Spring 2007 Volume 6, Issue 2

NEWSLINE Forest Products Laboratory

All Decked Out

Building and maintaining a deck that's strong, safe, and stunning

Ah, the backyard deck. Home of neighborhood barbecues, family gatherings, and relaxing afternoons with a good book. As spring approaches, many homeowners are getting ready to refinish their decks, while others are dreaming of adding this outdoor living space to their homes.

Whether you're still in the planning stages of building your deck or have been enjoying one for years, research results from the USDA Forest Service, Forest Products Laboratory (FPL), can help you build and maintain a strong, long-lasting structure. Here, FPL researchers give tips for choosing deck construction materials, properly installing a safe structure, and maintaining your deck in the years to come.

Research Demonstration House decking made using nine different preservative-treated woods, four wood–plastic composite materials, and three naturally decay-resistant species.

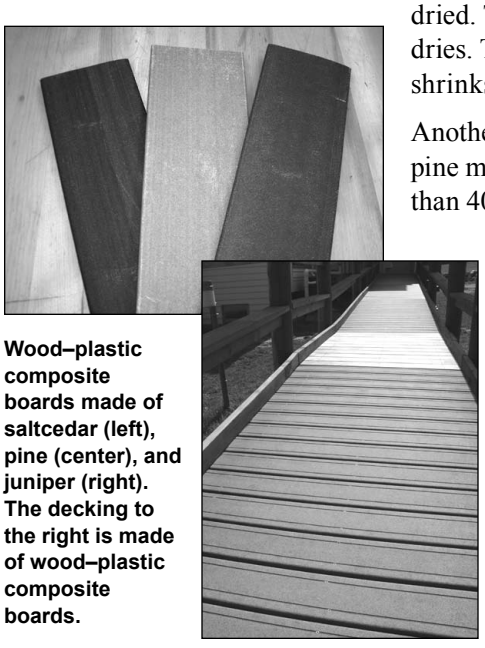
Not just your average lumber

For decades, deciding what material to build a deck of was fairly simple, as choices were mainly limited to pressure-treated lumber or naturally decay-resistant species such as cedar or redwood. But in today's market, choices abound, and it can be difficult to decide what material is best for your project.

FPL botanist Alex Wiedenhoeft and chemical engineer Dr. Nicole Stark are experts on two of the more common new alternatives in decking materials: tropical wood species and wood–plastic composites.

One increasingly popular tropical species used in decking is ipe. Known for its natural resistance to decay, ipe is a strong and naturally durable material. However, according to Wiedenhoeft, these properties alone do not make ipe a perfect choice.

"Our research shows that ipe heartwood really is as decay-resistant as everyone claims," says Wiedenhoeft. "Unfortunately, ipe is often brought into the country green, then processed and even installed without being properly dried. This gives rise to noticeable shrinkage after installation as the wood dries. Therefore, ipe is much more likely to fail as a deck because the material shrinks, causing cracks, splits, and cups, rather than failing from decay."



Wood–plastic composite boards made of saltcedar (left), pine (center), and juniper (right). The decking to the right is made of wood–plastic composite boards.

Another tropical species often considered is meranti, also known as Philippine mahogany. These come from the genus *Shorea*, which includes more than 400 species, not all of which are suitable for deck construction.

"*Shorea* is generally categorized into five groups of timbers: white merantis, yellow merantis, light red merantis, dark red merantis, and the balau group," says Wiedenhoeft. "For decking, only the dark red group and balau group should be considered. The other groups of *Shorea* probably do not have sufficient natural durability for decking applications."

Wiedenhoeft also comments that the balau group is higher density material and often experiences many of the same problems found with ipe, such as cracking.

