TBIRC
Timber Bridge Information Resource Center

CROSSINGS

NEWSLETTER OF THE NATIONAL TIMBER BRIDGE INITIATIVE

Editor - Tinathan Royce | Issue 9 | August 1992

WANTED

More of America's Best Timber Bridges

The 1991 Timber Bridge competition drew entries from throughout the country. Applications are now being accepted for the **1992** Timber Bridge Awards Competition. Anyone (architects, designers, engineers, contractors, developers, owners, and town, city, county, state and federal agencies) involved in creating a modern wood bridge opened to traffic prior to January 1, 1992, is eligible.

There are four categories of awards:

1. pedestrian/light vehicular bridges,
2. vehicular bridges with main span under 40 feet,
3. vehicular bridges with main span over 40 feet, and
4. rehabilitation of an existing bridge using timber.

There will be two award winners in each category (First Place and Award of Merit.)

This awards competition is co-sponsored by the National Forest Products Association Special Task Group on Timber Bridges and the USDA Forest Service.

Deadline for entries is September 30, 1992. Entry forms for the 1992 competition and a brochure highlighting the 1991 winners are available by contacting:

American Institute of Timber Construction
11818 Mill Plain Blvd., Suite 415
Vancouver, WA 98684
Phone: 206-254-9132

Borates Can Aid the Preservation of Bridge Timbers

The continued success of timber bridges will require the use of safe, effective, economical wood preservatives that are suitable for hardwoods and softwoods. Objective research programs should include many potential preservatives and preservative combinations to develop the most effective preservation system for hardwood and softwood bridge timbers.

Because many timber bridges are being placed over environmentally sensitive streams in heavily visited public areas, public environmental concerns are not being ignored. The objective selection of candidate preservatives is based on factual information. The selection process for an environmentally compatible preservative should give consideration to criteria such as: energy consumption in providing treatment, long-term cost effectiveness (expected service life versus cost of providing treatment), and efficiency in wood conservation (broad-spectrum biocidal activity), as well as relative hazard to mammals and the environment (Williams 1990). For example, when wood is used without treatment or improperly treated and later fails, it may result in costly remedial treatment or replacement. Such a practice is less environmentally compatible than using wood properly treated with acceptable preservatives.

Lessons from the past - Worldwide, borates, chromated copper arsenate (CCA), and creosote all have 50 or more years of research and commercial use. In the United States, borate wood preservatives often are regarded as new because they were not seriously considered for wood preservation until the late 1970s (Barnes et al. 1989). We need to consider what has been learned from many years of research and commercial use.

First, large timbers cannot be completely penetrated by pressure treatment with CCA or creosote. The penetration may result in a shallow envelope treatment despite the use of long air-seasoning periods and incising pretreatments. Also, the distribution of many preservatives in hardwoods is much less uniform than in softwoods.

Factors contributing to both the penetration and distribution problems include the physical structure of wood elements in different species and the difficulty of adequately drying large timbers as is required for

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The Use (or Misuse) of Steel Facia Channels -- Page 2

Your University at Work

The Use (or Misuse) of Steel Facia Channels on Stressed Timber Bridge Decks

The Pennsylvania State University - Selection of steel facia channels for stressed timber bridge decks is currently based on two criteria. First, the channel depth is chosen to be between 85% and 100 % of the timber deck depth. Second, minimum web thickness and minimum moment of inertia for weak-axis bending are established empirically as functions of nominal lamination depth. No attempt has been made to analyze or design the channels for flexure or deflection because they have not been considered as structural components of the deck. Their primary purpose has been to help distribute rod bearing plate stresses.

Recent observations of channel behavior on the two-lane, 43-foot span stressed deck near Clarion, Pennsylvania indicate that further channel design considerations are in order. This stressed deck is 16 inches deep and was dedicated in May 1991 as the first stressed deck to employ steel sandwich plates. The original design called for no facia channels but C15x50 channels were added. Measurements made in 1992 indicate that the top flange of the south facia channel has buckled outward as much as one and one-eighth inches with respect to the bottom flange. This is in addition to lateral displacements caused by rod force variations. Thus, twist buckling needs to be considered.

Flexure - Loading of the channel for strong-axis bending takes place by friction forces between channel and timber. Lateral support of the compression flange is non-existent—even at channel ends. Lateral support is provided only at mid-depth by rod forces. As a consequence, neither AASHTO nor any other steel specifications would consider this channel to be a structural member; but, it is a component of the deck and behaves as a structural member whether or not it is designed as such. This fact must be recognized for future stressed deck designs.

Twist buckling is exacerbated because of loading which does not pass through the shear center of the channel. Even in the ideal case of full lateral support, no residual stresses, and uniform loading through the shear center of the channel, a center deflection of 2.48 inches would cause the maximum allowable AASHTO flexural stress to occur; a displacement smaller than the 3-inch camber specified for the bridge. Actual cambering techniques affect channel behavior also and deserve discussion.

