Causes and Control of Wood Decay, Degradation & Stain

LSU AgCenter
Research & Extension

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Causes and Control of

Wood Decay, Degradation & Stain

Our society depends on wood for a variety of uses. As population increases, so does our need for wood. Steel, concrete and aluminum are some alternatives to treated wood in certain applications, but they have higher material costs, higher energy requirements in the production process, greater air and water pollution or environmental protection costs, and greater dependency on foreign sources for materials.

Substitute materials may not be appropriate for some uses. For example, some types of steel may corrode; concrete may deteriorate in salt water; and plastic may not have the necessary strength, durability and structural integrity. Wood is a renewable natural resource that, if properly treated, maintained and placed in service, will last indefinitely. It is critical for us to use our wood resource efficiently.

This publication is intended to increase your knowledge of the causes and control of wood decay, degradation and stain. A common cause for replacing wood structures is decay or degradation. Wood decay and most insect problems can be prevented for years by properly using and protecting wood. The heartwood of some species, such as black locust and Osage orange, also has a unique chemical composition that makes it very durable.

Two common terms used to describe wood features are heartwood and sapwood. Heartwood is wood in the inner section of a log and is entirely composed of dead cells. This region has a higher concentration of extractives (phenolic-based compounds that make heartwood more decay resistant than sapwood). Sapwood is wood near the bark and is often lighter in color than heartwood. Nutrient translocation occurs only in sapwood. Although most wood species can be treated with a preservative, certain species are considered difficult to treat because of their permeability and anatomical features. Douglas fir, a western species, has below-average permeability and is classified as difficult to treat. Species such as white oak have inclusions in the vessels called tyloses. These inclusions also decrease permeability and make treating more difficult. In general, lumber that has a high percentage of heartwood or is improperly seasoned will be more difficult to pressure treat. Southern yellow pine (SYP) characteristics make it useful for many applications and easily treatable. Most pressure-treated lumber in the South is Southern yellow pine.

Moisture

It is commonly believed that wood shrinks as it loses moisture and swells as it gains moisture. This is partially true. Actually, wood will change dimension only between two precise moisture conditions. One condition is when the wood is void of moisture. This is termed the ovendry condition. The second condition is when the wood fibers are saturated with moisture. This point usually occurs at about 30 percent moisture content for most Louisiana species. As wood is dried from an original green condition, sometimes more than 100 percent moisture content, moisture is first lost from the cell cavities. No shrinkage will occur until the wood reduces to a moisture content of about 30 percent (fiber saturation point). If drying continues below 30 percent moisture content, water is removed from the cell walls and shrinkage occurs. The amount of shrinkage or swelling depends on the species, density and board direction.

Pressure treatment with waterborne preservatives raises the moisture content above the fiber saturation point, and shrinkage will occur as the wood dries down to its in-service moisture content. In many applications, such as deck boards, this shrinkage is not a major concern. When dimensional stability is critical, it is imperative that the lumber be kiln dried after treatment (KDAT). Any KDAT lumber you buy should be kept under a roof or at least under cover and off the ground.

The dimensional stability of different wood species is affected by width and density differences between earlywood and latewood in the growth rings. For example, in species having wide, dense latewood bands and low-density earlywood bands, the differential shrinking and swelling of the bands with changes in moisture content can cause large stresses in the wood that can result in raised grain and a defect known as shelling. Raised grain will tend to be more pronounced on flat grained lumber. Shelling is an extreme case of raised grain in which the latewood bands separate from the earlywood bands to form a knife-like or spearlike edge. This is one reason why deck lumber is often recommended to be placed pith-side down (or bark-side up). If the two sides of a particular board are of equal quality, it's better to place the board bark-side up. If, however, the pith side is clearly the better side, place this side up.

Figure 1. Severe weathering occurred on the surface of these treated southern yellow pine boards used to construct a boat dock. Most docks are continually exposed to wet and dry conditions and direct sunlight. It is recommended to brush apply each year a water repellent that also protects from ultraviolet (UV) degradation of the wood surface.

Moisture greatly affects lumber in use and can quickly lead to deterioration. Moisture can also allow wood to be attacked by insects, hinder the performance of finishes and paints, and induce surface stains.

Wood Degradation: Causes and Control

Wood degradation is not the same as wood decay. The three primary sources of wood degradation are fungi (decay or rot), insects and weathering. In addition, fire can also degrade wood. The organisms that decay wood have four basic requirements: moisture (generally 25 to 100 percent of dry-wood weight), oxygen, temperature (generally between 50 degrees and 95 degrees Fahrenheit) and food (the wood itself). We can control wood degradation by altering one or more of these requirements. A sawmill will often keep its logs moist under a sprinkler system to saturate the logs with water and create an anaerobic environment in which there is insufficient oxygen for most wood decay organisms and insects. Wood can undergo slow bacterial degradation in fresh water or be attacked by marine borers in brackish or salt water, however.

It is impractical for consumers to keep lumber under a sprinkler system or buried in mud! Most wood decay can be prevented by simply keeping the wood dry. If lumber is dried to 6-8 percent moisture content for indoor uses or 15-18 percent for outdoor uses, it should not decay if the moisture content is maintained below 20 percent. A common cause of wood decay is when untreated wood is alternately exposed to wet and dry conditions, as in ground contact, or when it collects moisture and remains moist for an extended period. To prevent this situation, either keep your untreated lumber dry or use treated wood if you suspect it will get wet in service. Be sure to use pressure-treated lumber approved for ground contact if you are building a structure that requires one end of some boards to be in contact with soil and moisture.

