RESEARCH in Progress

NATIONAL CENTER FOR WOOD TRANSPORTATION STRUCTURES

# Corrosion of Fasteners in Wood Treated with Newer Wood Preservatives for Potential Rehabilitation of Covered Bridges

Metallic fasteners have been used in covered bridges for centuries and have performed well in untreated timbers. However, durability concerns during rehabilitation of these historic structures typically dictate the use of treated wood. Because of environmental considerations, effective wood preservatives that have been used for many years are being replaced with newer wood preservatives, such as alkaline copper quaternary (ACQ) and copper azole (CuAz), that are showing accelerated corrosive effects on iron fasteners.


**Hot-dip galvanized (left) and common steel (right) fasteners exposed to treated wood during a 1-year exposure at 27°C, 100% relative humidity.**

## Background

One major hurdle to designing for corrosion performance with newer wood preservatives is the amount of time it takes to obtain results; previous real-life exposure tests have taken up to 20 years. Accelerated test methods currently being used to examine corrosion of fasteners in treated wood do not correlate well with in-service performance because the mechanism of corrosion in treated wood is not well understood.

Corrosion of metals in contact with wood depends on the wood moisture content (the ratio of water held in the wood to the weight of the dry wood) and the type and amount of preservative used. Corrosion of metals in wood is believed to be an aqueous process occurring in unbound or loosely bound water within the cellular structure of the wood. There appears to be a threshold, somewhere between 15% to 20% wood moisture content, below which metallic fasteners do not corrode in wood or treated wood. Corrosion is also believed to be influenced by cupric ions present in many wood preservatives. One theory is that the corrosion reaction involves reduction of cupric ions in treated wood to form metallic copper, which causes the steel or galvanized steel fasteners to corrode at an accelerated rate.

A better understanding of the mechanism of corrosion in wood is needed before a meaningful accelerated test can be developed.

## Objectives

This project has three principal objectives:

1. Evaluate corrosion performance of ferrous, nonferrous, and nonmetallic fasteners in wood treated with new preservatives, specifically, ACQ, CuAz, and micronized copper quaternary (MCQ)
2. Examine the feasibility of a rapid test to evaluate corrosion of metals in contact with wood
3. Examine the role of moisture on corrosion of metals in contact with treated wood

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## Approach

The project consists of four subprojects: (1) long-term exposure tests on ferrous and zinc-galvanized fasteners; (2) development and execution of a test method for non-metallic fasteners; (3) development and execution of an accelerated test for ferrous and zinc-galvanized fasteners; and (4) examination of moisture-corrosion interactions.

Long-term exposure tests of ferrous and zinc-galvanized fasteners will provide useful data on performance of fasteners used with treated wood in rehabilitated bridges. The fasteners will be exposed for 1 year to an environment of 27°C and close to 100% relative humidity, conditions that have been historically used as a baseline for measuring corrosion of metals in contact with wood. In addition to newer preservatives, such as ACQ, CuAz, and MCQ, chromated copper arsenate (CCA) and untreated wood will also be tested to benchmark performance.

Non-metallic (polymeric) fasteners do not undergo corrosion in the traditional sense but may be prone to other environmental degradation in treated wood, such as depolymerization, environmental stress cracking, or embrittlement. Non-metallic fasteners will be exposed to the same environment as the metallic fasteners. In addition to measuring weight changes, mechanical properties of the fasteners will be measured to detect possible degradation.

During the exposure period, accelerated tests will be performed using standard electrochemical methods in an extract of the treated wood. Preliminary research using this method has shown promising results in ACQ-treated wood for common steel, hot-dip galvanized, and electroplated galvanized fasteners.

Throughout the duration of the study, wood–water interactions will be studied in the context of corrosion. A recent study hypothesized a connection between loosely bound water that can be observed using differential scanning calorimetry (DSC) and the threshold for corrosion in wood. Further DSC measurements will confirm or deny this hypothesis.

## Expected Outcomes

This study will result in corrosion rate data of ferrous and non-ferrous fasteners in several wood preservatives; this data can be used to calculate a "corrosion life" when rehabilitating timber bridges with treated wood. The study will also result in a better understanding of the mechanism of corrosion in treated wood, which may possibly lead to an accelerated test method that could be used to rapidly evaluate new wood preservatives. Information collected in this study on the relationship between moisture conditions and corrosion could be utilized as one input in web-based health monitoring of timber bridges.

## Timeline

Long-term exposure tests for ferrous and non-ferrous metal fasteners have been initiated and should be concluded by December 2009. The exposure test for non-metallic coated fasteners should begin by fall 2009 and be completed by December 2010. DSC and electrochemical tests will be performed throughout 2009 and 2010. The final report will be drafted in 2011.

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