Recent Trends in Preservative Treatments for Timber Bridges

James P. Wacker

Abstract

An overview of wood preservatives currently used for timber bridges is presented through a series of case studies from different regions of the United States. New wood species and preservative treatment options for timber bridges have made choosing the appropriate preservative more complicated. The compatibility of wood species and preservative treatment is often overlooked but can be very important to the durability of timber bridge components. More technical guidance is needed for bridge designers who are not familiar with wood preservative treatments. The current trend is toward the use of waterborne preservatives and untreated decay-resistant wood species in opposition to current American Association of State Highway and Transportation Officials design specifications.

Introduction

Timber bridge designers are faced with an increasingly complicated decision when choosing an appropriate preservative treatment. Preservative treatment information guides are available (Lebow and Makel 1995), but bridge designers need more specific information addressing compatibility issues between wood species and preservatives. Several new wood species (both hardwoods and softwoods) have been adopted for timber bridge applications through efforts of the National Wood in Transportation Program (USDA 2004). Widespread use of these non-traditional wood species in timber bridges has highlighted the importance of wood species and preservative compatibility for the durability of treated bridge components. In many cases, Compatibility issues between wood species and preservative are overlooked by design engineers, emphasizing the need for additional technical guidance. In addition, the treating industry is currently in transition from chromated copper arsenate (CCA) to alternative (arsenic-free) water-borne preservative treaments as a result of recent restrictions by the U.S. Environmental Protection Agency (EPA). However, waterborne preservatives tend to be more corrosive to galvanized steel fasteners in the exposed bridge environment, where wood moisture contents can exceed 20 percent.

Currently, the American Association of State Highway and Transportation Officials (AASHTO) design specification (AASHTO 2002a) require that exposed timber bridge members be treated with preservatives by pressure-treatment methods according to industry standards. The American Wood-Preservers' Association (AWPA) determines minimum penetration and retention requirements for many species and preservatives to achieve good durability under various exposure conditions (AWPA 2003). In addition, AASHTO has a preference for oil-type preservatives for structural members, primarily due to their moisture barrier properties and low corrosion interaction with metal fasteners. Current AASHTO M168 material specifications (AASHTO 2002b, section 3.1.2) permit certain decay-resistant species to be used without preservative treatment, but only as non-structural bridge members. This paper provides an overview of current wood preservatives used for timber bridges in the United States through a series of case studies (Table 1). Many of the timber bridges included in the case studies were built as demonstration structures partially funded by the National Wood in Transportation Program.

Michigan Case Study

New timber bridges have been built along primary and secondary roadways of several counties in Michigan. The locally available softwood species utilized for many of these timber bridges was red pine. CCA preservative was used for the first several structures (such as the Graves Crossing Bridge in Antrim County, **Fig. 1),** and creosote was used for structures built later (such as the Cameron Bridge in Crawford County, **Fig. 2).** However, some creosote-treated highway bridges experienced excessive amounts of bleeding, which raised environmental concerns. Preliminary field investigations (Wacker et al. 2003) found that after many years in service, several bridges constructed with glued-laminated timber (glulam) components had creosote retention levels much higher than the required level of 12 lb./ft.^{3}. As a result, the publication entitled *Best Management Practices for the Use of Preservative-Treated Wood in Aquatic Environments in Michigan* (Pilon 2002) was developed in conjunction with the state department of natural resources to prevent similar problems in the future. The Michigan Department of Transportation (MI-DOT) also revised their bridge specifications to provide additional technical guidance to design engineers regarding preservative treatments by pressure methods. These MI-DOT timber bridge specifications encourage the use of pentachlorophenol (penta) (in light oil) and CCA (type C), while discouraging the use of creosote.

Pennsylvania Case Study

The Pennsylvania Deparment of Transportation (PennDOT) had approximately 20 timber highway bridges constructed on their secondary road system. The locally available hardwood species utilized for many of these timber bridges was northern red oak Creosote was primarily used for these bridge structures (such as the Dutch Hill Road Bridge, Fig. 3). Some minor creosote bleeding has occurred at some bridge sites, but it has not led to significant environmental concerns to date.

PennDOT incorporated standard designs for creosote-mated northern red oak timber bridges into their bridge specifications in 1996. Current PennDOT design standards also accept red maple (the current underutilized hardwood species in Pennsylvania) glulam treated with creosote preservatives.

Recent timber bridge projects by the Pennsylvania Bureau of Forestry have included alternative species or treatments. The Linn Run Trail Bridges were constructed with CCA-treated eastern hemlock lumber. A recent field investigation found the protective preservative-treated zone for the bridge members to be minimal. In general, the treatability of eastern hemlock can vary widely, which can lead to penetration and retention levels significantly lower than AWPA standards. The Stoney Run Road Bridge project used diffusible borate (non-pressure) treatment methods to increase the du-

Table 1.—Summary of state-based timber bridge preservative case studies.

Case study	County	Bridge name	Preservative	Wood species
Michigan	Crawford	Cameron	Creosote	Red pine
	Antrim	Graves Crossing	CCA	Red pine
Pennsylvania	Crawford	Dutch Hill Rd.	Creosote	No. red oak
	Lancaster	Mill Cross Rd.	Creosote	No. red oak
Ohio	Richland	McCurdy Rd.	ACQ	So. pine
	Richland	Huntsman Rd.	ACQ	So. pine
Alaska	Matmush-Susima	Kepler–Bradley	Copper flouride	AK white spruce
	Skagway	Nelson Slough	None	AK yellow cedar

Figure 1.—Deck superstructure of the Graves Crossing Bridge is CCA treated.

