# Short Span Steel Bridge Cost Effective Solutions

SHORT SPAN STEEL BRIDGE ALLIANCE™

David Clemens
Director – Engineered Product Sales
Wheeler

# Members

Producers

Fasteners

Coaters

Service Centers

Fabricators

SHORT SPAN STEEL BRIDGE ALLIANCE™

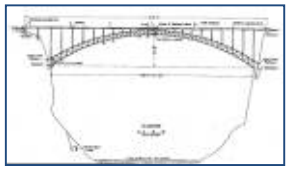
AGA American Galvanizers Association

NCSPA

American Iron and Steel Institute

NSBA

Trade Organizations



Design Firms

Contractors

NACE International — National Association of County Engineers

Bridge Owners

Universities

# What 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)
- Prefabricated Bridge Manufacturers (industry contacts)
- Innovative & ABC Design

eSPAN140™

SHORT SPAN STEEL BRIDGE ALLIANCE™

# Short Span Steel Girder Economics & eSPAN140

**Overview**

Initial Costs

- County Case Studies

Design/Supply Examples

# Initial Costs – Steel vs Concrete

## Preconception:

## Concrete is Less Expensive than Steel for Typical Bridges

Many Times Steel is Not Considered

Paying Too Much?

Add Competition

Case Studies from County Bridges

# Case Study Bridges: Audrain County, MO

**County Crew Built Bridges**

## 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

# Side-by-Side Comparison of Total Cost of Bridge

Steel:

- Total Bridge Costs:
  - Material = $41,764
  - Labor = $24,125
  - Equipment = $21,521
  - Guardrail = $7,895
  - Rock = $8,302
  - Engineering = $8,246
  - **TOTAL = $111,853 ($97.48/ft²)**

**19.3% Total Cost Savings w/ Steel**

Concrete:

- Total Bridge Costs:
  - Material = $67,450
  - Labor = $26,110
  - Equipment = $24,966
  - Guardrail = $6,603
  - Rock = $7,571
  - Engineering = $21,335
  - **TOTAL = $154,035 ($120.83/ft²)**

# Take Out Engineering & Rock Costs

Steel:

- Total Cost per $ft^2$:
  - Total Cost = $97.48/ft^2$
  - Construction = $90.29/ft^2$
    - No Engineering
  - Adjusted = **$83.05/ft^2$**
    - No Engineering or Rock

Concrete:

- Total Cost per $ft^2$ :
  - Total Cost = $120.83/ft^2$
  - Construction = $104.08/ft^2$
    - No Engineering
  - Adjusted = **$98.14/ft^2$**
    - No Engineering or Rock

# Superstructure Only Cost Comparison

## Steel:

- Superstructure Only:
  - Time = 10 days
  - Girders = $21,463
  - Deck Panels = $7999
  - Reinf. Steel = $3135
  - Concrete = $4180
  - Labor = $5522
  - Equipment* = $500
  - TOTAL = $42,799

$37.54 / $ft^2$

## Concrete:

- Superstructure Only:
  - Time = 13 days
  - Slab Girders = $50,765
  - Deck Panels = $0
  - Reinf. Steel = $724
  - Concrete = $965
  - Labor = $4884
  - Equipment* = $4000
  - TOTAL = $61,338

$50.61 / $ft^2$

# True Steel vs Concrete Cost Comparison

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 FT²** | **$74.68** | **$83.91** | **$80.01** | **$102.42** | **$84.68** | **$86.09** | **$91.54** | **$107.63** | **$95.48** | **$91.23** | **$96.32** |

# Summary on Initial Costs

Avoid the Misconception

Steel & Concrete Bridges Are Competitive

Both Steel & Concrete Bridges Should Be Considered for Local Roads

# Axtell, UT

# Buffalo County, WI

# Buffalo County, WI

# Saint Louis County, MN

# Standard Designs for Short Span Steel Bridges –eSPAN140

## Short Span Steel Bridge Alliance Industry-Wide Effort

Goal:

- Economically competitive (repetitive details and member sizes)
- Expedite the design process

Bridge Parameters:

- Span lengths: 20 ft to 140 ft (in 5 ft increments)
  - 20’, 25’, 30’, …, 135’, 140’
- Four increments of girder spacing:
  - 6’-0”, 7’-6”, 9’-0” and 10’-6”
- For each of these increments, the following were designed:
  - Steel girders
  - Shear stud & stiffener layouts
  - Welding and fabrication details
  - Elastomeric bearings
  - Concrete deck design

# Standard Designs for Short Span Steel Bridges –eSPAN140

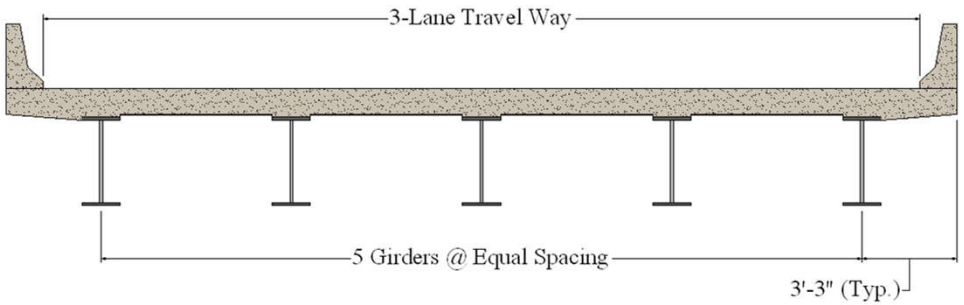
Three Types of Girder Bridges:

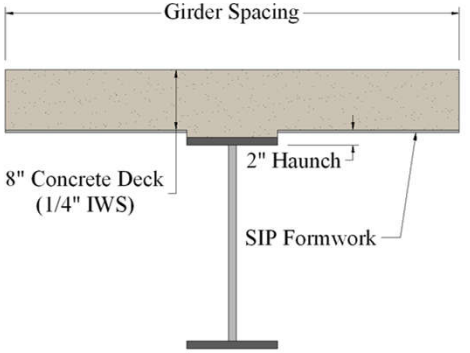

- Homogeneous plate girders (50 ksi steel)
- Lightest weight rolled beams (50 ksi steel)
  - Utilizing the lightest weight girder necessary
- Limited depth rolled beams (50 ksi steel)
  - Designed to meet a target L/D of 25

# Standard Designs for Short Span Steel Bridges –eSPAN140

Bridges were Designed According to AASHTO LRFD Specs:

- Strength I, Service II, Fatigue, Constructability, L/800 Deflection
- HL-93 Vehicular Live Loading




Additional Design Loads:

- SIP unit weight: 15 psf
- FWS: 25 psf
- Concrete Barriers = 305 lb/ft
- Misc. steel wt. increase = 5%
- $f_c'$ = 4,000 psi
- Concrete unit weight = 150 pcf
- Steel unit weight = 490 pcf
- Concrete haunch = 2 in
- Constant flange width
- Constant web height

# Standard Designs for Short Span Steel Bridges –eSPAN140

Summary of lightest weight rolled shape designs:

| COMPOSITE ROLLED BEAM WITH PARTIALLY STIFFENED WEB - LIGHTEST WEIGHT DESIGNS | | | | | | |
|---|---|---|---|---|---|---|
| SPAN (L) - ft. | GIRDER SPACING | | | | SELECTED SECTIONS RECOMMENDED | DIAPHRAGM SPACING (C) - ft. |
| | 6'-0" | 7'-6" | 9'-0" | 10'-6" | | |
| 40 | W21x62 | W21x73 | W24x76 | W24x84 | W24x84 | 20 |
| 45 | W24x68 | W21x101 | W27x84 | W30x90 | W30x90 | 22.5 |
| 50 | W27x84 | W21x111 | W30x99 | W30x108 | W30x108 | 25 |
| 55 | W30x90 | W24x117 | W30x116 | W33x118 | W33x118 | 27.5 |
| 60 | W30x108 | W27x129 | W33x118 | W36x135 | W36x135 | 20 |
| 65 | W33x118 | W30x132 | W36x135 | W40x149 | W40x149 | 21.67 |
| 70 | W33x130 | W30x148 | W40x149 | W40x167 | W40x167 | 23.33 |
| 75 | W36x135 | W36x150 | W40x167 | W36x182 | W36x210 | 25 |
| 80 | W40x149 | W36x160 | W36x182 | W36x210 | | 20 |
| 85 | W40x167 | W36x182 | W36x210 | W36x231 | W36x247 | 21.25 |
| 90 | W40x183 | W40x183 | W40x211 | W36x247 | | 22.5 |
| 95 | W40x211 | W40x199 | W40x235 | W40x249 | W44x262 | 23.75 |
| 100 | W44x230 | W40x211 | W40x249 | W44x262 | | 25 |

# eSPAN140 Overview

eSPAN140 is an easy-to-use and free resource for bridge engineers & owners.

- In 3 easy steps, multiple steel solutions are recommended!

