8.1.1 REVISION

Splice lengths per AASHTO 14th Edition - Section 8.25.2.3, policy change with regard to epoxy-coated reinforcing.

8.1.2 GENERAL

Grade 60 reinforcing is required for #4 bars and larger.

No reinforcing smaller than #4 bars shall be used except as shown on standard details for precast members.

Reinforcing larger than #11 i.e., #14 and #18, may be used to eliminate reinforcement congestion if availability from suppliers is verified through the Staff Design Cost Estimates Unit.

Splice lengths shall be shown on the plans in a table included with the General Notes. These lengths are to be Class B splices as modified for 6 inch or greater spacing and shall reflect a 15% increase in length for epoxy coated reinforcing. WHEN ANY OTHER SPLICE LENGTH IS NECESSARY, IT MUST BE DETAILED ON THE PLANS. The following table gives the minimum Class B lap splice length for epoxy coated reinforcing and shall be used in lieu of the length shown in paragraph 4.6 of the Detailing Manual.

BAR SIZE	#4	#5	#6	#7	#8	#9	#10	#11
SPLICE LENGTH FOR CLASS A OR B CONCRETE	1’-3"	1’-6"	2’-0"	2’-8"	3’-6"	4’-5"	5’-7"	6’-10"
SPLICE LENGTH FOR CLASS D OR S CONCRETE	1’-3"	1’-6"	1’-10"	2’-2"	2’-10"	3’-7"	4’-7"	5’-7"

8.1.3 EPOXY-COATED REINFORCING

8.1.3.A BACKGROUND

Corrosion in reinforcing steel and the lack of concrete durability are two of the most severe deterioration problems for bridges today. Colorado has experienced both of these problems. In an effort to minimize the problems which became apparent in about the 1960’s, various bridge deck protective strategies have been employed, either singularly or in combination, as follows:

8.1.3.A.1 DURABILITY OF CONCRETE

Before 1960, concrete durability was usually considered the ability of concrete to resist freeze-thaw deterioration, consisting of scale, popouts and reactive aggregates. Freeze-thaw scale in concrete has been effectively addressed through the incorporation of an air entraining agent that is now a standard practice for bridge decks, other structural concrete, and in fact, concrete generally.

Additionally, the water-cement ratio has been decreased to a point such that in bridge decks a target ratio of 0.44 is specified. Both experience and research results suggest that a variation of ± .03 from the specified value can be expected. Thus, in any extended life predictions, for the improved water-cement ratio a value of 0.47 is used. In any event, a lower water-cement ratio is not used as an exclusive protection strategy.

This background is merely to record that durability has been addressed by improved water-cement ratio considerations in addition to air entraining agents. It is also included to support the future direction toward lower water cement ratios through the use of admixtures which can provide workability during placement of concrete with reduced water in the mix. A lower water-cement ratio will help limit corrosion if it occurs and is therefore desirable.

8.1.3.A.2 WATERPROOFING MEMBRANES WITH ASPHALT OVERLAYS

One of the earlier responses to freeze-thaw scale was to use an asphalt overlay. The overlay smoothed the roadway and was thought to be effective in waterproofing the bridge deck against future scaling. Alone, an asphalt overlay proved to have the opposite effect, letting water and salt through the asphalt, but reducing evaporation and keeping the concrete surface saturated with water. With the introduction of membranes, this combination strategy has proven to be fairly effective. The research and experience in Colorado verifies that this combined strategy alone is effective and under certain conditions of low deicer salt applications can provide a deck life in excess of 50 years.

The need for maintenance of the overlay and more particularly the membrane is open to question. Research in Colorado has shown minor failures in the membrane effectiveness. Nationwide research suggests that membranes do deteriorate over time.

Nevertheless, waterproof membranes and asphalt overlays are still in common use throughout Europe and the United States, as well as in Colorado, as a principle protective system. However, it is reasonable to assume that a preventive maintenance approach may need to be initiated to avoid a breakdown in the system’s waterproofing effectiveness. The breakdown of the membrane could go undetected because it is hidden from view; and the result being severe deterioration of the deck.

8.1.3.A.3 COVER OVER REINFORCING STEEL

Increased cover over reinforcing steel was one of the earlier responses to bridge deck deterioration. This direction was taken primarily for two reasons; *(1)* to ensure a minimum desired cover, it is necessary to start with an increased target cover because of statistical variations in rebar placement resulting from many construction practices; and *(2)* to prevent the intrusion of deicer chemicals into decks causing corrosion in black rebars and resulting in delamination and subsequent rapid deterioration. Research has generally concluded that covers of 1-3/4" or more decrease the risk of corrosion. To assure a minimum cover of 1-3/4" an extra amount, perhaps 1/2", should be added to allow for construction tolerances, resulting in a cover of 2-1/4". Colorado has responded to this and now requires a minimum of 2-1/2" clear cover to the top mat of reinforcing steel in bridge decks.

