

Covered Bridges in the United States and the Preservation Program

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Summary

Covered wooden bridges once dotted the landscape of the United States numbering 14,000 at one time as reported in the Federal Highway Administration's Covered Bridge Manual [1]. Today there are only 500 to 600 covered bridges remaining in the country, having survived hundreds of years largely as result of the roof structure which kept the bridge timbers dry. This paper reports on select number of existing covered bridges and current efforts to preserve and restore these historic structures. It provides an overview of the National Historic Covered Bridge Preservation (NHCBP) Program administered by the Federal Highway Administration. This program includes preservation of covered bridges that are listed, or are eligible for listing on the National Register of Historic Places. It also includes research for better means of restoring and protecting covered bridges, and includes education component to disseminate information as a means of preserving our cultural heritage.

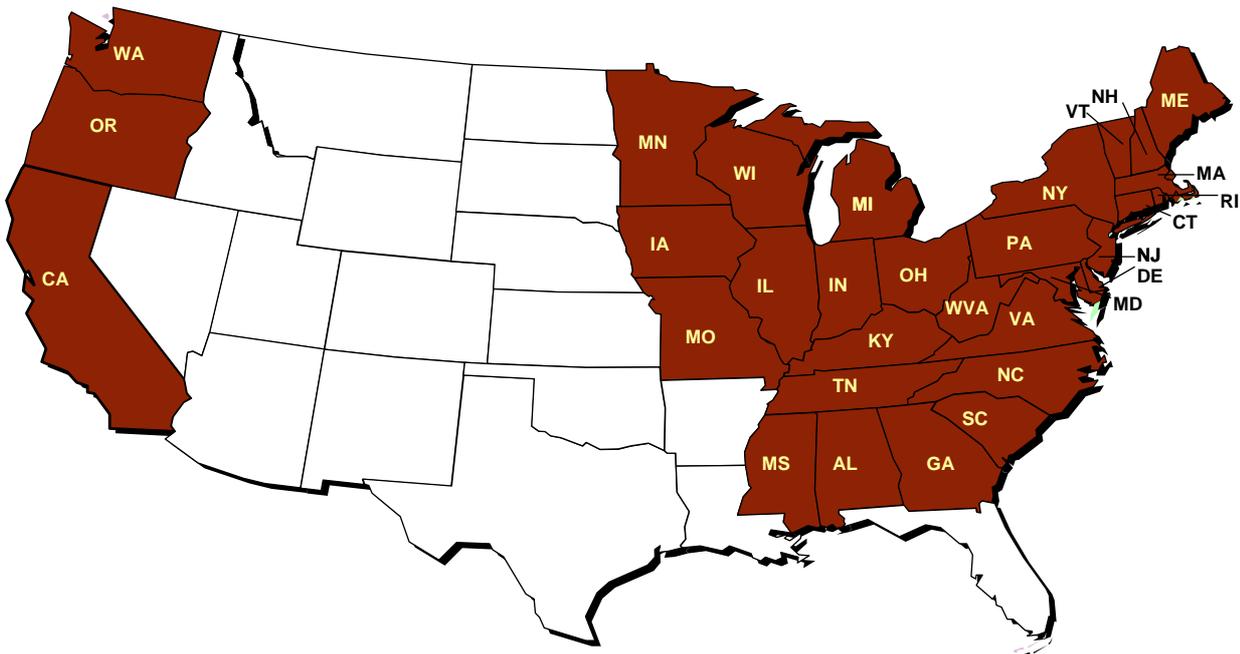
1. Introduction

Covered wooden bridges proliferated in the United States in the mid-nineteenth century. Today 500 to 600 remain, but nevertheless are cherished links to the technological heritage of the United States. The through-truss designs vary from the Kingpost trusses built in the craft tradition, to the engineered Burr arch and Paddleford trusses. Covered bridges are our links to the past and the pioneering bridge-building efforts, and as such, are considered important early American transportation structures to preserve for our posterity.