*Developed by the Short Span Steel Bridge Alliance*

*http://www.espan140.com/*

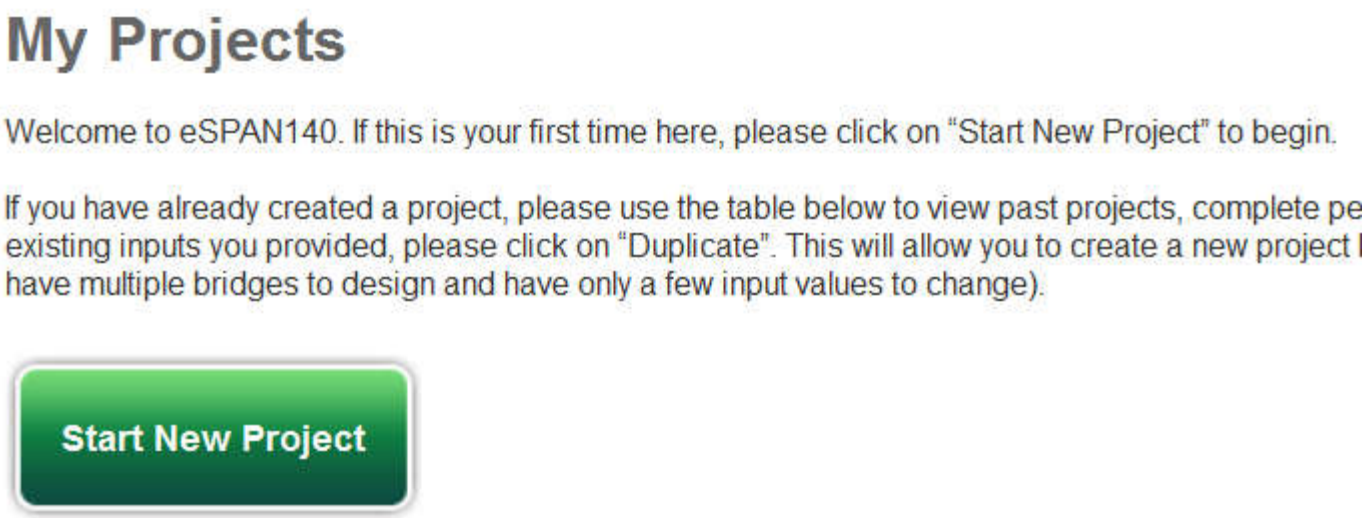
**Step 1.**
Create a User's Account

**Step 2.**
Input Your Specific Project Details


**Step 3.**
View Your Instant Customized Solutions Books

# eSPAN140 Overview

## Start New Project



# Design Example

## Step 2: Project Information

Project Name*

Sample Bridge

City/County*

Morgantown

State/Province*

West Virginia

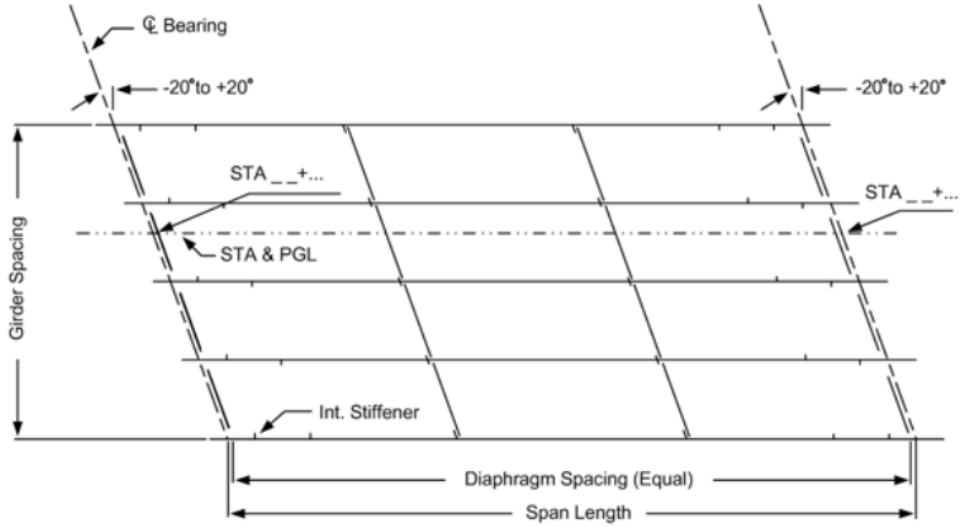
Roadway Name

Main Street

Bridge Span Length*

82 *Feet* 4 *Inches*

Next > Return to Projects



# Design Example

## Step 2: Project Details (general dimensions)

# of Striped Traffic Lanes*

2

Roadway Width*

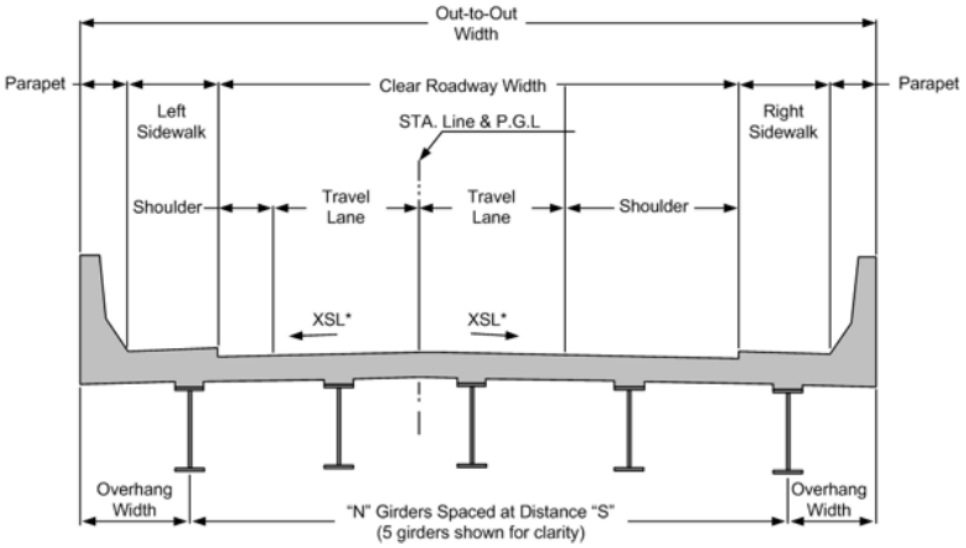
30 Feet 0 Inches

Individual Parapet Width

1 Feet 3 Inches

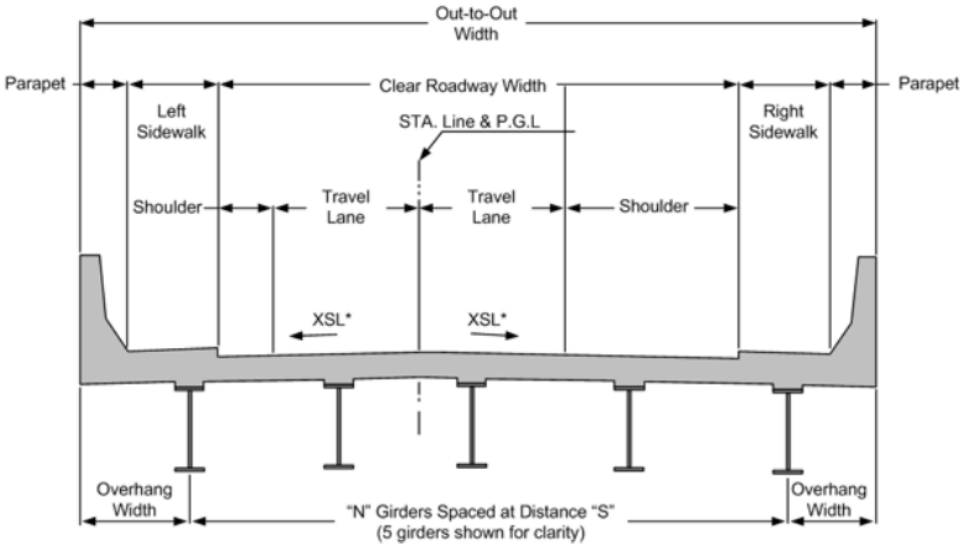
