Development of West Virginia Short Span Steel Bridge Design Standards

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Short Span Steel Bridge Workshop

Outline of Today's Presentation

- Introduction to SSSBA
- The "Problem"
  - Audrain Co, MO Case Study
- eSPAN140 Example Project
- Development of Standard Designs for West Virginia
- Questions & Answers

Introduction

Short Span Steel Bridge Alliance

http://www.shortspansteelbridges.org/

http://www.espan140.com/

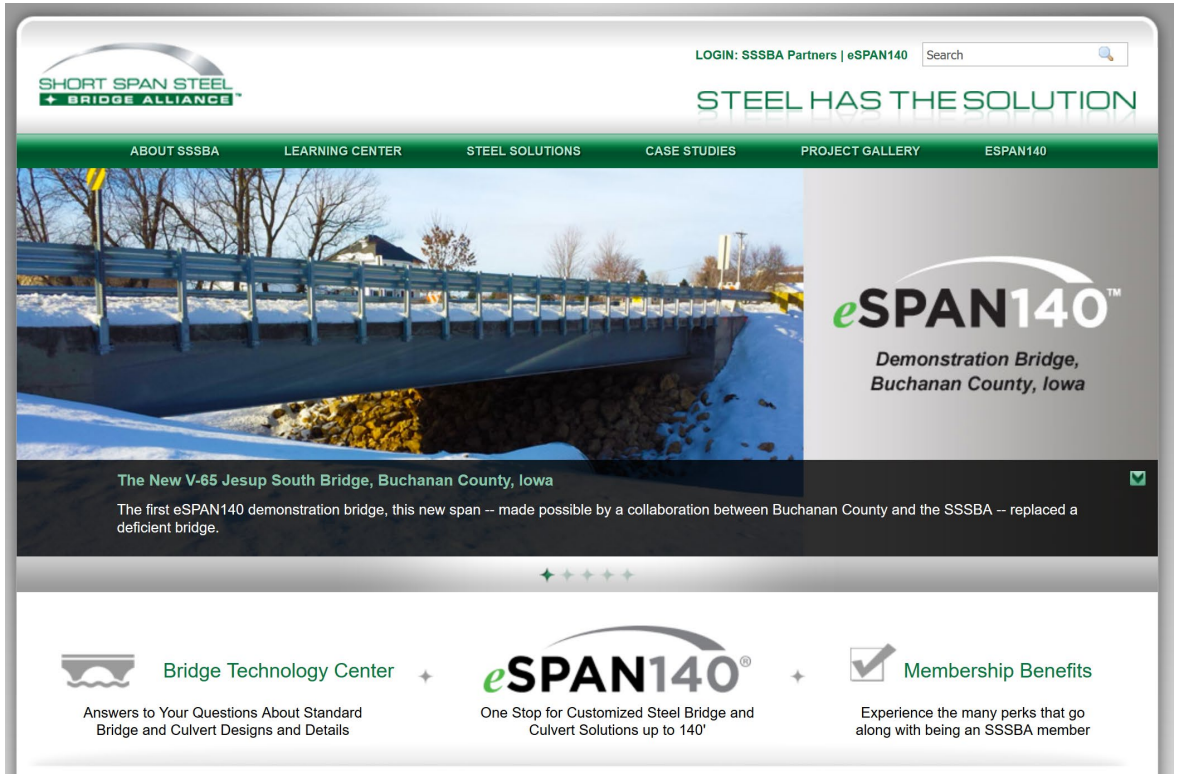
The Short Span Steel Bridge Alliance (SSSBA)

- Program officially started September 2007
  - Objective – make steel the material of choice for short span steel bridges.
  - Short span steel bridges have spans up to 140 ft

SSSBA Website

https://www.shortspansteelbridges.org/

- eSPAN140 Web-based Design Tool
- Bridge Technology Center
- Technical Design Resources
- Project Case Studies
- News Updates & Social Media
  - Twitter
  - LinkedIn
  - Facebook
- Email Newsletter (sign-up to receive it)



Join Today!

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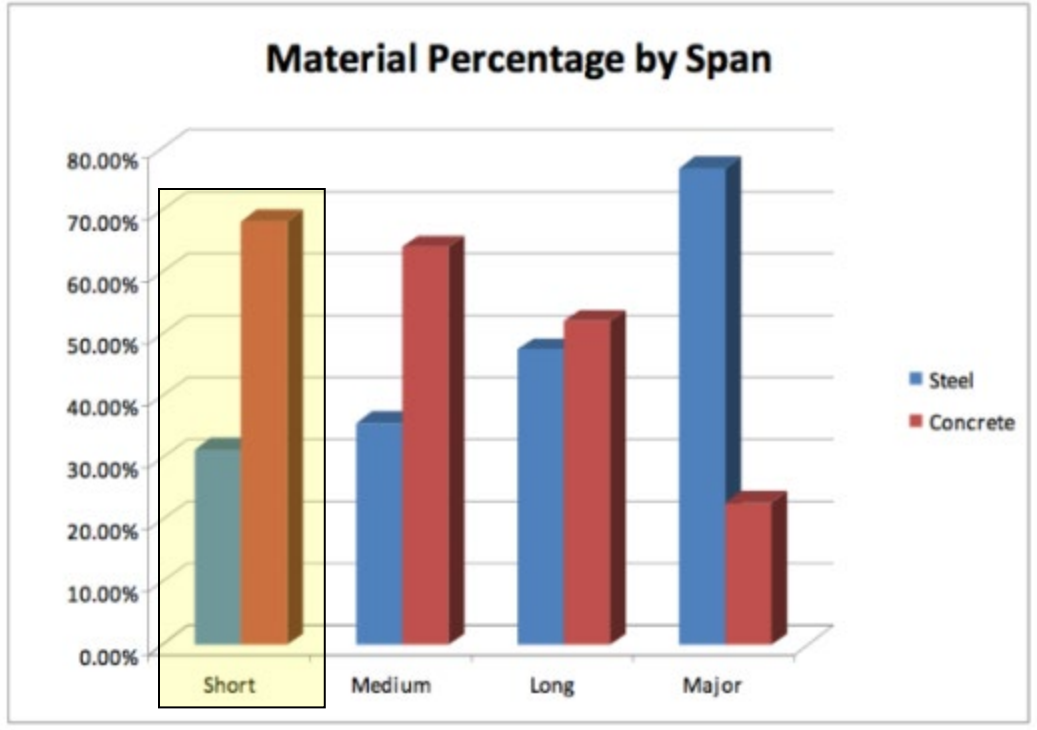
412.580.1492

The Problem

- Bridge engineers are well trained on the use of short span concrete bridges.
  - In fact, over than 80% of the short span bridges in the United States are made of concrete.
- **Many County and (DOT) engineers are simply not educated/familiar with the design, construction, and economics of short span steel bridges.**
  - Concrete provides simple, standardized, cost-effective, “tinker toy” solutions to construct short span steel bridges.
  - **Steel bridges are “perceived to be too” complex, “Swiss watch”-like, and too expensive.**



Case Study Bridges: Audrain County, MO

- Project Location:

Case Study Bridges: Audrain County, MO (cont'd)

- MO Bridge 411
  - Built 2012

  - 4 Steel Girders
  - 47.5 ft Span
  - 24 ft Roadway Width
  - 2 ft Structural Depth + Slab

- MO Bridge 336
  - Built 2012

  - 6 Precast Hollowcore Slabs
  - 50.5 ft Span
  - 24 ft Roadway Width
  - 2 ft Structural Depth + Slab

Case Study Bridges: Audrain County, MO (cont'd)

- Steel:

  - Superstructure total cost of $37.54 per ft^2

25.8% Superstructure Cost Savings

- Concrete:

  - Superstructure total cost of $50.61 per ft^2

Same bridge conditions:

- *Structural Depth = 2 ft + Slab (No Difference in Approaches)*
- *Roadway Width = 24 ft*
- *Same Abutments for Both Can be Used (Steel Could Use Lighter)*
- *Same Guard Rail System*
- *Same Work Crew*

Case Study Bridges: Additional Bridges in MO

Superstructure	Steel						Concrete				
Bridge Number	061	140	149	152	710	AVG	028	057	069	520	AVG
Year Built	2008	2008	2008	2009	2010	AVG	2009	2010	2011	2006	AVG
Span Length	50	50	40	62	64	53.2	36	36	38	40	37.5
Skew	0	0	0	30	35	13	0	15	20	30	16.25
Cost Summary											
- Labor	$14,568	$21,705	$15,853	$24,765	$31,949	$21,768	$12,065	$15,379	$14,674	$19,044	$15,291
- Material	$56,676	$53,593	$46,282	$92,821	$69,357	$63,746	$51,589	$54,450	$50,576	$46,850	$50,866
- Rock	$6,170	$6,216	$3,694	$8,235	$6,501	$6,163	$5,135	$7,549	$5,378	$3,621	$5,421
- Equipment	$7,487	$12,026	$7,017	$19,579	$15,266	$12,275	$5,568	$10,952	$11,093	$14,742	$10,589
- Guardrail	$4,715	$7,146	$3,961	$7,003	$7,003	$5,966	$4,737	$4,663	$5,356	$3,323	$4,520
Construction Cost	$89,616	$100,686	$76,807	$152,403	$130,076	$109,918	$79,094	$92,993	$87,077	$87,580	$86,686
CONST. COST PER FT^2	**$74.68**	**$83.91**	**$80.01**	**$102.42**	**$84.68**	**$86.09**	**$91.54**	**$107.63**	**$95.48**	**$91.23**	**$96.32**

eSPAN140 Example Project

Step-By-Step Process for Obtaining a Steel Solution

One-stop shop for customized steel bridge and culvert solutions!

- eSPAN140 provides:
  - Standard designs and details for short span steel crossings
    - Rolled Beam and Plate Girders
    - Buried Soil Steel Bridge Structures
  - Manufacturers' Steel Solutions (SSSBA Partners)
  - Coatings Solutions
  - Industry Contacts
    - Contacts can provide budget estimates and pricing information

Free and easy to use!!!
https://www.espan140.com/

Step 1.
Create a User's Account

Step 2.
Input Your Specific Project Details

Step 3.
View Your Instant Customized Solutions Books

Standards for Short Span Steel Bridge Designs

- Goals:
  - Economically competitive
  - Expedite & economize the design process
  - Simple repetitive details & member sizes.
- Bridge Design Parameters:
  - Span lengths: 40 feet to 140 feet (5-foot increments)
  - Girder spacing: 6 feet, 7.5 feet, 9 feet and 10.5 feet
  - For each of these increments, the following were designed:
    - Steel girders
    - Shear stud & stiffener layouts
    - Welding and fabrication details
    - Elastomeric bearings
    - Concrete deck design

Primary value is use as an estimating tool!

