Wisconsin Department of Transportation

Wisconsin Highway Research Program

Request for Proposal

Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges

Questions submitted to research@dot.wi.gov regarding the content of this RFP are due by **4:30 PM (CST) on January 4, 2019**.

Responses to questions will be posted to the WisDOT Research and Library website (https://wisconsindot.gov/Pages/about-wisdot/research/researchers.aspx) by **4:30 PM (CST) on January 11, 2019**.

Proposers must submit a PDF version of their proposal to research@dot.wi.gov by **4:30 PM (CST) on February 6, 2019.**

Proposers will be notified of the proposal review decision by **May 1, 2019**.

This RFP is posted on the WisDOT Research and Library website (https://wisconsindot.gov/Pages/about-wisdot/research/researchers.aspx). For more information, contact the WisDOT Research Program at research@dot.wi.gov.

Wisconsin Highway Research Program (WHRP)
Request for Proposals (RFP)
Structures Technical Oversight Committee (TOC)

Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges

I. Background and Problem Statement

Over the past 10 years, WisDOT, Bureau of Structures (BOS) bridge rating engineers have been working on a program to update the load ratings of all bridges in Wisconsin. This effort was also driven by the mandate from the Federal Highway Administration (FHWA) to evaluate the State and Local inventory for Specialized Hauling Vehicles (SHVs). BOS developed and executed a data-driven analytical process that concluded with updated load ratings and load postings added, as required. BOS used existing plan information, field measurements, and standard structural analysis computer files to accomplish this task efficiently and effectively. As part of this process, BOS examined the 500 locally owned timber bridges. The analysis determined that these timber bridges are unable to carry contemporary AASHTO rating loads, based on standard structural analysis practices. This has resulted in the posting of these bridges, restricting traffic and impacting commerce.

Current AASHTO guidance on wheel load distribution widths for timber slab bridges load rated using Allowable Stress may be conservative and results in unnecessary reduction in capacity and resulting load postings. While significantly less conservative, wheel load distribution widths for timber slab bridges (load rated using Load Resistance Factor Design) are not prescribed for older timber slab bridges that do not meet modern detailing requirements required by LRFD. More accurate/reflective wheel load distribution widths for laminated slab timber bridges of the type used in Wisconsin would help reduce the number of unnecessary load restrictions and impacts to commerce.

Efforts to increase load capacity of timber slab bridges have typically been based on increasing the effective wheel load distribution. Methods include: tightening existing spreader beams, adding spreader beams, using transverse post-tensioning and using 4-inch thick laminated spreader deck panels placed transversely on top of the existing slab. These methods are meant to increase the effective wheel width; however, further research is required to more reliably quantify the effective wheel distribution width of these retrofit conditions.

Bridge owners would also benefit from an economical, efficient method of load testing timber bridges to determine whether load postings are necessary. Load testing to determine refined ratings for complex structures carrying overweight loads is an extensive and expensive process; load testing of small, simple structures for a threshold value (legal load) is likely much more practical. If the objective is to demonstrate a minimum capacity to raise or remove a load posting to allow legal loads (proof testing) instead of determining maximum capacity for overweight permit loads (diagnostic testing), the process can be simplified. If a process is developed that can be deployed and repeated for multiple structures, its cost could favorably

compare to the costs of strengthening or the economic impact of detours. Given that most of the timber bridges in Wisconsin are longitudinal laminated deck slabs, such a defined process could be tailored to this type of bridge and used on many structures as an evaluation tool.

