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Noncomposite and Composite Simple-Span Steel Plate Girder Bridge Design

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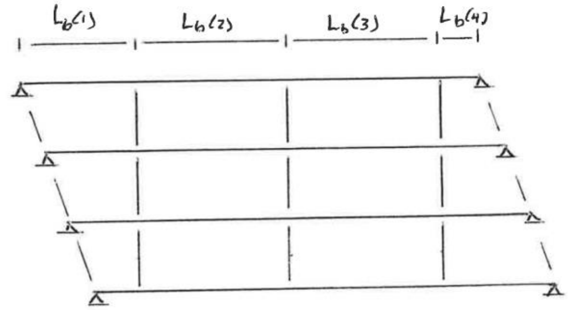
AASHTO 10th Edition



Skewed Simple Span Bridge with Variable Unbraced Lengths.

Capabilities of the Short Span Steel Bridge Design Program

Two to Four Lane NonComposite and Composite Plate Girder Simple Span Bridges
Prismatic Section Along Length
Use 50, 65 or 70 ksi Steel (not Hybrid)
Bridge Layout (with recommendations & warnings):
- Bridge Length
- Roadway Width
- Striped Lanes
- Barrier Width
- Overhangs

Any Girder Spacing and Number of Girders (at least 4 girders); Variable Overhangs
Cross-Frames Variable Along Span; Up to 7 Unbraced Lengths; Skewed Bridges
- Define Compression Flange Braced for Construction
- Define Compression Flange Braced for Final State

Any Decking: Wood, Non-Composite Concrete, Grid, Corrugated Metal, Composite Concrete
- For Composite
  - Variable f'c
  - Full-Depth, Stay-in-Place Forms
  - Haunch
  - Sacrificial Wearing Surface
  - Shear Connector Size and Fu

Wearing Surface
Additional DC1 and DC2 Dead Load (Utilities, etc)
Bridge Railing
HL93 Truck and Tandem Loading, Lane Loading
User Defined Vehicle Loading; Up to 9 Axles
- User Vehicle Live Load Factor (Strength II)
- Optional Lane Load
- Single or 2 Lane Distribution Factors
- User Vehicle Impact Factor

Target L/D ratio
Minimum Depth (Diaphragms)
Maximum Depth (Approaches/Clearances)
Set Live Load Deflection Limit
Add % Steel for Miscellaneous (Diaphragms, etc)
Steel Girder Weight Considered Individually for Design
Live Load Distribution Factors Determined for Individual Girder, Including Rigid Rotational Analysis
- Can Use User Input Lateral Distribution Factors

Applies AASHTO 6.10.8 (Conservative) or AASHTO Appendix A6 (Optimal)

Calculated Cb Factors for Each Unbraced Length
- Can Use Cb = 1 (Conservative)

Performs Either Fatigue I or Fatigue II Design
` Automatic Based on $(ADTT)_{SL}$
- Variable Design Life

Bridge Analysis & Design:

Performs Dead Load, Construction Loading and Live Load Analysis
- Construction Vertical Bending and Lateral Flange Bending Construction Loading (Top Flange) for Each Unbraced Length
- HL93 Truck & Tandem & Lane Load for Each Unbraced Length
- User Defined Vehicular Loading for Each Unbraced Length
- Single Lane and 2 or More Lane Lateral Distribution Factors
- C_b for Each Unbraced Length

Performs Strength I/II & Constructability Design Analyses for Each Unbraced Length and Service II near Centerline
- Performance Ratios
- Determines Top Flange, Web & Bottom Flange Sections That Meets Specs Over All Unbraced Lengths

Performs Fatigue (Fatigue I or II) Design Analysis at Critical Cross-Frame Location
- Performance Ratios
- Determines Top Flange, Web & Bottom Flange Sections That Meets Specs – and Shows those that do not

Performs Live Load Deflection Design Analysis at Bridge Centerline
- Performance Ratios
- Determines Top Flange, Web & Bottom Flange Sections That Meets Specs – and Shows those that do not

Performs Shear Design Check at Girder End
- Performance Ratios
- Calls out shear stiffener requirement if necessary

Results:

Ranks from Lightest Weight Top Flange, Web & Bottom Flange Sections That Meet Strength I/II, Service II & Construction Specs
- Performance Ratios and Design Characteristics
- Bridge Steel Weight

Corresponding Fatigue Design Performance
- Performance Ratios

Corresponding Deflection Design Performance
- Performance Ratios and Equivalent L/xx Live Load Deflections

Design Investigation:

User Chooses Any Top Flange, Web & Bottom Flange Section to Investigate
- Alternatives to Lightest Weight
- Top Flange, Web & Bottom Flange Sections That Barely Do Not Pass Design Checks For Consideration

Examine Performance Ratios for Strength I/II, Service II, Construction, Fatigue & Deflection
- Strength I/II Performance Ratios for Each Unbraced Length
- Modify Diaphragm Layout for Optimum Designs

List of Top Flange, Web & Bottom Flange Sections That Barely Did Not Meet Specs for Consideration
- Strength I/II Performance Ratios for Each Unbraced Length
- Consider Modified Diaphragm Layout for Possible Acceptance

Dead Load Deflections for Camber Design

Abutment Loads and Locations for Abutment and Foundation Design

Final Design Sheet:
All Information
If Composite, Shear Stud Fatigue and Strength Design