- Now have the ability to produce a valid steel bridge design in minutes
- Obtain a cost estimate from a fabricator within a day
- Can directly compete with concrete alternate
- Design can then be further optimized

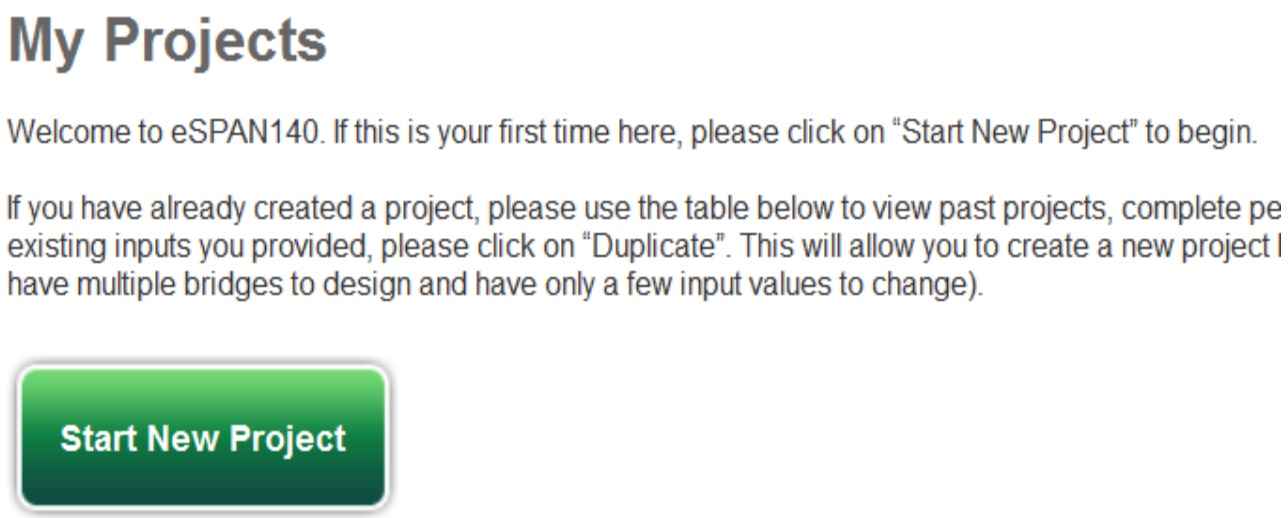
Resulting Economical Standard Selections

- Based on weight comparisons of resulting designs, the following solutions are recommended for the span ranges shown:

Solution Type*	Bridge Span Length	Skew Angle	Overhang Width
	0' 20' 40' 60' 80' 100' 120' 140'		
Rolled Beam (40' to 100')**		+/- 20 degrees	3'3" or less
Homogeneous Plate Girder (60' to 140')**		+/- 20 degrees	3'3" or less
Hybrid Plate Girder (80' to 140')**		+/- 20 degrees	3'3" or less

eSPAN140 Example Project

- Start new project:



eSPAN140 Example Project (cont'd)

- Step 1: Project Information

Project Name*

Sample Bridge

City/County*

Morgantown

State/Province*

West Virginia

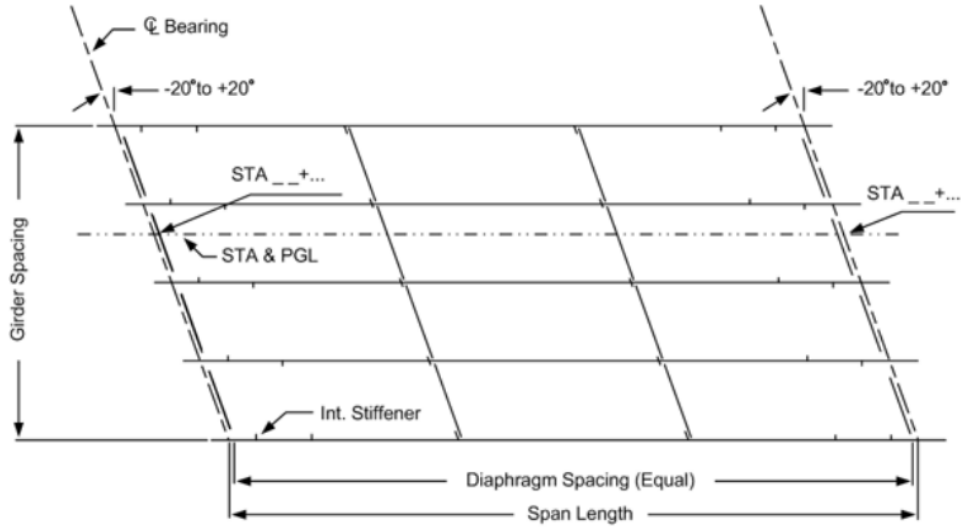
Roadway Name

Main Street

Bridge Span Length*

82 *Feet* 4 *Inches*

Next > Return to Projects



eSPAN140 Example Project (cont'd)

- Step 2: Project Details (general dimensions)

# of Striped Traffic Lanes*

2

Roadway Width*

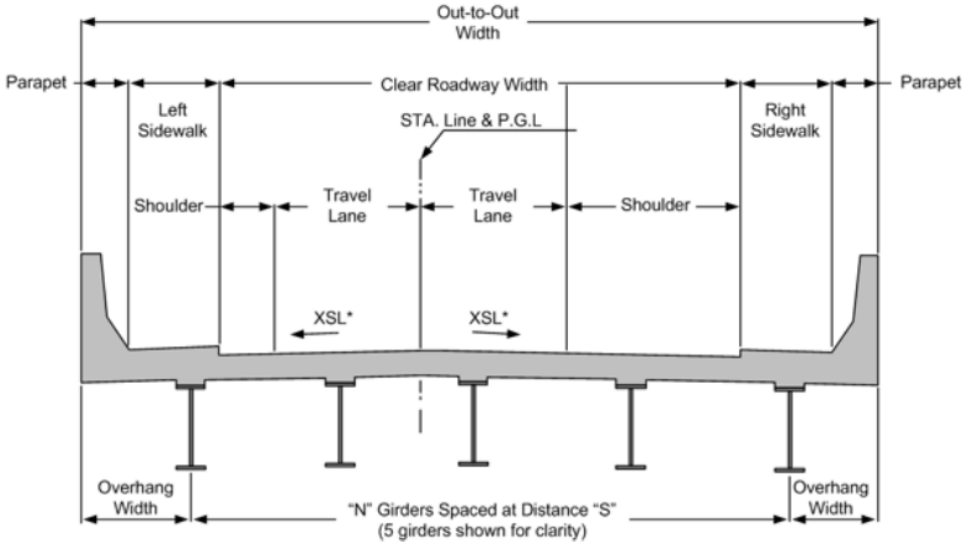
30 Feet 0 Inches

Individual Parapet Width

1 Feet 3 Inches

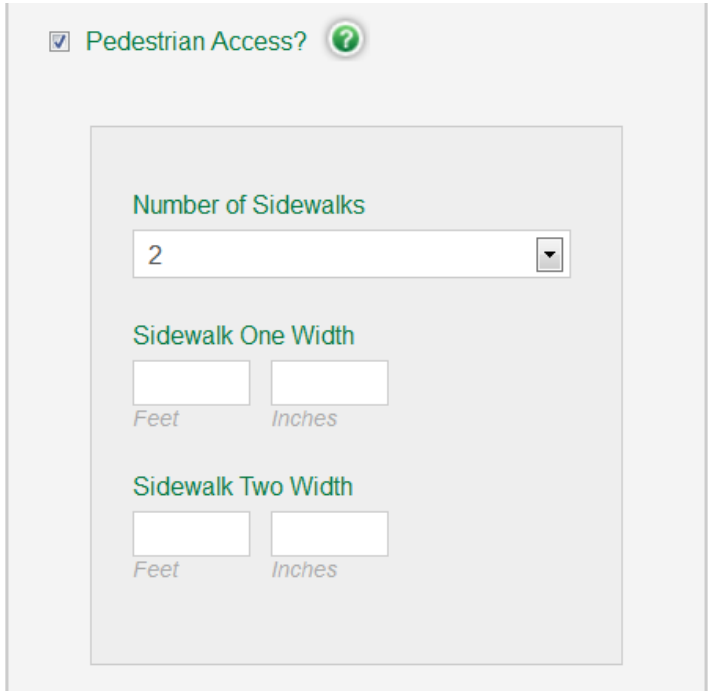
Individual Deck Overhang Width

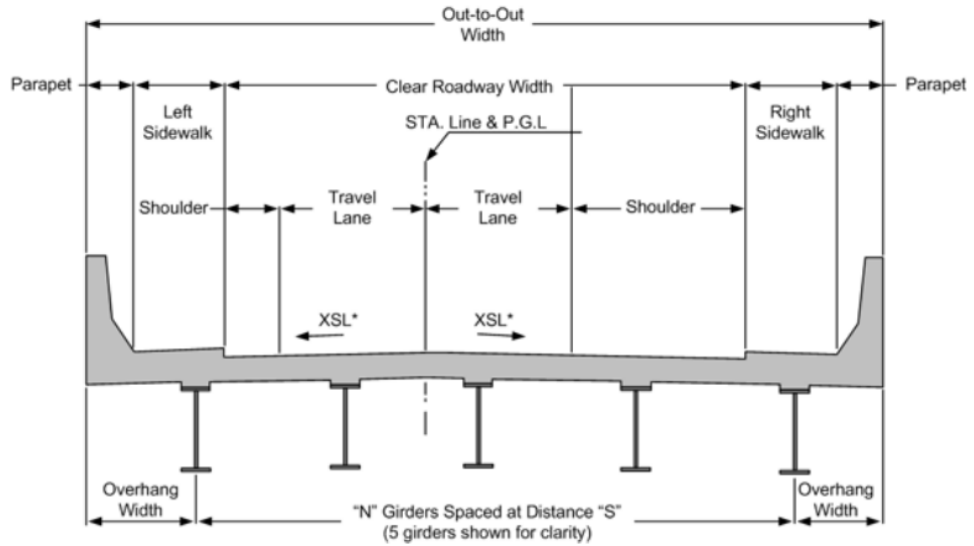
3 Feet 0 Inches



eSPAN140 Example Project (cont'd)

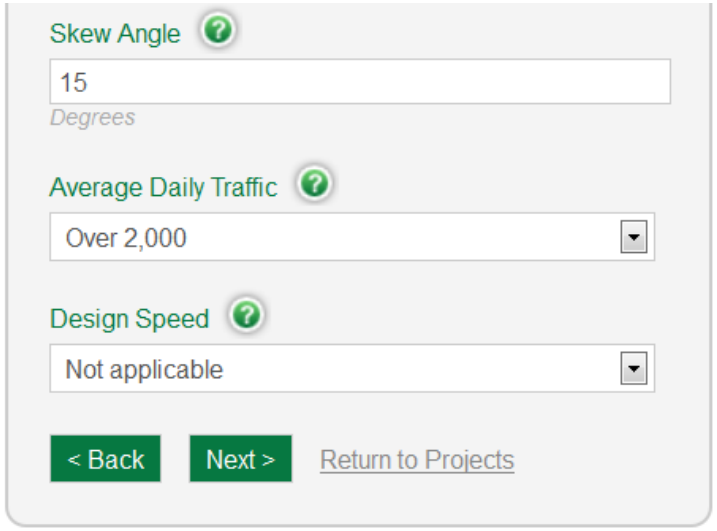
- Step 2: Project Details (pedestrian access option)