8.1.3.A.4 EPOXY-COATED REBARS

Fusion-bonded epoxy-coated reinforcement reached the commercial market in 1976 and almost immediately became a major bridge deck protective strategy. In 1981, an ASTM Standard Specification for Epoxy-Coated Reinforcing Steel Bars was issued. The use of such bars for all practical purposes stopped corrosion of reinforcing steel. As one would expect, the epoxy-coated bars do not affect the physical condition or quality of concrete.

However, it is still important not to abandon vigilance in seeking durable concrete (air-entrainment, low water-cement ratio, and perhaps a silica fume admixture). Epoxy-coated rebars do not bond quite as effectively as black steel therefore have a tendency to "slip" more. Also, some research has indicated increases in crack occurrence and crack width. In some particularly severe corrosion environments (such as Florida), questions are being raised about the effectiveness of epoxy-coated bars. Clearly no such indication has been found.

8.1.3.B POLICY

Recognizing that the totality of a Colorado Bridge Deck Protective Strategy is not the sole prerogative of the Bridge Branch, the following Policy is established for the use of epoxy-coated bars. A continuing effort will be made to consider a total strategy (see Table 1).

The use of epoxy-coated reinforcing bars is intended to be responsive to three categories of needed protection based in part on the anticipated level of de-icing salt applications as follows:

HIGH - Bridges, including interstates or urban freeways and expressways, or a bridge in a metropolitan or urbanized area where heavy de-icing salt application is anticipated. These bridges would generally include those within the five counties of Adams, Arapahoe, Denver, Douglas, and Jefferson.

MODERATE - Bridges on all other interstates, primary and secondary systems or a bridge along a major arterial where moderate de-icing salt application is anticipated.

LOW - Bridges where little or no de-icing salt application is anticipated. Off-system bridges are included in this category unless the jurisdiction responsible for the bridge de-icing indicates otherwise, at which time such bridges will be designed in the moderate category.

8.1.3.C BOND AND BASIC DEVELOPMENT LENGTH OF EPOXY-COATED REINFORCING

Recent ACI research indicates that the required development length for epoxy-coated reinforcing is greater than uncoated reinforcing. For epoxy-coated reinforcing, the basic development length, ld, in AASHTO Section 8.25 shall be increased by 15% if the clear cover is 3 times the bar diameter or greater, and the clear spacing is 6 times the bar diameter or greater. If the clear cover is less than 3 bar diameters, or the clear spacing is less than 6 bar diameters, the basic development length shall be increased by 50%.

8.1.3.D SPLICE LENGTHS FOR EPOXY-COATED REINFORCING

Development length used to calculate Class B and Class C splices shall be increased by 50% or mechanical splices shall be used for epoxy-coated reinforcing when the clear cover is less than 3 times the bar diameter, or the clear spacing is less than 6 times the bar diameter. Splices for slab reinforcing, however, shall be as shown in the general notes or as detailed on the plans. when lap splices become excessively long, use of approved mechanical splices shall be specified.

TABLE 1
POLICY FOR USE OF EPOXY-COATED REBARS

MEMBER	TYPE OF PROTECTION	HIGH	MODERATE	LOW
Deck slabs on prestressed concrete Colorado G and box girders, Steel I and box girders.	*Top concrete cover *Bottom concrete cover *Epoxy-coated rebar *Water cement ratio	2-1/2" 1" *Top and bottom mats *(1)	2-1/2" 1" *Top Mat *(1)	2-1/2" 1" --------- *(1)
Box girders Post-tensioned concrete, reinforced concrete and concrete segmentals.	*Top concrete cover *Bottom of top slab cover *Epoxy-coated rebar *Water cement ratio	2-1/2" 1" *Top and bottom mats of top slab only *Vert. web steel projecting to within 5" of top slab *(1)	2-1/2" 1" *Top mat of top slab only *Vert. web steel projection to within 5" of top slab *(1)	2-1/2" 1" --------- *(1)
Prestressed DBLT's with no cast in place slab. (Colorado Double-T Std. Bridges)	*Top concrete cover *Bottom concrete cover *Epoxy-coated rebar *Water cement ratio	2-1/2" 1" *Deck and projections into Deck per above two practices *(1)	2-1/2" 1" *Deck and projections into Deck per above two practices * (1)	2-1/2" 1" --------- *(1)
Reinforced and Post-tensioned concrete slabs.	*Top concrete cover *Bottom concrete cover *Epoxy-coated rebar *Water cement ratio	2-1/2" 1" *Top and bottom sats of slab *(1)	2-1/2" 1" *Top mat of slab *(1)	2-1/2" 1" *(1)
Reinforced and Post-tensioned concrete T-Girders	*Top concrete cover *Bottom Concrete Cover *Epoxy-coated rebar *Water cement ratio	2-1/2" 1" *Top and bottom mats of slab *Web steel projecting to within 5" of top slab *(1)	2-1/2" 1" *Top mat of slab *Web steel projecting to within 5" of top slab *(1)	2-1/2" 1" -------- -------- *(1)
Approach slab	*Top concrete cover *Bottom Concrete Cover *Epoxy-coated rebar	2-1/2" 3" *Top mat of slab (When there is no asphalt mat)	2-1/2" 3" ---------	2-1/2" 3" ---------
Prestressed concrete Colorado G and Box Girders	*Epoxy-coated reinforcing	*All stirrup bars and shear connectors projecting into deck and reinforcing within eight feet of an expansion device in the bridge deck	*All stirrup bars and shear connectors projecting into deck and reinforcing within eight feet of an expansion device in the bridge deck	---------

