Recent Innovations in Short Span Steel Bridges

Overview and SSSBA Program Activities

2020 ACE Conference: October 22, 2020

ASSOCIATION OF CONSERVATION ENGINEERS

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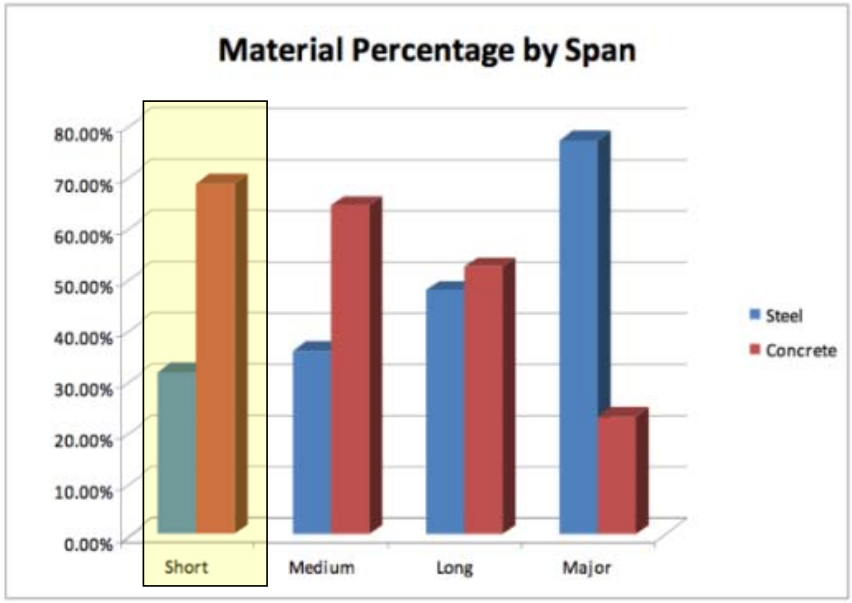
Outline

- SSSBA Overview
- Short Span Steel Bridge Standards & eSPAN140
  - Development
  - Examples of Use
  - State Standard Development
- Press-Brake-Formed Steel Tub Girders (Innovative Solutions)
  - Research and Development
  - Summary of Research to Date
  - Applications
- Available Resources

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.



The Solution (Why Use Steel for Bridges?)

- First Cost/Economical
  - 25% less than concrete with cost-efficient design, fabrication, and construction practices
- Modular
  - Light weight, prefabricated options, easy to construct (lends to standardized plans)
- Durable
  - Highly resistant to natural disasters (seismic)
  - Long life cycle (weathering steel & galvanized options)
- Steel is Resilient
  - Repair (damaged bridges can be repaired)
  - Reusable (recondition old beams and use for a new bridge)
  - Repurpose (functionally obsolete used for reduced loads, trails etc.)
  - Recycle (steel 100% recyclable and better than the original)
  - Recycled content of US plate 70%, rolled beams 85%

The Short Span Steel Bridge Alliance

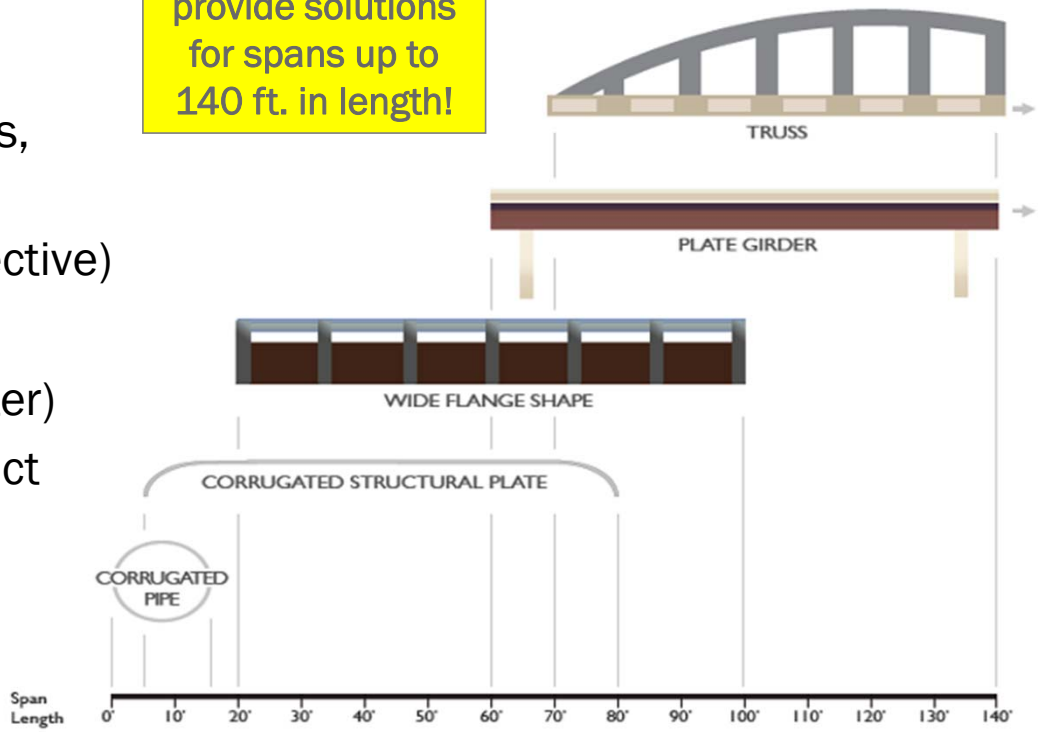
- Program officially started September 2007
  - Objective – make steel the material of choice for short span steel bridges.
  - Short span steel bridges have spans up to 140 ft
  - First North American industry-wide effort to provide education and design support for short span steel bridges.

