Chapter 2
Slab Design

Introduction

This chapter discusses the design of slabs or decks for bridges.

General Design & Miscellaneous Information

The design will be based on the Traditional Design as shown in Article 9.7.3 of the LRFD specification. For bridges with a girder system, the main or transverse reinforcing steel is designed perpendicular to traffic, with longitudinal reinforcing steel to help distribute the load. The design is based on a slab continuous over more than two girders. In the case of a two-girder system, a special design is required.

The minimum deck thickness will be 8". Additional sacrificial thickness to account for wearing is not to be included.

Use a crank bar as part of transverse reinforcing steel. A crank bar may not work with a curved deck on straight girders or for widenings.

For all standard slab designs, the following table is to be used to determine slab thicknesses and the transverse, longitudinal, and distribution reinforcing steel.

The table was developed based on the following:

- Live load based on equivalent strip method, LRFD Article 4.6.2 and Table A4-1
- The dead load includes the slab, stay-in-place (SIP) forms, and future wearing surface (FWS).
- The moment is based on the following equation:

$$M_{DL} = \frac{wS^2}{10}$$

Where: w = weight per linear foot per foot of width of slab
S = girder spacing

- The longitudinal reinforcing is determined from LRFD Articles 9.7.3.2 and 6.10.1.7.
- Bottom reinforcing is based on either:

$220/\sqrt{S}$ or ⅓ of 1 % of the deck area.

- Top reinforcing is based on ⅔ of 1 % of the deck area.
- Compressive reinforcing is neglected.

LRFD Deck Reinforcing Table

HL93 Design Vehicle

		Transverse Reinforcing Steel (Spacing = 12.0 in)									Longitudinal Steel	
		Bar Size			Positive Moment			Negative Moment			Max Spacing	
Girder Spacing	Slab Thickness	Top Bar	Crank Bar	Bottom Bar	d (in)	Mu+ (k-ft / ft)	ϕMn (k-ft / ft)	d (in)	Mu- (k-ft / ft)	ϕMn (k-ft / ft)	Bott Bar	Top Bar
(ft)	(in)										#5 Bar	#6 Bar
5.00	8.00	#5	#5	#5	6.688	8.56	17.30	5.188	6.03	13.12	9.00	8.00
5.25	8.00	#5	#5	#5	6.688	8.64	17.30	5.188	6.54	13.12	9.00	8.00
5.50	8.00	#5	#5	#5	6.688	8.76	17.30	5.188	7.04	13.12	9.00	8.00
5.75	8.00	#5	#5	#5	6.688	8.91	17.30	5.188	7.51	13.12	9.00	8.00
6.00	8.00	#5	#5	#5	6.688	9.07	17.30	5.188	7.95	13.12	9.00	8.00
6.25	8.00	#5	#5	#5	6.688	9.26	17.30	5.188	8.35	13.12	9.00	8.00
6.50	8.00	#5	#5	#5	6.688	9.47	17.30	5.188	8.72	13.12	9.00	8.00
6.75	8.00	#5	#5	#5	6.688	9.70	17.30	5.188	9.07	13.12	9.00	8.00
7.00	8.00	#5	#5	#5	6.688	9.95	17.30	5.188	9.88	13.12	9.00	8.00
7.25	8.00	#5	#5	#5	6.688	10.21	17.30	5.188	10.19	13.12	9.00	8.00
7.50	8.00	#5	#5	#5	6.688	10.48	17.30	5.188	10.46	13.12	9.00	8.00
7.75	8.00	#5	#5	#5	6.688	10.76	17.30	5.188	10.72	13.12	9.00	8.00
8.00	8.00	#5	#5	#5	6.688	11.05	17.30	5.188	10.98	13.12	9.00	8.00
8.25	8.00	#5	#5	#5	6.688	11.36	17.30	5.188	11.21	13.12	9.00	8.00
8.50	8.00	#5	#5	#5	6.688	11.72	17.30	5.188	11.42	13.12	9.00	8.00
8.75	8.00	#5	#5	#5	6.688	12.05	17.30	5.188	11.63	13.12	9.00	8.00
9.00	8.00	#5	#5	#5	6.688	12.39	17.30	5.188	11.83	13.12	9.00	8.00
9.25	8.00	#5	#5	#5	6.688	12.73	17.30	5.188	12.01	13.12	9.00	8.00
9.50	8.00	#5	#5	#5	6.688	13.07	17.30	5.188	12.58	13.12	9.00	8.00
9.75	8.00	#6	#5	#5	6.688	13.42	17.30	5.125	13.26	15.31	9.00	8.00
10.00	8.00	#6	#5	#5	6.688	13.77	17.30	5.125	13.94	15.31	9.00	8.00
10.25	8.00	#6	#5	#5	6.688	14.10	17.30	5.125	14.60	15.31	9.00	8.00
10.50	8.00	#6	#5	#5	6.688	14.43	17.30	5.125	15.25	15.31	9.00	8.00
10.75	8.00	#6	#6	#5	6.625	14.78	20.37	5.125	15.89	17.56	7.00	7.00
11.00	8.00	#6	#6	#5	6.625	15.12	20.37	5.125	16.52	17.56	7.00	7.00
11.25	8.50	#6	#6	#5	7.125	15.56	22.06	5.625	17.22	19.54	7.00	7.00
11.50	8.50	#6	#6	#5	7.125	15.91	22.06	5.625	17.83	19.54	7.00	7.00
11.75	8.50	#6	#6	#5	7.125	16.26	22.06	5.625	18.43	19.54	7.00	7.00
12.00	8.50	#6	#6	#5	7.125	16.59	22.06	5.625	19.02	19.54	7.00	7.00

