Utilizing Software to improve Bridge Inspection and Management

Presented by: Jeremy Shaffer, Ph.D.
Mike Schellhase
Agenda

• Vision
• Basics of Inspection and Management
• Examples of Software Usage
  – Inspection
  – Management
  – Large Bridges
• Summary
• Questions
A Vision for Software

• One stop location for all structure information
  – Entering data
  – Retrieving information
  – Reports/Searching
  – Projecting needs
  – Integration of all relevant data sources
A Vision for Software

• Powerful Tool
  – People like it
  – Easy to use
  – Efficient - never enter data more than once
  – Integrates resources needed in one place
  – Serves multiple audiences
  – Clearly communicates needs
High-Level Current State of Affairs

- Aging Infrastructure
- High Construction and Maintenance Costs
- Tighter Budgets
- Data Overload on Owners
- New Regulations

Bigger Need + Fewer Resources = ?

No room for errors or wasted efforts
Goals for Bridge Inspection and Management

• Ensure optimal safety and operational capability in the most efficient manner.
  – Inspection is used as the eyes/ears of the program to find and document the current condition including any problems
  – Management utilizes the inspection data along with the organization’s priorities to determine the most efficient way to ensure goals are met (i.e. safety, performance, capacity)
Need for Inspections

• Regulations/Laws
  – FHWA NBIS
  – State/Intl. specific laws
• Liability
  – Insurance or bond requirements
• Best Practice for Maintenance
  – Much cheaper to fix problems early than later
• Sustaining Reliable Operations
Types of Inspection

• Visual Inspections
  – Primary type
    • Cursory, In-Depth, Special, etc.
  – Performed every 2 years (most locations)
  – Identify overall conditions and areas for additional exploration

• Advanced Technology for Detailed Data
  – NDE/NDT approaches
  – Destructive testing
  – On-going monitoring/sensors
Utilizing Software to Assist

- Inspections generate a large amount of text and file based data
- Ideal for software to assist in collecting and managing
- Allows information to be easily searchable and retrievable
Benefits of Computerized Inspections

- Eliminate mistakes during the transcription process
- Ability to integrate in detailed manuals and error checks
- Easy incorporation of pictures and other attachments
- One-click generation of reports
- Field/Office data entry options
Inspection Condition Data

• Quantification via a Rating Scale
  – Need to be able to compare relative conditions within a structure and between structures

• Subjective results via Narrative Text
  – Need to be able to have descriptions indicating the scope and nature of the condition
Mn/DOT Example
Supporting Information

- Pictures
  - Digital pictures for overall inventory and every deficiency
- Videos
  - Can be appropriate to show time based effects of live loads or multiple angles
- Sketches/Drawings
- Test/Sensor Results
  - Boring information, Stress readings
Adding/Linking Pictures
Annotating Pictures
Detailed Inspection Program / Beyond NBI

- Structures are divided into primary sub-parts (Abutments/Piers, Spans, CrossBox, etc.)
- Forms are unique for the type of the sub-component (i.e. Steel Box Girder vs. Concrete Box Beam)
- Multiple inspectors work on the same bridge independently, rolled up to bridge summary of all parts.
Software Supports Reference Materials

• Integration of Manuals and Reference Material for the inspectors
  – NBI Manuals
  – Coating Rating Manuals
  – Example Pictures
  – Pontis Coding Guides
  – Video descriptions

• Yields more accurate results
Photo Reference Guide

The approaching pavement has gone through a recent improvement and is the reason for this rating upgrade. (Sherwood Garrison, 9/23/1999 12:40:00 AM)
**Let the Software Do The Work**

**Simple Report Generation**

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**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY**

**STRUCTURAL MAINTENANCE INSPECTION REPORT**

**Wheaton Parking Garage Bridge**

**Abutment (Entrance Side)**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>NO.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Dams and weir-works.</td>
<td>4</td>
<td>Holes in dam body with eroded mortar.</td>
</tr>
<tr>
<td>j. Joints (replacement, construction, costs).</td>
<td>4</td>
<td>Joint grout injected between end of span and backwall.</td>
</tr>
</tbody>
</table>
| k. Bearing assemblies (List type and dates). | 4 | Bearing seat pads and rail seat pads.

