Steel Bridge Design & Fabrication

TEAM Conference

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Anthony Peterson, PE
NSBA – Bridge Steel Specialist, Central Region
peterson@aisc.org
515-499-2029

National Steel Bridge Alliance
A division of the American Institute of Steel Construction
www.steelbridges.org
Steel Bridge Topics

- Steel Plate and Rolled Beam Availability and Price
- Design Considerations
- Bridge Girder Fit
- Bridge Connection Details
- Steel Plate Girder Fabrication
- Bolted Splice Design
- NSBA Overview & Resources for Designers
Steel Plate and Rolled Beam Availability and Price
Steel Plate
Steel Plate

- Structural Plate availability
Steel Plate

- Structural Plate availability

Availability
Intersection

ArcelorMittal

Nucor

SSAB
Steel Plate

• Structural Plate availability

<table>
<thead>
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<th>Producer</th>
<th>Maximum Thickness (in)</th>
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* Approximately 700,000 tons of plate used annually for construction projects in the United States.
Steel Plate

- Structural Plate availability

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</table>

* A709-50 and A709-50W (Non-FC) Availability only.
Rolled Shapes

• Structural Shape availability

- Gerdau Ameristeel
  - Petersburg
- Steel Dynamics
  - Butler
- Nucor-Yamato Steel
  - Blytheville
- Gerdau Ameristeel
  - Beaumont
Rollled Shapes

- ASTM A992; ASTM A709, Grade 50S
  - Minimum Yield = 50 ksi.
  - No HPS

<table>
<thead>
<tr>
<th>Producer**</th>
<th>Maximum Depth (in)</th>
<th>Length (ft)</th>
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<tbody>
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<td>Nucor-Yamato Steel</td>
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<td>Gerdau Ameristeel</td>
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* Maximum length for some beam sizes may be shorter.
** These mills account for over 90% of all wide flange shapes produced in the US
Rolled Shapes

• Structural Shape availability
Historic Material Costs

Relative Construction Producer Price Index

Source: US Bureau of Labor Statistics (St Louis Federal Reserve)
Relative Construction Producer Price Index

Source: US Bureau of Labor Statistics (St Louis Federal Reserve)
Historic Material Costs

Relative Construction Producer Price Index

Source: US Bureau of Labor Statistics (St Louis Federal Reserve)
Historic Material Costs

Relative Construction Producer Price Index

Average Annual Inflation Rates Since 2010:
- All Construction Materials = 2.5%
- Steel = 2.2%
- Concrete = 2.8%

Source: US Bureau of Labor Statistics (St Louis Federal Reserve) - through 12/1/18
Design Considerations
Design

• Rolled Beam vs. Plate Girder
  – Rolled beam generally more economical
  • Dependent on availability – rolling schedules, etc
  – Allow plate girder alternate (show on bid documents)
Welded Plate Option Allowed

- For horizontally curved members with a radius less than 1,200’
- For members requiring camber greater than ¼ of the depth of the member (e.g., 6” camber for a 24”deep member)
- If cover plates are required for the rolled beam option
- Length should be a consideration (over 60’ length)
- Availability on short notice
• Girder Spacing

- Wider is more economical

- A reduced number of girders to be detailed, fabricated, coated, transported, erected, inspected and maintained
  - Fewer bolts, x-frames, bearings, and less welding

- Stiffer structure with smaller relative girder deflection

- Reduced out-of-plane rotations
Design

- Use 10’ to 13’ with spans less than 175’
  (not a lot of appreciable difference in structural steel unit weight)
- Use 11’ to 13’ with spans greater than 175’
Design

- Girder Spacing Considerations
  - Thicker deck may be required for larger spacings
  - Spacing larger than 13’ may require stringers
  - Consider future redecking under traffic
  - Balancing loads for exterior and interior girders
• Girder Spacing
Design

• Minimum Thicknesses
  – Plate girder webs
    • 1/2” minimum
  – Plate girder flanges
    • 3/4” minimum
  – Stiffeners, connection plates
    • 1/2” minimum
Design

