SERVICE LIFE

Treatments for Improving the Durability of Engineered Wood Products

by Benjamin Floyd and Alan S. Ross

Editor's Note: *The following article is based on a presentation delivered at a Forest Products Society conference on enhancing the durability of wood products held last February in Orlando, FL*.

Engineered wood is a widely used building material. In some applications, however, its use is limited by concerns over its long-term durability in environments where agents of deterioration such as mold, decay, insects (primarily termites) and moisture may be present. As a result, a number of treatments have been developed recently to protect engineered wood products in service. Some of the basic protection needs for various applications and the factors driving those needs are outlined in this article. Treatment methods, treating materials and test methods for evaluating those treatments also are outlined.

The term Engineered Wood (or e-wood) is used here to signify cellulose-based composites that are used primarily as building materials. Examples include oriented strand board (OSB), plywood, laminated veneer lumber (LVL), and medium density fiberboard (MDF). A listing of engineered wood categories along with their common abbreviations is given in **Table 1**.

Applications: The Use Category System

It is useful to examine the various applications of engineered wood in the context of expected service conditions and the potential agents of deterioration that may be present in those situations. A good way to approach this is through the American Wood Preservers' Association (AWPA) Use Category System (UCS). Introduced in 1999, the UCS defines a series of different exposures for engineered wood products. Each exposure has a different degree of biodegradation hazard and/or product service life expectation. In general, as the use category number rises, there is a consequent increase in potential hazard, which also increases the level of protection required for continued service.

As can be seen in **Table 2**, UC1 has the lowest hazard level of dry, interior, aboveground service conditions. The only concern here would be from insect attack. Typical applications are interior construction and furnishings.

The environment for UC2 involves damp, interior, aboveground conditions. In addition to insects, mold and decay fungi are potential agents of deterioration. Applications to UC2 include flooring, sheathing and wallboard.

The next category, UC3A, involves exterior, aboveground environments where the materials are protected by a cladding or coating. Decay fungi and insects are the main potential hazards. The most common e-wood applications in this category are in coated millwork components and coated exterior siding.

Category UC3B encompasses exterior, aboveground environments as well. Here, however, the materials are exposed to the elements. Again, decay fungi and insects are the main potential agents of deterioration. Applications in this category include uncoated millwork or siding, roof decking and backyard deck components.

Categories above UC3B involve ground contact applications where engineered wood products (with the exception of treated plywood) are seldom used at this time.

Thus, in order to enhance the durability and extend the service life of e-wood products, protection needs must be met for the potential hazards of decay and mold fungi, insect attack and water damage. The level and type of protection will depend upon the service conditions and expected service life as outlined by the AWPA Use Category System.

Drivers

While it is desirable to enhance the durability of engineered wood, the addition of protective treatments to e-wood products inevitably increases their cost. Offsetting these product cost considerations are a number of factors that are driving the need for more protection.

Concerns over indoor air quality have been around for a number of years. Those concerns in the past have revolved primarily around asbestos, radon and formaldehyde emissions. More recently, widespread media coverage has given rise to homeowner concerns over potential toxins emitted from mold. While it remains to be scientifically determined whether these concerns are based on true hazards or are manifestations of homeowner hysteria, it is clear that plaintiffs' attorneys, insurers, various levels of government, and product manufacturers are taking them seriously.

Degradation of e-wood due to fungal attack is not limited to areas inside the home or between the walls. Some producers of composite siding have faced decay issues in areas of the country well suited to fungal growth. Additionally, some types of backyard decking made from plastic-wood composites have exhibited problems due to fungal attack.

Widespread infestations of the Formosan termite in southern Louisiana have caused damage estimated in the hundreds of millions of dollars. Formosan termites pose a major threat to cellulosic building materials because they consume wood much faster than native subterranean termites, and they grow colonies that can be ten times larger than those of native termites. Due to the spread of Formosan termites in infested recycled railroad ties, there is a serious concern that this voracious pest will soon threaten other parts of the South and Gulf Coast. Engineered wood products such as OSB are vulnerable to termite attack if unprotected. However, OSB and other e-wood products can be successfully treated with insecticides, as has been standard practice in Hawaii for a number of years.

