Cost-Competitive Timber Bridge Designs for Long Term Performance

tech transfer summary

Cost, construction, and performance information on various types of the new generation timber bridges can provide cost-effective bridge options for use in Iowa and other states.

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RESEARCH PROJECT TITLE
Cost-Competitive Timber Bridge Designs for Long Term Performance

SPONSORS
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The National Center for Wood Transportation Structures (NCWTS) is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of the NCWTS is to bring together academia, government, and industry to efficiently complete research, demonstration, and education that result in durable, cost-effective wood transportation structures to improve the transportation infrastructure of America and the world.

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Problem Statement

Iowa, Minnesota, and many other states are facing the need to replace their aging bridge inventory, while also facing many challenges for adequate funding, particularly for rural bridge construction. Innovative, sustainable, and cost-effective timber bridge options need to be developed and shared with a focus on local agency needs.

Objective

The objective of this project was to develop a series of design, contracting, and construction options and strategies for cost-competitive, sustainable timber bridges in Iowa that meet the American Association of State Highway and Transportation Officials (AASHTO) HL-93 load requirements and Load and Resistance Factor Design (LRFD) specifications for bridges.

Project Scope

While there is a wealth of existing information on timber bridges across the US, the objective of this project was to focus on timber bridges that have been constructed in Iowa that could potentially provide useful information. The project scope originally focused on incorporating standard plans for timber bridge superstructures that are currently under development by the U.S. Department of Agriculture (USDA) Forest Products Laboratory (FPL) in cooperation with other timber bridge designers and perhaps others.

The Buchanan County Catt Bridge is a geosynthetic-reinforced soil-timber bridge on 215th Street, east of Independence, Iowa

The research plan called for identification of several bridge construction projects with partnering counties in Iowa in cooperation with the Institute for Transportation (InTrans) Bridge Engineering Center (BEC). The intent was for Iowa bridge construction projects to provide technical data for assessment and validation of the initial costs of construction, prediction of life-cycle costs, and a life-cycle assessment for these bridges.

These construction projects, along with cost information from two timber bridge projects under construction in Buchanan County, Iowa, would provide the data needed for this study. Unfortunately, the scope of the originally planned project had to be scaled back due to unsuccessful attempts to identify and implement the bridge construction projects.

Background

Over the last 35 years, new generations of timber bridges have been developed and implemented successfully across the US and in numerous states. The FPL and other agencies have developed numerous standard superstructure options for use nationwide.

These designs include multiple timber bridge types, including glued laminated girders with glued laminated decks; sawn timber, spike-laminated panels; stress-laminated panel bridges; and steel beams with timber decks.

A considerable amount of technical information also exists on timber bridge viability. Recent guidance includes timber-bridge cost and overall performance information from completed research demonstration projects as well as some limited information regarding non-research projects and other FPL projects.

Still, concerns remain that timber bridges are not cost-effective options when compared to steel and/or concrete bridges. This has led to continued efforts to develop reliable, readily applicable, cost information for timber bridges.

Research Methodology

As noted in the Project Scope section, the original research plan needed to be scaled back. The proposed scope of the project is presented in this document in hopes of future opportunities to implement the project as originally planned.

A comprehensive literature review was completed to identify previous research on modern, cost-effective, sustainable timber bridge superstructure plans, cost studies, and assessment strategies for initial and life-cycle costs. A survey was developed and distributed to solicit information from county engineers, with a goal of understanding timber bridge concerns, construction protocols for bridges, and the use of county crews or engineering construction firms.

The project team proposed to identify and interface with several partnering counties in Iowa. Two timber bridge construction projects that had been completed previously in Buchanan County, Iowa, provided some recent data (see table).

The research intent was to demonstrate and validate the cost parameters associated with Iowa timber bridge construction projects utilizing the identified bridge designs and strategies that exist and compare them to preconstruction estimates.