• Thickness Increments
  – 1/8” for plate up to 2½” thick
  – 1/4” for plate over 2½” thick

• Width Preferences
  – Fabricators prefer 72” and 96” widths
  – Cost increases with width
Plate Girder Flange Sizing

- Shop butt splices within a shipping piece – when to change area?
  - No more than 2 butt splices or 3 different flange thickness for an individual flange between field splices
  - Flange Thickness
    - 1/8” increments up to 2½”
    - ¼” increments over 2½”
  - Maximum change; thinner piece at least 1/2 of thicker…
  - **ONLY** when material cost saved > labor cost spent
## Flange Sizing – when to change area?

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<thead>
<tr>
<th>Thinner Plate at Splice (inches)</th>
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</table>

**Multiply weight savings/inch x flange width (length of butt weld)**

Weight Saving Factor Per Inch of Plate Width
for ASTM A709-Gr 50 Non-Fracture Critical Flanges Requiring Zone 1 CVN Testing
Plate Girder Flange Sizing

- Shop butt splices within a shipping piece – how to change area? width or thickness?
  - Keep width constant (i.e., to change cross section area, change thickness)
  - WHY?
  - compare changing width vs. changing thickness
Flange Sizing - change width

FABRICATE 4 FLANGE ASSEMBLIES

STEP 1: Bevel (4) plate edges
Flange Sizing - change width

STEP 2: Burn 12 pieces from 3 plates
Flange Sizing - change width

STEP 3: Fit up and tack weld 4 flange assemblies
Flange Sizing - change width

STEP 4: Attach 16 run-off tabs
Flange Sizing - change width

STEP 5: Weld and grind 8 splices
Flange Sizing - change width

STEP 6: Turn over 4 flange assemblies
Flange Sizing - change width

STEP 7: Back gouge, weld and grind 8 butt joints
Flange Sizing - change width

STEP 8: Remove and grind 16 run-off tabs, taper wider plates
Flange Sizing - change thickness

CHANGE THICKNESS

STEP 1: Bevel (4) and taper (2) plate edges
STEP 2: Fit up and tack weld 3 plates
Flange Sizing - change thickness

STEP 3: Attach 4 run-off tabs
STEP 4: Weld and grind 2 splices
• Flange Sizing - change thickness

STEP 5: Turn over 1 piece
STEP 6: Back gouge, weld and grind 2 butt welds
Flange Sizing - change thickness

STEP 7: Remove and grind 4 run-off tabs
Flange Sizing - change thickness

STEP 8: Burn 4 flanges from 1 assembly
STEP 8: Burn 4 flanges from 1 assembly
• Flange Sizing
  – Width transitions increase labor for flange assemblies up to 35%
  – If you must change flange width, do so at bolted field splice (do not clip corners of top flanges)
  – Allow fabricators to eliminate splices within a shipping piece by carrying thicker material through to next designed splice location
Bridge Girder Fit
Skewed and Curved I-Girder Fit Guide

- What is Fit?
- Common Fit Conditions
- Customary Practice
- Recommended Fit Conditions
- Special Considerations
- Design and Analysis
- Conclusion
Girder Fit

• The “Fit Decision”
  • Affects design decisions regarding rotation demands on the bearings.
  • Affects internal force effects for which the cross-frames and girders must be designed.
  • Allows Fabricator/Detailer complete shop drawings and successfully fabricate the bridge components.
  • Allows Erector/Contractor assemble the steel and achieve the desired geometry in the field.
Design

• Differential Dead Load Deflections
  – Skewed girder example
  – Phased construction
    • omit crossframes between phases, if possible
    • otherwise, single angle top & bottom strut (w/ 1 bolt)
Skewed Girders