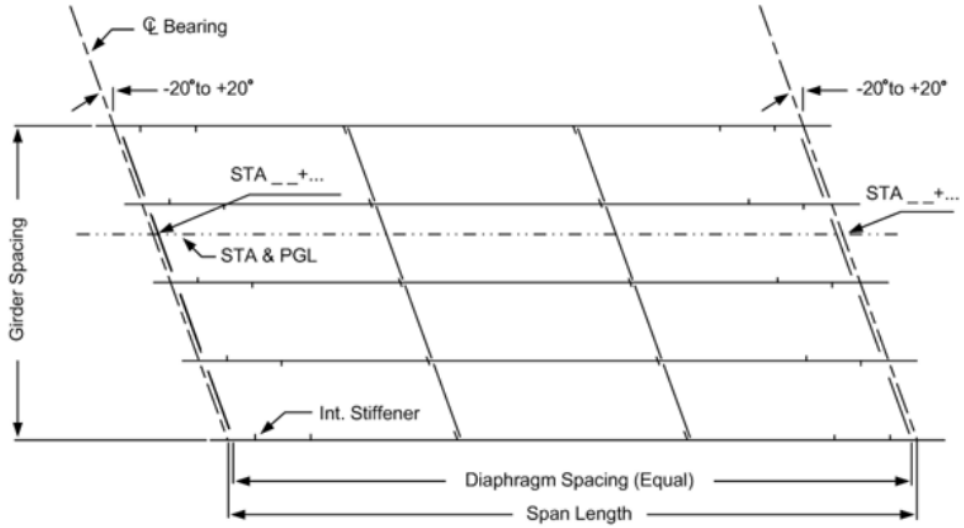




eSPAN140 Example Project (cont'd)

- Step 2: Project Details (remaining details)

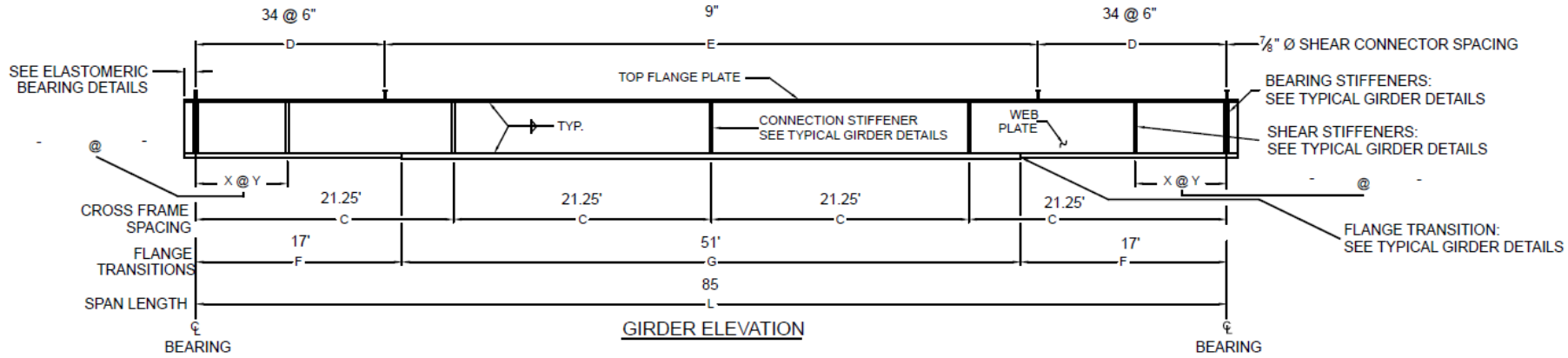




eSPAN140 Example Project (cont'd)

- Example output (sample plate girder elevation):

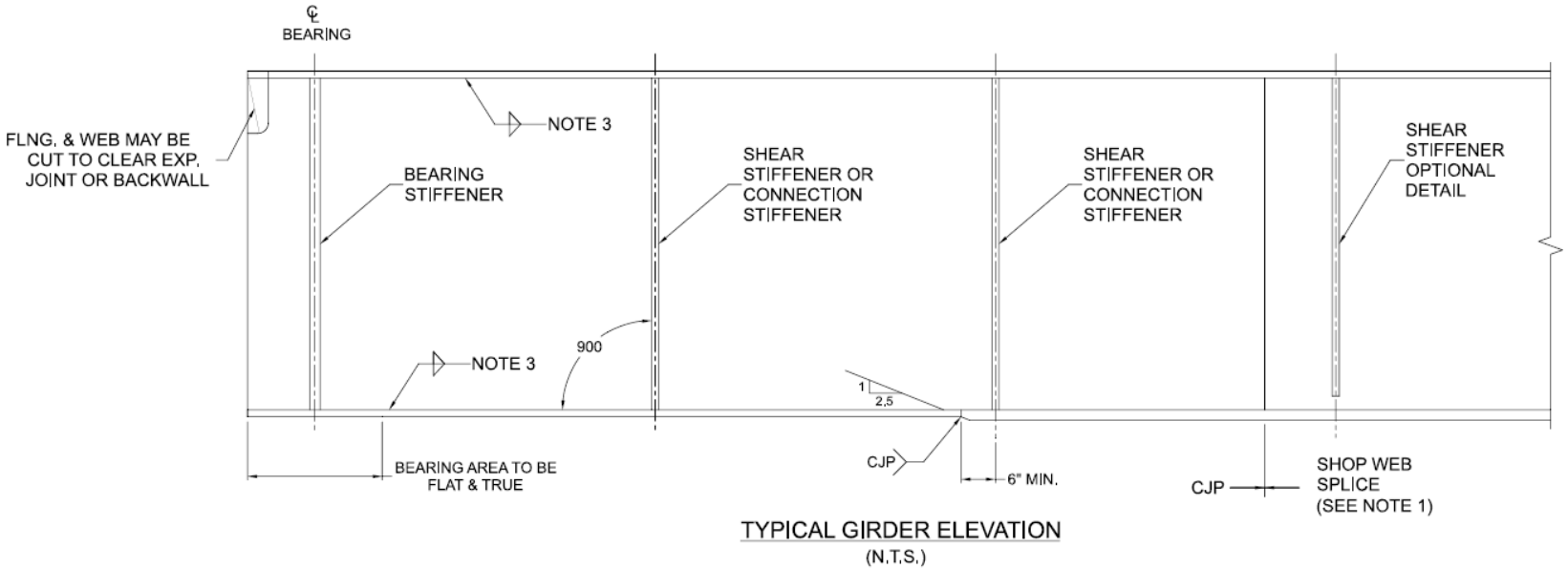
COMPOSITE PLATE GIRDER WITH PARTIALLY STIFFENED WEB - 4 GIRDERS AT 8' 10" GIRDER SPACING, HOMOGENEOUS



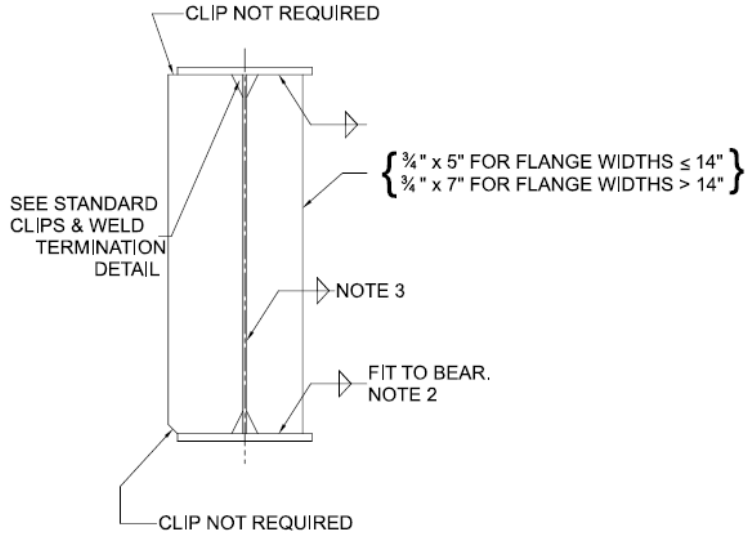
SPAN (L) - ft	PLATE GIRDER SIZE						DIAPHRAGM SPACING (C) - ft	SHEAR STIFFENERS		SHEAR CONNECTOR MAX. SPACING		INDIVIDUAL GIRDER WEIGHT
	TOP FLANGE - in	BOTTOM FLANGE (F)		BOTTOM FLANGE (G)		WEB PLATE- in		X (NO. REQ'd)	Y - ft. (SPACING)	D	E	
		PLATE - in	LENGTH - Ft	PLATE - in	LENGTH - Ft							
85	14 x 3/4"	14 x 1"	17'	14 x 2"	51'	32 x 1/2"	21.25'	-	-	34 @ 6"	9"	14,144 lbs

eSPAN140 Example Project (cont'd)

- Example output (typical fabrication details):



TYPICAL GIRDER ELEVATION
(N.T.S.)