Cambering and Residual Stresses - Cold cambering is used for most structural sections which do not require excessive camber. While the beam is being cold cambered, extreme fiber stresses are on the horizontal portion of the stress strain curve. Upon release if ram forces, some residual deformation is evident. Fabricators usually consider a camber loss of about 25% between shop fabrication and field erection. If, for example, a center camber of 3 inches is required in the facia channel at erection time, then 4 inches of camber should be specified on the drawings. Remember that cambering methods are crude and results less than precise. A 4-inch camber on a 40-foot length of channel will probably require heat cambering to be employed. Most heat cambering is accomplished by heating wedge-shaped segments in serpentine paths at intervals along the length of the member. Unlike cold cambering, heat cambering causes residual stresses, especially in flanges, and must be considered in the design. Further, to avoid the danger of embrittlement, heat cambering should be performed only on low carbon steels such as A36, A572, Gr. 50, A588, A441, and A242. Thus, cambering and residual stresses do complicate facia channel behavior and design.

Solution - A simple and reasonable solution to the problem is to omit facia channels. Use hardwood facia timbers with butt joints located behind rod bearing plates so that timber ends do not bow laterally. Both bearing plates and anchor plates should be used. Tests have shown that adequately designed plates distribute rod forces in hardwood (oak) timbers quite well without appreciable indentation caused by jacking and releasing of rod forces.

Last but not least, without facia channels, the timber bridge appears more natural and aesthetically appealing.

— **Ralph R. Mozingo**
Associate Professor of Civil Engineering
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Williamson Leaves AITC

Tom Williamson, American Institute of Timber Construction (AITC), has accepted the position of General Manager of the American Plywood Association /American Wood Systems (APA/AWS) program. As general manager,he will be working with many of the glued laminated timber manufacturers with continued involvement in some of the timber related activities of his previous position.

Mr. Williamson intends to continue in his role as Chairman of the NFPA Special Task Group on Timber Bridges and plans to continue to coordinate the Engineered Timber Bridge Award program. In the past, Tom has participated as a speaker at many of the timber bridge workshops and will continue on an invitational basis and as his schedule permits.

You may contact Tom at: American Plywood Association, P.O. Box 11700, Tacoma, WA 98411
Phone: 206-565-6600; FAX: 206-565-7265.

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pressure treatment with these preservatives. Natural checking through or mechanical damage to envelope treatments often occurs in service and causes added problems. Thus, cross-ties, exposed timbers, and utility poles often fail because decay fungi and termites enter through breaches in the treated envelope and destroy the untreated wood in the centers of large timbers even though they have been treated to industry-specified retentions.

Second, large hardwood timbers and other refractory woods can be treated more uniformly and with better penetration by proper dip-diffusion treatment of unseasoned wood with borates than by pressure treatment of seasoned wood with non-diffusible preservatives. Because of this capability, research is in progress to improve the decay and insect resistance of cross-ties during both air-seasoning and in service by dip-treating unseasoned ties in borates prior to standard treatments (Amburgey and Barnes 1988). This research is expected to show that the decay and insect resistance of ties in service will be much greater in borate-treated ties that are subsequently treated with creosote than in those that are only treated with creosote. It is also likely that less creosote could be used with the borate-treated ties. Many of these expected benefits should be obtained by borate diffusion treatment of hardwood bridge timbers followed by an envelope treatment with a preservative approved for treatment of wood in ground contact or exterior exposure.

Benefits and limitations of borates - The beneficial characteristics of borates include: toxicity towards most wood-damaging fungi and insects, mobility within wood to move to decay- or termite-damaged areas along a moisture gradient, low toxicity to mammals, and adaptability to a wide range of treatment processes (Williams 1991). Also, borates are not reported to cause any odor, color, corrosiveness, or wood machining problems. Borate treatment chemicals and equipment for diffusion treatments are relatively inexpensive, but the cost of treatment must include the costs of inventory storage required for diffusion. Because borate-treated wood should not be used for bridge timbers without additional treatment, the cost of a secondary treatment also must be included.

There are limitations to attaining many of the benefits of borate diffusion treatments that warrant discussion. With current technology, deep penetration of large timbers and refractory woods and use of inexpensive equipment are only possible when unseasoned wood is treated with a diffusible preservative. The increased fire resistance and mobility of borates also may present both benefits and limitations.