(1) Not to exceed 0.44

TABLE 1
POLICY FOR USE OF EPOXY-COATED REBARS
(Continued)

MEMBER	TYPE OF PROTECTION	HIGH	MODERATE	LOW
Box culverts at grade or having 2’-0" or less cover	*Top slab, bottom slab, and webs concrete cover	*(2)	*(2)	*(2)
	*Epoxy-coated bars	*Top and bottom mats of top slab and projections to within 5" of top slab	*Top mat of top slab and projections to within 5" of top slab	---------
	*Water cement ratio	*(1)	*(1)	*(1)
Box culverts having greater than 2’-0" cover	*Top slab, bottom slab, and webs concrete cover	*(2)	*(2)	*(2)
	*Epoxy-coated bars	---------	---------	---------
	*Water cement ratio	*(2)	*(2)	*(2)
Concrete diaphragms	*End diaphragms epoxy-coated rebars	*All Reinf.	*All Reinf.	---------
	*Interior diaphragms epoxy-coated rebars	---------	---------	---------
Parapets	*Epoxy-coated rebars	*All Reinf.	*All Reinf.	---------
Pier caps on structure with joints over caps	*Concrete cover	*(2)	*(2)	*(2)
	*Epoxy-coated rebars	*All reinf. bars within 5" of top of concrete	*All reinf. bars within 5" of top of concrete	---------
Pier caps on structures with closed decks	*Concrete cover	*(2)	* (2)	*(2)
	*Epoxy-coated bars	*All reinf. bars within 5" of top slab	---------	---------
Columns and caisson	*Concrete cover	*(2)	*(2)	*(2)
	*Epoxy-coated rebars	*All reinf. except caissons (3)		---------
Retaining walls	*Concrete cover	*(2)	*(2)	*(2)
	*Epoxy-coated rebars	--------- (3)	---------	---------
Abutments and Wingwalls	*Concrete cover	*(2)	*(2)	*(2)
	*Epoxy-coated rebars	*All reinf. in bridge seat and roadway side of wingwall	*All reinf. in bridge seat	*All reinf. in bridge seat

(1) Not to exceed 0.44
(2) Per AASHTO Standard Specifications
(3) Where retaining wall and columns are within splash zone, approximately 10’-0" beyond edge of roadway shoulder, consideration to use of epoxy-coating of bars projecting above the footing shall be given by the designer.

GENERAL

Concrete deck slabs shall have 2-1/2o the top layer of reinforcing. For bare concrete deck slabs with a mechanical saw cut finish, the minimum cover to the top layer of reinforcing shall be 3 inches. Top of concrete box culverts shall have 2-1/2 inches of cover when the fill height is 2 feet or less and 2 inches of cover when fill height is greater than 2’-0".

New concrete deck slabs shall be designed to include the dead load due to 4 inches of asphalt = 48 psf. Bare concrete deck slabs shall be designed to account for the dead load due to 2 inches of future asphalt.

Uplift at supports and girder stresses due to deck pouring sequence shall be considered during design.

The deck pouring sequence should progress from one end of the bridge to the other. When this progressive sequence cannot be accommodated in design, the pouring sequence shall be shown on the plans. All bridges with decks containing more than 300 cubic yards of concrete shall have the pouring sequence shown on the plans. Individual pours within the sequence given by the plans may exceed 300 cubic yards if approved by the Staff Bridge Engineer. Pours should end near the 3/4 point of a span in the direction of pour to minimize cracking in the negative moment regions. The deck pour should progress in the direction of increasing grade. A continuous pour will be an acceptable alternate, unless stated otherwise on the plans.

WATERPROOFING MEMBRANE

New bridge construction with asphalt pavement or an asphalt overlay over concrete pavement approaching the bridge shall have asphalt and waterproofing membrane applied over the concrete bridge deck and approach slabs. (C1)

New bridge construction and approach slabs with bare concrete pavement approaching the bridge will require a bare deck with a concrete sealer. (C2)

On bridge widening and rehabilitation projects the bridge deck surfacing will be compatible with the conditions at the bridge site. The design engineer will choose the surfacing with consultation of the district preconstruction engineer.

C1: Waterproofing membranes and asphalt overlays are used to protect the exposed surface of concrete bridge decks. However, an asphalt overlay may not be desirable where concrete roadway is adjacent to the bridge.

C2: Concrete sealer will penetrate into the deck to protect against deterioration.

PERMANENT DECK FORMS

The use of permanent bridge deck forms is required under the following conditions:

1. Where the structure crosses over an Interstate Highway.
2. Where the forms are deemed necessary for construction purposes.
3. Where form removal may be a problem.
4. When requested by the district.

When permanent bridge deck forms are required, the following note shall be added to the plans, "PERMANENT BRIDGE DECK FORMS ARE REQUIRED."

