SHORT SPAN STEEL BRIDGE ALLIANCE

STEEL HAS THE SOLUTION

Innovative, Accelerated, and Cost Effective Options for Short Span Bridges

Western Bridge Engineers' Seminar

Michael Barker, PE
University of Wyoming & SSSBA Bridge Technology Center

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Outline of Today's Presentation

- SSSBA & eSPAN140 Design
- Competitiveness of Steel Bridges
- Economics & Bridges Built Using eSPAN140
- Modular Systems
- Training

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Short Span Steel Bridge Alliance - What do we 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

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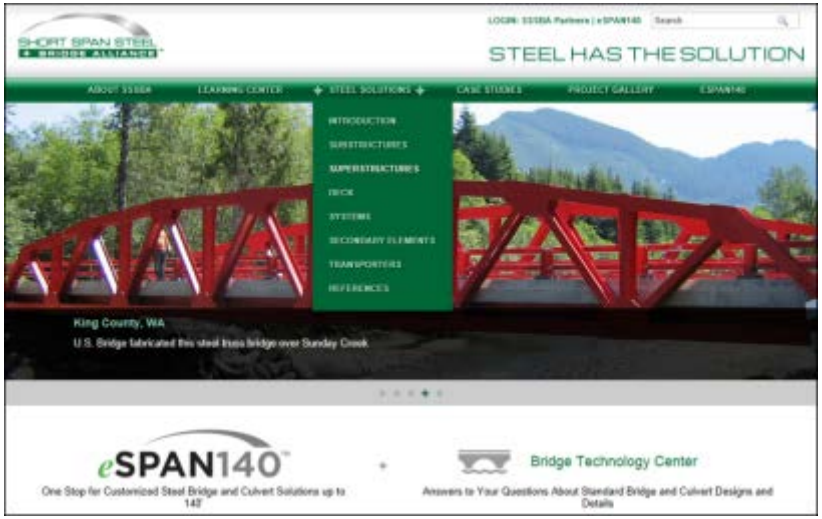
Website



www.ShortSpanSteelBridges.org

- eSPAN140 Web-based Design Tool
- Bridge Technology Center
- Technical Design Resources
- Catalog of Short Span Steel Solutions
- Project Case Studies
- Video & Photo Gallery
- News Updates & Social Media (Twitter / LinkedIn / Facebook)
- Email Newsletter (sign-up to receive it)
- Calendar of Industry Events

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eSPAN140

Free Online Design Tool for
Short Span Steel Bridges

Developed by the Short Span Steel Bridge Alliance

http://www.espan140.com/

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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)

- Range of available solutions:

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
Corrugated Steel Pipe/Structural Shape (0' to 85')		All	All
Manufacturer's Steel Solutions (all)		All	All

eSPAN140

- eSPAN140 is an easy-to-use and **free** resource for bridge engineers & owners.
- In 3 easy steps, multiple steel solutions are recommended!