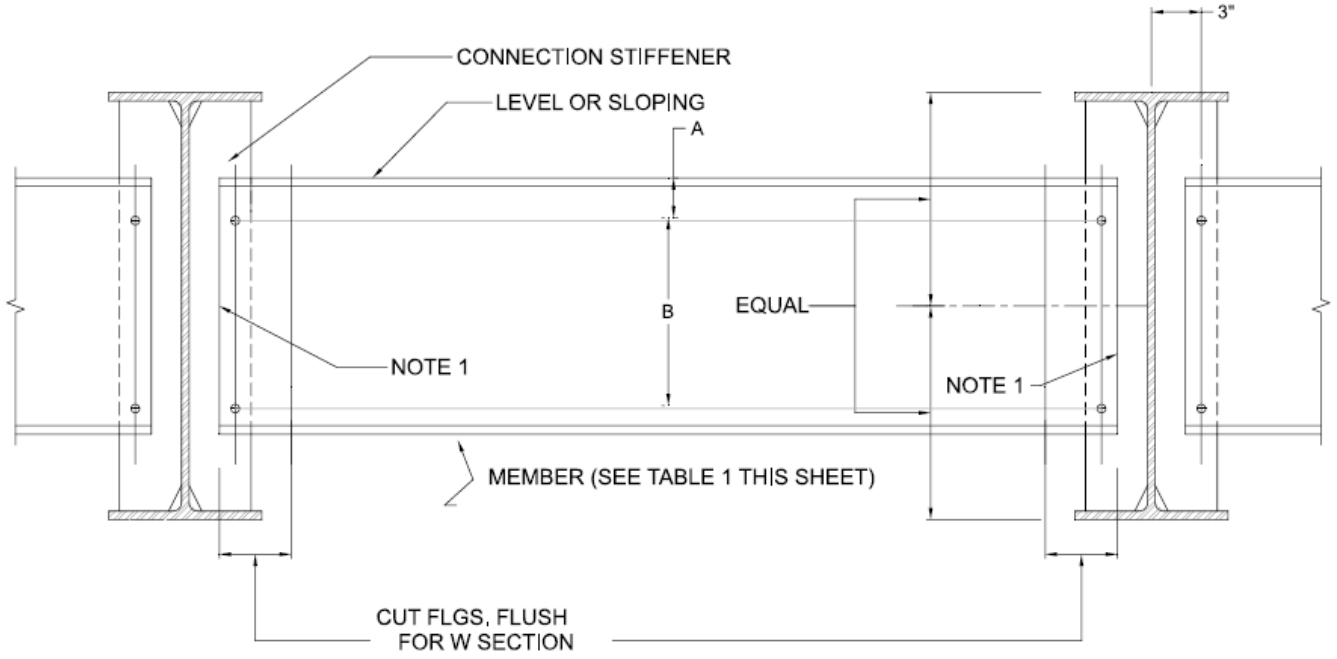


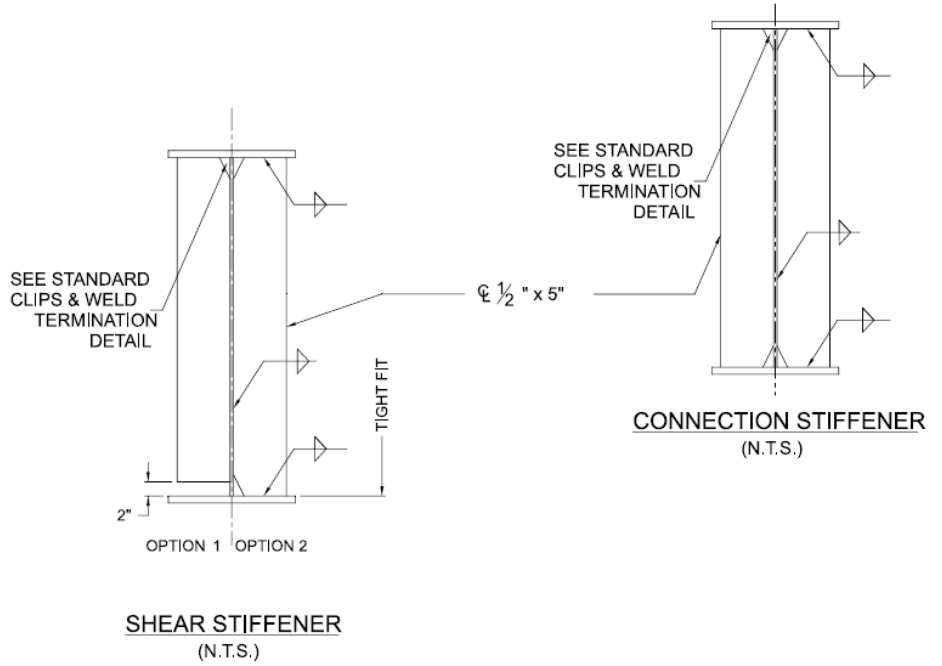
BEARING STIFFENER
(N.T.S.)

BEARING STIFFENER TO FLANGE WELDING IS REQUIRED IF A DIAPHRAGM OR CROSS FRAME IS ATTACHED TO THE STIFFENER

eSPAN140 Example Project (cont'd)

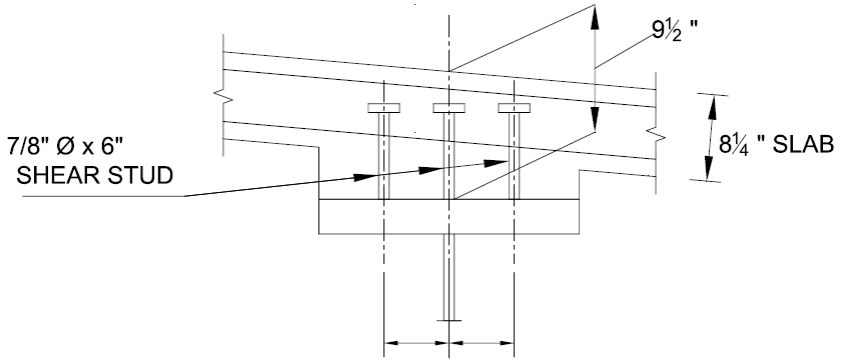
- Example output (typical fabrication details, cont'd):



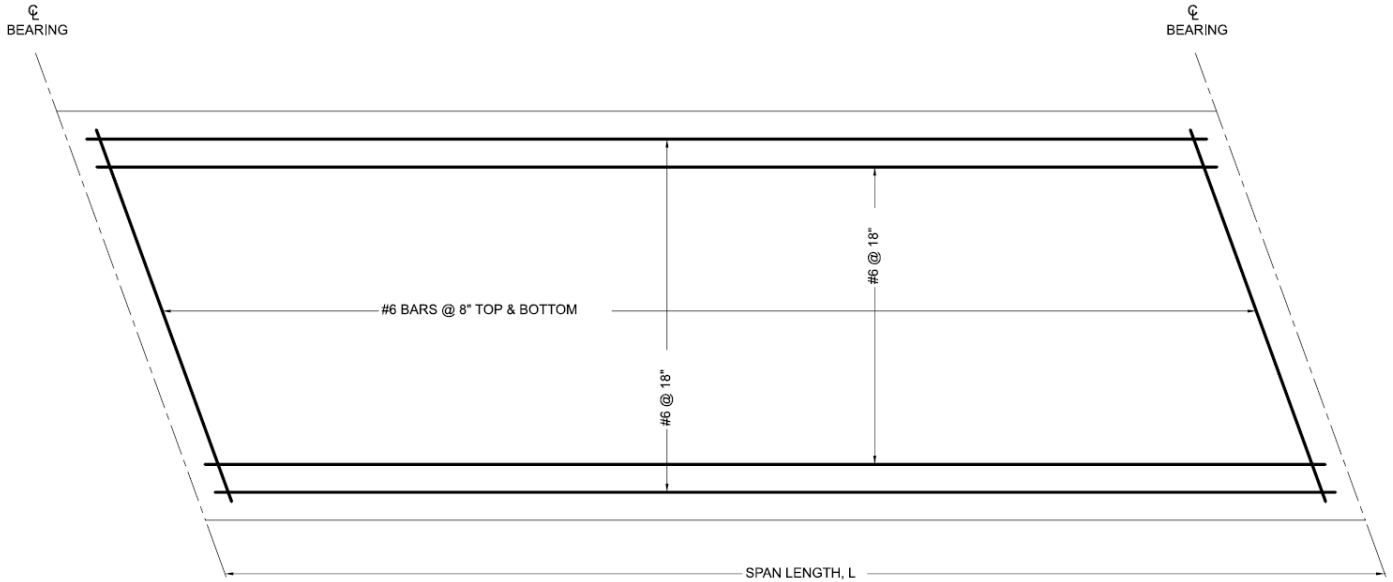


eSPAN140 Example Project (cont'd)

- Typical section & deck details:



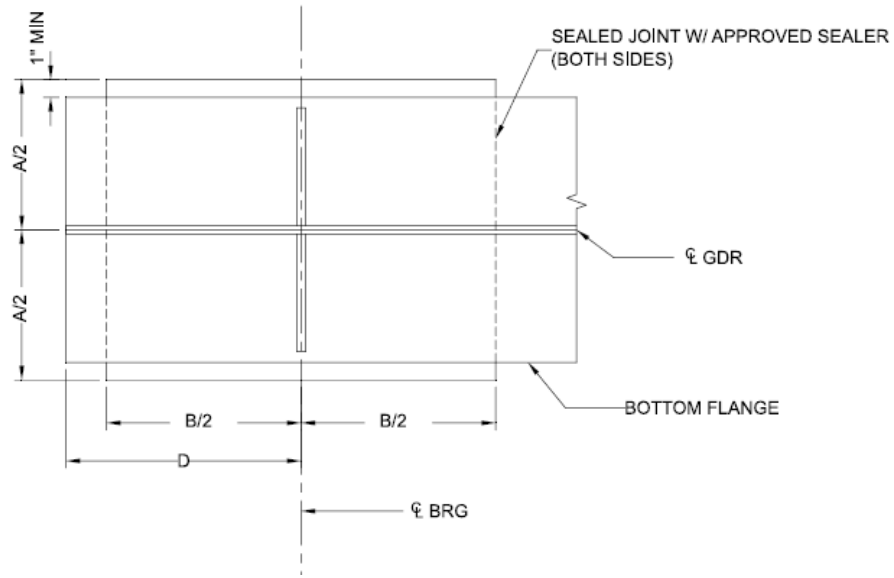
DETAIL A

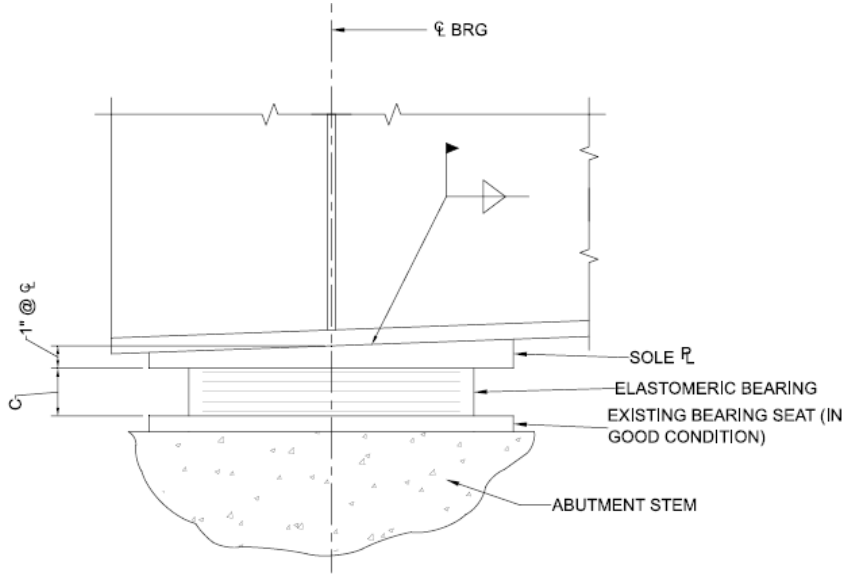


REINFORCING PLAN
(N.T.S.)

eSPAN140 Example Project (cont'd)

- Typical bearing details:



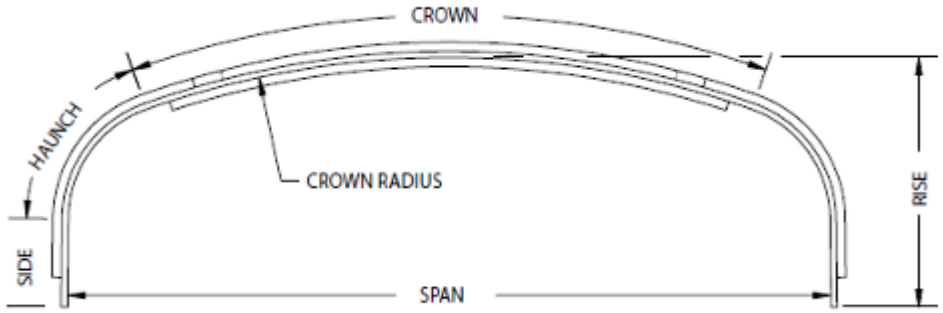


BEARING ELEVATION
OPTION "A"
(N.T.S.)

