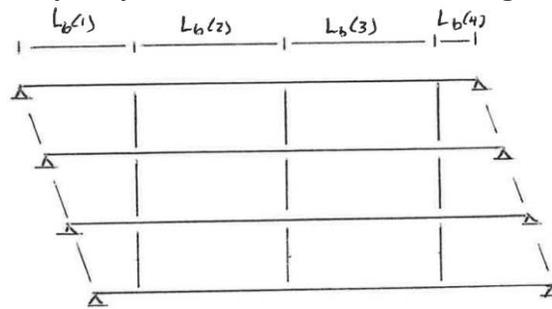


## **Noncomposite and Composite Simple-Span Rolled- Section Steel Bridge Design**

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## Noncomposite and Composite Simple-Span Rolled-Section Steel Bridge Design

AASHTO 10<sup>th</sup> 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 Rolled Section Simple Span Bridges

Use 33, 36, 50, 65 or 70 ksi Steel

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  $F_u$

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

Limit L/D ratio

Minimum Depth (Diaphragms)

Maximum Depth (Approaches/Clearances)

Option to Rule out W40/W44

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  $C_b$  Factors for Each Unbraced Length

Can Use  $C_b = 1$  (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 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 Every W Shape That Meets Specs Over All Unbraced Lengths

Performs Fatigue (Fatigue I or II) Design Analysis at Critical Cross-Frame Location

Performance Ratios

Determines Every W Shape That Meets Specs – and Shows those that do not

Performs Live Load Deflection Design Analysis at Bridge Centerline

Performance Ratios

Determines Every W Shape That Meets Specs – and Shows those that do not

Performs Shear Design Check at Girder End

Performance Ratios

### **Results:**

Ranks from Lightest Weight All W Shapes 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 W Shape to Investigate

Alternatives to Lightest Weight

W Shapes 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 W Shapes 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	G
2	<b>Bridge Layout</b>						
3	Bridge Length (ft)	75		Type of Bridge	NonComposite		
4	Roadway Width (ft)	28					
5	Number Striped Lanes	2	Bridge Width = Roadway Width + 2 * Barrier Width				
6	Barrier Width (ft)	0					
7	Est. Overhang = XX% GS	15%					
8	Number of Girders	Girder Spacing (ft)	Overhang	Roadway Width	Bridge Width		
9	4	8.48	1.27	28.00	28.00		
10	5	6.51	0.98	28.00	28.00		
11	6	5.28	0.79	28.00	28.00		
12	7	4.44	0.67	28.00	28.00		
13	8	3.84	0.58	28.00	28.00		
14	9	3.37	0.51	28.00	28.00		
15	10	3.01	0.45	28.00	28.00		
16	11	2.72	0.41	28.00	28.00		
17	12	2.48	0.37	28.00	28.00		
18	13	2.28	0.34	28.00	28.00		
19	<b>Cross Section Trial</b>						
20	Number of Girders	Girder Spacing	Calculated Overhang	Overhang	Roadway	Bridge	
21	5	6	2.00	2.00	28.00	28.00	
22	Overhang > 25% of Girder Spacing					4.00 ft of Shoulder	
23	<b>NonComposite Bridge Information</b>						
24	Type of Decking	Concrete (full depth or on SIP)		<b>Line Girder Dead Loading</b>			
25	DC1 Deck Only Loading (psf)	123.33		DC1 Girder Deck (lb/ft)		631.0	
26				DC2 Barrier (lb/ft)		20	
27				<b>DC1 (no stl) + Additional DC1 (lb/ft)</b>		<b>631.0</b>	
28	<b>Composite Bridge Information</b>		Check For LLDf (Warning if Violation)	<b>DC2 + Additional DC2 (lb/ft)</b>		<b>45</b>	
29	Deck f'c (psi)	4000		<b>DW (lb/ft)</b>		<b>140.0</b>	
30	Structural Deck Thickness (in)	8		Add'l DC1 on Bridge (Overhang, Haunch, Utilities, etc) (lb/ft)		0	
31	Sacrificial Concrete Deck (in)	0.5		Max % on Additional DC1 on Girder		100%	
32	Haunch from Top of Web (in)	2		DC2 Barrier Load (lb/ft)		40	
33	Stay-in-Place (SIP) Forms?	Yes		Max % on Girder		50%	
34	Weight of SIP (pcf)	15		Add'l DC2 on Bridge Utilities, etc) (lb/ft)		25	
35	Depth of SIP (in)	2		Max % Additional DC2 on Girder		100%	
36	Shear Connector Diameter (in)	0.875		Wearing Surface (pcf)		25	
37	Shear Connector Fu (ksi)	60		% Misc Stl for Diaphragms, etc		5%	
38	DC1 Deck Only Loading (psf)	108.75					
39				<b>Construction Loading</b>			
40	<b>Fatigue (AASHTO 10th Edition Applied)</b>			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 (ADTT)	200	Fatigue II Controls	Construction p (lb)		3000	
43	If ADTT > 374 Fatigue I Controls			1/2 of Deck Overhang Weight (lb/ft)		123.33	
44							
45	<b>User Defined Truck? (up to 9 Axles)</b>	No		<b>ADDITIONAL CONSTRUCTION VERTICAL BENDING ON GIRDER</b>			
46	1st Axle (kips) and Spacing to Next Axle (ft)	12	14	Construction w (lb/ft)		275	
47	2nd Axle (kips) and Spacing to Next Axle (ft)	37	4.5	Construction p (lb)		3000	
48	3rd Axle (kips) and Spacing to Next Axle (ft)	37	14				
49	4th Axle (kips) and Spacing to Next Axle (ft)	37	4.5				
50	5th Axle (kips) and Spacing to Next Axle (ft)	37					
51	6th Axle (kips) and Spacing to Next Axle (ft)						
52	7th Axle (kips) and Spacing to Next Axle (ft)						
53	8th 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?	Yes					
57	Lane or 2 or More Lane Distribution Factor?	Two Lane					
58	Vehicle Impact Factor for Str II Serv II Design	1.33					

