National Wood In Transportation Information Center

CROSSINGS

NEWSLETTER OF THE WOOD IN TRANSPORTATION PROGRAM

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De-icing Salts, Timber Decks, and Steel Beams

Nail-laminated timber bridge decks treated with waterborne preservatives are water permeable and tend to absorb water. This can cause problems unless measures are taken to keep the deck dry or to keep the water away from underlying structural members and abutments.

A county in northern New York, similar to many counties and other jurisdictions in the area, began installing timber deck bridges on weathering steel beams in the late 1980's. From 1988 through 1997, 42 of the county's 260 bridges were replaced. Forty of these bridges have chromated copper arsenate (CCA) treated nail-laminated timber decks on steel beams.

The decision to use a combination of pressure-treated wood and weathering steel in an engineered design took advantage of unique properties and cost efficiencies of both structural elements. This system has low capital and life cycle costs, and is quickly installed. The steel selected for the beams was ASTM A588 weathering steel. This type of steel is designed to be used unpainted in a low-to-moderate corrosive environment. The steel develops a fine, impermeable tight-grained surface rust, which bonds to the underlying steel, thereby protecting it from further corrosion.[1,2,3] However, when

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Georgia Forestry Commission's Wooden Bridge Demonstration Program

In fiscal year 1989 the Georgia State Legislature authorized the first funding for the Georgia Forestry Commission's Wooden Bridge Demonstration Program. This initial funding enabled the Commission to work with Putnam County to construct a 30-foot free span stress deck bridge on a rural road in an area of the county primed for rapid development. The demonstration wooden bridge program, patterned after the U.S. Forest Service Wood in Transportation Program, is directed at improving local transportation systems on county roadways in the state.

This timber bridge located in Putnam County has a stress-laminated deck, 30-feet long by 16-feet wide, constructed from southern yellow pine and treated with Pentachlorophenol.

The cost-share program aims at providing assistance to local county governments in selecting potential bridge sites, attaining engineering assistance, and providing assistance in locating vendors and other contractors for actual bridge installation. Locally grown and processed pressure treated southern pine is the primary wood material utilized for the bridges. They are designed and constructed at the HS20-44 load-carrying capacity.

Since 1989, the emphasis of the program has progressed from building demonstration bridges to rural economic development through improving local infrastructures. The modern wooden vehicular bridge is still the central focus of the program.

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Georgia Forestry Commission. . . ***continued from page 1***

Funding for the program has increased from slightly over $30,000 in 1989 to $160,000 for fiscal year 1998. Since inception, the State of Georgia has invested over $800,000 in the program. The total economic benefit for the State is estimated to be $3.4 million dollars based on total investment in each bridge constructed.

With assistance from the Georgia Forestry Commission, Georgia counties have completed construction on fourteen vehicular bridges. Fifteen more bridges are in various stages of construction. In addition, the program has provided funding for twenty pedestrian bridges.

For more information on Georgia's Wooden Bridge Program, contact the Georgia Forestry Commission, P.O. Box 819, Macon, Georgia 31202-0819.

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A588 steel is used in a corrosive environment, it must be painted or galvanized.

The timber decks on the New York bridges are nominal 2-inch x 10-inch, no. 1 dense, southern pine lumber pressure-treated with CCA. The timber deck laminations are installed across the tops of the stringers and fastened together with nails (nail-laminated). Steel clips hold the deck to the steel stringers.

The first of these bridges was installed in 1988. An asphalt surface was placed on top of the deck. No impervious membrane was installed. In 1989, the county began placing an impervious paving membrane between the deck and the asphalt surfacing. The membrane covered the deck to the face of the traffic rails (which is about the location of the exterior steel girders) and to the ends of the deck. This system was used until 1997.

In 1996, county employees noticed large flake rusting on several bridges. Closer investigation revealed extensive rusting on all girders installed in 1988, and extensive rusting on exterior girders of bridges installed during the time period that the paving membrane was used.

Several concerns initially surfaced. One concern was that since some girders were rusting substantially more than others, perhaps common steel (ASTM A36) had inadvertently been substituted for the weathering steel beams. Testing indicated that this was not the case. Another immediate concern was that the CCA pressure treatment (a waterborne preservative treatment) of the wood had contributed to the rusting. It is commonly known that road or table salt (sodium chloride) causes accelerated rusting of steel. Could the chromium and copper have had the same effect?