Weathering

The surface of wood can be degraded if the wood repeatedly becomes wet and dry, is exposed to high and low temperatures and is exposed to direct sunlight. This degradation causes roughening of the surface, checking, splitting and wood cell erosion. Erosion, caused by the loss of wood cells from the lumber surface, is a slow process (Figure 1).

A water-repellent preservative is recommended to minimize weathering, shrinking and swelling. Consumers can purchase a water repellant or a water-repellent preservative. The difference is that a water-repellent preservative contains a mildewcide, which provides mildew protection, and the water repellant by itself does not. Both finishes contain a water repellant, such as wax, paraffin or other repellant, and a binder but may not contain color pigments. The amount of water repellency varies among brands. Some water-repellent preservatives have a low concentration of water repellant (about one percent by volume) so they can be used as a primer for other finishes. Others with a higher concentration of water repellant (about three percent by volume) are meant to be used as stand-alone repellent finishes (Figure 2).

Naturally Decay-resistant Species

A few native species in Louisiana offer natural decay resistance. Old-growth bald cypress and SYP harvested at the turn of the century have not been degraded in most antebellum homes in the South. This is partly because of chemical and density differences between the old-growth timber and today's young forests. Also, many of these houses were built off of the ground to keep the wood dry, and the boards had a slight space between them for air circulation. Other Louisiana species, such as sassafras, live oak, Eastern red cedar, catalpa and black locust, offer better-than-average natural decay resistance. In the West, redwood and Western red cedar offer natural decay resistance, particularly with heartwood lumber.

Wood Decay

Wood-destroying fungi are grouped into three categories: brown rot, white rot and soft rot. These different fungi will attack the three different, main chemical components of wood: cellulose, hemicellulose and lignin. When wood-degrading fungi metabolize wood, a decrease in strength occurs. The extent of the strength loss will vary depending on the type of fungi involved, wood species and lumber dimensions. Louisiana and most of the Deep South are classified as a severe-risk area for wood decay (Figure 3).

Not all fungi that attack wood cause degradation. In fact, many are classified as wood-staining or mildew (mold) fungi because they discolor or stain wood rather than cause decay. These fungi typically develop because of poor lumber-drying practices or excessively wet conditions. Stain fungi do not cause strength loss but result in a lower grade for some grading lumber and are considered unfavorable by consumers because of their appearance. Stain is not as important for structural-grade lumber. Structural integrity is more important than aesthetical appeal in certain situations, such as rural fencing or construction. Consumers should be aware if they notice stain fungi even though no strength loss may have occurred, because conditions that favor stain fungi are often ideal for wood-degrading organisms

"Dry rot" is a frequently misused term. Wood with dry rot appears to be dry, but it must have been wet for decay to occur. Some mycelium can "wick" moisture from a distance, however.

Figure 2. This water has been stopped from penetrating the wood by using a water repellent. A water repellent or water-repellent preservative enhances the performance of treated wood in many ways. A water repellent decreases the amount of water absorption during rainy periods, reducing the associated shrinking and swelling of the wood. Less dimensional change in the wood results in less weathering. The preservative in a water-repellent preservative helps protect wood from decay, insects, molds and stains. (Source: Forest Products Society)

Figure 3. Map of deterioration hazard zones for the U.S. as developed by the USDA Rural Electrification Administration (REA) and adopted by the American Wood Protection Association (AWPA). (Source: REA. 1973. Pole Performance study staff report. U.S. Department of Agriculture)

Brown rot

These fungi will preferentially attack softwoods but will also attack hardwood lumber and logs (Figure 4). It is imperative to use treated wood or brush apply a preservative and

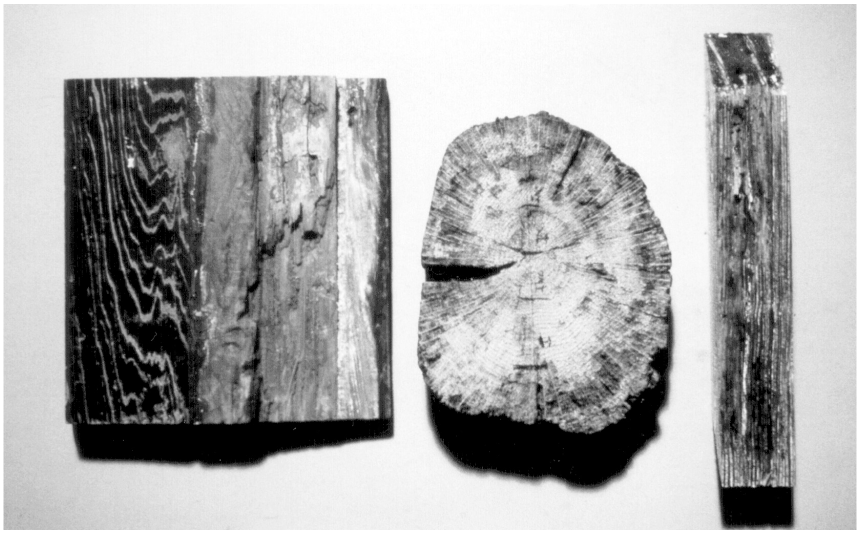


Figure 4. Fungal decay of wood by brown-rot decay fungi. (Source: Forest Products Society)

water repellant to prevent brown rot on wood used outside. The appearance of any mushroom-like bodies, which is an indication of advanced wood decay and substantial strength loss, is important for the consumer (Figure 5). Brown-rotted wood will develop a reddish-brown color and have a charred appearance. It also displays more than average shrinkage upon drying and is friable (soft).

