Wood Preservatives

Specifying Alternatives to Conventional Treatments

Dr. Paul Morris of FPInnovations,
Canada's National Forest Products Research Institute

Dr. David Moses, PEng, PE, LEED AP, Principal,
Moses Structural Engineers Inc.

Dr. Stan Lebow, USDA Forest Service,
Forest Products Laboratory

*In the first part of this article (*Wood Design & Building, *Spring 2009), the basics of preservative treatments were reviewed. This follow-up article discusses options and strategies that designers and specifiers can use to choose the alternatives best suited for durable wood applications.*

The wood durability business is full of terminology that many of us have heard, but that oftentimes leaves us unsure of their exact meanings. For example, properties such as UV-protection, water-repellence, termite-resistance, and fungi-stain resistance seem self-explanatory; however, quantifying these properties in real terms is a challenge. We hear of claims regarding the benefits of many alternatives such as naturally durable species, wood plastic composites, thermally-modified wood and chemically-modified wood, but are never quite sure which one to choose or even what questions to ask a supplier. With more concern over the lifecycle cost of wood products, including dollar value and environmental impact, and re-use and recycling alternatives, designers and specifiers need to be prepared to do research for the best available wood durability alternatives on a project-by-project basis. While there is no definitive answer, with a few basic tools, we can equip ourselves to make educated assessments.

Assess the risk

Determine the exposure category (see Table 1 from Part 1 on page 39) such as seawater, fresh water, ground contact, above-ground or dry. Determine the decay and termite hazard for your region (see www.durable-wood.com for continent-wide maps). Key questions: How long do I want this material to last? How critical are the components? How much am I willing to pay? How much maintenance am I willing to do? What is the cost of the maintenance? The cost items can be determined as net present values for the purposes of lifecycle cost analysis.

Naturally durable species

Start by considering wood species that are inherently decay resistant. These durable woods may cost more, however, some species such as cedar and redwood are typically resistant to decay and termites. Differences exist within species groups. For example, yellow cedar is more resistant to termites than red cedar. The naturally durable species native to North America tend to be less durable than pressure-treated wood when used in contact with the ground. The extent of durability in untreated wood is also more variable than that of treated wood, with durability varying between lumber cut from different trees or even lumber cut from the same tree. As a result, these species are most commonly used out of ground contact, or for members where long-term durability is less critical. While these species are much less prone to warp and surface checking, they are susceptible to UV damage and black-stain fungi. As a result, they require periodic application of finishes. Clear finishes may need to be applied annually, while high-quality pigmented stains may provide protection for two or more years. Key questions: What is the expected design life of this species in this application? What is the material cost? What is the stain and maintenance cost?

There are currently no national standards regarding the durability of naturally durable species. Expected service life is normally based on local experience. However, testing is now underway to assess the performance of these woods in ground, above ground, in continental, temperate, subtropical and tropical sites in Canada and the United States. Some woods grown in second growth forests have appeared to be less durable than those from old growth forests. However, this only appeared to be of concern in some fast-grown plantation woods but not in longer-rotation managed forests. More data is being collected to confirm this.

Some imported naturally durable species come from endangered tropical forests. Others come from plantations. While the book value and reputation for durability of a species may be excellent, these have always been based on old-growth wood. Tests on plantation-grown woods typically show much reduced durability. China cedar (China fir) and teak are good examples of this phenomenon. There is often little scientific data – and especially field testing – to document the durability of imported species. Durability classifications in widely cited publications such as the tables in the *USDA, Forest Service's Wood Handbook* may be based on one or two laboratory tests and/or anecdotal evidence. Although some imported species have been used for many years and have shown good in-service durability, others have little performance history. Another issue with tropical woods is that common names often cover a large number of related tree species some of which are durable and others are not. Unlike preservative-treated wood, there are no rapid chemical tests to determine whether imported naturally durable woods have sufficient natural preservatives present in them. Key questions to ask when purchasing a tropical hardwood are: Is this wood sustainably harvested or is it from a plantation? Do you have documentation to show that this wood is the durable species it is purported to be? How far will it travel to get to the destination? What is its expected design life? What data was used to establish its durability?

Treated wood

Treated wood, while not an alternative, is included here for comparison. The environmental perception of treated wood has improved tremendously with the introduction of preservatives based on copper- and carbon-based compounds that are closely related to the components of household sanitizers and personal care products. The performance of new preservatives is compared to older systems like CCA, which has proven to last more than 60 years in the ground, even in the hottest and wettest parts of North America.

Preservative-treated wood treated to national standards is highly resistant to decay, termites and ultraviolet light (UV). Copper oxide is as good at blocking UV as zinc oxide, but the treated wood may be susceptible to splitting and checking caused by cyclical wetting and drying. Annual application of water repellent will minimize the problem. Some of the newer high-quality deck stains need only to be applied every two to four years (but check with the manufacturer). Recent research at FPInnovations has shown that ribbed surface profiling can virtually eliminate noticeable checking. Hidden fasteners can eliminate the problem of end-splitting. Wood treated with copper-containing preservatives will mellow from green to honey brown and can be maintained at that color by the application of a high-quality deck stain immediately after installation when the best bond between the wood and the resin in the stain can be achieved. Do not wait for the wood to weather. Without staining, the wood will eventually fade to grey over a period of several years. Wood treated with the new carbon-based preservatives should have an added pigment for UV protection or be coated with a high-quality wood stain with a high solids content.