Many engineered wood products are susceptible to damage from exposure to excessive amounts of moisture. This can cause swelling, delamination and loss of strength. Moisture sources include rain and snow during storage and the construction process, humidity and condensation inside wall cavities, plumbing leaks, flooding and rainwater intrusion due to faulty construction or design. Excessive or repeated moisture contact can be especially devastating since it can also lead to mold growth and decay and can be an attractant to insects.

In response to these drivers, e-wood manufacturers have begun to treat their products to help protect against mold growth, decay fungi, termites and water damage. Globally, products are being treated in Japan, Australia, New Zealand and in North, Central and South America. In North America, hardboard, MDF, OSB and laminated strand lumber (LSL) are some of the products currently being treated.

Treatment Methods

Engineered wood products can be protected by several methods. These include surface, glue line, pressure, vapor and integral treatments.

Surface treatments, either dip or spray, afford short-term protection. They are mainly water repellents and fungicides for mold control. These treatments are generally utilized to protect e-wood products during storage and the construction process. They have the advantage of being relatively cost-effective.

Glue line treatments are mainly used for insect protection. They are applicable in products made from glued veneers such as plywood and LVL. Active ingredients are incorporated in the glue or resin system. In order to be effective, they must be able to migrate into the veneers during processing. It is also important that they be compatible with the resins and not interfere with the curing process.

Pressure treatment of plywood has been in commercial use for many years. This can involve fungicides, insecticides, water repellents and fire retardants. Plywood is one of the few e-wood materials that can be successfully pressure treated with waterbased carriers. Other types of e-wood such as OSB, MDF and LVL can only be pressure treated with solvent carriers such as mineral spirits. This type of treatment has been protecting e-wood building materials in Hawaii from decay and termites for more than 20 years.

Vapor boron treatment (VBT) was developed by researchers at Imperial College in London and the Forest Research Institute in New Zealand. It utilizes trimethyl boron to deliver boron in the vapor phase into solid wood and wood composites. Ultimately, boric acid is deposited within the substrate. Depending upon the retention level, boric acid is effective against decay, mold, and termites, and at high enough levels has fire-retardant properties. Full commercialization of VBT has been elusive, but there is a potential for several niche markets for this treatment.

The term “integral treatments” refers to combining the active ingredients with the wood furnish (i.e., chips, flakes, strands, etc.) before processing. Active ingredients can include fungicides, insecticides and water repellents, either singly or in combination. They are often applied to the furnish in tumblers. Water, waxes, or resins are used as the carriers for liquid systems. Powders also can be used. Ingredients must be capable of withstanding the processing temperatures associated with e-wood production and must be compatible with the resins used. Since they are distributed throughout the thickness of the component, integral treatments offer long-term protection against decay, mold, insect attack, and water intrusion. They are used commercially in a variety of wood composite products, including LSL, OSB, hardboard and MDF.

Treatments For Engineered Wood

Active ingredients for the treatment of e-wood can be comprised of inorganic or organic materials. The most common inorganic systems are zinc borate and calcium borate. Zinc borate systems are covered by several U.S. patents. Calcium borate also provides efficacy against decay and insects and also is patented for this use. It is not an EPA-registered preservative at this time, however. As noted above, organic treatments must be capable of withstanding processing temperatures if they are utilized in integral treatment processes. Organic materials which have been evaluated for use as e-wood fungicides include iodocarbamates, triazoles and isothiazalones. A variety of organic insecticides also have been evaluated for protection against termites. Water repellents are often comprised of waxes, polymers and other resins. These are utilized as both surface and integral treatments.