For those looking to build a deck that doesn't require a lot of maintenance, lumber made from wood–plastic composites is a

(continued on pg. 6)

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

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Upcoming Events

Deconstruction, Building Materials Reuse, and C&D Recycling Conference

May 14-16, 2007—University of Wisconsin, Madison, Wisconsin. The Building Materials Reuse Association (BMRA), the USDA Forest Products Laboratory, and WasteCap Wisconsin welcome you to DECON '07, an international conference on deconstruction, building materials reuse, and construction and demolition debris (C&D) recycling. If you are in the demolition, deconstruction or architectural salvage business; a construction and demolition debris recycler; used building materials retailer; architect; green builder; or anyone else interested in materials reuse and recycling, this conference is for you! http://www.union.wisc.edu/bmra/index.html

Wood & Biofiber Plastic Composites

May 21-23, 2007—Monona Terrace Community and Convention Center, Madison, Wisconsin. The Forest Products Laboratory and the Forest Products Society will host the 9th International Conference on Wood & Biofiber Plastic Composites to exchange and disseminate information on the latest advances and opportunities for composite materials. http://www.forestprod.org/woodfiber07announcement.html

Cooperative Forest Products Technology Transfer

June 3-8, 2007—USDA Forest Products Laboratory, Madison, Wisconsin. The USDA Forest Products Laboratory and the State and Private Forestry Technology Marketing Unit will host a National Utilization and Marketing Conference titled "Cooperative Forest Products Technology Transfer." The program will include cooperative technology transfer, traditional and new innovative technology transfer approaches, networking approaches, and building technology transfer relationships. http://www.fpl.fs.fed.us/notices/events/2007jun3-8--nue&m-conference.html

Biotechnology in the Pulp and Paper Industry

June 10-14, 2007—Monona Terrace Community and Convention Center, Madison, Wisconsin. The USDA Forest Products Laboratory and the IOGEN Corporation will host the 10th International Congress on Biotechnology in the Pulp and Paper Industry. Meet and hear experts recognized internationally for their research excellence and industrial experience. http://www.bact.wisc.edu/icbppi_2007/

News

FPL Researcher Honored by International Association

Theodore Wegner

Theodore H. Wegner, Assistant Director for Wood, Fiber, and Composites Research at the U.S. Forest Service Forest Products Laboratory (FPL), has been named Fellow by the Technical Association of the Pulp and Paper Industry (TAPPI).

"Ted is a visionary and a real leader in the fields of pulp and paper research, nanotechnology, and biorefining," says FPL Director Chris Risbrudt. "His efforts to expand scientific knowledge, as well as partner with industry, universities, and other organizations, are recognized internationally."

Wegner currently leads the cellulosic ethanol and other forest biorefinery efforts at FPL and has been heavily involved in helping define the research needs for nanotechnology in the U.S. forest products industry. Under his leadership, FPL successfully collaborated with industry partners to make major recycling advances. Wegner also made significant contributions to the development of the Biopulping Research Consortium.

FPL Scientist Profile

Robert Falk

Editor's note: *Periodically in NewsLine, we feature an FPL researcher who has made significant contributions in his or her area of research. In this issue, we meet Dr. Robert Falk, a Research Engineer who has been at the Lab since 1987. Bob has worked in engineered wood products for most of his career and has produced more than 90 technical publications, magazine articles, manuals, and a book during that time. Many of these publications are considered cornerstone pieces in the field.*

Bob's current research focuses on the development of re-use options for wood materials salvaged from building dismantlement (or deconstruction). Simply put, deconstruction is building construction in reverse, involving the careful dismantling, salvage, and re-use of building components. Each year, over a billion board feet of structural lumber goes into landfills from the demolition of buildings. Much of it is high quality, old-growth wood that is for the most part unavailable from any other source. Bob's work is central to the tenets of green building and is not only helping conserve our nation's wood resource but helping divert high-quality lumber from going into landfills. The potential market for salvaged lumber is large and includes structural re-use in construction or remanufacturing as millwork, flooring, and trim.

In addition to developing a basic understanding of the engineering properties of these materials, Bob is active in helping develop the engineering property and engineering design standards necessary to facilitate their widespread use in construction applications. He participates in many technical committees, including the American Society for Testing and Materials (ASTM), the American Society of Civil Engineers (ASCE), American Institute of Timber Construction (AITC), and the International Council for Building Research Studies and Documentation (CIB). He is a registered professional engineer in California and Wisconsin and holds a BS degree in Civil Engineering from California Polytechnic State University, an MS degree in Civil Engineering from Michigan Technological University, and a Ph.D. in Structural Engineering from Washington State University.