Figure 4.—McCurdy Road Bridge is ACQ treated.

Figure 2.—Cameron Bridge is creosote treated.

Figure 5.—Huntsman Road Bridge is ACQ treated with water-repellent additives.

Figure 3.—Dutch Hill bad Bridge is creosote treated.

rability of red oak lumber. Borate pressure treatment methods are also an option, but borates should be used cautiously for bridge members because they tend to leach unless the treated members are sheltered from rainfall.

Ohio Case Study

The Richland County (Ohio) Highway Department has had several timber bridges built along rural roadways during the past 10 years. The softwood utilized for many of these timber bridges was southern pine. Alkaline copper quat (ACQ) was used for treating structural members in the McCurdy Road Bridge (pig. 4). ACQ with water-repellent additives was used for treating structural members in the Huntsman Road Bridge (Fig. 5) in efforts to alleviate concerns about dimensional stability for water-based preservative treatments used in bridges. The wood preservative ACQ (an arsenic-free alternative to CCA) was chosen primarily to address worker safety concerns associated with creosote and avoid environmental concerns associated with CCA. Some corrosive interaction was noted at the interface of ACQ-treated wood and galvanized steel components, and further field inspections are planned.

Alaska Case Study

In Alaska, several timber bridges have been built during the past 10 years. Pressure-treatment methods have been used but are more expensive because a pressure-treatment facility is not available within the state. The Alaska Department of Transportation has had many copper-naphthenate-treated wood decks built for use with steel beam highway bridges. The National Forests in Alaska have had many bridges built using members that were pressure treated with creosote and penta preservatives. However, some creosote-treated glulam bridges have caused local residents to raise environmental concerns because of excessive bleeding in-service. Bridge engineers have responded and are beginning to choose alternative protection techniques to provide for prolonged timber bridge durability The Kepler–Bradley Bridge (Fig. 6) is built with Alaska white spruce treated by double diffusion (non-pressure treatment) methods using copper sulfate and sodium fluoride. These double diffusion chemical preservatives have not yet been approved by EPA for widespread use as a wood preservative. The Nelson Slough Bridge **(Fig. 7)** is built with untreated Alaska yellow cedar, relying solely on its natural decay-resistant properties. More information is needed regarding the durability of Alaska yellow cedar and other naturally decay-resistant wood species in different bridge environments to ensure adequate performance.

Efforts are underway to develop a comprehensive Alaska Wood in Transportation Program. The program aims to identify specific Alaska wood species (yellow cedar, white spruce, Sitka spruce, and western hemlock) and preservative treatments (copper fluoride by double diffusion and natural decay resistance) as the basis for developing standardized timber bridge designs and enhancing forest-based communities.

Summary

Several case studies are presented on current practice for timber bridge preservatives and species used in different regions of the United States. The trend in current practice is toward waterborne preservatives and untreated decay-resistant wood species, with increased emphasis on water-proofing strategies (Blankenhorn et al. 1999). However, the corrosive interaction between waterborne preservatives and galvanized steel fasteners will need to be addressed to achieve a durable bridge system. Bridge designers need technical guidance to address the issue of compatibility between wood species and preservatives and new treatment alternatives.

References

American Association of State Highway and Transportation Offi-& (AASHTO). 2002a. Standard specifications for highway bridges. 17th ed. Washington, DC.

American Assouation of State Highway and Transportation Officials (AASHTO). 2002b. M-168 Standard specifications for transportation materials and methods of sampling. 22nd ed. Washington, DC.

American Wood Preservers' Association [AWPA). 2003. Standards. C-14, Wood for highway construction. Selma, AL.

Blankenhorn, Paul R., Steven Bukowski, James A. Kainz, and Michael Ritter. 1999. Moisture protection for timber members. In: Proc. of the Pacific Timber Engineering Conf., 14-18 March 1999, Rotorua, New Zealand. Walford, G.B. and D.J. Gaunt Ed. New Zealand Forest Research Institute. Forest Research Bulletin No. 212. Vol. 2:240-248.

Lebow, S.T. and W.J. Makel. 1995. Selection and use of preservative mated wood in forest service recreational structures. TEO1A35. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center. 12 p.

USDA. 2004. National Wood in Transportation Information Center program. www.fs.fed.us/na/wit. Morgantown, WV: U.S. Department of Agriculture, Forest Service, State and Private Forestry, Northeastern Area.

Pilon, J. 2002. Best management practices for the use of preservative-treated wood in aquatic environments in Michigan. Roscommon, MI: Michigan Department of Natural Resources.

Wacker, J.P., D.M. Crawford, and M.O. Eriksson. 2003. Creosote retention levels of timber highway superstructures in Michigan's lower peninsula. Res. Note FPL-RN-289. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 17 p.

Figure 6.—Kepler–Bradley Bridge is copper fluoride treated.

Figure 7.—Nelson Slough Bridge is naturally durable Alaska yellow cedar (untreated).

James P. Wacker, Research Engineer, USDA Forest Service, Forest Products Laboratory, Madison, WI, jwacker@fs.fed.us.