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Forest Products Laboratory's
Newsline

Fall 2015

Deck Demise: Corroded Fasteners Pose Hidden Dangers

By Tom Owens

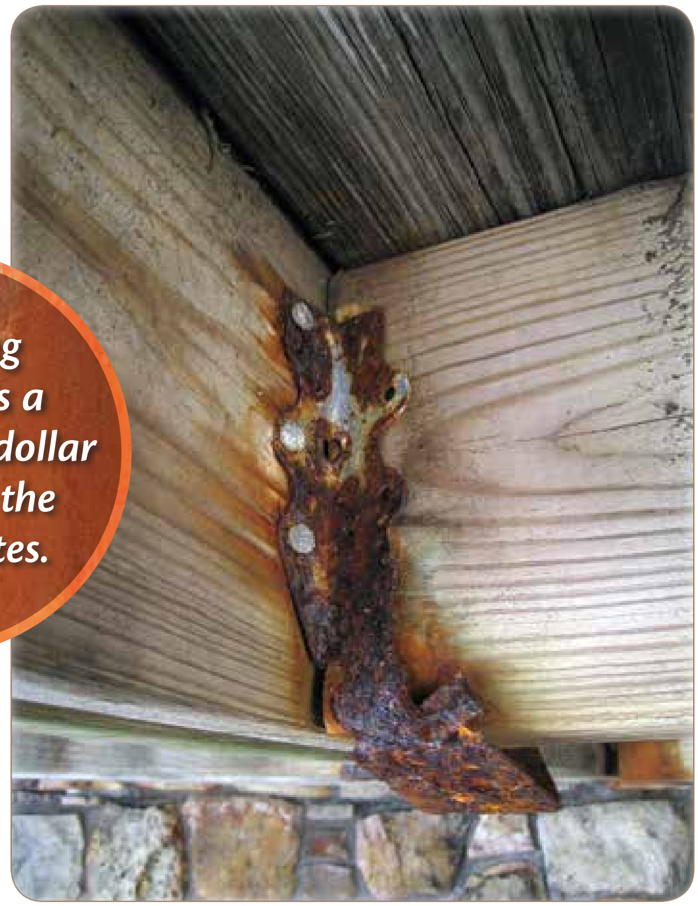
A creak here, a groan there—the familiar orchestra of an aging deck. Though in most cases these noises are innocent, some may betray a deeper problem. Beneath your feet could be impending disaster, a backyard platform poised to plummet to the ground below—even if the wood comprising it is completely sound.

Corroded metal fasteners have been responsible for several deck collapses across the country, and tragically, decks seldom fail when they are unoccupied. Researchers at the Forest Products Laboratory (FPL), in cooperation with the U.S. Department of Transportation and the Federal Highway Administration, have been investigating metal fasteners, and their corrosion problems, for years. They found that although wood is generally not corrosive, copper-based wood preservatives can react with the metal components of the deck and lead to compromised structural integrity.

Preventing corrosion is a multi-billion-dollar industry in the United States.

In 2004, changes in regulations saw an influx of wood treatments with increased copper content. Although effective at preserving the wooden components of external structures, they increase the incidence of corrosion.

When two dissimilar metals (for example, the nails in a deck and the wood's copper-based coating) come into



Corrosion of a galvanized joist hanger and nails supporting a wood deck treated with a copper-containing wood preservative. This deterioration would be easily spotted during a visual inspection.

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Wood Wise—*Terms from the World of Wood*

Tension Wood: Abnormal wood found in leaning trees of some hardwood species. Tension wood fibers hold together tenaciously, so that sawed surfaces usually have projecting fibers and planed surfaces often are torn or have raised grain. Tension wood may cause warping.

Treenail: A wooden pin, peg, or spiked used chiefly for fastening planking and ceiling to a framework. Often used in timber framing, covered bridges, and wooden boat and ship building.

Delamination: The separation of layers in laminated wood or plywood because of failure of the adhesive, either within the adhesive itself or at the interface between the adhesive and the wood.

Intumesce: To expand with heat to provide a low-density film; used in reference to certain fire-retardant coatings.

Naval Stores: A term applied to the oils, resins, tars, and pitches derived from oleoresin contained in, exuded by, or extracted from trees, chiefly species of pines. Historically, these were important items in the stores of wood sailing vessels.

