2016 AASHTO LRFD Specification Update

ASCE Met Section
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Why are we here?

- Talk briefly about how the specification change process happens
- Provide an update on changes in the AASHTO specifications
AASHTO Subcommittee Process

- Committees meet throughout the year
- Ballot items are proposed and approved at Committee Level
- AASHTO SCOBS (bridge engineers from the DOT’s) vote annually to approve
AASHTO Subcommittees

- T1 – Security
- T2 – Bearings & Exp. Devices
- T3 – Seismic
- T4 – Construction
- T5 – Loads and Load Distribution
- T6 – FRP
- T7 – Guardrail and Bridge Rail
- T8 – Moveable Bridges
- T9 – Bridge Preservation
- T10 – Concrete Design
- T11 – Research
- T12 – Signs, Luminaires, Signals
- T13 – Culverts
- T14 – Structural Steel
- T15 – Substructures & Walls
- T16 – Timber Structures
- T17 – Welding
- T18 – Bridge Mgmt., Eval, Rehab
- T19 – Computers
- T20 – Tunnels
T5 – Loads and Load Distribution
Guide Specification for Wind Loads on Bridges During Construction

- In 2015 AASHTO changed the format of the wind load design provisions
  - From - The “fastest mile approach”
  - To - The “3 second gust” approach

- The pending construction wind load provisions were tabled until the “completed bridge” provisions could be implemented
Guide Specification for Wind Loads on Bridges During Construction

- What's unique about these provisions?
  - Final bridge pressures are based on wind speeds with a 7% probability of exceedance in 50 years.
    - This is not reasonable for the short exposure period (reduced risk) of bridges under construction

- New wind design procedures based on a 3-second gust model
3-Second Gust Wind Maps

- For NY City (and much of the U.S.) the 3-sec gust is given as 115 mph

- Consider wind at various stages

- Ground surface characteristics are important
  - i.e. dense obstructions, limited obstruction, flat open terrain

- Wind exposure categories
  - How prevalent is the obstruction “around” the bridge site
Guide Specification for Wind Loads on Bridges During Construction

- Wind pressure equation

\[ P_z = 2.56 \times 10^{-6} V^2 R^2 K_z G C_d \]

- V = 3-sec wind speed, ft./sec
- R = wind reduction factor
- \( K_z \) = exposure and elevation coefficient
- G = gust factor, typically 1
- \( C_d \) = drag coefficient

<table>
<thead>
<tr>
<th>Superstructure Construction Duration</th>
<th>Wind Speed Reduction Factor during Construction, R</th>
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<tbody>
<tr>
<td>0-6 weeks</td>
<td>0.65</td>
</tr>
<tr>
<td>6 weeks to 1 year</td>
<td>0.73</td>
</tr>
<tr>
<td>&gt;1-2 years</td>
<td>0.75</td>
</tr>
<tr>
<td>&gt;2-3 years</td>
<td>0.77</td>
</tr>
<tr>
<td>&gt;3-7 years</td>
<td>0.84</td>
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</tbody>
</table>
Guide Specification for Wind Loads on Bridges During Construction

- Wind pressure equation application – assume <6 weeks duration

\[
P_z = 2.56 \times 10^{-6} V^2 R^2 K_z G C_d
\]

\[
P_z = 2.56 \times 10^{-6} (115)^2 (0.65)^2 (0.71, or 1, or 1.15)(1)(2.2)
\]

- = 22 psf, 31 psf, 36 psf @ approx. 30’ above ground

- Prior to this Specification there was no value other than 50psf in an AASHTO design specification for bridges
Guide Specification for Wind Loads on Bridges During Construction

GIRDER NUMBER

1

2

3

4

5

6

AND UP

S

GIRDER SPACING

D

GIRDER DEPTH

S/D ≤ 3

DRAG COEFFICIENT

C₀base

C₀base

0.25 C₀base

0.25 C₀base

0.25 C₀base

0.5 C₀base
Assessment Question – Wind Loading

- True or False – *The wind design approach used for structures under construction is the same as we use for completed bridges?*
T-10 Concrete
Chapter 5 – Concrete

- Q - What changed?
  - A – EVERYTHING
  - A – NOTHING (MUCH)

- Let’s explain
Chapter 5 – Concrete

- AASHTO LRFD Bridge Design Specifications was published in 1994.
- Some frustration about how this affected the usability over time.
- Many felt the organization of the section had become confusing and that there were inconsistencies between articles.
Chapter 5 – Concrete

- AASHTO T-10 funded a pooled fund project
- Modjeski and Masters, along with Dr. Dennis Mertz were selected as the Contractor for the reorganization process
- T-10 invited PCI and ASBI, to participate in the reorganization.
- Past interims were reviewed for accuracy and to make sure no inconsistencies had been introduced into Section 5.
- A revised TOC was recommended
- This is why “EVERYTHING” is different
Chapter 5 - Concrete