User Manual

EXCEL SHEET Bridge Description & Results

First Sheet Includes Design Inputs and Design Characteristics

Design Inputs

	A	B	C	D	E	F
1						
2	Bridge Layout					
3	**Bridge Length (ft)**	**75**		Type of Bridge	**Composite**	
4	**Roadway Width (ft)**	**32**				
5	**Number Striped Lanes**	**2**	Bridge Width = Roadway Width + 2 * Barrier Width			
6	**Barrier Width (ft)**	**0**				
7	**Est. Overhang = XX% GS**	**20%**				
8	**Number of Girders**	**Girder Spacing (ft)**	**Overhang**	**Roadway Width**	**Bridge Width**	
9	**4**	9.41	1.88	32.00	32.00	
10	**5**	7.27	1.45	32.00	32.00	
11	**6**	5.93	1.19	32.00	32.00	
12	**7**	5.00	1.00	32.00	32.00	
13	**8**	4.32	0.86	32.00	32.00	
14	**9**	3.81	0.76	32.00	32.00	
15	**10**	3.40	0.68	32.00	32.00	
16	**11**	3.08	0.62	32.00	32.00	
17	**12**	2.81	0.56	32.00	32.00	
18	**13**	2.58	0.52	32.00	32.00	
19	Cross Section Trial					
20	Number of Girders	Girder Spacing	Calculated Overhang	Overhang	Roadway	Bridge
21	5	7.250	1.50	1.50	32.00	32.00
22	**Overhang = 20.7% of Girder Spacing**				**8.00**	**ft of Shoulder**
23						
24	**NonComposite Bridge Information**			**Line Girder Dead Loading**		
25	Type of Decking	Concrete (full depth or on SIP)		DC1 Girder Deck (lb/ft)	816.0	
26	DC1 Deck Only Loading (psf)	108.75		DC2 Barrier Load (lb/ft)	150	
27				**DC1 (no stl) + Additional DC1 (lb/ft)**	**816.0**	
28	**Composite Bridge Information**		Check For LLDF (Warning if Violation)	**DC2 + Additional DC2 (lb/ft)**	**150**	
29	Deck f'c (psi)	4000		**DW (lb/ft)**	**160.0**	
30	Structural Deck Thickness (in)	9.75		Add'l DC1 on Bridge (Overhang ,Haunch, Utilities, etc) (lb/ft	0	
31	Sacrificial Concrete Deck (in)	0.25		Max % of Additional DC1 on Girder	100%	
32	Haunch from Top of Web (in)	3		DC2 Barrier Load (lb/ft)	300	
33	Stay-in-Place (SIP) Forms?	Yes		Max % on Girder	50%	
34	Weight of SIP (psf)	15		Add'l DC2 on Bridge Utilities, etc) (lb/ft)	0	
35	Depth of SIP (in)	2		Max % Additional DC2 on Girder	100%	
36	Shear Connector Diameter (in)	0.875		Wearing Surface (psf)	25	
37	Shear Connector Fu (ksi)	60		% Misc Stl for Diaphrams, etc	0%	
38	DC1 Deck Only Loading (psf)	127.50				
39				**Construction Loading**		
40	**Fatigue (AASHTO 10th Edition Applied)**			AT END OF OVERHANG FOR LATERAL BENDING	May be 0 for many types of decking	
41	Design Life (yrs)	75		Construction w (lb/ft)	275	
42	Average Daily Truck Traffic Single Lane (AD	200	Fatigue II Controls	Construction p (lb)	3000	
43	If ADTT > 974 Fatigue I Controls			1/2 of Deck Overhang Weight (lb/ft)	95.625	
44						
45	**User Defined Truck? (up to 9 A**	No		ADDITIONAL CONSTRUCTION VERTICAL BENDING ON GIRDER		
46	lst Axle (kips) and Spacing to Next Axle (ft)	12	14	Construction w (lb/ft)	275	
47	nd Axle (kips) and Spacing to Next Axle (ft)	37	4.5	Construction p (lb)	3000	
48	rd Axle (kips) and Spacing to Next Axle (ft)	37	14			
49	th Axle (kips) and Spacing to Next Axle (ft)	37	4.5			
50	th Axle (kips) and Spacing to Next Axle (ft)	37				
51	5thAxle (kips) and Spacing to Next Axle (ft)					
52	'th Axle (kips) and Spacing to Next Axle (ft)					
53	th Axle (kips) and Spacing to Next Axle (ft)					
54	9th Axle (kips)					
55	User Vehicle Live Load Factor	1.35				
56	Apply Lane Load to User Truck?	No				
57	ane or 2 or More Lane Distribution Factor?	Single Lane				
58	hicle Impact Factor for Str I / Serv II Design	1.33				
59						

Blue Cell E3 is for composite or noncomposite design

All green cells are user inputs

- Cells B3-B7 are bridge characteristics
  - B3 Bridge length
  - B4 Roadway width
  - B5 Number of striped lanes
  - B6 Bridge railing/barrier width
  - B7 Estimated overhang width as % of girder spacing (used to determine final spacing and width)
- Cells A1-B1 and D1 are final number of girders, girder spacing and overhang
  - A9-E18 are values to help user with design

A1 Number of girders
B1 Girder spacing
D1 Overhang width

Cells B25-B26 are for noncomposite (ignored if composite)

- B25 Type of noncomposite deck
  - Corrugated Metal Deck (gravel)
  - Concrete (full-depth or on SIP forms)
  - Wood Planked
  - Wood Stressed Laminated
  - Wood Spiked Laminated
  - Wood Glue Laminated
  - Open Steel Grid >= 4 in
  - Open Steel Grid < 4 in
- B26 Weight of decking (psf)

Cells B20-B37 are for composite bridges (ignored if noncomposite)

- B29 Deck f'c (psi)
- B30 Structural Deck Thickness (in)
- B31 Sacrificial Concrete Deck (in)
- B32 Haunch from Top of Web (in)
- B33 Stay-in-Place (SIP) Forms?
- B34 Weight of SIP (psf)
- B35 Depth of SIP (in)
- B36 Shear Connector Diameter (in)
- B37 Shear Connector Fu (ksi)

Cells B41-B42 are fatigue inputs

- C42 determines infinite or finite fatigue life design
- B41 Design life (usually 75 yrs)
- B42 Average Daily Truck Traffic in Single Lane

Cells E30-E37 are Line girder dead loading (Steel shape weight individually considered by the program)

- E30 Additional DC1 on bridge (overhang material, haunch, utilities, etc)
  - E31 % of Additional DC1 on critical girder
- E32 DC2 railing/barrier load
  - E33 % of DC2 railing/barrier load on critical girder
- E34 Additional DC2 on Bridge (utilities, tec)
  - E35 % of Additional DC2 on critical girder
- E36 Future/existing wearing surface load
- E37 % of miscellaneous steel to account for stiffeners and diaphragms

Cells E41-E42 are construction loading at end of overhang

- E41 Uniform loading (formwork, etc)
- E42 Concentrated loading (screed, etc)

Cells B45-B58 and C46-C53 are User Defined loading (Up to 9 axle truck)

- B45 Yes if User Defined Truck is considered (ignored if No)
- B46 & C46 (and following thru B54) is axles loading and distance to next axle
- B55 LRFD Live Load Factor applied to User Truck (Strength I/II)
- B56 Yes if applying AASHTO Lane Load in addition to User Truck (ignored if No)
- B57 Use Single Lane or Multiple Lane Live Load Distribution Factors
- B58 Dynamic Allowance (Impact) factor applied to User Truck

Design Characteristics

	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Yield Strength (ksi)	50					Bridge Width (ft)	32						
2						Target D = 36 in	Roadway Width (ft)	32						
3	Bridge Length (ft)	75		Target L/D	25	Trial D's for Design	Shoulders (ft each side)	4	Double for One-Sided Shoulder					
4						D= 34, 36, 38, 40, 42 in	2 Striped Lanes and 2 Design Lanes							
5	Girder Spacing (ft)	7.25	For Diaphragms	Min Depth (in)	12									
6			For Approach/Clearance	Max Depth (in)	60	L/D =15	ANYTIME A VALUE IS CHANGED IN THE YELLOW, HIT RUN DESIGN FOR UPDATED RESULTS							
7	Number of Girders	5					Run Design							
8				x for Deflection Limit in L/x	800									
9	Overhang (20.7% of Girder Spacing) (ft)	1.50		(If Deflections not Considered enter Low Number)										
10							Lightest 10 Sections (see to the right for additional Information)							
11	Barrier Width (ft)	0		Is Compression Flange Fully Braced For Construction?	No		Str I, Serv II, Constr	Fatigue	Deflection	L/D	Defl	Mn/My	Weight (tons)	
12				Is Compression Flange Fully Braced For Final State?	Yes		TF:12 x 0.75 Web:38 x 0.5 BF:13 x 0.75	OK	OK	23.7	L/1377	2.00	24.1	
13	Diaphragm Bracing Locations in Span (ft)						TF:12 x 0.75 Web:40 x 0.5 BF:12 x 0.75	OK	OK	22.5	L/1461	1.96	24.2	
14	Enter Support Bracing at End of Span (ft)			Maximum Accepted Performmance Ratio	1.00		TF:13 x 0.75 Web:36 x 0.5 BF:14 x 0.75	OK	OK	25.0	L/1292	1.94	24.4	
15	Distance from End to 1ST Brace (ft) = 0	0					TF:13 x 0.75 Web:36 x 0.5 BF:14 x 0.75	OK	OK	25.0	L/1292	1.94	24.4	
16	Distance from End to 2nd Brace (ft)	18.75		Override Calculated Lateral Distribution Factors?	No		TF:12 x 0.75 Web:38 x 0.5 BF:14 x 0.75	OK	OK	23.7	L/1425	2.03	24.6	
17	Distance from End to 3rd Brace (ft)	37.5		Single Lane Moment			TF:13 x 0.75 Web:38 x 0.5 BF:13 x 0.75	OK	OK	23.7	L/1377	1.90	24.6	
18	Distance from End to 4th Brace (ft)	56.25		Two Lane Moment			TF:13 x 0.75 Web:34 x 0.5 BF:16 x 0.75	OK	OK	26.5	L/1247	2.02	24.7	
19	Distance from End to 5th Brace (ft)	75		Fatigue Moment			TF:12 x 0.75 Web:40 x 0.5 BF:13 x 0.75	OK	OK	22.5	L/1513	1.99	24.7	
20	Distance from End to 6th Brace (ft)			Single Lane Shear			TF:13 x 0.75 Web:36 x 0.5 BF:15 x 0.75	OK	OK	25.0	L/1336	1.98	24.9	
21	Distance from End to 7th Brace (ft)			Two Lane Shear			TF:14 x 0.75 Web:36 x 0.5 BF:14 x 0.75	OK	OK	25.0	L/1293	1.85	24.9	
22	Distance from End to 8th Brace (ft)													
23								If No Section is Shown that Meets all the Criteria, See Sections to the Right						
24	Use AASHTO Appendix A.6 for Strength?	Yes						If No Sections are Shown to the Right, There is No W Section that Meets Design and Criteria						
25	(No Limits Strengths to AASHTO 6.10.8)													
26								If Mn/My is Low (~0.70 is Elastic LTB), Lighter Section Possible with Cross-Frame Changes for Unbraced Lengths						
27	Calculate Cb Factors or Use Cb = 1?	Calc Cb												
28														

