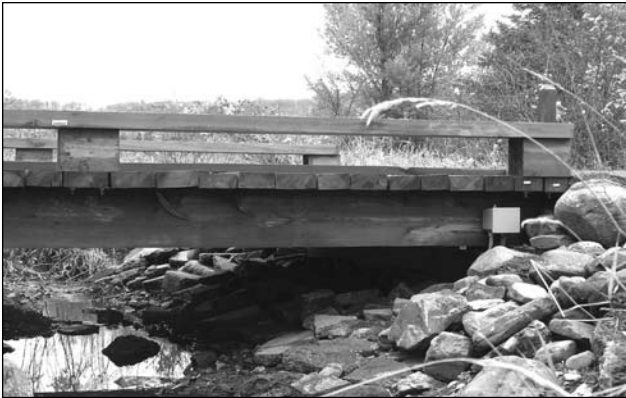


BRIDGING THE GAP

NEW INSPECTION TECHNOLOGIES IMPROVE BRIDGE SAFETY



Timber bridge at Michigan Technological University's Ford Forestry Center equipped with smart bridge technology.

By Rebecca Wallace, Public Affairs Specialist

The tragic collapse of the I-35W bridge in Minneapolis, Minnesota, raised concerns nationwide about the safety of bridges across the country and how their conditions are being inspected and monitored.

People tend to think of bridges as steel and concrete structures, such as the I-35W bridge. However, it may be surprising to learn that more than 27,600 timber bridges (defined as those spanning 20 feet or more in length by the Federal Highway Administration) are in use across the United States. Improvements in inspection and monitoring techniques for these wood structures could increase the safety of millions of motorists.

Current timber bridge inspection procedures in many states are mostly limited to visual inspection of the wood components, sounding with a hammer, and coring to confirm suspected damage areas, according to Brian Brashaw, program director for wood materials and manufacturing at the University of Minnesota–Duluth Natural Resource Research Institute (NRRI).

“These techniques have proved adequate for advanced decay detection,” says Brashaw, “but they’re not adequate when the damage is in the early stage or is located internally in the members.”

Brashaw suggests that traditional inspections need to be supplemented by new monitoring techniques and instrumentation to assess the ongoing performance of each bridge as a system.

Along these lines, Brashaw and the NRRI, along with Forest Products Laboratory (FPL) and Michigan Technological University, have been working for years to transfer advanced techniques to significantly improve the reliability of bridge inspections.

Brashaw and his colleagues, including FPL researcher Robert Ross and Xiping Wang, an NRRI researcher stationed at FPL, developed a short course on timber inspection techniques and equipment in 1995 that is ongoing through the American Society of Engineers and have written several user-friendly publications and manuals for bridge inspectors and engineers, including the *Wood and Timber Condition Assessment Manual*, a practical, comprehensive guide to the inspection of wood in service.

Some of the advanced technologies these training courses and manuals focus on include stress wave timing, resistance drilling, and the use of moisture meters, says James Wacker, research engineer at FPL.

Stress wave timing utilizes acoustics to detect decay in wood members. This method involves tapping a wood member and measuring the time it takes for the sound wave to travel through the wood. Results are then compared with a base measurement; the slower the sound wave travels, the more decay is present, says Wacker.

Resistance micro-drilling is another technique that can be used to measure the internal condition of a wood member. Inspectors bore a very small hole in the

(continued on pg. 5)



NEWSLINE TEAM

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Check out our website at
<http://www.fpl.fs.fed.us>

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UPCOMING EVENTS

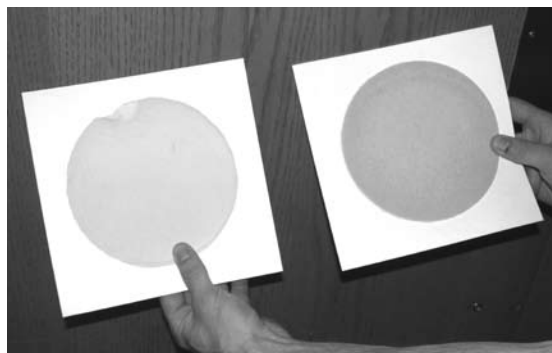
IUFRO ALL-DIVISION-5 CONFERENCE: FOREST PRODUCTS AND ENVIRONMENT – A PRODUCTIVE SYMBIOSIS