What Does SSSBA Do?

- Education (webinars, workshops, forums, conferences)
- Technical Resources (standards, guidelines, best practices)
- Case Studies (economics: steel is cost-effective)
- Simple Design Tools (eSPAN140)
- Answer Questions (Bridge Technology Center)
- Access to Industry Partners (industry contact list)

- All FREE for bridge owners, designers, & universities

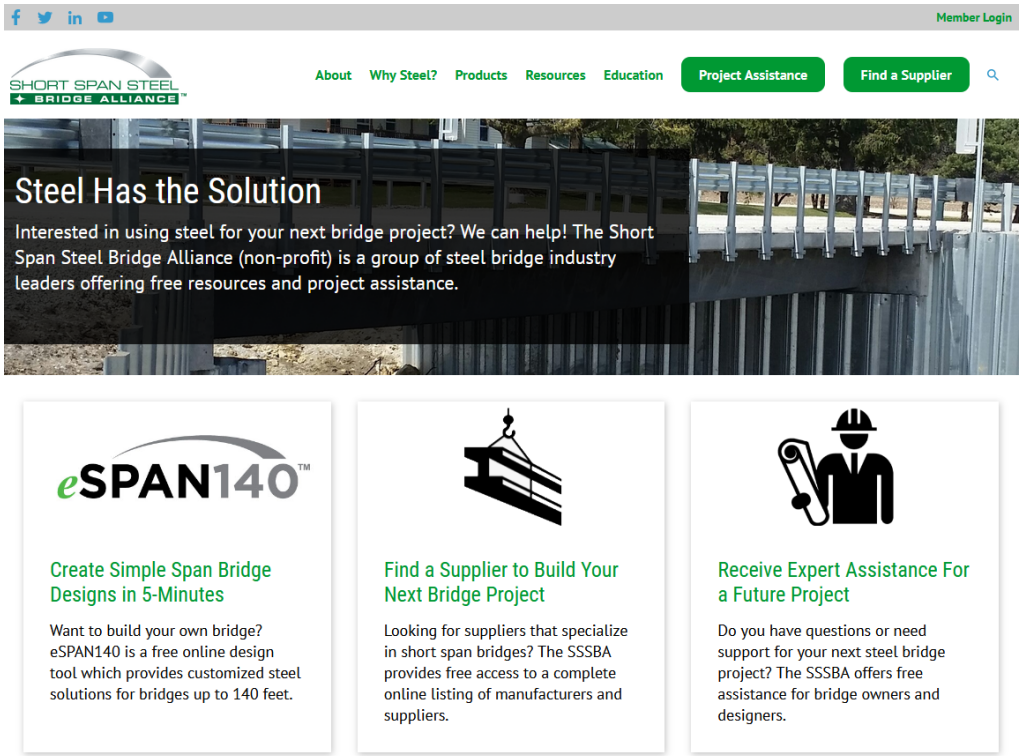
Our focus is to provide solutions for spans up to 140 ft. in length!



SSSBA Website

- 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)

https://www.shortspansteelbridges.org/



Join Today!

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SHORT SPAN STEEL BRIDGE ALLIANCE™

eSPAN140™

http://www.espan140.com/

Free Online Design Tool for Short Span Steel Bridges

Utilizes Standard Short Span Steel Bridge Designs

SHORT SPAN STEEL BRIDGE DESIGN STANDARDS

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
  - Homogeneous & Hybrid plate girders with limited plate sizes
  - Limited Depth & Lightest Weight Rolled Beam Sections
  - Selective cross-frame placement/design (AASHTO/NSBA)

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

SHORT SPAN STEEL BRIDGE ALLIANCE™

eSPAN140

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
    - Corrugated Steel Pipe and Structural Plate
  - Manufacturers' Steel Solutions (SSSBA Partners)
  - Coatings Solutions
  - Industry Contacts
    - Contacts can provide budget estimates and pricing information

