Strengthening of Local Bridges in Wisconsin to Remove Load Postings

Alex Pence, PE, SE
WisDOT Bureau of Structures

Local Agency Bridge Innovation and Demonstration Days
Independence, IA

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Presentation Overview

• Load Postings on WI Local System
• Strengthening Program Overview
• Example Projects
Load Postings on the Local System
## Wisconsin Bridge Inventory

<table>
<thead>
<tr>
<th></th>
<th>State</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridges (Length ≥ 20 ft)</td>
<td>5,347</td>
<td>8,935</td>
</tr>
<tr>
<td>Average Age</td>
<td>36 years</td>
<td>41 years</td>
</tr>
<tr>
<td>% Structurally Deficient</td>
<td>134 (2.5%)</td>
<td>771 (8.6%)</td>
</tr>
<tr>
<td>Weight Limit Postings</td>
<td>17 (0.3%)</td>
<td>504 (5.6%)</td>
</tr>
</tbody>
</table>
# Design Loads: State vs. Local

<table>
<thead>
<tr>
<th></th>
<th>State</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designed for HS20 or HL93</td>
<td>88%</td>
<td>65%</td>
</tr>
<tr>
<td>Lighter Design Loads</td>
<td>12%</td>
<td>35%</td>
</tr>
</tbody>
</table>

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**Chapter Trans 214**

**TOWN ROAD BRIDGE STANDARDS**

Trans 214.04 Minimum design standards. The following minimum standards for bridge design load and bridge width are established for improvements on town road bridges:

<table>
<thead>
<tr>
<th>TRAFFIC VOLUME</th>
<th>BRIDGE DESIGN LOAD</th>
<th>BRIDGE WIDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Under 250 ADT</td>
<td>H–15</td>
<td>24 feet</td>
</tr>
<tr>
<td>(2) 251 to 400 ADT</td>
<td>H–20</td>
<td>26 feet</td>
</tr>
<tr>
<td>(3) 401 to 1,000 ADT</td>
<td>H–20</td>
<td>28 feet</td>
</tr>
<tr>
<td>(4) 1,001 to 2,400 ADT</td>
<td>H–20</td>
<td>30 feet</td>
</tr>
<tr>
<td>(5) Over 2,400 ADT</td>
<td>State Trunk Highway Standards</td>
<td></td>
</tr>
</tbody>
</table>

Note: Information on state trunk highway design standards may be obtained from the DOT Division of Highways and Transportation Facilities, P.O. Box 7916, Madison, Wisconsin 53707.

History: Cr. Register, March, 1982, No. 315, eff. 4–1–82.
Posting Trucks
Weight Limit Signs
SHV Load Posting Evaluation: Results

• What was the outcome?
  ▪ Some new postings
  ▪ Some lower load postings

• Concurrent Review
  ▪ Overly conservative postings
  ▪ Update evaluation methods

• Ongoing Efforts
  ▪ Replacements
  ▪ Strengthening
  ▪ Refined Analysis
FAST Act – Emergency Vehicles

• May exceed Standard Weight Limits everywhere in Wisconsin

• Signs required on Interstate bridges or within reasonable access (1 mile)
  • Completed Sept. 2020
  • Outreach thru Firefighter Associations

• All other bridges: online list
  • Targeting early 2023
Strengthening Program Overview
The Problem

Weak Bridges + Good Condition = Ineligible for LBP Funding
Strengthening Program: Overall Concepts

• Remove postings for bridges with significant service life remaining
  ▪ Not on track for Local Bridge Improvement Assistance Program
• Work with local owners to implement cost-effective, stream-lined process to strengthen bridges and remove postings
• BOS to provide engineering and oversight for retrofits
• Primarily use local crews to perform retrofits
• Limited scope (pursue projects with minimal environmental impact)
• Identify common solutions for multiple bridges
Project Selection

- Want to target “high value” bridges – important for freight & commerce
- Consider life remaining (condition)
- Not every strengthening option is feasible for every bridge

**Best Candidates** screening group:
- Not in program for replacement
- Posting < 40 TON
- All NBI Conditions 5+
- ADT 100+ or ADT<100 w/ 10+ mi Detour
Refined Analysis Screening

• Refined analysis goes above and beyond the routine or traditional methods of analysis
  ▪ 3D FE modeling (CSI Bridge)
• Taking advantage of
  ▪ Better live load distribution
  ▪ Additional stiffness (e.g. monolithic parapet)
Pilot Projects

