Research in Progress

Coalition for Advanced Wood Structures
a university, industry, government partnership

Development of a Smart Timber Bridge—Phase II: Integration of Sensors into Glued-Laminated Beams

The critical deterioration of bridges nationwide has prompted a search for new methods to rehabilitate, repair, manage, and construct bridges. The concept of smart structures has recently emerged as a new technology for improving bridge management. This technology could replace or supplement on-site inspections currently specified by the National Bridge Inspection Program. Research on smart structures typically involves materials, structural mechanics, electronics, signal processing, communication, and control. In practice, a smart structure would incorporate the use of sensors, data reduction techniques, and remote systems that allow for monitoring of the structure. With these elements, the smart structure is able to

Big Shoal Creek glulam bridge located in Arkansas' Ozark National Forest.

- monitor its *in situ* behavior,
- assess its performance under service loads,
- detect damage or deterioration, and
- determine its current condition.

Background

Past timber bridge evaluation and maintenance efforts have principally focused on the internal integrity of timber components using various non-destructive evaluation tools to supplement visual inspection data. This project is part of a larger effort to develop smart structure concepts for improving the long-term performance, maintenance, and management of timber bridges, with the focus of proactively managing bridges rather than passively reacting to serious deterioration issues. Smart timber bridge development will take advantage of existing and new sensors, health monitoring technologies, and bridge management approaches to create an integrated, turnkey structural health monitoring system. This effort focuses on developing a system to analyze, monitor, and report on the performance and condition of the most commonly constructed timber bridge type, the longitudinal glued-laminated girder with transverse glued-laminated deck.

Objective

The objective of this work is to develop techniques for integrating sensors within timber bridge glued-laminated components. Because sensors have not typically been embedded within glued-laminated components, a significant amount of work is needed to determine how to embed sensors—both with and without physical

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attachment—within timber components. These techniques will be needed before the development of new sensors can be completed.

Approach

Several tasks must be completed to accomplish project objectives:

- Working with various adhesive manufacturers, we will identify candidate adhesives for attaching sensors to timber.
- Using candidate adhesives, we will embed a variety of sensors in small timber specimens and test the specimens under static loads. Comparing results from embedded and external sensors, we will select the most promising adhesives.
- We will test the most promising adhesive/timber combinations under cyclic loads to determine if performance is repeatable over time. We will again select the most promising adhesives for further study.
- We will then test the remaining adhesives for relaxation and temperature effects. Variables of interest will include performance under temperature variations and slip and/or relaxation characteristics.
- We will construct a full-scale specimen to be tested under laboratory conditions, evaluating ease of installation and overall performance.

Expected Outcomes

This study will result in procedures for embedding sensors within timber bridge glued-laminated components. These procedures will be needed during the development of sensors to measure timber-specific parameters.

Timeline

The review of available adhesives will be completed by December 2006 and static tests completed by March 2007. Cyclic testing will be completed by May 2007, with testing of the full-scale specimen completed by December 2007.

Cooperators

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