S-BRITE

Steel
Bridge
Research
Inspection
Training
Engineering
Need for S-BRITE

- Infrastructure continues to age
  - Avg. age of steel bridge nearly 50 years old
- Workforce changing
  - Loss of legacy expertise not being replaced
  - New workforce not versed in older materials, structures, design, deterioration, etc. etc. etc
- Current available training (all levels) does not seem to meet the needs of owners
- Much $$$ spend on inspection, but no knowledge regarding inspection reliability and POD, etc.
However, “Aging Infrastructure” is More than Just Steel Bridges

- Led to concept of Center for Aging Infrastructure (CAI)
- Natural to move into other structure types
  - Concrete, timber, etc
- Consider other aspects of aging infrastructure
  - Pavements
  - Safety
  - Drainage
  - Signals
  - Foundations
  - Etc.
Grand Vision...

To Develop a Unique Center Focused on Extending the Safe Life of Existing Transportation Structures
CAI Opportunities

- Unique opportunity for Purdue Civil Engineering
  - Nothing like this in the world... at least for bridges
- New research initiatives are possible that could not be considered in past
  - Large-scale components, systems, system interaction
    - Long-term durability
    - Interaction... drainage off of a bridge deck or road, through ground into a pond...
  - Trials of new construction techniques
  - Long-term testing of sensors, monitoring, etc.
  - Unique educational opportunities
    - K-12, undergrad, grad, professionals
S-BRITE Progress

- Construction of S-BRITE/CAI
- Short Courses
- DEN Update
- Research Updates
  - Proposed Pooled Fund Tasks
  - Suggestions for future/additional research
Location Map

Approximately 22 acres
CONSTRUCTION OF S-BRITE/CAI
Status
Status
Status
Status of S-BRITE/CAI

- Construction bids received August 7, 2014
- Construction began October 2014
- Approximately 90% complete Dec. 2014
- Work stopped in January 2015
  - Weather
- Some “clean-up” in Spring 2015
S-BRITE Status
Specimens Acquired to Date

- Virginia Ave over I-65
  - Girders impacted by trucks
  - Bolted repairs of fractures due to impact damage
- Three sections
  - Total length over 150 ft
Specimens Acquired to Date

- I-35W Components
  - Bearings
  - U10 & L11 Joints
  - Portion of L7-L8
  - Floortruss components
Specimens Acquired to Date

- Components of Lafayette St. Bridge
- Provided by MN DOT
- Large plate girders
  - “Hoan” repairs
  - Full-depth girder fracture repair
  - Misc. details
Lafayette St. Bridge Fractured Girder (Minnesota)
Specimens Acquired to Date

- TTI (Pueblo) provided an entire 65 foot two-girder welded RR bridge
  - Delivery donated via BNSF/CSX
  - Has a “Hoan” fracture(s), corrosion, fatigue cracks, etc.
  - Erected on concrete piers
Indian Trail Bridge

- 100 foot span pony truss
  - To be erected Spring 2015
Other Specimens Acquired

- Various riveted and welded components
- Chords, beams, floorbeams, etc.
- Various failed components
  - Real bridges
  - Sign/signal structures
  - Fatigue/fracture tests
- Luminary and sign structures
Always Looking for More

- Please keep S-BRITE in mind as bridges are planned for removal

- Send plans, inspection reports, photos, etc.
  - We can always say “No”

- Need to plan early so salvage of components are included in the contract documents
2015 On-site S-BRITE Activities

- Finish all “general” construction
  - Seeding
  - Finish grading
  - Fence
  - Looking at adding electrical service
- Erect more components/bridges
- Continue with training
S-BRITE TRAINING
TRAINING COURSES

- Courses offered in:
  - Kansas
  - South Dakota
  - Illinois
  - Minnesota
  - Iowa