Preserving historic properties as important reflections of the American heritage became a national policy through the Historic Sites Act of 1935, the National Historic Preservation Act of 1966, as amended, and the Surface Transportation & Uniform Relocation Assistance Act of 1987. In 1998, the Transportation Equity Act for the 21st Century (TEA-21) as amended by the TEA-21 Restoration Act (the Act) established the National Historic Covered Bridge Preservation (NHCBP) program. The program was re-authorized within the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) legislation i.e. the 'Highway Bill' funding roads and bridges in the United States. The program provides funding in two categories (1) assisting States in their efforts to rehabilitate, restore, repair, or preserve the Nation's historic covered bridges and (2) for conducting research to find improved means of restoring, and protecting these structures and for education and technology transfer. To date, over 94 covered bridges have been, or are in the process, of being preserved under the NHCBP program. This paper will summarize several covered bridge restoration projects and provide an update on research projects.

2. Covered Bridge Preservation & Restoration Projects

Even today, covered bridges in the United States exist from coast to coast, but are predominant in a few States. Figure 1 shows the States where covered bridges exist. Although these bridges have remained and continue to carry both vehicular and pedestrian traffic many have undergone some restoration and preservation work over their lifetime. Repairs have included strengthening to increase load capacity, replacement of deteriorated members, roofs and sidings, and addition of arson prevention systems such as alarms and sprinklers. In a number of cases the bridges have been reengineered keeping only the external appearance the same. The design types vary and include the Town Lattice, the Howe, the Burr Arch, the Kingpost, the Wheeler, the Paddleford, the Queenpost, the Long and the Warren trusses, most of which are depicted on Figure 2.



Source: World Guide to Covered Bridges, 1989

Fig 1. Locations of Covered Bridges in the USA

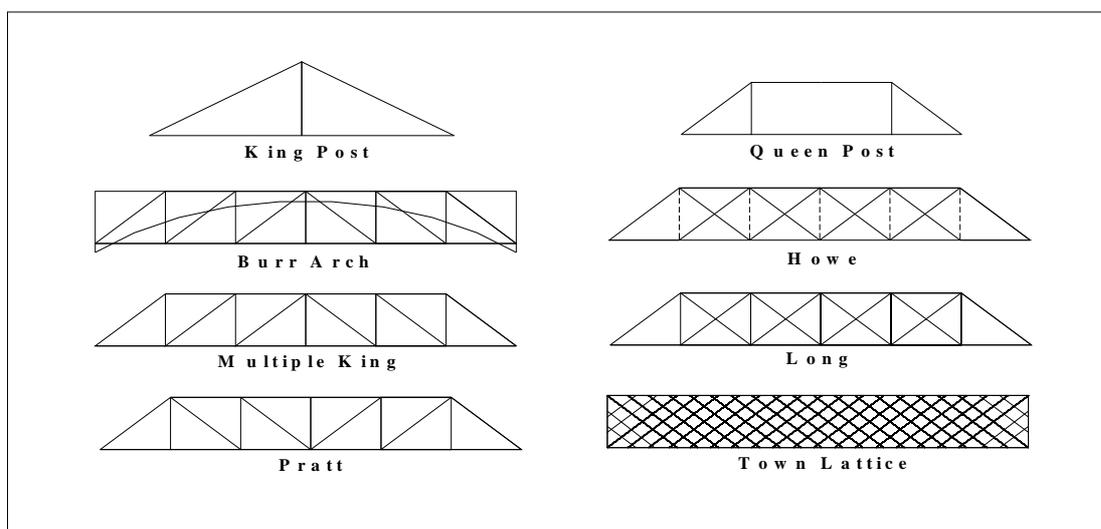


Fig 2. Covered Bridge Truss Types

Below are brief descriptions of some of these bridges that have been funded through the preservation effort by the Federal Highway Administration.