**i. Physical condition.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>NO.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal</td>
<td>4</td>
<td>Some minor wear observed.</td>
</tr>
</tbody>
</table>

**ii. Working condition.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>NO.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal</td>
<td>4</td>
<td>No unusual wear or distress observed.</td>
</tr>
</tbody>
</table>

**3. Duct.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>NO.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal</td>
<td>5</td>
<td>All ducts in good condition.</td>
</tr>
</tbody>
</table>

**4. Concrete patches.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>NO.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal</td>
<td>4</td>
<td>All concrete patches are in good condition.</td>
</tr>
</tbody>
</table>

**5. Grout / masonry work.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>NO.</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal</td>
<td>4</td>
<td>All grout and masonry work is in good condition.</td>
</tr>
</tbody>
</table>

---

**Photo 1**

Several vertical cracks on breast wall, open from 0.050" to 0.125" in length of 7 ft. See description on 1a. Picture 1 shown.

**Photo 2**

Several vertical cracks on breast wall, open from 0.050" to 0.125" in length of 7 ft. See description on 1a. Picture 2 shown.
Overview of Integrated System

- Start inspection on laptop/tablet
- Submitted to Web-Server when in office
- Report continued from any computer
- Submitted for review
- Reviewed and approved online
- Able to run reporting and searching on data

Inspection

1) Inspection conducted at structure using BridgeInspect™ Collector on laptop or tablet computer (multiple teams). When done on-site the report is sent to Collector Online Server.

Management

3) BridgeInspect™ Manager is available from any WMATA computer with proper username/password. Functions include:
   - Review and approval of all inspection reports.
   - Access to all bridge pictures, sketches, and other files.
   - Creation of standard and custom reports.
   - Data and maintenance needs available with all supporting information for Capital Planning.
   - Interface customized for WMATA, with interactive line map.
Bridge Management Basics

- Few entities have unlimited funds.
- Setting and developing priorities is an important function of bridge managers.
- Bridge funding must be justified against other priorities.
- Deterioration and trade-off modeling possible with extensive details.
Bridge Management Basics

• Maintaining and monitoring a scheduled maintenance activities program for a bridge can significantly extend service life

  – “An ounce of prevention is worth a pound of cure” – Ben Franklin
  – Would you drive your car and never change the oil? Do we effectively do that with many bridges?
How can software help Bridge Management?

- Prioritization
- Scheduling
- Pictures/Sketches
- GIS
- Reporting/Searching
- Deterioration Modeling
- Cost Estimates
- Data Visualization

Outstanding Deficiencies

<table>
<thead>
<tr>
<th>Color</th>
<th>Bridges</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>576</td>
<td>576</td>
</tr>
<tr>
<td>Yellow</td>
<td>3,322</td>
<td>3,322</td>
</tr>
<tr>
<td>Red</td>
<td>1,095</td>
<td>1,095</td>
</tr>
<tr>
<td>Total</td>
<td>5,093</td>
<td>5,093</td>
</tr>
</tbody>
</table>
Benefits of Computerized Management

• Ability to instantly retrieve all information
  – Current and Past
  – Text and Pictures
  – Maintenance needs and actions
• Prioritize based on desired metrics/variables
• Integrated Mapping/Visualization
• Standard or ad-hoc report generation
Digital File Cabinet for all Bridge Information

- Link all current and past information on the bridge
  - Reports, Pictures, Sketches, Maintenance Items
  - Contracts, Load Rating, Letters, etc.
- Link to Bridge Location
- Bridge Notes
- Upcoming inspection dates
- Functionality and data integrated from other programs
Digital File Cabinet for all Bridge Information

Indiana Department of Transportation
Bridge and Structure Inspection Management System
inspecttech

Seymour: I65-85-05527 BNBL

Bridge Number: I65-85-05527 BNBL
NBI Number: 35740
Feature Intersected: SUGAR CREEK
Facility Carried: I-65 NBL
District Code: 05 - Seymour
Location: 376 S SR 44
Post: 85
Offset: 80
Name of Structure:
Latitude: 39 - 26 - 06.00
Longitude: 085 - 58 - 54.00

Click here to see the location of the structure.
Click here to change the central database values.
Click here to view audit history for this asset.
Click here to view the central database values report for this asset.