Free and easy to use!!!

http://www.espan140.com/

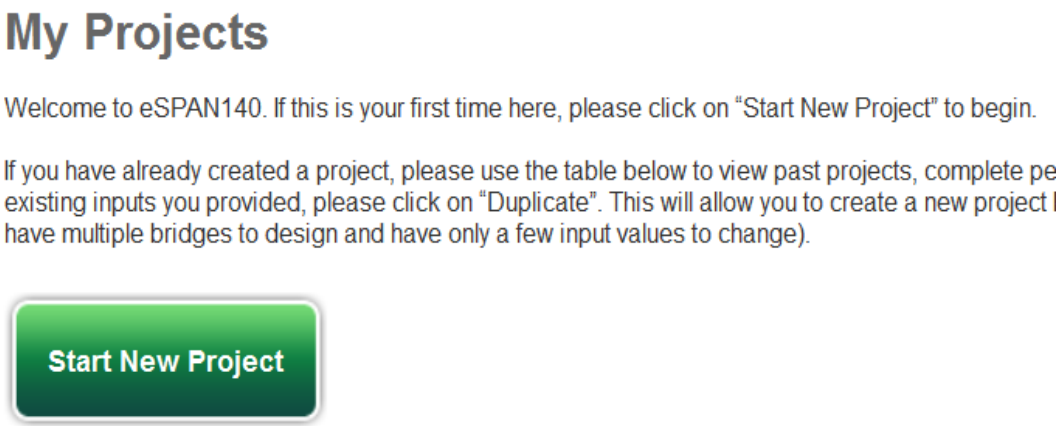
Step 1.
Create a User's Account

Step 2.
Input Your Specific Project Details

Step 3.
View Your Instant Customized Solutions Books

eSPAN140 Example

- Start new project:



eSPAN140 Example (cont'd)

- Step 1: Project Information

Project Name*
Sample Bridge

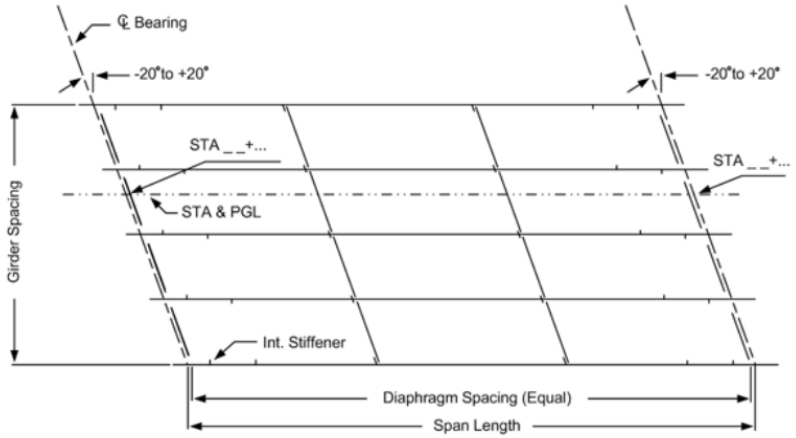
City/County*
Morgantown

State/Province*
West Virginia

Roadway Name
Main Street

Bridge Span Length*
82 Feet
4 Inches

Next > Return to Projects



eSPAN140 Example (cont'd)

- Step 2: Project Details (general dimensions)