Blue Cell L3 is for target span / depth ratio: M4 are the web depths considered for design alternatives

All yellow cells are design characteristics

Cells I1 is grade of rolled shape steel (50, 65 or 70 ksi)

Cells I16-I22 Locations of diaphragms from left end for critical girder (Up to 7 unbraced lengths)

Lateral Torsional Buckling ignored if both L11 and L12 are Yes

I16 Location of first diaphragm from left end (I17-I22 others)

Last Location must be bridge length

Cell I24 is for AASHTO Design Limit State Strengths

If Yes, use AASHTO Appendix A.6 – Inelastic moment capacities

If No, use AASHTO 6.10.8 – Elastic Capacities (Conservative)

Cell I27 defines Cb for Lateral Torsional Buckling

If Calc Cb, the program calculates Cb for every unbraced length (AASHTO 10)

If Cb = 1, Cb = 1 is used for all unbraced lengths (Conservative)

Cells L5-L6 are the minimum and maximum depths for the web depth results

L5 minimum depth (diaphragms)

L6 maximum depth (clearance, approaches)

Cell L8 is the live load deflection limit (i.e., L/800 or L/1000 or other)

Cells L11-L12 are bracing for construction and final state (If No, Lateral Torsional Buckling considered)

L11 if Yes, no Lateral Torsional Buckling considered for the construction loading

L12 if Yes, no Lateral Torsional Buckling considered for the final state loading

Cell L14 is the acceptable Strength I/II, Service II and Construction performance ratio (usually 1.00)

Cells L16-L21 are Live Load Lateral Distribution Factors (If L16 No, program calculated LLDFs)

If L16 Yes, User inputs for LLDFs

L17 Single lane moment LLDF

L18 Two or more lane moment LLDF

L19 Fatigue moment LLDF

L20 Single lane shear LLDF

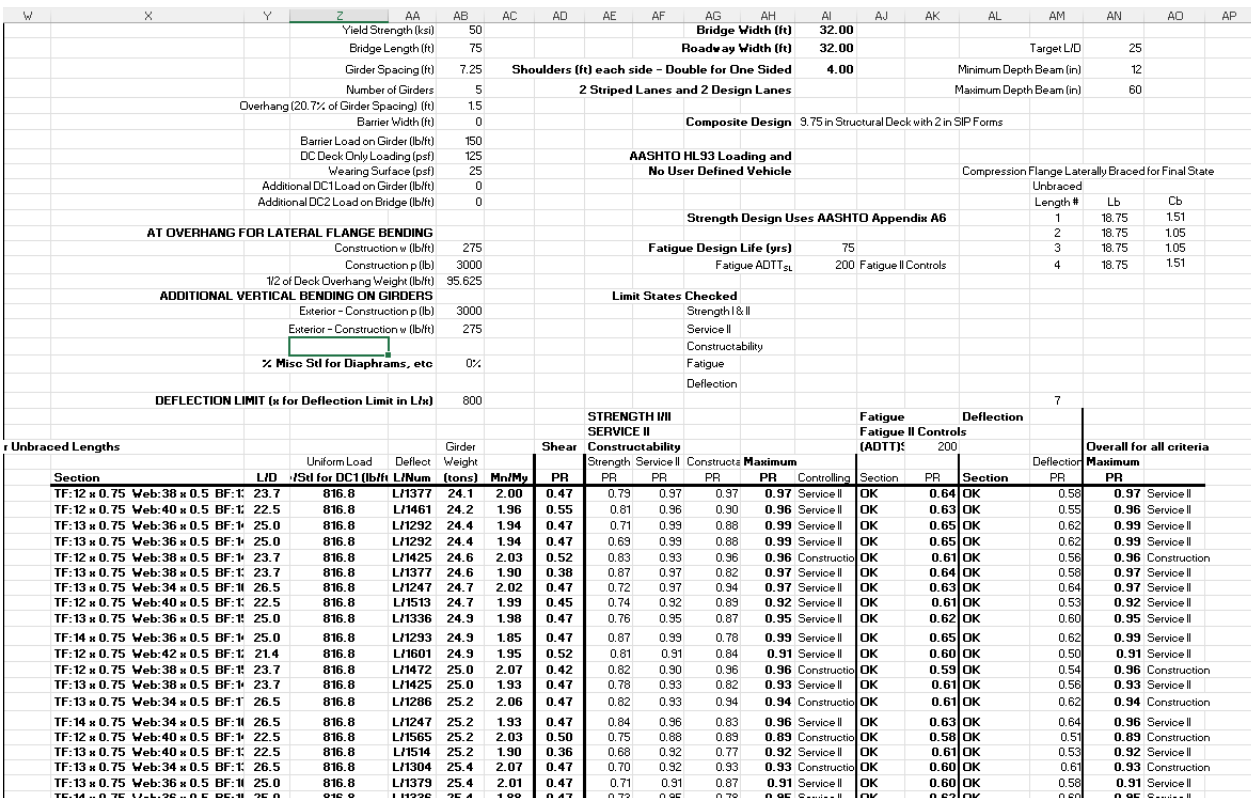
L21 Two or more lane shear LLDF

AFTER ALL INPUTS ENTERED (**OR WHEN ANY INPUT IS CHANGED**), Click “Run Design,” cell N7

Cells N10-T21 shows the lightest 10 Plate Girders that meet the Strength I/II, Service II and Constr limit states.