Step 1.
Create a User's Account

Step 2.
Input Your Specific Project Details

Step 3.
View Your Instant Customized Solutions Books

- Step 2: Project Information

Project Name*
Sample Bridge

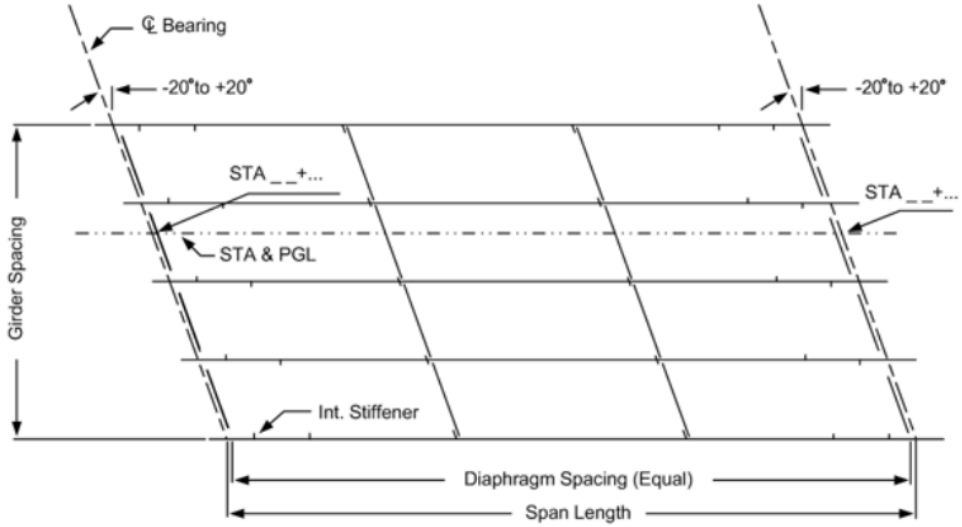
City/County*
Morgantown

State/Province*
West Virginia

Roadway Name
Main Street

Bridge Span Length*
82 Feet
4 Inches

Next > Return to Projects



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- Step 2: Project Details (general dimensions)

# of Striped Traffic Lanes*

2

Roadway Width*

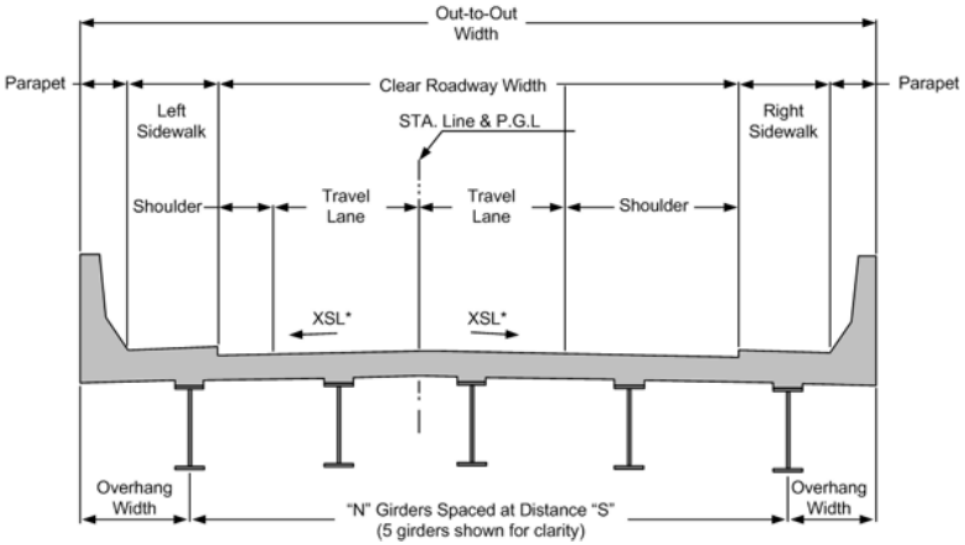
30 Feet 0 Inches

Individual Parapet Width

1 Feet 3 Inches

Individual Deck Overhang Width

3 Feet 0 Inches



- Step 3: Customized Solutions Book is Provided (pdf)

Standard Design and Details of Short Span Steel Bridges Solutions

- Rolled Beam Recommendations
- Plate Girder Recommendations

Standard Design and Details of Corrugated Steel Pipe and Structural Plate Solutions

Manufacturer's Steel Solutions (SSSBA Partners)