Protection Measurements: Safety Factors

As is the case for solid wood products, it is important to be able to measure the level of protection afforded by the various e-wood treatments. Typically, protection measurements involve laboratory tests, accelerated field tests and, ideally, in-service performance history. In many situations, however, in-service performance history is not available, so manufacturers are obliged to rely on laboratory and accelerated field tests to predict actual performance in the field. To mitigate the risk of failure in the field, safety factors are often utilized to determine the appropriate level of preservative or insecticide needed to protect e-wood products. A “safety factor" is defined as some multiple of the threshold level of a preservative or insecticide as defined in a laboratory or accelerated field test. The threshold level is the lowest concentration of active ingredient or combination of ingredients that totally controls the fungi or insects in the test. This level is then multiplied by the appropriate safety factor to determine the concentration utilized in service. As the Use Category level increases, the safety factor will generally increase accordingly (see **Table 3**).

The concept of safety factors for defining active ingredient concentrations in service is widely used in the wood preservative industry. For example, the Window and Door Manufacturers Association (WDMA) Standard I.S.-4 covering the treatment of wood window components utilizes a multiplier of 5.4 times the threshold level as determined in the soil block test to specify the concentration of active fungicide to be used. For ground contact exposures of critical components such as utility poles, safety factors can be greater than 20 times the threshold kill levels as determined in laboratory decay testing.

Thus, in predicting the long-term durability of e-wood treatments where in-service performance history is not available, safety factors are frequently built into the active ingredient concentrations as a means to mitigate potential field failures over time. The typical procedure in enhancing durability in these situations is to run laboratory and accelerated field tests, extrapolate the results for longer-term performance, and build in safety factors to help insure performance over time in service.

Conclusions

Like solid wood products, engineered wood products often require protection against mold, decay, termites and water damage. The type and level of protection required can be defined by the use category of the product in question. The AWPA Use Category System takes into account the expected service conditions, length of service, and potential agents of deterioration for each e-wood application.

A variety of treatments and treatment methods are available to protect engineered wood products. The choice of treatment chemical, level of treatment, and treating method will depend upon the type of component and its intended application. Due to limited long-term performance history for many treated engineered wood products, safety factors should be employed in determining the appropriate level of preservative, insecticide, or water repellent utilized.

The use of chemical treatments is a cost-effective way to enhance the performance and extend the service life of engineered wood products in a variety of applications.

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Table 1

ENGINEERED WOOD CATEGORIES			
MDF -	Medium Density Fiberboard	LVL -	Laminated Veneer Lumber
OSB -	Oriented Strand Board	PSL -	Parallel Strand Lumber
LSL -	Laminated Strand Lumber	PB -	Particleboard
WB -	Waferboard	HB -	Hardboard
SB -	Strawboard	CB -	Chipboard
PW -	Plastic Wood	PD -	Plywood

Table 2

ENGINEERED WOOD TYPICAL APPLICATIONS			
AWPA Use Category	Service Conditions	Agents of Deterioration	Typical Applications
UC1	Interior Construction, Dry, Aboveground	Insects Only	Interior Construction and Furnishings
UC2	Interior Construction, Damp, Aboveground	Mold, Decay, Insects	Flooring, Subflooring, Sheathing, Wallboard, Joists
UC3A	Exterior Construction, Coated, Aboveground	Decay, Insects	Coated/Clad Millwork, Coated Siding
UC3B	Exterior Construction, Exposed, Aboveground	Decay, Insects	Uncoated Millwork, Roof Decking, Uncoated Siding, Decking, Deck Joists

Table 3

SAFETY FACTORS			
AWPA Use Category	Service Conditions	Agents of Deterioration	Typical Safety Factor*
UC1	Interior Construction, Dry, Aboveground	Insects Only	1X – 2X
UC2	Interior Construction, Damp, Aboveground	Mold, Decay, Insects	2X – 3X
UC3A	Exterior Construction, Coated, Aboveground	Decay, Insects	3X – 6X (Millwork 5.4X)
UC3B	Exterior Construction, Exposed, Aboveground	Decay, Insects	5X – 10X
UC4	Ground Contact, Exposed	Decay, Insects	> 20X
* "X" – Laboratory Threshold Level			