# of Striped Traffic Lanes*

2

Roadway Width*

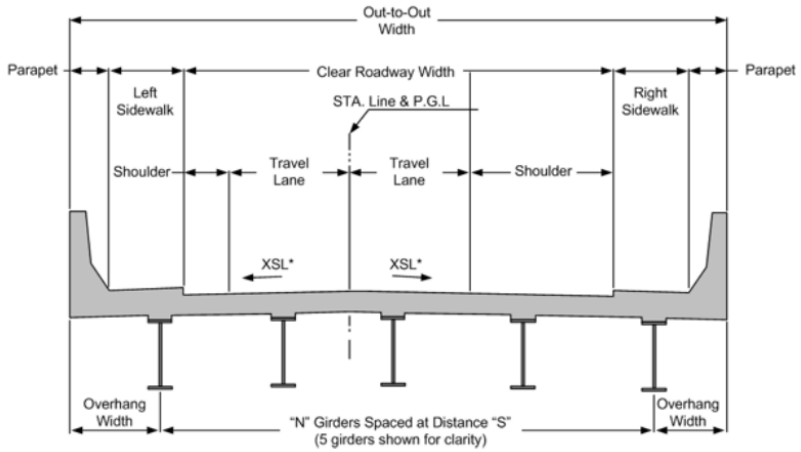
30 Feet 0 Inches

Individual Parapet Width

1 Feet 3 Inches

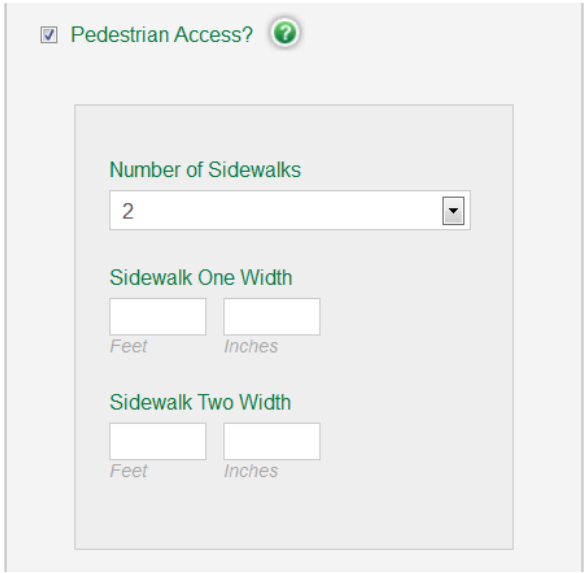
Individual Deck Overhang Width

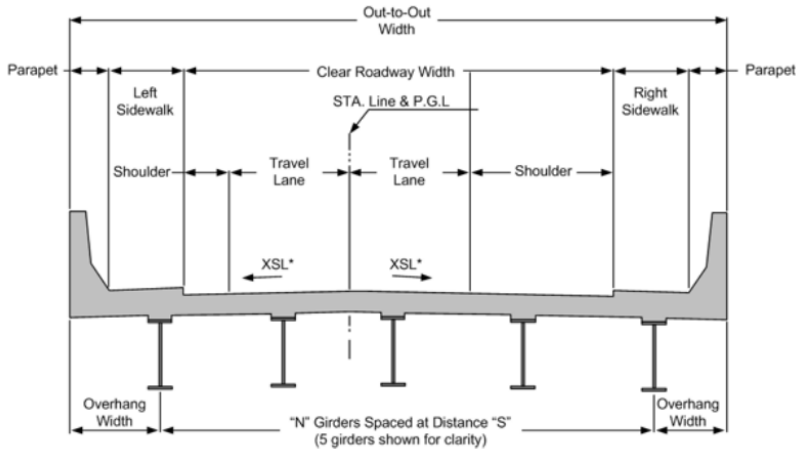
3 Feet 0 Inches



eSPAN140 Example (cont'd)

- Step 2: Project Details (pedestrian access option)





eSPAN140 Example (cont'd)

- Step 2: Project Details (remaining details)

Skew Angle

15

Degrees

Average Daily Traffic

Over 2,000

Design Speed

Not applicable

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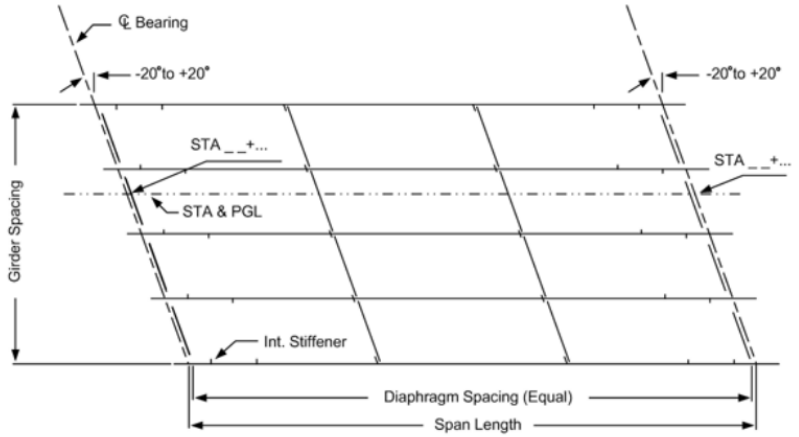
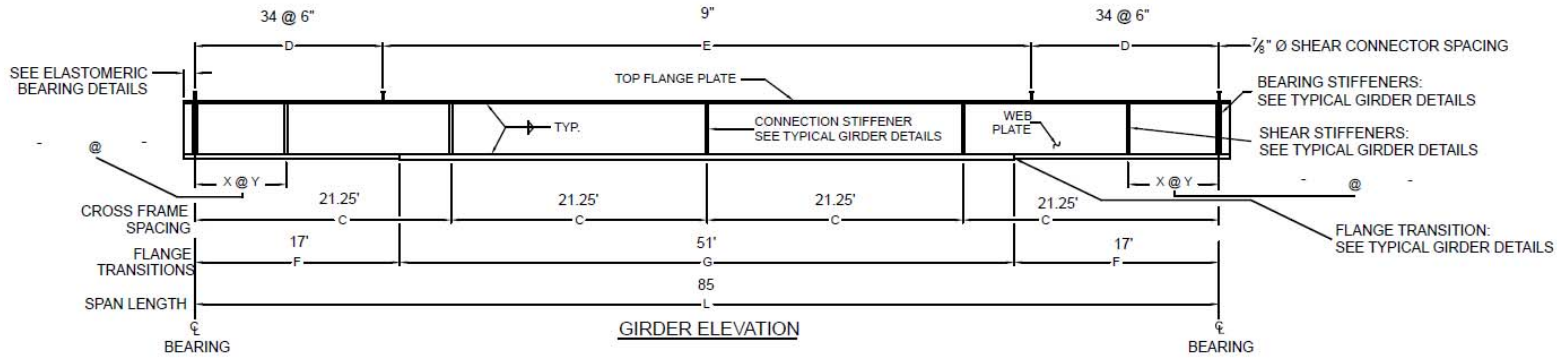