Individual Deck Overhang Width

3 Feet 0 Inches



# Design Example

## Step 2: Project Details (pedestrian access option)

# Design Example

## Step 2: Project Details (remaining details)

Skew Angle

15

*Degrees*

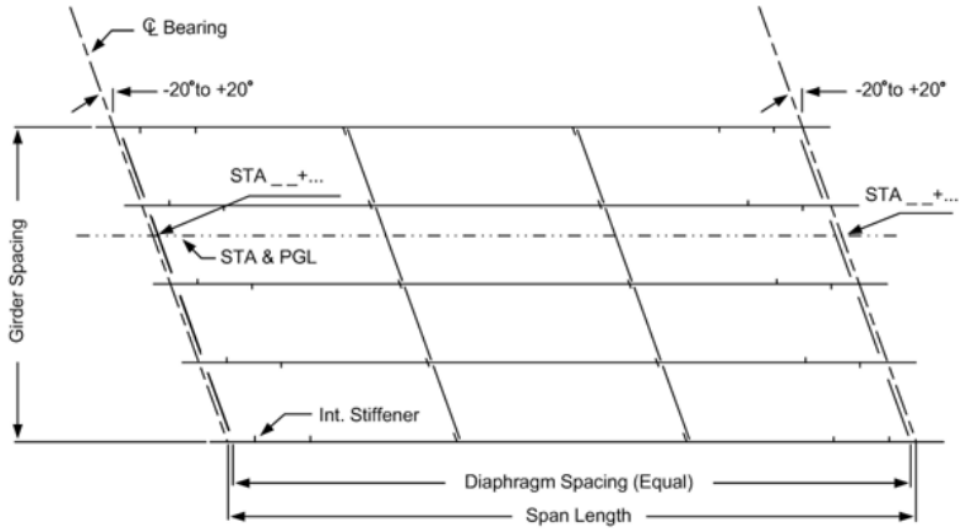
Average Daily Traffic

Over 2,000

Design Speed

Not applicable

< Back  Next >  Return to Projects



# eSPAN140 Overview

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

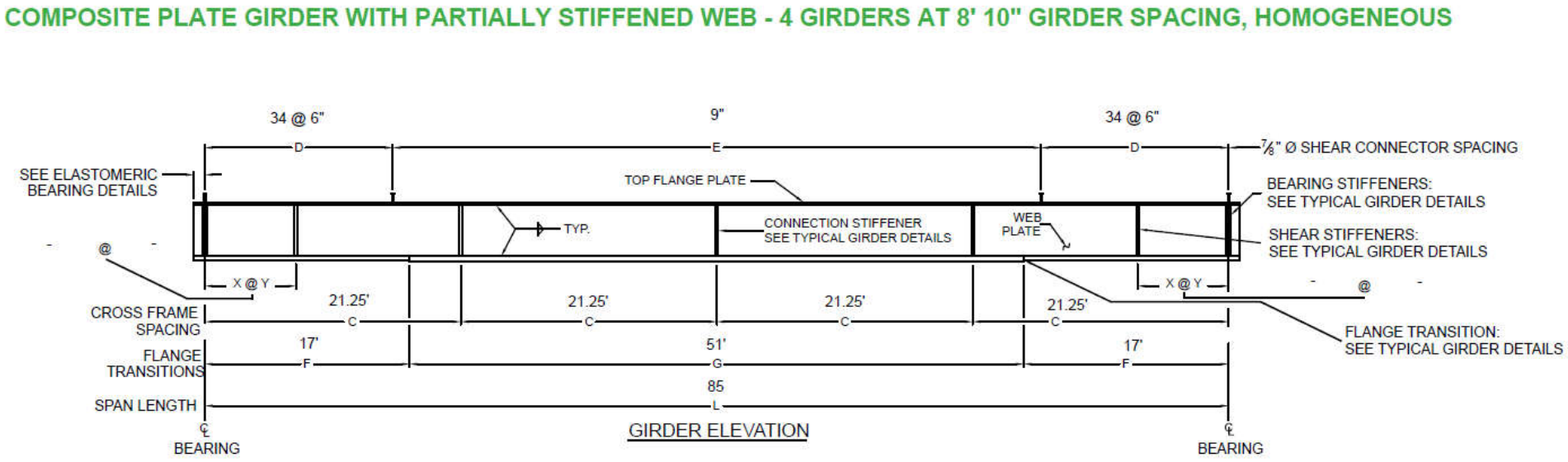
# Design Example Output

## Step 3: Customized Solutions Book (.pdf format)

- Standard Design and Details of Short Span Steel Bridges Solutions
  - Rolled Beam Recommendations
  - Plate Girder Recommendations
- Standard Design 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
  - Producers, Service Centers, Fabricators, Fasteners, Coaters and Industry Organizations