For all other cases, except as noted below, the use of these deck forms are optional. The following note shall be added to the plans -- "PERMANENT BRIDGE DECK FORMS ARE OPTIONAL."

All form flutes, when steel deck forms are used, shall be filled with styrofoam or covered with sheet metal. The dead load used to design the girders and substructure elements shall include an additional 5 psf to account for the steel forms.

Permanent bridge deck forms shall not be used under the following conditions:

1. Between girders or stringers where longitudinal deck construction joints are located.
2. With box culvert structures and cast-in-place post-tensioned T-girder, or box girder bridges.
3. For cantilevered portions of decks.
4. Where architectural constraints would not allow their use.

OVERHANGS

Deck overhang shoring subject to screed rail loads and construction loads has resulted in excessive deflections and torsional rotation of the exterior girders. In order to eliminate potential construction problems from deflections and rotation, the limits for deck overhangs shall be as follows.

Multi-girder structures with precast concrete or steel I-girders, use the greater of:

$L = s/3$ and

$L = (b/2 + 12")$

Steel box girders and multi-girder structures with girders continuously shored, use:

$L = s/2$

Where:

s = center-to-center spacing of girders or cast-in-place box webs.
b = top flange, or web, width.
L = average overhang width from centerline girder, or web, to edge of deck.

The maximum overhang may exceed the average overhang by not more than 1'-0". The minimum overhang shall extend beyond the edge of the top flange or web by 6 inches to prevent water from dripping onto girder and the bottom flange shall not extend beyond the drip line of the deck.

These overhang criteria may be exceeded with the approval of the Staff Bridge Engineer.

DESIGN

To maintain consistency and to standardize the bridge deck details, slab design charts have been prepared for both working stress and load factor design (see attached charts).

These charts are to be used for all slab designs with three or more girders. The deck slab overhang shall be designed for each project.

For concrete decks supported on Colorado prestressed G-Girders, effective span 'S' shall be the clear distance between edges of top flange ('S' shall be measured along direction of transverse rebar). (C3)

Single cell box girders, post-tensioned slabs, and effective slab spans greater than 12'-0" will require project specific designs. Slabs for noncomposite double tees and precast box girders placed side-by-side shall conform to Subsection 8.3.

C3: Regarding Article 3.24.1.2 of the AASHTO Standard Specifications, Staff Bridge does not consider Colorado G-54 and G-68 girders (b/t = 5.09>4) as thin flange girders because of large continuous fillets. Paragraph (b) of the above Article is appropriate for AASHTO Type V, VI and Bulb tee type girders. Note, paragraph (b) was revised by the 1990 Interims to include thin flange prestressed girders.

POLICY	COMMENTARY

Composite decks for precast boxes meeting the requirements of the AASHTO Standard Specifications, Article 3.23.4.1, shall conform to the CDOT Bridge Design Manual Subsection 8.3 for composite double tees.

Load factor design shall be used only where the longitudinal girder design is done using the load factor method and as approved by the Staff Bridge Engineer.

The minimum deck thickness shall be 8 inches. (C4)

C4: The minimum deck thickness has been raised to 8 inches due to demonstrated higher performance of thicker decks. Slab longevity increases significantly with increased thickness.

CONCRETE SLAB DESIGN DATA
WORKING STRESS DESIGN

Effective Span S(ft.)	Top Slab Thick. T(in.)	Top Slab Reinf. Size	Top Slab Reinf. Spa.	"D" Bars No. of #5 Bars	Bot. Slab Thickness TB(in.)	Bot. Slab Reinf. Size	Bot. Slab Reinf. Spa.
3.50	8.00	#5	8.0"	3	5.50"	#4	14"
3.75	8.00		7.5"	3			
4.00	8.00		7.5"	3			
4.25	8.00		7.0"	3			
4.50	8.00		6.5"	3			
4.75	8.00		6.5"	4			
5.25	8.00		6.0"	4			
5.50	8.00		5.5"	5			
5.75	8.00		5.5"	5			
6.00	8.00		5.0"	5			
6.25	8.00		5.0"	5			
6.50	8.00		5.0"	6			
6.75	8.00		5.0"	6			
7.00	8.00		5.0"	6			
7.25	8.00		5.0"	6	5.50"		
7.50	8.00		5.0"	6	5.75"		14"
7.75	8.00		5.0"		6.00"		13"
8.00	8.00		5.0"	7	6.00"		13"
8.25	8.00		5.0"	7	6.25"		12"
8.50	8.25		5.0"	7	6.50"		12"
8.75	8.25	#5	5.0"	7	6.75"		11"
9.00	8.25	#6	6.5"	8	6.75"		11"
9.25	8.25		6.5"	9	7.00"		11"
9.50	8.25		6.5"	9	7.25"		11"
9.75	8.25		6.5"	9	7.50"		10"
10.00	8.50		6.5"	9	7.50"	#4	10"
10.25	8.50		6.0"	10			
10.50	8.50		6.0"	10			
10.75	8.75		6.0"	11			
11.00	8.75		6.0"	11			
11.25	8.75		5.5"	12			
11.50	8.75		5.5"	12			
11.75	8.75		5.5"	12			
12.00	9.00	#6	5.5"	12			