Lightest 10 Sections (see to the right for additional Information)						
Str I, Serv II, Constr	**Fatigue**	**Deflection**	**L/D**	**Defl**	**Mn/My**	**Weight (tons)**
TF:12 x 0.75 Web:38 x 0.5 BF:13 x 0.75	OK	OK	23.7	L/1377	2.00	24.1
TF:12 x 0.75 Web:40 x 0.5 BF:12 x 0.75	OK	OK	22.5	L/1461	1.96	24.2
TF:13 x 0.75 Web:36 x 0.5 BF:14 x 0.75	OK	OK	25.0	L/1292	1.94	24.4
TF:13 x 0.75 Web:36 x 0.5 BF:14 x 0.75	OK	OK	25.0	L/1292	1.94	24.4
TF:12 x 0.75 Web:38 x 0.5 BF:14 x 0.75	OK	OK	23.7	L/1425	2.03	24.6
TF:13 x 0.75 Web:38 x 0.5 BF:13 x 0.75	OK	OK	23.7	L/1377	1.90	24.6
TF:13 x 0.75 Web:34 x 0.5 BF:16 x 0.75	OK	OK	26.5	L/1247	2.02	24.7
TF:12 x 0.75 Web:40 x 0.5 BF:13 x 0.75	OK	OK	22.5	L/1513	1.99	24.7
TF:13 x 0.75 Web:36 x 0.5 BF:15 x 0.75	OK	OK	25.0	L/1336	1.98	24.9
TF:14 x 0.75 Web:36 x 0.5 BF:14 x 0.75	OK	OK	25.0	L/1293	1.85	24.9

The table also shows if the Plate Girder Sections meet the Fatigue and Deflection limit states



Yield Strength (ksi)	50
Bridge Length (ft)	75
Girder Spacing (ft)	7.25
Number of Girders	5
Overhang (20.7% of Girder Spacing) (ft)	1.5
Barrier Width (ft)	0
Barrier Load on Girder (lb/ft)	150
DC Deck Only Loading (psf)	125
Wearing Surface (psf)	25
Additional DC1 Load on Girder (lb/ft)	0
Additional DC2 Load on Bridge (lb/ft)	0
AT OVERHANG FOR LATERAL FLANGE BENDING	
Construction w (lb/ft)	275
Construction p (lb)	3000
1/2 of Deck Overhang Weight (lb/ft)	95.625
ADDITIONAL VERTICAL BENDING ON GIRDERS	
Exterior - Construction p (lb)	3000
Exterior - Construction w (lb/ft)	275
% Misc Stl for Diaphrams, etc	0%
DEFLECTION LIMIT (x for Deflection Limit in L/x)	800

Bridge Width (ft)	**32.00**
Roadway Width (ft)	**32.00**
Shoulders (ft) each side - Double for One Sided	**4.00**
2 Striped Lanes and 2 Design Lanes	
Composite Design	9.75 in Structural Deck with 2 in SIP Forms
AASHTO HL93 Loading and No User Defined Vehicle	
Strength Design Uses AASHTO Appendix A6	
Fatigue Design Life (yrs)	75
Fatigue $ADTT_{SL}$	200 Fatigue II Controls

Limit States Checked
Strength I & II
Service II
Constructability
Fatigue
Deflection

Target L/D	25
Minimum Depth Beam (in)	12
Maximum Depth Beam (in)	60

Compression Flange Laterally Braced for Final State

Unbraced Length #	Lb	Cb
1	18.75	1.51
2	18.75	1.05
3	18.75	1.05
4	18.75	1.51

7

r Unbraced Lengths

Section	L/D	Uniform Load /Stl for DC1 (lb/ft	Deflect L/Num	Girder Weight (tons)	Mn/My	Shear PR	STRENGTH I/II SERVICE II Constructability Strength PR	Service II PR	Constructa PR	Maximum PR	Controlling	Fatigue Fatigue II Controls (ADTT)S 200 Section	PR	Deflection Section	Deflection PR	Overall for all criteria Maximum PR	
TF:12 x 0.75 Web:38 x 0.5 BF:1	23.7	816.8	L/1377	24.1	2.00	0.47	0.79	0.97	0.97	0.97	Service II	OK	0.64	OK	0.58	0.97	Service II
TF:12 x 0.75 Web:40 x 0.5 BF:1	22.5	816.8	L/1461	24.2	1.96	0.55	0.81	0.96	0.90	0.96	Service II	OK	0.63	OK	0.55	0.96	Service II
TF:13 x 0.75 Web:36 x 0.5 BF:1	25.0	816.8	L/1292	24.4	1.94	0.47	0.71	0.99	0.88	0.99	Service II	OK	0.65	OK	0.62	0.99	Service II
TF:13 x 0.75 Web:36 x 0.5 BF:1	25.0	816.8	L/1292	24.4	1.94	0.47	0.69	0.99	0.88	0.99	Service II	OK	0.65	OK	0.62	0.99	Service II
TF:12 x 0.75 Web:38 x 0.5 BF:1	23.7	816.8	L/1425	24.6	2.03	0.52	0.83	0.93	0.96	0.96	Constructio	OK	0.61	OK	0.56	0.96	Construction
TF:13 x 0.75 Web:38 x 0.5 BF:1	23.7	816.8	L/1377	24.6	1.90	0.38	0.87	0.97	0.82	0.97	Service II	OK	0.64	OK	0.58	0.97	Service II
TF:13 x 0.75 Web:34 x 0.5 BF:1	26.5	816.8	L/1247	24.7	2.02	0.47	0.72	0.97	0.94	0.97	Service II	OK	0.63	OK	0.64	0.97	Service II
TF:12 x 0.75 Web:40 x 0.5 BF:1	22.5	816.8	L/1513	24.7	1.99	0.45	0.74	0.92	0.89	0.92	Service II	OK	0.61	OK	0.53	0.92	Service II
TF:13 x 0.75 Web:36 x 0.5 BF:1	25.0	816.8	L/1336	24.9	1.98	0.47	0.76	0.95	0.87	0.95	Service II	OK	0.62	OK	0.60	0.95	Service II
TF:14 x 0.75 Web:36 x 0.5 BF:1	25.0	816.8	L/1293	24.9	1.85	0.47	0.87	0.99	0.78	0.99	Service II	OK	0.65	OK	0.62	0.99	Service II
TF:12 x 0.75 Web:42 x 0.5 BF:1	21.4	816.8	L/1601	24.9	1.95	0.52	0.81	0.91	0.84	0.91	Service II	OK	0.60	OK	0.50	0.91	Service II
TF:12 x 0.75 Web:38 x 0.5 BF:1	23.7	816.8	L/1472	25.0	2.07	0.42	0.82	0.90	0.96	0.96	Constructio	OK	0.59	OK	0.54	0.96	Construction
TF:13 x 0.75 Web:38 x 0.5 BF:1	23.7	816.8	L/1425	25.0	1.93	0.47	0.78	0.93	0.82	0.93	Service II	OK	0.61	OK	0.56	0.93	Service II
TF:13 x 0.75 Web:34 x 0.5 BF:1	26.5	816.8	L/1286	25.2	2.06	0.47	0.82	0.93	0.94	0.94	Constructio	OK	0.61	OK	0.62	0.94	Construction
TF:14 x 0.75 Web:34 x 0.5 BF:1	26.5	816.8	L/1247	25.2	1.93	0.47	0.84	0.96	0.83	0.96	Service II	OK	0.63	OK	0.64	0.96	Service II
TF:12 x 0.75 Web:40 x 0.5 BF:1	22.5	816.8	L/1565	25.2	2.03	0.50	0.75	0.88	0.89	0.89	Constructio	OK	0.58	OK	0.51	0.89	Construction
TF:13 x 0.75 Web:40 x 0.5 BF:1	22.5	816.8	L/1514	25.2	1.90	0.36	0.68	0.92	0.77	0.92	Service II	OK	0.61	OK	0.53	0.92	Service II
TF:13 x 0.75 Web:34 x 0.5 BF:1	26.5	816.8	L/1304	25.4	2.07	0.47	0.70	0.92	0.93	0.93	Constructio	OK	0.60	OK	0.61	0.93	Construction
TF:13 x 0.75 Web:36 x 0.5 BF:1	25.0	816.8	L/1379	25.4	2.01	0.47	0.71	0.91	0.87	0.91	Service II	OK	0.60	OK	0.58	0.91	Service II

Columns X – AO show a summary of the design

Cells X29-AO29 and below show a more detailed list of results for the acceptable Plate Girder Sections.