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  $\geq$  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  $F_u$  (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

Str I	Serv II	Constr	Fatigue	Deflection	L/D	Defl	M <sub>n</sub> /M <sub>y</sub>	Weight (tons)
W40X215	W40X215	W40X215	23.1	L/819	1.03	40.3		
W44X230	W44X230	W44X230	21.0	L/1020	1.03	43.1		
W36X231	W36X231		24.7	L/765	1.05	43.3		
W33X241	W33X241		26.3	L/696	1.06	45.2		

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 C<sub>b</sub> for Lateral Torsional Buckling

If Calc C<sub>b</sub>, the program calculates C<sub>b</sub> for every unbraced length (AASHTO 10)

If C<sub>b</sub> = 1, C<sub>b</sub> = 1 is used for all unbraced lengths (Conservative)

Cell L1 is whether W 40 and W44 rolled shape beams are considered in the results.

Cell L3 is the Maximum L/D ratio for the rolled beam solution

Cells L5-L6 are the minimum and maximum depths for the rolled shape 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



Columns X – AO show a summary of the design

Cells X29-AO29 and below show a more detailed list of results for the acceptable W shape members.

### EXCEL SHEET Select A Girder

ENTER W SECTION FOR MORE INFORMATION							LIST OF ALL W SHAPES RANKED FROM STRENGTH I, SERVICE II & CONSTRUCTION																																																																																																																																																									
W40X215 NonComposite							Top 20 That Meet Min Depth, Max Depth & W40 & W44 Limits																																																																																																																																																									
<b>OVERALL PERFORMANCE FOR W40X215</b>							<table border="1"> <thead> <tr> <th>Shape</th> <th>Strength I/II</th> <th>Service II</th> <th>Construction</th> <th>Fatigue</th> <th>Deflection</th> <th>Overall</th> </tr> </thead> <tbody> <tr><td>W40X215</td><td>0.98</td><td>0.95</td><td>0.48</td><td>0.73</td><td>0.98</td><td>0.98</td></tr> <tr><td>W44X230</td><td>0.87</td><td>0.85</td><td>0.42</td><td>0.65</td><td>0.78</td><td>0.87</td></tr> <tr><td>W36X231</td><td>0.97</td><td>0.96</td><td>0.47</td><td>0.73</td><td>1.05</td><td>1.05</td></tr> <tr><td>W33X241</td><td>1.00</td><td>0.99</td><td>0.49</td><td>0.74</td><td>1.15</td><td>1.15</td></tr> <tr><td>W36X247</td><td>0.91</td><td>0.90</td><td>0.44</td><td>0.68</td><td>0.98</td><td>0.98</td></tr> <tr><td>W40X249</td><td>0.85</td><td>0.83</td><td>0.41</td><td>0.62</td><td>0.83</td><td>0.85</td></tr> <tr><td>W36X256</td><td>0.97</td><td>0.92</td><td>0.61</td><td>0.68</td><td>0.97</td><td>0.97</td></tr> <tr><td>W30X261</td><td>1.00</td><td>1.00</td><td>0.50</td><td>0.72</td><td>1.25</td><td>1.25</td></tr> <tr><td>W44X262</td><td>0.76</td><td>0.75</td><td>0.36</td><td>0.56</td><td>0.68</td><td>0.76</td></tr> <tr><td>W36X262</td><td>0.85</td><td>0.85</td><td>0.40</td><td>0.64</td><td>0.91</td><td>0.91</td></tr> <tr><td>W33X263</td><td>0.90</td><td>0.90</td><td>0.44</td><td>0.66</td><td>1.03</td><td>1.03</td></tr> <tr><td>W40X264</td><td>0.91</td><td>0.85</td><td>0.60</td><td>0.65</td><td>0.84</td><td>0.91</td></tr> <tr><td>W40X277</td><td>0.76</td><td>0.76</td><td>0.36</td><td>0.56</td><td>0.74</td><td>0.76</td></tr> <tr><td>W40X278</td><td>0.86</td><td>0.82</td><td>0.54</td><td>0.60</td><td>0.80</td><td>0.86</td></tr> <tr><td>W36X282</td><td>0.79</td><td>0.79</td><td>0.37</td><td>0.58</td><td>0.83</td><td>0.83</td></tr> <tr><td>W44X290</td><td>0.68</td><td>0.67</td><td>0.33</td><td>0.50</td><td>0.60</td><td>0.68</td></tr> <tr><td>W33X291</td><td>0.81</td><td>0.82</td><td>0.39</td><td>0.59</td><td>0.92</td><td>0.92</td></tr> <tr><td>W30X292</td><td>0.89</td><td>0.90</td><td>0.44</td><td>0.64</td><td>1.09</td><td>1.09</td></tr> <tr><td>W40X294</td><td>0.80</td><td>0.77</td><td>0.48</td><td>0.56</td><td>0.74</td><td>0.80</td></tr> <tr><td>W40X297</td><td>0.72</td><td>0.72</td><td>0.35</td><td>0.53</td><td>0.70</td><td>0.72</td></tr> </tbody> </table>							Shape	Strength I/II	Service II	Construction	Fatigue	Deflection	Overall	W40X215	0.98	0.95	0.48	0.73	0.98	0.98	W44X230	0.87	0.85	0.42	0.65	0.78	0.87	W36X231	0.97	0.96	0.47	0.73	1.05	1.05	W33X241	1.00	0.99	0.49	0.74	1.15	1.15	W36X247	0.91	0.90	0.44	0.68	0.98	0.98	W40X249	0.85	0.83	0.41	0.62	0.83	0.85	W36X256	0.97	0.92	0.61	0.68	0.97	0.97	W30X261	1.00	1.00	0.50	0.72	1.25	1.25	W44X262	0.76	0.75	0.36	0.56	0.68	0.76	W36X262	0.85	0.85	0.40	0.64	0.91	0.91	W33X263	0.90	0.90	0.44	0.66	1.03	1.03	W40X264	0.91	0.85	0.60	0.65	0.84	0.91	W40X277	0.76	0.76	0.36	0.56	0.74	0.76	W40X278	0.86	0.82	0.54	0.60	0.80	0.86	W36X282	0.79	0.79	0.37	0.58	0.83	0.83	W44X290	0.68	0.67	0.33	0.50	0.60	0.68	W33X291	0.81	0.82	0.39	0.59	0.92	0.92	W30X292	0.89	0.90	0.44	0.64	1.09	1.09	W40X294	0.80	0.77	0.48	0.56	0.74	0.80	W40X297	0.72	0.72	0.35	0.53	0.70	0.72
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The Select A Girder sheet allows the user to examine the lightest weight (or any W shape) for the design