October 29–November 2, 2007— Grand Hotel, Taipei, Taiwan. IUFRO Division 5 (Forest Products) will host a forum for the exchange of knowledge and experience in forest products research at national and international levels. Participants will discuss recent research progress, exchange information, and collaborate on research related to the conference theme. <http://www.alldiv5iufro2007.org.tw/index.asp>

DURABILITY OF WOOD-FRAMED HOUSING: LESSONS LEARNED FROM NATURAL DISASTERS

November 13–15, 2007—Beau Rivage Resort and Casino, Biloxi, Mississippi, USA. This conference will provide attendees with the latest information on lessons learned from natural disasters related to the durability of wood-framed housing. Attendees include design professionals, builders, code officials, government officials, researchers, and educators. <http://www.forestprod.org/durability07bro.pdf>

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Source: www.paperproject.org

LOOKING INSIDE A CITY'S TREES

TECHNOLOGY ASSESSES INTERNAL CONDITION OF STANDING TREES IN AN URBAN ENVIRONMENT

By Rebecca Wallace, Public Affairs Specialist

The term “urban forestry” might sound like an oxymoron since many people don’t think about forestry being practiced in a city. But in reality, trees are valuable assets to urban communities, and special care and consideration must be taken of these trees to ensure the safety of people and property around them.

Here in Madison, Wisconsin, century-old trees surround the state capitol. Called Capitol Park, this area bustles with thousands of people enjoying farmer’s markets, art fairs, concerts, and picnic lunches on the capitol lawn.

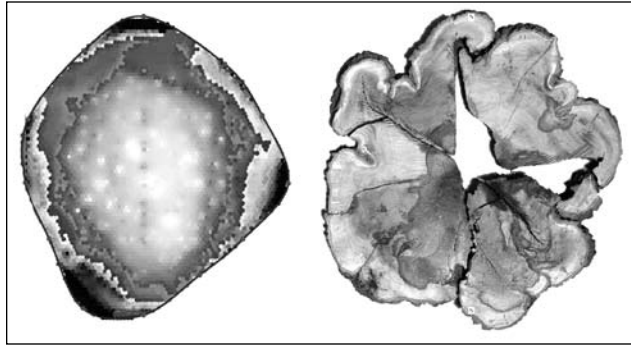
In the interest of their safety, as well as the well-being of the trees, state officials contacted Dr. R. Bruce Allison of Allison Tree Care, Inc., to inspect the Capitol Park trees and determine their condition. Recognizing the importance of the trees to this public park, Allison contacted researchers at the Forest Products Laboratory (FPL) looking for the best equipment available. FPL researchers suggested a relatively new method of inspection called acoustic tomography, a technique that uses sound waves to create a two-dimensional image of the inside of a tree.

“Traditional methods of evaluating a tree’s health have relied simply on the visual inspection of the exterior of a tree,” explains Xiping Wang, a researcher from the University of Minnesota–Duluth stationed at FPL. “But internal structural defects, such as decay or large cracks, are often hidden from view within the tree trunks. With acoustic tomography, we can get a much more accurate assessment of the internal condition of standing trees.”

According to Wang, acoustic tomography is conducted by placing acoustic sensors on a horizontal plane around the trunk of a tree. One by one, the sensors are tapped, sending a sound wave through the trunk that is picked up by the other sensors. By measuring the speed at which the sound wave travels through the tree in many different directions, researchers were able to generate the two-dimensional image using a software program called PiCUS Q70.

At Capitol Park, Allison and Wang conducted a preliminary study of more than 150 trees and identified

approximately 20 that needed to be more closely inspected. Those trees were then evaluated both visually and using the acoustic tomography technique to generate two-dimensional images of the cross sections of the trunks.



Comparison of acoustic tomogram with photograph of corresponding cross section of actual tree.

“Once the evaluation was complete, results were reported to state officials who decided two red oak trees were safety hazards and needed to be removed,” said Allison. “This gave us the opportunity to conduct a more precise study of the tomography equipment.”

The trees were felled and a 10- to 15-cm thick disk was cut from the same section of

the trunk where the acoustic testing was conducted. The disks were then taken to FPL for physical examination and laboratory acoustic measurements.