Inspection Due Dates

Next Routine Inspection Due Date: 5/21/2011
Next Underwater Due Date: 11/1/2011
### Deficiencies

- **Create New Deficiency Item**
- **Show Completed Items**

#### In Progress Items:

<table>
<thead>
<tr>
<th>Completed</th>
<th>Status</th>
<th>Report Date</th>
<th>Date of Correction</th>
<th>Description of Deficiency</th>
<th>Reported By</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
<td>To Do</td>
<td>6/1/2009</td>
<td></td>
<td>Hole near top of slope wall</td>
<td>Jerry L. Martin</td>
<td>[phone number]</td>
</tr>
</tbody>
</table>

### Contracts

- **Create New Contract**
- **Show Completed Items**

#### In Progress Items:

<table>
<thead>
<tr>
<th>Completed</th>
<th>Status</th>
<th>Contract Number</th>
<th>Date Due</th>
<th>Date Completed</th>
<th>Description of Contract</th>
<th>Des Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
<td>Started</td>
<td>B-31726</td>
<td>6/9/2018</td>
<td></td>
<td>Scour Protection</td>
<td>[Des Number]</td>
</tr>
</tbody>
</table>
Comparing Past and Present Trending Module

- Much cheaper and safer to fix problems when they are just starting
- Software’s trending tools allow agency to quickly find new problems early on
- Able to find changes on NBI and Element Level data
Search and Visualization of Data

- All data should be stored and organized in the database
- Tools can allow for the easy searching of this data
  - Simple queries
  - Complex
- Visualization of information very important
  - Spreadsheets
  - Maps
  - Graphs
Searching across Fields/Data
Visualization in Table

<table>
<thead>
<tr>
<th>Parent Asset</th>
<th>Asset Name</th>
<th>District Code</th>
<th>RBI Number</th>
<th>Feature Intersected</th>
<th>Facility Carried</th>
<th>SS - Deck (Rating)</th>
<th>Substructure</th>
<th>Superstructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawfordville</td>
<td>1160-4-064-02281</td>
<td>01</td>
<td>26890</td>
<td>EMILY GARDNER DITCH</td>
<td>US 136</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>525-4-08034</td>
<td>01</td>
<td>6380</td>
<td>SR 35</td>
<td>CSE RR</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>523-4-04112 A</td>
<td>01</td>
<td>13280</td>
<td>I-55</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Crawfordville</td>
<td>525-4-04147</td>
<td>01</td>
<td>19770</td>
<td>E FORK MONTGOMERY BRANCH</td>
<td>SR 25</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>1633-4-01724</td>
<td>01</td>
<td>28410</td>
<td>HUMPHREYS BRANCH</td>
<td>SR 162</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>523-4-04121 A</td>
<td>01</td>
<td>29810</td>
<td>S FORK LTL RACOON CR</td>
<td>SR 236</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>524-4-07395</td>
<td>01</td>
<td>30395</td>
<td>WEST FORK FISH CREEK</td>
<td>SR 246</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>524-4-09924 A</td>
<td>01</td>
<td>31720</td>
<td>I-74</td>
<td>SR 241</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>200-4-08736</td>
<td>01</td>
<td>60015</td>
<td>MARIO CREEK</td>
<td>SERVICE ROAD</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Crawfordville</td>
<td>200-4-07686</td>
<td>01</td>
<td>60940</td>
<td>DEWEES BRANCH</td>
<td>SERVICE ROAD</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fort Wayne</td>
<td>505-4-02480</td>
<td>02</td>
<td>1600</td>
<td>SR 5</td>
<td>CONRAIL</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Fort Wayne</td>
<td>200-4-07395 A</td>
<td>02</td>
<td>60050</td>
<td>MAKENA CREEK</td>
<td>PARK ROAD</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fort Wayne</td>
<td>200-4-08557</td>
<td>02</td>
<td>60040</td>
<td>ROCKAWAY CREEK</td>
<td>PARK ROAD</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Greenfield</td>
<td>919-4-04212</td>
<td>03</td>
<td>4990</td>
<td>MUD CREEK</td>
<td>SR 19</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Greenfield</td>
<td>956-4-07478</td>
<td>03</td>
<td>11810</td>
<td>LITTLE MUD CREEK</td>
<td>US 36</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Greenfield</td>
<td>1465-149-02221 BNEL</td>
<td>03</td>
<td>50770</td>
<td>US 136 &amp; ABANDONED RR</td>
<td>1-465 BNEL</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Greenfield</td>
<td>1465-150-04688 A</td>
<td>03</td>
<td>50840</td>
<td>I-465</td>
<td>10TH ST. WB RAMP</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>
Visualization on Map