- Cell B9 is the selected W shape 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		<b>W40X215</b>	<b>NonComposite</b>					Consider W40 & W44 Beams? Yes		Minimum Depth Beam W12							
2		<b>Overall PR = 0.980 - Strength I/II</b>						L/D Limited to 30		Maximum Depth Beam W44			<b>SERVICE II near Centerline</b>				
3		Yield Strength (ksi)	50										DC1 (ft-k)	644.6	S <sub>w</sub> =859.0 in <sup>3</sup>		
4		Bridge Length (ft)	75					Bridge Width (ft)	28.00				DC2 (ft-k)	316	S <sub>w</sub> =859.0 in <sup>3</sup>		
5		Girder Spacing (ft)	6					Roadway Width (ft)	28.00				DW (ft-k)	98.4	S <sub>w</sub> =859.0 in <sup>3</sup>		
6		Number of Girders	5			Shoulders (ft) each side - Double for One Sided		2.00					HL93 LL+IM (ft-k) LLF = 1.75	1502.8	S <sub>w</sub> =859.0 in <sup>3</sup>		
7		Overhang (33.3% of Girder Spacing) (ft)	2			2 Striped Lanes and 2 Design Lanes											
8		Barrier Width (ft)	0							Lateral Distribution Factors		Service II Stress	38.1				
9		Barrier Load on Girder (lb/ft)	20			Deck is Open Steel Grid < 4 in				Single Lane/Multi-Lane		Service II Allow	40.0				
10		DC Deck Only Loading (psf)	123.39							Moment LLDF = 0.800, 0.750		<b>SERVICE II PR</b>	<b>0.953</b>				
11		Wearing Surface (psf)	25							Fatigue LLDF = 0.667							
12		Additional DC1 Load on Girder (lb/ft)	0			Nominal Girder DC1 (lb/ft)	316.7			Shear LLDF = 0.600, 0.667			<b>LIVE LOAD DEFLECTION</b>	LL Defl (in) = 16700 in <sup>4</sup>			
13		Additional DC2 Load on Bridge (lb/ft)	25			Nominal Girder DC2 (lb/ft)	45.0						LL Defl (in)	1.10	= L/819		
14						Nominal Girder DW (lb/ft)	140.0						Allowable (in)	1.125	= L/800		
15		<b>AT OVERHANG FOR LATERAL FLANGE BENDING</b>	0										<b>DEFLECTION PR</b>	<b>0.977</b>			
16		Construction w (lb/ft)	275			AASHTO HL93 Loading and											
17		Construction p (lb)	3000			No User Defined Vehicle											
18		1/2 of Deck Overhang Weight (lb/ft)	123.39										<b>FATIGUE Cat C at Critical Brace</b>				
19		<b>ADDITIONAL VERTICAL BENDING ON GIRDERS</b>											Fat Moment (ft-k) LLF = 0.8	647.8	S <sub>fat</sub> =913.6 in <sup>3</sup>		
20		Exterior - Construction p (lb)	3000										Fat Stress (ksi)	6.81			
21		Exterior - Construction w (lb/ft)	275										Fat Allow (ksi)	9.30			
22													<b>FATIGUE PR</b>	<b>0.732</b>			
23		1/4 Misc Stl for Diaphragms, etc	0.05														
24													<b>STRENGTH III SHEAR at Support</b>				
25		<b>DEFLECTION LIMIT (s for Deflection Limit in L/s)</b>	800										DC1 (k)	34.4			
26													DC2 (k)	1.7			
27		Fatigue Design Life (yrs)	75										DW (k)	5.3			
28		Fatigue ADTTSL	200			Fatigue II Controls							HL93 LL+IM (k) LLF = 1.75	71.9			
29																	
30													Vu (k)	178.8			
31													Vn (k)	689.2			
32													<b>STRENGTH PR</b>	<b>0.259</b>			
33		Strength Design Uses AASHTO Appendix A6	<b>RENGTH III</b>					LLF = 1.75									
34			Lb (ft)	DC1 (ft-k)	DC2 (ft-k)	DW (ft-k)	HL93 LL+IM (ft-k)		Mu (ft-k)	Cb	Mn (ft-k)	Perf Ratio					<b>STRENGTH I/II MAX PR</b>
35			1	30	618.8	30.375	94.5	1462.3	3512.2	1.38	3904.0	0.900					<b>0.980</b>
36			2	15	644.6	31.640625	98.4	1502.8	3622.8	1.00	3697.7	0.980					
37			3	30	618.8	30.375	94.5	1462.5	3512.6	1.38	3905.0	0.900					
38																	
39																	
40																	
41																	
42		Strength Design Uses AASHTO Appendix A6	<b>CONSTRUCTION</b>					<0.60F <sub>y</sub>		PpcF <sub>y</sub> =1.12*50							
43			Lb (ft)	Mconstr (ft-k)	Mlat (ft-k)	AF	Affl (ksi)	Perf Ratio	I <sub>bu</sub> +Affl (ksi)	Perf Ratio	I <sub>bu</sub> +1/3Affl (ksi)	Fnc (ksi)	Perf Ratio				
44			1	30	1170.9	36.5	1.2	10.6	0.35	26.9	0.48	19.9	54.5	0.36			<b>CONSTRUCTION MAX PR</b>
45			2	15	1219.7	11.7	1.0	2.8	0.09	19.8	0.35	18.0	51.7	0.35			<b>0.490</b>
46			3	30	1170.9	36.5	1.2	10.6	0.35	26.9	0.48	19.9	54.6	0.36			
47																	

