Research Brief

Wisconsin Highway Research Program
Project 0092-20-01
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Rating Longitudinal Laminated Timber Slab Bridges

Research Objectives

- Develop updated wheel load distribution width equations
- Investigate retrofit techniques to potentially increase live load capacity
- Reduce the number of timber slab bridges with over-conservative load postings

Research Benefits

- The equations developed within this project better define the behavior of longitudinal timber slab bridges
- Retrofits on bridges improved the transverse load distribution and the equivalent strip width

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Background

The Wisconsin Department of Transportation (WisDOT) recognizes that there are many challenges in assessing bridge condition and performance, and, as a result, has been updating its bridge load-rating program to include more data analytics, especially for its timber bridge inventory. Of the 571 timber bridges in Wisconsin, 450 are timber slab bridges.

Current methods of load rating use equations that were first developed in the late 1980s and early 1990s for determining the equivalent strip width: these equations often yield results that unnecessarily penalize the bridge by requiring a posted weight limit. Research shows that inspecting, load testing and modeling representative bridge structures provides a means to more accurately create analytical bridge models for purposes such as load ratings. Additionally, once a baseline performance metric is attained from the live load testing, various retrofit techniques can be implemented into the analytical model to evaluate their efficacy at improving load distribution. The combination of experimental and analytical research results in more accurate load ratings and effective selection of strengthening options.

Methodology

Through a program of bridge live load tests and analytical modeling, the research team measured and modeled bridge behavior. The selection of bridges for field testing considered bridge type, year built, main span length, deck width, and posting information. The researchers identified 10 timber slab bridges from three counties (Barron, La Crosse and Monroe) with a span length of 23 to 31 feet and a width of 25.5 to 32 feet. They tested three bridges in La Crosse County twice, both before and after the strengthening measures, to study the effect of the transverse spreader deck retrofit method. Seven bridges in Barron and Monroe Counties were tested once each.

The researchers used trucks of three different sizes for the tests. For each bridge, a truck was driven across the bridge in specific transverse postioins to study the distribution of the loads.

Truck parked at position of maximum strain response for survey data collection

"Timber slab bridges account for only three percent of Wisconsin's bridge inventory, but 16 percent of its posted bridges. This research provides the knowledge we need to alleviate weight limit restrictions by improved analysis, load testing, or retrofit methods."

– Alex Pence, WisDOT

Interested in finding out more?

Final report is available at:
WisDOT Research website

Data were collected in two different ways, and the data collected from the first approach was used to validate the data from the second approach:

1. A conventional approach of using strain gages and deflection transducers connected to a data acquisition system to help the research team gain a comprehensive understanding of the timber deck behavior
2. Using surveying equipment to obtain the same or similar deflection data as obtained from the first method but reduced to only the longitudinal truck position where the maximum load response was realized.

Results

The research team confirmed the original speculation that the current equivalent strip width calculation methodologies are conservative. The equivalent strip width is a function of the ratio of longitudinal and transverse stiffness of the timber slab deck; where bridge strengthening or rehabilitation are being considered, it is to the benefit of the structural capacity to be mindful of this relationship.

Load testing proved to be extremely beneficial in developing models and recommendations. The resulting equation for calculating equivalent strip width is a good representation of actual structural behavior.

This research project presented the opportunity to test three bridges in La Crosse County before and after strengthening retrofits were completed. In these tests, it was evident that the retrofit improved the transverse load distribution and, accordingly, the equivalent strip width.

Recommendations for implementation

Experimental and analytical results support using less conservative, modified live load distribution equations for timber slab bridges in Wisconsin. Further, the use of transverse spreader decks is an effective retrofit method to further improve load distribution. This project focused on bridges constructed with nail-and-spike-laminated panels, and the research team recommends that the load test method should be conducted in the same way for timber bridges constructed differently, such as with glue-laminated panels. In the final report, the research team provides the full steps required to complete the additional live load testing so that other bridges can be tested in the future.

This brief summarizes Project 0092-20-01,
"Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges"
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