White rot

White-rot fungi attack is commonly observed on hardwoods. White-rotted hardwood undergoes little surface alteration, develops a white or bleached appearance, displays near-normal shrinkage and in the early stages of decay is solid to the touch rather than friable. These fungi attack cellulose, hemicellulose and lignin, but deterioration is slower than that with brown-rotted wood.

Soft rot

Soft-rot fungi affect wood exposed to long-term moist conditions. The wood is darkened and appears dull brown or blue-gray, and the surface can easily be scraped off with a probe.

Figure 5. Fungal fruiting body growing from wood. These fungi are sometimes referred to as mushrooms or toadstools. This is evidence of advanced decay and serious strength loss. This lumber is extremely dangerous if it is used as a walking surface such as a boat dock or backyard deck. (Source: Forest Products Society)

Soft-rot fungi display considerable variation in their effects on cell wall chemical constituents during decay development. For many species, the principal food source is the carbohydrates in wood, but some remove more lignin than carbohydrates. Lignin is the natural glue in wood that holds adjacent cells together. Soft rot is often confused with white rot because of their similar appearance. Figure 6 shows typical surface checking of soft-rotted wood when dry. Oil preservatives are recommended for protection from soft-rot fungi.

Control

Rot-inducing fungi can be stopped by removing one of the four elements necessary for the fungi to live (1) proper moisture, (2) oxygen, (3) food and (4) temperature. Only one of these elements needs to be removed to prevent wood decay. The simplest method is to keep wood dry. Most rot-causing fungi will not attack wood if the moisture content is less than 20 percent. The oxygen component can be removed by submerging the wood in water. Logs that cannot be processed soon after felling and bucking should be placed under a water sprinkler system or submerged in water. The food component cannot be removed, but we can poison the food by preservative-treating the wood. Also, temperatures below 50 degrees Fahrenheit will allow negligible fungi growth, and temperatures above 200 degrees Fahrenheit are lethal to fungi.

Dealing with Decay

Since most decay problems are caused by moisture, the cure is simple. Eliminate the source of moisture. Check the roof, walls and plumbing for leaks. Go outside and check the eaves and gutters. Are the eaves wide enough to prevent water from coming down the sidewalls? Are your gutters poorly maintained or missing? Be sure the foundation is not cracked and the soil slopes away from the house. Don't just treat the mildew, mold or decay problem. You need to eliminate the cause!

Then, remove as much decayed wood as is practical and economical. This is really important with load-bearing wood members. Cut back the rotted wood to the sound wood. Keep in mind that difficult to detect incipient decay can extend well beyond visibly rotted areas. When a partially decayed structural member can't be replaced, reinforce it with treated wood. Be aware that decayed wood absorbs and holds water more readily than sound wood, so let rotted areas of members not removed dry before making repairs. Consider treating infected but otherwise-serviceable wood left in place with a water-borne, borax-based preservative that will not only kill active fungi but guard against future infection as well. Borates have low human toxicity and do not affect wood's strength, color or finishability.

If the decay is too severe, and you want to preserve the historic or architectural character of moldings, carvings or furniture, consider an epoxy repair job. Epoxies consist of resin and hardener that are mixed just before use. Liquids for injection and spatula-applied pastes are available. After curing, epoxy-stabilized wood can be shaped with regular woodworking tools and painted. Epoxies are not preservatives and will not stop existing decay. They can be tricky to use, so follow all label directions.

Stains

Wood-staining fungi differ from the wood-destroying fungi in that wood-staining fungi do not noticeably affect wood strength or texture. Mold and stain are often considered together because of the similarity of action of the fungi on wood microstructure. Mold and stain cause little injury to the structure of wood they infest, provided that favorable conditions do not create a more advanced stage where it would be more appropriately considered as soft rot. A number of wood-staining fungi produce a wide range of color effects or different stains.

Blue Stain

Blue stain, also called sapstain, is the most economically important stain. It occurs in the sapwood of both hardwoods and softwoods. Heartwood is essentially immune to the fungus that causes blue stain, but the salability and price of blue-stained lumber are greatly reduced because of its appearance. A natural finish that looks good to most consumers cannot be applied to blue-stained lumber.

In Louisiana, blue stain frequently occurs in SYP lumber that is not seasoned or used quickly. All SYP lumber should be dried or chemically treated as soon as possible after sawing. Failure to do so can result in blue stain in as little as two weeks in certain times of the year. The SPIB does not specify that SYP dimension lumber be down-graded if blue stain is present, but SPIB does mandate that SYP lumber with blue stain cannot be sold as Appearance Grade lumber. The southern hardwoods such as yellow poplar, magnolia, tupelo and oak are also good candidates for blue stain. These species, however, can often be air dried for a longer period without the risk of stain before kiln drying. Blue stain may develop during various stages of manufacture, storage or shipping or even in the finished product if there are sufficient conditions (moisture, air and temperature). Not all blue stain occurs after sawing. It can also occur in standing trees or logs (Figure 7).