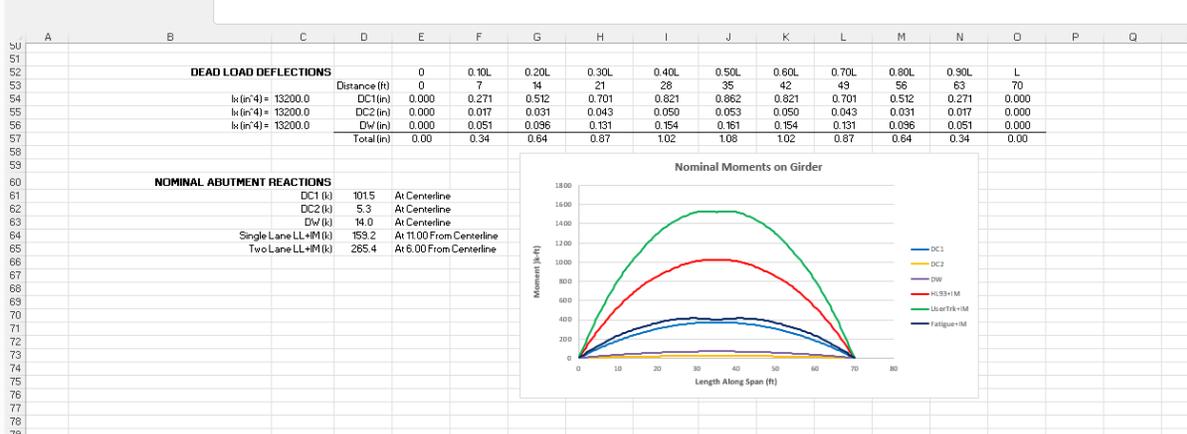
The Final Design Sheet presents the design checks for the selected W shape in the Select A Girder sheet.

