

# National Historic Covered Bridge Preservation Program

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## Summary

The National Historic Covered Bridge Preservation (NHCBP) program administered by the Federal Highway Administration since 2000 has included preservation, rehabilitation and restoration of covered bridges; and research, education and technology transfer. The program has provided opportunity to save many of our covered bridges from destruction by providing funds for restoration; and through research, education and technology transfer, develop better means to preserve, educate and inform the community. For the period from 2000 to 2012, more than 200 bridges in 24 States, and over 50 individual research projects have been funded. This paper will provide an overview of the NHCBP program over this year period.

**Keywords:** covered bridges, timber bridges, bridges, wood, historic structures.

## 1. Introduction

The 1998 *Transportation Equity Act (TEA21) for the 21<sup>st</sup> Century* as amended by the TEA21 Restoration Act established the National Historic Covered Bridge Preservation (NHCBP) program. It was subsequently continued in the succeeding 2005 Highway Legislation, the *Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users* or SAFETEA-LU for short. However, the program is not included in the current 2012 Highway Legislation, *Moving Ahead for Progress in the 21st Century* or MAP-21. The NHCBP program included preservation, rehabilitation or restoration of covered bridges that were listed or were eligible for listing on the National Register of Historic Places; and research for better means of restoring, and protecting covered bridges, development of educational programs, and technology transfer to disseminate information on covered bridges as a means of preserving our cultural heritage. In implementing the program, grants were awarded to the States through annual solicitations by the Federal Highway Administration to preserve, rehabilitate and/or restore these structures. Emphasis on research, education, and technology transfer was focused on finding means and methods for repairing, strengthening and treating covered bridges; developing historical documentation and educational videos and manuals; and on workshops and seminars.

The NHCBP program provided opportunity to save many of our covered bridges from destruction, and through research, ways on improving preservations practices. Research has also provided opportunity to develop detailed engineering records of these bridges so that we have the opportunity to learn from the past in order to build innovations for the future. What follows is a synopsis of the program.

## 2. Grants for Preservation

Administered through the FHWA Office of Bridge Technology, the FHWA awarded grants to States through annual solicitations for preservation of eligible bridges awarding approximately \$87M to save, protect, and rehabilitate many covered bridges across the Nation. More than 200 bridges in 24 states have received funds.

Some of the bridges the FHWA has funded follow with a complete list to be found at [www.fhwa.dot.gov/bridge/covered.cfm](http://www.fhwa.dot.gov/bridge/covered.cfm)

*Clarkson/Legg Covered Bridge over Crooked Creek- Cullman Co, Alabama* -This is a 82.3m (270 ft.) two span Town lattice truss bridge, built in 1902, and the second longest covered bridge in the southern U.S. It represents an era of civil engineering dating from 1840 to early 1900.

*Comstock Covered Bridge - East Hampton, Connecticut* - This is one of the 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 27.4m (90 ft.) 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 floor beams date from the original time of construction, including the original iron rods. The approach span is a 11.0m (36 ft.) long Queen post pony truss constructed in 1791.

*Thompson Mill Covered Bridge over Kaskaskia River- Shelby Co, Illinois* - This is a five span 49.1m (161.2 ft.) long bridge built in 1868. It is one of five 19<sup>th</sup> century covered bridges in Illinois and one of only two of the Howe truss types.

*Norris Ford Covered Bridge - Rush County Bridge #100, Rush County, Indiana* - This is a 45.1m (148 ft.) long single span Burr Arch truss built in 1916. The bridge was built by E.L. Kennedy & Sons and is one of 13 remaining bridges of the 58 built by the Kennedys.

*Six surviving covered bridges of Madison County, Iowa*

1. Imes covered bridge is a 25.0m (82 ft.) long Town lattice truss built in 1870 - 1871 by J.P. Clark. It has two wood trestle approaches.
2. Cutler - Donahue covered bridge is a 25.0m (82 ft.) long Town lattice truss built by Eli Cox in 1871. It has two wood tress approaches.
3. Hogback covered bridge is a 29.9m (98 ft.) long Town arch lattice truss with three wood approaches totaling 48.8m (160 ft.), built by H.P. Jones in 1884.
4. Holliwell covered bridge is a 33.2m (109 ft.) Bowed arch truss with two wood approaches totaling 47.2m (155 ft.) built by H.P. Jones in 1880. (*see Fig. 1*)
5. Roseman covered bridge is a 31.7m (104 ft.) Town arch lattice truss with four wood approaches totaling 62.5m (205 ft.) built by H.P. Jones in 1883.
6. Cedar covered bridge was a 21.3m (70 ft.) town Town arch Lattice truss with three wood approaches totaling 39.6m (130 ft.) built by H.P. Jones in 1883. This bridge has subsequently been destroyed by fire and a replica structure was completed in 2002.