ELASTOMETRIC BEARING DETAILS - in					
A	B	C	D	INTERNAL ELASTOMER LAYERS	
				NO. OF LAYERS	THICKNESS - in
16"	18"	4.375"	12"	5	0.625"

eSPAN140 Example Project (cont'd)

- Buried Bridge Solutions



eSPAN140 Example Project (cont'd)

- Manufacturer Solutions

eSPAN140 Example Project (cont'd)

- Durability Solutions:
  - Weathering steel
  - Galvanized steel
  - Painted steel

eSPAN140 Applications

- Jesup South Bridge, Buchanan County, Iowa – 1st Direct Application
  - Buchanan County Iowa – Constructed with County Crew
  - Replacement using W36x135 rolled beams
  - 65 feet length, 40 width
  - Over $100,000 donations from members
  - Better Roads (February 2014)

eSPAN140 Applications (cont'd)

- High Point Lane Bridge in Boone County, Missouri , 102 ft.
  - Plate Girder (4 girder lines, 44" deep weathering steel)
  - Designed by Chris Criswell, Bartlett and West
  - Fabricated by Delongs Inc.
  - County "did not know steel could span over 100 feet" – used eSPAN140 for preliminary designs

- KDOT Shawnee Co. Hwy K-4 over Blacksmith Creek, 112 ft.
  - Plate girder – 5 girder lines, weathering steel
  - Designed by Bartlett and West, Fabricated by Delongs Inc.
  - Initially assumed that concrete would be cheaper, but the ability of eSPAN140 to produce a valid design in minutes and obtain a lower cost estimate from the fabricator within a day allowed steel to win the job.

WV Short Span Steel Bridge Design Standards

Goals & Design Parameters

Ohio Short Span Steel Bridge Design Data Sheets

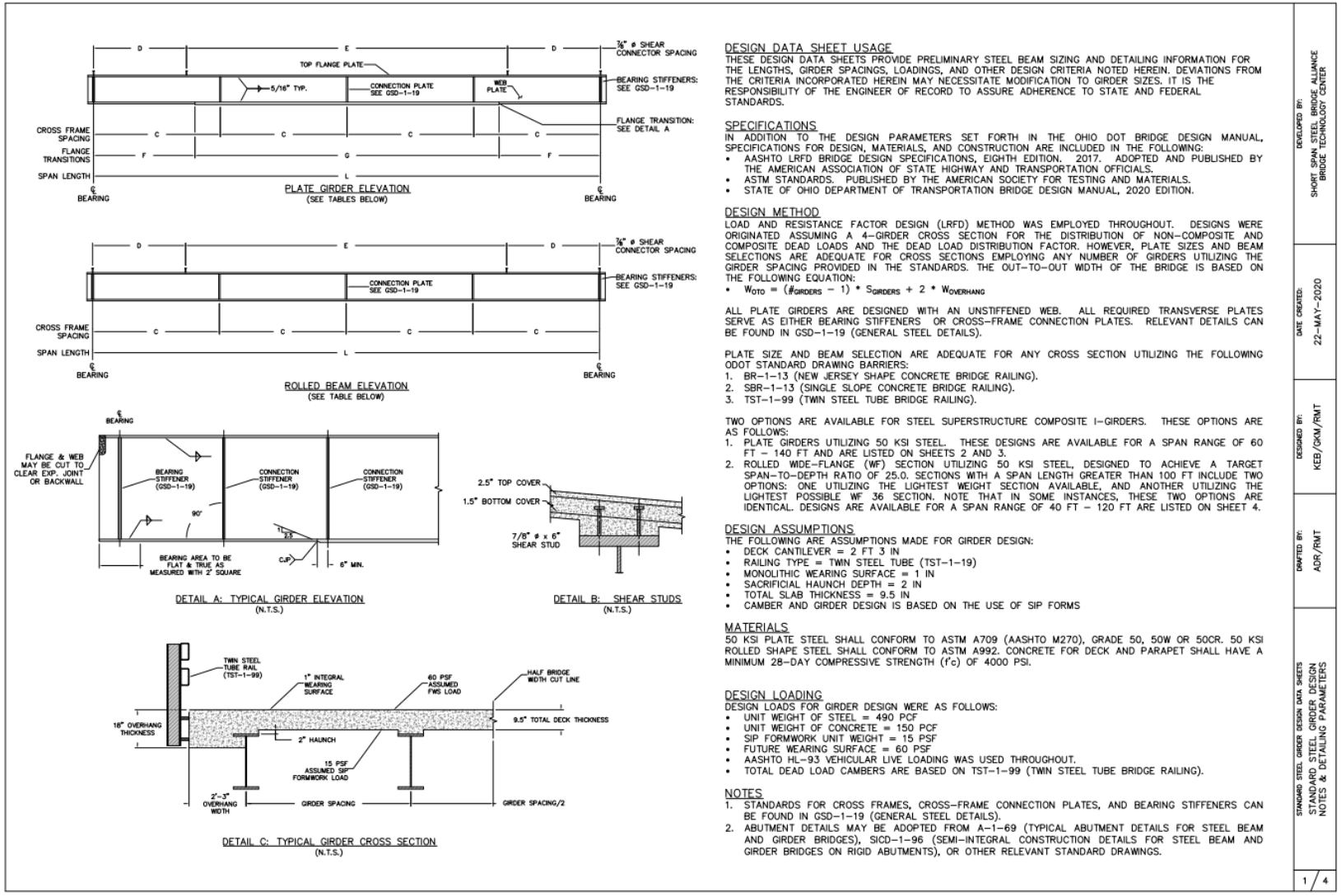
- Considering the success of eSPAN140, the Bridge Technology Center has been engaged in efforts to generate state-specific short span design standards and data sheets.
  - The Short Span Steel Bridge Alliance recently completed development of Ohio-specific short span steel bridge data sheets.

- We are eager to assist other agencies in the development of owner-specific short-span steel bridge standards!

Ohio Short Span Steel Bridge Design Data Sheets

These data sheets contain all relevant details, dimensions and associated notes necessary for design and construction of steel bridges according to Ohio DOT Standards.

Existing ODOT standards are referenced where appropriate.



Ohio Short Span Steel Bridge Design Data Sheets

Both rolled beam and plate girders are available, designed to ODOT standards, and presented according to owner preferences.

DESIGN DETAILS – COMPOSITE ROLLED BEAMS (6' GIRDER SPACING)

SPAN (L) – ft.	ROLLED SECTION	DIAPHRAGM SPACING (C) – ft.	SHEAR CONNECTOR MAX. SPACING		STEEL DEAD LOAD CAMBER – in.					TOTAL DEAD LOAD CAMBER – in.				
			D	E	0.1L	0.2L	0.3L	0.4L	0.5L	0.1L	0.2L	0.3L	0.4L	0.5L
40	W24X104	20.00	–	6	0.021	0.040	0.054	0.064	0.067	0.083	0.156	0.214	0.251	0.263
45	W33X130	22.50	–	9	0.019	0.037	0.050	0.059	0.062	0.073	0.137	0.188	0.220	0.231
50	W27X146	25.00	20 @ 6	9	0.040	0.075	0.102	0.120	0.126	0.137	0.259	0.354	0.415	0.436
55	W36X160	27.50	–	9	0.037	0.069	0.095	0.111	0.116	0.126	0.238	0.326	0.382	0.401
60	W33X130	20.00	24 @ 6	9	0.061	0.116	0.159	0.186	0.195	0.229	0.434	0.594	0.696	0.730
65	W36X150	21.67	14 @ 6	9	0.072	0.137	0.188	0.220	0.231	0.256	0.484	0.663	0.776	0.815
70	W33X169	23.33	28 @ 6	9	0.106	0.201	0.275	0.322	0.338	0.354	0.669	0.916	1.073	1.127
75	W30X191	25.00	46 @ 6	9	0.160	0.303	0.414	0.485	0.509	0.502	0.950	1.301	1.523	1.599
80	W36X194	20.00	32 @ 6	9	0.160	0.303	0.414	0.485	0.509	0.500	0.946	1.295	1.517	1.593
85	W33X221	21.25	34 @ 6	9	0.219	0.414	0.567	0.664	0.698	0.651	1.232	1.687	1.976	2.075
90	W36X231	22.50	18 @ 6	9	0.238	0.450	0.616	0.721	0.757	0.704	1.331	1.823	2.135	2.242
95	W36X262	23.75	20 @ 6	9	0.291	0.551	0.754	0.883	0.927	0.811	1.534	2.100	2.460	2.583
100	W36X282	20.00	20 @ 6	9	0.351	0.663	0.908	1.063	1.117	0.948	1.793	2.455	2.875	3.019
105	W36X302	21.00	22 @ 6	9	0.425	0.804	1.101	1.289	1.354	1.109	2.098	2.873	3.365	3.533
	W44X262	21.00	–	9	0.323	0.611	0.836	0.979	1.028	0.918	1.736	2.377	2.784	2.923
110	W36X330	22.00	–	9	0.505	0.955	1.307	1.531	1.608	1.266	2.395	3.279	3.840	4.032
	W44X290	22.00	–	9	0.384	0.726	0.994	1.164	1.223	1.040	1.968	2.694	3.155	3.313
115	W36X361	23.00	–	9	0.598	1.131	1.549	1.814	1.905	1.439	2.722	3.726	4.364	4.583
	W36X361	23.00	–	9	0.598	1.131	1.549	1.814	1.905	1.439	2.722	3.726	4.364	4.583
120	W36X441	24.00	–	9	0.696	1.317	1.803	2.111	2.217	1.525	2.885	3.950	4.627	4.858
	W36X441	24.00	–	9	0.696	1.317	1.803	2.111	2.217	1.525	2.885	3.950	4.627	4.858

DESIGN DETAILS – COMPOSITE ROLLED BEAMS (7' GIRDER SPACING)