eSPAN140 Example (cont'd)

- Example output (sample plate girder elevation):

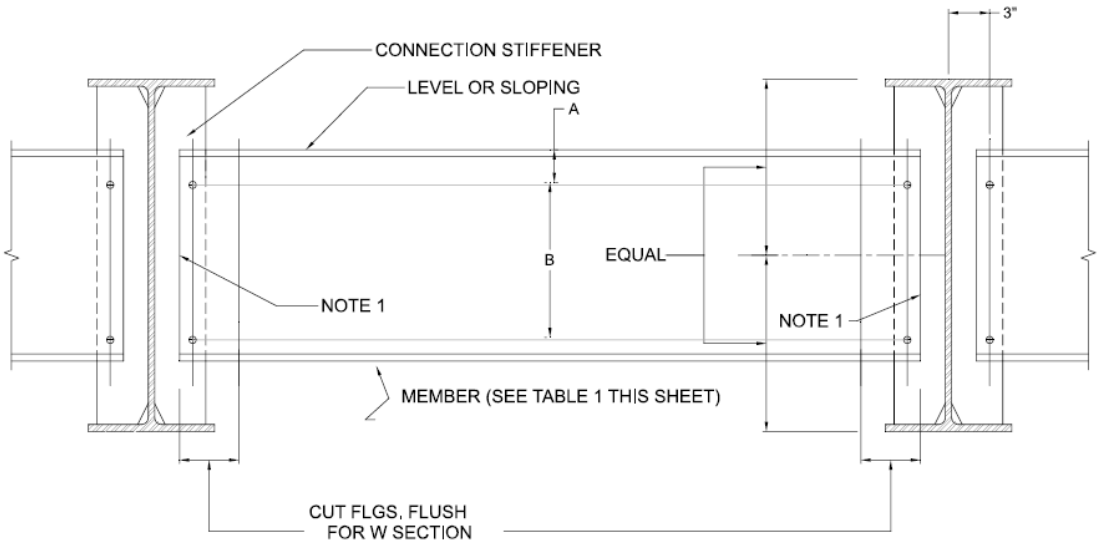
COMPOSITE PLATE GIRDER WITH PARTIALLY STIFFENED WEB - 4 GIRDERS AT 8' 10" GIRDER SPACING, HOMOGENEOUS

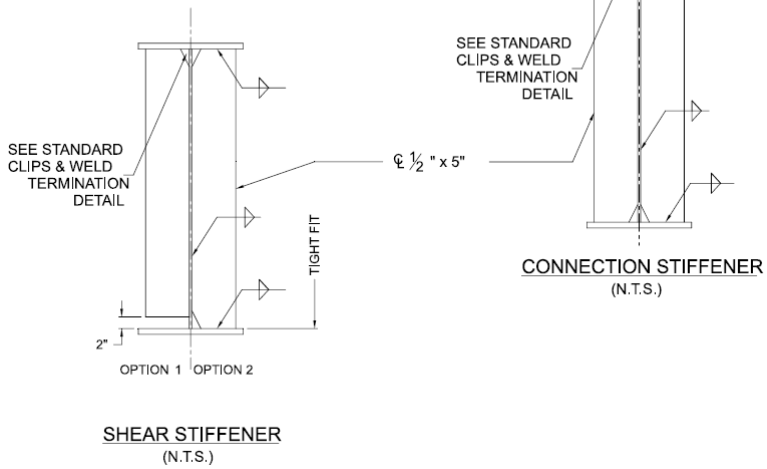


SPAN (L) - ft	PLATE GIRDER SIZE						DIAPHRAGM SPACING (C) - ft	SHEAR STIFFENERS		SHEAR CONNECTOR MAX. SPACING		INDIVIDUAL GIRDER WEIGHT
	TOP FLANGE - in	BOTTOM FLANGE (F)		BOTTOM FLANGE (G)		WEB PLATE- in		X (NO. REQ'd)	Y - ft. (SPACING)	D	E	
		PLATE - in	LENGTH - Ft	PLATE - in	LENGTH - Ft							
85	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 (cont'd)