–Gordie Blum, Communications Director

Bob, let's start with something easy. What is a Research Engineer, and how did you end up at FPL?

As an engineer involved in wood and wood construction research, I develop and carry out scientific studies to better understand the performance of the wood products used in construction of homes and other wood structures. This work has ranged from developing a better understanding of the earthquake resistance of wood house construction to testing and evaluation of green building products produced from waste wood.

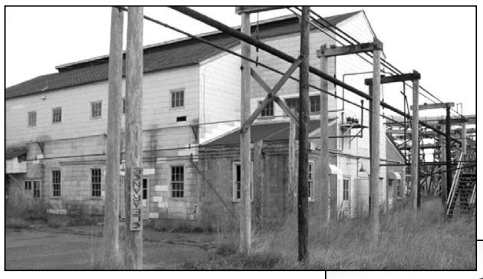
As a hobbyist woodworker and active house remodeler (I'm working on my third historic home remodel), I've always been interested in wood and wood construction. After graduate school (where I did my Masters and PhD theses on wood product performance) I was fortunate to land a position at FPL, a place considered to be the Mecca of wood research. I am lucky that I am able to meld my personal interest in woodworking and remodeling with a career in wood research.

Tell us about your current area of research. How did you get into deconstruction?

Through my research, I am trying to foster the re-use of wood materials so that less high-quality wood gets thrown away. Studies by the Environmental Protection Agency (EPA) estimate that the equivalent of about 250,000 buildings are disposed of each year in the United States, which equates to an estimated 1.2 billion board feet of salvageable structural lumber. This volume of lumber represents about 3% of our annual softwood timber harvest. The amount of recoverable materials is even greater if non-structural building products, such as the millions of wood windows, doors, and the thousands of miles of trim, siding, and flooring, are considered. I got into the deconstruction area because I realized what a horrible waste it is to throw away all that high-quality old-growth lumber and I wanted to try to do something about it.

You've done a lot of deconstruction work on military bases or posts. Where are some of the bases and what was the outcome of the projects? Why are military installations good sources of material?

I've worked extensively with the U.S. Army over the last several years trying to promote the use of



Buildings ready for deconstruction at the Badger Army Ammunition Plant in Wisconsin.

deconstruction and lumber salvage on the many military bases around the country, including the Twin Cities Army Ammunition Plant (TCAAP) in Minnesota; the Badger Army Ammunition Plant in Wisconsin, Fort Ord in California, and Fort Chaffee in Kentucky. Military bases are ideal for deconstruction because most of the buildings slated for disposal were constructed during World War II and are wood-framed; there are thousands of the same types of buildings making assembly line deconstruction practical; and there is often adequate time and room to easily accommodate deconstruction. Most importantly, we have shown that we can save the military money by using deconstruction and salvage rather than demolition and landfill. As an example, my work with the Army at the TCAAP resulted in the salvage of over 1 million board feet of timber from a large (600,000 ft^2) wood-framed industrial building and lowered the Army's cost of building removal from $250,000 to $50,000.

In your work at Fort Ord, you had to remove a lot of lead–based paint to make the lumber both safe and usable. How did you come up with the unique approach?

Some years ago, I was asked by the Army to look at some of the thousand or so wood barracks slated for disposal at Fort Ord. I thought that the structural lumber would be the treasure trove for salvage; however, on a whim I also inspected the solid-wood siding covering the walls of the buildings. Though coated with lead based paint (LBP), to my amazement every piece I pulled off was old-growth, clear Douglas-fir (no knots) with about 30 growth rings per inch. It was some of the highest quality wood I had ever seen. And, because in California building materials coated with LBP must be disposed of in a hazardous waste landfill, the Army was trucking the siding about 100 miles and paying $175 a cubic yard (about 4 times normal rate) to dispose of it. It seemed crazy to me that all that beautiful wood was going to waste because of a layer of paint.