Design innovations and contracting options were to be explored to support reduced cost options as well. Ideally, the anticipated timber bridge construction projects to be a part of the project were to consist of contractor-built/contracting construction options to obtain initial cost information. This would complement the information from the two Buchanan County bridges that were built using the county workforce.

The combination of the contractor-built and county-built bridge datas would allow for comparison of both alternatives, as not all counties have the resources to construct their own bridges. A preliminary assessment of the initial costs of the identified Iowa options was then to be completed and compared to typical concrete bridge designs commonly used in Iowa.

Key Findings

Design plans developed by the USDA FPL in conjunction with the Federal Highway Administration (FHWA) are currently available on the National Center for Wood Transportation Structures (NCWTS) website (www.woodcenter.org).

Cost information for the superstructure materials of the two bridges previously constructed in Delaware County, Iowa, and one currently under construction in Buchanan County, Iowa, were gathered and are presented in the table.

Bridge	Length (ft)	Width (ft)*	ft^2	Total Cost**	$/ft^2$ Deck
Delaware County Demo	76	28	2,128	181,000	85
Delaware FRP-Timber***	69	29.5	2,035.5	215,000	105
Buchanan County GRS-Timber	52.5	30	1,575	172,000	109

**Out-to-out width of deck*
***Superstructure material costs only*
****Bridge girders were fiber-reinforced polymer (FRP); however, FRP prices were neglected for this study*
GRS=geosynthetic-reinforced soil

The Buchanan County bridge was constructed by the county workforce to reduce project costs. Although this may be a viable approach, not all counties have the work force available to conduct this level of work.

Typically, construction of engineered timber bridges requires much less skilled labor and time when compared to steel and concrete bridges of similar size. In addition, due to the reduced dead weight and size of the individual components, there is also less need for specialized equipment and large cranes.

Timber bridges have been developed and implemented successfully across the US, and particularly within local system agencies.

Recent national timber bridge assessments have shown that properly designed, treated, and maintained, timber bridge superstructures have demonstrated service lives of more than 50 years, and often approaching 70 years (Wacker et al. 2014).

The FPL has been updating standard plans for the new generation of timber bridges that will allow engineers to effectively design and evaluate timber bridge options for replacing structurally deficient or load-posted bridges. Timber bridge manufacturers, timber suppliers, including wood preservation suppliers, and bridge designers have also arisen in many states. Recent improvements in materials and treating processes also provide new long-lasting options for planning and construction of timber bridges.

Implementation Readiness and Benefits

To date, there is still insufficient interest in timber bridge construction from the broader bridge engineering agencies. This issue could be countered with cost, construction, and performance information on the various types of new generation timber bridges.

Providing information to the local agencies, including technical design, construction process, performance, and financial information, would help bridge owners make cost-effective decisions.

This information would illustrate the cost-effective timber bridge options that could be used in Iowa. However, results from this research project were limited both in implementation readiness and content due to the inability to coordinate efforts between the BEC and Iowa bridge engineering partners.

It is noteworthy that there is limited cost information available from several Iowa timber bridge projects built over the last 5 to 10 years. The hope is for another opportunity to garner the partnerships needed to develop a successful project with value for bridge engineers in the future.

Reference

Wacker, J. P., B. K. Brashaw, T. G. Williamson, P. D. Jones, M. S. Smith, T. K. Hosteng, D. L. Strahl, L. E. Coombe, and V. Gopu. 2014. Service Life Assessment of Timber Highway Bridges in USA Climate Zones. Proceedings, World Conference on Timber Engineering, August 10–14, Quebec City, Canada. https://www.fpl.fs.fed.us/documnts/pdf2014/fpl_2014_wacker001.pdf.

Catt Bridge News Links

www.equipmentworld.com/iowa-countys-grs-bridge-construction-technique-to-be-studied-for-cost-savings/

www.kcrg.com/content/news/Buchanan-County-experimenting-with-unusual-bridge-construction-398779871.html