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





Applications of eSPAN140

- 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)

Applications of eSPAN140 (cont'd)

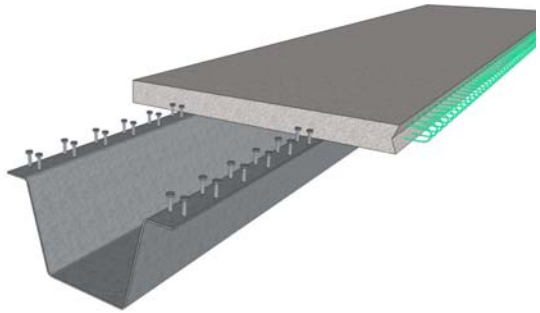
- High Point Lane Bridge in Boone County, Missouri , 102 ft.
  - Plate Girder (4 girder lines, 44" deep weathering steel)
  - Designed by Chris Criswell, Bartlett and West
  - Fabricated by Delongs Inc.
  - County "did not know steel could span over 100 feet" – used eSPAN140 for preliminary designs

- 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.

Ohio Short Span Steel Bridge Design Standards

- Considering the success of eSPAN140, the Bridge Technology Center has been engaged in efforts to generate eSPAN140-based standards approved in each state.
  - Recent efforts have been focused on in the State of Ohio.

COMPOSITE PLATE GIRDER WITH PARTIALLY STIFFENED WEB - 6' GIRDER SPACING														
SPAN - ft	PLATE GIRDER SIZE												CONTROLLING PERFORMANCE RATIO	
	TOP FLANGE		L/D Ratio	WEB		BOTTOM FLANGE (F)			BOTTOM FLANGE (G)					
	WIDTH - in	THICKNESS - in		DEPTH - in	THICKNESS - in	WIDTH - in	THICKNESS - in	LENGTH - ft	WIDTH - in	THICKNESS - in	LENGTH - ft		Label	PR
60	14	1	29.84	22	0.5	-	-	-	14	1.125	60		FAT I BF	0.997
65	14	0.875	29.86	24	0.5	-	-	-	14	1.25	65		FAT I BF	0.981
70	16	0.75	30.00	26	0.5	-	-	-	16	1.25	70		CFY SLC	0.969
75	16	0.875	29.88	28	0.5	-	-	-	16	1.25	75		FAT I BF	0.971
80	14	0.875	29.65	30	0.5	-	-	-	14	1.5	80		FAT I BF	0.995
85	14	0.875	29.57	32	0.5	-	-	-	14	1.625	85		FAT I BF	0.967
90	16	0.75	29.79	34	0.5	16	0.75	18	16	1.5	54		FAT I BF	0.963
95	16	0.875	29.71	36	0.5	16	0.875	19	16	1.5	57		FAT I BF	0.988
100	18	0.75	29.91	38	0.5	18	0.75	20	18	1.375	60		FAT I BF	0.992
105	18	0.75	29.82	40	0.5	18	0.75	21	18	1.5	63		CFY SLC	0.97
110	16	1	29.58	42	0.5	16	1	22	16	1.625	66		FAT I BF	0.981
115	18	0.875	29.76	44	0.5	18	0.875	23	18	1.5	69		FAT I BF	0.972
120	18	1	29.69	46	0.5	18	1	24	18	1.5	72		FAT I BF	0.984
125	16	1	29.70	48	0.5	16	1	25	16	1.5	75		CFY STR IV	1
130	20	0.875	29.79	50	0.5	20	0.875	26	20	1.5	78		CFY STR IV	0.996
135	20	1	29.72	52	0.5	20	1	28.5	20	1.5	78		STR I FLEX	0.955
140	22	1	29.80	54	0.5	22	1	31	22	1.375	78		STR I FLEX	0.959