# Design Example Output

## Sample Plate Girder (Homogeneous) Elevation

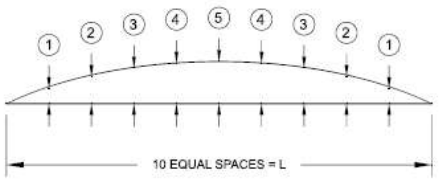


# Design Example Output

## Sample Plate Girder (Homogeneous) Information

| 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 |

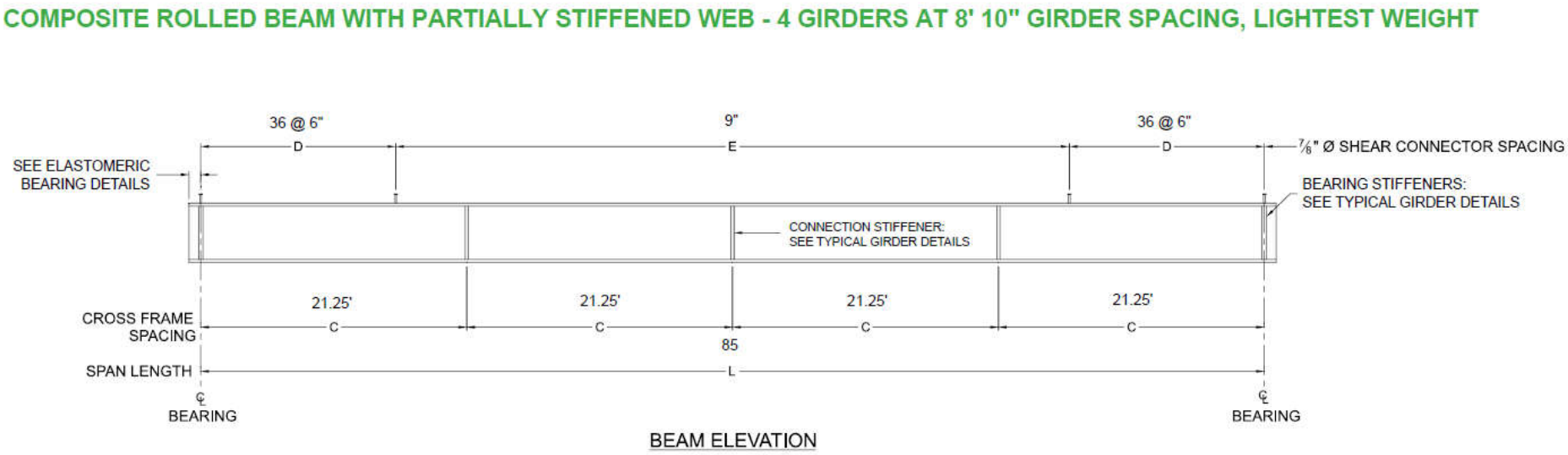
| STEEL D.L. CAMBER - in | | | | | TOTAL D.L. CAMBER - in | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 0.251" | 0.469" | 0.636" | 0.742" | 0.778" | 1.803" | 3.358" | 4.538" | 5.288" | 5.545" |



D.L. CAMBER

# Design Example Output

## Sample Rolled Beam (Lightest Weight) Elevation

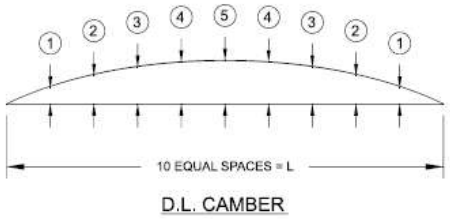


# Design Example Output

## Sample Rolled Beam (Lightest Weight) Information

| SPAN (L) - ft | SELECTED SECTIONS | DIAPHRAGM SPACING (C) - ft | SHEAR CONNECTOR MAX. SPACING | | WEIGHT |
|---|---|---|---|---|---|
| | | | D | E | |
| 85 | W36x247 | 21.25' | 36 @ 6" | 9" | 20,995 lbs |

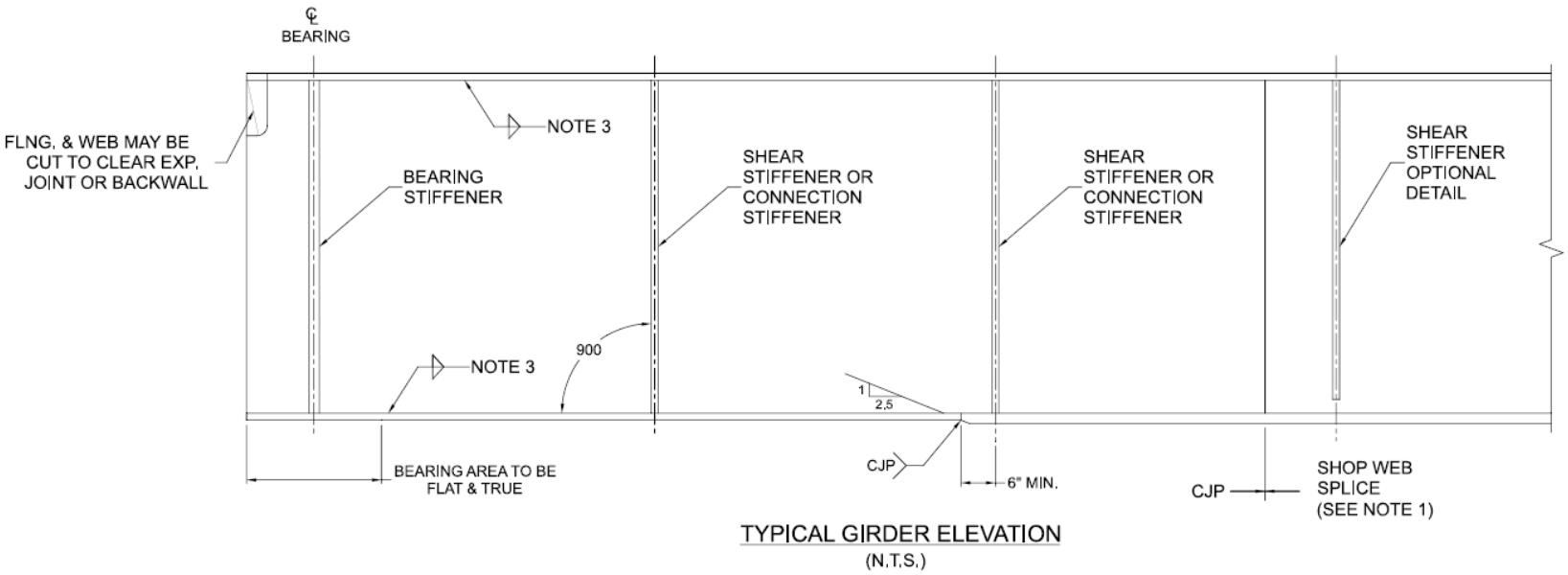
| STEEL D.L. CAMBER - in | | | | | TOTAL D.L. CAMBER - in | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 0.219" | 0.415" | 0.568" | 0.665" | 0.698" | 1.259" | 2.381" | 3.259" | 3.817" | 4.008" |