*Bennett's Mill Covered Bridge - Greenup County, Kentucky* - This 1855 bridge is a 48.3m (158.5 ft.) single span Wheeler truss. It is one of 13 remaining covered bridges in Kentucky.

*Bennett Covered Bridge - Oxford County, Maine* - Built in 1901, this is a single span 28.3m (93 ft.) Paddleford truss. It is the latest of five identified Paddleford truss bridges from 1857 to 1898.



*Figure 1. Holliwell Bowed Arch Covered Bridge in Madison County, Iowa.*

*Fitches Covered Bridge - Delaware County, New York* - This 30.5m (100 ft.) single span Town lattice truss was originally built in 1870 and located within the Village of Delhi. In 1885 it was dismantled and relocated to its current site about 4.8km (3 mi.) north of Delhi to make room for a 'modern' iron bridge.

*Ponn Covered Bridge - Vinton County, Ohio* – This bridge built in 1874 spanned 54.9m (180 ft.) across Raccoon Creek. It has a humpback feature which made it the only one of its kind in Ohio. The south end of the bridge was a double Queenpost Truss, the north end was a Multiple Kingpost Truss and the middle was a combination of a Multiple Kingpost with an arch. The bridge was destroyed by fire in June, 2013.

*Fisher School Covered Bridge - Lincoln County, Oregon* - This bridge built in 1919 is the fifth oldest Howe truss in Oregon. The bridge's unique features include semi-elliptical portal arches, ribbon openings, and flared side walls. It is the longest span covered bridge in the county at 22.0m (72 ft.).

*Knapps Covered Bridge - Bradford County, Pennsylvania* - This is a 27.1m (89 ft.) single span Burr Truss built in 1853.

*Sanderson Covered Bridge - Rutland County, Vermont* - This bridge built in 1840 is a single span 40.2m (132 ft.) long Town lattice truss.

*Greenbanks Hollow Covered Bridge - Caledonia County, Vermont* - This 23.8m (78 ft.) long Queenpost truss was built in 1886 as a single span. When it was reconstructed in 1976 two concrete piers were built at approximately 2/3 of the span making it into a 3 span bridge.

*Humpback Covered Bridge – Alleghany County, Virginia* – This 30.5m (100 ft.) long single span covered bridge was built in 1857, and is the oldest remaining covered bridge in Virginia. It received its National Historic Landmark Status in 2012.

*Fletcher Covered Bridge - Harrison County, West Virginia* - This bridge built around 1891 is a 17.6m (57.7 ft.) single span Kingpost truss. It is one of seventeen remaining covered bridges in the state of West Virginia, and one of nine still carrying vehicular traffic.

### **3. Research, Education and Technology Transfer**

Administered through the FHWA Office of Infrastructure R&D, the FHWA worked through partnership and close collaboration with the National Park Service – Historic American Engineering Record and the Forest Service – Forest Products Laboratory to identify, prioritize and conduct RD&T. More than 50 projects have been initiated and are at various stages of completion.

While the NHCBP program made available dedicated funding for preservation, restoration and rehabilitation of historic covered bridges, a practical ‘how to’ guide of use to engineers and preservationists alike to rehabilitate and restore these bridges was lacking. As a result effort was undertaken to develop such a resource. The ‘*Covered Bridge Manual*’ was published in 2005 and is available through the Federal Highway Administration, both in print and electronic version at: [www.fhwa.dot.gov/publications/research/infrastructure/structures/04098/04098.pdf](http://www.fhwa.dot.gov/publications/research/infrastructure/structures/04098/04098.pdf)

Wood if unprotected can deteriorate due to biological activity. 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 keeps the wood dry and prevents wood components from deterioration, overtime moisture can migrate and lead to suitable conditions 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 became a priority to identify treatments that could be used to preserve wood members while still being acceptable to the historic preservation community. The second concern was ‘fire’ and the need to identify fire retardant treatments as many wooden structures are burnt down by vandals. While large timbers have inherent fire resistive characteristics that eliminate the need for Fire Retardant Treatments (FRTs), these treatments add extra layer of protection giving more response time for authorities. Two studies were initiated, one dealing with identification of preservative treatments and fumigants for treating historic covered bridges and the other on effects of fire retardant treatments on covered bridges. The *Guide for In-Place Treatment of Wood in Historic Covered and Modern Bridges* published in 2012 compiles results of these studies and is available online at [http://www.fpl.fs.fed.us/documnts/fplgtr/fpl\\_gtr205.pdf](http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr205.pdf)

Protecting wood member from deterioration by use of chemical treatments is important to prevent decay, but many of the older, proven preservative treatments have use restrictions, and may not be acceptable for historic preservation. Some of the newer systems that are in use today have had

tendencies to accelerate the corrosion of metal fasteners. The *corrosion of fasteners in wood treated with newer wood preservatives* study was initiated to evaluate corrosion performance of ferrous and nonferrous fasteners and degradation of non-metallic fasteners in wood treated with newer preservatives, specifically, alkaline copper quaternary (ACQ), Copper azaole (CuAz) and micronized copper quaternary (MCW) and examine feasibility of rapid test to evaluate corrosion; and examine role played by moist environment.