Researchers compared the acoustic tomograms with actual cross sections of the trees. The tomograms were mapped into different color zones: dark-colored zones represented solid wood, light-colored zones represented decayed wood. The tomograms clearly showed a strong correspondence to the condition of the actual tree discs.

One observation made by researchers was that the light-colored zones of the tomograms were larger than the actual areas of decay in the trees. Researchers concluded this was caused by large internal cracks that were dominating defects in both trees, illustrating that the light-colored zones cannot be simply interpreted as decay.

“To make the best assessment of the internal condition of urban trees, acoustic tomography should be used in conjunction with other techniques, such as visual inspection or resistance microdrilling, to provide supporting evidence whenever necessary,” says Wang. “But overall, the acoustic tomography technique was accurate in locating large areas of decay and provided strong evidence of structural instability in both trees.”

And if further evidence was necessary, Mother Nature provided it. According to Allison, two more trees later marked for removal were blown down by strong winds before they could be felled by professionals, and they failed exactly along the lines predicted by the tomography equipment.



SPOTLIGHT ON PARTNERSHIPS

By Rebecca Wallace, Public Affairs Specialist

Forest Products Laboratory (FPL) researchers have a long history of successful partnerships with a vast array of organizations, from industry to academia, non-government to government organizations, tribes to trade associations. Combining ideas, skills, expertise, lab facilities, and equipment with various partners has expanded our capabilities—and those of our partners—to everyone's benefit. Here is one example of long-standing, productive partnership between FPL and the wood products industry.

APA—The Engineered Wood Association

APA—The Engineered Wood Association (APA) is the nonprofit trade association of the U.S. and Canadian engineered wood products industry. The Association includes and represents manufacturers of structural plywood, oriented strandboard, glued-laminated (glulam) timber, wood I-joists, and laminated veneer lumber.

For over 70 years, APA has focused on helping the industry create structural wood products of exceptional strength, versatility, and reliability. The Association's primary functions are quality auditing and testing, product application and systems research, and market support and development.

The partnerships between APA and FPL illustrate the benefits of collaborative efforts when working toward a common goal. "FPL's wood products research expertise makes it an ideal partner for a wide variety of mutual projects," says Jack Merry, industry communications director for APA. "FPL complements APA's own research capabilities and lends additional strength to our technology transfer efforts."

According to Mike Ritter, assistant director for wood products research at FPL, the partnership between APA and FPL is key to the efficient use of government resources. "Partnering with APA and its members allows us to leverage government funding, thereby providing the biggest return to taxpayers," Ritter says.

APA has been involved in many of FPL's high-profile projects. A key player in the construction of the Research Demonstration House at FPL in 2001, the Association also provided educational materials from their Build a Better Home program, a builder/designer education and training program to address moisture-related building envelope performance issues.
(www.fpl.fs.fed.us/ahrc/index.html)



The Sustainable Resource House was on display in Washington, D.C. in 2005.

The Sustainable Resource House, a structure demonstrating the use of engineered wood products, was built on the National Mall in Washington, D.C., during the Smithsonian Folklife Festival in 2005. This educational outreach project was the result of collaboration between APA, FPL, and several other partners.
(www.sustainableresourcehouse.org)

The Forest Products Laboratory has also worked with APA through several partnerships that focus on the improved use of wood products in a variety of applications. For example, the Coalition for Advanced Wood Structures (CAWS), a university, industry, and government partnership created to foster the sustainable use of forest resources, is the result of a joint effort between APA, FPL, the NAHB Research Center, the University of Idaho, Iowa State University, and Mississippi State University.
(<http://www.fpl.fs.fed.us/caws/index.html>)

According to Merry, joint projects currently underway through CAWS include a cost comparison study of raised wood floor versus slab-on-grade construction and research to provide raised wood floor moisture performance data. Both projects are especially relevant to Gulf Coast rebuilding efforts.

Recently, FPL cooperated with APA and the Wood Products Council to conduct a research needs assessment for wood-framed commercial buildings in California. According to Ritter, this is the beginning of a large-scale North American program to help introduce more wood applications in the commercial building market.

"Conducting a needs assessment such as this helps to ensure our research not only addresses key issues, but also focuses our limited resources in areas that provide the most benefit to the American public," says Ritter.