EXCEL SHEET Select A Girder

ENTER SECTION FOR MORE INFORMATION

bfc	tfc	D	tw	bft	tft	Weight (lb/ft)	Total Wt (tons)
12.00	0.750	38.00	0.500	13.00	0.750	128	24.1

bfc>=D/6 OK
bfc/2tfc<=12 OK
D/tw<=150 OK
2Dcp/tw<=lrw OK
Iyc/Iyt>=0.3 OK

OVERALL PERFORMANCE FOR TF:12 x 0.75 Web:38 x 0.5 BF:13 x 0.75

Strength I/II	Service II	Construction	Fatigue	Deflection	Overall
PR	PR	PR	PR	PR	PR
0.870	0.974	0.971	0.640	0.581	0.974
In Lb #	At Centerline	In Lb #	At Critical Brace	At Centerline Equal to	Service II
3		2		L/1377	

Meets Reqrments for A6?
Yes
Construction Uses A6

PERFORMANCE BY UNBRACED LENGTH FOR TF:12 x 0.75 Web:38 x 0.5 BF:13 x 0.75

Compression Flange Laterally Braced for Final State			Strength I/II		
Unbraced Length #	Unbraced Length (ft)	Lb Range	PR	Mn/My	Cb
1	18.75	0 - 18.75 ft	0.669	1.997	1.508
2	18.75	18.75 - 37.5 ft	0.870	1.997	1.052
3	18.75	37.5 - 56.25 ft	0.870	1.997	1.052
4	18.75	56.25 - 75 ft	0.669	1.997	1.508

LIST OF GIRDERS RANKED FROM STRENGTH I, SERVICE II & CONSTRUCTION

Shape	Strength I/II PR	Service II PR	Construction PR	Fatigue PR	Deflection PR	Overall PR	Total Wt (tons)
TF:12 x 0.75 Web:38 x 0.5 BF:13 x 0.75	0.87	0.97	0.97	0.64	0.58	0.97	24.1
TF:12 x 0.75 Web:40 x 0.5 BF:12 x 0.75	0.84	0.96	0.90	0.63	0.55	0.96	24.2
TF:13 x 0.75 Web:36 x 0.5 BF:14 x 0.75	0.90	0.99	0.88	0.65	0.62	0.99	24.4
TF:13 x 0.75 Web:36 x 0.5 BF:14 x 0.75	0.90	0.99	0.88	0.65	0.62	0.99	24.4
TF:12 x 0.75 Web:38 x 0.5 BF:14 x 0.75	0.85	0.93	0.96	0.61	0.56	0.96	24.6
TF:13 x 0.75 Web:38 x 0.5 BF:13 x 0.75	0.87	0.97	0.82	0.64	0.58	0.97	24.6
TF:13 x 0.75 Web:34 x 0.5 BF:16 x 0.75	0.91	0.97	0.94	0.63	0.64	0.97	24.7
TF:12 x 0.75 Web:40 x 0.5 BF:13 x 0.75	0.82	0.92	0.89	0.61	0.53	0.92	24.7
TF:13 x 0.75 Web:36 x 0.5 BF:15 x 0.75	0.88	0.95	0.87	0.62	0.60	0.95	24.9
TF:14 x 0.75 Web:36 x 0.5 BF:14 x 0.75	0.90	0.99	0.78	0.65	0.62	0.99	24.9
TF:12 x 0.75 Web:42 x 0.5 BF:12 x 0.75	0.79	0.91	0.84	0.60	0.50	0.91	24.9
TF:12 x 0.75 Web:38 x 0.5 BF:15 x 0.75	0.83	0.90	0.96	0.59	0.54	0.96	25.0
TF:13 x 0.75 Web:38 x 0.5 BF:14 x 0.75	0.85	0.93	0.82	0.61	0.56	0.93	25.0
TF:13 x 0.75 Web:34 x 0.5 BF:17 x 0.75	0.89	0.93	0.94	0.61	0.62	0.94	25.2
TF:14 x 0.75 Web:34 x 0.5 BF:16 x 0.75	0.92	0.96	0.83	0.63	0.64	0.96	25.2
TF:12 x 0.75 Web:40 x 0.5 BF:14 x 0.75	0.80	0.88	0.89	0.58	0.51	0.89	25.2
TF:13 x 0.75 Web:40 x 0.5 BF:13 x 0.75	0.82	0.92	0.77	0.61	0.53	0.92	25.2
TF:13 x 0.75 Web:34 x 0.5 BF:13 x 1	0.88	0.92	0.93	0.60	0.61	0.93	25.4
TF:13 x 0.75 Web:36 x 0.5 BF:16 x 0.75	0.86	0.91	0.87	0.60	0.58	0.91	25.4
TF:14 x 0.75 Web:36 x 0.5 BF:15 x 0.75	0.88	0.95	0.78	0.62	0.60	0.95	25.4
TF:12 x 0.75 Web:42 x 0.5 BF:13 x 0.75	0.77	0.87	0.83	0.57	0.48	0.87	25.4
TF:12 x 0.75 Web:38 x 0.5 BF:12 x 1	0.80	0.86	0.95	0.56	0.52	0.95	25.5
TF:12 x 0.75 Web:38 x 0.5 BF:16 x 0.75	0.80	0.86	0.95	0.57	0.53	0.95	25.5
TF:13 x 0.75 Web:38 x 0.5 BF:15 x 0.75	0.83	0.89	0.81	0.59	0.54	0.89	25.5

The Select A Girder sheet allows the user to examine the lightest weight (or any Plate Girder Section) for the design

Cell B9-G9 is the selected Plate Girder Section to examine
- The lightest weight
- A section based on availability
- Other sections

Cells B14 - H18 give the overall performance of the selected section
- Strength I/II
- Service II
- Construction
- Fatigue
- Deflection

Starting in Cells B23 – G23, for each unbraced length, the design information is listed
- The user can examine the results to modify and economize the design
  - Change diaphragm spacing if Mn/My is low
  - Change diaphragm spacing if construction controls
  - Change diaphragm location if fatigue controls