Source: Wood Handbook—Wood as an Engineering Material, General Technical Report FPL–GTR–190, **www.fpl.fs.fed.us/woodhandbook**

New Treatment Plant Ushers in Next Century of Wood Preservatives

by Tom Owens

The Forest Products Laboratory (FPL) is pleased to announce the opening of a new, state-of-the-art pressure treatment facility to continue the laboratory's tradition of being an innovator in the field of wood preservation. The new computer-controlled, vacuum and pressure wood preservative treatment system includes five pressure vessels capable of treating material ranging from small test specimens to large post and pole sections. Separate systems are maintained for water-based and oil-based preservative treatments.

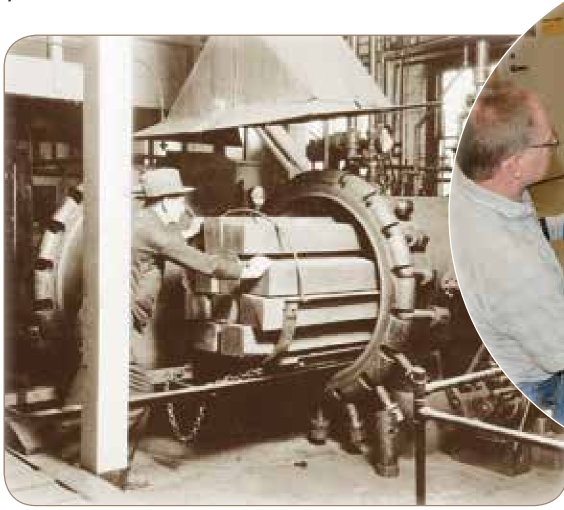
The new facility builds on the successes of the past to better the future of wood preservation.

The vast landmass of the United States was forged into a single nation through common ideology, shared destiny, and more than a little help from the railroad system. Supporting these tracks were thousands upon thousands of wooden railroad ties—but supporting these wooden ties were researchers at FPL.

Helping to keep the country's trains rolling was the pressure treatment facility at FPL. One of the lab's first objectives was to research better methods to make railroad ties last longer through pressure treatment methods.

Steve Schmieding, USDA FS-FPL

FPL's state-of-the-art pressure treatment facility



Experimental treatment of railroad ties at FPL's original location on the University of Wisconsin campus.

FPL invites collaboration with partners from industry, academia, trade associations, and other government agencies to ensure that research is converted into useful technology that benefits the public.

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Turning Research into Reality: Demo House Showcases Energy-Efficient Engineering

by Tom Owens

Although researchers can accomplish amazing things from the comfort of the laboratory, sometimes all the testing, computer modeling, and scientific theory in the world is no substitute for the real thing. Sometimes, researchers at the Forest Products Laboratory (FPL) need a real-world example in order to convey the exciting discoveries and developments happening every day at FPL's home in Madison, Wisconsin.

In the world of wood science, sometimes that means you have to build a house.

APA – The Engineered Wood Association

"The Inside View Demonstration House" near Chicago, Illinois.

Just a few hours south of Madison in the suburbs of Chicago, Illinois, FPL researchers, in cooperation with APA – The Engineered Wood Association, recently completed a demonstration house to showcase energy-efficient building technologies. The project, dubbed "The Inside View Demonstration House," is focused on educating residential homebuilders, designers, and building code officials across the country on how to cost-effectively construct an energy-efficient house with 2×6 advanced framed walls.

APA – The Engineered Wood Association

"The Inside View Demonstration House" is focused on educating residential homebuilders, designers, and building code officials across the country on how to cost-effectively construct an energy-efficient house with 2×6 advanced framed walls.

Thicker walls constructed with 2×6 lumber offer a larger wall cavity than conventional walls built with 2×4 lumber. In addition to increased structural integrity, this method of construction allows for more insulation, increasing the energy efficiency of the building. FPL is leading the charge in evaluating these wall systems and hopes to release a comprehensive guide focused on using 2×6 walls with optimized framing in residential construction next year.

The demonstration house, built by Beechen & Dill Homes, will be used primarily for training and education and will advance the use of advanced frame walls through seminars, open houses, articles in construction trade magazines, and educational videos produced through APA.