DESIGN DATA

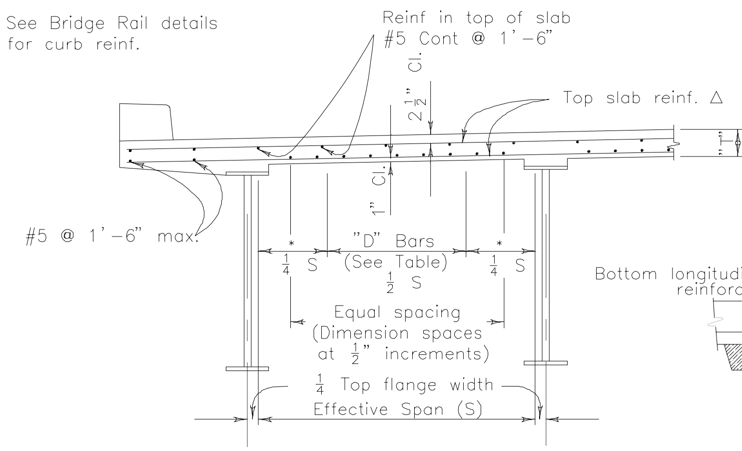
Live Load = HS 20
fs = 24000 psi
fc = 1800 psi
n = 8
Dead load includes
48 psf for 4" HBP

CONCRETE SLAB DESIGN DATA
LOAD FACTOR DESIGN

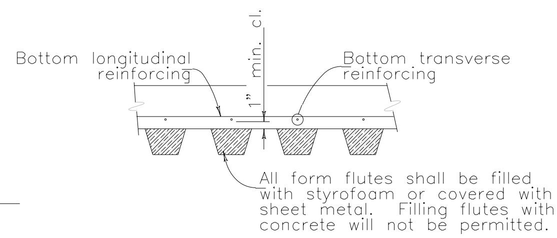
Effective Span S(ft.)	Top Slab Thick. T (in.)	Top Slab Reinf. Size	Top Slab Reinf. Spa.	"D" Bars No. of #5 Bars	Bot. Slab Thickness TB (in.)	Bot. Slab Reinf. Size	Bot. Slab Reinf. Spa.
3.50	8.00	#5	9.0"	3	5.50"	#4	14"
3.75	8.00		9.0"	3			
4.00	8.00		9.0"	3			
4.25	8.00		8.5"	3			
4.50	8.00		8.5"	3			
4.75	8.00		8.0"	4			
5.00	8.00		8.0"	4			
5.25	8.00		8.0"	4			
5.50	8.00		8.0"	4			
5.75	8.00		7.5"	4			
6.00	8.00		7.5"	4			
6.25	8.00		7.0"	5			
6.50	8.00		7.0"	5			
6.75	8.00		6.5"	5			
7.00	8.00		6.5"	5			
7.25	8.00		6.0"	6	5.50"		
7.50	8.00		6.0"	6	5.75"		14"
7.75	8.00		6.0"	6	6.00"		13"
8.00	8.00		6.0"	6	6.00"		13"
8.25	8.00		6.0"	6	6.25"		12"
8.50	8.00		5.5"	7	6.50"		12"
8.75	8.00		5.5"	7	6.75"		11"
9.00	8.00		5.5"	7	6.75"		11"
9.25	8.25		5.5"	7	7.00"		11"
9.50	8.25		5.5"	7	7.25"		11"
9.75	8.25		5.0"	8	7.50"		1 0 "
10.00	8.25		5.0"	8	7.50"	#4	10"
10.25	8.50		5.0"	9			
10.50	8.50		5.0"	9			
10.75	8.75		5.0"	9			
11.00	8.75		5.0"	10			
11.25	8.75		5.0"	10			
11.50	8.75		5.0"	10			
11.75	9.00		5.0"	11			
12.00	9.00	#5	5.0"	11			

DESIGN DATA

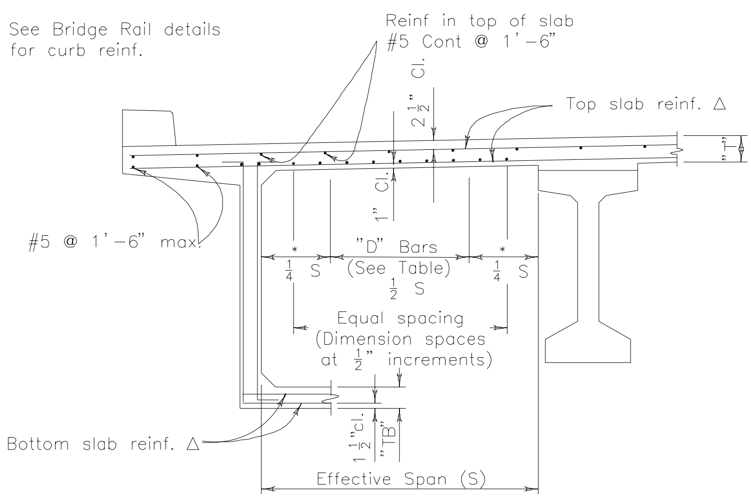
Live Load = HS 20
fy = 60000 psi
f'c = 4500 psi
Dead Load Includes
48 psf for 4" HBP