I thought there was potential in remilling the siding to remove the LBP while producing a value-added product at the same time. Some searching told me that no one had ever performed such a study, so I was able to convince the Army to fund a project to remill a sample of siding. They agreed and we brought back to FPL the siding from two barracks (about 20,000 lineal feet or nearly 5 miles of material). This is an example where my woodworking background really helped my research program. Using conventional woodworking equipment and off-the-shelf dust collection, we produced high-quality and high-value flooring and paneling (worth about $4 per square foot). More importantly, by monitoring air quality, blood lead levels in the machine operators, and testing for residual lead in the produced product, we showed that it could be done safely. So, we were able to take a high cost disposal problem and turn it into an value-added opportunity.

I know you also did a successful project with the City of Philadelphia. Tell us about that.

This is another example where we looked at using deconstruction as an alternative to demolition. In the inner city of Philadelphia, there are thousands of row houses slated for demolition. Most were constructed around 1900 and contain a fair amount of larger lumber (3 by 12s, 3 by 6s) as well as period architectural elements. Currently, most demolition is done by hand as there is little room for heavy machinery in the small lots. Unbelievably, the contractors are throwing everything away, including the lumber, brick, oak trim, walnut newel posts, claw footed bathtubs, and Victorian tile. We showed that by making some small changes in the demolition process and saving materials rather than trashing them, viable small businesses could be developed in the inner city by utilizing this resource.

What makes your job at the FPL rewarding, and what have been some of your career highlights?

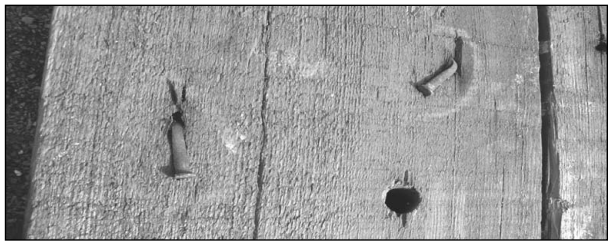
What is most rewarding about my work is with the knowledge as a wood researcher, I am able to help people get better performance out of the wood products used in the construction of their homes. Also, I believe my research on the reuse of lumber and timber is fostering the reuse of wood materials that would otherwise end up in the landfill. That helps conserve our wood resource and is good for the environment.

Back in the early 1990s, before I got into the deconstruction area, I had the chance to collaborate with wood researchers in Norway where I studied the manufacturing and load-carrying capability of glued-laminated (glulam) timber beams used in both heavy construction and home building. As a result of my research, the engineering design standards for the entire European Union (25 countries) were modified to incorporate my findings. It was satisfying to know that my work had an impact on so many countries and made the lives of so many people a little safer.

More recently, I have written articles for *Fine Homebuilding Magazine* and a full-length book for the same publisher. It's gratifying to know that the information I provide is read and used by hundreds of thousands of building professionals, Do-It-Yourselfers, and homeowners.

Some lumber may be clean while other pieces may be painted.

Covering the deconstructed lumber with tarps open at the ends allow for air drying while preventing further wetting from rain.



Remove all nails during the deconstruction process. Use of an inexpensive hand-held metal detector will find broken-off nail shanks that are difficult to see.

Speaking of your book, tell us more about it.

The book *Unbuilding: Salvaging the Architectural Treasures of Unwanted Houses* explains the green art of unbuilding (or deconstruction) and covers everything from assessing a building for salvage potential to deconstructing a whole house safely. With 248 pages and 300 photographs, it's a comprehensive guide to taking apart a building and rescuing its reusable parts and pieces. The information in the book can help a homeowner save money while incorporating into their new construction or remodeling project the high quality materials available from deconstruction and salvage; including ornate hardware, period lighting, and quality hardwood flooring.

And Finally, Any chance I'm going to get you to help me restore my 1860s-era barn that is starting to show its age?

I'd be happy to tell you how YOU can do it yourself.

For more information on deconstruction (or many other topics), check out Bob's website at http://www.fpl.fs.fed.us/rwu4714/robert-falk.html#deconstruction

Also check out the announcement at the back of this issue on an upcoming Deconstruction conference to be held in Madison, Wisconsin, this May.

good alternative to solid wood. With more than 30 brand name products available in North America, composite decking is catching on in today's market.

