Copyright ©2015 American Institute of Steel Construction. All rights reserved.

This presentation is provided solely for informational purposes and does not constitute conveyance of any intellectual property rights.

This presentation may not be reproduced or redistributed, in whole or in part, without the prior consent of the American Institute of Construction or the National Steel Bridge Alliance.
Steel Updates to AASHTO 8th Edition

Matt Shergalis, PE
Bridge Specialist

Steel: The Bridge Material of Choice
National Steel Bridge Alliance
A Division of the American Institute of Steel Construction
Background
Background

• AASHTO moved to 3 year revision cycle.
 • 8th Edition is the first document produced on the 3 year cycle.
   – Updates are effective from SCOBS (COBS) meeting in Minneapolis in June 2016.

• Due to new revision cycle, AASHTO saw a number of important updates come through.
Shear Connector Spacing
Increase in Shear Connector Spacing

- Maximum pitch was increased from 24” to 48”.

- 24” spacing came from 1940’s guidance regarding limiting shear spacing to 3x to 4x the slab depth.
- Increased shear spacing facilitates the use of more ABC construction practices while alleviating many of the constructability and alignment issues.
Fatigue Load Factors
Fatigue Load Factors

- Increase in load factors

| Fatigue I — LL, IM & CE only |  | 1.50 | 1.75 |
|-----------------------------|--|-----|--|-----|
| Fatigue II — LL, IM & CE only |  | 0.75 | 0.80 |
Fatigue Load Factors

- Increase in load factors

<table>
<thead>
<tr>
<th>Detail Category</th>
<th>75-yr (ADTT)$_{SL}$ Equivalent to Infinite Life (trucks per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>530 690</td>
</tr>
<tr>
<td>B</td>
<td>860 1120</td>
</tr>
<tr>
<td>B'</td>
<td>1035 1350</td>
</tr>
<tr>
<td>C</td>
<td>1290 1680</td>
</tr>
<tr>
<td>C'</td>
<td>745 975</td>
</tr>
<tr>
<td>D</td>
<td>1875 2450</td>
</tr>
<tr>
<td>E</td>
<td>3530 4615</td>
</tr>
<tr>
<td>E'</td>
<td>6485 8485</td>
</tr>
</tbody>
</table>

\[ 75\text{ - Year (ADTT)}_{SL} = \frac{A}{\left[\frac{(\Delta F)_{IM}}{2}\right] (365)(75)(n)} \]
Fatigue Load Factors

• Increase in load factors

<table>
<thead>
<tr>
<th></th>
<th>Span Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Span Girders</td>
<td></td>
</tr>
<tr>
<td>Continuous Girders</td>
<td></td>
</tr>
<tr>
<td>1) near interior support</td>
<td>1.5</td>
</tr>
<tr>
<td>2) elsewhere</td>
<td>1.0</td>
</tr>
<tr>
<td>Cantilever Girders</td>
<td>5.0</td>
</tr>
</tbody>
</table>

• Resulting changes will increase bottom flange plate sizes on some bridges
  – particularly continuous span bridges on higher volume roadway
Unified Effective Width Approach
Unified Effective Width Approach

• For the calculation of the nominal compressive resistance of members with slender element cross-sections (Articles 6.9.4.1 & 6.9.4.2).
  • Adopted in the 2016 AISC Specification and the 2016 AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
  • Accounts for the effect of potential local buckling of slender elements, supported along one or two longitudinal edges, on the overall column-buckling resistance of the member.
Unified Effective Width Approach

• More streamlined approach that applies to slender plate elements supported along one or two longitudinal edges.

• Assists with the future implementation of new LRFD Design Specifications for noncomposite steel box sections under development.
Skewed & Curved Girder Fit
Skewed & Curved Girder Fit

“Fit” Document

- NCHRP Project 12-79: “Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges”

- NCHRP Project 20-07, Task 355: “Guidelines for Reliable Fit-Up of Steel I-Girder Bridges”
Skewed & Curved Girder Fit

• The contract documents should state the fit condition for which the cross-frames or diaphragms are to be detailed for the following bridge geometries.