SPAN (L) – ft.	ROLLED SECTION	DIAPHRAGM SPACING (C) – ft.	SHEAR CONNECTOR MAX. SPACING		STEEL DEAD LOAD CAMBER – in.					TOTAL DEAD LOAD CAMBER – in.				
			D	E	0.1L	0.2L	0.3L	0.4L	0.5L	0.1L	0.2L	0.3L	0.4L	0.5L
40	W24X104	20.00	–	6	0.021	0.040	0.054	0.064	0.067	0.088	0.166	0.228	0.267	0.280
45	W33X130	22.50	10 @ 6	9	0.019	0.037	0.050	0.059	0.062	0.077	0.146	0.200	0.234	0.246
50	W27X146	25.00	30 @ 6	9	0.040	0.075	0.102	0.120	0.126	0.145	0.275	0.376	0.440	0.462
55	W27X161	27.50	44 @ 6	9	0.057	0.108	0.148	0.174	0.182	0.200	0.378	0.518	0.607	0.637
60	W36X135	20.00	24 @ 6	9	0.055	0.104	0.142	0.167	0.175	0.214	0.406	0.555	0.650	0.683
65	W36X150	21.67	26 @ 6	9	0.072	0.137	0.188	0.220	0.231	0.272	0.514	0.704	0.824	0.866
70	W36X170	23.33	28 @ 6	9	0.095	0.179	0.245	0.287	0.302	0.336	0.636	0.870	1.019	1.070
75	W33X201	25.00	46 @ 6	9	0.134	0.253	0.346	0.405	0.426	0.442	0.837	1.146	1.342	1.410
80	W36X210	20.00	40 @ 6	9	0.159	0.301	0.412	0.483	0.507	0.505	0.956	1.308	1.532	1.609
85	W36X231	21.25	34 @ 6	9	0.189	0.358	0.490	0.574	0.602	0.592	1.121	1.534	1.797	1.887
90	W36X247	22.50	36 @ 6	9	0.236	0.447	0.611	0.716	0.752	0.717	1.356	1.857	2.175	2.284
95	W36X282	23.75	38 @ 6	9	0.286	0.540	0.740	0.866	0.910	0.815	1.542	2.111	2.473	2.596
100	W36X302	20.00	40 @ 6	9	0.350	0.661	0.905	1.060	1.114	0.963	1.821	2.494	2.920	3.067
105	W36X330	21.00	42 @ 6	9	0.419	0.793	1.085	1.271	1.335	1.108	2.095	2.869	3.360	3.528
	W44X290	21.00	–	9	0.319	0.603	0.825	0.967	1.015	0.912	1.726	2.363	2.768	2.906
110	W36X361	22.00	22 @ 6	9	0.500	0.947	1.296	1.518	1.594	1.268	2.399	3.284	3.846	4.039
	W40X324	22.00	22 @ 6	9	0.452	0.855	1.170	1.370	1.439	1.144	2.289	3.134	3.670	3.854
115	W36X395	23.00	24 @ 6	9	0.590	1.116	1.528	1.790	1.879	1.434	2.712	3.713	4.349	4.567
	W36X395	23.00	24 @ 6	9	0.590	1.116	1.528	1.790	1.879	1.434	2.712	3.713	4.349	4.567
120	W36X441	24.00	24 @ 6	9	0.696	1.317	1.803	2.111	2.217	1.601	3.029	4.147	4.857	5.101
	W36X441	24.00	24 @ 6	9	0.696	1.317	1.803	2.111	2.217	1.601	3.029	4.147	4.857	5.101

DESIGN DETAILS – COMPOSITE ROLLED BEAMS (8' GIRDER SPACING)

SPAN (L) – ft.	ROLLED SECTION	DIAPHRAGM SPACING (C) – ft.	SHEAR CONNECTOR MAX. SPACING		STEEL DEAD LOAD CAMBER – in.					TOTAL DEAD LOAD CAMBER – in.				
			D	E	0.1L	0.2L	0.3L	0.4L	0.5L	0.1L	0.2L	0.3L	0.4L	0.5L
40	W24X117	20.00	–	6	0.021	0.039	0.053	0.063	0.066	0.086	0.163	0.223	0.261	0.274
45	W33X130	22.50	18 @ 6	9	0.019	0.037	0.050	0.059	0.062	0.082	0.154	0.211	0.248	0.260
50	W27X146	25.00	–	6	0.040	0.075	0.102	0.120	0.126	0.153	0.290	0.397	0.465	0.488
55	W27X161	27.50	–	6	0.057	0.108	0.148	0.174	0.182	0.211	0.399	0.546	0.640	0.672
60	W36X150	20.00	36 @ 6	9	0.053	0.100	0.136	0.160	0.168	0.208	0.394	0.540	0.632	0.664
65	W36X160	21.67	40 @ 6	9	0.071	0.135	0.185	0.216	0.227	0.275	0.521	0.713	0.835	0.877
70	W36X182	23.33	56 @ 6	9	0.094	0.179	0.244	0.286	0.301	0.340	0.644	0.882	1.033	1.085
75	W36X210	25.00	60 @ 6	9	0.123	0.233	0.319	0.373	0.392	0.411	0.777	1.064	1.247	1.309
80	W36X231	20.00	48 @ 6	9	0.148	0.281	0.384	0.450	0.473	0.490	0.926	1.268	1.485	1.560
85	W36X247	21.25	52 @ 6	9	0.188	0.355	0.486	0.570	0.598	0.600	1.136	1.555	1.821	1.912
90	W36X282	22.50	54 @ 6	9	0.230	0.435	0.596	0.698	0.733	0.690	1.306	1.788	2.094	2.199
95	W36X302	23.75	58 @ 6	9	0.285	0.539	0.738	0.864	0.907	0.824	1.558	2.134	2.499	2.624
100	W36X330	20.00	60 @ 6	9	0.345	0.652	0.893	1.046	1.098	0.956	1.809	2.477	2.901	3.047
105	W36X330	21.00	64 @ 6	9	0.419	0.793	1.085	1.271	1.335	1.163	2.199	3.011	3.527	3.703
	W40X324	21.00	42 @ 6	9	0.375	0.710	0.971	1.138	1.195	1.055	1.995	2.732	3.199	3.360
110	W36X361	22.00	66 @ 6	9	0.500	0.947	1.296	1.518	1.594	1.329	2.515	3.443	4.033	4.235
	W44X335	22.00	22 @ 6	9	0.384	0.727	0.995	1.166	1.224	1.073	2.030	2.780	3.256	3.419
115	W36X395	23.00	70 @ 6	9	0.590	1.116	1.528	1.790	1.879	1.502	2.841	3.890	4.556	4.784
	W36X395	23.00	70 @ 6	9	0.590	1.116	1.528	1.790	1.879	1.502	2.841	3.890	4.556	4.784
120	W36X441	24.00	48 @ 6	9	0.696	1.317	1.803	2.111	2.217	1.675	3.169	4.338	5.081	5.335
	W36X441	24.00	48 @ 6	9	0.696	1.317	1.803	2.111	2.217	1.675	3.169	4.338	5.081	5.335

DESIGN DETAILS – COMPOSITE PLATE GIRDERS (6' GIRDER SPACING)

SPAN (L) – ft.	PLATE GIRDER SIZE					DIAPHRAGM SPACING (C) – ft.	SHEAR CONNECTOR MAX. SPACING		STEEL DEAD LOAD CAMBER – in.					TOTAL DEAD LOAD CAMBER – in.				
	TOP FLANGE – in.	BOTTOM FLANGE (F)		BOTTOM FLANGE (G)		WEB PLATE – in.											
		PLATE – in.	LENGTH – ft.	PLATE – in.	LENGTH – ft.		D	E	0.1L	0.2L	0.3L	0.4L	0.5L	0.1L	0.2L	0.3L	0.4L	0.5L
60	12 x 0.875	–	–	14 x 0.875	60	28 x 0.5000	20.00	36 @ 6	9	0.070	0.132	0.181	0.212	0.223	0.261	0.494	0.676	0.792	0.832
65	14 x 0.750	–	–	14 x 1.000	65	30 x 0.5000	21.67	26 @ 6	9	0.085	0.160	0.220	0.257	0.270	0.303	0.574	0.786	0.920	0.966
70	16 x 0.750	–	–	16 x 1.000	70	30 x 0.5000	23.33	28 @ 6	9	0.111	0.210	0.287	0.337	0.353	0.385	0.728	0.996	1.167	1.225
75	16 x 0.750	–	–	16 x 1.000	75	34 x 0.5000	25.00	16 @ 6	9	0.117	0.222	0.304	0.356	0.374	0.408	0.772	1.057	1.238	1.300
80	14 x 0.750	–	–	16 x 1.125	80	36 x 0.5000	20.00	16 @ 6	9	0.140	0.265	0.363	0.425	0.446	0.455	0.861	1.179	1.381	1.450
85	16 x 0.750	–	–	16 x 1.250	85	36 x 0.5000	21.25	18 @ 6	9	0.173	0.328	0.449	0.526	0.552	0.552	1.044	1.430	1.675	1.759
90	16 x 0.750	16 x 0.750	18	16 x 1.375	54	36 x 0.5000	22.50	36 @ 6	9	0.221	0.418	0.572	0.670	0.704	0.732	1.385	1.897	2.221	2.333
95	16 x 0.875	18 x 0.875	19	18 x 1.375	57	36 x 0.5000	23.75	38 @ 6	9	0.264	0.500	0.684	0.801	0.841	0.838	1.585	2.169	2.541	2.668
100	16 x 0.875	18 x 1.000	20	18 x 1.500	60	36 x 0.5000	20.00	40 @ 6	9	0.323	0.612	0.838	0.981	1.030	0.984	1.861	2.548	2.984	3.134
105	16 x 1.000	18 x 1.125	21	18 x 1.625	63	36 x 0.5000	21.00	22 @ 6	9	0.381	0.721	0.987	1.156	1.214	1.135	2.147	2.940	3.443	3.615
110	18 x 1.000	20 x 1.000	22	20 x 1.250	66	44 x 0.5000	22.00	–	9	0.317	0.599	0.820	0.961	1.009	0.995	1.883	2.577	3.019	3.170
115	18 x 1.000	18 x 1.000	23	18 x 1.375	69	48 x 0.5000	23.00	46 @ 9	12	0.325	0.616	0.843	0.987	1.037	1.031	1.950	2.669	3.126	3.283
120	18 x 1.000	18 x 1.000	24	18 x 1.375	72	50 x 0.5000	24.00	48 @ 9	12	0.359	0.680	0.930	1.090	1.144	1.133	2.143	2.934	3.437	3.609
125	18 x 1.000	18 x 1.000	25	18 x 1.375	75	52 x 0.5000	25.00	50 @ 9	12	0.395	0.747	1.023	1.198	1.258	1.240	2.346	3.212	3.761	3.950
130	20 x 1.000	20 x 1.000	26	20 x 1.250	78	54 x 0.5000	26.00	36 @ 9	12	0.425	0.803	1.100	1.288	1.353	1.320	2.498	3.420	4.005	4.206
135	20 x 1.000	20 x 1.000	27	20 x 1.375	81	54 x 0.5000	27.00	36 @ 9	12	0.492	0.930	1.274	1.492	1.566	1.498	2.835	3.881	4.546	4.773
140	20 x 1.000	20 x 1.000	28	20 x 1.500	84	54 x 0.5000	28.00	56 @ 9	12	0.567	1.073	1.469	1.720	1.807	1.695	3.206	4.390	5.141	5.398

DESIGN DETAILS – COMPOSITE PLATE GIRDERS (7' GIRDER SPACING)

