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Wood Bridges in New England

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Abstract

Wood bridges in New England predate the 18th century. This paper presents an overview of the history, current status, and future of wood bridges in this region. The resurgence of wood bridges is tied to economics, serviceability, and longevity. Research on new bridge designs, which are adaptable to native New England wood species, may improve wood utilization and increase the use of wood bridges.

Historical Perspective

New England was once a center for the development of wood bridges. Most wood bridges built before the 18th century were short span structures constructed by settlers. During the mid-18th century, longer spans were made with trestle bridges consisting of timber beams placed between closely spaced pile bents. The first long-span wood bridge may have been constructed in 1761 over the York River at York, Maine, by Samuel Sewell. This bridge was 82 m long and 7.6 m wide; it was supported on pile bents spaced approximately 6 m apart. It also included a draw span to allow boat passage under the structure. The earliest wood bridge to provide clear spans greater than could be negotiated with a single log or beam was completed by Colonel Enoch Hale in 1785. Constructed over the Connecticut River at Bellows Falls, Vermont, the bridge was a 111-m-long, two-span structure with center support provided by a natural rock pier. This bridge stood until approximately 1840 (Eby 1986).

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An estimated 10,000 covered wood bridges were built in the United States between 1805 and 1885 (Fletcher and Snow 1976). Many of these bridges were developed and built in New England using a variety of truss and arch configurations. One noteworthy bridge builder was Ithiel Town (1784-1884), a New Haven architect who recognized the need for a covered bridge truss that could be built at low cost. In 1820, he was granted a patent on a plank-lattice bridge truss design that represented a first step toward the modern truss form. This bridge included a web of light planks, 50 to 100 mm thick and 200 to 250 mm wide, that were criss-crossed at a 45° to 60° angle. The webs were fastened together at their intersections with wooden pins. The lattice trusses could be built for spans up to 67 m, were lightweight and inexpensive, and could be assembled in a few days. A great number of these covered lattice trusses were built for highway and railroad traffic throughout the United States.

For most of the 19th century, wood bridges were constructed of untreated material; builders relied mainly on the use of naturally durable species and roofs to provide long service lives. A major development that improved wood bridge performance was the introduction of pressure preservative treatments. The first pressure creosoting plant in the United States was built in Somerset, Massachusetts, in 1865. The number of treating plants increased steadily to 70 by 1910 (Eby 1986). Thus, by the end of the 19th century, preservative treated wood could be used as an alternative to covers to protect wood from deterioration.

The 1840's marked a turning point for wood bridge development. Prior to that time, most wood bridges were built almost totally from wood. Iron components, when used, were limited to small fasteners or other hardware that could be forged by blacksmiths. In 1840, William Howe of Massachusetts patented a parallel-chord truss design that used two systems of web members. The chords and diagonal braces were made of wood and the vertical web-tension members were made of round cast-iron rods. This was the first design to use iron as an essential structural element of a wood truss system and the first to include a complete stress analysis of the design by mathematical practices then in use. After a number of years, several modifications were made to the original Howe design to more accurately reflect the actual member stresses. The design continued to be widely used for railroads and highways and became the most popular truss for the last half of the 19th century.

In the latter half of the 19th century, iron bridges became increasingly popular and began to compete strongly with wood; the use of wood declined as new materials were introduced. Technology in the steel industry developed rapidly in the early part of the 20th century, leading to a more expanded and economical use of steel as a bridge material. Later, the use of reinforced and prestressed concrete became more prevalent for bridge construction. During this rapid technological development of other bridge materials, progress in wood bridge development slowed and the number of wood bridges in New England relative to bridges made from other materials declined substantially.

Current Status

Based on information obtained from the 1992 National Bridge Inventory (FHWA 1992), there are a total of 14,831 highway bridges in New England (Table 1). Of this total, 431 bridges are constructed of wood. On a percentage basis, wood bridges represent less than 3% of the bridges in New England; Connecticut has the lowest percentage (1%) and New Hampshire the highest (6%). Covered bridges constitute a significant portion of the wood bridge population in New Hampshire (73 bridges) and Vermont (60 bridges).

Table 1-- Bridges in New England

State	Total Number of Bridges	Number of Wood Bridges
Connecticut	3,263	37
Maine	2,000	32
Massachusetts	4,429	125
New Hampshire	2,028	123
Rhode Island	634	30
Vermont	2,477	84
Total	14,831	431

As in other regions of the country, interest in wood bridges has recently increased in several New England states as a result of the Timber Bridge Initiative (TBI) and the Intermodal Surface Transportation Efficiency Act, passed by Congress in 1988 and 1991, respectively. Through these legislative programs, information transfer and demonstration bridges have been funded to provide technical information to designers and builders and to encourage the development and demonstration of new technology. Since 1989, a total of seven TBI demonstration wood bridges have been funded in New England (USDA 1994). The majority of these bridges have been constructed with wood species indigenous to the New England area and have employed stress-laminated design concepts (Ritter 1990).

Future Potential

The future of wood as a bridge material in New England will depend primarily on the economics, serviceability, and longevity of wood bridges compared to bridges constructed of other materials. To compete effectively, wood bridges must be cost effective and provide performance comparable to that of steel and concrete bridges. Economics is a key issue that is tied directly to material cost and the costs for fabrication and construction. Like that of other materials, the cost of wood is variable and depends on supply and demand. The use of new wood species that have not been previously used for structural applications is initially more expensive

but should decline as manufacturing and grading practices are refined. Fabrication and construction costs depend to a large degree on contractor experience. Given the relatively small number of wood bridges that are currently constructed in New England, construction costs may be artificially high since contractors are not as familiar with using wood compared to other materials. This situation will likely change as more bridges are built and contractors become more familiar with wood bridge construction methods and techniques.

Aside from economic considerations, the future of wood bridges in New England also depends on designs that provide the required structural capacity, servicability, and longevity. Many wood bridge designs that have been used throughout the United States have demonstrated acceptable performance (Ritter 1990). Nevertheless, engineers are generally not familiar with wood design and are hesitant to accept wood as a viable construction material. More widespread education of designers in wood design fundamentals and modern wood bridge technology will contribute to the increased acceptance of wood bridges and better distribution of bridge designs that meet required design applications.

Within New England, research programs have been implemented to develop new wood bridge designs that are more cost-effective and structurally efficient and are adaptable to native wood species. Work in progress at the University of Maine is aimed at developing wood bridges constructed of metal-plate-connected trusses and producing structural glued laminated timber using native New England wood species. Projects are also underway to develop stress-laminated bridge decks to replace deteriorating concrete decks on steel stringers. Projects such as these will help improve wood utilization and will potentially increase the use of wood bridges in New England.

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