- Customized Solutions from Members of the SSSBA

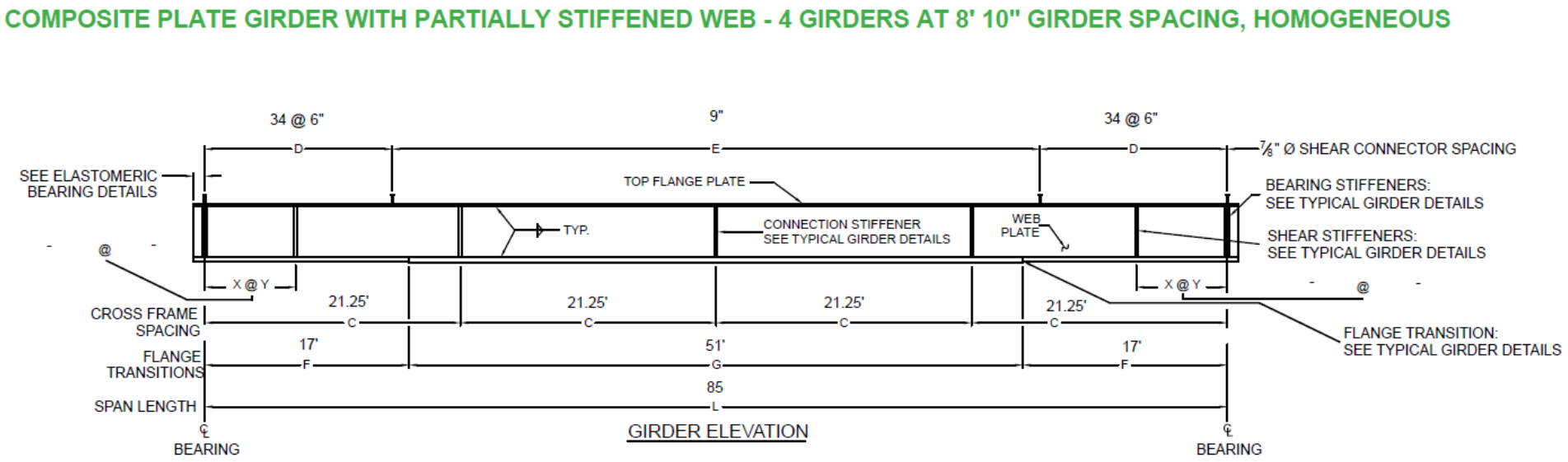
Durability Solutions (SSSBA Partners)

- Galvanized & Paint
- Weathering Steel

Additional Contact Information

Design Example

- Sample plate girder (homogeneous) elevation:



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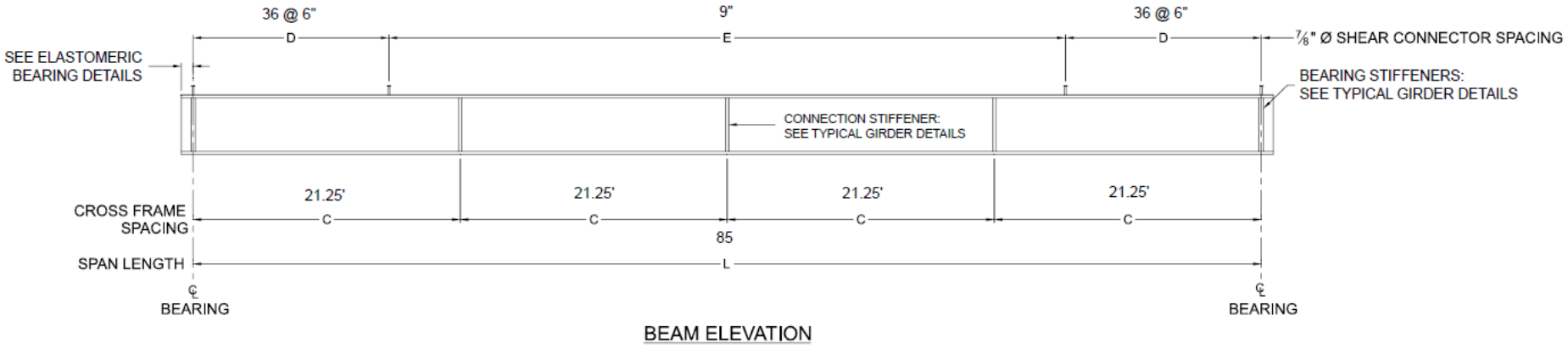
Design Example