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Preservative-treated wood can be treated to national standards published by the American Wood Protection Association (AWPA) and the Canadian Standards Association (CSA). These organizations have committees with representatives from the preservative manufacturers, treaters, users of treated wood and scientists from academia and national research institutes. Treatments listed in these standards have been rigorously tested and examined in detail by competing manufacturers and scientists. National building codes reference the AWPA and CSA standards. As an alternative approach to code approval, some preservatives have been evaluated by the International Codes Commission Evaluation Service (ICC-ES), a review process that is much simpler and shorter and involves fewer experts. All preservatives, even those that fall outside these formalized processes, must be registered with the U.S. Environmental Protection Agency (EPA) or Canada's Pest Management Regulatory Agency (PMRA). PMRA requires efficacy data, while EPA does not. Every year new treatments become available which claim to be non-toxic and are only available through a few suppliers. Some of these are the re-working of ideas that were explored and abandoned years ago. Others appear to defy the laws of physics, chemistry and biology. Occasionally there may be a true breakthrough. Key questions: Have field exposure tests been conducted to document durability and are original independent reports available for review? Has this wood been treated to AWPA or CSA standards? (Look for proof in the form of end tags with a third party quality assurance mark.) What are the terms of the limited lifetime warranty from the preservative manufacturer? (Read the fine print carefully.)

Wood plastic composites (WPC)

Some wood plastic composites (WPC) have a high recycled material content but increasing amounts of virgin plastic are being used in an attempt to improve performance. Warranties vary but the service life projections have not necessarily been backed up by testing. There have been a number of class action lawsuits associated with these products and it is now acknowledged that they are not maintenance free. Indeed, the coatings industry has developed stains specifically for WPC. It has also been recognized that they are not naturally decay resistant and almost all incorporate wood preservatives. A number of manufacturers have switched over to pure plastic products, commonly using virgin plastic. Key questions: What long term or accelerated testing has been done on this product, particularly the latest version? What is the recycled material content?

WPC that contain a preservative and pure plastic products are resistant to decay and termites. They are susceptible to UV damage and will fade to grey. Pure plastics are immune to moisture, but some WPC will slowly gain moisture and expand. They are not all immune to cracking. Typically these materials are non-structural and require a preservative-treated wood substructure with closely spaced joists.

Thermally-modified wood

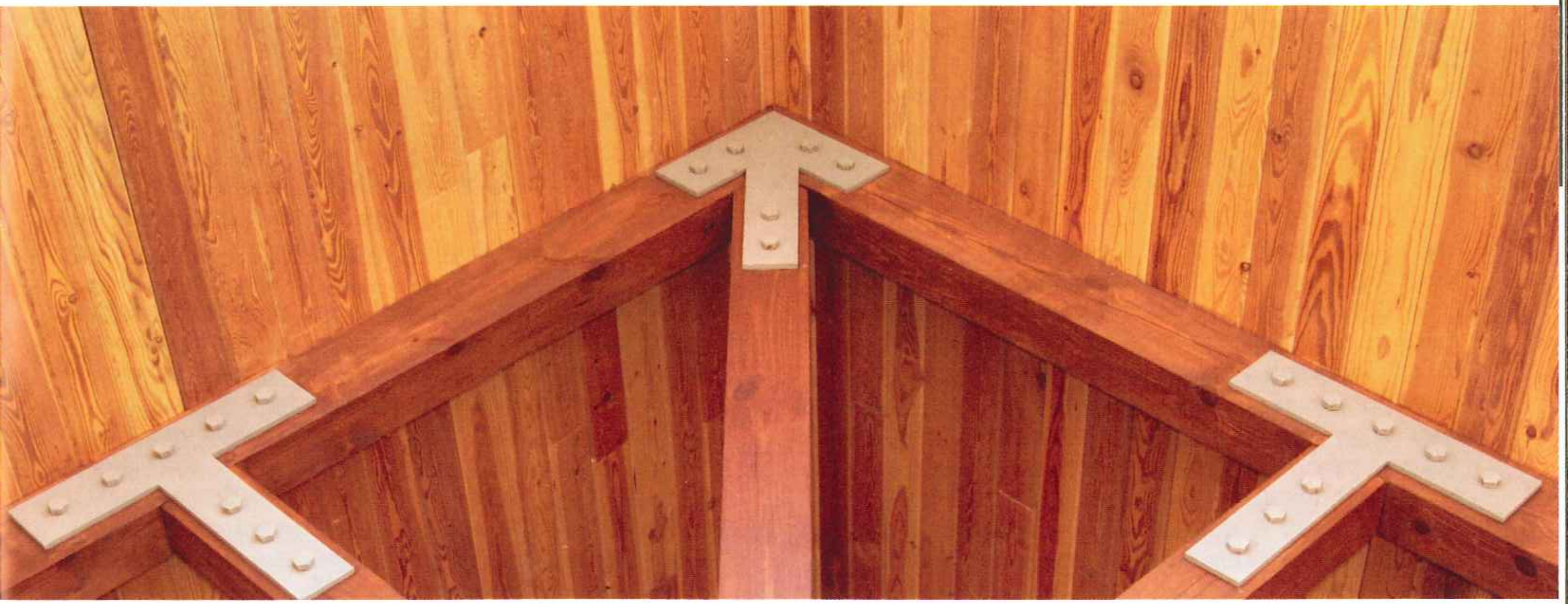
The thermal processes now being commercialized are mostly based on technologies originally developed in the 1960s. The product is sometimes confused with wood that has been heat treated for import/export sterilization requirements. Thermally modified wood is heated for a longer time, and to much higher temperatures (typically 320-500 F). Several thermal treatment processes are in commercial use in Europe, and to a lesser extent in North America. The processes may utilize steam, nitrogen or vacuum to mini-

