Presentation Overview

- The Forest Resource
- Evolution of Materials and Designs
- The Timber Bridge Initiative
- Where We are Today
- An Opinion on the Future
The Forest Resource

It’s all about the resource
The Forest Resource
The Forest Resource
The Forest Resource
The Forest Resource
H.H.

U.S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
WASHINGTON, D.C.

February 2, 1900.

Mr. John Muir,
Martins, Calif.

Dear Mr. Muir:

Many thanks for your telegram, which gives me exactly the information I was after. We are going to try to interest Congress in the preservation of the Calaveras Groves. I will keep you posted from time to time as the matter progresses.

Very sincerely yours,

Gifford Pinchot
Forester.

What is being done in California because these trees?
The Forest Resource

1910

[Image of a house from 1910]
The Forest Resource

1910 - 1931
The Forest Resource

1931 - Present
The Forest Resource
The Forest Resource
The Forest Resource
The Forest Resource
Fire readiness and suppression has gone from 20% of the FS budget in 2001 (approximately $1 billion) to over 60% (approximately $3 billion) in 2014. It is not uncommon to spend $1 million per hour fighting fires.
The Forest Resource
The Forest Resource
Material and Design Evolution

The last 150 years
Material and Design Evolution

208’ high x 843’ long
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution

High quality laminations where bending stress is highest

Lower quality laminations where bending stress is lower

The same quality of lamination is used for the entire member
Material and Design Evolution

1948
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution
Material and Design Evolution

Press-Lam PLV 1979
Material and Design Evolution

Open Deck Design
Material and Design Evolution

Ballast Deck Design
Timber Bridge Initiative

1989 – 2004

We must understand the past to grow in the future
Timber Bridge Initiative
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Timber Bridge Initiative
Timber Bridge Initiative
What is the situation, what are the opportunities and challenges?

Where We are Today
Annual Growth and Removal

Billions of Cubic Feet

Growth

Removals


0 5 10 15 20 25 30
National Bridge Inventory – 12/2012

- 607,380 bridges (over 20’ span)
- 22,724 bridges are wood bridges
- 151,497 bridges are deficient
  - 66,749 bridges are “Structurally Deficient”
  - 84,748 bridges are “Functionally Obsolete”
- Pennsylvania, Oklahoma and Iowa have the highest percentage of deficient bridges
Bridge Replacement is a Critical Need

The Fix We’re In For: The State of Our Nation’s Bridges 2013

Transportation for America

66,405 deficient bridges = 1,500 miles
Where We are Today
Challenge: Longevity Misconception
Where We are Today
Challenge: Longevity Misconception

1966

2010
Where We are Today
Challenge: Strength Misconception
Where We are Today
Challenge: Strength Misconception
Where We are Today
Challenge: Strength Misconception
Where We are Today
Challenge: Durability Misconception
Where We are Today
Challenge: Durability Misconception
Where We are Today
Challenge: Durability Misconception
Where We are Today
Challenge: Durability Misconception


Robert L. Smith, Virginia Tech
Kim Stanfill-McMillan, Forest Products Laboratory, USDA Forest Service

Abstract
Bridge material selection is one of the most difficult decisions an engineer has to make. Many factors and individuals are often involved in choosing the proper bridge material for a given site and location. Not only physical factors such as strength or lifespan of material but also site specific factors like roadway alignment and traffic count play important roles in material selection. It is not uncommon for state Department of Transportation engineers, private consulting engineers, and local highway officials all play roles in the material selection process. Each individual may have his or her own perception of bridge materials based upon past experience and education. It is important to know how these perceptions influence the choice of materials. In this study perceptions of engineers and highway officials toward timber as a bridge material were compared to the actual performance of timber as reported in the National Bridge Inventory. To accomplish this case studies were conducted in four selected states. Highway officials and engineers in Missouri, Virginia, Washington, and Wisconsin were surveyed by mail and personally interviewed to capture their perceptions toward timber as it compared to other major bridge materials (prestressed concrete, steel, and reinforced concrete). This information was compared with the actual performance data obtained from the National Bridge Inventory. The results indicate that there is a strong correlation between highway officials’ perceptions towards bridge materials and the reported performance of those materials.

Introduction
The need for bridge replacement has been well documented (Braybrooke et al. 1987; Cheney 1986; USDA 1989). Over 24% of our Nation’s bridges are in need of repair or replacement. According to the FHWA (1992) four major structural materials make up over 98% of all bridges in the United States. These include prestressed concrete (15%), steel (36%), reinforced concrete (40%), and timber (8%). However, since 1982 over seventy percent of the replacement bridges have been prestressed or reinforced concrete, while timber and steel were used in less than thirty percent of replacement structures. This suggests that perceptions toward prestressed and reinforced concrete by highway officials are better than that of competing materials.

The United States has more than 3.9 million miles of roadway and 575,000 bridges. In 1967, in response to the collapse of the Silver River bridge over the Ohio River, Congress mandated the implementation of National bridge inspection standards. The individual bridge inspection records constitute the National Bridge Inventory (NBI). The purpose of the NBI is to provide a uniform base of bridge information that can be used to identify those bridges that are most in need of repair and to serve as a basis for allocating Federal Highway Administration (FHWA) funding for bridge replacement or rehabilitation. The NBI is administered by the FHWA in Washington, D.C. Data are updated continuously based on the latest bridge inspections, which are usually completed on a two year cycle.
Where We are Today
Challenge: Fire Performance
Where We are Today
Challenge: Fire Performance
Where We are Today
Challenge: Fire Performance
Where We are Today
Challenge: Fire Performance
Where We are Today
Challenge: Engineering Education