Furthermore, load testing could be used as a preemptive measure to determine whether extensive retrofits are even required. It could address questions such as:

A. For bridges designed via AASHTO Standard Specifications, should different wheel load distribution widths be used for single-lane vs. multi-lane loading?
B. For field-nailed laminated bridges, with uneven laminations and not all in contact with the spreader beam, is the actual wheel load distribution closer to wheel width plus one or two times the slab thickness?
C. Does tire width correlate with effective slab width? If so, are the tire width formulas most commonly used from the 15th Edition (1992) of the AASHTO Standard Specifications appropriate? (These tire width formulas were removed from later editions, and the result has been that engineers are using their discretion to determine tire width.)
D. Do bridges with thicker overburden (commonly 8" to 12") demonstrate better wheel load distribution than those with the typical 3" asphalt?
E. Could minor modifications (such as the addition of quarter-point spreader beams) allow bridges, designed before LRFD implementation and that meet some but not all of the LRFD detailing requirements, to be rated with the increased distribution widths published in LRFD?

WisDOT is interested in the development of refined wheel load distribution widths for longitudinal laminated deck slab timber bridges and the development of methods for standardized proof load testing for this type of superstructure. We are also interested in the effectiveness of retrofit techniques to increase live load capacity. The focus of this study is related to evaluation of super-structures only.

II. Research Objectives

The objective of this research is to improve tools used to assess the condition, load distribution factor and load rating of Wisconsin timber slab structures by:

A. Using a combination of an analytical program and a field testing program to develop refined wheel load distribution widths for laminated timber deck slab bridges, based on the actual measured load responses of Wisconsin timber bridges.
B. Developing a process to easily load test and proof rate legal load capacity of timber slab bridges, with common loads (e.g., County dump trucks). To achieve

these objectives, it is expected that the research team would establish load response relationships for the longitudinal laminated timber structures.

C. Evaluating the effectiveness of retrofit techniques to increase live load capacity: tightening existing spreader beams, adding spreader beams, using transverse post-tensioning and using 4-inch thick laminated spreader deck panels placed transversely on top of the existing slab.

D. Making in-situ moisture content and temperature (above and below freezing) measurements of timber bridges used in this study and comparing these measurements with current WisDOT assumptions and practices.

E. Completing the study with the following expected implementable results: removal of load postings of good-condition timber slab bridges and allowance for more capacities than current standard analytic methods quantify.

III. Scope of Work

A. Conduct a literature review and assessment of current timber bridge practices at other state DOTs, FHWA, USDA Forest Products Laboratory, US Forest Service, agency owners, industries, and manufacturers.

B. Create a concise summary of the available information related to current practices at other state DOTs and agency owners that relate to policies and practices for load rating, proof loading, and retrofitting to increase load capacity.

C. Formulate and present to the WHRP Project Oversight Committee the analytical and technical field evaluation program that will be used to develop and collect information. Use this information to develop the relationships and recommendations needed to meet the objectives and deliverables of this project.

D. Conduct an analytical program related to live load distribution and live load response for longitudinal laminated slab timber bridges.

E. Implement a field testing program for timber bridges that will support the development of wheel load distribution width, specification for proof load testing (including load response relationships) and effectiveness of retrofit techniques to increase live load capacity. (It is anticipated that this may be 5-10 timber bridges in Wisconsin.)

F. Collect information related to the in-situ moisture content of timber bridges that can be used to verify current AASHTO and WisDOT Policy and Practice related to moisture adjustment factors. Document this information in the final report.

G. Determine and make recommendations for wheel load distribution width for laminated deck slab timber bridges common to the Wisconsin inventory. Base these on the analytical modeling and field experiments and the measurements of load response behavior.

H. Evaluate the effectiveness of timber bridge retrofit techniques. (These will be coordinated with the WHRP Project Oversight Committee and may involve pre-installation and post-installation load response measurements on 2-3 select Wisconsin bridges.)

I. Develop recommendations and guidelines (in a format consistent with WisDOT Bridge Manual - Chapter 40 and Chapter 45) and associated presentation materials for WisDOT practitioners.

J. Develop and recommend a process/specification to easily load test (proof load) the load capacity of longitudinal laminated timber slab bridges with a common load (e.g., county dump trucks). This specification could be calibrated to be a "Legal Load" threshold that would justify removal of load restrictions and postings. To achieve these objectives, it is expected that the research team will establish load response relationships for the laminated slab timber structures. This will take the form of a specification with the detail and guidance consistent with the needs of a Professional Engineer who would apply/oversee the proof load testing.