  – Straight bridges where one or more support lines are skewed more than 20 degrees from normal.
  – Horizontally curved bridges where one or more support lines are skewed more than 20 degrees from normal and with an $L/R$ in all spans less than or equal to 0.03.
  – Horizontally curved bridges with or without skewed supports and with a maximum $L/R$ greater than 0.03.

• Good practice would always indicate bridge.
# Skewed & Curved Girder Fit

<table>
<thead>
<tr>
<th>Loading Condition Fit</th>
<th>Construction Stage Fit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-Load Fit (NLF)</td>
<td>Fully-Cambered Fit</td>
<td>The cross-frames are detailed to fit to the girders in their fabricated, plumb, fully-cambered position under zero dead load.</td>
</tr>
<tr>
<td>Steel Dead Load Fit (SDLF)</td>
<td>Erected Fit</td>
<td>The cross-frames are detailed to fit to the girders in their ideally plumb as-deflected positions under bridge steel dead load at the completion of the erection.</td>
</tr>
<tr>
<td>Total Dead Load Fit (TDLF)</td>
<td>Final Fit</td>
<td>The cross-frames are detailed to fit to the girders in their ideally plumb as-deflected positions under the bridge total dead load.</td>
</tr>
</tbody>
</table>
Skewed & Curved Girder Fit

- Bullet item added in Article 6.7.4.1 to emphasize importance of cross-frames in controlling torsional stresses & rotations due to eccentric deck overhang loads.
- Language added to Article C6.7.4.2 to discuss beneficial framing arrangements in skewed and curved I-girder bridges to alleviate detrimental transverse stiffness effects.
- Revision made to recommended offset of first intermediate cross-frame placed normal to the girders adjacent to a skewed support.
Skewed & Curved Girder Fit

- Sample beneficial crossframe plan

Offset first interior crossframe recommended distance
Skewed & Curved Girder Fit

- Sample beneficial crossframe plan

Removed every other cross-frame from interior girders
FCM’s and SRM’s
FCM’s and SRM’s

A new Article 6.6.2.2 is added ‘Fracture-Critical Members (FCMs)’

- Contains all existing requirements related to FCMs.
- **Primary** members that are FCMs are to be designated on the contract plans.
  - Members not subject to a net tensile stress under Strength I are not to be designated as FCMs.

- **System Redundant Member (SRM):** A steel primary member or portion thereof subject to tension for which the redundancy is not known by engineering judgment, but which is demonstrated to have redundancy through a refined analysis. SRMs must be identified and designated as such by the Engineer on the contract plans, and designated in the contract documents to be fabricated according to Clause 12 of the AASHTO/AWS D1.5M/D1.5 Bridge Welding Code. An SRM need not be subject to the hands-on in-service inspection protocol for a FCM as described in 23 CFR 650.
FCM’s and SRM’s

Updated Definitions

**Fracture-Critical Member (FCM):** A steel primary member or portion thereof subject to tension whose failure would probably cause a portion of or the entire bridge to collapse.

**Primary Member:** A steel member or component that transmits gravity loads through a necessary as-designed load path. These members are therefore subjected to more stringent fabrication and testing requirements; considered synonymous with the term “main member”.

**Secondary Member:** A steel member or component that does not transmit gravity loads through a necessary as-designed load path.
## FCM’s and SRM’s