Table 1 Preservatives classified by durability

Type of exposure	Preservative
Seawater	Creosote, chromated copper arsenate (CCA), Ammoniacal copper zinc arsenate (ACZA)
Fresh water or terrestrial piles	All above plus pentachlorophenol, oilborne copper naphthenate alkaline copper quat (ACQ) and copper azole (CA-B)
Critical ground contact	All above plus ESR-1721, ESR-1980 and ESR-2325
Ground contact	All above plus acid copper chromate (ACC), waterborne copper naphthenate, ESR-2325, ESR-2500 and ESR-2500-B
Above-ground, fresh water	All above plus copper xyligen (CX-A), 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one and imidacloprid (EL2), propiconazole-tebuconazole-imicloprid (PTI) and ESR-2067
Dry or occasionally damp	All above plus SBX (borates)

Note: Availability of preservatives varies with location. Also check with local authorities for allowable uses in some jurisdictions. For preservatives for use in Canada, the applicable building code and CSA standards should be consulted.

mize degradation and lower the availability of oxygen. One process heats the wood in oil. Thermal modification destroys some of the wood components that fungi require to start the decay process. Thermal modification converts these to compounds that reduce the natural (equilibrium) moisture content of the wood and provide some fungal resistance. The available scientific literature suggests thermally treated wood is not termite resistant. Some of these processes cause knots that are not tightly bound into the wood to shrink and drop out. Decay resistance increases at higher processing temperatures, but losses in mechanical properties, especially impact bending strength, also increase. An advantage of heat treatment is that it can be used with wood species that are difficult to penetrate with preservatives. The high degree of processing required to give adequate durability for exterior applications turns the wood to a beautiful dark brown color throughout the cross section. However, it is quite possible to turn wood brown without conferring any durability, and there are currently no on-site tests to verify the degree of thermal modification. Key questions: What quality control procedure has been used to ensure this wood is durable? What standard long term or accelerated testing has been done on this product? Will the boards supplied for my project be completely free of knots like this demonstration piece?



With thermal modification, the high degree of processing required to give adequate durability for exterior applications turns the wood to a beautiful dark brown color throughout the cross section.

Most manufacturers are recommending thermally modified wood only for above-ground uses where its resistance to humidity and decay fungi are sufficient. Thermally modified wood is susceptible to UV damage and black staining fungi so it too should be maintained with a high-performance wood stain. Thermal modification is energy intensive, but wood waste can be used as part of the energy source in the process.

Chemically-modified wood

Due to its relatively recent arrival on the scene, not much can be said about chemically modified wood. However, the chemical modification processes now being commercialized are mostly based on technologies originally developed in the 1960s and 70s. Chemically-modified wood tends to be expensive compared to preservative-treated wood. Preservative treatment adds 1.5 per cent by weight of preservatives that cost a few dollars per pound while chemical modification adds 15 per cent by weight of chemicals that cost tens of dollars per pound. Energy and handling costs are similar. The challenge is determining the potential service life and the maintenance requirements for these products.

Acetylation, furfurylation and DMDHEU (you don't want to know the chemical name) cross linking are the most prominent chemical processes. Acetylated and furylated wood are commercially available under various trade names. These chemicals react with the wood structure and cross-link to form polymers within the wood structure. They have been postulated to protect the wood by both excluding moisture and by occupying reactive sites that fungi utilize in degrading wood. Key to success of the acetylation process is removal of unreacted acetic acid. If the wood smells of vinegar, there is still acid present, which can cause loss of strength over the long term.

Chemically modified wood is decay, and in some cases, termite resistant. It is also resistant to moisture cycling but not necessarily resistant to UV damage. Key questions: What long-term or accelerated testing has been done on this product, particularly the latest version? What quality control procedure has been used to ensure this wood is durable? What is the price?

Conclusion

There are many alternative treatments available in the marketplace but it is up to designers and specifiers to do their homework and research the pros and cons of each alternative.

There is a lot of research going on in wood preservatives right now. We should start to see some innovations in the industry and standards within the next few years in areas such as recycling of treated wood and lifecycle assessment, but this is still a few years away. In the meantime, ask the right questions and develop a plan for your specific application.

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