Simple diffusion treatments - Simple treatment procedures and inexpensive equipment should aid small wood producers in providing relatively inexpensive borate-treated stock from locally grown hardwoods. However, correctly performing dip-diffusion treatments involves more than simply treating the surface of wood by dip or spray treatment. Dip-diffusion treatments consist of two steps: (1) getting a sufficient quantity (loading) of the preservative on the surfaces of wood that has sufficient moisture content to allow diffusion, and (2) storing treated wood under the proper conditions for sufficient time until the wood is penetrated by the preservative to the desired depth. A general rule of thumb is a minimum of 1 week of covered storage for each inch of thickness of the stock to be treated.

Although not complicated or necessarily expensive to achieve, the correct performance of diffusion treatment processes is difficult to control in commercial operations. Logging and milling operations must be closely coordinated to maintain the high wood moisture content necessary for good, uniform diffusion. Freshly treated stock must be protected from rain-wetting or much of the boron will be washed off. Thus, long diffusion storage times cause a protected storage-space problem and add to inventory costs. As production volume increases, these problems may become formidable. Covered storage times can be decreased by first pressure treating unseasoned wood to increase the surface loading and to aid immediate penetration before diffusion storage. Diffusion can also be enhanced by heating stock during storage.

Thus, the current technology of diffusion treatments is best suited for small-volume operations. However, an expensive research and technology transfer effort would be required to develop and prescribe specific treatment procedures for various hardwood species for many small wood producers. Concurrent with treating information, knowledge must be disseminated about the techniques, chemicals, and equipment for assessing the quality of treatments with color tests. Treatment quality also would have to be monitored by independent, third-party inspection agencies.

Fire resistance - The added fire resistance of borate-treated waste may create a problem when waste is burned for power generation unless a high-temperature furnace or a mixture of untreated and treated waste is burned. Thus, research is needed to verify that borate-treated waste can be safely used in other ways, such as animal and poultry bedding.

Mobility of borates - The mobility of borates in wood is highly advantageous for treating large timbers and refractory woods, and for remedial treatment of wood in service. But the mobility of borates means that it is leachable and this could result in a significant loss of borate in wood that frequently becomes wetted in service. This undesirable aspect can be overcome, however, by secondary treatment of borate-treated wood with additional protective coatings or

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preservatives to provide a water repellent or water resistant envelope. Oil-borne preservatives such as creosote or copper naphthenate when used to retreat borate-treated wood would provide an additional preservative barrier and would significantly reduce the leaching of borate from the center of timbers.

Maintenance (remedial) treatments - Maintenance procedures and inspection schedules should be developed for any wooden structures, including bridges, as part of the design and planning process. Diffusible preservatives such as fused borate rods, borate or fluorine pastes, are used as part of many utility pole maintenance and remedial treatment programs. These same formulations should prove useful in extending the service life of bridge timbers.

Borate wood preservatives - Readers can gain some familiarity with borate wood preservatives by reviewing the articles in the proceedings of the "First International Conference on Wood Protection with Diffusible Preservatives" held November 1990 (available from the Forest Products Research Society, 2801 Marshall Court, Madison, WI 53705, telephone 608-231-1361 for $50.00 per copy). In addition to historical reviews of the use of borate wood preservatives in Austral-asia, Canada, Europe, and New Zealand, these proceedings provide an overview of the current status of research and commercial use of borates in the United States.

Readers are encouraged to review other discussions of the benefits and limitations of borate diffusion treatments for freshly sawn hardwood lumber (Amburgey and Williams 1991), for structural timbers (Williams 1990), and for commercial use in the Western Hemisphere (Williams 1991).

Literature cited

Amburgey, T.L. and Barnes, H.M. 1988. The care and feeding of the wood crosstie: What's new in research? Crossties Vol. 69 (3): 9-10

Amburgey, T.L. and Williams, L.H. 1991. Treatment of freshly-sawn hardwood lumber. In: Proceedings of the 19th annual hardwood symposium of the Hardwood Research Council: Facing uncertain futures and changing rules in the 1990's; 1991 March 10-12; Starkvill, MS Memphis, TN: Hardwood Research Council. pp. 105-117

Barnes, H.M., T.L. Amburgey, L.H. Williams, and J.J. Morrell. 1989. Borates as wood preserving compounds: The status of research in the United States. Doc. No. IRG/WP3542. Inter. Res. Group on Wood Pres. 16 pp.

Williams, L.H. 1990. Potential benefits of diffusible preservatives for wood protection: An Analysis with emphasis on building protection. In: Hamel, Margaret, ed. Proceedings of the 1st international conference on wood protection with diffusible preservatives; 1990 November 28-30; Nashville, TN. Proceedings 47355. Madison, WI: Forest Products Research Society. pp. 29-34.

Williams, L.H. 1991. Diffusion treatment of wood—An American perspective. In: Thompson, Ray. Proceedings of a symposium: The Chemistry of Wood Preservation, 28 February 28-March 1, 1991; Teddington, United Kingdom. Royal Society of Chemistry. pp. 34-52.

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