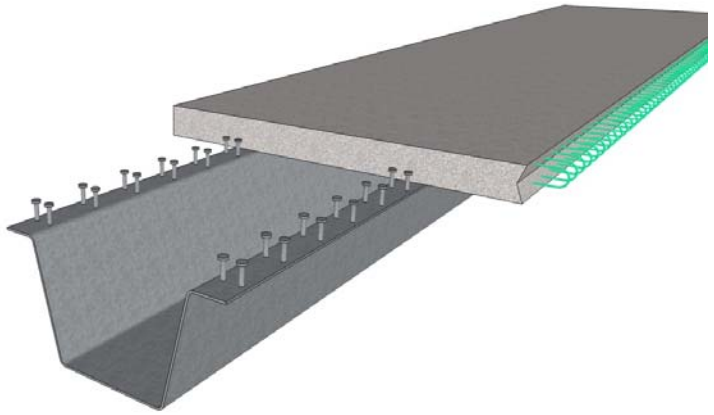


Innovative Design Solutions for Short Span Bridges

PRESS-BRAKE-FORMED STEEL TUB GIRDERS

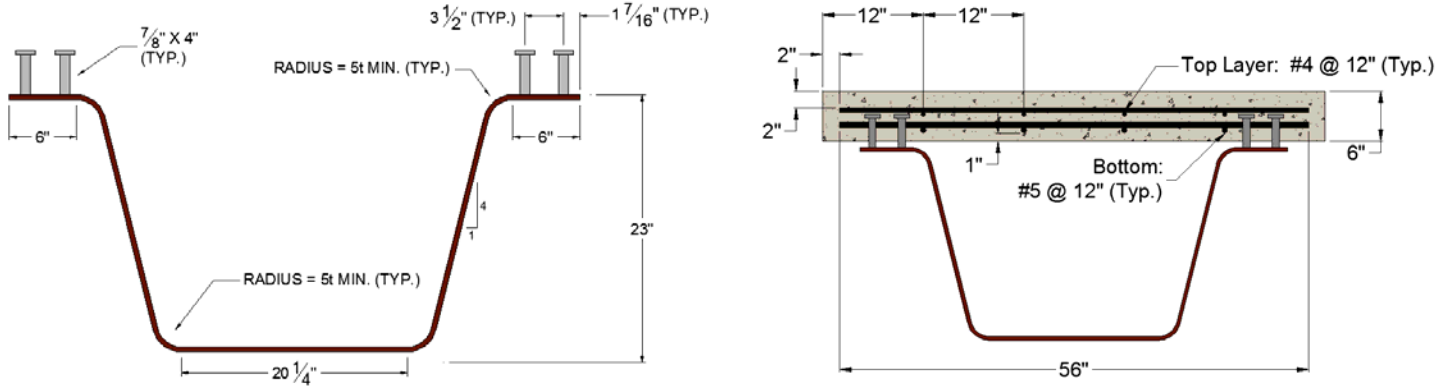
Press-Brake-Formed Steel Tub Girders

- Modular shallow trapezoidal boxes fabricated from cold-bent structural steel plate
  - Weathering steel or galvanized.
- Potential for economy through a significant reduction in fabrication costs due to cold-bending versus welding of the section and mass production.
- Reduces need for stiffeners and cross frames.
- Advantages include:
  - Accelerated with precast deck (install in 1 or 2 days)
  - Modular
  - Simple to fabricate and install
  - Potential to replace thousands of bridge in need of repairs
  - Opens doors for “new” bridge fabricators



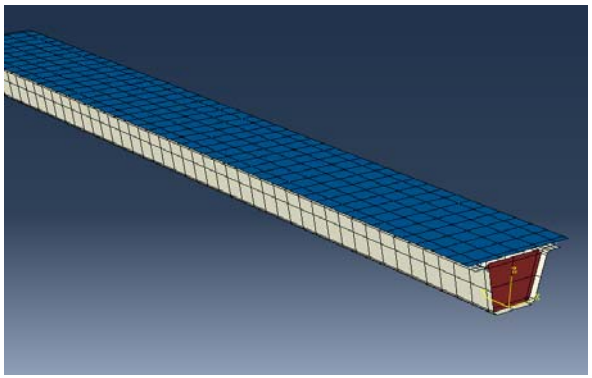
Experimental Testing & Analytical Modeling

- Testing was conducted on composite, noncomposite, and modular flexural specimens:
  - 84” × 7/16” PL
  - Dimensions shown below:

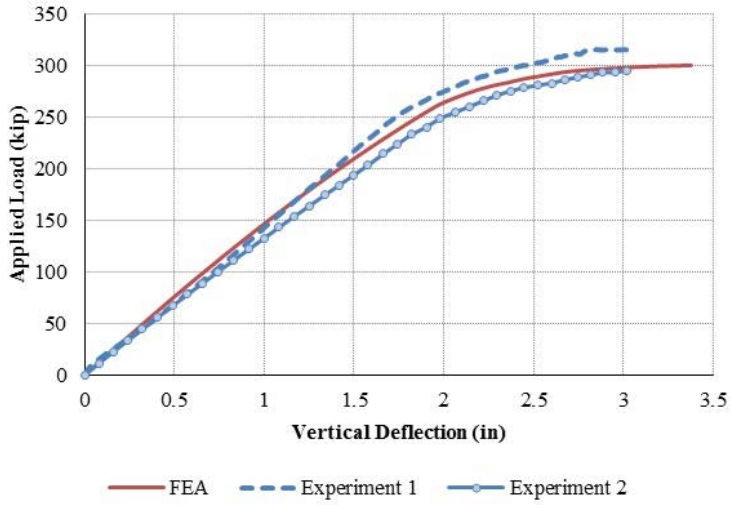


Experimental Testing & Analytical Modeling (cont'd)