STEEL GIRDER



PERMANENT STEEL DECK FORM DETAIL



CONCRETE GIRDER

* Add 1 "D" bar at each ¼ S for S = 3'-6" thru 6'-6"
Add 2 "D" bars at each ¼ S for S = 6'-9" thru 10'-3"
Add 3 "D" bars at each ¼ S for S = 10'-6" thru 12'-0"

△ For curved structures place radially and space along ℄ between edges of deck. When the difference in spacing between the outside edge of deck and the ℄ between edges of deck becomes greater than ¼ inch, place bars parallel.

For skews 20° or less place parallel to abutments and piers and space along ℄ of structure.

For skews greater than 20° place perpendicular

COMPOSITE DOUBLE TEES AND PRECAST BOX GIRDERS

Slabs comprised of cast-in-place concrete on top of precast elements may be considered to act as composite for live loads and additional dead loads (HBP, rails, etc.) provided the following criteria are met.

1. The overall thickness of the laminated slab shall be at least the minimum stipulated by the slab design charts in Subsection 8.2 for the effective span used for design. However, the minimum thickness of the cast-in-place concrete portion of deck shall be 4-3/4 inches.

2. The top surface of the precast element at the cast-in-place/precast concrete interface shall be roughened by approved methods. This interface shall be clean and free of laitance at the time of placing the cast-in-place concrete.

The precast flange or top slab shall be designed to support self weight, construction load, and the weight of the cast-in-place slab concrete.

NONCOMPOSITE DOUBLE TEES AND PRECAST BOX GIRDERS

The design of noncomposite double tee and precast box girder bridge slabs shall be based on the following criteria.

1. Use allowable stress design with $f_c = 0.4f'_c \leq 2.4$ ksi and $f_s = 24$ ksi.

2. Consider the slab simply supported with an effective span for positive moment analysis. The magnitude of the LL moment is to be determined in accordance with AASHTO 3.24.3, including impact, and for double tees, omitting the continuity factor.

3. Double Tees - For negative LL moment, consider a simple cantilever with an effective overhang length of L. The magnitude of this moment shall be: (1/(2E))(L)(P20)(1+I) if L ≤ 1’-8" or: (1/E)(L-0.833’)(P20)(1+I) if L > 1’-8".

4. The minimum slab thickness shall be (1/2)(b) or 8 inches, whichever is greater.

5. Provide positive distribution steel in accordance with Section 8-2 and the slab design charts.

6. The longitudinal reinforcing in the top of the slab shall be continuous #5’s at a maximum spacing of 1’-6" for simple spans.

7. For bridge slabs precast with the girder, provide 2-1/2" clear cover for top steel and 1" clear for bottom steel.

Definition of Variables:

S = effective simple span length of slab between common stems of double tee.
b = double tee stem thickness at bottom of slab (neglect fillets).
L = effective cantilever overhang of double tee defined as: clear cantilever overhang, neglecting fillet, plus (1/4)(b).
E = longitudinal width of slab over which a wheel load is distributed = (0.8X + 3.75).
X = L if L ≤ 1’-8" or,
= (L-0.8333’) if L > 1’-8".
P20 = load due to one rear wheel of an HS 20 truck.
I = fractional part of impact factor.

GENERAL

1. Live load deflections shall be limited to 1/800 of the span maximum or limited to 1/1000 of the span maximum for bridges with walks.

2. Intermediate diaphragms, when required, shall be placed perpendicular to the girders (or radially with curved girders).

3. Maximum shear stirrup spacing shall be 1’-6".

4. For (+) M in T-beams and box girders, the size of flexure steel required for positive moment at the most highly stressed section shall be determined and this size bar shall be used at every section to facilitate detailing and construction.

5. For (-) M in the top slab of T-beams or box girders, consider only the bars in the top of the top slab within the effective flange width as flexural reinforcement for (-) M. The longitudinal slab distribution bars in the bottom of the top slab shall not be considered to resist (-) M.

CAST IN PLACE CONCRETE BOX GIRDERS

1. Except in unusual cases, the bottom slab should be made parallel to the top slab.

2. Design shall include the additional dead load for deck formwork to be left in place. This formwork load shall be applied over a width equal to exterior web to exterior web.

3. Bottom slab drains shall be located in the low points of each cell.

4. Box girders with an inside depth of 5 feet or greater shall be made fully accessible for interior inspection. Access to each cell shall be provided by bottom slab access doors, interior web openings, or diaphragm openings. Where solid pier diaphragms are used, each span will require access doors. Bridge Standard B-618-2 shows typical bottom slab access door details. Refer to Subsection 2.7, Access for Inspection, for additional information.