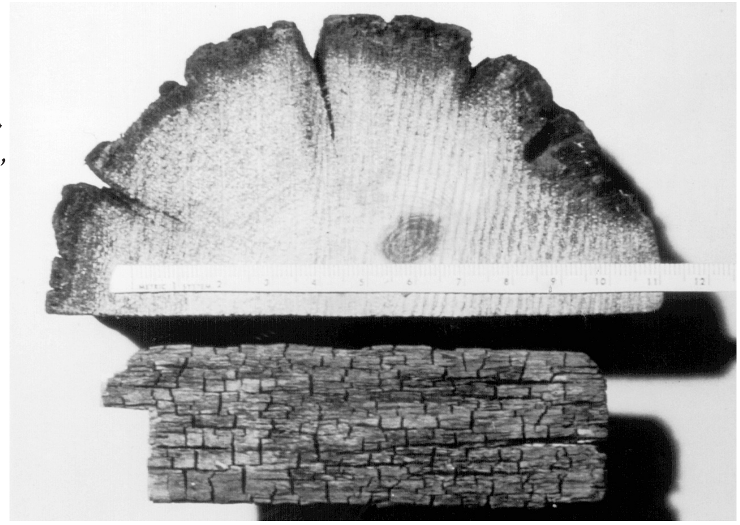


Figure 6. The surface of soft-rot wood appears as if it was lightly charred, and there are often cracks along and across the grain. (Source: Forest Products Society)

Control

Control can be accomplished either by rapid drying of the wood to reduce moisture content or by dipping or spraying with fungicidal solutions. Dipping is usually fairly inexpensive. If the risk of stain is severe, both fungicidal protection and good drying practices are recommended for high-grade products. Drying can be accomplished either by kiln drying or air drying with proper stack placement and air flow. Since stain can be transferred from stained lumber to unstained, green wood, proper protection from contamination is important. Therefore, don't stack stained and unstained material together, especially without using stickers between the boards.

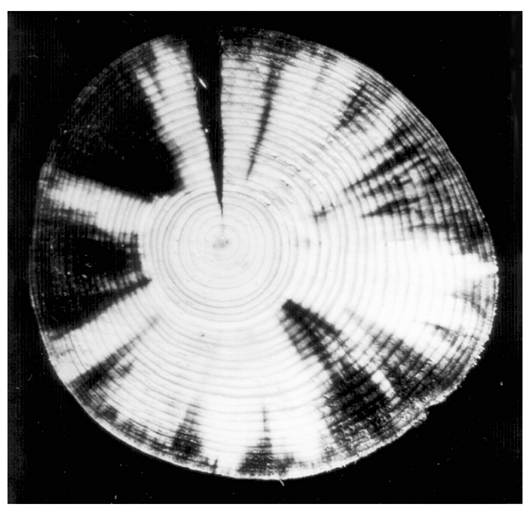


Figure 7. Blue stain is often referred to as sapstain because it tends to occur in the sapwood of logs and lumber. The lumber cut from this southern yellow pine log will contain blue stain because it is already present in the log. (Source: Forest Products Society)

Chemical Stain

In addition to discolorations produced by fungi, wood is also subject to certain other stains that result from chemical changes in wood cell walls. The nature and causes of these changes are not definitely known, although, in some cases at least, they involve enzymatic or non-enzymatic oxidation of certain organic compounds largely confined to sapwood. Such stains are found in both softwoods and hardwoods. They sometimes appear in logs that have been stored for prolonged periods, but they usually develop in lumber during seasoning. The most important are the so-called brown stains – yellow to dark-brown discolorations – which are especially common in some western pines. Chemical brown stains are often confused with brown-sap stain, a fungus discoloration affecting the sapwood of some western and northern pines. They and other chemical stains are also mistaken at times for the discolorations produced by the incipient stages of certain decays, in which cases they may be responsible for rejection of sound wood. Brown stain is a severe economic problem because of surface color degradation.

Molds and Mildew

Certain molds, similar to those that form on old bread, can form on the surface of wood and produce "cottony" growths that range from white and other light shades to black. These organisms differ from wood-staining fungi mainly in their habit of surface growth. The same conditions of moisture, air and temperature that promote wood-destroying and wood-staining fungi will favor the growth of molds. Mold is especially common in freshly sawn lumber that is stacked with no stickers or room air circulation.