Bridge Number: 039-06-04115 B
NBI Number: 13290
Feature Intersected: I-65
Facility Carried: SR 39
District Code: 01 - Crawfordsville
Location: 0.9 S SR 32
Post: 63
Offset: 74
Name of Structure:
Latitude: 40° 02′ 06.00″
Longitude: 086° 28′ 18.00″
Bridge Number: 039-06-04115 B
NBI Number: 13290
Feature Intersected: I-65
Facility Carried: SR 39
District Code: 01 - Crawfordsville
Location: 0.9 S SR 32
Post: 63
Offset: 74
Name of Structure:
Latitude: 40 - 02. - 06.00
Longitude: 086 - 28. - 18.00
Advanced Views

- Interactive StreetView
  Q: How many beams were there?

- Google Earth

- 3-D Models
Risk Based Management

• Risk Based Management takes into account the multiple variables/objectives
• Example of two part metric
  – Likelihood of Failure
  – Consequence of Failure
• Can weight different factors based on importance
  – i.e.: Safety, Capacity, Detour length, Cost
### Individual Maintenance Needs Tied to Risk

There are no pictures linked to this record.
## Prioritization of Individual Components (Paint Example)

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>% Rating 1</th>
<th>% Rating 2</th>
<th>% Rating 3</th>
<th>% Rating 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girders</td>
<td>90</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1.1</td>
</tr>
<tr>
<td>Fascias</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1.05</td>
</tr>
<tr>
<td>Bearings</td>
<td>80</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>1.2</td>
</tr>
<tr>
<td>Edges</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1.05</td>
</tr>
<tr>
<td>End Dam</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Deck Pans (Galv:Paint)</td>
<td>85</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>1.15</td>
</tr>
<tr>
<td>Railings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Overall Rating**: 1.09
# Prioritized Reports By Component

## DECKS - OCR

Sorted by Overall Condition Rating utilizing all four condition states

Criteria selected for this report includes:

- Turnpike District(s): 8
- Mile: 0.00 to 175.00

<table>
<thead>
<tr>
<th>Dist/ Area (Div)</th>
<th>Milepost</th>
<th>Description</th>
<th>Top Deck Type</th>
<th>Decks - Top Deck</th>
<th>Decks - Under Bare</th>
<th>Decks - Under w/Pans</th>
<th>Latest Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 8 (T)</td>
<td>MP 117.67NI</td>
<td>0 0 0</td>
<td>7.5</td>
<td>0 4 0</td>
<td>12376</td>
<td>1 0 416</td>
<td>1 0 11960</td>
</tr>
<tr>
<td>2) 8</td>
<td>MP W109.16</td>
<td>0 0 0</td>
<td>6.51</td>
<td>0.48 3.32 0.32</td>
<td>32768</td>
<td>1.02 0 1024</td>
<td>1 0 31744</td>
</tr>
<tr>
<td>3) 8</td>
<td>MP W112.85</td>
<td>0 0 0</td>
<td>5.24</td>
<td>0 2.49 0</td>
<td>24835</td>
<td>1 0 809</td>
<td>1 0 24026</td>
</tr>
<tr>
<td>4) 8</td>
<td>MP W116.10</td>
<td>0 0 0</td>
<td>4.94</td>
<td>0 2.29 0</td>
<td>99468</td>
<td>1 0 9362</td>
<td>1 0 90106</td>
</tr>
<tr>
<td>5) 8</td>
<td>MP W108.91</td>
<td>0 0 0</td>
<td>4.83</td>
<td>0 2.1 0</td>
<td>24855</td>
<td>1.12 0 688</td>
<td>1 0 24167</td>
</tr>
<tr>
<td>6) 8 (T)</td>
<td>MP 117.67NO</td>
<td>0 0 0</td>
<td>3.66</td>
<td>0 1.44 0</td>
<td>17995</td>
<td>1 0 1220</td>
<td>1 0 16775</td>
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<tr>
<td>7) 8</td>
<td>MP W108.79A</td>
<td>0 0 0</td>
<td>3.62</td>
<td>0 1.38 0</td>
<td>20109</td>
<td>1.03 0 606</td>
<td>1 0 19503</td>
</tr>
<tr>
<td>8) 8 (T)</td>
<td>MP 105.56SO</td>
<td>0 0 0</td>
<td>3.48</td>
<td>0 1.25 0</td>
<td>11310</td>
<td>1.07 0 9998</td>
<td>1 0 1312</td>
</tr>
<tr>
<td>9) 8</td>
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<td>0 1.31 0</td>
<td>25080</td>
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<td>1.02 0 24244</td>
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<tr>
<td>10) 8 (T)</td>
<td>MP 117.67SI</td>
<td>0 0 0</td>
<td>3.44</td>
<td>0 1.29 0</td>
<td>16422</td>
<td>1 0 952</td>
<td>1 0 15470</td>
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<tr>
<td>11) 8</td>
<td>MP W109.34</td>
<td>0 0 0</td>
<td>3.23</td>
<td>0 1.12 0</td>
<td>18688</td>
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<td>1 0 18104</td>
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<tr>
<td>12) 8</td>
<td>MP W112.72B</td>
<td>0 0 0</td>
<td>3.05</td>
<td>0 1.02 0</td>
<td>13815</td>
<td>1.01 0 1842</td>
<td>1 0 11973</td>
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<td>13) 8</td>
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<td>3.03</td>
<td>0 1 0</td>
<td>43719</td>
<td>1.02 0 2238</td>
<td>1 0 41481</td>
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<tr>
<td>14) 8 (T)</td>
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<td>0 0 0</td>
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<td>0 1.01 0</td>
<td>11865</td>
<td>1 0 585</td>
<td>1 0 10920</td>
</tr>
<tr>
<td>15) 8</td>
<td>MP W112.72C</td>
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<td>3.02</td>
<td>0 1 0</td>
<td>8051</td>
<td>1.01 0 388</td>
<td>1 0 7663</td>
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<tr>
<td>16) 8</td>
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<td>0 1 0</td>
<td>11189</td>
<td>1.01 0 3698</td>
<td>1.01 0 10819</td>
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</tbody>
</table>

**Top Deck Type:** AO (Asphalt Overlay), NS (No Surfacing), LMC (Latex Modified Concrete)

**OCR:** Overall Condition Rating (includes all 4 condition states); OCRs: Overall Condition Rating (includes only Condition States 3 and 4)

**Decks Top Deck:** OCR (Overall Condition Rating for Top of Deck only in all 4 Condition States); OCRs (Overall Condition Rating for Top of Deck only in Condition States 3 and 4)
Executive Dashboard of Main Metrics
Large/Special Bridges
2008 Biennial Inspection of Commodore Barry Bridge  
URS Corporation