EXCEL SHEET Final Design

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		TF:12 x 0.75 Web:38 x 0.5 BF:13 x 0.75	Composite								Minimum Depth Beam	12					
2		Overall PR = 0.974 – Service II	Unstiffened Web					Target L/D	25		Maximum Depth Beam	60	SERVICE II near Centerline				
3		Yield Strength (ksi)	50										DC1 (ft-k)	664.1	Sx=481.3 in^3		
4		Bridge Length (ft)	75				Bridge Width (ft)	32.00					DC2 (ft-k)	105.5	S3n=680.7 in^3		
5		Girder Spacing (ft)	7.25				Roadway Width (ft)	32.00					DW (ft-k)	112.5	S3n=680.7 in^3		
6		Number of Girders	5				Shoulders (ft) each side - Double for One Sided	4.00					HL93 LL+IM (ft-k)	1269.6	Sn=765.7 in^3		
7		Overhang (20.7% of Girder Spacing) (ft)	1.5				2 Striped Lanes and 2 Design Lanes										
8		Barrier Width (ft)	0							Lateral Distribution Factors			Serv II Stress	46.3			
9		Barrier Load on Girder (lb/ft)	150				9.75 in Structural Deck with 2 in SIP Forms				Single Lane/Multi-Lane		Serv II Allow	47.5			
10		DC Deck Only Loading (psf)	125				Deck f'c (psi	4000		Moment LLDF = 0.621 , 0.676			SERVICE II PR	0.974			
11		Wearing Surface (psf)	25				Haunch from Top of Web (in)	3		Fatigue LLDF = 0.517							
12		Additional DC1 Load on Girder (lb/ft)	0				Nominal Girder DC1 (lb/ft)	944.5		Shear LLDF = 0.650 , 0.761			LIVE LOAD DEFLECT		In=28073.1 in^4		
13		Additional DC2 Load on Bridge (lb/ft)	0				Nominal Girder DC2 (lb/ft)	150.0					LL Defl (in)	0.65	L/1377		
14							Nominal Girder DW (lb/ft)	160.0					Allowable (in)	1.125	=L/800		
15		AT OVERHANG FOR LATERAL FLANGE BENDING	0										DEFLECTION PR	0.581			
16		Construction w (lb/ft)	275				AASHTO HL93 Loading and										
17		Construction p (lb)	3000				No User Defined Vehicle						FATIGUE Cat C' at Critical Brace				
18		1/2 of Deck Overhang Weight (lb/ft)	95.625										Fat Moment (ft-k) LLF = 0.8	484.2	Sfat=781.7 in^3		
19		ADDITIONAL VERTICAL BENDING ON GIRDERS											Fat Stress (ksi)	5.95			
20		Exterior - Construction p (lb)	3000										Fat Allow (ksi)	9.30			
21		Exterior - Construction w (lb/ft)	275										FATIGUE PR	0.640			
22																	
23		% Misc Stl for Diaphrams, etc	0%										STRENGTH I/II SHEAR at Support				
24													DC1 (k)	35.4			
25		DEFLECTION LIMIT (x for Deflection Limit in L/x)	800										DC2 (k)	5.6			
26													DW (k)	6.0			
27		Fatigue Design Life (yrs)	75					165279.601					HL93 LL+IM (k) LLF = 1.75	82.1			
28		Fatigue ADTTSL	200	Fatigue II Controls													
29													Vu (k)	204.0			
30													Vn (k)	434.3			
31													UnstiffendEAR PR	0.470			
32			STRENGTH I/II		Compression Flange Laterally Braced f			LLF = 1.75									
33				Lb (ft)	DC1 (ft-k)	DC2 (ft-k)	DW (ft-k)	IL93 LL+IM (ft-l		Mu (ft-k)	Cb	Mn (ft-k)	Perf Ratio				
34			1	18.75	498.1	79.10156	84.4	987.3		2575.7	1.51	3852.1	0.669		STRENGTH I/II MAX PR		
35			2	18.75	664.1	105.4688	112.5	1269.4		3352.1	1.05	3852.1	0.870		0.870		
36			3	18.75	664.1	105.4688	112.5	1269.6		3352.5	1.05	3852.1	0.870				
37			4	18.75	498.1	79.10156	84.4	987.1		2575.4	1.51	3852.1	0.669				
38																	
39																	
40																	
41																	
42		Strength Design Uses AASHTO Appendix A6	CONSTRUCTION						<0.60Fy		#N/A						
43				Lb (ft)	Mconstr (ft-k	Mlat (ft-k)	AF	Affl (ksi)	Perf Ratio	fbu+Affl (ksi	Perf Ratio	bu+1/3Affl (k	Fnc (ksi)	Perf Ratio			
44			1	18.75	903.4	12.4	1.23	10.2	0.34	33.6	0.67	26.8	58.7	0.46	CONSTRUCTION MAX PR		
45			2	18.75	1204.5	12.4	2.10	17.3	0.58	48.5	0.97	37.0	43.7	0.85	0.971		
46			3	18.75	1204.5	12.4	2.10	17.3	0.58	48.5	0.97	37.0	43.7	0.85			
47			4	18.75	903.4	12.4	1.23	10.2	0.34	33.6	0.67	26.8	58.7	0.46			
48																	
49																	

The Final Design Sheet presents the design checks for the selected Plate Girder Section in the Select A Girder sheet.

Cells B1 – L28 are the design inputs and design characteristics

Cells M2 – O30 are the Service II, Live Load Deflection, Fatigue and Strength I/II Shear Checks

DC1, DC2, DW, Live Load Factors and HL93 and User Truck Nominal Loading at critical locations
Limit State Demand
Limit State Capacity
Performance Ratios

Cells B32 – O32 and below are the Strength I/II results for each unbraced length

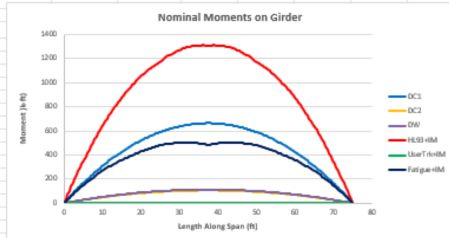
DC1, DC2, DW, Live Load Factors and HL93 and User Truck Nominal Loading within length
Limit State Demand
Limit State Capacity
Performance Ratios

Cells B42 – O42 and below are the Construction results for each unbraced length

DC1, DC2, DW, Live Load Factors and HL93 and User Truck Nominal Loading within length
Limit State Demand
Limit State Capacity
Performance Ratios

	B	C	D	E	F	G	H	I	J	K	L	M	N	O
52	**DEAD LOAD DEFLECTIONS (Max Loaded Girder)**			0	0.10L	0.20L	0.30L	0.40L	0.50L	0.60L	0.70L	0.80L	0.90L	L
53			Distance (ft)	0	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75
54	Ix (in^4) =	9320.2	DC1 (in)	0.000	0.781	1.477	2.023	2.369	2.488	2.369	2.023	1.477	0.781	0.000
55	I3n (in^4) =	19812.4	DC2 (in)	0.000	0.058	0.110	0.151	0.177	0.186	0.177	0.151	0.110	0.058	0.000
56	I3n (in^4) =	28073.1	DW (in)	0.000	0.044	0.083	0.114	0.133	0.140	0.133	0.114	0.083	0.044	0.000
57			Total (in)	0.00	0.88	1.67	2.29	2.68	2.81	2.68	2.29	1.67	0.88	0.00

	B/C	D	E
60	**NOMINAL ABUTMENT REACTIONS**		
61	DC1 (k)	153.1	At Centerline
62	DC2 (k)	22.5	At Centerline
63	DW (k)	30.0	At Centerline
64	Single Lane LL+IM (k)	129.4	At 11.00 From Centerline
65	Two Lane LL+IM (k)	215.7	At 5.00 From Centerline