SPAN (L) – ft.	PLATE GIRDER SIZE					DIAPHRAGM SPACING (C) – ft.	SHEAR CONNECTOR MAX. SPACING		STEEL DEAD LOAD CAMBER – in.					TOTAL DEAD LOAD CAMBER – in.				
	TOP FLANGE – in.	BOTTOM FLANGE (F)		BOTTOM FLANGE (G)		WEB PLATE – in.												
		PLATE – in.	LENGTH – ft.	PLATE – in.	LENGTH – ft.		D	E	0.1L	0.2L	0.3L	0.4L	0.5L	0.1L	0.2L	0.3L	0.4L	0.5L
60	14 x 0.750	–	–	14 x 1.250	60	24 x 0.5000	20.00	48 @ 6	9	0.090	0.170	0.233	0.273	0.287	0.302	0.570	0.781	0.915	0.961
65	16 x 0.750	–	–	16 x 1.250	65	24 x 0.5000	21.67	52 @ 6	9	0.121	0.230	0.315	0.368	0.387	0.391	0.741	1.014	1.187	1.247
70	16 x 0.875	–	–	16 x 1.250	70	26 x 0.5000	23.33	56 @ 6	9	0.137	0.259	0.355	0.416	0.437	0.458	0.866	1.186	1.389	1.459
75	16 x 0.875	–	–	16 x 1.375	75	28 x 0.5000	25.00	46 @ 6	9	0.158	0.299	0.410	0.480	0.504	0.511	0.966	1.323	1.550	1.627
80	16 x 0.875	–	–	16 x 1.375	80	30 x 0.5000	20.00	48 @ 6	9	0.181	0.343	0.469	0.550	0.577	0.589	1.115	1.526	1.787	1.877
85	16 x 0.875	–	–	16 x 1.500	85	32 x 0.5000	21.25	34 @ 6	9	0.206	0.390	0.534	0.625	0.656	0.647	1.224	1.676	1.963	2.061
90	16 x 0.875	16 x 0.875	18	16 x 1.500	54	34 x 0.5000	22.50	36 @ 6	9	0.235	0.445	0.610	0.714	0.750	0.801	1.516	2.075	2.430	2.552
95	16 x 0.875	16 x 0.875	19	16 x 1.625	57	36 x 0.5000	23.75	20 @ 6	9	0.264	0.500	0.685	0.802	0.842	0.879	1.663	2.276	2.666	2.800
100	18 x 0.750	18 x 0.750	20	18 x 1.500	60	38 x 0.5000	20.00	20 @ 6	9	0.300	0.567	0.776	0.909	0.955	0.985	1.864	2.552	2.989	3.139
105	18 x 0.875	18 x 0.875	21	18 x 1.500	63	40 x 0.5000	21.00	–	9	0.320	0.606	0.830	0.972	1.021	1.056	1.998	2.735	3.204	3.364
110	18 x 0.875	18 x 0.875	22	18 x 1.500	66	42 x 0.5000	22.00	–	9	0.354	0.670	0.917	1.074	1.128	1.165	2.204	3.018	3.534	3.711
115	20 x 0.875	20 x 0.875	23	20 x 1.375	69	44 x 0.5000	23.00	–	9	0.382	0.723	0.990	1.159	1.217	1.249	2.363	3.236	3.790	3.979
120	20 x 0.875	20 x 0.875	24	20 x 1.500	72	46 x 0.5000	24.00	–	9	0.419	0.792	1.084	1.270	1.333	1.333	2.522	3.453	4.045	4.247
125	20 x 0.875	20 x 0.875	25	20 x 1.500	75	48 x 0.5000	25.00	–	9	0.457	0.865	1.184	1.387	1.456	1.452	2.747	3.760	4.404	4.625
130	20 x 1.000	20 x 1.000	26	20 x 1.500	78	50 x 0.5000	26.00	52 @ 9	12	0.483	0.914	1.251	1.465	1.538	1.524	2.884	3.948	4.624	4.855
135	20 x 1.000	20 x 1.000	27	20 x 1.500	81	52 x 0.5000	27.00	54 @ 9	12	0.524	0.991	1.357	1.590	1.669	1.648	3.118	4.269	5.000	5.250
140	20 x 1.000	20 x 1.000	28	20 x 1.625	84	54 x 0.5625	28.00	38 @ 9	12	0.580	1.098	1.503	1.760	1.848	1.732	3.276	4.486	5.254	5.517

DESIGN DETAILS – COMPOSITE PLATE GIRDERS (8' GIRDER SPACING)

SPAN (L) – ft.	PLATE GIRDER SIZE					DIAPHRAGM SPACING (C) – ft.	SHEAR CONNECTOR MAX. SPACING		STEEL DEAD LOAD CAMBER – in.					TOTAL DEAD LOAD CAMBER – in.				
	TOP FLANGE – in.	BOTTOM FLANGE (F)		BOTTOM FLANGE (G)		WEB PLATE – in.												
		PLATE – in.	LENGTH – ft.	PLATE – in.	LENGTH – ft.		D	E	0.1L	0.2L	0.3L	0.4L	0.5L	0.1L	0.2L	0.3L	0.4L	0.5L
60	14 x 0.875	–	–	14 x 1.250	60	24 x 0.5000	20.00	–	6	0.087	0.165	0.226	0.264	0.277	0.315	0.596	0.817	0.956	1.004
65	16 x 0.875	–	–	16 x 1.250	65	24 x 0.5000	21.67	–	6	0.117	0.222	0.304	0.356	0.374	0.408	0.773	1.058	1.239	1.301
70	16 x 0.875	–	–	16 x 1.375	70	26 x 0.5000	23.33	70 @ 6	9	0.137	0.259	0.354	0.415	0.436	0.461	0.872	1.194	1.399	1.469
75	16 x 0.875	16 x 0.875	15	16 x 1.750	45	28 x 0.5000	25.00	60 @ 6	9	0.161	0.304	0.416	0.487	0.512	0.540	1.022	1.399	1.638	1.720
80	16 x 0.750	16 x 0.750	16	16 x 1.625	48	30 x 0.5000	20.00	64 @ 6	9	0.191	0.362	0.495	0.580	0.609	0.659	1.247	1.707	2.000	2.100
85	16 x 0.875	16 x 0.875	17	16 x 1.625	51	32 x 0.5000	21.25	68 @ 6	9	0.209	0.395	0.540	0.633	0.665	0.729	1.378	1.887	2.210	2.321
90	16 x 0.875	16 x 0.875	18	16 x 1.750	54	34 x 0.5000	22.50	54 @ 6	9	0.236	0.447	0.611	0.716	0.752	0.806	1.525	2.088	2.446	2.568
95	18 x 0.750	18 x 0.750	19	18 x 1.625	57	36 x 0.5000	23.75	38 @ 6	9	0.269	0.510	0.698	0.818	0.858	0.909	1.720	2.354	2.757	2.895
100	18 x 0.875	18 x 0.875	20	18 x 1.625	60	38 x 0.5000	20.00	40 @ 6	9	0.289	0.547	0.748	0.876	0.920	0.981	1.856	2.540	2.975	3.124
105	18 x 0.875	18 x 0.875	21	18 x 1.625	63	40 x 0.5000	21.00	22 @ 6	9	0.321	0.607	0.831	0.973	1.021	1.088	2.059	2.819	3.301	3.467
110	20 x 0.875	20 x 0.875	22	20 x 1.500	66	42 x 0.5000	22.00	22 @ 6	9	0.347	0.657	0.899	1.053	1.106	1.171	2.216	3.034	3.553	3.731
115	20 x 0.875	20 x 0.875	23	20 x 1.625	69	44 x 0.5000	23.00	–	9	0.382	0.723	0.990	1.160	1.218	1.257	2.379	3.256	3.814	4.005
120	20 x 1.000	20 x 1.000	24	20 x 1.625	72	46 x 0.5000	24.00	–	9	0.406	0.768	1.051	1.231	1.293	1.331	2.518	3.447	4.038	4.240
125	20 x 1.000	20 x 1.000	25	20 x 1.625	75	48 x 0.5000	25.00	–	9	0.443	0.839	1.148	1.345	1.412	1.450	2.743	3.755	4.398	4.618
130	20 x 1.000	20 x 1.000	26	20 x 1.625	78	50 x 0.5625	26.00	–	9	0.494	0.934	1.279	1.498	1.573	1.565	2.962	4.055	4.749	4.986
135	20 x 1.000	20 x 1.000	27	20 x 1.625	81	52 x 0.5625	27.00	–	9	0.536	1.014	1.388	1.626	1.707	1.693	3.203	4.385	5.135	5.392
140	20 x 1.125	20 x 1.125	28	20 x 1.750	84	54 x 0.5625	28.00	–	9	0.564	1.067	1.461	1.711	1.797	1.738	3.287	4.501	5.271	5.535

WV Standards for Short Span Steel Bridges

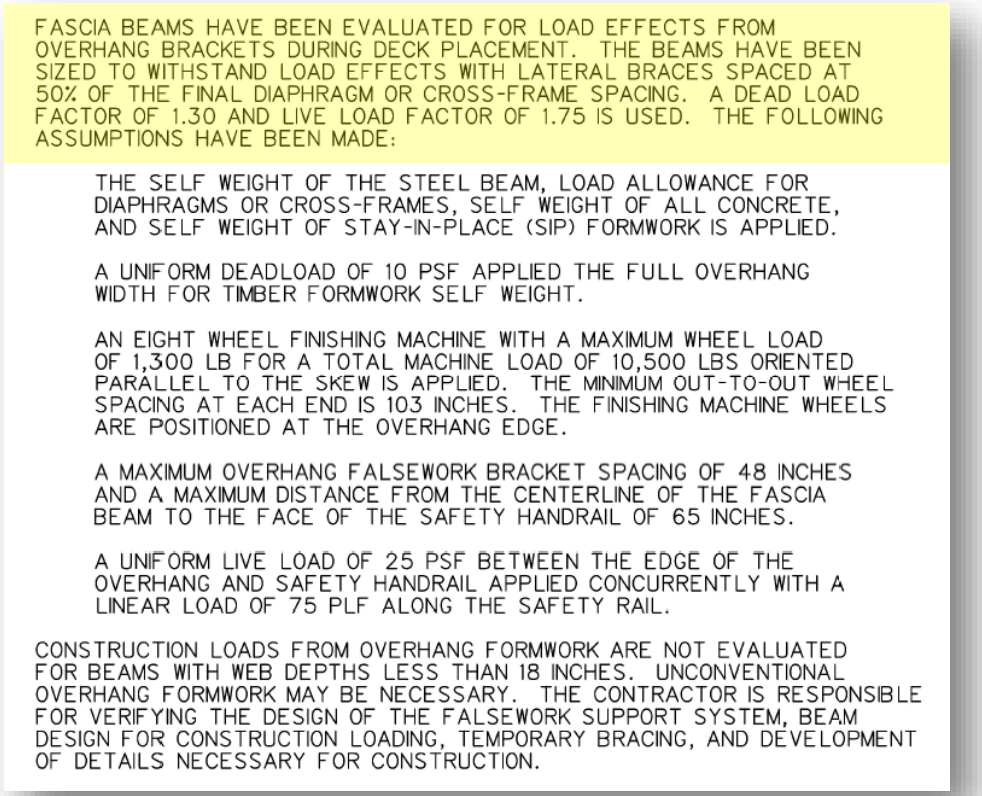
- Goals:
  - Economically competitive
  - Expedite & economize the design process
  - Simple repetitive details & member sizes.
- Bridge Design Parameters:
  - **Rolled Beam Span lengths: 30’ – 110’ (5’ increments)**
  - Plate Girder Span lengths: 60’ – 140’ feet (5’ increments)
  - **Girder spacing: 6 feet to 11 feet in 1-foot increments**
- Skew Considerations
  - **Both 0° and 30° skew angles were accommodated.**

ALL BEAMS PROVIDED HEREIN ARE LOAD RATED IN ACCORDANCE WITH SECTION 3.15 OF THE WEST VIRGINIA BRIDGE DESIGN MANUAL TO ACHIEVE EQUAL OR GREATER LOAD CARRYING CAPACITIES THAN NOTED IN THE TABLE SHOWN. A LEGAL LOAD FACTOR OF 1.45, CORRESPONDING TO UNKNOWN ADTT, IS USED. SEE OTHER LITERATURE FOR TRUCK AXLE CONFIGURATIONS.