- Sample rolled beam (lightest weight) elevation:

COMPOSITE ROLLED BEAM WITH PARTIALLY STIFFENED WEB - 4 GIRDERS AT 8' 10" GIRDER SPACING, LIGHTEST WEIGHT



BEAM ELEVATION

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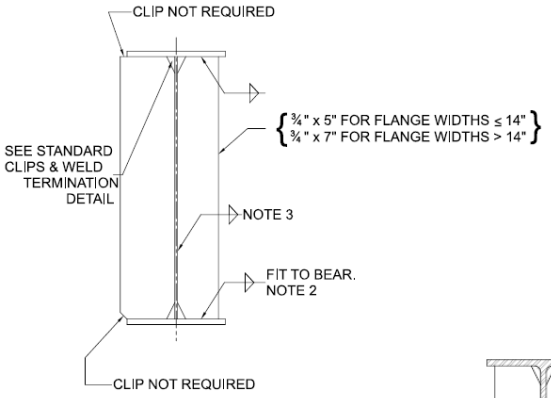
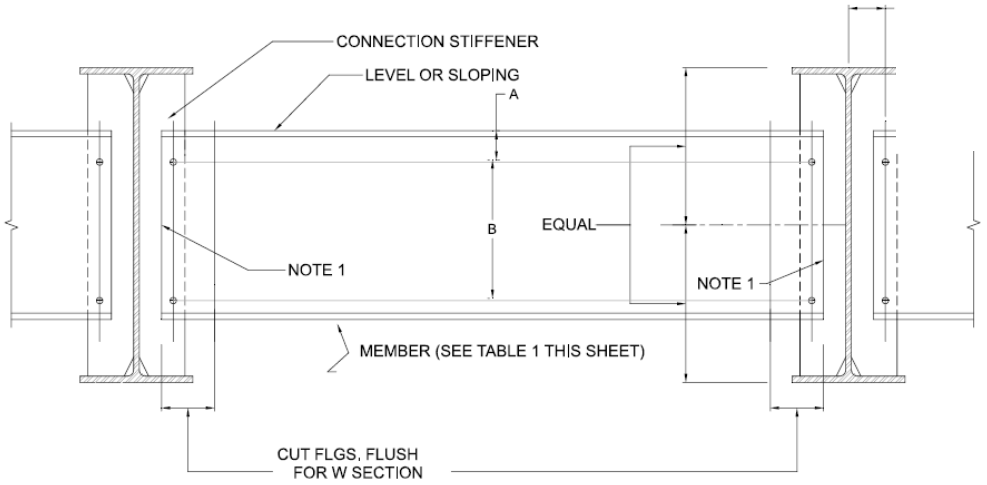
Practical and Economical Detailing

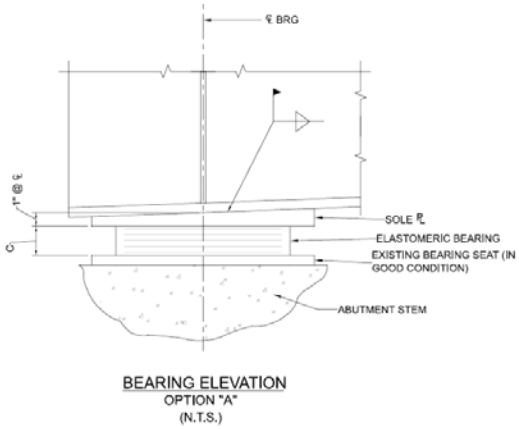
Typical stiffener details



Typical diaphragm details



Typical bearing details



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Economics Case Study

Steel vs. Concrete Costs
Audrain County, MO

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Case Study Bridges: Side-by-Side Comparison

Steel

Audrain County, MO Bridge 411
Built 2012
Steel 4 Girders
47.5 ft. Span
24 ft. Roadway Width
2 ft. Structural Depth
No Skew