Skew Angle

Avoid

$\Delta = 1\frac{1}{2}$

$\Delta = 1\frac{1}{2}$

$\Delta = 1\frac{1}{2}$

$\Delta = \text{Differential Deflection}$
Skewed Girders

STAGE 1

Differential Deflection

1 1/2”
Skewed Girders

STAGE 2

STAGE 3

STAGE 4
Skewed Girders

STAGE 5
Skewed Girders

STAGE 6
Skewed Girders

STAGE 7
Plate Girders

- Bearing Stiffeners/Diaphragms, Connection & Intermediate Stiffeners
- Welding
- General Details
Bearing Stiffeners/Diaphragms, Connection & Intermediate Stiffeners

- Bearing stiffeners can be either fabricated normal to top flange or vertical (plumb) under full dead load (DL) – there is no clear benefit one way or the other
- Connection (and intermediate) stiffeners should be normal to top flange
Bearing Stiffeners

Bearing Stiffener Attachment

- mill to bear fit on bottom flange
  - add a fillet weld (if transversely loaded)

- **NO** Complete joint penetration (CJP) weld

- AWS D1.5 tolerances for fit between underside of bottom flange and bearing sole plate (projected area of bearing stiffeners and web)
Bearing Stiffeners

UNLOADED

LOADED

Mill-to-Bear
Bearing Stiffeners

Pipe Option for Skewed Girders
Connection Stiffeners

Connection Stiffener Attachment

- attach to top and bottom flanges
- welds to tension flanges ARE ALLOWED as long as the live load stress range does not exceed the allowable fatigue stress
- if needed, use bolted tab plates ONLY at the specific location, not at all connection plates
- good placement of connection plates should eliminate need for any tab plates
Connection Stiffener Attachment

• Bolted Tab Plate
  (NOT RECOMMENDED)
Skewed Cross Frame Connections

20° maximum skew

preferred (by fabricators)
Skewed Cross Frame Connections

Give the fabricator the option to use either a skewed connection or bent gusset plates.
Skewed Cross Frame Connections
Rolled beams

- Connection stiffener alternate for rolled beams
  - AASHTO requirements revised in 2011 to allow ‘bolted clip angle’ for intermediate diaphragms – see 6.6.1.3.1
Plate Girders

• General Details
  – Intermediate Stiffeners – weld to compression flange, tight fit (per AWS D1.5) to tension flange (not required, but may help fabricator to control flange tilt)
Plate Girders

• General Details
  – Cross Frame design
Plate Girders

• General Details
  – Curved Plate Girders
    • heat curve / cut curve
  – Rolled Beams
    • cold camber OK
Shipping/Fabrication Piece Limits

• To have the most competition:
  - Length < 80 feet
  - Weight < 40 tons
  - Height < 9 feet tall

• To ship by road, ‘max’
  - Length < 175 feet
  - Weight < 90 tons
  - Height < 13.5 feet (on side), < 9.5 feet (upright)
  - Width < 16 feet
Steel Plate Girder Fabrication
Main Steps

- Preparation
- Girder Assembly
- Fit & Weld Components
- Laydown
- Cleaning & Painting
- Final Inspection
- Shipping
Raw Material
Burning
Shop Splicing (SAW)
Material Handling
Plasma Burning
Girder Assembly
Clamp & Tack Web to Flange (GMAW)
Web to Flange Continuous Welding
Web to Flange Continuous Welding
Inspection & Quality Control
Fit & Weld Components
Laydown – Vertical Assembly
Laydown – Horizontal
Laydown – Horizontal
Cleaning & Painting
Final Inspection
Shipping
Shipping
Erection & Placement
Bolted Splice Design
Field Erection

• Note 2 rows of bolts each side of web and 16 bolts each flange
1. New ASTM Bolt Specifications
2. Bolt Design
3. Standard Hole Sizes
4. Girder Field Splice Design
• New Specification Combines 4 Specifications into 1 for both buildings and bridges-F3125
  – A325 Standard Hex Bolt
  – F1852 (A325 Tension Control)
  – A490 Standard Hex Bolt
 – F2280 (A490 Tension Control)
  – + Metric

• The old names become Grades
1. Grade A325: $F_u = 120$ ksi for all diameters (results in an increase in shear capacity for bolts $\geq 1$ in. and increase in required installation tension)

