Snake River Bridge Load Test
Addressing Bridge Management Issues
WBES 2015 – Reno, NV

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Presentation Outline

1. Description of the Structure
2. Standard Load Rating Results
3. General Problem & Selected Resolution
4. Testing Plan Overview
5. Data Review & Model Creation
6. Model Calibration Results
7. Refined Load Rating Results
8. Project Conclusions
Snake River Bridge – Location
Snake River Bridge – Overall Details

<table>
<thead>
<tr>
<th>Span 1</th>
<th>Span 2</th>
<th>Span 3</th>
<th>Span 4</th>
<th>Span 5</th>
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<tbody>
<tr>
<td>39 ft</td>
<td>185 ft</td>
<td>239 ft</td>
<td>185 ft</td>
<td>39 ft</td>
</tr>
</tbody>
</table>
Snake River Bridge – Structure Type

Typical Section Spans 1 & 5
(Reinforced Concrete)

Half Typical Section Spans 2, 3, & 4
(Steel)
Snake River Bridge – Initial Load Rating Results

Oregon DOT Rating (LRFR) Using BRASS Software

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Vehicle Wt. (kips)</th>
<th>LRFR Legal Rating Factors</th>
<th>Controlling Member</th>
<th>Controlling Location</th>
<th>Controlling Limit State</th>
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<tbody>
<tr>
<td>ODOT Type 3</td>
<td>50</td>
<td>1.00</td>
<td>Steel Girder</td>
<td>Span 2 @ 0.35L</td>
<td>Positive Flexure</td>
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<tr>
<td>ODOT Type 3S2</td>
<td>80</td>
<td>0.73</td>
<td>Steel Girder</td>
<td>Span 2 @ 0.35L</td>
<td>Positive Flexure</td>
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<tr>
<td>ODOT Type 3-3</td>
<td>80</td>
<td>0.73</td>
<td>Steel Girder</td>
<td>Span 2 @ 0.35L</td>
<td>Positive Flexure</td>
</tr>
</tbody>
</table>

TD Rating (LFR) Using AASHTOWare Bridge Rating Software

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Vehicle Wt. (kips)</th>
<th>LFR Operating Rating Factors</th>
<th>Controlling Member</th>
<th>Controlling Location</th>
<th>Controlling Limit State</th>
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<tbody>
<tr>
<td>Idaho Type 3</td>
<td>54</td>
<td>0.62</td>
<td>Steel Stringer</td>
<td>Span 4 @ 2.0</td>
<td>Negative Flexure</td>
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<tr>
<td>Idaho Type 3S2</td>
<td>79</td>
<td>0.69</td>
<td>Steel Stringer</td>
<td>Span 3 @ 2.0</td>
<td>Negative Flexure</td>
</tr>
<tr>
<td>Idaho Type 3-3</td>
<td>79</td>
<td>0.72</td>
<td>Steel Stringer</td>
<td>Span 2 @ 9.0</td>
<td>Negative Flexure</td>
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</table>
Diagnostic Testing Overview

Testing Goal - To capture the overall structural behavior of the primary girders and floor system.

Key factors of testing plan:

- Recorded continuous data under a moving load
- Installed enough sensors to measure global structural behavior
- Applied large enough load to capture reliable readings
Instrumentation Plan Overview

The instrumentation plan included:
- 62 Strain Transducers
- 6 Rotation Sensors
- 1 Load Position Sensor
Instrumentation Details

Girder Rotations & Support Behavior

Stringer Flexure & Floor System Distribution

Girder Flexure & Composite Action with Deck

Bracing Forces & Distribution
Testing Plan Overview

- Single & double truck configurations
- Test vehicles were the only vehicle on the bridge
- Crossed the structure at 3-5 mph
- Symmetric load paths
Load Configurations Used