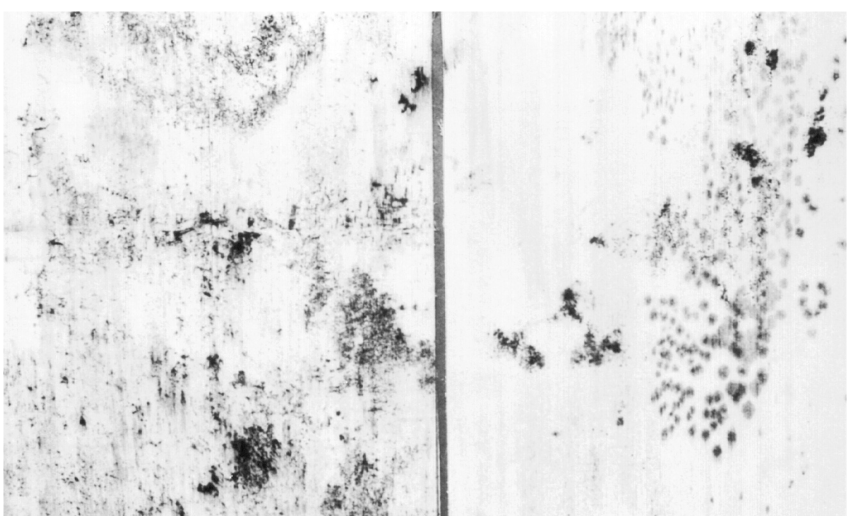


Figure 8. Surface mold on sweetgum veneer. Molds will discolor the surface of wood and make it appear green, black or sometimes even shades of orange. (Source: Forest Products Society)

Although molds and mildew are more common with untreated wood, they can also be a problem with preservative-treated wood. Annual treatment of the preservative-treated wood with a water-repellent preservative can reduce mold and mildew. Most unprotected wood will be discolored to a dull gray or black by mold and mildew. Preservative-treated wood that has not been treated with a water-repellent preservative will quickly turn to a dull gray or silver gray in some areas. Some molds are surprisingly tolerant of wood preservatives. Sometimes mold will be present in banded shipments of solid-piled, CCA-treated SYP, especially if the lumber was not kiln dried after treatment. Most molds, however, die once the lumber is dry, but if not, they can be washed off with the same solution used for mildew.

Mildew fungi do not reduce strength. Molds are objectionable because of their appearance. These fungi are often a result of poor lumber drying or wet conditions and are objectionable because of their appearance. Inspect your lumber closely if mildew is present, because conditions that favor mildew are also favorable for wood-degrading fungal growth (Figure 8).

Control

Because most molds need a surface moisture content of about 20 percent to begin growth, they can be controlled by controlling air moisture levels and minimizing condensation. This includes proper site drainage and dampproofing, and use of soil covers, vapor retarders, insulation and ventilation as ambient conditions call for.

If preventive measures fail, then other methods are available. The natural color of an outdoor wood structure can be partially maintained by scrubbing the wood surface annually with a bleach/water mixture or a commercial wood cleaner. The cleaned wood surface should be scrubbed with a stiff bristle brush and rinsed thoroughly with water. Always allow the surface to dry for several days before refinishing. If you're working with a wood structure that has been neglected for many years, much of the natural color in the surface of the wood has probably leached out. The amount of color that returns after bleaching depends largely on the extent of surface weathering.

A bleach/water mixture can be made with this formula: one quart of household liquid bleach, 1/3 cup of liquid laundry detergent and three quarts of warm water. Do not use a detergent that contains ammonia because it reacts with bleach to form a poisonous gas.

There are a few steps to follow to refinish a wood structure with severe mildew. First, use the bleach/water mixture or commercial wood cleaner and allow to dry for two to four days before refinishing. Always follow label directions when finishing wood, and be aware of temperature limitations. Many wood finishes will cure improperly if the temperature is too high or low. Sanding with 80-100 grit sandpaper before applying a water-repellent preservative may be necessary if raised grain is present. Always wear a dust mask while sanding treated wood. Apply the water-repellent preservative with a brush, roller or pad. Apply a liberal amount in decay-prone areas such as end-grain and around fasteners.

Bacteria

Bacteria do not deteriorate wood seriously, but they do cause some species to absorb moisture excessively and may indicate related potential problems. The excessive absorption interferes with satisfactory painting of wood of some species and causes more rapid biodeterioration in hazardous situations.

Oxidative Hardwood Stain

Some hardwoods can develop deep yellow to reddish-brown discolorations on the surface when exposed to air immediately after sawing or peeling. Louisiana species such as cherry, birch, sycamore, oak, maple and sweet gum are some examples. Stain can develop in oaks, birch and maple during air-seasoning and is greatest at the point where the sticker contacts the lumber. Therefore, the term sticker stain is often used in such instances. This stain will not appear in lumber that is immediately kiln-dried after sawing and is less present in the winter. A related gray stain in several southern oaks also is oxidative in nature.

Mineral Stain

This stain is most common in hardwood (both sapwood and heartwood) in the Northeast and Lake States. The stain is variable in occurrence and may appear as streaks or as a broad discoloration. Mineral-stained wood is often denser and harder than normal wood and will twist and warp when dried if severely stained. The lumber will tend to split when nailed and may be less suitable for construction.

Iron Stain

Iron stain can be recognized as a dark purple or black stain that develops in the sapwood and surface of wood when sawn with an iron blade. Louisiana species that are susceptible are birch, cherry, sweet gum and oaks. Iron stain can also occur around nails in softwood lumber. The use of steel wool in sanding combined with a water-based finish can cause severe iron stain on dried wood surfaces (Figure 9).

