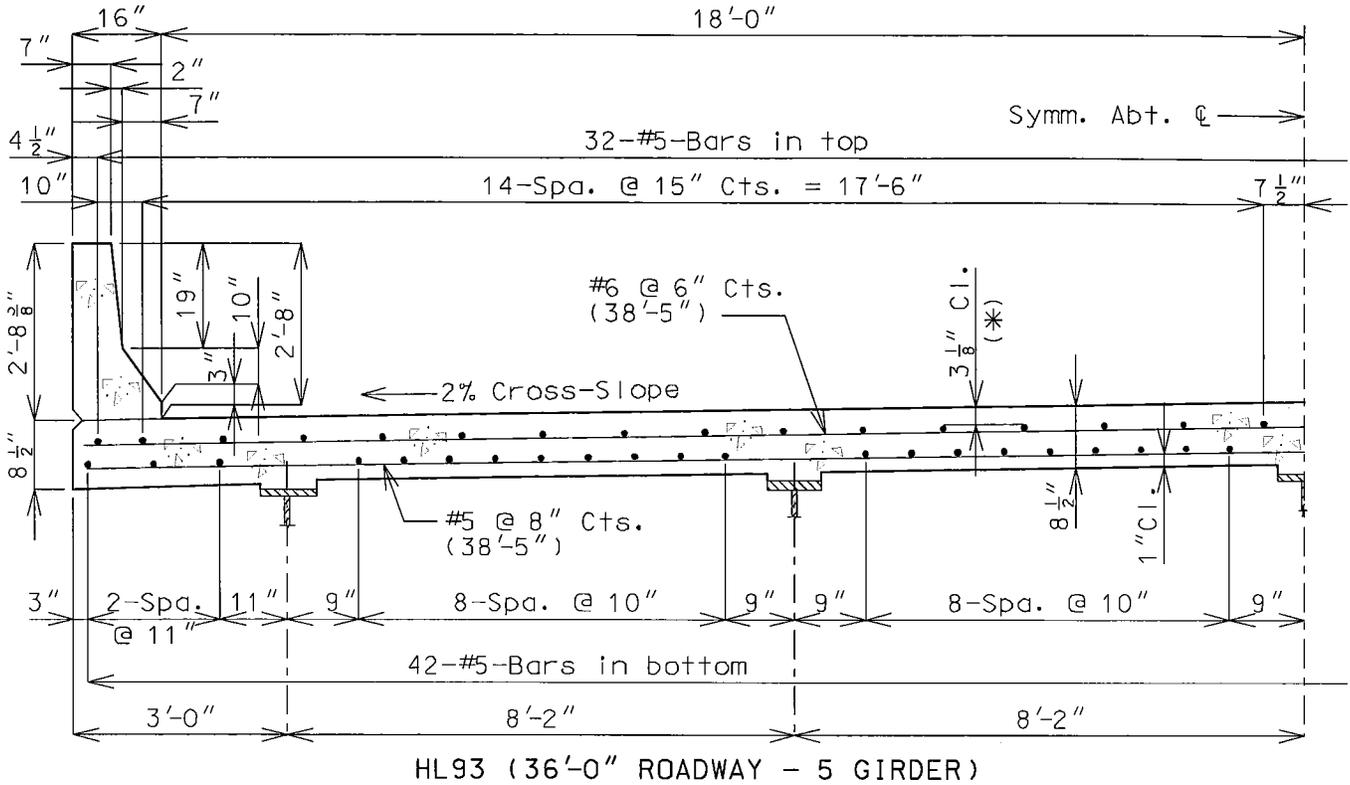
(*) Cover will be less for other than #5 longitudinal bars.

LRFD Bridge Design Guidelines

General Superstructure - Section 3.30

Details of Concrete Slab on Girder (Cont.)

