Field Performance of Timber Bridges: A National Study

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Topics Covered

- Introduction
- Objective / Scope
- Bridge Selection Criteria
- Inspection Protocol
- UMD Upper Midwest Inspections
- Summary
48,759 (10.3%) utilize timber as a structural component in the superstructure
- 24,267 all timber superstructure
- 24,492 timber deck, steel beam

Often rural highways with <300 vehicles
National Timber Bridge Inventory

The map shows the distribution of timber bridges across the United States, color-coded based on the number of bridges:

- **1,500+**: These states have over 1,500 timber bridges.
- **1,000-1,500**: These states have between 1,000 and 1,500 timber bridges.
- **500-1,000**: These states have between 500 and 1,000 timber bridges.

The states with the highest concentration of timber bridges are

- **Texas**
- **Missouri**
- **Louisiana**
National Bridge Inspection Study

- **Purpose** – Provide a better understanding of the design, performance, and durability characteristics of timber bridge structures

- **Objective** - Assess the condition of over 100 timber highway bridges in various climatic regions and establish a baseline for evaluating future performance

- **Outcome** - Consolidate findings into a comprehensive final report and to support future service life predictions and improved bridge designs
Region & Team Designations
Field Performance of Timber Highway Bridges: A National Study

Project Team Members:
USDA Forest Products Laboratory
US Forest Service - Region 6
FHWA’s Turner-Fairbank Highway Research Center

Project Team Members:
University of Minnesota Duluth
Iowa State University
Mississippi State University
Louisiana Transportation Research Center

Project Team Members:
Laminated Concepts Inc.
Williamson Timber Engr. LLC
State of Alabama
State of Georgia
State of North Carolina
Wood Decay Hazard Zone Map
American Wood Protection Association
Wood Decay Hazard Zone Map
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FROM AWPA STANDARDS

[Map of the United States with different regions highlighted in various colors indicating wood decay hazard zones.]
Key Bridge Selection Criteria

- Located on a public roadway
- 15 years minimum service
- Good documentation of all repair or rehabilitation work
- Safe access for arm’s length inspection work
Standard Inspection Protocol
A 5-Step Field Procedure

In-Depth Inspection
1. Visual assessment
2. Sounding
3. Moisture content surveys
4. Stress wave timing
5. Resistance microdrilling

NDE tools used to characterize size & extent of decayed zone
Visual Inspection
Hammer Sounding & Moisture Content
Stress Wave Timing

200 μs

Decay

200 μs

t= 837 μs
Resistance Microdrilling

Relative density plot characterizes internal decay zone
Resistance Microdrilling
# National Bridge Inventory (NBI) – Condition Ratings

<table>
<thead>
<tr>
<th>Condition Rating Code</th>
<th>Condition Rating Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>NOT APPLICABLE</td>
</tr>
<tr>
<td>9</td>
<td>EXCELLENT CONDITION - New or like new condition.</td>
</tr>
<tr>
<td>8</td>
<td>VERY GOOD CONDITION - No problems noted.</td>
</tr>
<tr>
<td>7</td>
<td>GOOD CONDITION - Some minor problems but no structural defects at critical locations (wood decay is a defect).</td>
</tr>
<tr>
<td>6</td>
<td>SATISFACTORY CONDITION - Structural elements show some minor defects and/or deterioration at critical locations. No measurable section loss.</td>
</tr>
<tr>
<td>5</td>
<td>FAIR CONDITION - All primary structural elements are sound but may have minor to moderate defects and/or deterioration with measurable section loss at critical locations. No significant reduction in primary structural member load carrying capacity.</td>
</tr>
<tr>
<td>4</td>
<td>POOR CONDITION - Primary structural elements show moderate to serious defects, deterioration, corrosion, cracking, crushing, and/or scour. Advanced section loss at critical locations. Diminished load carrying capacity of members is evident.</td>
</tr>
<tr>
<td>3</td>
<td>SERIOUS CONDITION - Serious and widespread defects have substantially reduced load carrying capacity of primary structural members. Local failures may be evident. Deflection/misalignment of members may be evident. Signs of severe structural stress are visible. Fatigue cracks in steel, shear cracks in concrete, and severe decay, checking, splitting, and crushing of beams or stringers in wood elements may be present.</td>
</tr>
<tr>
<td>2</td>
<td>CRITICAL CONDITION - Advanced deterioration of primary structural elements. Defects have now resulted in significant local failures. Scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.</td>
</tr>
<tr>
<td>1</td>
<td>IMMINENT FAILURE CONDITION - Major deterioration or section loss present in critical structural components and/or obvious vertical or horizontal movements affecting structure stability. Bridge is/should be closed. However, correction action may put bridge back in light service.</td>
</tr>
<tr>
<td>0</td>
<td>FAILED CONDITION - Out of service. Beyond corrective action.</td>
</tr>
</tbody>
</table>
Upper Midwest Inspection Locations
Solid Sawn Stringer/ Timber Deck

- Southern Minnesota
  - County (4)

- Northern Wisconsin
  - Forest Service (4)
  - 1-3 spans
    - 6-10 m, 20-35 ft length
    - 1 and 2 lanes wide
  - Gravel, bituminous, timber plank over timber deck

- Superstructure NBI (5-7)
- Deck NBI (5-7)
Glulam Stringer / Timber Deck

- Southern Minnesota
  - County (4)
  - 45 years old
  - Single span
    - 10-12 m, 33-40 ft length
    - 2 lanes wide
  - Bituminous and gravel over timber deck
- Superstructure NBI (6-7)
- Deck NBI (6-7)
Steel Beam / Timber Deck

- Northern Minnesota
  - County owned (5)
  - 26-42 years old
  - Single span
    - 9-11 m, 28-35 ft length
    - 2 lanes wide
  - Bituminous over timber deck
- Superstructure NBI (6-7)
- Deck NBI (7-8)
Spike Laminated Slab

- Northern Minnesota
  - County owned (5)
  - 22-32 years old
  - Multiple span
    - 15-18 m, 46-62 ft length
    - 2 lanes wide
  - Bituminous overlay
- Superstructure NBI (5-7)
- Deck NBI (4-5)
Jackson County, Minnesota
Built in 1940 – 73 years of service

- Average Daily Traffic - 1,050
- **Condition Rating** – 7 on a scale of 0 thru 9 (New)
Summary

- Nearly 130 timber bridges inspections completed during 2012-2013
- Most common type: sawn lumber girder with a sawn lumber deck (plank or nail-laminated)
- Numerous examples of bridge durability of more than 70 years
- Use of NDE inspection tools was key for collecting reliable inspection data among the six project teams
- All field data currently being analyzed for estimation of service life for bridges in different climatic regions
- Completion of this work will help provide a better understanding of the design, performance, and durability characteristics of timber bridge structures
- Final report to available in fall 2014
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- Joe Dahlen, University of Georgia
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Thank you!

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