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

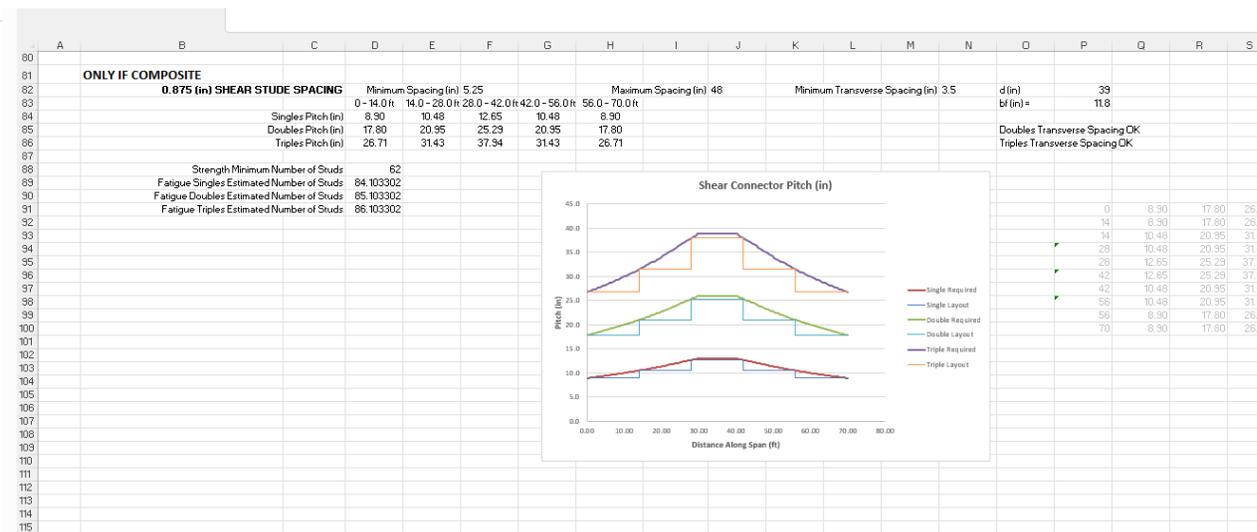
Cells B32 – O32 and below are the Strength I/II results for each unbraced length  
 DC1, DC2, DW, Live Load Factors and HL93 and User Truck Nominal Loading within length  
 Limit State Demand  
 Limit State Capacity  
 Performance Ratios

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



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