Generally composed of 50 to 60 percent wood fiber combined with plastic (mainly polyethylene), composite decking is appealing for several reasons. "People are attracted to this material because it is low-maintenance, won't splinter or crack, and is available in a wide variety of colors and surface patterns," says Stark. But she also mentions that composites are not without their drawbacks: they are more expensive, heavier, and less stiff than wood, and the color can fade.

According to Stark, upcoming trends for composite decking include the development of railing lines to match the decking, improved color stability, and production of a lighter deck board. For consumers desiring a more natural appearance, color streaking and embossing a grain pattern on the lumber will help composites look more like solid wood.

Stark has been researching decking for several years as a part of the Engineered Composites Sciences research work unit at FPL. If you decide to use this material, she offers a few important tips for successfully constructing and maintaining a composite deck:

- Carefully follow the installation instructions and maintain the recommended gap and spacing of boards, including the joist spacing.
- For a cleaner look, use a color-coated deck screw or hidden fastener system.
- Clean the deck as recommended. Periodic cleaning is necessary to keep mold and mildew at bay.

Both Stark and Wiedenhoeft agree that it's best to do a little leg work before deciding on a decking material; weigh the pros and cons carefully, and you're sure to find a product that will suit your needs.

Spiral-groove or ring-shank nails are best used for decking.

Proper installation is key for safety

While much attention is often paid to aesthetics when building a deck, a more important—and potentially life-saving—area of focus is the design and construction of the deck.

Properly connected joists and beams.

Why? Because as much as decks provide a locale for good summer fun, they can also be the site of potential disaster when not installed correctly. "Unfortunately, many people have lost their lives and many more have been injured in deck collapses due to incorrect installation or inadequate maintenance," says Dr. Robert Falk, research engineer at FPL.

Falk has been involved in the investigation of numerous deck collapses over the past decade and through his research has helped determine proper construction techniques.

For homeowners planning to build a deck, Falk offers the following recommendations for building a structure that will last:

- **Good connections are key**—Properly connecting joists to beams, beams to posts, and decks to houses is a critical component to deck construction. Use hot-dipped galvanized or stainless steel hardware for long-term performance.
- **Carefully plan the connection to the house**—This is the area where many catastrophic deck failures occur. Properly attaching the deck to the house requires that the deck is firmly fastened to the house framing. However, this opens the protective envelope of the siding, potentially allowing moisture penetration which can lead to decay and insect infestation. To deter water damage, caulk pilot holes in the house before installing fasteners, add spacers between the two structures to allow for drying, and extend metal flashing under the siding above the deck and over the siding below the deck. And proper fasteners are a must. "Nails are not enough here," says Falk. "Lag screws or through-bolts must be used for a secure connection."

- **Use high-quality fasteners**—Choose deck fasteners with good holding capacity and resistance to corrosion. Inadequate or improperly installed fasteners can cause connections to loosen and can weaken the surrounding wood if they corrode. Although they are costly, stainless steel fasteners have the longest lifespan; however, hot-dipped galvanized-steel fasteners are also a good choice. When using galvanized fasteners, be sure to choose those with the thickest protective coating (hot-dipped are usually the thickest) and avoid electroplated nails as they are not as durable.
- **Choose deformed-shank nails or screws for deck boards**—Deck screws are widely available and are a good choice for securing the deck board to the framing. If you choose to use nails, avoid smooth-shank nails as they will loose their withdrawal resistance after years of wetting and drying cycles, and can eventually pop up and loosen connections. Spiral-groove or ring-shank nails are a better choice.
- **Keep decay at bay**—You can increase the decay resistance of your deck if you treat any drilled holes with a wood preservative or water-repellent preservative. This will provide added protection from decay in areas where water can collect.

According to Falk, following the proper installation guidelines will give you the best chance of safely enjoying your deck. "Continued maintenance is still important to prolong the life of your deck, but if you begin with solid construction using the proper connections, you've gotten off to the best start possible."

Proper maintenance a must

For homeowners with an existing deck, it is important to remember that while quality materials and construction are a good starting point, regular maintenance of your deck is also vital to its continued performance.

Early spring is the perfect time to start thinking about refinishing your deck. "A cool, cloudy day is ideal," says Sam Williams, a supervisory research chemist at FPL. "That allows your deck to stay wet and the cleaner then has time to work."