- So what did we wind up with?
- As Dr. Kulicki surmised as the effort was near completion...We have “old friends in new places”
Rewrite Goals

- Advancing the concept of B-Regions and D-Regions
- Promote the strut and tie method (STM) for D-Regions
- Keeping the current bending and axial design articles for B-Regions
- Reducing the number of shear design procedures
- Consolidate prestressed, non-prestressed, and seismic details into 3 separate articles
- Have topics and procedures appear only once in the section
- Organize Section 5 such that more common design provisions appear before more unique design provisions
Chapter Reorganization

- 5.1 – Scope (Introduce B and D region concept)

  - The provisions of this Section characterize regions of concrete structures by their behavior as:

    B- (beam or Bernoulli) Regions or
    D- (disturbed or discontinuity) Regions

  The characterization of regions into B-Regions and D-Regions is discussed in Article 5.5.1.
Chapter Reorganization

- The next 3 sections
  - 5.2 – Definitions
  - 5.3 – Notation
  - 5.4 – Material properties

are virtually unchanged
Chapter Reorganization

- 5.5 – Limit states and design methodologies (further clarification of B and D regions)
- Regions of a concrete structure shall be characterized by their behavior as B- (beam) or D- (disturbed) Regions.
Chapter Reorganization

- 5.6 (old 5.7)– Design for flexural and axial force effects – B Regions (clarifies these articles only apply to B regions)

- 5.7 (old 5.8) – Shear and torsion B Regions
  - Vcw and Vci removed (again)
  - Segmental moved to 5.12.5
Chapter Reorganization

- **5.8 (old 5.6) Design of D Regions**
  - 5.8.2 Includes S&T Method enhancements introduced in 2016 interims (old 5.10.9.4)
  - 5.8.3 Includes recommendations for elastic analysis of anchor zones (old 5.10.9.5)
  - 5.8.4 Approximate methods of analysis (old 5.10.9.6)
    - Deep beams, brackets and corbels, ledges, local zones, general zones etc.
Chapter Reorganization

- **5.9 Prestressing**

- **5.10 Reinforcement**
  - Only RC structures
  - Pieces from old 5.10 and 5.11

- **5.11 Seismic Details**
  - Old 5.10.11 but pushed “out” in the structure to be more prominent
Chapter Reorganization

- 5.12 Provisions for components and structure types (old 5.13)
  - Deck slabs
  - Superstructures
  - Beams and girders
  - Diaphragms
  - Segmental
  - Arches
  - Culverts
  - Footings
  - Piles
Chapter Reorganization

- 5.13 Anchors (new borrowed from ACI 318-14)
Chapter Reorganization

- 5.13 Anchors (new borrowed from ACI 318-14)
- 5.14 Durability
  - Design concepts
  - Chemical and mechanical factors
  - Cover
  - Coating
  - Protection for tendons
Assessment Questions – Concrete Design

- A method of design used for the design of disturbed regions is called:
  - (a) a finite element model
  - (b) the modified compression field theory
  - (c) a strut and tie model

- To design post-installed anchors, an engineer must rely on an ACI or some other documents
  - True or false?
T-14 Steel Structures
New load factors for the Fatigue 1 and 2 Limit States.

Based on calibration performed as part of SHRP2 Project R19B, 100-yr service life

Consequences
- Harder to meet infinite life check
- Finite life check stresses increase slightly

<table>
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<tr>
<th>Fatigue I</th>
<th>1.50</th>
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<tbody>
<tr>
<td></td>
<td>1.75</td>
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<table>
<thead>
<tr>
<th>Fatigue II</th>
<th>0.75</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.80</td>
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</table>
T-14, Steel Structures

- New “cycles per passage” table
- Simplified (eliminated under / over 40 ft. distinction)
- Generally lesser cycles per passage (lowers finite life cycles)
- These new factors come from WIM data calibration

<table>
<thead>
<tr>
<th>Longitudinal Members</th>
<th>Span Length</th>
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<tbody>
<tr>
<td></td>
<td>&gt;40.0 ft</td>
</tr>
<tr>
<td>Simple Span Girders</td>
<td>1.0</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></td>
</tr>
<tr>
<td>Orthotropic Deck Plate</td>
<td></td>
</tr>
<tr>
<td>Connections Subjected to Wheel Load Cycling</td>
<td></td>
</tr>
</tbody>
</table>
T-14, Steel Structures

- Improved details and descriptions for detailing to avoid constraint-induced fracture (CIF), i.e. “Hoan” details
- Example – Longitudinal Stiffeners
T-14, Steel Structures

- Example – Bearing Stiffeners
T-14, Steel Structures

- Example – Gusset Plates
Assessment Question – Fatigue Design

- The 7th edition AASHTO load factors for fatigue are 1.5 for Strength I and 0.75 for Strength II. In the 8th edition these will be revised to ..... ?
T-14, Steel Structures