The Clarkson/Legg Covered Bridge over Crooked Creek in Cullman County, Alabama is a Town Lattice Truss, built in 1902. With 82.3 m two spans, it is the second longest covered bridge in the southern US. It represents an era of civil engineering dating from 1840 to early 1900. The bridge was repaired extensively in 1922 after flood damage, then completely restored in 1975. It is open to pedestrian traffic because of insufficient height and width for other traffic uses. Major rehabilitation has included the use of prestressing tendons to reduce creep in the lower chords.

The Comstock Covered Bridge in East Hampton, Connecticut is one of three remaining covered bridges in Connecticut. Of the three, it is the only one still carrying its own weight with the original timber superstructure. The main span is a 27.4 m long Howe Truss built in approximately 1840. It is one of the oldest, if not the oldest, remaining original Howe Truss in existence. The truss and floorbeams date from the original time of construction, including the original iron rods. The approach span is 11 m long Queenpost Pony Truss constructed in 1791. The bridge now carries pedestrian traffic in a state park. In 1974, major rehabilitation was conducted which included removal of a 305 mm negative camber, and strengthening of the bridge.

Thompson Mill Covered Bridge over Kaskaskia River in Shelby County, Illinois is a five span 49 m long and 3.23 m wide bridge built in 1868. It is one of five 19th century covered bridges in Illinois and one of only two of the Howe Truss types. The bridge is open to pedestrian and bicycle traffic.

Medora Covered Bridge in Jackson County, Indiana is the longest covered bridge in the United States at 131 m length. It is a three span Burr Arch Truss with a clear width of 4.9 m built in 1875. This bridge was bypassed in 1972, and is closed to all traffic. At completion of the planned restoration work, which includes repair deterioration of substructure, repair arches and plumb trusses, replace decayed wood, and repair siding and roof, the bridge will be open to automobile, and light vehicle traffic.

There are a number of covered bridges in Madison County, Iowa famous for the book and movie 'The Bridges of Madison County'. The bridges described below and funded for restoration work in 2000 were built between 1871 and 1884. These include the Imes bridge, a 25 m long Town Lattice Truss built in 1870 - 1871; the Cutler - Donahue bridge, a 25 m long Town Lattice Truss built in 1871; the Hogback bridge, a 30 m long Town Arch Lattice Truss with three wood approaches totaling 49 m, built in 1884; the Holliwell bridge, a 33 m Bowed Arch Truss with two wood approaches totaling 47 m built in 1880, the Roseman bridge, a 32 m Town Arch Lattice Truss with four wood approaches totaling 62 m built in 1883; and the Cedar bridge, a 21 m Town Arch Lattice Truss with three wood approaches totaling 40 m built in 1883.

The State of Kentucky has 3 remaining covered bridges. One, the Bennett's Mill Covered Bridge in Greenup County, Kentucky built in 1855 was funded in 2000 to restore structural integrity by replacing deteriorated members thereby increasing the bridge rating from 3 to 8 tons. It is a single span Wheeler Truss 48.3 in length with a clear width of 4.9 m and a vertical clearance of 4.4 m. The bridge is open to vehicular traffic. Previous repairs on this bridge have included truss repairs, new siding and roof around 1915; roof replacement in 1925; and floor beams and lower chords replaced or repaired following damage from an overloaded vehicle in 1976.

The Ponn Covered Bridge in Vinton County, Ohio built in 1874 spans 55 m across Raccoon Creek. This bridge has a humpback-like feature which makes it the only one of its kind in Ohio. The south end of the bridge is a double Queenpost Truss, the north end is a Multiple Kingpost Truss and the middle is a combination of a Multiple Kingpost with an arch. The bridge is open to pedestrian traffic.

Hills Covered Bridge in Washington County, Ohio built in 1878 is a Howe Truss bridge. It consists of two approach spans of 9 m each and a main span of 35 m. Existing piers are the original stone piers. The bridge is open to pedestrian traffic.