Prep work is important

Williams says before refinishing your deck, you first must clean it. He suggests using a commercial cleaner having sodium percarbonate as the active ingredient. A 4:1 solution of water and household bleach with a little added powdered laundry detergent may also be used. (Williams says it is important to use powdered detergent. Liquid detergent, particularly those containing ammonia, can form noxious vapors when mixed with chlorine bleach).

Williams advises against using an overly aggressive cleaner, and to start with a gentle mixture. "Some

Wood–plastic composite boards on a test rack for natural weathering.

cleaners are so strong that they will pulp the surface of the deck," Williams said. "That is not what you want." Laundry bleach tends to cause excessive pulping of the wood surface, resulting in the removal of the wood surface. This is particularly true for cedar decks. Watch for signs of this damage as you wash; if there are a lot of loose fibers washing away as you clean and rinse the deck, you probably have excessive pulping.

Williams adds that it is important that you let the cleaner or bleach do the work, protecting the vital surface wood from damage. Aggressive scrubbing or using a power sprayer can do damage to the surface that later makes it hard for an absorbing finish to work properly.

Williams suggests using a kitchen broom or sponge mop to spread the solution out on the deck. Let the solution sit for about 15 minutes, keeping the deck wet.

For large decks, clean no more than 200 square feet at a time. If you try to clean a large area, it is too difficult to keep the deck wet during the treatment. Following the treatment, rinse with large amounts of water using a garden hose for at least 10 minutes.

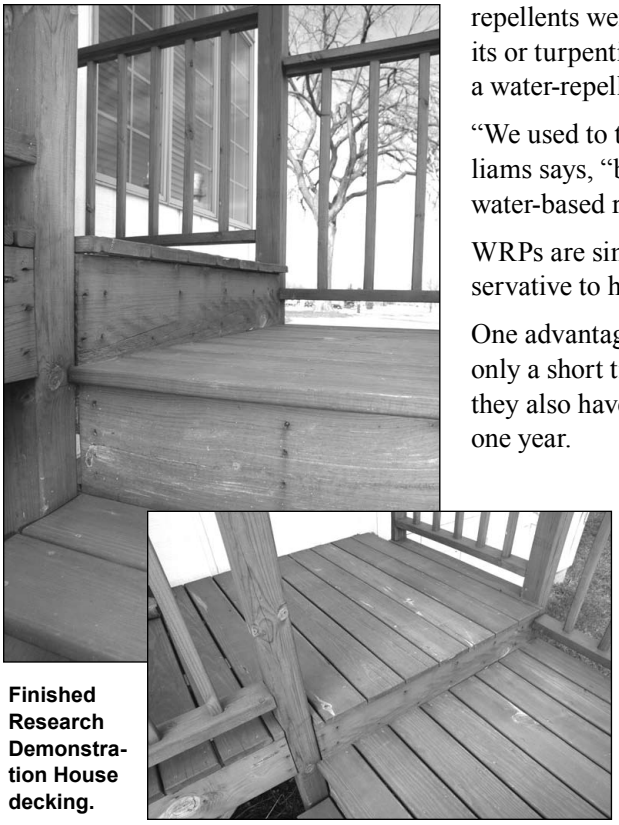
After cleaning your deck, you should let it dry for at least one day in the sun, but "two to three days are probably better, and you can easily wait two to three weeks before adding a finish," Williams says.

"I like to wait until April," Williams says. "The warmer the weather, the better the penetrating finishes work."

Choosing a finish

According to Williams, choosing a good penetrating finish is the most important part of maintaining your deck's performance and appearance. There are currently three choices of finishes on the market: Clear finishes such as water repellents and water-repellent preservatives (WRPs), tinted finishes and deck sealers, and semitransparent stains.

Modern water repellants are usually water-based and contain a water repellent and a sealer. Traditional water



Finished Research Demonstration House decking.

repellents were usually oil-based and had organic solvents (mineral spirits or turpentine) as the solvent for the sealer (linseed oil or varnish), and a water-repellant (paraffin wax).

"We used to think a repellent had to be oil-based to be effective," Williams says, "but we're actually getting good results with some of the new water-based repellents."