Slab on Girder



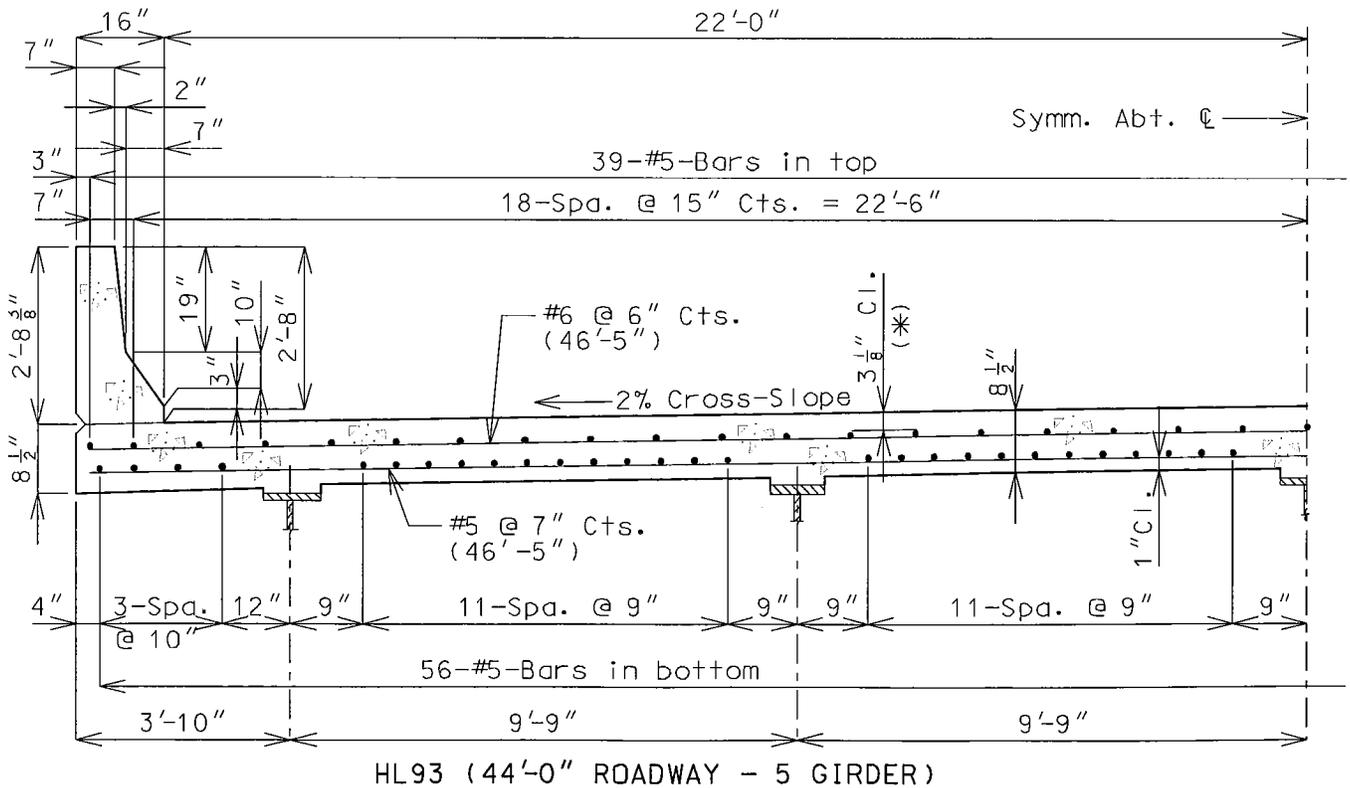
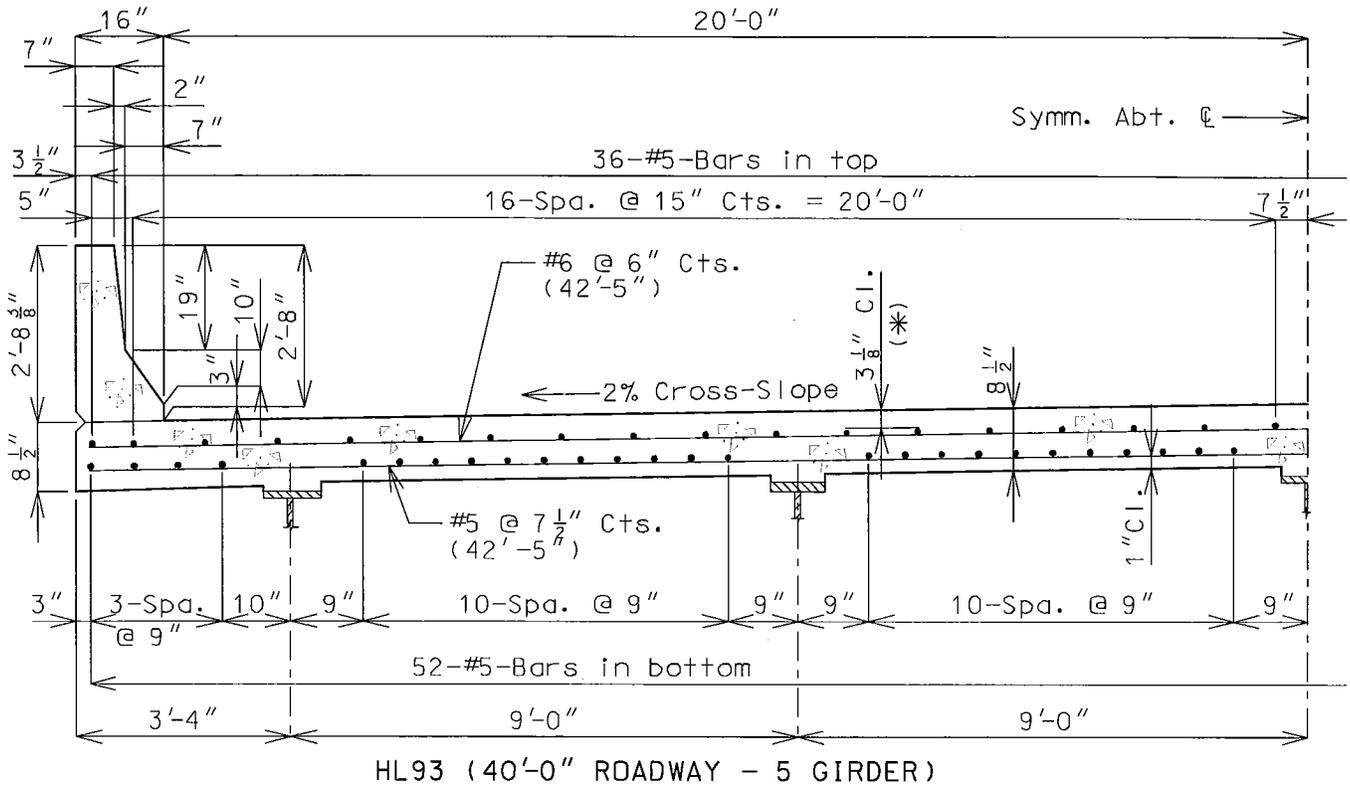
(*) Cover will be less for other than #5 longitudinal bars.