Teegarden-Centennial Covered Bridge in Columbiana County, Ohio built in 1875-76 and is an 8-panel, single-span, Multiple Kingpost Truss. The overall length is 20 m with a clear span of 19 m. The width is 3.45 m, with a height of 3 m. The bridge was in daily use from 1875 to 1992 when it was bypassed by a concrete structure. It is now used for pedestrian traffic only. This is one of five covered bridges remaining in Columbiana County and one of two on its original site.

Fisher School Covered Bridge in Lincoln County, Oregon built in 1919 is the fifth oldest Howe Truss in Oregon. Its unique features include semi-elliptical portal arches, ribbon openings, and flared side walls. It is the longest span covered bridge in the county at 22 m. The bridge was bypassed in 1975 with a prestressed concrete bridge, and is currently open for pedestrian use only.

Meens Bottom Covered Bridge in Shenandoah County, Virginia, built in circa 1893 is a single span 62 m long and 5 m wide Burr Arch Truss. It is the longest single span covered bridge in Virginia. Aside from minor maintenance repair, three major repairs have been carried out on this bridge. In 1937, reinforced steel beam floor system was installed. In 1979 restoration work was undertaken to repair damage caused by arson in 1976 where fire destroyed much of the bridge's superstructure and weakened surviving arch and trusses. The third major project was carried out in 1984, where the bridge's load carrying system was transferred from the arch truss to steel girders and piers. The bridge now includes a fire detection and suppression system. The bridge is open to vehicular traffic and has a 12 metric ton load capacity.

3. National Program Emphasis

The thrust of recent preservation effort to save historic covered bridges has been the establishment of the National Historic Covered Bridge Preservation Program under two recent 'highway bills' i.e. TEA-21 and SAFETEA-LU. The bridges that are eligible for funding under this program have to be listed or be eligible for listing on the National Register of Historic Places. The program provides funding for preservation, rehabilitation, and restoration as defined in the Secretary of the Interior's Standards for the Treatment of Historic Properties [2]. The program however does not provide for reconstruction of a historic bridge. Therefore if a bridge is destroyed by arson or natural event, this funding cannot be used to rebuild the structure. Both TEA-21 and SAFETEA-LU authorized \$10 million to be appropriated each year for the life of the Bills. However, even though funding was authorized the actual amount given by US Congress has varied from year to year, with some years receiving no funds as shown in Table 1.

Table 1
National Historic Covered Bridge Preservation Program
Funding Levels 1999 thru 2009

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Funds (in millions)	0	\$8	\$9	\$2.8	\$6	0	0	\$8.6	\$9.2	---	---

Restoration of historic structures requires that the projects be carried out in the most historically appropriate manner preserving the historic fabric of the structure. This is often a challenge as the covered bridges of the past were not designed to carry today's loadings. Although these bridges can be relocated to another location and used as a pedestrian structure, and many of them are serving that purpose, the preference is to keep it for vehicular use so proper inspection as required by law under the National Bridge Inspection Program is conducted. Hence the research component of this program becomes essential to develop means and methodologies to strengthen and restore these structures without altering the historic fabric of the structure. Often vandalism and arson are the main causes of these bridges being destroyed rather than age and loading. The program adequately provides for preservation and restoration including installation of fire protection systems, including fire detection systems and sprinklers.

4. Research and Education Efforts

Because of the historical significance and to preserve these structures as they were originally engineered, research effort has included developing techniques, while not compromising safety, to preserve the historic design and retain the fabric of the structures. Developing techniques and methodologies utilizing the right blend of the new and traditional, and resulting in preserving historic integrity including the original architectural, structural and material characteristics of the bridge has been the thrust of the research program. In addition to strengthening, developing practical knowledge essential for diagnosing the causes of deterioration and for selecting the most appropriate treatments to prevent both biological and physical deterioration while maintaining the original appearance, texture, and strength properties has also been an important aspect of the program.