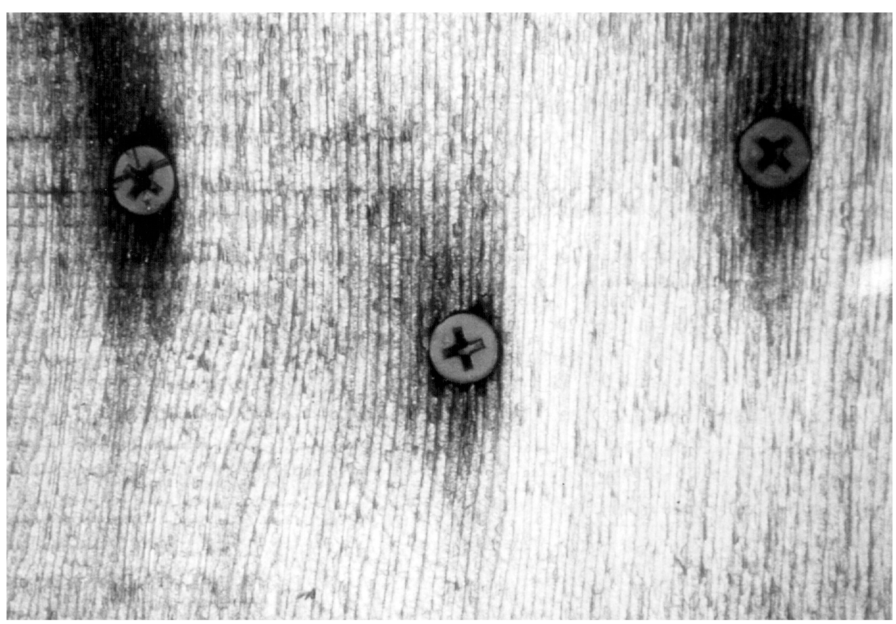
Control

Iron stain can be removed by saturating the stained area with a mixture of oxalic acid (one pound per gallon of hot water) and allowing the solution to soak into the wood for several minutes. The area should be rinsed thoroughly and allowed to dry before refinishing. Since many iron stains are caused by a fastener, remove the fastener before applying the oxalic acid solution to the wood. Inspect all other fasteners to make sure they are noncorrosive. Remember to use caution and avoid skin contact with oxalic acid. It is toxic and is dangerous if ingested.

General Stain Control

The best control for most forms of stain is proper handling during harvesting and seasoning. It's possible for a sawmill or user to handle the lumber properly but still have stain that developed in the log before it was milled. Logs should be quickly transported to the sawmill and not allowed to stay in the forest for weeks, especially during wet summer months. If a log is not to be processed in the near future, store it in a pond or under a sprinkler system to create an anaerobic environment. Quality lumber should be treated with an anti-stain fungicide within 24 hours of sawing. Don't store treated lumber in the rain and risk the possibility of diluting surface retention levels. If lumber is to be stored, do so on stickers made of heartwood or preservative-treated wood. Also, use proper piling practices that allow for good air flow,

Figure 9. Iron stain has developed on these boards as a result of iron or steel contacting the wood. Iron stain is more common on red oak wood than other species because of its tannic acid content. Wipe the surface of the wood with a solution of bleach, laundry detergent and warm water to make sure the discoloration is not simply mildew. See directions on how to remove mildew in this publication. (Source: Forest Products Society)



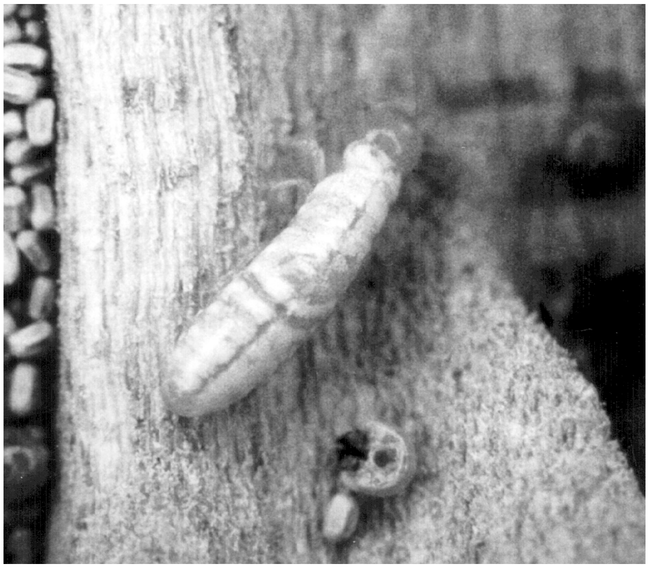


Figure 10. In Louisiana, subterranean termites were once found only in the southern Louisiana parishes. They are found throughout most of the United States. Most termites require wood in ground contact and moist wood. Subterranean termites are dangerous to wood because they can provide additional moisture to the wood by constructing earthen connecting tubes to wood that is not in ground contact. (Source: Forest Products Society)

prevent direct rain and place wood high enough off the ground to prevent rain splashing or flooding.

Insects

Many insects destroy wood. The three most important insects for the wood user to be aware of are termites, beetles and carpenter ants. Three categories of insects attack wood. First, pests of moist wood are insects that attack improperly protected lumber and usually attack together with wood-destroying fungi. Second, pests of dry wood are insects that can attack dry wood. These dry wood insects do not attack in association with wood-destroying fungi and are capable of reinfesting the same piece of wood. Third, marine borers are not insects but are mollusks and crustaceans that infest wood in salt water, destroying pilings, ships and boats.