5. Configuration of shear stirrups shall be according to Bridge Standards B-618-1 and B-618-2. Stirrup hooks shall extend into the lower plane of the bottom slab steel and between the upper and lower planes of top slab steel and shall be developed in accordance with AASHTO 8.27.

6. One-piece "U" stirrups shall not be used in box webs.

PIER CAP REINFORCING DETAILS

Preferred reinforcement configuration for pier caps and integral pier caps shall be as follows.

INTEGRAL PIER CAPS FOR CAST-IN-PLACE GIRDERS

1. Cap reinforcement shall be placed below both mats of slab steel and below the main girder reinforcement in mild reinforced T-beams and boxes. In post-tensioned T-beams and boxes, the cap reinforcement shall be placed below both mats of slab steel or between the mats of slab steel, if necessary, to provide clearance for P/T ducts.

2. Hooks on integral cap shear stirrups shall be bent away from the centerline of the cap. The hooks shall enclose a cap reinforcement bar and the stirrups shall be developed according to AASHTO 8.27.2. To insure proper concrete cover for stirrup hooks, hooks shall be below the top mat of slab steel.

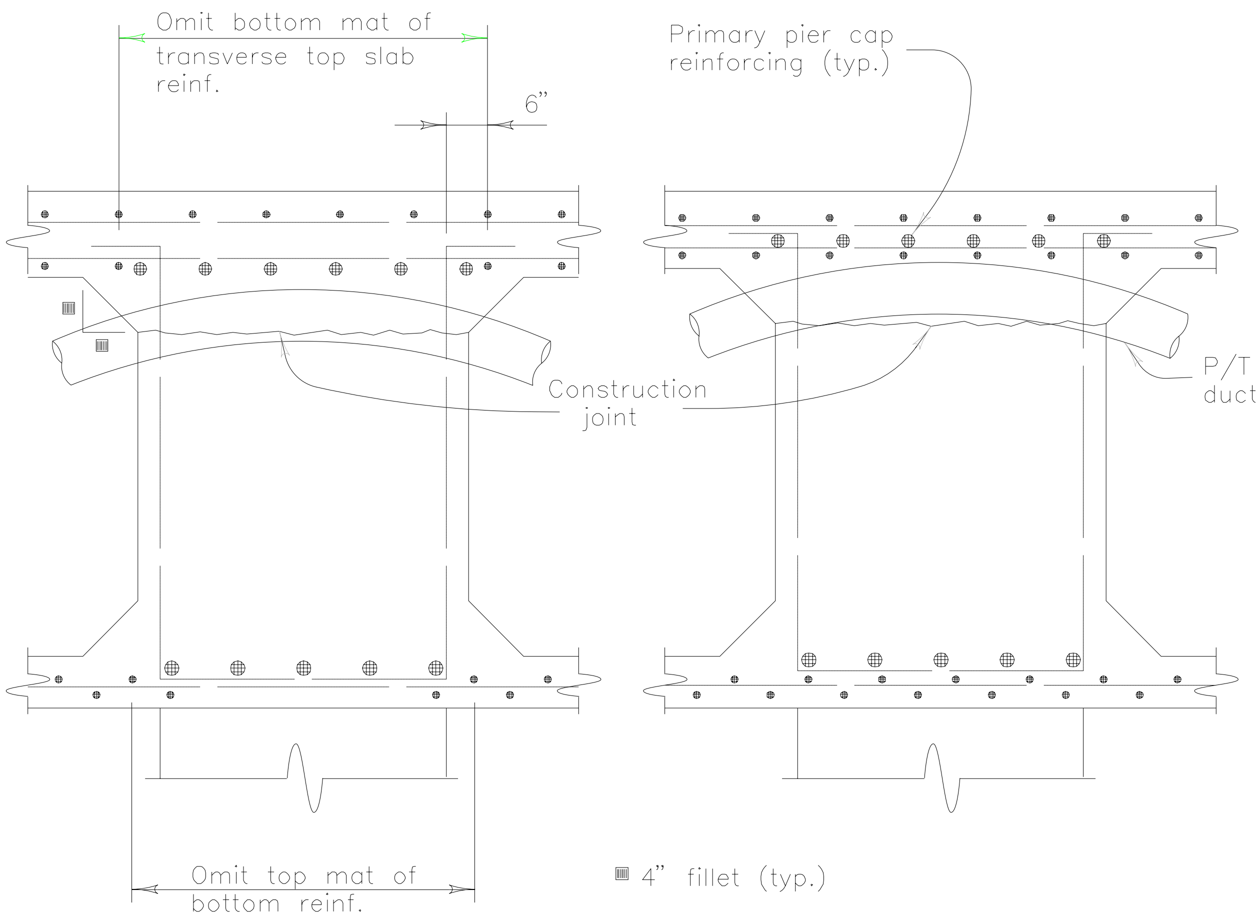
3. Maximum spacing of shear stirrups shall be 1’-6".

4. See Figure 8.5.1 and 8.5.2 for details.

PIER CAPS FOR STEEL AND PRECAST GIRDERS

1. Cap reinforcement shall be enclosed in closed stirrups, as shown in Figure 8.5.3 and 8.5.4. Stirrups shall be developed according to AASHTO 8.27.2.