Bridging the Gap (continued from pg. 1)

wood (the diameter of the steel bit is just 1/16-in.) and a device measures the torque required to drill into the wood. Sound wood requires a higher torque, whereas less torque is needed if decay or other voids are present in the wood. According to Wacker, resistance drilling is more accurate than stress wave timing for determining the relative size of a decay pocket.



Wacker also explains how moisture meters, in combination with the aforementioned methods, can help determine where decay may occur.

“In order for wood to decay the moisture content must exceed approximately 25 percent,” says Wacker. “Taking moisture measurements first can give inspectors an idea of the location of wet pockets in the wood and help narrow down an area to conduct more specific tests.”

The next generation of equipment being developed by this group of researchers involves in-place techniques using forced vibration testing, which tests the bridge system as a whole, rather than just the individual components tested during stress wave timing or resistance drilling.

Forced vibration testing involves an electronic box connected to a motor used to vibrate the bridge, similar to what happens when a car drives over it. Inspectors can plug a laptop computer into the box, monitor the affects of the vibrations, and then compare those results with measurements taken when the bridge was initially installed. Any changes in the measurements would signal a change in the bridge system. Further investigation would be necessary to determine exactly where the problem was located.

According to Ross, project leader for the Engineering Properties of Wood, Wood-Based Materials and Structures unit at FPL, the ultimate goal of their research is to develop a “smart bridge” that would alert inspectors when a repair is needed. “Forced vibration testing gets us closer to the goal of a smart bridge,” he says.



Researchers conducting forced vibration testing.

Researchers are moving toward developing a monitoring system that would include a motor permanently attached to a bridge with the capability of running periodic, automatic tests. Results of the test would be sent electronically to inspectors and they could in turn determine whether or not further inspection was necessary.

Currently, bridges are inspected according to a predetermined schedule, and it is time consuming for inspectors to travel to each and every bridge and perform the necessary inspections.

“An automated inspection system would save time and money while increasing safety,” says Ross. “Right now it takes the same amount of resources to inspect a good bridge as it does a bad one. With an automated system, inspectors could focus on the bridges that need work and not spend valuable time inspecting those in good shape.”

Questions?

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I KNOW THE PRESERVATIVES USED TO TREAT WOOD HAVE CHANGED OVER THE PAST FEW YEARS. DOES THAT HAVE AN EFFECT ON THE TYPE OF FASTENERS I SHOULD CHOOSE FOR PROJECTS USING TREATED WOOD?

By Rebecca Wallace, Public Affairs Specialist

The increased use of alkaline copper quaternary (ACQ) and copper azole (CuAz) as wood preservatives for residential construction has led to concerns about corrosion of fasteners.

Simpson Strong Tie published a technical bulletin indicating that both ACQ and CuAz are roughly twice as corrosive as chromated copper arsenate (CCA), which was the most common wood preservative treatment until its withdrawal for residential construction in 2004. It is believed this increase in corrosiveness results from the higher percentage of copper and the absence of chromium and arsenic, both known corrosion inhibitors.

Many “corrosion resistant” products are now marketed for use with new wood preservatives as a more cost-effective alternative to stainless steel. However, many factors must be considered when choosing fasteners and connecting hardware to minimize their corrosion when in contact with treated wood.

Metallic coatings, of which galvanizing (zinc plating) is a specific example, work by applying a layer of slower-to-corrode metal over a substrate made of a metal that corrodes more quickly. The two types of metallic coatings are anodic and cathodic. Common anodic coatings for steel are zinc and cadmium, and they are advantageous because the steel is galvanically protected when holes and cracks form in the coating. Common cathodic coatings, such as chromium, nickel, and tin, act only as a barrier between the substrate and the treated wood, and the underlying metal is therefore susceptible to corrosion if defects in the coating occur. Increasing the thickness of cathodic coatings can increase corrosion performance because it provides a thicker barrier with less chance of defects reaching the substrate.

Ceramic and organic coatings are another option available. These coatings, varying from common alkyd paints to epoxy resins to various rubbers, attempt to completely isolate the substrate from the corrosive environment. Their effectiveness depends on their ability to provide and maintain a defect-free, dry environment on the surface of the fastener. Ceramic linings have a greater hardness, which is important because any damage that occurs to the coating as the fastener is inserted can create an opportunity for corrosion.

Whatever product you decide to use, remember one important tip: do not mix metals (such as a carbon steel bolt with a galvanized washer or a galvanized screw with a stainless steel hanger), because increased corrosion will occur.