In addition to identifying suitable chemical wood preservatives that can be used to prolong member life, and yet not negatively impact connectors and connections, a study has been underway to *evaluate naturally durable wood species* where the wood would not have to be treated. Outdoor tests are being conducted on a number of wood species replicating the covered bridge environment.

In order to enhance transportation education at all levels and to build a bridge between America's youth and the transportation community, a study was undertaken to develop a comprehensive guide on covered bridges in the United States to be used by educators in developing lesson plans for K-12 for math, science and American history courses. The *educational guide on the history of covered bridges in the United States* available in hard copy and online at [www.woodcenter.org/covered\\_bridges\\_education](http://www.woodcenter.org/covered_bridges_education) is formatted in sections for grades K-5, 6-8, and 9-12 and includes compilation of all different types of covered bridges used in the United States, and their history. It includes a pictorial coverage, and descriptive drawings including bridge type, year built, design loads, traffic, wood species used, information on the designer/builder, and much more. The Guide has two components: printed lesson plans for educators and a companion disk with interactive and animated elements for students.

Additionally, a documentary entitled *Bridge to the Past* was funded that has been broadcast Nationwide on Public Television stations.

Accurate documentation of historic structures is essential, as often these structures are old and fragile, and can be destroyed as in the case of the Bartonsville covered bridge swept away from raging waters during tropical storm Irene in Vermont. A large effort has gone into developing documentation for historically significant covered bridges. Through the *HAER level I documentation* measured and interpretive drawings, large format photographs, and written historical reports have been produced for many bridges. The documentation continues to be developed using experts in the field of cultural resources. 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. The documentation provides a rich history of the covered bridges. Completed works are available through the Historic American Engineering Record (HAER) Collection, Prints and Photographs Division at the Library of Congress at [www.loc.gov/pictures/collection/hh/](http://www.loc.gov/pictures/collection/hh/)

Using the detailed local and regional information generated by HAER Level I documentation of significant covered bridges, as well as material contained in existing HABS/HAER documentation the Program is supporting a study linking covered bridge construction techniques with local and regional wood construction practices, and a book on *Covered Bridges and Vernacular Construction Practices* is being developed. The book will provide information on the extent to which local and regional practices of barn and house construction influenced bridge construction techniques and materials. In addition, a collective biography of bridge builders and their links to local and/or regional building practices will be reported.

Accurately documenting covered bridge as is done under the HAER Level 1 documentation requires taking field measurements of the bridges and its various components in the detail necessary to develop interpretative drawings. *Use of Laser Scanning Technology to obtain As-Built Records* is studying the feasibility of utilizing advanced cameras and laser scans to generate as-built drawings that are less labor intensive, yet produce the same level of detail. If feasible, this could greatly shorten the recording process.

The *World Guide to Covered Bridges* is a database of all covered bridges in the United States. An interactive site has been developed where the data can be searched to provide location, condition, descriptive information and the history of covered bridges. It can be accessed online at [www.woodcenter.org](http://www.woodcenter.org) website. For the covered bridge enthusiasts, it gives the location and history of the bridge, and can be an useful tool if planning a trip to visit covered bridges.

The highest official recognition of historic properties is a designation as a National Historic Landmark. The NHCBP program has supported the *National Historic Landmark Theme study* to assess and nominate covered bridges for National Historic Landmark status. Through this effort two bridges have now been granted the National Historic Landmark status. These include the Knight's Ferry covered bridge in California a 1864 Howe truss, and the Humpback covered bridge in Virginia a 1857 multiple kingpost truss.

The *Secretary of the Interior's Standards for the Treatment of Historic Properties* and accompanying Guides are the documents used in preservation, restoration, rehabilitation and reconstruction of historic properties. These documents provide the do's and the don'ts in historic preservation, but have been developed with emphasis towards buildings rather than transportation systems. Therefore, a study is being supported to develop similar document focused on covered bridges. The *Covered Bridge Preservation Guide* will be similar in concept and of use to any agency or group undertaking a covered bridge preservation project. The *Guide* will list treatments that should be embraced as well as avoided.