Inspection Field Notes

- There is a notch in top surface of the L1 inside connection plate to truss lateral diagonal bracing top flange (Photo #4).
  - Moderate corrosion at connection between lower diagonal lateral bracing and bottom chord at panel point 4 and splices between FB and FB brackets to lower chord connection.
  - Three (3) 1 in. long tack-welds on backer bar at end of FB connection to lower chord.
  - Two (2) 1 in. long tack-welds on top of weld between backer bar of lower diagonal lateral bracing and lower chord at L9.
  - Moderate corrosion on splice plate and several splice bolts at L9-L10 at panel point 10.
  - Heavy corrosion on flange interior bottom plate splice bolts at L9-L10 to L10 chord splice.

L10:
- Four open modded holes on truss vertical member flange connection to L12 at flange thickness transition.
  - One missing bolt on L11-L12 to L12 chord splice for drainage from truss chord interior mid-depth plate.
  - Heavy to severe corrosion on several truss chord bottom plate interior splice bolts.

L13:
- Web plate on outside of truss bottom chord at L13 has heavy corrosion around the perimeter with heavy rust stains.
  - 8 in. long tack weld along backer bar at west side of FBE3 to L13 connection plate and L13 inside gusset plate.

L14:
- Pudung water and water stains on top surface of L14-L15 chord member. One missing bolt at mid-depth of L14-L15 outside bond splice plate to L15 with moderate corrosion along help perimeter. Hole is actually leaking with rust stains.

L15:
- One missing bolt on truss vertical connection plate to truss lateral diagonal bracing top flange, note that there is no hole at the face plate at this location.
  - Bonding water up to 1/4" on top surface of truss chord at L15 between inside and outside gusset plates on both sides of vertical.

L16:
- One missing bolt on outside L15-L16 to L16 truss chord splice for drainage from truss chord interior mid-depth plate.

Suggested Issues:
- Heavy spalling of concrete pad on top surface of bottom chord at L6.

L2:
- Moderate to heavy corrosion on five interior bottom plate splice bolts at L2-L3 to L3 truss chord splice.

L3:
- Vertical backer bar on west side of FBE connection to L3 inside gusset plate terminates two chord up floor beam connection plate and a weld continues from that point to top.

L9:
- One (3/4") tack weld between truss bracing member connection plate backer bar and inside gusset plate at L9.

L10:
- Moderate to heavy rust on five interior bottom chord L9-L10 to L10 bottom plate splice bolts.
  - Water stains and evidence of bonding water on top surface of interior chord between gusset plate on east side of truss vertical at L10.

L11:
- Web plates on outside gusset plate have heavy corrosion around perimeter with heavy rust stains (Photo #1).

L12:
- One missing bolt on outside L11-L12 to L12 chord splice for drainage from interior mid-depth plate.
  - Moderate to heavy rust on all interior bolts and plates at L11-L12 to L12 truss chord splice including the underside of the truss chord interior mid-depth plate.
Tree Structure of Bridge

User drilling down to bridge, span, superstructure, main span, verticals, north truss and specific parts
3-D Bridge Representations
Interactive Model
Query Results on the 3-D Model
Click on Component and Get Information (Rating, Text, Pictures)
Details

- 3D Solid Model
- Represent only the details that user cares about
- Utilize color for different layers – condense to single color for search results
- Ability to turn on/off layers
- Information all driven off database and web-interface
Summary
Many Possible Tools but Remember Purpose

- To ensure a safe and reliable infrastructure for customers/users.

- To protect the investment into the infrastructure by detecting structural problems before they deteriorate to the point where they create unsafe conditions or threaten operations.
Conclusions

• Inspections form the foundation of a good bridge program
• Active management is important to the most efficient use of funds
• Software can significantly improve the collection and ongoing management of bridge data
• Software is a key tool to allow engineers to select actions to meet their agency’s goals in the most optimum manner