TBIRC
Timber Bridge Information Resource Center

CROSSINGS

Editor Tinathan Royce | Issue 3 | February 1991

Timber Bridge Optimization Project:

Can we Improve our Current Designs and Decrease Costs?

The success of any project can be measured in many ways. At West Virginia University we have experienced success building timber bridges, if success is measured by shear number, 32 bridges have been built since 1988 through the Timber Bridge Initiative. In terms of performance, these bridges are all performing as we hoped they would. But for the Timber Bridge Initiative to be a long-term success after the federal funding has ended, bridge builders and design engineers must be convinced that timber is a legitimate, cost-competitive alternative to precast concrete.

Currently, the biggest obstacle to long-term success of timber bridges is first cost. The first two years of the project have demonstrated two important facts: 1) we can build stress-laminated timber bridges which can meet today's bridge performance criteria, and 2) we cannot <u>yet</u> build stress-laminated timber bridges which will compete with the costs of precast concrete bridges.

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Disposal of Treated Wood from Timber Bridges

The disposal of treated wood products has recently become a concern for the major users of these treated products. This includes treated lumber and timbers from timber bridges that have been designated to be taken out of service. The wood from these timber bridges can be disposed of in three different ways.

- Reused as a treated wood product such as fence posts or parking lot bumper guards.
- Once the metal fasteners have been removed, the treated wood could be "chipped or hogged" for use as a fuel. Creosote and penta in oil can be used in this manner with the proper permits from local and state authorities. The heavy metal compounds that are in the waterborne preservative chromated copper arsenate (CCA) will require special handling and disposal considerations for the ash product which is generated when this particular treated wood is incinerated or burned as a fuel for cogeneration.
- The disposal of treated wood in a landfill. The information given in the remaining portion of this article will describe the new Environmental Protection Agency (EPA) regulations.

In March 1990, the EPA issued a final rule regarding a new test procedure known as Toxicity Characteristic Leaching Procedure (TCLP). This new test procedure is to be used for classifying hazardous waste materials to be disposed of in a landfill. Landfill wastes must be evaluated to determine whether or not they are "hazardous."

This new EPA test rule became effective September 25, 1990, and it lists 39 chemical constituents and their regulatory levels to be measured in accordance with the TCLP laboratory tests. It is important to recognize that the chemical constituent being measured is a

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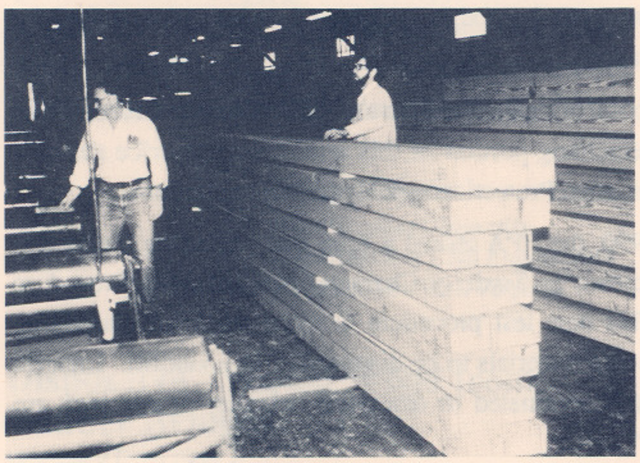
Bilayer Design — Page 2 . . .

Your University At Work

The Pennsylvania State University - Research is underway at Penn State University to develop design standards and specifications for hardwood glulam bridges spanning from 18 to 90 feet. The research, sponsored and supported by the Pennsylvania Department of Transportation and the Pennsylvania Agricultural Experiment Station, is being conducted in the Agricultural and Biological Engineering Department and the School of Forest Resources. The principal investigators are Drs. H.B. Manbeck, P.R. Blankenhorn, J.J. Janowiak and P.L. Labosky.

The research objectives prior to development of bridge design standards are: 1) identify three candidate hardwood species for development of bridge standards; 2) identify and evaluate resin systems for structural gluing; 3) identify and evaluate adequate preservative treatments; 4) identify adequate laminating processes and procedures, including finger joint details and acceptable layup combinations; and 5) verify or determine the allowable flexural and compressive design strengths and the stiffness of both treated and untreated glulam members.