2. Maximum spacing of shear stirrups shall be 1’-6".



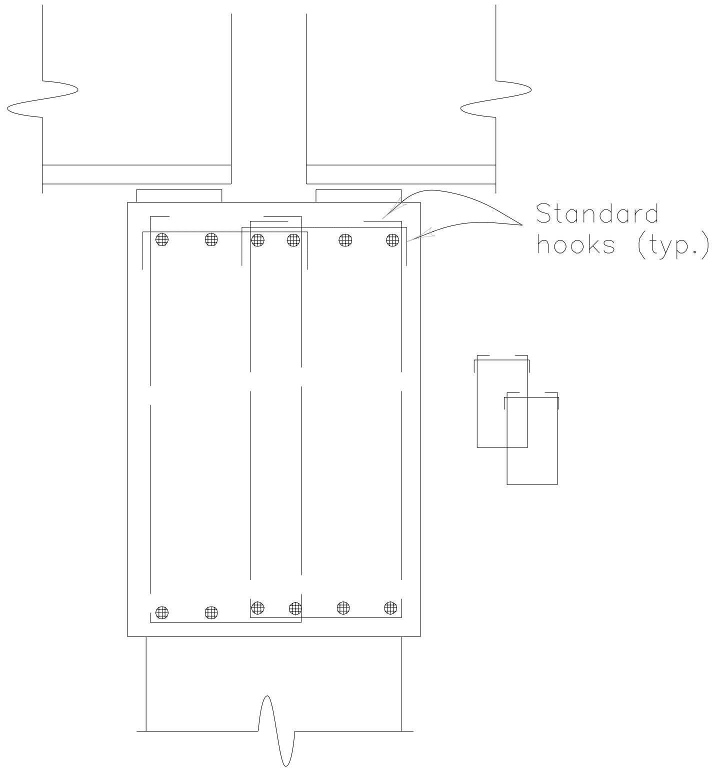
Note: Side face steel not shown.

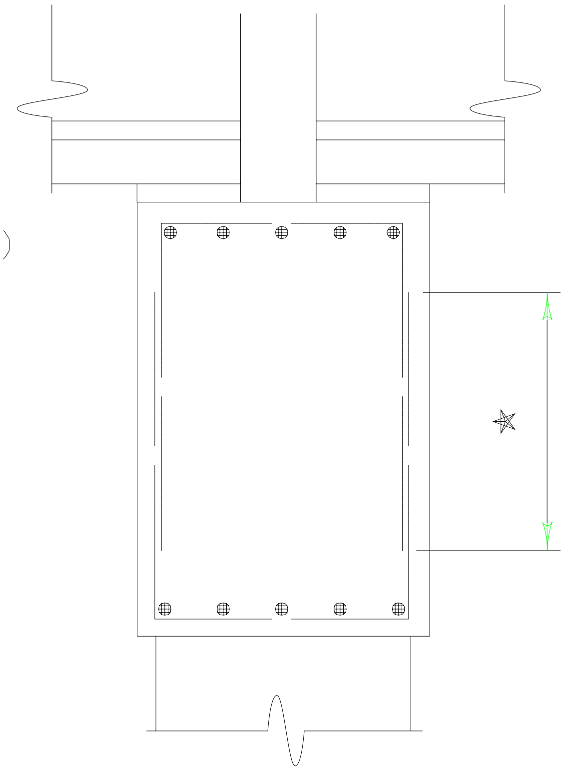
Skew = 20° or less
Deck reinforcing
parallel to cap.

Skew > 20°
Deck reinforcing
not parallel to cop.

FIGURE 8.5.1

FIGURE 8.5.2





★ Minimum splice=1.7L_d
Class C splice

Note: Side face steel not shown.

Constant depth cap.

Variable depth cap.

FIGURE 8.5.3

FIGURE 8.5.4

SPIRALS FOR ROUND COLUMNS

POLICY

Spiral reinforcement should be included in the plans as an option to the more traditional stirrup ties normally used. This option shall be provided by a note on the plans; i.e., #4 column stirrups shown, substitution shall be at the Contractor's option and expense.

To establish consistent pitch and size, the following shall be used:

COLUMN DIA.	CONCRETE STRENGTH f'c, psi 3000	4000	4500	5000	6000
24"	#4	#4	#5	#5	#5
30"	#4	#4	#5	#5	#5
36"	#4	#4	#5	#5	#5
42"	#4	#4	#4	#5	#5
48"	#4	#4	#4	#4	#5
pitch = 3" for all of the above					

The above assumes a 2" clearance on columns. Where a greater cover is provided for conditions other than loading (caissons or example), the reinforcement requirements of AASHTO 8.18.2 are waived, as provided for in 8.18.2.1, and the above criteria shall prevail. For conditions other than described above, individual calculations should be made.

COMMENTARY

This Subsection, 8.6, is taken directly from the Staff Bridge Engineer's 5/22/90 Policy Letter Number 3.

The potential benefits from the use of spiral reinforcement in round columns are such that the use of spirals should be permitted.