AASHTOWare Bridge Update

SCOBS T-19

Todd Thompson, Chair
AASHTOWare Bridge Task Force
Agenda

• Bridge Design and Rating
  • Update on Releases
  • Modernization
Releases since last year

- 6.7.1 – March 2016
  - Multi-cell Concrete Box Enhancements
- 6.8 – July 2016
  - PS Design Tool Phase 1
  - Rating Tool
  - Regression Comparison Tool
Multi-cell Concrete Box Enhancements

- Point-of-Interest Control Options – (supports, 10th points, critical shear locations)
- Specify effective support locations for all concrete beams
- Added a Web Schematic to Show Stirrups and Dimensions
- Performance Improvements
- Added Range of Applicability Override for LRFD Distribution Factors Calculations
Enhancements for 6.7.1 – March 2016

Multi-cell Concrete Box Enhancements

- Added a Web Schematic to Show Stirrups and Dimensions
Enhancements for 6.7.1 – March 2016

Multi-cell Concrete Box Enhancements

• Performance Improvements

• Added Range of Applicability Override for LRFD Distribution Factors Calculations
## Enhancements for 6.8 – July 2016

### User Group Enhancements

<table>
<thead>
<tr>
<th>Incident</th>
<th>Description</th>
<th>Product</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>JIRA 687</td>
<td>LFR analysis of reinforced concrete and post-tensioned multi-cell box beams</td>
<td>BrR</td>
<td>Completed for 6.8 release</td>
</tr>
<tr>
<td>(Ranked #3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JIRA 553</td>
<td>3D FEM and 3D FEM-Vehicle Path analysis of superstructure with hinges</td>
<td>Both</td>
<td>Completed hinge modeling study for 3D girder system models</td>
</tr>
<tr>
<td>(Ranked #4)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Enhancements for 6.8 – July 2016

### Top Maintenance Items

<table>
<thead>
<tr>
<th>Incident</th>
<th>Description</th>
<th>Product</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI 10332</td>
<td>Ability to specify design vehicles in the Shear Stud Design Tool and Shear Stirrup Design Tool</td>
<td>BrD</td>
<td>Completed for 6.8 release</td>
</tr>
<tr>
<td>VI 12091</td>
<td>Ability to process only applicable limit states based on vehicle categories for reinforced concrete box culverts</td>
<td>Both</td>
<td>Completed for 6.8 release</td>
</tr>
<tr>
<td>VI 12135</td>
<td>Culvert Wizard for creating culverts, culvert structure alternatives and assign culvert definitions to alternatives</td>
<td>Both</td>
<td>Completed for 6.8 release</td>
</tr>
<tr>
<td>VI 12608</td>
<td>Ability to specify limit states for LRFD design review of reinforced concrete box culverts</td>
<td>BrD</td>
<td>Completed for 6.8 release</td>
</tr>
<tr>
<td>JIRA 269</td>
<td>Remove Uniform Load Contraflexure Points dead load case from the Analysis Results window</td>
<td>Both</td>
<td>Completed for 6.8 release</td>
</tr>
<tr>
<td>JIRA 452</td>
<td>Ability to enforce unique name for the Bridge Workspace items in a folder</td>
<td>Both</td>
<td>Completed for 6.8 release</td>
</tr>
<tr>
<td>JIRA 499</td>
<td>Ability to specify LRFD 6th Edition 2013 Interim for LRFD design review and LRFR analysis of reinforced concrete box culverts</td>
<td>Both</td>
<td>Completed for 6.8 release</td>
</tr>
</tbody>
</table>
Enhancements for 6.8 – July 2016

Curved Girder Part 3 – Diaphragm and Lateral Bracing Rating

- Enhances the existing 3D analysis capabilities for straight and curved girders

- Cross Frame Definitions
- Cross Frame Spec Checking

- Lateral Bracing Definitions
- Lateral Bracing Spec Checking
Enhancements for 6.8 – July 2016

- Nonstandard Gage analysis for Floor Systems

- Refinements to the strain-compatibility computation of PS beam flexural capacity
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1

• I beams
• Box beams
• Tee beams
• Debonded or harped strands
• Simple span
• Continuous spans
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1