Dr. John Janowiak is monitoring the quality of red oak glulam test beams fabricated for the research project at The Pennsylvania State University

The candidate hardwoods have been identified as red oak, red maple, and yellow poplar. Red oak will serve as a benchmark, while the other two species are under-valued hardwoods which have good structural characteristics. Suitable resin systems have been identified for each species. Work is currently underway to develop suitable preservative treatment processes for the three species and to evaluate the structural performance of red oak glulam members. The structural performance for the red maple and yellow poplar members will be determined within approximately 12 to 15 months.

Keith R. Shaffer
Senior Research Technologist
The Pennsylvania State University

Bilayer Stressed Timber Bridge Decks

Design plans have been made for BILAYER stressed timber deck bridges with steel sandwich plates to be constructed at several locations in Pennsylvania. For this bridge type, two (or more) layers of timber with steel plates allow smaller widths and lengths of timber to be used.

The idea of using steel sandwich plates in stressed timber bridges first occurred to the writer in 1987 while monitoring a stressed deck which had lost its camber. Scale model tests indicated that bridge stiffness could be significantly increased with the inclusion of steel plates. Consequently, a 40 foot long prototype was constructed and tested in the Civil Engineering structural laboratory at The Pennsylvania State University. Results confirmed model test indications and showed that timbers with shorter lengths than used previously could be employed. The first single layer stressed timber deck bridge with steel sandwich plates has just been completed near Clarion, Pennsylvania and will probably be opened to traffic in April 1991.

From a practical point of view, large quantities of hardwood timbers with widths exceeding 12 inches and lengths exceeding 12 feet are not available in states like Pennsylvania because most timber is harvested from

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Bilayer Stressed Timber Bridge Decks

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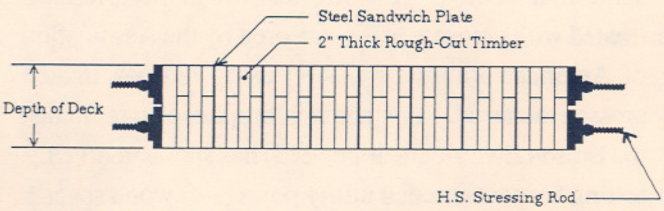
medium sized trees. The BILAYER stressed deck, shown here, is intended to allow timber widths between 6 and 12 inches to be used together with timber lengths between 6 and 12 feet. When two or more layers are used, butt joints may not only be staggered transversely but also between layers, which is a stiffness advantage. Laboratory tests on a 40 foot long BILAYER prototype with one layer of stressing rods have been completed and show very favorable results. Bridge stiffness was found to drop less than 15% when 3% of steel was used in the cross-section, compared with a single layer structure of the same overall dimensions and 3% of steel, but with half as many butt joints.



Bilayer Timber Stressed Bridge Deck

When two levels of rods are used, larger rod forces are applied to rods which pass through the bottom layer than to those rods passing through the top layer of timbers. This force differential causes transverse bending movements which counter downward deflections and improve the transverse compressive stress situation near the underside of the deck. Testing of the BILAYER structure will continue with low grade woods of various species to enable design coefficients and design methodology to be formulated.

Computer studies show that spans in excess of 100 feet are possible if multi-layers of timber are combined with steel sandwich plates.

Ralph R. Mozingo
Associate Professor of Civil Engineering
The Pennsylvania State University

Timber Bridge Optimization Project:

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The West Virginia University Timber Bridge Optimization project is our first concerted attempt to find more economical methods and materials for building stress-laminated bridges. Funded by the USDA-Forest Products Laboratory, the project has the goal of identifying, and where possible, quantifying areas of cost reduction or performance improvement. Dr. Julio Davalos and I modeled the project to resemble a "value engineering" study. Value engineering is a teamwork approach to cost reduction. A team of five or six experts identify options available to solve an engineering problem, weigh the options according to criteria they have selected, and eventually develop a"best" solution. Unfortunately, the problems associated with cost reduction of timber bridges are not easily quantified because of the newness of the product. This uncertainty makes a true value engineering process workable - our optimization project had to function more on opinion than on known values.