- Excellent feedback

- Next courses
  - Purdue (Scheduled)
  - See Website
## Training Program Data

<table>
<thead>
<tr>
<th>Location</th>
<th>Course</th>
<th>Dates</th>
<th># Students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2013 Courses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purdue University</td>
<td>High Strength Structural Bolting</td>
<td>April</td>
<td>30</td>
</tr>
<tr>
<td>Purdue University</td>
<td>High Strength Structural Bolting</td>
<td>May</td>
<td>25</td>
</tr>
<tr>
<td>Purdue University</td>
<td>Inspecting Steel Bridges for Fatigue</td>
<td>June</td>
<td>25</td>
</tr>
<tr>
<td>Purdue University</td>
<td>Designing Steel Bridges for Fatigue</td>
<td>June</td>
<td>25</td>
</tr>
<tr>
<td>Purdue University</td>
<td>Inspecting Steel Bridges for Fatigue</td>
<td>August</td>
<td>30</td>
</tr>
<tr>
<td><strong>2014 Courses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purdue University</td>
<td>High Strength Structural Bolting</td>
<td>February</td>
<td>31</td>
</tr>
<tr>
<td>South Dakota DOT</td>
<td>Designing Steel Bridges for Fatigue</td>
<td>March</td>
<td>21</td>
</tr>
<tr>
<td>Purdue University</td>
<td>Inspecting Steel Bridges for Fatigue</td>
<td>April</td>
<td>14</td>
</tr>
<tr>
<td>Kansas DOT</td>
<td>Inspecting Steel Bridge for Fatigue</td>
<td>April</td>
<td>23</td>
</tr>
<tr>
<td>Illinois DOT</td>
<td>Designing Steel Bridges for Fatigue</td>
<td>May</td>
<td>19</td>
</tr>
<tr>
<td>Iowa DOT</td>
<td>High Strength Structural Bolting</td>
<td>August</td>
<td>26</td>
</tr>
<tr>
<td>Purdue University</td>
<td>Inspecting Steel Bridges for Fatigue</td>
<td>September</td>
<td>12</td>
</tr>
</tbody>
</table>
Courses

- Held @ Purdue Utilizing S-BRITE & Bowen Laboratory
Unique Training Environment
2015 Planned Training Activities

- Continue with training
- New course – “Implementing Effective Retrofits in Selected Steel Bridge Details”
  - Includes hands-on retrofit implementation
- Looking into new course related to welding
  - “Welding 101”
IMPLEMENTING EFFECTIVE RETROFITs IN SELECTED STEEL BRIDGE DETAILS
SPR # 3915
Problem Statement

- Development and implementation of effective retrofits in steel bridges is essential in extending the life of our aging infrastructure.
Problem Statement cont’d

- Few engineers have direct experience with proper retrofit selection
  - Younger/new engineers even less
- New research has resulted in improved guidance in retrofit selection and implementation

NCHRP 721 – Bowman, et.al.
Training Objective

- Develop classroom and hands-on training to educate bridge engineers and other stakeholders so that the most effective, efficient, and safe retrofit strategies are employed on INDOT's aging steel bridge inventory.
Details to be Included

- Out-of-plane distortion
- Details susceptible to constraint induced fracture (CIF)
- Weld toe peening
- General repairs
  - Grinding of cracks
  - Plasma cutting
- Leverage some existing specimens at S-BRITE
Details to be Included

- For efficiency, each mock-up will include multiple details for retrofit

Specimen illustrating multiple locations for students to perform CIF retrofits
Deliverables

- Development of a two-day short course that includes both classroom and “field” exercises (at S-BRITE) which includes the following:
  - Case study examinations and discussion;
  - Guidance on retrofit selection – (do’s and don’ts);
  - Hands-on examination of specimens that included effective, ineffective, and incorrect retrofits;
  - Installation/execution of selected retrofit methods by the student;
  - Guidance on inspection after installation
Deliverables

- Develop a certification program that INDOT would require of engineers and contractors
  - Written exam
    - Reinforced with specimens with “good” and “bad” retrofits that a student would inspect at S-BRITE
  - Hands-on practical
    - Student will actually install selected retrofit types
      - Hole drilling
      - Plasma cutting
      - Grinding
      - Peening
      - Etc.
- Students successfully completing course earn a certificate
  - INDOT could require this for consultants/contractors
Training Deliverables