The deck overhang or cantilever design is based on the following design cases from LRFD Article 13.4.1.

- Design Cases 1 and 2 do not need to be checked. The rail system has been crash tested in accordance with NCHRP 350, test levels 3 and 4.
- Design Case 3 - Verify that the cantilever moment, based on the dead and live loads, is below the capacity shown in the Deck Reinforcing Table.

The bridge should be checked to see if deck drains are required using a 25-year return period and a 15 minute duration. Drains are required if the bridge grade is less than 1% or if the width of the water at the curbs extends into the driving lanes (greater than the shoulder width).

Deck drains should not be placed directly over roadways, within railroad right-of-ways, or over slopes where drainage could cause erosion unless a drain collection system which outfalls outside of these features is used.

For Load Factor designs, a deck design table for the HS25 truck is shown in Appendix A. This table should be used for HS20 designs also.

Longitudinal steel for Load Factor designs should be per Article 3.24.10.2 of the AASHTO Standard Specifications.

Appendix A

The slab thicknesses and reinforcing shown in the table are based on the load factor design method and shall be used for all bridge deck designs. Compressive reinforcing is neglected.

SLAB DESIGN TABLE					
EFFECTIVE SPAN	SLAB THICKNESS	TRANSVERSE REINFORCING			NEGATIVE (CANTILEVER RESISTING) MOMENT CAPACITY - KIP-FT
		TOP BAR SIZE	CRANK BAR SIZE	BOTTOM BAR SIZE	
6'-0" thru 7'-0"	8"	5	5	5	13.12
7'-1" thru 8'-0"	8"	6	5	5	15.31
8'-1" thru 9'-6"	8"	6	6	5	17.56
9'-7" thru 10'-0"	$8\frac{1}{4}$"	6	6	5	18.55
10'-1" thru 10'-6"	$8\frac{1}{2}$"	6	6	5	19.54
10'-7" thru 11'-0"	$8\frac{3}{4}$"	6	6	5	20.53
11'-1" thru 11'-6	9"	6	6	5	21.52
11'-7" thru 12'-0"	$9\frac{1}{4}$"	6	6	5	22.51

f_y = 60000psi

f'_c = 3750psi

n = 8

$$M_{DL} = \frac{wS^2}{10}$$

$$M_{LL+I} = \frac{(S+2)P_{25} \times I \times 0.80}{32}$$

$$M_{ultimate} = 1.30\left[M_{DL} + \frac{5}{3}\left(M_{LL+I}\right)\right]$$

where:

w= weight per lineal foot per foot of width of slab
S= Effective span length
I= Live load impact, 1.30
P_{25} = 20 kips for HS25 loading
0.80= Continuity factor for slabs continuous over three or more supports

The design is based on a slab continuous over more than two supports. In the case of a two-girder system, a special design is required.