IV. WisDOT/TOC Contribution

WisDOT will provide the following support through the WHRP Project Oversight Committee and Regional Bridge Maintenance Engineers:

A. Work will be conducted with project oversight by the WHRP Structures Technical Oversight Committee (TOC). The TOC members will appoint a Project Oversight Committee (POC) to support the successful completion of the project.

B. The research team will not assume the availability of WisDOT staff or equipment in the proposal. If WisDOT or another entity donates equipment or staff time, a letter of commitment must be included in the proposal.

C. WisDOT staff/TOC members can be expected to contribute a maximum of 40 hours over the duration of the project. The research team will consult with POC members in the selection of project sites.

D. Field work on or around in-service facilities is anticipated to conduct this research. As practical, the researcher shall specify in the proposal the nature and extent of traffic control that will be required for this project including: traffic flagging, signage, barricades, etc., as well as the duration needed (hours/day/location). There also needs to be a discussion in the proposal of the specific traffic control support that is being requested from WisDOT. The researcher will need to coordinate the location(s) of the project fieldwork with the POC chair, WisDOT regional personnel and possibly the county personnel. The researcher should make accommodations in their proposal budget for traffic control and should not assume WisDOT will fund traffic control expenses.

V. Required Travel

Travel is required in Wisconsin for field investigation and testing of timber bridges. It is expected the PI will deliver the final presentation to the TOC in-person in Madison.

VI. Deliverables

A. Reporting Requirements: An electronic copy of the final report will be delivered to WisDOT by the contract end date including: the report, specifications and manual recommendations.

B. Policy recommendations for Bridge Manual (Chapters 40 and 45), Wheel Load Distribution Widths, Proof Loading Process/Specification, and commentary related to retrofits to increase live load capacity of timber bridge superstructures.

C. Development of a PowerPoint presentation that will serve as a training tool for WisDOT bridge and pavement design and construction staff. (WisDOT staff will provide the associated training.)

D. Presentation Requirements: The PI is required to give an in-person Close-Out presentation to the TOC.

VII. Budget and Schedule

A. Project Budget shall not exceed **$220,000.**

B. Proposed project duration is **24 months** starting around **October 1, 2019.**

C. Deadline for submittal of the Before Close-Out presentation (BCOP) report is three months before the contract end date to allow for report review activities.

D. Deadline for the Close-Out presentation is six to eight weeks before the contract end date.

E. Deadline for submittal of the publication-ready, After Close-Out Presentation (ACOP) report is the contract end date.

VIII. Implementation

Successful implementation of this research will be achieved through the development of the following items:

A. Final report detailing the results of the research project and following the report preparation instructions: Researcher Report Preparation.

1. The final report should be a maximum of 50 pages (plus supporting appendices) and be as concise as possible.
2. The research team should format the report such that significant findings are provided at the beginning (e.g., in an extended executive summary).

B. The literature review and summarized interviews may be provided as a separate document or in the appendices of the report.

C. Procedure and specification for standardized Proof Load Testing to establish Legal Load Capability of longitudinal laminated timber slab bridges of the type used in Wisconsin.

D. This specification should emphasize loads (county dump truck) and measurement methods (simple level or other) readily available to the local owner's engineer of record.

E. Recommendation for more accurate wheel load distribution widths (method of calculating the DF) that load rating engineers will use when evaluating simple span timber slab bridges of the type used in Wisconsin. This will be policy added to chapters 40 (Bridge Rehabilitation) and 45 (Load Rating) of the Bridge Manual.

F. Commentary/documentation on the effectiveness of timber bridge retrofit techniques.

G. Information on in-situ moisture content of timber bridges that can be used to verify assumptions and practices during the bridge rating process.

H. A PowerPoint presentation to serve as a training tool for WisDOT Bridge Maintenance, Bridge Asset Management, Pavement Maintenance and Regional Planning staff.