- Enter basic geometry
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1

• Enter load descriptions
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1

- Enter design parameters
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1

• Initiate a design run
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1
Specification Checking Details

PS Design Tool Test 4 - BID9.brdx - Design Run 1-11.1

Specification reference:
- 2.5.2.6.2 Criteria for Deflection
- 5.11.4.2 Bonded Strand
- 5.4.2.1 Compressive Strength
- 5.4.2.5 Poisson's Ratio
- 5.4.2.6 Modulus of Rupture
- 5.5.3.1 Fatigue Limit State - General
- NA 5.5.3.2 Reinforcing Bars
- 5.5.4.2 PS Strength Limit State - Resistance Factors
- 5.7.2.2 Rectangular Stress Distribution
- 5.7.3.2 Flexural Resistance (Prestressed Concrete)
- 5.7.3.3.2 Minimum Reinforcement
- 5.8.2.5 Minimum Transverse Reinforcement
- 5.8.2.7 Maximum Spacing of Transverse Reinforcement
- 5.8.3.3 Nominal Shear Resistance
- 5.8.3.4 Procedures for Determining Shear Resistance
- 5.8.3.5 Longitudinal Reinforcement
- 5.8.4.4 Minimum Area of Interface Shear Reinforcement
- 5.8.4 Interface Shear Transfer

Pass/Fail:
- Passed
- General Comp.
- Not Required

Span 1 - 66.00 ft.

Span 1 - 0.00 ft.
Span 1 - 6.16 ft.
Span 1 - 11.00 ft.
Span 1 - 22.00 ft.
Span 1 - 33.00 ft.
Span 1 - 44.00 ft.
Span 1 - 55.00 ft.
Span 1 - 66.00 ft.
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1
Specification Checking Details

Spec Check Detail for 5.7.3.2 Flexural Resistance (Prestressed Concrete)

Concrete Structures
5.7 Material Properties
5.7.3 Flexural Members
5.7.3.2 Flexural Resistance
(AASHTO LRFD Bridge Design Specifications, Seventh Edition - 2014, with 2015 Interim)

PS I Wide - At Location = 66.0000 (ft) - Left Stage 3

Cross Section Properties

Name: BT-72
Girder f'c = 7.00(ksi) Girder f'ci = 5.50(ksi)
Slab f'c = 4.00(ksi)

Effective Slab Width = 123.00(in)
Effective Slab Thickness = 8.00(in)
Haunch Width = 42.00(in)
Haunch Thickness = 0.50(in)
Beam Height = 72.00(in)

Total Aps = 7.20(in^2)
Total CGS = 7.52(in)
Eff Aps = 7.20(in^2)
Eff CGS = 7.52(in)

Flexural Reinforcement

<table>
<thead>
<tr>
<th>As (in^2)</th>
<th>Dist. From Bottom (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.40</td>
<td>77.13</td>
</tr>
<tr>
<td>3.72</td>
<td>77.06</td>
</tr>
<tr>
<td>10.81</td>
<td>74.90</td>
</tr>
</tbody>
</table>

Note: If the capacity has been overridden, the Resistance is computed as override phi*override capacity.
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1

Tabular Results

![Tabular Results](image_url)
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1

Graphical Results
Enhancements for 6.8 – July 2016

Prestressed Concrete Beam Design Tool – Phase 1
Export the design to BrD
Rating Tool – Phase 1

• New tool for computing rating factors very quickly by using precomputed analysis data

• Tool can be used by permitting systems or within BrR to compute ratings for a list of bridges and vehicles

• LFR capability

• Steel and concrete multi-girder straight superstructures

• LRFR, floor systems and trusses in subsequent phases
Enhancements for 6.8 – July 2016

Rating Tool – Phase 1

BrDR UI

Yes

Bridge has Pre Comp Data

Rating Tool

No

BrDR

3rd Party Permit Routing System

Yes

Bridge has Pre Comp Data

Rating Tool

No

BrDR
Regression Comparison Tool

• New tool to assist with regression testing of BrDR

Regression testing is a form of testing that verifies that the work performed to add new features and capabilities did not break or inappropriately alter the existing code causing incorrect results or behavior.