A number of research and education efforts have been initiated since the start of the program and more are planned. Some of these that have been initiated are highlighted below.

4.1 Covered Bridge Manual for Engineers

Because a practical 'how to' guide for use by engineers and preservationists was lacking a study was initiated which produced a 'Covered Bridge Manual' [1]. The manual covers inspection, repair, rehabilitation, and restoration of historic covered bridges. It contains descriptions of techniques that reflect the latest developments in the field of preservation; both theoretical and practical aspects of inspection; and historic/traditional construction techniques. The techniques and methodologies described are such that the end result of the project utilizes the right blend of the new and the traditional, and results in preserving the historic integrity including the original architectural, and structural and material characteristics of the bridge. Both hardcopy and online version of the Manual are available. The online version can be obtained at the following website: www.tfsrc.gov/structur/pubs/04098/index.htm

4.2 Identification of Preservative Treatments and Fumigants for Treating Historic Covered Bridges

During the era when covered bridges were built there were no chemical treatments available to prevent fungi and insects from attacking and colonizing the wood and thereby deteriorating the structure. In order to prevent this deterioration, the method used was to cover the bridge with roof and sides thereby eliminating moisture. Although covering a bridge kept the wood dry and prevented wood components from deterioration, overtime moisture did migrate and led to suitable condition for colonization by wood destroying organisms. There are many covered bridges that have had to be repaired due to deterioration. Therefore, knowing that chemical preservatives exist today which can prolong the life of wood components and also reduce maintenance work, it would be irresponsible to build or restore wooden structures for outdoor applications without suitably treating these with available chemical preservatives. However because these are historic structures the treatments and methods identified need to be such that the wood retains its original appearance, or can be stained or painted to regain its original appearance after use. Therefore, this study was initiated to identify acceptable preservative systems for replacement members, and acceptable preservatives and fumigants for field applications of existing structures. The project conducted by Oregon State University is completed and the final report prepared. The report is under review by the Federal Highway Administration. A product of this study, a chapter on wood preservatives, is included as Chapter 19 in the 'Covered Bridge Manual' [1].

4.3 Strengthening Historical Covered Bridges to Carry Modern Traffic Loads

The preference when restoring covered bridges is to keep them open for today's vehicular traffic even though they were not designed as such. Many times this is done by keeping the external appearance but reengineering the structure. In order to truly restore a historic covered bridge however, both the external appearance and the 'engineering aspects' should be preserved. Means and methodologies identified need to be such that the structural and material integrity of the original structure is maintained, while the proposed strengthening method is complementing the original architecture. As these structures would be listed or eligible to be listed on the National Register of Historic Places, any strengthening methods recommended need to be in line with the Secretary of Interior's Guidelines for preservation of historic structures. Therefore, this study was initiated to develop means and methods for strengthening historic covered bridges to carry today's highway loadings without damaging the integrity of the original structure. The study conducted by West Virginia University has been completed and a 'Techbrief' has been published as FHWA-HRT-07-041. [3] The web version can be found at www.tfrc.gov/structur/pubs/07041/index.htm. The complete report is available through the National Technical Information Service at www.ntis.gov as NTIS Accession number PB2007-103714 at a nominal cost.

4.4 Fire retardant treatments for covered bridges

While large timbers have inherent fire resistive characteristics due to their size that eliminates the need for Fire Retardant Treatments (FRTs), for extra insurance often times the owners of wooden structures prefer these be protected against fire through the use of FRTs. Because FRTs have affected the structural properties of wood, the wood industry has been hesitant on using these on their product. In general because of problems in the past where wood treated with FRTs significantly affected the properties of wood leading to numerous lawsuits, FRTs are not recommended for structural applications especially in regions of high moisture and temperature conditions. In addition, corrosion of fasteners can be accelerated under conditions of high humidity with certain flame retardants. There are new generations of FRTs being developed however which

lessen much of these problems, but most of these are for wood used in indoor applications. This study was started to identify new generation FRTs and evaluate their effects on structural properties of wood and wood products, and on connections for outdoor bridge applications. This study conducted by Keast & Hood is complete and the final report recommending fire retardant treatments for use on historic structures in outdoor environments is under FHWA review.