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 divided 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  $\frac{1}{2}$  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 10<sup>th</sup> 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.

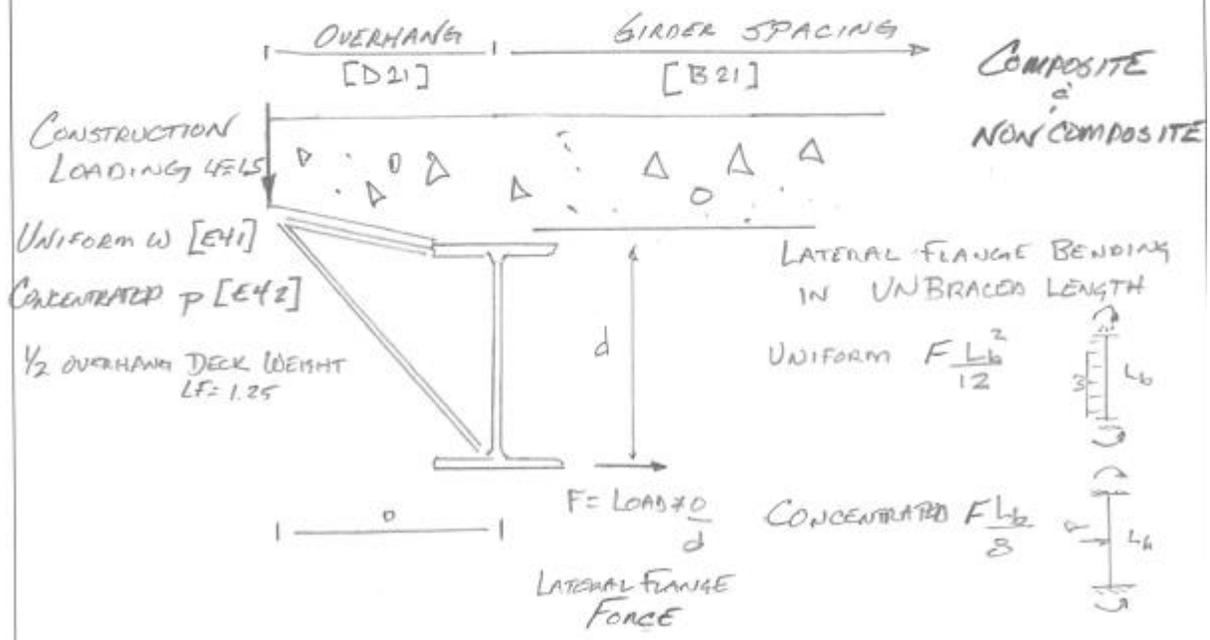
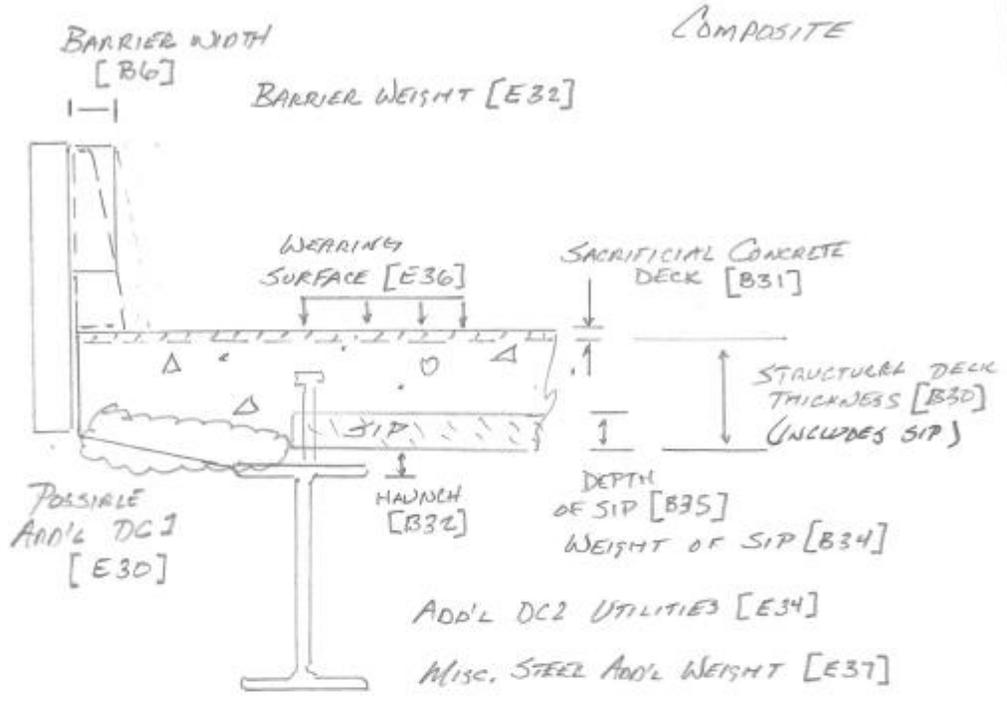
For Composite Bridges, the Effective Width for the deck is  $\frac{1}{2}$  the girder spacing plus the Overhang.