2. Annex A1- Table gives permitted coatings and over tapping required for nuts
   - No hot dip or mechanical galvanizing of Grade A490 bolts
   - F1136 and F2833 Zinc/Aluminum Allowed on all Grades Both A325 and A490
## Slip Critical Connections

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<tr>
<th>Class</th>
<th>Typical Surface</th>
<th>Slip Coefficient</th>
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<tr>
<td>A</td>
<td>Mill Scale</td>
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<tr>
<td>B</td>
<td>Zinc-Rich Paint, Blasted, *Metalized</td>
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<tr>
<td>C</td>
<td>Galvanized</td>
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<td>D</td>
<td>Organic Zinc- Rich Paint</td>
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</table>

*Unsealed metalized zinc or 85/15 zinc aluminum, sealed metalized coatings are not included.*
Bolt Holes

- Hole diameter for bolts greater than or equal to 1” in diameter is increased to the nominal diameter of the bolt plus 1/8”. This eliminates the need to field ream holes to fit large-diameter hot forged bolts, which have a longitudinal forging seam that interferes with holes 1/16” larger than the bolt diameter.

- Miss drilled holes- fill with fully tensioned high strength bolt (Category B fatigue strength).
Remove applicability of the 75 percent and average rules in Article 6.13.1 to the design of bolted and welded splices for flexural members.

Revise general article on design of bolted splices for flexural members implementing new simplified bolted splice design procedure.

Removal of check for slip of bolts during erection of steel.

Simplified design procedure produces more economical field splice designs.
Splice Design Procedure

Design Flange Connection to Develop the Smallest Design Yield Resistance of the Connected Flanges.

\[ P_{fy} = F_{yf} A_e \]

Design Web Connection to Develop the Smallest Factored Shear Resistance of the Connected Webs.

\[ V_r = \phi_v V_n \]

Two Rows of bolts minimum on each side of splice.
Typical Girder Field Splice

- Fill Plate
- Top Flange Splice Plates
- Bottom Flange Splice Plates
Plate Girder Field Splice

- Field Splice
- 92 bolts in each web
- 32 bolts each flange

- Bolts: $312 \times 20 = $6,240
- Labor: $312 \times 10 \text{ min} = 52 \text{ field hours each splice}$
Tub Girder Splice

- Field Splice
- 36 bolts each top flange
- 80 bolts in each web
- 85 bolts bottom flange
- 634 bolts
- 1,902 holes

- Bolts: 634 x $20 = $12,680
- Labor: 634 x 10 min = 106 field hours each splice
Overview & Design Examples

Bolted Field Splices for Steel Bridge Flexural Members
Overview and Design Examples

Fig. 1-1 Typical Bolted Field Splice for an I-Section Flexural Member

The AASHTO design procedure for the design of bolted splices for flexural members given in the 8th Edition LRFD Bridge Design Specifications (2017) is based upon designing the bolted flange and web splice connections for 100 percent of the individual design resistances of the flange and web, that is, the individual flange splices are designed for the smaller design yield resistance of the corresponding flange on either side of the splice, and the web splice is designed for the smaller factored shear resistance of the web on either side of the splice. Therefore, the method satisfies the AASHTO design criteria since the web and flange splices have design resistances equal to the design resistances of their respective components. However, additional forces in the web connections may need to be considered if the flanges are not adequate to develop the factored design moments at the splice.
<table>
<thead>
<tr>
<th>Design Input</th>
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<tr>
<td><strong>Unfactored Loads - Splice Centerline</strong></td>
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<tr>
<td>Moment (kip-ft)</td>
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<tr>
<td>Noncomposite Dead Load (DC1)</td>
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<tr>
<td>Superimposed Composite Dead Load (DC2)</td>
</tr>
<tr>
<td>Future Wearing Surface (DM)</td>
</tr>
<tr>
<td>Positive Live Load plus Impact (L + I)</td>
</tr>
<tr>
<td>Negative Live Load plus Impact (L + I)</td>
</tr>
<tr>
<td>Deck Casting</td>
</tr>
</tbody>
</table>

