Timber-Based Bridges Offer a Cost-Effective, Durable Alternative

What Was the Need?
MnDOT and the Local Road Research Board (LRRB) have been supporting timber bridge owners with research on inspection and repair since the early 2000s, including acquired tools for inspectors.

Advocates of timber bridges credit advances in design, preservation, maintenance and inspection that should dispel misconceptions about the cost, durability and structural strength of contemporary timber bridges.

Yet from 2000 through 2019, Minnesota local agencies built 4,335 concrete-based bridges, 26 steel-based bridges and 26 timber-based bridges. While timber bridges are traditionally believed to perform satisfactorily for 50 years or more, few local road agencies in Minnesota have extensive experience with timber in new bridge construction. Common misperceptions about timber bridges include that they can be expensive to construct, less durable than other types of bridges and cannot carry heavy truckloads.

As Minnesota’s local road agencies grapple with the challenges of renewing an aging bridge infrastructure with limited resources, LRRB needs to provide these agencies with design and construction guidance on alternatives to bridges made with concrete and steel such as timber.

What Was Our Goal?
The LRRB sought to help local agencies understand how timber bridges can be built cost-effectively. Investigators needed to examine the literature and Minnesota practice, develop new superstructure design aids that meet national bridge design standards and compile case studies presenting timber-based bridge options to Minnesota bridge builders and owners.

What Did We Do?
To identify design needs, researchers reviewed current literature on timber bridges and building products, interviewed Minnesota manufacturers of timber bridge elements, and surveyed county engineers in Minnesota and Iowa about their perceptions of timber-based bridges.

In 2017 St. Louis County built a bridge west of Babbitt with steel girders and a glue-laminated timber deck. In 2019 Hennepin County erected a bridge with a longitudinal spike-laminated timber deck in Dayton. Researchers worked with each county during design and visited these sites during bridge construction to collect design and construction information. They also conducted life cycle cost analyses of the bridges to compare the cost-effectiveness to traditional bridge designs. Using the findings of these efforts, the research team prepared a series of superstructure design guidelines and developed presentations for Minnesota county engineers.

What Did We Learn?
The research established that timber-based bridges can be cost-competitive with bridges built from other materials, particularly when deploying an asphalt wearing course with a geotextile membrane. National studies demonstrate that timber bridges can be built...
to meet a 70-year service life. Using important drainage and flashing details, conducting routine maintenance, and employing effective and reliable inspection techniques are key aspects to achieving and extending this service life.

Cost comparisons of timber structures versus concrete and steel options proved complex and elusive. The St. Louis County bridge superstructure cost was similar to a concrete superstructure, and the accepted Hennepin County bridge bid was 20 percent below the engineering estimate.

Timber bridges offer unique advantages for low-volume rural sites with straight approaches where they are best-suited. With metal flashing, waterproofed surfaces, gutters and borate-infused timber pier caps, timber bridges can manage water runoff in ecologically responsible ways with improved durability. Laminated timber slabs and decks with asphalt overlays featuring a waterproof membrane protect superstructures from water and ice damage.

County crews completed the St. Louis County bridge superstructure in 14 days; a concrete structure would have taken 42 to 56 days. Hennepin County’s contractors delivered similar time savings. Both counties avoided a month or more of traffic detours, dramatically reducing inconvenience to drivers in rural areas with limited detour options. Timber structures can also be built in winter conditions that can otherwise harm the integrity of concrete materials during construction. Furthermore, timber bridges offer reduced greenhouse gas emission benefits over other construction materials that could help meet green building standards, which may become a factor in bridge design selection in the future.

Researchers published appendices with design guidelines for transverse glue-laminated timber decks with steel stringers, transverse glue-laminated timber decks with glue-laminated timber stringers and spike-laminated longitudinal decks. Details meet the American Association of State Highway and Transportation Officials (AASHTO) load standards and load and resistance factor design specifications.

What’s Next?
As manufacturing, construction, inspection and maintenance expertise with timber bridges grows in coming years, durable timber bridges may become more common and less expensive. Future research may include instrumenting a timber bridge during construction for performance monitoring over time. MnDOT may also develop standard plans and details for new railing alternatives for timber bridges.

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