Luckily, there is no shortage of opinions on improving our timber bridges. A meeting was held at West Virginia University with representatives of WVU, the USDA Forest Service and the Forest Products Laboratory, the West Virginia Department of Transportation, and bridge contractors. From this first meeting, we developed a questionnaire which was sent to a broader group of experts. The questionnaire included sections on design, materials, construction, and life cycle costs and required selection of "best" options on all aspects of timber technology. Based upon the results of the returned questionnaires, we set up a one-day workshop for 18 timber bridge experts to discuss the various options available to improve the designs and decrease the bridge costs.

Although we did not resolve all the problems facing timber bridges during these meetings, many ideas were discussed. Some immediately applicable problem solutions surfaced and several future research topics

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Timber Bridge Optimization Project:

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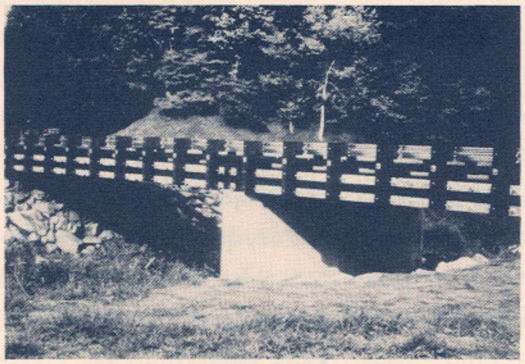

Cedar Creek State Park Bridge
Photographed by Barry Dickson, Dept. of Civ. Eng., WVU

evolved. Among the best ideas is the modularization scheme developed by John Crist, USDA-Forest Service, portions of which are already being implemented in the most recent West Virginia bridges.

Dr. Davalos, Dr. GangaRao and Barry Dickson will soon be completing a report of the project findings. The success of the optimization project is difficult to measure as is the success of the Timber Bridge Initiative. At first glance, the project did not meet the lofty goals we set for it, but as we see some of the recommendations being implemented in the 1990 Timber Bridge Initiative bridges in West Virginia, the rewards of the project are becoming more evident.

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Disposal of Treated Wood from Timber Bridges

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leachate and not the solid waste which in this instance is treated wood. To further reiterate, the TCLP test is not for just treated wood; it is for all materials which will be disposed of in a landfill.

Of the 39 chemcial compounds which have regulatory levels established by EPA, only nine could possibly occur in preservative treated wood: pentachlorophenol; arsenic and chrome as components of CCA waterborne preservative; benzene, which is a possible trace compound in creosote and petroleum oil carriers; and in creosote with possible traces of pyridine and creosols which are measured in four different ways. Currently, all of the TCLP data that has been developed indicates treated wood does not exceed the regulatory limits. Thus, treated wood is not a listed hazardous waste. The data, however, are somewhat limited with the margins being substantial before exceeding the regulatory limits. This also applies to freshly treated wood products and strongly indicates treated wood will not be classified as a hazardous waste under the current federal standard.

With respect to timber bridges, the data available is somewhat limited. A TCLP test for timber products treated with creosote was sponsored by the Association of American Railroads (AAR) using red oak treated crosstie material. For pentachlorophenol treatments, the Edison Electric Institute (EEI) has sponsored TCLP testing for penta treated utility poles (soft wood species of southern pine and Douglas fir). The Hickson Corporation has developed some data for CCA southern pine treated products; and in addition, Koppers Industries has developed TCLP test data for creosote lumber products which include red and hard maple, beech and hickory timbers.

It can be concluded that based on the available data, new and used treated wood products are not hazardous waste for disposal under the federal regulation. However, producers of preservative wood can only advise generators of waste products. The industry cannot step into the "shoes" of a generator in making the determination for handling their waste materials. The treated wood industry will be developing more data in the near future; it will be made available through the Timber Bridge Information Resource Center, P. O. Box 4360, Morgantown, WV; Phone: 304-291- 4159.

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