WRPs are similar to water repellents, but contain a mildewcide or preservative to help control mold, mildew, and algae.

One advantage to using unpigmented sealers is that they generally take only a short time to apply, maybe only an hour for a typical deck. But they also have the shortest life of the three, generally only lasting about one year.

Tinted water-repellant preservatives are lightly pigmented to give the finish more color, but not as much as semi-transparent stains. They color the wood slightly, but you can still see the grain. The added pigment increases the service life of the finish about two years, but they also take longer to apply. More care must be used to ensure an even coating.

Semi-transparent stains have a much higher concentration of pigments and provide the longest service life of all (about four to six years depending on a number of factors), but they also take the longest to apply. They are also susceptible to lap-marks, which occur when the application of fresh finish overlaps an area that has already been finished. To avoid lap-marks, apply the finish to the full length of just two to four boards at a time. Repeat this process, taking care to avoid applying finish to any boards that have already been completed. "If you're using a semi-transparent stain, you're probably looking at an all-day job," says Williams.

Williams adds there are many things to consider when choosing a finish. The service life of a WRP is only about a year for the exposed surfaces of most decks, but they are the easiest to reapply. They absorb easily into the wood, and because they are not pigmented, problems with uneven wear and brush marks are eliminated. Williams says if you're unsure whether to stain or use a WRP, apply a WRP to the deck first. You can always switch to a semi-transparent stain when the deck needs to be refinished.

"Personally, WRPs are the route I go," says Williams. "For me, it is easier to do my deck quickly every year or two, and I've gotten pretty good at it. My record is about 40 minutes to clean the deck and 20 minutes to apply the WRP a few days later. However, some people like the color of a stain, or prefer to do it once and then forget about it for a few years. There are a lot of options, but in general the more pigment, the longer the finish will last and the more difficult it is to refinish."

Ask FPL

We get thousands of inquiries each year. We print what we feel are some of the best questions. Here is one we recently received.

Can you explain how the many new wood treatment products on the market these days are tested for effectiveness?

By Rebecca Wallace, Public Affairs Specialist

Third point strength bending test on corrugated fiberboard.

Many tests are useful for evaluating wood protection treatments such as preservatives. Following are some of the most important tests conducted on these products.

Laboratory leaching test

- Small cubes of wood are immersed in water for two weeks. This test evaluates how rapidly the treatment is depleted by exposure to water. Good leach resistance is necessary for long-term wood protection.

Laboratory decay test

- Specimens are subjected to fungi known to aggressively attack wood in a test that helps determine the level of treatment needed to prevent decay.

Field stake evaluation test

- Treated wood stakes are placed into soil for at least three years in areas with a warm, wet climate. At least two different sites are recommended to account for differences in soil properties and types of organisms present. The most important of the tests, it challenges the treated wood with a wide range of natural organisms under severe conditions.

Aboveground field exposure test

- Specimens are exposed to the weather for at least two years in an area with a warm, wet climate. The wood specimens are designed to trap moisture and create ideal conditions for aboveground decay.

Corrosion test

- This test is used to determine the compatibility of wood treatment with metal fasteners.

Treatability test

- This test evaluates the penetration of treatment into wood and is important because degradation organisms can still attack the interior of wood if treatment is only on the surface.

Field stake testing is extremely important when evaluating new wood treatments.

Strength test

- This compares mechanical properties of treated wood with those of untreated specimens. This test is necessary because treatment chemicals or processes have the potential to dam age wood, making it weak or brittle.

This is only a partial list of the evaluations that wood-protection treatments must undergo. For more information on testing and standardization of treatments, visit our website at http://www.fpl.fs.fed.us/documnts/techline/learn-more-about-new-wood-protection-treatment.pdf

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WOOD YOU BELIEVE...

"The net cooling effect of a young, healthy tree is equivalent to ten room-size air conditioners operating 20 hours a day."

"Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20–50 percent in energy used for heating."

"The planting of trees means improved water quality, resulting in less runoff and erosion. This allows more recharging of the ground water supply. Wooded areas help prevent the transport of sediment and chemicals into streams."

—U.S. Department of Agriculture