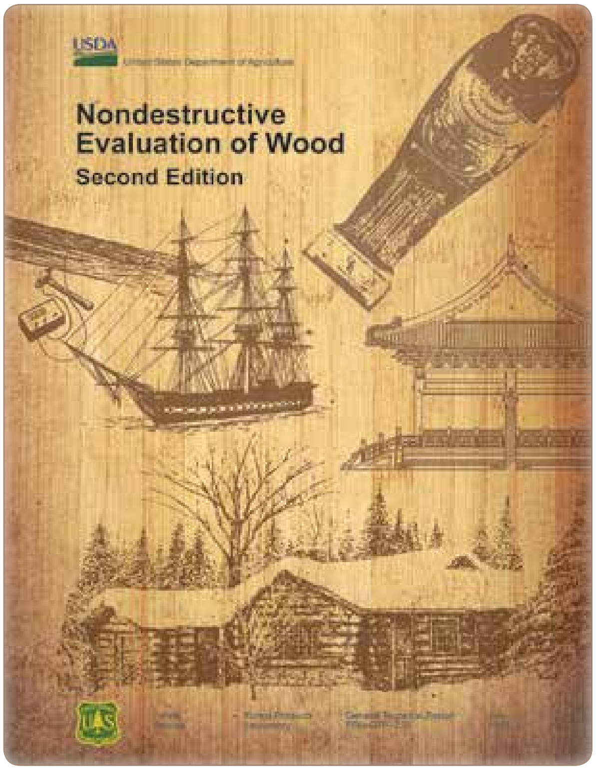
In addition to the walls, the cutting-edge floor system featured in the Inside View House uses high-performance wood I-joists and 7/8 Performance Category OSB and plywood structural panels. This combination creates a cost-effective floor that drastically reduces construction time and increases efficiency.

Projects like the Inside View Demonstration House help put FPL's research directly into the hands of those that can use it. This transfer of knowledge from FPL and its industry partners to the American public completes the chain of scientific research and realizes the Forest Service's motto of "caring for the land and serving people."

"Landmark Book" Covers Nondestructive Testing of Wood

by Rebecca Wallace

USDA Forest Service Forest Products Laboratory (FPL) has assembled the most comprehensive publication ever regarding nondestructive testing and evaluation (NDE) of wood materials.



Geared toward industry professionals, ***Nondestructive Evaluation of Wood, Second Edition,*** offers guidance, analysis, and practical application of NDE techniques, including the use of lasers, x-rays, and ultrasound, to assess and report on the condition and integrity of wood. These techniques, which do not damage the objects being evaluated, can be used on structures, bridges, standing trees, and even historic artifacts.

"Nondestructive testing of wood is an exciting area of research and has the potential to greatly enhance the wise use of wood," said Bob Ross, the book's editor, author or co-author of several chapters, and supervisory research general engineer at FPL. "Wood, in any form—trees through timber bridges—is highly variable because of how it grows, where it comes from, and what it is exposed to. Nondestructive evaluation technologies are the scientific foundation for all assessment and grading of wood-based materials," Ross added

The book's 13 chapters contain information from many of the industry's foremost experts in the world, on topics such as static bending, transverse vibration, resistance drilling, piezoelectricity, acoustic assessments, and laser methodology. The book also provides information concerning more traditional evaluation techniques, such as machine grading, and advice for practical application in urban environments.

"To make the best, highest use of our forest resources," Ross explained, "we need to have technologies that help us assess what the quality of a particular tree, log, or piece of lumber is. We can then utilize it appropriately. One of the fastest growing sectors of the wood products industry—engineered wood products—relies heavily on the use of nondestructive evaluation technologies." NDE techniques described in the book have been employed around the world in many projects:

- Use of sound waves to evaluate the quality of timber in National Forests
- Use of ultrasound technology to locate decay in urban trees
- Evaluation of structural performance potential of logs, veneer, lumber, and timbers before installation
- Inspection of historic covered bridges
- Inspection of historic artifacts, including the USS Constitution and a 2,500-year-old mummy coffin from Egypt

"Nondestructive evaluation technologies are the scientific foundation for all assessment and grading of wood-based materials."