TARGET LOAD RATINGS (TONS)		
CLASSIFICATION	TRUCK	TONS
STANDARD	TYPE 3	41
	SU4	49
	SU5	51
	SU6	51
	SU7	51
	TYPE 3S2	55
EMERGENCY	EV2	36
	EV3	54
CRTS	SU-40	53
	SU-45	60
	3S-55	73
	3S-60	79
PERMIT	WP47	59

WV Standards for Short Span Steel Bridges (cont'd)

- Bridges were designed according to AASHTO LRFD Specs:
  - Strength I, Service II, Inf. Life Fatigue, Constructability, L/800 Deflection
  - HL-93 Vehicular Live Loading
- Additional Design Loads:
  - SIP Unit Weight = 15 psf
  - Future Wearing Surface = 25 psf
  - **Concrete barriers = 305 plf (each)**
  - **Misc. Steel Wt. Increase = 25 plf**
  - f_c' = 4,000 psi
  - Concrete Unit Weight = 150 pcf
  - Steel Unit Weight = 490 pcf
  - Concrete Haunch = 2 in
  - Constant Flange Width
  - Constant Web Height



FASCIA BEAMS HAVE BEEN EVALUATED FOR LOAD EFFECTS FROM OVERHANG BRACKETS DURING DECK PLACEMENT. THE BEAMS HAVE BEEN SIZED TO WITHSTAND LOAD EFFECTS WITH LATERAL BRACES SPACED AT 50% OF THE FINAL DIAPHRAGM OR CROSS-FRAME SPACING. A DEAD LOAD FACTOR OF 1.30 AND LIVE LOAD FACTOR OF 1.75 IS USED. THE FOLLOWING ASSUMPTIONS HAVE BEEN MADE:

THE SELF WEIGHT OF THE STEEL BEAM, LOAD ALLOWANCE FOR DIAPHRAGMS OR CROSS-FRAMES, SELF WEIGHT OF ALL CONCRETE, AND SELF WEIGHT OF STAY-IN-PLACE (SIP) FORMWORK IS APPLIED.

A UNIFORM DEADLOAD OF 10 PSF APPLIED THE FULL OVERHANG WIDTH FOR TIMBER FORMWORK SELF WEIGHT.

AN EIGHT WHEEL FINISHING MACHINE WITH A MAXIMUM WHEEL LOAD OF 1,300 LB FOR A TOTAL MACHINE LOAD OF 10,500 LBS ORIENTED PARALLEL TO THE SKEW IS APPLIED. THE MINIMUM OUT-TO-OUT WHEEL SPACING AT EACH END IS 103 INCHES. THE FINISHING MACHINE WHEELS ARE POSITIONED AT THE OVERHANG EDGE.

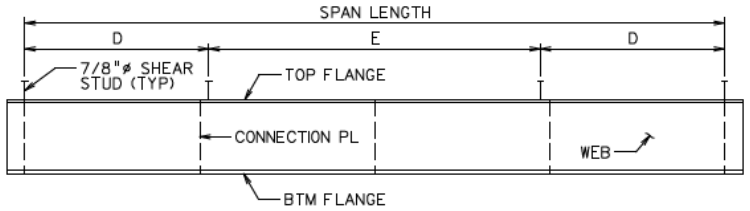
A MAXIMUM OVERHANG FALSEWORK BRACKET SPACING OF 48 INCHES AND A MAXIMUM DISTANCE FROM THE CENTERLINE OF THE FASCIA BEAM TO THE FACE OF THE SAFETY HANDRAIL OF 65 INCHES.

A UNIFORM LIVE LOAD OF 25 PSF BETWEEN THE EDGE OF THE OVERHANG AND SAFETY HANDRAIL APPLIED CONCURRENTLY WITH A LINEAR LOAD OF 75 PLF ALONG THE SAFETY RAIL.

CONSTRUCTION LOADS FROM OVERHANG FORMWORK ARE NOT EVALUATED FOR BEAMS WITH WEB DEPTHS LESS THAN 18 INCHES. UNCONVENTIONAL OVERHANG FORMWORK MAY BE NECESSARY. THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING THE DESIGN OF THE FALSEWORK SUPPORT SYSTEM, BEAM DESIGN FOR CONSTRUCTION LOADING, TEMPORARY BRACING, AND DEVELOPMENT OF DETAILS NECESSARY FOR CONSTRUCTION.

WV Standards for Short Span Steel Bridges (cont'd)

- Example Standards (9' Spacing)



BEAM ELEVATION

COMPOSITE PLATE GIRDERS (9' GIRDER SPACING, 0 DEGREE SKEW)

SPAN LENGTH	DIAPHRAGM SPACING	PLATE GIRDER SIZE			SHEAR CONNECTOR MAX. SPACING		TABLE NOTES
		TOP FLANGE PLATE	WEB PLATE	BOT FLANGE PLATE	(D)	(E)	
60	20.00	14 x 0.750	28 x 0.5000	14 x 1.125	-	6	B,D
65	21.67	14 x 0.875	30 x 0.5000	16 x 1.000	52 @ 6	9	D
70	23.33	16 x 0.750	32 x 0.5000	16 x 1.125	56 @ 6	9	B,D
75	25.00	16 x 0.875	32 x 0.5000	16 x 1.375	60 @ 6	9	B,D
80	20.00	14 x 1.000	34 x 0.5000	16 x 1.375	64 @ 6	9	D
85	21.25	16 x 0.875	34 x 0.5000	18 x 1.375	68 @ 6	9	D
90	22.50	16 x 1.000	36 x 0.5000	18 x 1.500	54 @ 6	9	D
95	23.75	18 x 1.000	40 x 0.5000	20 x 1.250	38 @ 6	9	F
100	25.00	18 x 1.000	40 x 0.5000	20 x 1.375	20 @ 6	9	F
105	21.00	18 x 1.000	44 x 0.5000	18 x 1.500	22 @ 6		
110	22.00	18 x 1.000	46 x 0.5000	20 x 1.375	-		
115	23.00	18 x 1.000	46 x 0.5000	18 x 1.625	-		
120	24.00	18 x 1.000	48 x 0.5000	20 x 1.500	-		
125	25.00	18 x 1.000	50 x 0.5625	18 x 1.625	-	9	F
130	26.00	20 x 1.000	52 x 0.5625	20 x 1.500	-	9	F
135	27.00	20 x 1.000	54 x 0.5625	20 x 1.500	54 @ 9	12	F
140	28.00	20 x 1.000	58 x 0.5625	20 x 1.500	38 @ 9	12	F

COMPOSITE PLATE GIRDERS (9' GIRDER SPACING, 30 DEGREE SKEW)

SPAN LENGTH	DIAPHRAGM SPACING	PLATE GIRDER SIZE			SHEAR CONNECTOR MAX. SPACING		TABLE NOTES
		TOP FLANGE PLATE	WEB PLATE	BOT FLANGE PLATE	(D)	(E)	
60	20.00	16 x 1.000	32 x 0.5000	18 x 1.375	-	6	D
65	21.67	18 x 1.000	32 x 0.5000	18 x 1.625	66 @ 6	9	D
70	23.33	18 x 1.125	32 x 0.5000	18 x 1.875	70 @ 6	9	D
75	25.00	16 x 1.125	34 x 0.5000	18 x 1.625	76 @ 6	9	B,D
80	20.00	14 x 1.125	34 x 0.5000	18 x 2.000	-	6	B,D
85	21.25	14 x 1.125	36 x 0.5000	18 x 2.000	86 @ 6	9	B,D
90	22.50	16 x 1.125	36 x 0.5000	18 x 1.875	-	6	B,D
95	23.75	16 x 1.125	36 x 0.5000	18 x 1.875	-	6	B,D
100	25.00	18 x 1.000	40 x 0.5625	18 x 1.625	50 @ 6	9	F
105	21.00	18 x 1.000	40 x 0.5625	18 x 1.625	-	6	F
110	22.00	18 x 1.000	44 x 0.5625	18 x 1.500	88 @ 6	9	F
115	23.00	18 x 1.000	44 x 0.5000	20 x 1.500	-	6	F
120	24.00	18 x 1.000	48 x 0.5000	18 x 1.625	72 @ 6	9	F
125	25.00	18 x 1.000	52 x 0.5625	18 x 1.500	50 @ 6	9	F
130	26.00	20 x 1.000	54 x 0.5625	20 x 1.375	26 @ 6	9	F
135	27.00	20 x 1.000	56 x 0.5625	20 x 1.375	28 @ 6	9	F
140	28.00	20 x 1.000	58 x 0.5625	20 x 1.500	28 @ 6	9	B,F

Example variation in nonskewed vs. skewed designs.

WV Standards for Short Span Steel Bridges (cont'd)

- Example Standards (9' Spacing)

COMPOSITE ROLLED BEAMS (9 FT GIRDER SPACING, 0 DEGREE SKEW)									
SPAN LENGTH	DIAPHRAGM SPACING	STANDARD DESIGN				OPTIONAL DESIGN			
		ROLLED SECTION	SHEAR CONNECTOR SPACING		TABLE NOTES	ROLLED SECTION	SHEAR CONNECTOR SPACING		TABLE NOTES
			(D)	(E)			(D)	(E)	
30	15.00	W30X90	30 @ 6	9	D				
35	17.50	W30X90	-	6	B,D				
40	20.00	W24X104	-	6	D				
45	22.50	W33X130	18 @ 6	9	B,D				
50	25.00	W27X146	-	6	D				
55	18.33	W27X146	-	6	D				
60	20.00	W36X150	36 @ 6	9	D				
65	21.67	W36X160	40 @ 6	9	D				
70	23.33	W36X182	56 @ 6	9	B,D				
75	25.00	W33X201	60 @ 6	9	D	W40X199	46 @ 6	9	F
80	20.00	W36X231	64 @ 6	9	D	W40X211	48 @ 6	9	F
85	21.25	W36X247	68 @ 6	9	D	W44X230	34 @ 6	9	F
90	22.50	W36X262	72 @ 6	9	D	W44X230	36 @ 6	9	F
95	23.75	W36X282	76 @ 6	9	D	W44X262	38 @ 6	9	F
100	25.00	W36X302	80 @ 6	9	D	W44X290	40 @ 6	9	F
105	21.00	W36X330	84 @ 6	9	D	W44X290	42 @ 6	9	F
110	22.00	W36X361	78 @ 6	9	D	W44X335	44 @ 6	9	F

Note the optional W40/W44 options for design.

Questions & Answers

Thank You!

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