• A large part of the testing is regression testing

• Based on NCHRP Report 485 – Bridge Software – Validation Guidelines and Examples
Regression Comparison Tool

- Improve the efficiency of regression testing

- Can be used for:
  - Comparison of two versions of BrDR (Regression Testing)
  - Comparison of two editions of the specification
  - Comparison of two analysis engines within BrDR

- Includes features that help find differences and identify the cause of those differences
The modernization proposes to create more powerful, easier to use tools to assist agencies in designing and load rating their inventory in a more cost-effective manner.
Modernization Update

Software Design Process:

- Worked with Professor Anthony Lattanzia from the Software Research Institute at Carnegie Mellon University
- Conducted a workshop with stakeholders to identify the requirements that drive the software design
- Top 4 Drivers
  - Performance
  - Usability
  - Extensibility
  - Modifiability
Modernization Update

Software Design Process:

• Completed an architecture design to satisfy those requirements.

• Performed numerous tests/experiments to evaluate the design especially with regard to the drivers

• Beginning the task of preparing mockups of the new user interface

• Continuing the design of the analysis engine based on the P/S Design Tool engine design
Modernization Update

Timeline:

• Phase 1 – Modernize the analytical modules
  ➢ Release June 2018
  ➢ Includes Legacy maintenance release
  ➢ Existing user interface with the modernized analysis engine
  ➢ Both the modernized engine and the legacy engine will be available for use

(At this point, since no enhancements have been implemented, the analysis results of the modernized engine should closely match the legacy engine analysis results)
Modernization Update

Timeline:

• Phase 2 – Modernize the user interface and the rest of the system
  - Release June 2019
  - Includes last Legacy maintenance release
  - The modernized user interface and access to the database with the modernized engine – i.e. the *fully modernized system*
Modernization Update

Timeline:

• Phase 3 – Implement selected user-requested enhancements
  ➢ Release June 2020
  ➢ The fully modernized system with selected user-requested enhancements
Modernization Update

• Modernization Kickoff meeting ½ day following the RADBUG meeting
  • Subdividing the TRT members into various groups and tasks
    • GUI TRT
    • Reports TRT
    • Beta Testing TRT
  • Providing overview
  • Tasking them with items with to start reviewing
  • Hope that all participants will be able to help BETA Test when the time arises
In conclusion…

**Improve efficiency** for more than 500 consultants and 40 agencies.

“It’s all about the data!” Licensing agencies have an enormous investment in their bridge data. **The data and your investment will be preserved.**
3D Bridge Models

• Watching progress on 3D and which data exchange method might be used
• Refine or redevelop method(s) to be able to exchange data with others into/from Bridge Design Rating after the decision has been made
<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>Todd Thompson</td>
<td>South Dakota</td>
</tr>
<tr>
<td>Vice Chair</td>
<td>Eric Christie</td>
<td>Alabama</td>
</tr>
<tr>
<td>Member – BrM</td>
<td>Bruce Novakovich</td>
<td>Oregon</td>
</tr>
<tr>
<td>Member – BrM</td>
<td>Thomas Martin</td>
<td>Minnesota</td>
</tr>
<tr>
<td>Member – BrM</td>
<td>Mark Faulhaber</td>
<td>Kentucky</td>
</tr>
<tr>
<td>Member – BrM</td>
<td>Beckie Curtis</td>
<td>Michigan</td>
</tr>
<tr>
<td>FHWA Liaison – BrM</td>
<td>Derek Constable</td>
<td>FHWA</td>
</tr>
<tr>
<td>Member – BrR</td>
<td>Joshua Dietsche</td>
<td>Wisconsin</td>
</tr>
<tr>
<td>Member – BrD</td>
<td>Jeff Olsen</td>
<td>Montana</td>
</tr>
<tr>
<td>Member – BrD</td>
<td>Dean Teal</td>
<td>Kansas</td>
</tr>
<tr>
<td>Member – BrR</td>
<td>Amjad Waheed</td>
<td>Ohio</td>
</tr>
<tr>
<td>FHWA Liaison – BrDR</td>
<td>Tom Saad</td>
<td>FHWA</td>
</tr>
</tbody>
</table>
User Group Training Meetings

- **Bridge Design and Rating**
  RADBUG
  August 2-3, 2016
  Chicago, ILL

- **Bridge Management**
  BrMUG
  September 20-21, 2016
  San Antonio, TX
Thank you