From “Corrosion Avoidance with New Wood Preservatives” by Samuel L. Zelinka and Douglas R. Rammer



Avoid corrosion by choosing the right fasteners for preservative-treated wood.

CONSTRUCTION BEGINS ON MULTI-USE LABORATORY

By Rebecca Wallace,
Public Affairs Specialist

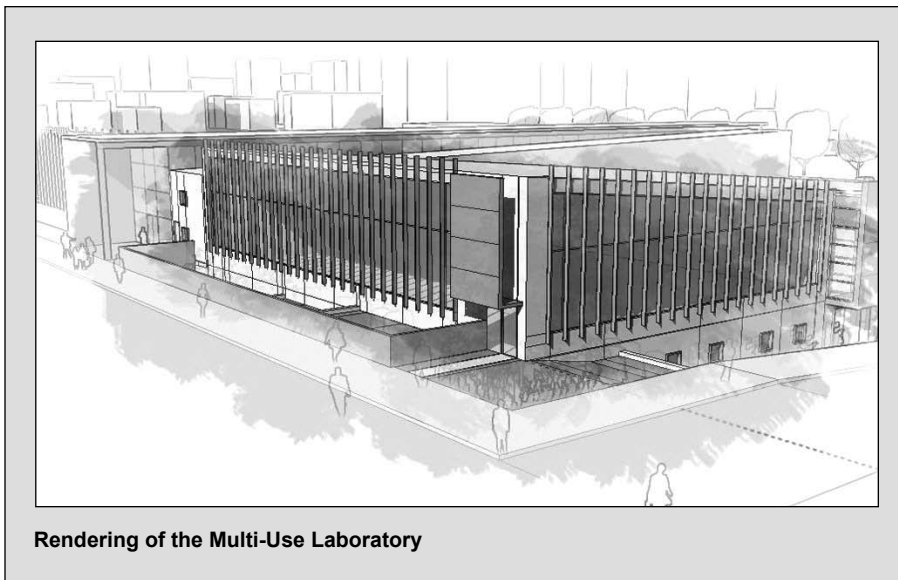
A groundbreaking ceremony was held on Wednesday, August 15, at the Forest Products Laboratory to kick off construction of the new 90,000-square-foot Multi-Use Laboratory (MUL) featured in the Summer 2007 issue of NewsLine.

In addition to the groundbreaking and a VIP tour of the FPL's current facilities, several honored guests spoke the ceremony, including U.S. Senator Herb Kohl, FS Deputy Chief for Research and Development Ann Bartuska, TAPPI President Larry Montague, Executive Vice President of the Forest Products Society Carol Lewis, and FPL Director Chris Risbrudt.

Senator Kohl commented that industry and consumers will see benefits from



Left to Right: FPL Director Chris Risbrudt, U.S. Senator Herb Kohl, TAPPI President Larry Montague, Executive Vice President of the Forest Products Society Carol Lewis, Forest Service Deputy Chief for Research and Development Ann Bartuska



Rendering of the Multi-Use Laboratory

and composite sciences. The MUL was designed to address critical safety needs, update outdated and insufficient facilities, and greatly improve scientific capabilities. The facility will feature one-of-a-kind equipment, including a custom-made stainless steel weathering chamber that mimics actual weather conditions, including temperature, humidity, sunlight, wind, and rain.

the research. “(They will see) benefits like safer homes, safer water quality, sustainable development, and new fuel resources. Those are really important things,” said Kohl, a Democrat from Wisconsin and a member of the Senate Appropriations Committee.

The \$36 million facility will house state-of-the-art equipment and laboratories for four major areas of research: wood preservation, durability, engineering mechanics,



Forest Products
Laboratory

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Chris Risbrudt
Director

NOBEL PRIZE-WINNING EFFORTS BY FPL RESEARCHER



Ken Skog, project leader and scientist for the Economics and Statistics Research group at the Forest Products Laboratory, participated on teams for two projects for the United Nations Intergovernmental Panel on Climate Change (IPCC), which was awarded the 2007 Noble Peace Prize along with former U.S. Vice President Al Gore. Skog has been involved with the IPCC since 1998, and his work contributed to the publication of two reports, *Good Practice Guidance for Land Use, Land Use Change and Forestry*, published in 2003, and the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.

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