D.L. CAMBER

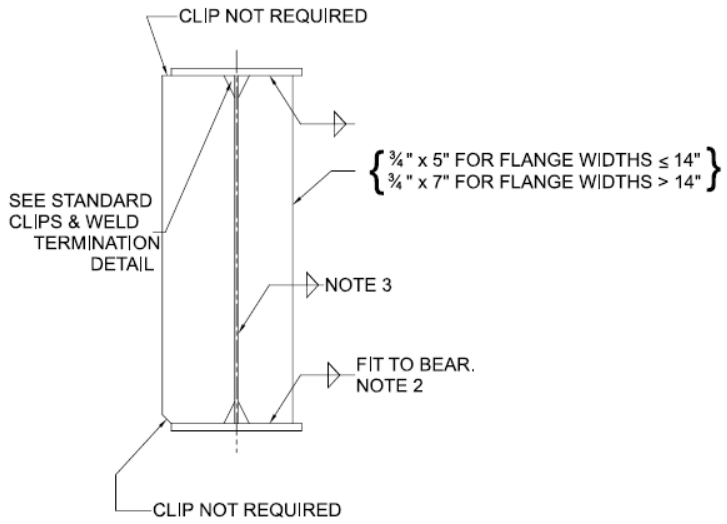
# Design Example Output

## Typical Girder Elevation



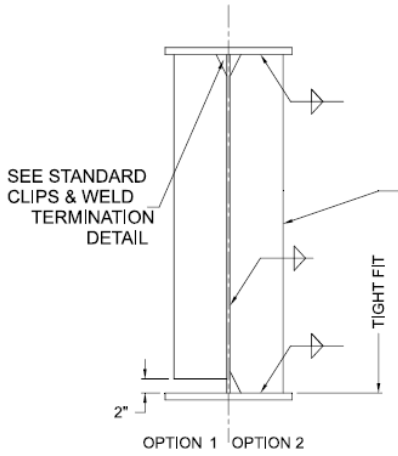
# Design Example Output

## Typical Stiffener Details

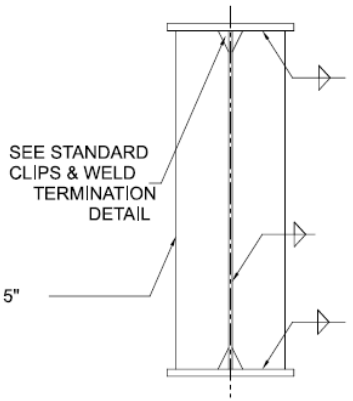



BEARING STIFFENER
(N.T.S.)