Because covered bridges are older structures designed to carry much lighter loads than the heavy vehicles of today, several studies have been funded to understand their load carrying capacity, develop methods to strengthen members, develop more accurate rating procedures, and identify ways to decrease dead load. *Improved ratings for covered bridges through load testing* will develop rating procedures for reliably determining safe load-carrying capacity of these bridges. *Strengthening historic covered bridges to carry modern traffic* assessed the use of Fiber-Reinforced Polymers as a means to strength components. *Improved analytical techniques for historic covered bridges* will recommend improved analysis methods that have been validated through field load test data to determine behavior of various covered bridge types. *Lightweight floor replacement systems* will assess commonly used systems that have been proven for bridge applications for covered bridge use. *Residual capacity of structural wood members in historic covered bridges* will provide guidance on determining remaining capacity of members.

Unlike steel and concrete, engineering properties of wood can vary both within and between species. Additionally, wood is orthotropic which means material properties vary depending on grain direction. Therefore, wood design values given in specifications and standards are based on statistical samples with large amount of safety factor to account for the variability. Often the type, source and grade of existing wood in old covered bridge are difficult to identify, but the current practice is to guess the species and select wood values from existing specifications. In *Species identification and field-grading* a field manual is being developed which can be used to more easily

determine the timber species and help in identifying the grade, and therefore more reliably predicting engineering properties.

Timber trusses that make covered bridges were engineered structures that set the stage to modern day trusses. The bridge builders of the period were ingenious in designing the truss and arch systems that make up these bridges to carry and transfer loads safely. Projects are being supported to study several of these designs. The original design of William Howe who patented the Howe Truss permitted tightening of the tension rods to induce compression in the wood diagonals. *Howe truss bridge design and performance* study will provide a better understanding of the design of William Howe by studying the Moose Brook Howe Boxed Pony Truss bridge through both analytical and full scale experimental tests. Similarly, *Burr truss arch systems* will be studied to have a better understanding of the design and connection details of Theodore Burr's designs. The recovered Bartonsville covered bridge damaged by Tropical Storm Irene will be used to study the performance of *Town lattice trusses* and the interaction of the lattice system to carry and distribute loads in order to develop more precise calibrated models.

Historic covered bridges need to be protected from vandals as many of these bridges have been lost due to arson. *Best practices guide on security of historic covered bridges* will provide cost effective, tested systems that can be used to protect against vandalism.

Condition assessment of all bridges is essential to determine bridge safety. In accordance with the National Bridge Inspection Program all bridges greater than 6.1m (20 ft.), on public roads are required by law to be inspected every two years. While visual inspection to determine condition is by far most prevalent for all bridge types, more advanced technologies for bridge inspection continues to be developed, but mostly for steel and concrete structures. *Advanced field evaluation tools for condition assessment of wood members in covered bridges* is a new study that will be underway to identify, adapt and evaluate low cost innovative technologies that can be used by bridge inspectors to inspect wood members and more accurately determine the condition of covered bridges.

In addition to damages to covered bridges that are caused by age, environment, arson, and increasingly heavier loads, natural hazards such as floods have also played a role in destroying these historic structures. Hurricane Irene as it moved up the northeastern US in 2011 caused major rainfall, and subsequent flooding damaged many roadways and bridges in Pennsylvania, New York, Massachusetts, Vermont and New Hampshire. Several covered bridges were washed away and destroyed during this event. *Improved hydraulic safety of covered bridges* will evaluate hydraulic forces on covered bridges and develop retrofit strategies to save these structures from future hydraulic events.

To further knowledge transfer, and educated engineering and architecture students about structural behavior and the evolution of wooden truss designs *educational models for four significant truss designs: Burr, Town, Long & Howe* will be developed. Designs for scale models of 100ft trusses will be developed to allow users to construct them and demonstrate the aspects of each design.

#### **4. Summary**

The National Historic Covered Bridge Preservation Program, from the years 2000 to 2012 funded more than 200 covered bridges. These funds went into preservation, restoration and rehabilitation of the Nation's covered bridges that are listed or are eligible for listing on the National Register of

Historic Places. The NHCBP Program during this period funded over 50 research, educational, and technology transfer projects many of which are still ongoing. The research, education and technology transfer has been conducted as a partnership between the FHWA, NPS and FS, and has worked well. As studies are completed, information resulting from the program will be made available at the National Center for Wood Transportation Structures site at [www.woodcenter.org](http://www.woodcenter.org).

Covered bridges proliferated in the United States in the mid-nineteenth century. Today 500 to 600 remain, and represent the technological heritage of the United States. 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. 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 program.

## 5. References

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