Concrete

Audrain County, MO Bridge 336
Built 2012
Precast 6 Hollowcore Slab Girders
50.5 ft. Span
24 ft. Roadway Width
2 ft. Structural Depth
20º Skew

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Case Study Bridges:
Side-by-Side Comparison Total Cost of Structure

Steel

Total Bridge Costs

Material	= $41,764
Labor	= $24,125
Equipment	= $21,521
Guard Rail	= $ 7,895
Rock	= $ 8,302
Engineering	= $ 8,246
TOTAL	**= $111,853 ($97.48 / sq. ft.)**

19.3% Total Bridge Cost Savings with Steel

Concrete

Total Bridge Costs

Material	= $67,450
Labor	= $26,110
Equipment	= $24,966
Guard Rail	= $ 6,603
Rock	= $ 7,571
Engineering	= $21,335
TOTAL	**= $154,035 ($120.83 / sq. ft.)**

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Case Study Bridges:
Side-by-Side Comparison SuperStructure Only Costs
(Remove Site Prep, Abutment, Grading & Finishing, Guardrail, Engineering, Rock, Etc)

Steel: Superstructure $37.54 per sq. ft.

25.8% superstructure cost savings

Concrete: Superstructure Cost $50.61 per sq. ft.

Same bridge conditions:

- Structural Depth = 2 ft. (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

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Case Study Bridges: Other 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**

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eSPAN140 Designed Bridges

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1st Direct Application of eSPAN140 – start to finish

Jesup South Bridge, Buchanan County, Iowa

- Buchanan County Iowa
- Count Crew Built Bridge
- Replacement using W36x135 rolled beams
- 65 feet length, 40 width
- Better Roads (February 2014)

County Crew Accomplishments:

- Longest Bridge Built
- First Steel Bridge Built
- First Concrete Deck
- First Integral Abutment
- Galvanized Steel
- Galvanized Rebar
- County Equipment

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Other eSPAN140 Bridges

- **Boone County, Missouri (Local)**
  - High Point Lane Bridge
  - 102 feet (2 lane rural road plate girder bridge)
  - 44” weathering steel plate girders (4 lines)
  - Constructed in summer 2013

- **Kansas Department of Transportation (State)**
  - Shawnee County
  - 112 feet (5 plate girder bridge)
  - Competitive bid process (steel vs. concrete)
  - DOT used eSPAN140 for preliminary design
  - Constructed in summer 2014

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One More - Boggs Road Bridge Replacement

Muskingum County, OH

Open to traffic in

21- working days

Before:
33-foot Span
22'-7" Wide

After

44 - Foot Span Composite Design:
5 - W24 x 76 GR 50, Galvanized Steel Beams on 5-Foot spacing w/ 2-FT Overhang

MUSKINGUM COUNTY MCEO ENGINEER'S OFFICE

Why 21 Days?

- eSPAN140 related design / used “in-house” engineering
- Local crew installed the bridge
- “Light” crane / light weight and handling
- Stay-in-place forming / shear studs were installed through decking
- Traditional Abutments

BOGGS ROAD BRIDGE REPLACEMENT
STEEL VS. CONCRETE

Material Costs Steel:

1.	Bolt Together Steel Structure	$26,016
2.	Decking (1.5C – 18 ga. Decking	$2,223
3.	Shear Studs	$1,680
4.	Bridge Railing and Guard Rail	$14,590
5.	Reinforcing Steel	$7,490
6.	Concrete /Forms (180.5 CYs)	$27,026
7.	Asphalt Repair	$11,500
	Subtotal	$90,524

Labor and Equipment Costs:

1.	Labor (21 days)	$19,562
2.	Equipment	$21,679

Grand Total = $131,765

= $124.77 /ft^2

Material Costs Concrete:

1.	Concrete Box Beams (6 Beams)	$59,400
2.	Bridge Railing and Guard Rail	$11,500
3.	Reinforcing Steel	$5,000
4.	Concrete/Forms (160 CYs)	$24,000
5.	Asphalt Repair	$11,500
6.	Crane Rental	$2,500
	Subtotal	$113,900