LRFD Bridge Design Guidelines

General Superstructure - Section 3.30

Details of Concrete Slab on Girder (Cont.)

Slab on Girder



(*) Cover will be less for other than #5 longitudinal bars.

2.2 Analysis Methods

MoDOT office practice generally utilizes the following:

The elastic stress at any location on the composite section due to the applied loads shall be the sum of the stresses caused by the loads applied separately at the following three stages:

LRFD 6.10.1.1.1a

Non-Composite Stage – The dead load of slab and haunching and stringer self weight shall be analyzed at this stage. This stage shall also be used for any construction loading checks. The section properties used are of the steel section only.

Long Term Composite Stage – The dead load of barrier curb, future wearing surface and any other appurtenances shall be analyzed at this stage. The section properties used are of the composite section of slab and stringer assuming an elastic modulus of $3n$ for the slab. Where “ n ” is the modular ratio.

Short Term Composite Stage – Any live loading shall be analyzed at this stage. The section properties used are of the composite section of slab and stringer assuming an elastic modulus of “ n ” for the slab. Where “ n ” is the modular ratio.

LRFD 6.10.1.1

Composite regions shall be defined as regions where shear connectors are used to connect the steel section to a concrete deck. Simple spans are designed as composite throughout.

Compact Section

Compact Design will be allowed if holes drilled in tension flange are investigated for LRFD 6.10.1.8 Net Section Fracture.

LRFD 4.6.2.7.1

Wind

For girder and intermediate diaphragm and cross-frame design, wind acting on the top half of girder is distributed to deck and wind on the lower half is assumed to be carried by the bottom girder flange.

2.6 Other Requirements

Deflection

LRFD 2.5.2.6.2

For allowable live load deflection, see Section 1.2 Page 4.2-1. (The deflection limits indicated are an attempt to ensure that LRFD provides a structure that will meet or exceed current MoDOT LFD deflection criteria.)

Compute at 1/4 points for bridges with spans < 75 ft,
Compute at 1/10 points for spans ≥ 75 ft.

Deflection shall be based on deflection distribution factor and loading specified in LRFD DG Sec. 1.2.4.2.

Minimum Negative Flexure Deck Reinforcement

LRFD 6.10.1.7

See LRFD DG Sec. 2.4.

Bearing Stiffeners

- Bearing stiffener width shall be given in ½" increments and shall extend to within a ½" of the bottom flange.
- Bearing stiffener thickness shall be given in 1/8" increments.
- If the skewed stiffener option is used, make stiffeners on both sides of web for skews thru 45° the same size as the larger except in cases where overhang would be produced. This does not apply to end bearing stiffeners for skews over 45°.

Diaphragms and Cross-Frames

LRFD 6.7.4.1

Diaphragms and cross-frames and their connections shall:

- Meet all applicable limit states for the calculated force effects.
- Follow LRFD 4.6.2.7 for transfer of wind loads
- Meet slenderness requirements of LRFD 6.8.4 or 6.9.3
- Meet connection plate design requirements of LRFD 6.6.1.3.1
- Be designed for stability of top flange in compression during noncomposite stage, and bottom flange for all loads when in compression.

Top horizontal members in end diaphragms shall be designed for vertical live load and dead loads.