4.5 Educational Guide on the History of Covered Bridges in the United States

The Department of Transportation in an effort to enhance transportation education at all levels has established the Garrett A. Morgan Transportation and Technology Futures Program with one of the goals being to build a bridge between America's youth and the transportation community through the process of providing educational aids. As covered bridges provide an opportunity to bring historical real-world problems and their solutions into the classroom, the objective of this study was to develop a comprehensive guide on covered bridges in the United States to be used by educators in developing lesson plans for grades K - 12 for math, science and American history courses. Building on its decade of work preserving and interpreting historic industries and structures, the Institute for the History of Technology and Industrial Archaeology developed a comprehensive educational guide on covered bridges in the United States. It worked in consultation with educators, engineers, and a multimedia education consultant, to produce a printed guide, a companion CD-ROM, and an Internet presentation. The guide is geared for use in American and state history, math, and science curricula on three separate educational levels: K-5, 6-8, and 9-12. It includes compilation of different types of covered bridges used in the United States, and their history. It includes pictorial coverage, and descriptive drawings including bridge type, year built, design loads, traffic, wood species used, information on the designer/builder, etc. The study is complete and under FHWA review.

4.6 Documentary on Covered Bridges

In order to increase awareness of covered bridge's place in American history this project developed and produced a broadcast television-ready documentary examining the cultural significance, history, construction techniques, preservation efforts and activities surrounding covered bridges throughout the United States. The documentary titled, 'Spanning Time: America's Covered Bridges' [4] has been airing on Public Television stations. Information on this documentary may be obtained by contacting WTIU/Indiana University Television at www.wtiu.indiana.edu.

4.7 Documentation for the Historic American Engineering Record

This project was initiated to develop Level I documentation for bridges selected as being the most historically significant in the United States, for inclusion in the National Park Service's Historic American Engineering Record (HAER) Collection, Prints and Photographs Division, Library of Congress. Level I documentation is defined in the Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation, and consists of measured and interpretive drawings, large-format photographs, and written historical reports. Included in the historical reports are detailed engineering analyses of both the unusual (Haupt, Post, Paddleford, Smith) and standard (Town, Howe, Burr) truss configurations, assessing their behavior and performance characteristics. Complete documentation on 75 covered bridges has been completed with a history report and large format photographs for each bridge. Twenty on these received measured drawings while 12 underwent engineering analysis. All of this is available through the US Library of Congress.

4.8 Update of World Guide to Covered Bridges

HAER has been working with the National Society for the Preservation of Covered Bridges and selected state covered bridge societies to update the United States section of the World Guide to Covered Bridges (National Society for the Preservation of Covered Bridges, 1980). This will produce an accurate count of existing bridges, their condition, and descriptive material across seven variables: name, location, crossing (stream, river, etc.), spans, length, year and type. It will be linked by photos, drawings, and websites on select bridges. This study is ongoing.

5 Conclusion

This paper has presented an overview of several covered bridge restoration projects in the United States funded through the National Historic Covered Bridge Preservation (NHCBP) program sponsored by the Federal Highway Administration. Funds are available to States for the repair, restoration and preservation of covered wooden bridges listed or eligible for listing on the National Register of Historic Places, and to researchers for the development of innovative preservation or educational techniques pertaining to historical covered wooden bridges. To date, 94 covered bridges in 21 States have been rehabilitated or preserved, and several research projects completed. The goal of these efforts is the preservation of these important transportation structures that represent the early American bridge-building tradition.

6 References

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