- Single module testing (assessing flexural capacity):



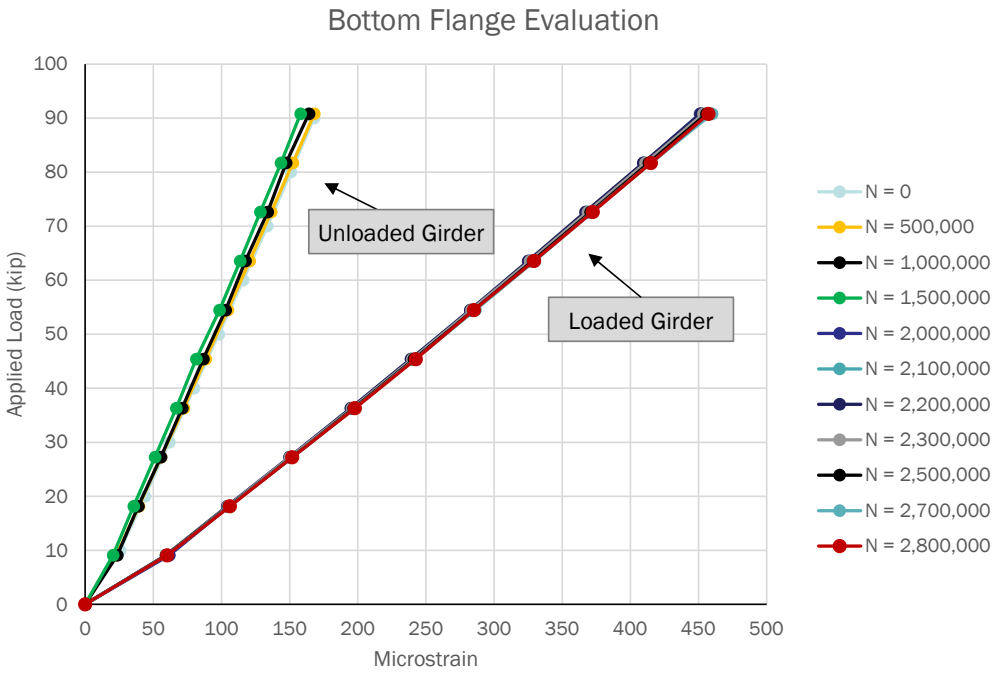
One composite girder was able to withstand over 300 kips before failure!!!



Experimental Testing & Analytical Modeling (cont'd)

- Double module testing (assessing fatigue/service behavior):

No appreciable change in behavior after 2.8 million cycles of loads!



PBFTG Applications

- *Amish Sawmill Bridge (Buchanan County, IA)*
  - Brian Keierleber, P.E., was awarded $350,000 from FHWA IBRD Program to replace the Amish Sawmill Bridge at 1358 Dillon Avenue in Fairbank, Iowa.
    - The grant laid the groundwork to complete the first installation of the proposed modular press-brake-formed steel tub girder system in the U.S.
  - Construction on the Amish Sawmill Bridge began in the late summer of 2015 and was completed in December 2015
    - Completing the journey from concept to implementation in under three years, a remarkable feat in the field of bridge engineering.

PBFTG Applications (cont'd)

- *Muskingum County, OH*
  - PBFTG combined with SPS deck system.
    - Led to extremely shallow superstructure.
    - Served a significant advantage for hydraulic opening
  - Winner of NSBA 2018 Innovative Bridge Award

steel
elastomer
steel

SPS TECHNOLOGY

PBFTG Applications (cont'd)

- *Fourteen Mile Road (Lincoln County, WV)*

PBFTG Applications (cont'd)

- *Additional Applications*

Monroe County, MI

Boone County, MI

Spring Gully, TX

Bridge Technology Center

- Free resource available to bridge owners and designers with questions related to:
  - Standard design and details of short span bridges (plate & rolled beam)
  - Standard design and details of corrugated steel pipe and structural plate.

Bridge Technology Center (cont'd)

- Training & Education Available!
  - Topics
    - Bridge Engineering-101
    - Steel bridge economy & cost-effective design
    - Standard designs (rolled beam, plate, CSP, structural plate)
    - Case studies/cost analysis
  - Format
    - Half-day workshops (county engineers/LTAPs)
    - Webinars (online training / presentations)
    - Steel Bridge Forums (DOTs)
    - Conferences/Trade show presentations
    - Technical Design Support (Bridge Technology Center)
    - SSSBA Website (Solutions Center, videos, etc.)

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Website:
http://www.shortspansteelbridge.org/

Short Span Steel Bridge Alliance – SSSBA

@ShortSpanSteel

Questions?

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