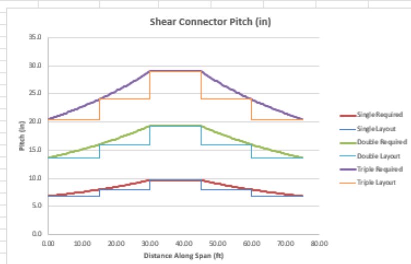


Cells B52 – O57 show the Dc1, Dc2, DW and Total deflections for girder cambers

Cells B60 – O76 show the abutment reactions for the number of design lanes and nominal moments DC1, DC2, DW, HL93, User Truck and Fatigue Truck

	B	C	D	E	F	G	H	I/J	K/L/M/N	O	P
81	ONLY IF COMPOSITE										
82	**0.875 (in) SHEAR STUDE SPACING**		Minimum Spacing (in) 3.5					Maximum Spacing (in) 48	Minimum Transverse Spacing (in) 3.5	d (in)	39.50
83			0 - 15.0 ft	15.0 - 30.0 ft	30.0 - 45.0 ft	45.0 - 60.0 ft	60.0 - 75.0 ft			bf (in) =	12.00
84		Singles Pitch (in)	6.83	8.00	9.66	8.00	6.83				
85		Doubles Pitch (in)	13.65	16.00	19.33	16.00	13.65			Doubles Transverse Spacing OK	
86		Triples Pitch (in)	20.48	24.00	28.99	24.00	20.48			Triples Transverse Spacing OK	
88		Strength Minimum Number of Studs	129								
89		Fatigue Singles Estimated Number of Studs	117.353								
90		Fatigue Doubles Estimated Number of Studs	118.353								
91		Fatigue Triples Estimated Number of Studs	119.353								

	P	Q	R	S
91	0	6.83	13.65	20.48
92	15	6.83	13.65	20.48
93	15	8.00	16.00	24.00
94	30	8.00	16.00	24.00
95	30	9.66	19.33	28.99
96	45	9.66	19.33	28.99
97	45	8.00	16.00	24.00
98	60	8.00	16.00	24.00
99	60	6.83	13.65	20.48
100	75	6.83	13.65	20.48



If the bridge is Composite, Cells B81 – N110 shows an acceptable shear stud layout Singles, doubles and triples across the flange for Strength and Fatigue

Notes on Assumptions and Simplifications in the Program:

Limits on skew apply with the program assuming the bridge is straight.

The largest Interior and Exterior Girder Live Load Distribution Factors are used for Single Lane and Two-or-More Lanes for Moment and Shear. For Fatigue, the largest Single Lane Moment LLDF is dived by 1.2.

For deflection, the deflection is determined by lanes loaded (two through four) divided by number of girders considering multi-presence factors.

If there is SIP decking, the DC1 concrete loading is reduced ½ of the SIP depth

Additional DC1 or DC2 dead loads are assigned a percentage to the critical girder.

The Railing/Barrier loading is assigned a percentage to the critical girder.

The Cb Factors are determined with a Live Load Distribution based on the maximum of the Rigid Rotational Analysis and the Lever Rule. Cb is based on HL93 Loading only for 1.25DC + 1.50DW + 1.75LL+IM (not a User Vehicle).

AASHTO 10th Edition is used for Cb (same as AISC)

For NonComposite Bridges the Live Load Distribution Factor follows AASHTO. However, for a NonComposite Concrete deck, the LLDFs for a Corrugated Metal Deck are used.

For Composite Bridges, the LLDFs are determined for the individual girders according to AASHTO.

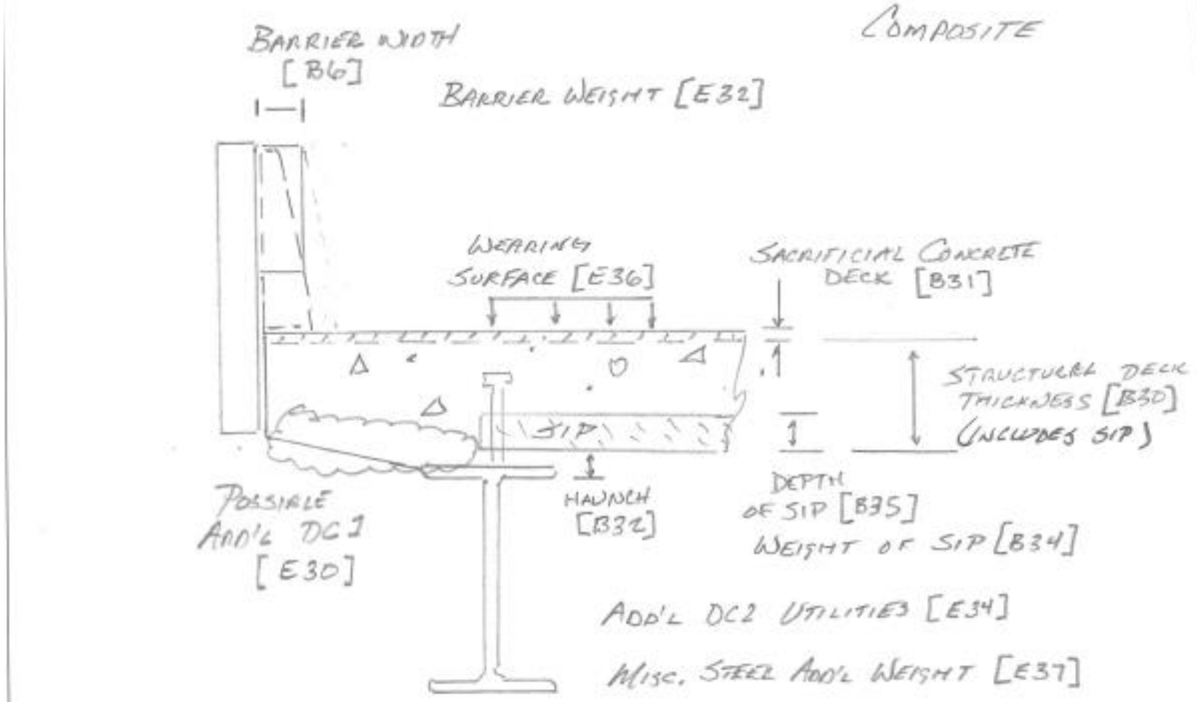
For Composite Bridges, the Effective Width for the deck is ½ the girder spacing plus the Overhang.

1.25DC1 + 1.50 Construction Loading is used for the Construction check. Lateral Flange Bending is determined from a bracket method, fixed between the Lateral Bracing withing the Unbraced length. Additional Vertical Bending in the girder is also considered from the Construction Loading.