— Bob Ross

"This landmark book continues the proud legacy we have established at the Forest Products Laboratory as a cutting-edge scientific institution," said FPL Director Michael T. Rains. "It represents years of research across the full spectrum of scientific endeavor, from technical journals and research reports, to the proceedings from various symposia. The book will serve as a guide to the public and a touchstone for future generations of scientists and land managers, as we continue to find better ways to utilize one of our planet's most cherished and renewable resources—wood."

Better Bridges: Considering Wood–Concrete Construction

by Tom Owens

The United States is facing an infrastructure crisis. According to the American Road & Transportation Builders Association, more than 61,000 bridges in America are structurally deficient. Although expensive to maintain, particularly in these tough economic times, when these vital pieces of our transportation system fail, the human toll is incalculable.

One needs to look no further for a reminder than the 2007 collapse of the Interstate 35 bridge near Minneapolis, Minnesota. The steel truss arch bridge suddenly failed under the load of rush hour traffic, plunging into the Mississippi river below. The bridge had consistently ranked near the bottom of nationwide federal inspection ratings, and its collapse claimed 13 lives. In the disaster's wake, fearing similar incidents, federal and state governments mobilized to assess the condition of their own bridges.

More than 61,000 bridges in America are structurally deficient.

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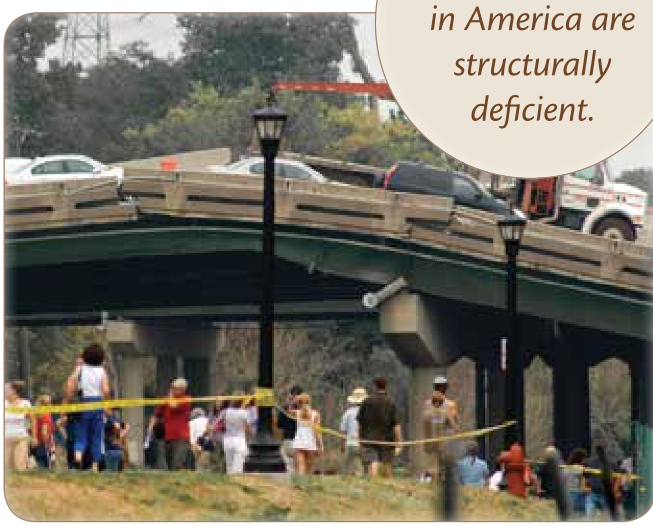


A scene from the 2007 collapse of the Interstate 35 bridge near Minneapolis.

As states continue to evaluate and improve their transportation infrastructure, researchers at the Forest Products Laboratory (FPL) are working hard envisioning the future of durable and cost-effective bridges. They believe that the answer may lie in wood, one of humankind's oldest construction materials, used in conjunction with another time-tested material, concrete.

In cooperation with Iowa State University, Research General Engineer Jim Wacker, from the Engineering Properties of Wood, Wood Based Materials, and Structures unit at FPL, has set out to investigate the state-of-the-practice related to the use of concrete decks supported by glued-laminated (glulam) timber girders for highway bridge applications. Glulam timber bridges have already proven themselves in our nation's National Forests, but the practice of using them in conjunction with concrete decks is relatively scarce across the highways of America. The project, which commenced earlier this year, is expected to be finished June 2017.

James Wacker, USDA FS-FPL

A view of the underside of a wood–concrete bridge on the Gifford Pinchot National Forest in Washington.

A composite timber–concrete bridge consists of a concrete slab rigidly connected to supporting timber sections so that the combination functions as a unit. Composite timber–concrete bridges are of two types: T-beam decks and slab decks.

T-beam decks are constructed by casting a concrete deck, which forms the flange of the T, on a glulam beam, which forms the web of the T. Composite slab decks are constructed by casting a concrete layer on a continuous base of longitudinal nail-laminated sawn lumber.