**Bolt Properties**
- **Bolt Type**: A325
- **Bolt Diameter (in)**: 7/8
- **Web Threads**: Included
- **Flange Threads**: Excluded
- **Surface Condition Factor (K_C)**: 8
- **Hole Size Factor (K_h)**: Standard
- **Top Flange Rows**: 4 (OK)
- **Web Rows**: 2 (OK)
- **Bottom Flange Rows**: 4 (OK)

**Concrete Deck Properties**
- **Composite**
- **Thickness (in)**: 9
- **Haunch (in)**: 0

**Girder Properties**
- **Left**
  - **Grade 50W**: 1
  - **HPC Grade 70W**: 1
- **Right**
  - **Grade 50W**: 16
  - **Grade 70W**: 18

**Web Material**
- **Grade 50W**: 1/2
- **Grade 50W**: 9/16

**Web Depth (in)**: 60
# Flange Splice Calculations

## Load Combinations - Factored Moment

<table>
<thead>
<tr>
<th>Load Combination</th>
<th>Noncomposite Dead Load (DC1)</th>
<th>Composite Dead Load (DC2)</th>
<th>Future Wearing Surface (DW)</th>
<th>Positive Live Load plus Impact (LL+1)</th>
<th>Negative Live Load plus Impact (LL-1)</th>
<th>Deck Casting</th>
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<td>0.00</td>
</tr>
<tr>
<td>Service II - Negative</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>1.30</td>
<td>0.00</td>
</tr>
</tbody>
</table>

## Bolt Factored Shear Resistance

<table>
<thead>
<tr>
<th>Location</th>
<th>Bolt Type</th>
<th>Bolt Area (sq-in)</th>
<th>K_m</th>
<th>Φ</th>
<th>F_y (ksi)</th>
<th>P_y (kip)</th>
<th>R_v - Single Shear (kip)</th>
<th>( \phi_v \cdot C )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flange</td>
<td>A325 - Excluded</td>
<td>0.0013</td>
<td>Standard</td>
<td>0.60</td>
<td>129</td>
<td>39.00</td>
<td>32.33</td>
<td></td>
</tr>
</tbody>
</table>

## Bolt Nominal Slip Resistance

<table>
<thead>
<tr>
<th>Surface Condition Factor (K_j)</th>
<th>Hole Size Factor (K_m)</th>
<th>P_y (kip)</th>
<th>R_v - Double Shear (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>1.00</td>
<td>99.00</td>
<td>99.00</td>
</tr>
</tbody>
</table>

## Strength Limit State Design

<table>
<thead>
<tr>
<th>Location</th>
<th>( F_x ) (ksi)</th>
<th>( F_y ) (ksi)</th>
<th>0.84 (( F_x / F_y ))</th>
<th>Width (in)</th>
<th>Thickness (in)</th>
<th>Filler Plate Thickness (in)</th>
</tr>
</thead>
</table>

---

NOTICE: DO NOT MODIFY THIS SHEET

NSBA Bolted Splice Designer - Plate Girder

National Steel Bridge Alliance - Founded 1955

[NSBA Logo]
NSBA Bolted Splice Designer - Plate Girder

Web Calculations

**Load Combinations - Factored Shear**

<table>
<thead>
<tr>
<th>Load Combination</th>
<th>Noncomposite Dead Load (DC1)</th>
<th>Superimposed Composite Dead Load (DC2)</th>
<th>Future Wearing Surface (DW)</th>
<th>Positive Live Load plus Impact (LL+ I)</th>
<th>Negative Live Load plus Impact (LL- I)</th>
<th>Deck Casting</th>
<th>Factored Shear (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck Casting</td>
<td>-82.00</td>
<td>-12.00</td>
<td>-11.00</td>
<td>19.00</td>
<td>-112.00</td>
<td>140</td>
<td>-114.80</td>
</tr>
<tr>
<td>Service II - Positive</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.70</td>
<td>0.00</td>
<td>0.00</td>
<td>-80.30</td>
</tr>
<tr>
<td>Service II - Negative</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>1.80</td>
<td>0.00</td>
<td>-250.60</td>
</tr>
</tbody>
</table>