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



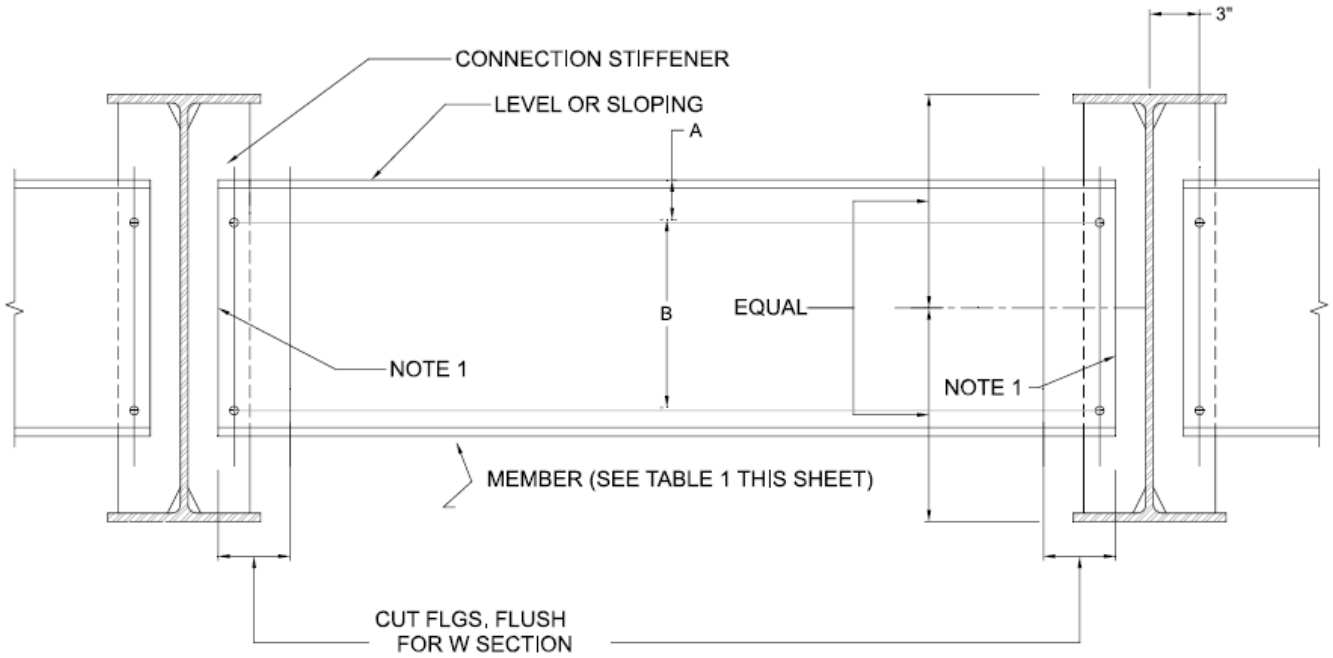

SHEAR STIFFENER
(N.T.S.)




CONNECTION STIFFENER
(N.T.S.)