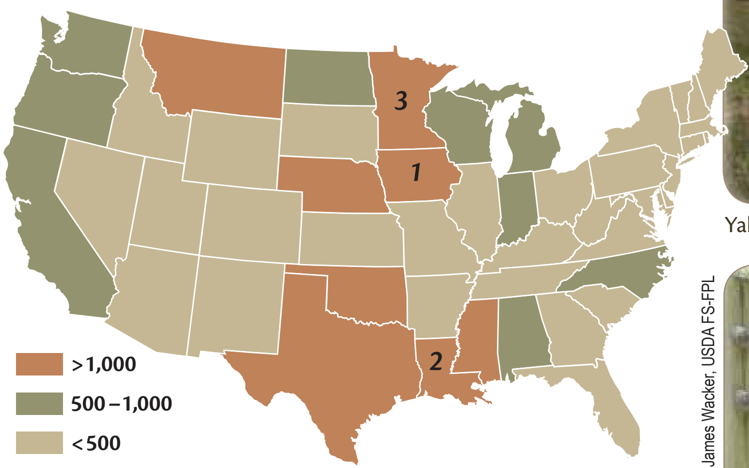
Recent research has found that performance of timber bridges constructed 50 to 70 years ago is above average, but despite this, only a small percentage of new bridges built every year are built with graded and engineered lumber. This project hopes to change that.

Composite slab decks were used as far back as the 1930s, and Wacker's reassessment of concrete–timber bridge construction will arm bridge engineers with a wealth of knowledge on the best practices of the past—so that bridges of the future can be as cost-effective, durable, and safe as possible.

Taking the Long Road: Studying Timber Bridge Service Life

by Rebecca Wallace

Timber bridges are a much larger part of the U.S. transportation system than many people realize. In fact, one-third of the states have more than 500 timber bridges in their inventories, and wood continues to be a viable option for modern bridge construction.



State timber bridge inventories in the contiguous United States. Iowa, Louisiana, and Minnesota have the most timber bridges.

More reliable data on the expected service life of highway bridges is a significant need, as engineers begin to implement life-cycle costs analyses within preliminary bridge designs. Claims are made that the expected longevity of concrete and steel bridges stands at 75 years or more, whereas timber bridges (which engineers are less familiar with) are estimated to last only 20–30 years. Unfortunately, because little data exists, these claims are not based on actual performance data.

One-third of U.S. States have more than 500 timber bridges in their inventories.

To generate more quantitative and unbiased data on timber bridge durability, Forest Products Laboratory (FPL) researchers designed a nationwide study in conjunction with the Federal Highway Administration. The goal of the multi-year team effort was to assess the condition of more than 100 timber bridge superstructures around the United States to provide a better understanding of their design, performance, and durability characteristics.

James Wacker, USDA FS-FPL

Yakima County, Washington.

James Wacker, USDA FS-FPL

Tangipahoa Parish, Louisiana.

Six different inspection teams with members from various organizations conducted field assessments of 132 timber bridges. Selected bridges were required to be along public roadways, have been in service for at least 16 years, and have available records regarding inspection, maintenance, and repair. The in-depth inspections included visual, probing, and nondestructive evaluation techniques to characterize the condition of the primary bridge superstructure components.

Results of this study found that timber is a durable option for primary structural members in highway bridges superstructures and that it can perform adequately for more than 70 years when properly pressure-treated with preservatives.

A comprehensive technical report (currently under review) will include more detailed information about all the timber bridges evaluated in this study and will provide the basis for development of life-cycle cost analyses and bridge deterioration rate modeling for timber bridge superstructures in the future.

Timber Turn-Ins: Disposing of Preservative-Treated Wood

by Tom Owens

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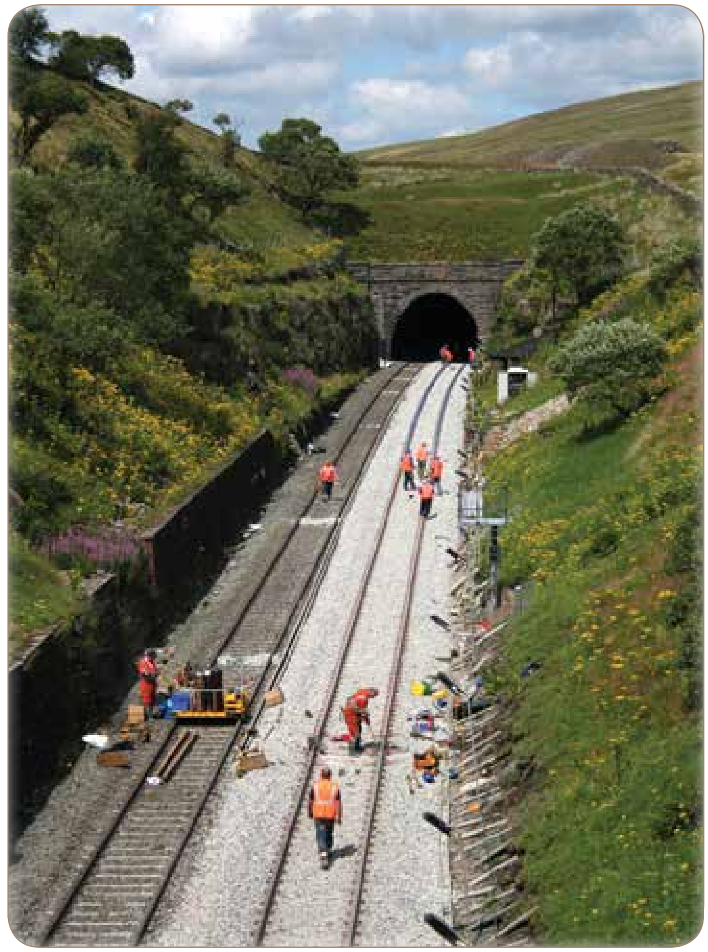