Insects of Moist Wood

Some insects attack trees or wood that is partially moist as a result of contact with the ground or becomes wet from faulty construction, improper maintenance or previous insect activity. These insects are usually associated with protozoa, fungi and bacteria that aid them by converting the cellulose and lignin in the wood into materials that are more digestible. Because of these microorganisms, moist and decaying wood provides suitable food and shelter for these insects. Some insects attacking moist wood found in living trees are also usually pests of wood products in contact with the ground or another moisture source.

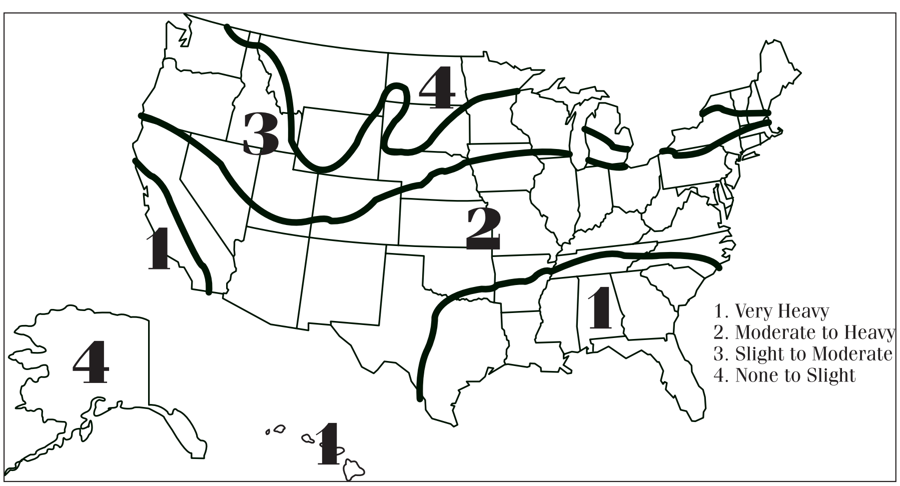


Figure 11. This range map of subterranean termites shows a very heavy population throughout Louisiana and most of the South. (Source: Forest Products Society)

Termites

In Louisiana, two groups of termites attack wood. Native subterranean termites are the more common (Figure 10). They require wood with a moisture content of more than 20 percent. This group of termites is unique in that they can provide additional moisture to the wood by constructing earthen connecting tubes to wood that is not in contact with the ground. Therefore, if untreated wood is to be placed outside in moist locations, it is imperative that it be placed covered above ground on blocks and not in ground contact. The area around the block should be treated for termite control. Subterranean termites are found throughout Louisiana (Figure 11). Formosan subterranean termites are similar to native subterranean termites but form larger colonies and have more aggressive feeding habits. This species was first discovered in Texas in 1965 and has been found in several Louisiana port cities and in coastal areas near the Gulf of Mexico. Termites are often confused with winged ants, but there are several differences (Figure 12).

Termite Control

The prevention and control of subterranean termites are based on the same factors that affect the growth of wood-destroying fungi (temperature, oxygen, food and moisture). The best method to prevent attack by subterranean termites is to build wooden structures in a manner that allows the wood to be kept dry. Structural and sanitary measures will not give complete protection against termites, so a chemical means of protection is often advocated. The ideal time to install a chemical barrier under a home or shed is at the time of construction. But if a building becomes infested, steps can be taken to dry the wood or construct a chemical barrier between the nest and the infested wood. Also, nests and potential nesting places near the building should be eliminated if they can be found. Contact a reputable pest control company for assistance when termites attack wooden structures.

Modern styles of architecture that demand central heat, heated basements and low foundations may be contributing factors to more insect pests. There is a tendency on the part of some builders to leave wood in a trench or under the foundation and to throw in other waste materials, knowing they will be hidden when backfilled. This creates ideal conditions for termites. A major contributor to the subterranean termite attack is the lack of adequate soil treatment prior to laying the foundation. The outside of the slab should be treated. Also, soils under buildings should be stabilized and installed with drains before construction to prevent movement which can cause cracks in the foundation and support timbers and allow moisture to enter the building. The importance of drainage cannot be overstated. Louisiana residents are advised to check with a local pest control agent regarding the building codes for minimum protective practices. Also, home buyers can specify that waste be disposed of away from buildings when making construction plans for a new home or building.

In general, protection against subterranean termites and decay requires that these points be observed:

1. Remove all tree stumps before grading, and clean up all wood (forms, grade stakes and waste) under and around buildings before backfilling or construction.

2. Treat soil with insecticides before pouring foundations, and allow foundation soils three to six months to settle properly before building.

3. Set buildings on concrete foundations that have an 8-inch clearance between wooden joists and soil.

4. Buildings with crawl spaces should have an 18-inch clearance between wooden joists and ground.

5. Grade land to slope away from the building on flat sites, and install drains to divert moisture away from buildings.

6. Wood closest to the ground or foundation, especially soleplates, should be pressure treated to at least above-ground retention standards. All untreated wood should be kept away from contact with the ground or moisture sources

7. Prevent lumber in the home from becoming wet from rain, leaks and condensation. Adequate ventilation must be maintained in crawl spaces. In Louisiana, at least a 24-inch overhang is recommended to keep walls dry.