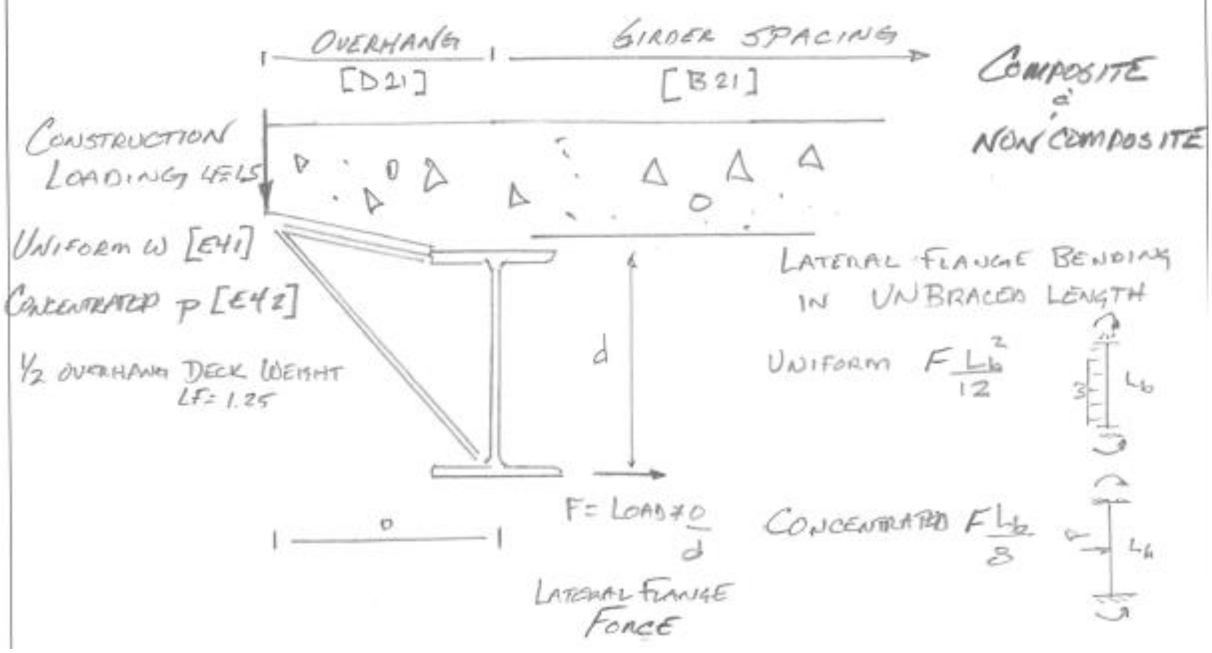
Fatigue Stresses are checked at the critical Stiffener Location. The stress is calculated at the top of the bottom flange. Number of fatigue cycles per truck passage n = 1 (AASHTO 10th Ed).

AASHTO 10th Edition used for shear stud fatigue and strength design.

For flexural capacities, $L_p = 1.1r_t\text{sqrt}(E/Fy)$ as per AASHTO 10th Edition.



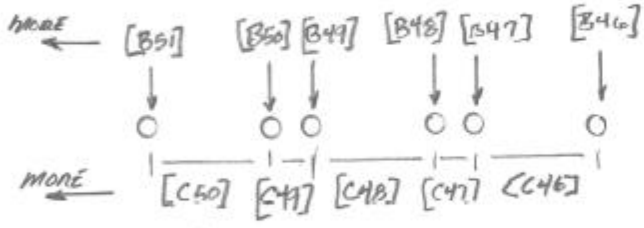
COMPOSITE
BARRIER WIDTH [B6]
BARRIER WEIGHT [E32]
WEARING SURFACE [E36]
SACRIFICIAL CONCRETE DECK [B31]
STRUCTURAL DECK THICKNESS [B30] (INCLUDES SIP)
SIP
POSSIBLE ADD'L DC 1 [E30]
HAUNCH [B32]
DEPTH OF SIP [B35]
WEIGHT OF SIP [B34]
ADD'L DC2 UTILITIES [E34]
MISC. STEEL ADD'L WEIGHT [E37]



OVERHANG [D21]
GIRDER SPACING [B21]
COMPOSITE & NON COMPOSITE
CONSTRUCTION LOADING 4ELS
UNIFORM w [E41]
CONCENTRATED P [E42]
1/2 OVERHANG DECK WEIGHT LF= 1.25
d
LATERAL FLANGE BENDING IN UNBRACED LENGTH
UNIFORM $F\frac{L_b^2}{12}$
L_b
CONCENTRATED $F\frac{L_b}{8}$
L_b
F= LOAD*$\frac{o}{d}$
o
LATERAL FLANGE FORCE

USER DEFINED TRUCK

COMPOSITE & NONCOMPOSITE



LIVE LOAD FACTOR [B55]
STRENGTH I / II

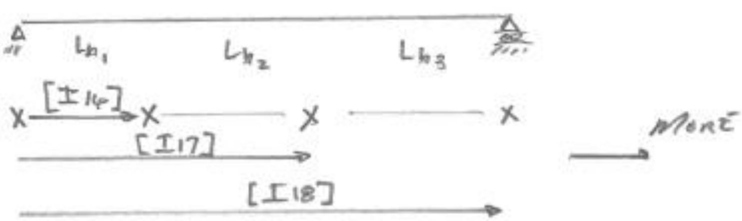
APPLY 640 lb/ft LANE LOAD? [B56]

SINGLE LANE OR 2 OR MORE LANE LATERAL DISTRIBUTION FACTORS? [B57]

DYNAMIC IMPACT FACTOR [B58]

DIAPHRAGM BRACING, UNBRACED LENGTHS & LATERAL TORSIONAL BUCKLING

COMPOSITE & NONCOMPOSITE



COMPRESSION FLANGE FULLY BRACED FOR CONSTRUCTION? [L11]

COMPRESSION FLANGE FULLY BRACE FOR FINAL STATE? [L12]

ePLATE140 Variables for Design Optimization

Web: D/tw <= 150 – All tw = 0.5 in

User Selected Target L/D, Plate Girder Designs for Webs of:

Target L/D – 2”

Target L/D

Target L/D + 2”

Target L/D + 4”

Target L/D + 6””

Over 5100 possible design combinations for 5 different Web Depths.

Flanges: 0.1 <= Iyc/Iyt <= 10; bf/2tf <= 12; bf min = 12 in; tf min = 0.75 in

[Appendix A6 Used for Iyc/Iyt >= 0.3, Otherwise 6.10.8 Used for NonComposite]

Top Flange: bf>= D/6;

12 x0.75

12 x 1

12 x 1.25

13 x 0.75

13 x 1

13 x 1.25

14 x 0.75

14 x 1

14 x 1.25

15 x 0.75

15 x 1

15 x 1.25

16 x 0.75

16 x 1

16 x 1.25

17 x 0.75

17 x 1

17 x 1.25

18 x 0.75

18 x 1

18 x 1.25

18 x 1.5

18 x 1.75

19 x 1

19 x 1.25

19 x 1.5

19 x 1.75

19 x 2

20 x 1

20 x 1.25

20 x 1.5

20 x 1.75

20 x 2

21 x 1

21 x 1.25

21 x 1.5

21 x 1.75

21 x 2

22 x 1

22 x 1.25

22 x 1.5

22 x 1.75

22 x 2

Bottom Flange: Area Bottom Flange >= Area Top Flange; bft >= bfc;

12 x0.75

12 x 1

12 x 1.25

13 x 0.75

13 x 1

13 x 1.25

14 x 0.75

14 x 1

14 x 1.25

15 x 0.75

15 x 1

15 x 1.25

16 x 0.75

16 x 1

16 x 1.25

17 x 0.75

17 x 1

17 x 1.25

18 x 0.75

18 x 1

18 x 1.25

18 x 1.5

18 x 1.75

19 x 1

19 x 1.25

19 x 1.5

19 x 1.75

19 x 2

20 x 1

20 x 1.25

20 x 1.5

20 x 1.75

20 x 2

21 x 1

21 x 1.25

21 x 1.5

21 x 1.75

21 x 2

22 x 1

22 x 1.25

22 x 1.5

22 x 1.75

22 x 2

Plate Design Solutions Ranked by Least Weight

User Specified Solution Check