<table>
<thead>
<tr>
<th>Member or Component Description</th>
<th>Member or Component Designation</th>
<th>Member of Component Description</th>
<th>Member or Component Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girders, beams, stringers, floorbeams, bent caps, bulkheads, and straddle beams</td>
<td>Primary</td>
<td>Diaphragm, cross-frame, and top-flange lateral bracing members, struts, and mechanically fastened or welded cross-frame gusset plates and top-flange lateral connection plates in straight and horizontally curved bridges</td>
<td>Secondary</td>
</tr>
<tr>
<td>Truss chords, diagonals, verticals, and portal and sway bracing members</td>
<td>Primary</td>
<td>Diaphragm and cross-frame members, and mechanically fastened or welded cross-frame gusset plates and bearing stiffeners at supports in bridges located in Seismic Zones 3 or 4</td>
<td>Primary</td>
</tr>
<tr>
<td>Arch ribs and built-up or welded tie girders</td>
<td>Primary</td>
<td>Bearings, filler plates, sole plates, and masonry plates</td>
<td>Secondary</td>
</tr>
<tr>
<td>Rigid frames</td>
<td>Primary</td>
<td>Mechanically fastened or welded longitudinal web and flange stiffeners</td>
<td>Primary</td>
</tr>
<tr>
<td>Gusset plates and splice plates in trusses, arch ribs, tie girders, and rigid frames</td>
<td>Primary</td>
<td>Mechanically fastened or welded transverse intermediate web stiffeners, transverse flange stiffeners, bearing stiffeners, and vertical and lateral connection plates</td>
<td>Secondary</td>
</tr>
<tr>
<td>Splice plates and cover plates in girders, beams, stringers, floorbeams, bent caps, and straddle beams</td>
<td>Primary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bracing members supporting arch ribs</td>
<td>Primary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent bottom-flange lateral bracing members and mechanically fastened or welded bottom-flange lateral connection plates in straight and horizontally curved bridges</td>
<td>Primary</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Combined Structural Bolt Specification
Combined Structural Bolt Spec

F 3125

F 2280
F 1852
A 325M
A 490
A 325
A 490M
A 490
Bolt Grades

- Bolts categorized by tensile strength

120 ksi Minimum Tensile
- Grade A 325
- Grade A 325M
- Grade F 1852

150 ksi Minimum Tensile
- Grade A 490M
- Grade F 2280

Sample Bolt Specification “ASTM 3125 Grade A325”
Combined Structural Bolt Spec

• Galvanizing of A490 and A3125 bolts still not allowed but A490 bolts can be coated with approved zinc/aluminum coating.

• Note the single strength level for A325 bolts (120 ksi).
  – Anticipate A325 bolts over 1 inch in diameter will be more attractive given the higher strength.
Bolted Splice Connections
Bolted Splice Connections
# Bolted Splice Connections

## Estimated Splice Cost

<table>
<thead>
<tr>
<th>Tub Girder</th>
<th>Web Bolts</th>
<th>Flange Bolts</th>
<th>Shop Cost ($20/ bolt)</th>
<th>Field Labor Hours (10 mins / bolt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate Girder</td>
<td>92</td>
<td>64</td>
<td>$6,240</td>
<td>52 hours</td>
</tr>
<tr>
<td>Tub Girder</td>
<td>160</td>
<td>157</td>
<td>$12,680</td>
<td>106 hours</td>
</tr>
</tbody>
</table>

Plate Girder: 936 drilled holes  
Tub Girder: 1092 drilled holes
NSBA Splice

- Complete with 3 design examples:
  - Plate Girder
  - Deep Girder
  - Tub Girder

Free Download at www.steelbridges.org/nsbasplice.
Top 10 AASHTO Updates Webinar

- For in-depth review of Top 10 AASHTO 8th Edition Updates visit:
  
  aisc.org/education/continuingeducation/education-archives

- Search “AASHTO”
Upcoming 2020 Updates
Upcoming 2020 Updates

- Corrective action to shear stud fatigue life based on fatigue factor changes.
- Improved Article 6.12.2.2.2 addresses the flexural design of noncomposite rectangular box-section members; built-up welded boxes, bolted boxes, and square and rectangular HSS; singly- and doubly-symmetric rectangular sections; homogenous and hybrid sections; all ranges of web and flange plate slenderness; and all relevant limit states.
- Improvements to the web load-shedding factor, $R_b$, for longitudinally stiffened steel girders.
- Proposed downward shift in eqs 6.9.4.2.2a-2 and 6.9.4.2.2a-3 through introduction of factor $c_3=0.075$. 
Questions?
shergalis@steelbridges.org
Phone - (312) 363-8218

www.steelbridges.org

@SteelBridges

National Steel Bridge Alliance
130 E. Randolph St
Suite 2000
Chicago, Ill. 60601