- Fit & geometry changes to Art 6.7.2
- Numerous new definitions added to Ch. 6 glossary
  - Contiguous cross frame
  - Discontinuous cross frame
  - Fit condition
  - Locked-in forces
  - NLF, SDLF, TDLF Detailing
  - Phased construction
  - Staged deck placement
T-14, Steel Structures

- **Fit & geometry changes to Art 6.7.2**
  - Suggest engineers consider effect of slab placement and staged construction of camber
  - Requires the contract to plans to state a fit condition for certain bridges
    - NLF, SDLF, TDLF
  - Allows for a reduction on DL crossframe forces for bridges detailed as TDLF
    \[
    \left( \gamma_p \right)_{\text{red}} = \left( \gamma_p - 0.4 \right)
    \]
  - For further information see NCHRP Project 12-79 and 20-07 Task 355 reports
T-14, Steel Structures

- C6.7.4.2 Commentary changes to address detailing highly skewed steel bridges with staggered cross frames
- To reduce high crossframe forces, recommend to have no crossframe closer than 4 * b.f and 0.4*L.b from a support location
Assessment Question – Skewed Bridges

- To minimize forces in cross frames it is best to:
  - (a) Frame crossframes directly into a support
  - (b) Provide contiguous crossframe across the width of the bridge
  - (c) Offset crossframes from skewed supports
  - (d) Provide a noncontiguous pattern, i.e. a broken line
  - (e) C & D
6.10.3.4.2 Global Displacement Amplification

- Added $C_{bs}$ factor to buckling capacity

$$M_{gs} = C_{bs} \frac{\pi^2 W_g E}{L^2} \sqrt{I_{eff} I_x}$$

- $C_{bs} = 1.1$ for simple spans, $= 2.0$ for fully erected continuous spans

- Suggests that the point at which more refined analysis be conducted be raised to 70% of this predicted capacity
Shear Studs (6.10.10.1.2)

- Revises shear stud spacing to not exceed 48” (up from the prior limit of 24”)
- Spacing is still required to meet Fatigue and Strength Limit State Requirements
- Facilitates precast deck panel installation
Bolt shear strength

- Updated shear strength equations for HS bolts
  - i.e. old $0.48 = 0.6 \times 0.8$
  - Now $0.56 = 0.625 \times 0.9$

- Also revised “long lap splice” reduction to a 0.83 factor for lap splices longer than 38in. (was 0.8 @ 50in.)

- Where threads are excluded from the shear plane:
  \[
  R_N = 0.48 A_b F_{ub} N_s \\
  R_n = 0.56 A_b F_{ub} N_s
  \]

- Where threads are included in the shear plane:
  \[
  R_N = 0.28 A_b F_{ub} N_s \\
  R_n = 0.45 A_b F_{ub} N_s
  \]
Bolt shear strength

- New slip coefficients
- Some coefficients modified
- Class D added for inorganic zinc coatings that could not meet Class B

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Surface</th>
<th>Coefficient</th>
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<tbody>
<tr>
<td>Class A</td>
<td>A</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td>Class B</td>
<td>B</td>
<td>0.50</td>
</tr>
<tr>
<td>Class C</td>
<td>C</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td>Class D</td>
<td>D</td>
<td>0.45</td>
</tr>
</tbody>
</table>
New Bolt Designation

- ASTM F3125 replaces A325, A490, F1852, F2280
Bolted Field Splices – “Rock the World Item”

- The 75% rule is gone as is the “average of the load and member strength” criteria
- Develop the web shear strength
- Develop the flange capacity
  - Is it enough to carry $\varphi M_n$?
  - If so --- done
Bolted Field Splices – “Rock the World Item”

- If not, carry the balance of the moment through a web force

\[ A_w = \frac{D}{2} + t_{haunch} + \frac{t_s}{2} \]

\[ P_{fy} = F_{yf} A_s \]
Current LRFD

- Top Flange = 24 bolts
- Bottom Flange = 28 bolts
- Web = 102 Bolts
Adopted LRFD

- Top Flange = 24 bolts
- Bottom Flange = 24 (28) bolts
- Web = 50 (102) Bolts

- Will this work?
Current LRFD (Left) vs New LRFD (Right)
Assessment Question – Bolted Splices

- For the design of new splices which statement is true:
  - (a) Moment is carried by the web and flanges
  - (b) Flange splices are only designed for a force due to the factored / actual bending moments
  - (c) Flange and web splices must be independently capable of developing the flange axial strength and web shear strength
Guide Design Specifications for Bridge Temporary Works, 2nd Ed.

- Design oriented temporary works guide
- ASD and LRFD included
- Section 2 (Loads) significantly updated since last edition
  - New load combinations
  - New basic loads
Construction Handbook for Bridge Temporary Works, 2nd Ed.

- Construction oriented temporary works guide
- Focuses on quality and means / methods
- Addresses falsework, formwork and temporary retaining structures
Conclusions

- Concrete Design
  - Few technical changes but a new organization

- Steel Design
  - Continuation of incremental technical changes

- Construction
  - Various new documents and new technologies