The National Council of Structural Engineers Associations recommends one course in Timber Behavior and Design
Where We are Today
Challenge: Engineering Education
Where We are Today
Challenge: Contractor Education
Where We are Today
Challenge: Contractor Education
Where We are Today
Challenge: Contractor Education

- Glued Laminated Timber
  - Longitudinal Decks

- Glued Laminated Timber
  - Stringer Bridges

- Glued Laminated Timber
  - Stress–Lam Decks
Where We are Today
Challenge: Design Awareness
Where We are Today
Challenge: Design Awareness
Where We are Today
Challenge: Design Awareness
Where We are Today
Economics

Timber Bridge Economics

National Cost Study of Timber Bridges

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Abstract
A study is underway to determine the initial cost of timber bridges compared to those of steel, concrete, and prestressed concrete bridges. This report discusses the early results of the timber bridge portion of the data set. To this end, timber bridge owners, as identified in the June 2004 National Bridge Inventory (NBI), were sent a specially designed questionnaire to survey cost information on timber bridges under their ownership. In order to establish a comparable basis, timber bridges were selected under the requirements that they be built no earlier than 1980 and have a load rating according to American Association of State Highway and Transportation Officials (AASHTO) specifications. No private or government demonstration bridges were included in the study. Given these requirements, 164 timber bridges were identified as survey bridges.

This paper summarizes the analysis of data collected on the cost of timber bridge superstructures throughout the country. The results of such analysis suggest that unit costs were highest for both the longest and shortest bridges considered and tend to increase with higher load ratings. Additionally, it was noted that questionnaire responses were lower than expected for shorter, narrower bridges that were designed to carry lighter loads.

Keywords: Timber bridge(s) superstructure cost.

Purpose And Background
According to Smith and Stahl (1994), there are approximately 200,000 deficient bridges throughout the country with a projected replacement cost of $3.4 billion. As Welchik (1990) indicates, concrete decks account for about two-thirds of the deficiency cases. In the face of such staggering figures, there has been a renewed interest in the prospect of timber bridge utilization.

Throughout much of the 19th century, timber structures accounted for the majority of the bridges and railroad ties in the United States. These were simple structures constructed of sawn timber. Many timber bridges of the period even lacked preservative treatments that would allow them to withstand exposure to moisture and decay. Additionally, the older timber bridges were often crudely designed with little or no input by engineers. For example, it was not until 1880 that a complete stress analysis of a timber bridge design was included with the bridge designer’s patent. In the 20th century, timber bridges were first replaced by steel. Steel competed with timber as a bridge construction material on a cost-cut basis by 1910 and came to dominate the bridge market by 1930 (Bitter 1990).

The failure of older, primitive timber bridges and their eventual replacement by newer steel and, later, concrete designs is the likely source of a general perception held by some today that timber bridges are of inferior quality. Over time, however, the limitations of steel, concrete, and prestressed concrete have become apparent and range from susceptibility to corrosion to costly maintenance and replacement.

Beginning in the mid-1940s engineers began to reconsider timber for bridge construction. The development of such techniques as glue- and, later, stress-laminated demonstrated the strength of timber as a construction material and led to a renewed interest in timber bridge utilization (Bitter 1990). The rationale for this interest is three-fold. First, timber offers a potentially low-cost
Where We are Today

Opportunity: Versatility
Where We are Today
Opportunity: Versatility
Where We are Today
Opportunity: Versatility
Where We are Today
Opportunity: Versatility
Where We are Today
Opportunity: Versatility
Where We are Today
Opportunity: Versatility
Opinion on the Future
The Future
New Materials

1988 in Austria
The Future
New Materials
The Future
Composite Bridges
The Future
Smart Bridges and Remote Sensing
The Future
Fireproof Coatings
Nanotechnology is the understanding and control of matter at dimensions of 1 to 100 nanometers, where unique phenomena allow us to make new materials and devices with novel applications.

1 nanometer = 1 billionth of a meter
Nanoparticles of metals commonly used to preserve wood demonstrate unique properties compared to larger particles of the same material, including increased leach resistance, photostability and termite inhibition.
The Future
Nanotechnology

United States
Department of
Agriculture
Forest Service
Forest
Products
Laboratory
General
Technical
Report
FPL-GTR-210

Literature Review
and Assessment of
Nanotechnology for
Sensing of Timber
Transportation
Structures Final
Report

Terry Wulf
Bruce M. Phares
Michael Ritter
The Future
Adhesives
The Future
Sustainability and Green Building

Science Supporting the Economic and Environmental Benefits of Using Wood and Wood Products in Green Building Construction

Michael A. Ritter
Kenneth Skog
Richard Burgman
The Future
Sustainability and Green Building

Center for Environmental Excellence by AASHTO
One Stop Source of Environmental Information for Transportation Professionals
The Future
Sustainability and Green Building

**INPUTS**
- Materials
- Energy
- Water
- System boundary

**OUTPUTS**
- Emission
- Effluent
- Solid waste
- Other (i.e. heat)
- Product
- Co-products

Forest management (regeneration)

Resource extraction (harvesting)

Product manufacturing

Building construction

Use/maintenance

Reuse/recycling/disposal

$T =$ Transportation
The Future
Sustainability and Green Building
The Future
Research and Development
Conclusions

- Timber bridges are an excellent value-added option for a “growing” wood resource.
- Bridge replacement needs increase annually, especially on secondary road systems.
- There are numerous proven timber bridge designs.
- Acceptance of timber bridges can be further increased through education and technology transfer.
- Research must continue to develop and demonstrate new bridge systems, materials and technologies.
- The future is potentially bright!
Thank You