• Timber Slab – Spreader Decks
  ▪ 7 Projects  Avg Cost: $45,000 ($56/sf)
• Steel Girders – Adding Plates/Angles
  ▪ 1 Project  Avg Cost: $18,000 ($17/sf)
• Superstructure Replacement (Steel Girders → Timber Slabs)
  ▪ 2 Projects  Avg Cost: $72,000 ($96/sf)
• Concrete Slab – Negative Moment (Top) Reinforcement
  ▪ 2 Projects  Avg Cost: $33,000 ($15/sf)
• Concrete Slab – Positive Moment (Bottom) FRP
  ▪ 4 Projects  Avg Cost: $26,000 ($25/sf)
Timber Slab Retrofit

• Wheel Load Distribution

- Timber: 60, 43%
- Concrete Slab: 23, 17%
- Steel Girder: 38, 27%
- PS Concrete Girder: 4, 3%
- Concrete Deck Girder: 4, 3%
- Steel Truss: 4, 3%
- Other: 5, 4%
Timber Slab Retrofit

- 7 completed through Local Bridge Strengthening Pilot Program
- 4 more funded/completed by other programs
- Typically $50-$60/sf
Timber Slab Spreader Deck
# Timber Slabs – Follow Up Research

- Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges (December 2021)
  - WHRP / Iowa State University (Justin Dahlberg, Brent Phares, Zhengyu Liu)

<table>
<thead>
<tr>
<th>Wheel Load Distribution Width (inches)</th>
<th>Single Lane</th>
<th>Multi Lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO Std Specs (2002) -- ASR</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Assumed w/ 4&quot; Spreader Deck</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>WHRP - No Spreader Deck</td>
<td>61.8</td>
<td>55.6</td>
</tr>
<tr>
<td>WHRP - 4&quot; Spreader Deck</td>
<td>71.7</td>
<td>64.5</td>
</tr>
<tr>
<td>AASHTO LRFD -- LRFR</td>
<td>74.8</td>
<td>62.1</td>
</tr>
</tbody>
</table>

![Diagram of wheel load distribution](image)
Steel Girder Retrofit

- Bolt additional steel section to existing members
  - Can often be done by state or local crews
  - Relatively inexpensive

![Steel Girder Retrofit Images](https://example.com/steelpic.png)
Steel Girder Retrofit
Steel Girder Retrofit
Steel Girder Retrofit
Superstructure Replacement w/ Timber Slab
Superstructure Replacement w/ Timber Slab
Concrete Slab Retrofit

- Concrete bridges
  - Add Steel Plates
  - Add FRP

![Image of workers in protective gear installing concrete slabs]

![Pie chart showing percentage distribution of different types of bridge structures, with Concrete Slab at 23%, Steel Girder at 38%, Timber Girder & Slab at 60%, PS Concrete Girder at 4%, Concrete Deck Girder at 4%, Steel Truss at 4%, and Other at 5%].
Changes in Demand
Changes in Demand
Changes in Demand

Increased Moment Demand
Changes in Demand

HS20

Shifting of Moment Diagram
Concrete Slab – Top Surface Strengthening

Steel plates to extend negative moment reinforcement
Chippewa County Slab Retrofit
Concrete Slab – Top Surface Strengthening
Concrete Slab – Top Surface Strengthening

1. Remove existing asphalt overlay.
2. Saw cut channel into concrete.
3. Use compressed air to blow out debris.
4. Fill channel half deep w/ epoxy and set FRP rod into epoxy.
5. Cover FRP rod w/ epoxy, filling channel up remaining depth.
6. After epoxy has fully cured, place new concrete overlay over top.
Concrete Slab – Top Surface Strengthening

Near Surface Mounted (NSM) Carbon FRP Rods
Concrete Slab – Bottom Surface Strengthening
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Concrete Slab – Bottom Surface Strengthening
Concrete Slab – Bottom Surface Strengthening
Pilot Program Evaluation

• Cost-Benefit Success
  - Streamlined process to coordinate environmental impact
  - Resourcefulness of County Highway departments
  - DTSD BOS in-house engineering support and review of construction details
  - DTIM Local Programs & Finance execution of contracts and reimbursements
Pilot Program Evaluation

• Future Opportunities

  ▪ Legislative changes required to extend program
  ▪ Counties can implement similar projects on their own
  ▪ Development of standard details or repairs
  ▪ Implementation of new technology
For More Information:

Alex Pence
alex.pence@dot.wi.gov | 608-267-6880