**Bolt Factored Shear Resistance**

<table>
<thead>
<tr>
<th>Location</th>
<th>Bolt Type</th>
<th>Bolt Area (sq-in)</th>
<th>K_a</th>
<th>φ_t</th>
<th>F_v (kcal)</th>
<th>P_t (kip)</th>
<th>R_v - Single Shear (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web</td>
<td>A325 - Included</td>
<td>0.6015</td>
<td>Standard</td>
<td>0.80</td>
<td>120</td>
<td>39.00</td>
<td>25.98</td>
</tr>
</tbody>
</table>

**Bolt Nominal Slip Resistance**

<table>
<thead>
<tr>
<th>Faying Surface Class (K_s)</th>
<th>Hole Size Factor (K_h)</th>
<th>P_t (kip)</th>
<th>Slip Capacity - Double (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>1.00</td>
<td>39.00</td>
<td>39.00</td>
</tr>
</tbody>
</table>

**Flange Design Results**

**Flange Moment Resistance Check Results**

<table>
<thead>
<tr>
<th>H_m (kip)</th>
<th>Controlling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>DNA</td>
</tr>
<tr>
<td>Negative</td>
<td>DNA</td>
</tr>
</tbody>
</table>
### Design Result Summary

**Bolts Arrangement**

<table>
<thead>
<tr>
<th></th>
<th>Bolt Rows (Per Side)</th>
<th>Total Bolts (Per Side)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Flange</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Web</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>Bottom Flange</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>

**Splice Plate Dimensions**

<table>
<thead>
<tr>
<th></th>
<th>Thickness (in)</th>
<th>Width (in)</th>
<th>Length (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Flange - Outer</td>
<td>5/8</td>
<td>16</td>
<td>18 3/4</td>
</tr>
<tr>
<td>Top Flange - Inner (Each)</td>
<td>11/16</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Top Filler</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Web</td>
<td>3/8</td>
<td>14 3/4</td>
<td>6 1/2</td>
</tr>
<tr>
<td>Web Filler</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bottom Flange - Inner (Each)</td>
<td>7/8</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>
Steel Bridge Suite

• NSBA Splice
  – 8th Edition AASHTO LRFD
  – Plate Girder Bolted Splice Design Tool
NSBA Overview
What We Do

- We’re out in the Industry
- Bridge Forums
- AASHTO Collaboration Meetings
- Industry Meetings and Trade Shows
- Office/Site visits

- We work in close collaboration with the FHWA and AASHTO.
  - Coauthor with AASHTO on the AASHTO/NSBA Collaboration documents.
  - Major contributor to the FHWA’s *Steel Bridge Design Handbook*.

- We maintain an ever expanding library of publications and white papers.
Market Coverage

- Chris Garrell
- Jeff Carlson
What We Provide

• The NSBA maintains a growing list of technical resources to aid in making steel bridges more economical and constructible.
  • Design support strategies
  • Free software
  • Design Handbook, AASHTO/NSBA collaboration documents
  • Technical white papers
  • Modern Steel Construction Articles
  • New steel bridge technology in the marketplace
  • Material availability
  • Existing conceptual study library
  • Basic raw material price info

• Both updated to AASHTO 8th Edition
NSBA/AISC Technical Resources

- Practical Steel Tub Girder Design
- A Fatigue Primer for Structural Engineers
- Moments, Shears, and Reactions
- Bolted Field Splices
Steel Bridge Design Support

Understanding which steel bridge elements are fracture critical members will provide the required protection while saving on in-service inspection.