Labor and Equipment Costs:

1.	Labor (18 days)	$14,757
2.	Equipment	$21,679

Grand Total = $150,336

= $142.36 /ft^2

Difference Between Steel Beams and Concrete Box Beams

$18,571

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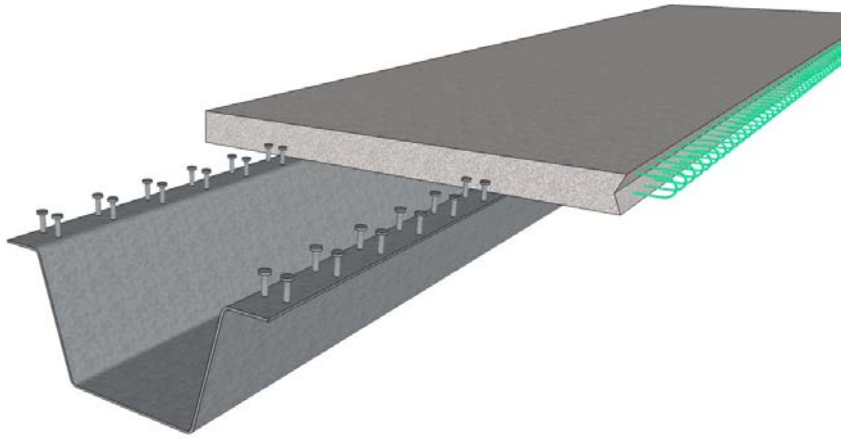
SSSBA Modular ABC Design

Press-Brake Tub Girders



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Press Brake Tub Girders

- Modular shallow trapezoidal boxes fabricated from cold-bent structural steel plate (weathering steel or galvanized).
- Economy through a significant reduction in fabrication costs due to cold-bending versus welding of the section.
- Reduces need for stiffeners and cross frames.
- Allows for a variety of owner-specified decking.
- Advantages include:
  - Accelerated (install in 1 or 2 days)
  - Modular
  - Cost-effective
  - Simple to fabricate and install

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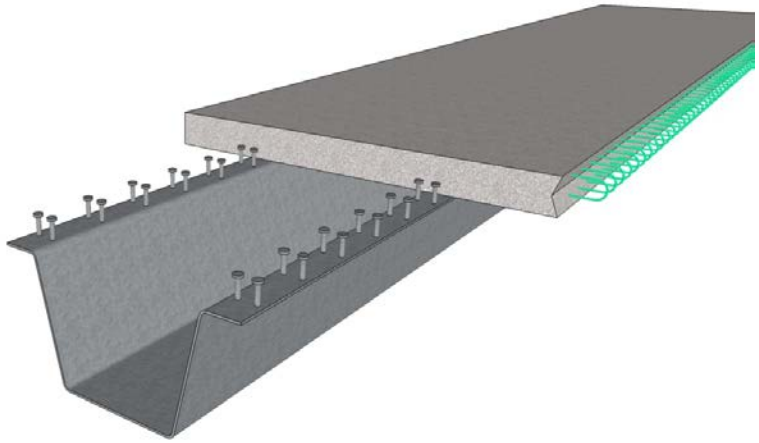
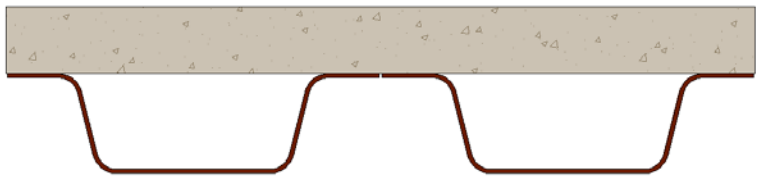
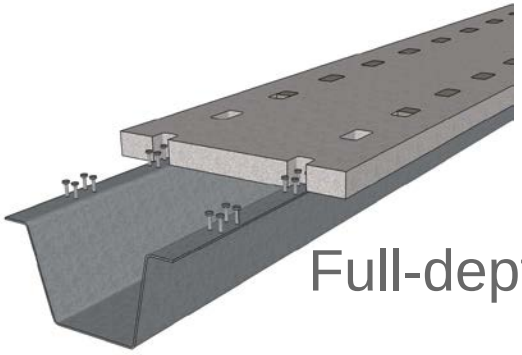
Standardization