Test along Truck Path Y2

Setup of Tandem Double Truck Test
Data Quality Review

Girder Stress Reproducibility Plot

Bottom Flange Stress near Midspan
Response Behavior Review

Verification of Composite Behavior using gage pairs

Gage Pair on Girder – Showing composite action
Response Behavior Review

Verification of Composite Behavior using gage pairs

Partial composite action in Stringer
Response Behavior Review

Verification of Composite Behavior using gage pairs

Non-composite action in Stringer
Model Creation and Test Simulation

Plan View of Structure Model

Modeling of Members

Modeling of Test Load
Model Calibration – Response Comparisons

Initial Model Comparison Plot

Girder Bottom Stress near Midspan

- Model Response
- Measured Response
- ERROR
Key optimization parameters:

- Composite action in the girders and stringers
- End restraint at the supports
- Continuity between spans
- Load distribution of the floor system
- Load distribution between girders
Model Calibration – Response Comparisons

Final Model Comparison Plot

Girder Bottom Stress near Midspan
Model Calibration – General Results

- Girder composite action with deck varied
  - Composite at midspan
  - Non-composite near the ends of the steel spans
  - Partially composite near and over the piers

- Varying composite action in the stringers but did not greatly effect the floor systems’ distribution

- The bottom cross-bracing (at bay points) was found to play a large part in the girders’ load distribution

- Friction based end-restraint behavior reduced the girder moments
Once calibrated, the model was adjusted to ensure the reliability of all optimized model parameters.

- All girder and stringer elements were made fully non-composite with the deck
- The end-restraint at the supports was significantly reduced
- The slab stiffness was reduced

Once the model was adjusted:

- Structural responses were obtained from the adjusted model
- Member capacities were determined from AASHTO LFD Standard Specifications
Load rating was performed on all stringer & girder elements using AASHTO LFR guidelines.

<table>
<thead>
<tr>
<th>RATING VEHICLE</th>
<th>LOCATION/LIMITING CAPACITY</th>
<th>INVENTORY RATING FACTOR</th>
<th>INVENTORY RATING WEIGHT, TONS</th>
<th>OPERATING RATING FACTOR</th>
<th>OPERATING RATING WEIGHT, TONS</th>
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<tbody>
<tr>
<td>HS-20</td>
<td>Girder Midspan / Positive Flexure</td>
<td>1.27</td>
<td>45.7</td>
<td>2.12</td>
<td>76.3</td>
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<tr>
<td>Idaho Type 3</td>
<td>Stringer / Positive Flexure</td>
<td>1.86</td>
<td>50.2</td>
<td>3.10</td>
<td>83.7</td>
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<tr>
<td>Idaho Type 3S2</td>
<td>Girder Midspan / Positive Flexure</td>
<td>1.50</td>
<td>59.3</td>
<td>2.50</td>
<td>98.8</td>
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<tr>
<td>Idaho Type 3-3</td>
<td>Girder Midspan / Positive Flexure</td>
<td>1.48</td>
<td>58.5</td>
<td>2.47</td>
<td>97.6</td>
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<td>Idaho 121K</td>
<td>Girder Midspan / Positive Flexure</td>
<td>1.09</td>
<td>65.9</td>
<td>1.82</td>
<td>110.1</td>
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<td>Idaho NRL</td>
<td>Girder Midspan / Positive Flexure</td>
<td>1.32</td>
<td>52.4</td>
<td>2.20</td>
<td>88.0</td>
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</table>
Testing Conclusions #1 - Girders

The distribution of live-load between the girders was 8 to 20% better than AASHTO distribution factors.

Structural conditions that influenced the actual load distribution included:

- The presence of the bay point bracing
- Wheel loads applied near the middle of the roadway reach the girders in a distributed fashion rather than as point loads
Testing Conclusions #2 - Stringers

Stringer live-load effects were also found to be significantly different than calculated by AASHTO DFs (~60% better)

Through the field-verified model, BDI was able to increase the stringer negative moment capacity.
ITD used BDI’s findings and reanalyzed the structure internally.

POSTING REMOVED!

User costs were not increased due to retrofit and the community’s economy and fire response time was no longer hindered.

This case study shows how bridge owners used evaluation tools at their disposal to solve a bridge management problem.