AASHTO/NSBA Steel Bridge Collaboration

Guidelines for Design for Constructibility
1. Bridge Steels and their Mechanical Properties
2. Steel Bridge Fabrication
3. Steel Bridge Shop Drawings
4. Structural Behavior of Steel
5. Selecting the Right Bridge Type
6. Stringer Bridges: Making the Right Choices
7. Loads and Load Combinations
8. Structural Analysis
9. Redundancy
10. Limit States
11. Design for Constructability
12. Design for Fatigue
13. Bracing System Design
14. Field Splice Design
15. Bearing Design
16. Substructure Design
17. Bridge Deck Design
18. Load Rating of Steel Bridges
19. Corrosion Protection of Steel Bridges
20. 3-span Straight Steel I-Girder Bridge
21. 2-span Straight Steel I-Girder Bridge
22. 2-span Straight Steel Wide-Flange Beam Bridge
23. 3-span Straight Steel Tub-Girder Bridge
24. 3-span Curved Steel I-Girder Bridge
25. 3-span Curved Steel Tub-Girder Bridge

• http://www.fhwa.dot.gov/bridge/
Steel Bridge Design Resources

- Span to Weight Charts
Steel Bridge Design Resources

- Span to Weight Charts

Single Span – All Girder Spacing

- Bridge Weight (psf) x Bridge Area (sq-ft) x Historical Cost
Steel Bridge Design Resources

- Span to Weight Charts
  - Used during preliminary design phase.
  - Evaluation alternative structures.
  - Quickly determine relative costs.
National Steel Bridge Alliance
Continuous Span Standard Solutions

From first cut... ...to final concept.
Steel Bridge Design Resources

• Continuous Span Standards
  – Center Span: 150 ft – 300 ft (15 foot increments).
  – End Spans: 78% of center span.
  – Girder Spacing: 7’– 6 through 12’ – 0.
  – Homogeneous and hybrid solutions.
  – Web depth to suit material efficiency.

• 88 Unique Steel Solutions.
Continuous Span Standards

• Assist engineers during the TS&L phase
  – Flange plate sizes and lengths
  – Web plate sizes and lengths
  – Diaphragm spacing
  – Stiffener locations
  – Girder weights
  – Shear connector spacing
  – Steel DL and Total DL camber tables
NSBA/AASHTO Collaboration Groups

- Includes participation from DOT’s, consultants, owners, fabricators, contractors and inspectors.
- Meet several times during the year.

**Task Groups**
- TG 1 - Detailing
- TG 2 - Fabrication Specification
- TG 4 - QA/QC
- TG 8 - Coatings
- TG 10 - Erection
- TG 11 - Steel Bridge Design Handbook
- TG 12 - Design for Economy and Constructability
- TG 13 - Analysis of Steel Bridges
- TG 15 - Data Modeling for Interoperability
- TG 16 - Orthotropic Deck Panels
Mission:

… provide a forum where professionals can work together to improve and achieve the quality and value of steel bridges through standardization of design, fabrication and erection.
• Specifications and Guidelines
  – Specifications:
    • Written in “spec language”
    • Can be adopted as a contract document
  – Guidelines:
    • Written as a reference
    • Consensus of the steel industry
NSBA/AASHTO
Collaboration Groups

Documents

• Shop Drawing Approval Review/Approval Guidelines (G1.1-2000)
• Guidelines for Design Details (G1.4-2006)
• Guidelines for Resolution of Steel Bridge Fab. Errors (G2.2-2016)
• Steel Bridge Bearing Design and Detailing Guidelines (G9.1-2004)
• Guidelines for Design for Constructability (G12.1-2016)
• Guidelines for Steel Girder Bridge Analysis (G13.1-2014)
• Specification for Application of Thermal Spray Coatings (S8.2-2017)
• Steel Bridge Fabrication Guide Specification (S2.1-2018)
High impact decisions are often made when minimal relevant information is available…
Right Information at the Right Time

- Project Timeline
- Impact of Decisions
- Available Information

- Project Timeline
Modern Steel Construction

- Monthly publication for steel construction in the US
- Generally at least one bridge article each month
- Submit it to: www.aisc.org/bridgeideas

Circulation = 60,000
68% Engineers
15% Architects
8% Fabricators
Thank you

Anthony Peterson
peterson@aisc.org
515-499-2029

www.steelbridges.org

solutions@aisc.org

www.aisc.org