$1.25DC1 + 1.50$  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.

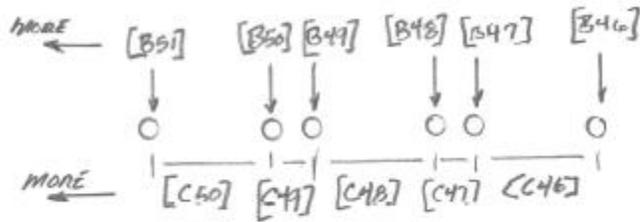
Fatigue Stresses are checked at the critical Stiffener Location. The stress is calculated at the top of the bottom flange. Number of fatigue cycles per truck passage  $n = 1$  (AASHTO 10<sup>th</sup> Ed).

AASHTO 10<sup>th</sup> Edition used for shear stud fatigue and strength design.

For flexural capacities,  $L_p = 1.1r\sqrt{E/F_y}$  as per AASHTO 10<sup>th</sup> Edition.



USER DEFINED TRUCK



COMPOSITE?  
NONCOMPOSITE

LIVE LOAD FACTOR [B55]  
STRENGTH I / II

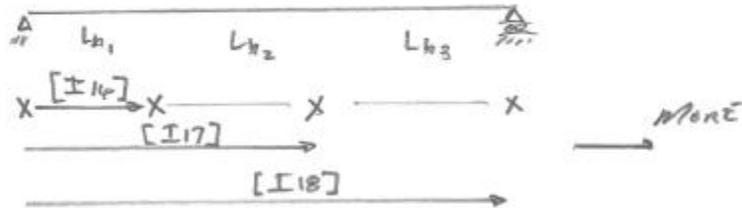
APPLY 640<sup>lb</sup>/ft LANE LOAD? [B56]

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

DYNAMIC IMPACT FACTOR [B58]

DIAHRAGM BRACING, UNBRACED LENGTHS  
; LATERAL TORSIONAL BUCKLING

COMPOSITE?  
NONCOMPOSITE



COMPRESSION FRAME FULLY BRACED FOR CONSTRUCTION? [L11]

COMPRESSION FRAME FULLY BRACE FOR FINAL STATE? [L12]