Railroad ties, which number in the millions, are just one example of treated wood that eventually needs to be disposed of.

We all know where to recycle our empty bottles, cardboard boxes, and plastic packaging, but where does preservative-treated wood go?

Treated wood is not listed as a hazardous waste under Federal law, and it can be disposed of in any waste management facility authorized under State and local law to manage such material. State and local jurisdictions may have additional regulations that impact the use, reuse, and disposal of treated wood and treated-wood construction waste, and users should check with State and local authorities for any special regulations relating to treated wood.

Treated wood must NOT be burned in open fires or in stoves, fireplaces, or residential boilers, however, because the smoke and ashes may contain toxic chemicals. Treated wood from commercial and industrial uses (for example, from construction sites) may be burned only in commercial or industrial incinerators in accordance with State and Federal regulations.

Spent railroad ties treated with creosote and utility poles treated with pentachlorophenol can be burned in properly equipped facilities to generate electricity. As fuel costs and energy demands increase, disposal of treated wood in this manner is becoming more attractive; however, it poses more challenges for wood treated with heavy metals (which remain in the ash for further processing).

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Spent railroad ties can be burned in properly equipped facilities to generate electricity.

Researchers have demonstrated that wood treated with heavy metals can be chipped or flaked and reused to form durable panel products or wood–cement composites.

Techniques for extraction and reuse of metals from treated wood have also been proposed, including acid extraction, fungal degradation, bacterial degradation, steam explosion, or some combination of these techniques. All these approaches show some potential, but none is currently economical. In most situations, landfill disposal remains the least expensive option.

Reuse of treated wood may be a viable alternative to landfill disposal, and in many situations, treated wood removed from its original application retains sufficient durability and structural integrity. Generally, regulatory agencies recognize that treated wood can be reused in a manner that is consistent with its original intended end use. The biggest obstacle, however, is the lack of an efficient process for collecting and sorting treated wood.

Researchers at the Forest Products Laboratory (FPL) hope to change this in the future. Pilot studies have already been conducted to develop cost-effective methods to collect, sort, and reuse wood (including treated wood) from urban areas. In addition to conserving resources and helping the environment, these methods have the added benefit of stimulating local economies with new jobs and industries.

Disposing of treated wood in a responsible way may not be as simple as a trip to your local recycling center, but it is still an important part in the life-cycle of the material that must be considered to ensure that wood remains a sustainable, environmentally friendly resource.

Continued from page 1 –
Deck Demise

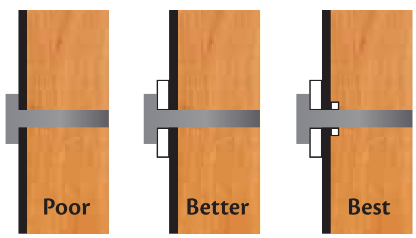
> *"If the wood is kept dry, both the wood and fasteners can last for centuries."*

contact with one another, the electron exchange between the two materials begins the corrosion process. In addition to producing unsightly rust, this significantly weakens the metal.

Fortunately, you can take several steps to mitigate these hazards. Because dry materials do not react with one another, FPL stresses that, "proper moisture management is the most important thing one can do to reduce corrosion of metals in treated wood." This includes preventing moisture from seeping in through the ends of wooden components (where it moves into the timber up to 10 times faster than from other directions) and designing roofs and overhangs so that they do not drain onto lower structures. Researchers maintain that, "if the wood is kept dry, both the wood and fasteners can last for centuries."