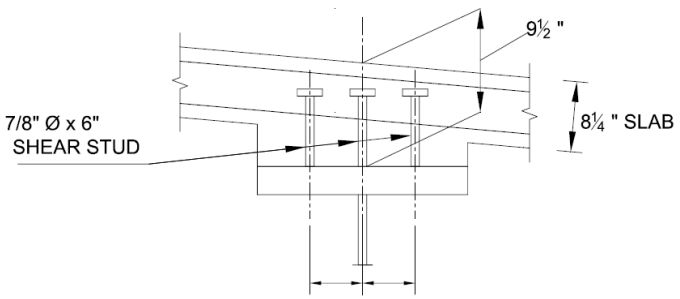
# Design Example Output

## Typical Diaphragm Details

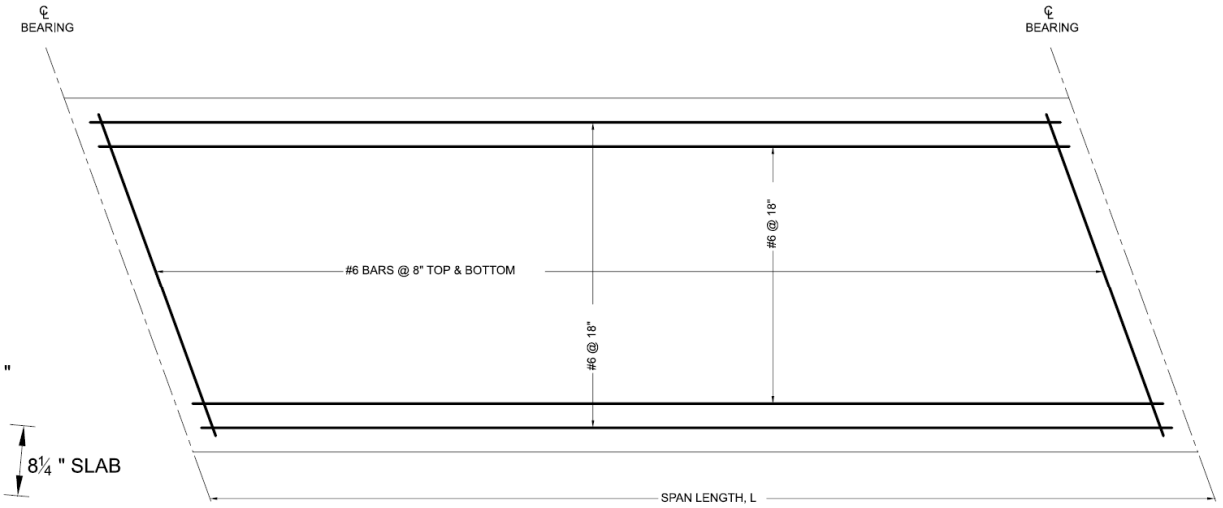


# Design Example Output

## Typical Deck & Shear Stud Details



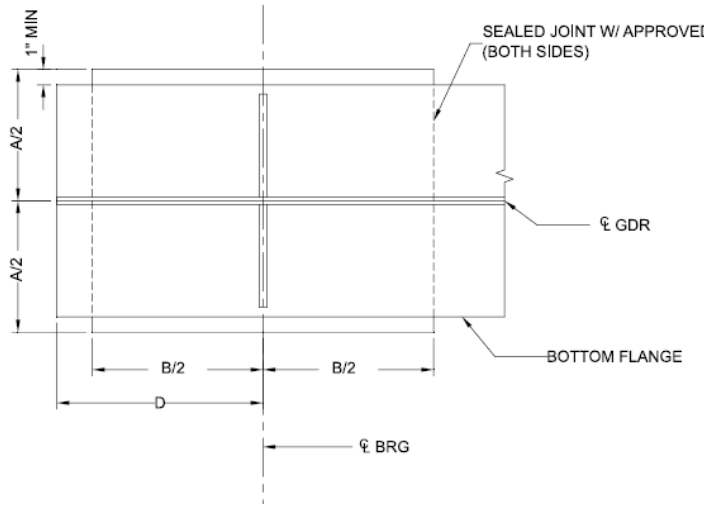

DETAIL A

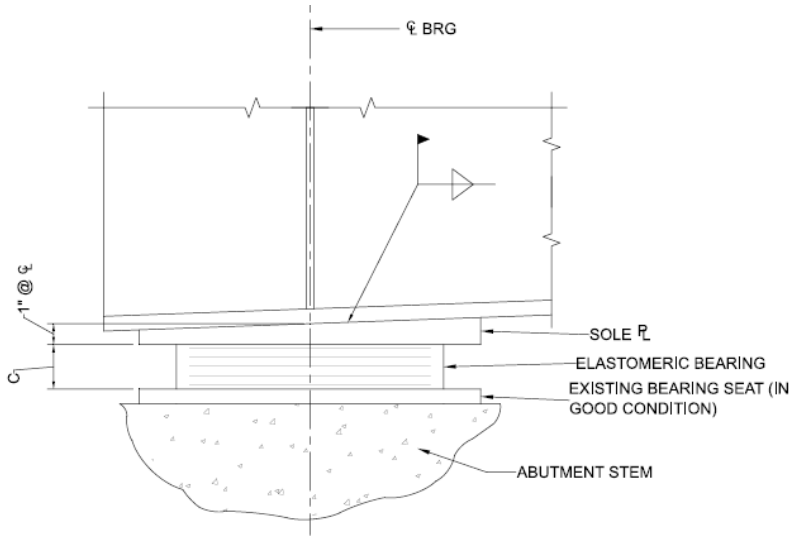



REINFORCING PLAN
(N.T.S.)

# Design Example Output

## Typical End Bearing Details



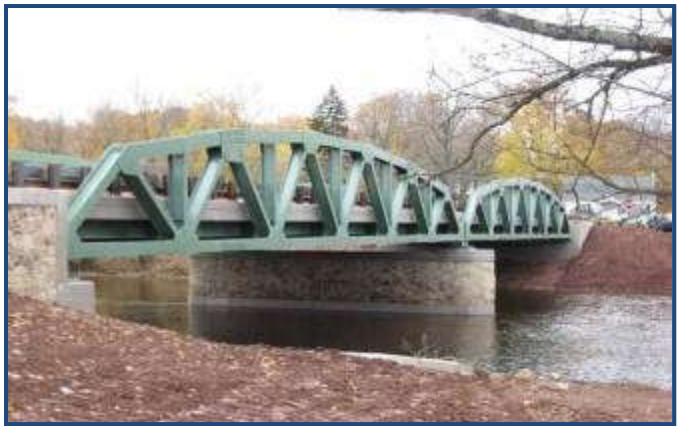

BEARING ELEVATION
OPTION "A"
(N.T.S.)

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

# Design Example Output

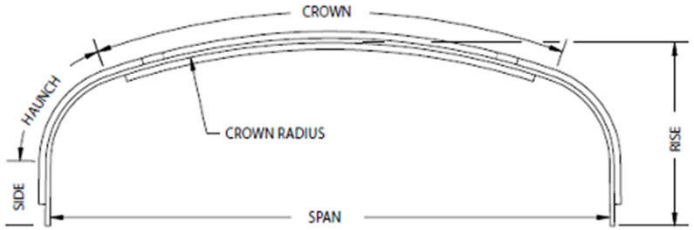
Durability Solutions

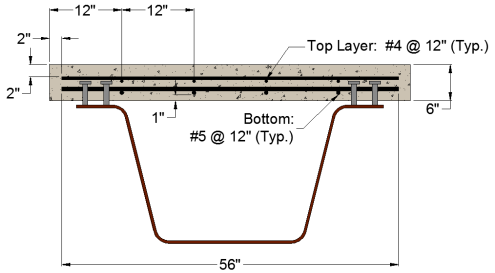
- Weathering steel
- Galvanized steel
- Painted steel

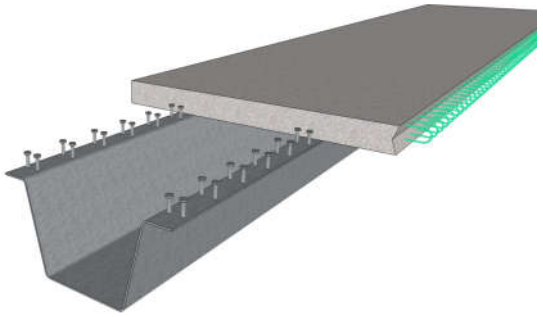


# Also Available through eSPAN140

## Buried Steel Bridge Standards & Press-Brake Tub Girders



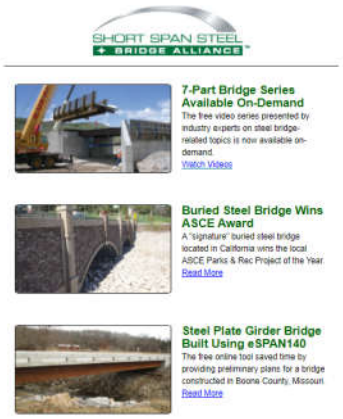



# Also Available through eSPAN140 from Alliance Members

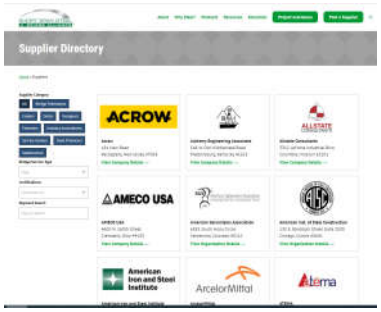
## Manufacturer Member Solutions

# 5 Ways to Keep Learning About Steel Bridges

**1. Subscribe to the Weekly Newsletter**




**2. Find a Supplier**




**3. Design a Bridge in 5-Minutes**

eSPAN140™

**4. Receive Free Project Assistance**

**5. Schedule a Workshop/Webinar**

## www.ShortSpanSteelBridges.org

Questions? Dan Snyder, Director, SSSBA, dsnyder@steel.org, (301) 367-6179

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|---|---|
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