- It is proposed that five (5) courses will be offered with 8-10 students per course during the quarters shown in the table:
  - 3rd quarter of 2015
  - 1st and 2nd quarters of 2016
  - 1st and 2nd quarters of 2017

- Limit attendance to 8-10 students per course:
  - Allows personal interaction during the hands-on portion
S-BRITE DEN
Distributed Expertise Network

- DEN is operational
- Not being utilized much to date
  - IN and SD thus far
- Website is up and running
  - Three Q/As on the site
    - More “general Q/A” being prepared
  - Will send log-in information to TPF partners following the webinar
Distributed Expertise Network

Above, from left to right:
I-465 fire damage; Canneilton Bridge flame cut repairs; Valsont pole fatigue evaluation; Sherman Minton Bridge "dog bone" retrofit

To help DOTs with their specialized technical impasses, a unique team of experts has been assembled through the S-BRITE Center to create a Distributed Expertise Network (DEN). Some of these individuals are housed locally at the Center while others are located at their respective institution. The DEN serves the role that no longer exists in many individual state DOTs today, specifically the existence of a group of highly specialized technical experts that are "on-call" to assist as issues arise. Providing access to such individuals makes the S-BRITE Center the national "go-to" place for solutions to complex issues regarding steel bridges, from high-profile failure investigations to working with policy makers on setting the future paths for asset management of the existing steel bridge inventory. No other such entity or resource exists in the United States. In addition, a database is made available to partnering states archiving the questions posed to the DEN. Thus, states with similar issues are quickly able to find answers to their tough questions.

Partner States can click here to access the question & answer database: Q&A Database
S-BRITE RESEARCH PROJECT UPDATES
Steel Bridge Database

By Robert J. Connor
Arcadia University

Published on
17 Dec 2014

Abstract

This database includes information collected from 47 steel bridges built between 1921 to 1981 in the U.S.

Data that are included are Charpy V-Notch test (CVN) results, chemistry, and tensile properties of the specimens taken from each bridge. The following are the column headers for this database:

1. Title (bridge name)
2. Project Personnel
3. Year (when data were collected)
4. Flaker
5. Main Subject
6. Report(s) (associated reports, or any other documentation)
7. Project page
PROBABILITY OF DETECTION STUDY FOR STEEL BRIDGES

ROBERT CONNOR, GLENN WASHER
JULIE WHITEHEAD, LUKE SNYDER, JASON LLOYD
BOB KOGLER
Problem Statement

- Ability of inspectors to identify defects in steel bridges is unknown
  - Data which exists is not encouraging (low POD)

- Influence of environmental conditions on detectability (night work, cold weather, etc.) also unknown

- Through this research, the probability of an inspector to detect and quantify various defects and forms of damage on steel bridges will be evaluated
POD Fixture Containing Specimens with Known Defects

- Focus is on visual inspection
- 16 ft x 80 ft three-girder “bridge”
  - Approx. 25 ft above ground
  - Man-lift access
- Over 100 specimens with various defects
  - However, well over 500 “sites” to inspect
- “Bridge” has been evaluated by 3 CWIs, Inspectors with 35+ years experience, PE, SE, NHI Certs., etc.
  - Conclusion….Details and layout reasonable
POD “Bridge”
POD “Bridge”

- Steel donated by SDI
- Galvanizing of frame donated by AZZ
POD Defect Types

- Fatigue Cracks
  - Out-of-plane distortion
  - Cracks at Rivet holes
  - Weld toe
    - Stiffeners to flange
    - Cover plate

- Cover plate crack
- Out of plane crack
- Rivet hole crack
Status

- 12 NHI Inspectors through the “course”
  - POD data can be developed
    - e.g., 50% chance of finding a 6 inch crack, but 10% chance of finding a 3 inch crack, etc.

- Objective not to find fault, rather identify deficiencies and develop training & procedures to improve POD

- Will try and include some consultants in as well
  - Any volunteers?
Summary

- Much progress in 2014 with more to come in 2015
- Training to continue and expand
- Research to continue and expand
- Work on developing industrial partner program in 2015
- “Grand Opening” in May/June 2015
  - Possibly hold an open house of facility