- Standardized girders are proposed:
  - PL 72” × 1/2”
    - Applicable for spans up to 40 feet
  - PL 96” × 1/2”
    - Applicable for spans up to 60 feet
  - PL 120” × 5/8”
    - Applicable for spans up to 80 feet
  - Double PL 60” × 1/2”
    - Applicable for spans up to 65 feet

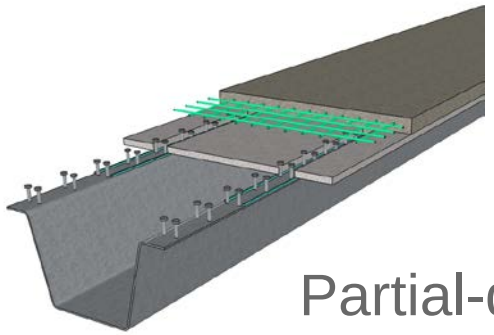




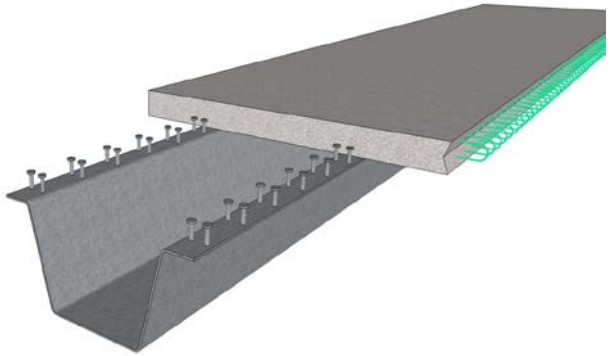
Decking Options



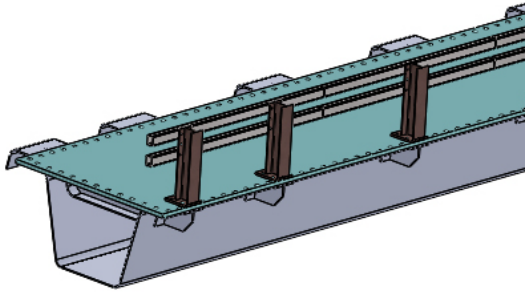
Full-depth panel



Partial-depth panel



Pre-topped



Sandwich plate

2015 Press-Brake Tub Girder

- Continuing PBTG Research

  Michaelson, G., Barth, K., and Barker, M., “Development and Experimental Validation of Composite Press-Brake-Formed Modular Steel Tub Girders for Short-Span Bridges,” Accepted to Bridge Engineering Journal, ASCE.

- Ohio Standard Designs

- First PBTG Built (Almost)
  - Iowa
  - September Start

- PBTG in Ohio and West Virginia Designs for 2016

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Training and Education

Resources & Contact Info

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Training & Education Available

- Format
  - Half-day workshops (county engineers/LTAPs)
  - Webinars (online training / presentations)
  - Steel Bridge Forums (DOTs)
  - Conferences/Trade show presentations

- Topics
  - Bridge Engineering-101
  - Steel bridge economy & cost-effective design
  - Standard designs (rolled beam, plate, CSP, structural plate)
  - Innovative bridge systems
  - Case studies/cost analysis

"Hand-outs" at SSSBA Booth

- **USB Flash Drive**
  - Member information
  - Research materials
  - eSPAN140 information
  - Myths & Realities brochure
- **eSPAN140 & SSSBA info**

All this and other information at:
www.ShortSpanSteelBridges.org

Thank You

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