Isolating the metals from one another is another step one can take. The most common way of doing this is through non-metallic coatings, such as those found on some screws or bolts designed for exterior use. Extreme care must be taken,

Strategies to mitigate galvanic corrosion



A non-conductive washer between the head of the lag screw and the sign should eliminate electrical contact between the bolt and the sign (Better). If there is a tight clearance between the hole and the bolt, it might be necessary to coat the edge of the holes to prevent electrical contact (Best).

Illustration of the importance of roof overhangs for protecting wood from biodeterioration and corrosion. The right side of the support beam is protected by the large roof overhang, whereas the left side is exposed to rain.

however, when using coated metals in construction, because the coatings can be easily damaged during the installation process.

Finally, avoiding metal-on-metal contact altogether is a surefire method to prevent corrosion, but the hardest to implement. Although copper preservatives and metal nails are sometimes unavoidable neighbors in deck construction, being aware of metallic washers used on dissimilar metal bolts, or metal signs hung by metallic screws, can help put a damper on the corrosion process. Using non-conductive washers with metal signs or joist hangers, for example, can significantly decrease the speed of the corrosion and extend the life of the metal by decades.

Preventing corrosion is a multi-billion-dollar industry in the United States, with over $100 billion spent in protective coatings alone. It is a problem as old as the material itself, and wherever moisture and metal are found, corrosion is sure to follow. By utilizing proper construction techniques, moisture management, and, of course, regular inspections of your deck or home, your fasteners can last a lifetime—and your deck and family can be spared the tragic results of corroded metal fasteners.

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Lab Notes FPL's online news feed

Continued from page 3 – **New Treatment Plant**

Steve Schmieding, USDA FS-FPL

FPL researchers and industry partners will use the new facility to advance the science of wood protection.

Lumber, poles, posts, and other outdoor wood products are usually treated with preservatives to prevent decay and insect damage. Pressure treatment is a process that forces a preservative deep into the wood structure. Without pressure treatment, only a thin outer layer of wood is protected.

The equipment can utilize pressures of up to 235 lb/in^2 (1,620 kPa) and temperatures up to 250 °F (121 °C). In addition, FPL's facility features a unique design, allowing for small specimens to be treated in pans within the pressure vessels while the treatment solution is circulated and heated.

Now that the equipment is fully operational, researchers hope to find new ways to optimize the quality of preservative treatments. By varying parameters such as steam, temperature, vacuum pressure, preservative type, and wood species, FPL hopes to identify cost-efficient treatment schedules that achieve thorough preservative treatment without damaging the wood structure.

The equipment is also critical to evaluating new types of preservatives. It can be used to prepare test specimens to study their resistance to biological degradation or leaching.

Steve Schmieding, USDA FS-FPL

Unlike other pressure treatment facilities, FPL's state-of-the-art equipment can recirculate the treatment solutions.

Other applications include accelerated weathering, extracting chemicals from wood, and elevated moisture simulations.

This new treatment facility has a much wider application than preserving railroad components. FPL invites collaboration with partners from industry, academia, trade associations, and other government agencies to take part in the next chapter of the laboratory's history, ensure that the research is converted into useful technology, and help support the Forest Service's mission of caring for the land and serving people.

Wood You Believe?

In the 1950s, FPL researchers were challenged with how to use waste wood as flooring.

During the wood flooring manufacturing process, many of the cut pieces were too short to be used as conventional flooring, so researchers demonstrated ways of combining short pieces of wood into designs that could be installed in decorative ways, just like tiles.

Researchers also developed paper-plywood flooring and demonstrated how floors could be made from little-used species, suppressed growth trees, and even veneer.

FPL's main building became a test site for the various types of flooring, and many still adorn office floors today.

The flooring in FPL's main lobby was made with papreg laminated to plywood. Papreg is paper saturated with resin and then pressed with heat.

Experimental mixed species wood flooring.

Experimental mixed wood flooring in which wood strips are held in blocks by splines and glued directly to a concrete subfloor.

Veneer wood flooring.

Different configurations using various species and arrangements of wood.

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