Research has shown that the CCA treatment has only a minor corrosive effect on steel. Because of its natural acidity, untreated wood is also mildly corrosive. The corrosiveness of CCA treated wood is slightly higher than that of untreated wood.[4,5,6] Chemical tests of the rust flakes from two of the New York bridges affirmed this information, since only trace amounts of copper and chromium were found in the rust. In addition, the results indicate a high amount of chlorine and sodium present in the rust.[7] This indicates that salt-laden water is finding its way onto the steel beams.[7]

Water carrying dissolved road salt easily passes through asphalt surfaces. On bridges that did not have an impervious paving membrane, the salt-laden water either passed directly through the timber decking onto the steel beams, or was absorbed by the timber decking to be released by the next rainfall onto the steel beams. The bridges with a guardrail to guardrail membrane partially protected the interior beams. However, it is believed that the salt-laden water penetrated the timber decking at the ends of the membrane, and through wicking, the water found its way to some of the interior beams.

When A588 steel is used in a corrosive environment it rusts much more quickly, and the surface rust loses its adhesion to the underlying steel. The rust flakes off and continually re-exposes the

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underlying steel. Uncoated weathering steel is not appropriate in a salt-containing, severely corrosive environment.

This problem would have been less severe if the wood had been treated with an oil-borne preservative such as creosote or pentachlorophenol. The oil carrier aids in sealing the wood from moisture intrusion and helps prevent moisture-loss shrinkage (which opens cracks). The oil in creosote or an oil-borne pentachlorophenal treatment coats the adjoining steel elements and deters corrosion.

Road de-icing salt must be kept away from steel elements. This applies whether the deck material is timber, concrete, steel, or plastic. Water should be channeled away from and off bridge decks as quickly as possible by an adequate crown or super elevation. An impervious paving membrane is mandatory. It should extend to the edge of the bridge and wrap around the edge of the deck to form a drip edge. Runoff water would then drip off the bridge and not run onto parts of the timber deck or the exterior beams. The membrane should either extend beyond the ends of the bridge into the approach fills or wrap over the ends of the bridge so runoff water does not flow onto the beam bearing seats. The deck should also overhang the exterior beams by a distance that maximizes the design efficiency of the deck (about two feet). This helps to keep salt-laden runoff away from the exterior beams. In addition, because wood (particularly treated with waterborne preservatives) tends to absorb and retain water, and because untreated and treated wood have a slightly corrosive effect, timber decks and steel beams should be physically separated by a material such as tar paper, paint, galvanizing, etc.

The Federal Highway Administration and most state departments of transportation have detailed limitations covering when and where uncoated weathering steel should be used.[2] It is imperative that designers and bridge owners have this information. When weathering steel beams are exposed to wetness for extended periods of time due to surface water, road runoff, or are in a severely corrosive atmosphere, the steel should be coated with an appropriate paint or galvanizing system. Waterborne treated timber bridge decks are not waterproof and measures must be taken to prevent intrusion of salt-laden water. This problem can be relatively easily prevented by the use of a waterproof paving membrane and good construction details.

References:

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NEW PUBLICATIONS

Field Performance of Timber Bridges — 13. Mohawk Canal Stress-Laminated Bridge

The Mohawk Canal bridge was constructed in August 1994, just outside Roll, Arizona. It is a simple-span, double-lane, stress-laminated deck superstructure, approximately 6.4 m (21 ft.) long and 10.4 m (34 ft.) wide and constructed with Combination 16F-V3 Douglas Fir glued-laminated timber beam laminations.

The performance of the bridge was monitored continously for 2 years, beginning shortly after installation. Performance monitoring involved gathering and evaluating data relative to the moisture content of the wood deck, the force of the steel stressing bars, the vertical creep of the deck, and the behavior of the bridge under static load conditions. Furthermore, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing properly with no structural deficiencies.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591.

Field Performance of Timber Bridges — 14. Dean, Hibbsville, and Decatur Stress-Laminated Deck Bridges

The Dean, Hibbsville, and Decatur bridges were constructed in southern Iowa during 1994. Each bridge is a simple-span, stress-laminated deck superstructure, approximately 7.3 m (24 ft.) long constructed from eastern cottonwood lumber.

The performance of each bridge was monitored for approximately 2 years, beginning shortly after installation. Monitoring involved collecting and evaluating data pertaining to the moisture content and vertical creep of the wood decks, the force level of the stressing bars, and the behavior of the bridges under static load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridges are performing well with minor serviceability deficiencies.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591.

Article contributions, questions or comments may be sent to Ed Cesa, Program Manager, National Wood In Transportation Information Center or Ms. Tinathan A. Coger, Information Assistant; USDA Forest Service; 180 Canfield Street; Morgantown, WV 26505; Phone: 304-285-1591 or 304-285-1596; or FAX: 304-285-1505; or E-mail to tcoger@mserv.fsl.wvnet.edu.

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