8. Inspect buildings annually for potential problems. Check plumbing, caulking near doors and windows, and water splash areas such as behind air conditioners.

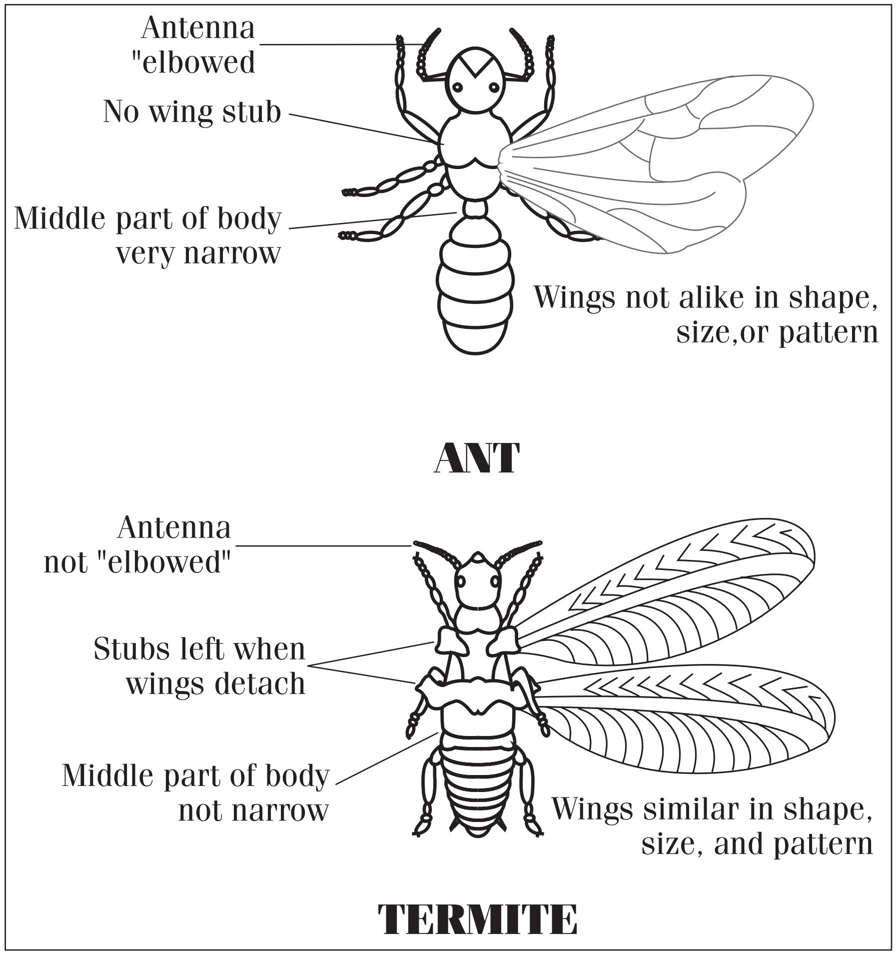


Figure 12. Winged termite and winged ant comparison. (Source: Moore 1979)

Carpenter Ants

Carpenter ants are widely distributed in Louisiana and North America. They are among the largest ants, occurring in lengths of 12 mm or more. They live in a colony in which three castes of adults are recognized: kings, queens and workers. In the South, carpenter ants readily infest live tulip poplar and black locust trees attacked by the locust borer. The tunnels are often in the grass above ground, disfiguring lawns in residential areas. The presence of carpenter ants in residential areas can be serious. They can burrow into wood to make nests, but unlike termites, they do not use wood for food. Also, carpenter ants differ from termites by making galleries that yield complete access across annual rings between the galleries (Figure 13). Trees with butt scars may be weakened by the ants' galleries and, with time, may be subject to wind throw.

Carpenter Ant Control

Carpenter ants can nest in houses without attacking wood by using existing voids or even termite galleries in wood. Carpenter ants foraging for food and water are generally more of a nuisance than a danger in houses. The same good building practices to minimize termite injury will also help to control carpenter ants. If you find carpenter ant nests in the house, treat the nests, approaches and surrounding areas with a residual contact insecticide (dust or spray). A pesticide specifically registered for treating indoors must be used in the house treatment. The infested wood can be bored before injecting the pesticide and plugging the holes. It is ineffective to treat only areas where the ants are seen, because many do not leave the nest.

Powder-post Beetle

The most economically important of the wood-attacking beetles are the powder-post beetles. The anobiid beetles and the lyctid beetles are the two most common powder-post beetles. The anobiid beetles are often called the death-watch beetles because of the tapping sound adults make with their heads as a mating signal. This sound was probably first heard by an individual sitting in a quiet room with a very ill person. These beetles primarily attack sapwood but will also destroy heartwood (Figure 14). They digest the cellulose component of the cell wall at a moisture content of 15 percent and above. Lyctid beetles are also commonly called powder-post beetles and prefer wood that has a moisture content of more than 20 percent or wood that has already been deteriorated by another organism. Lyctid beetles are a serious pest to the sapwood of hardwoods.

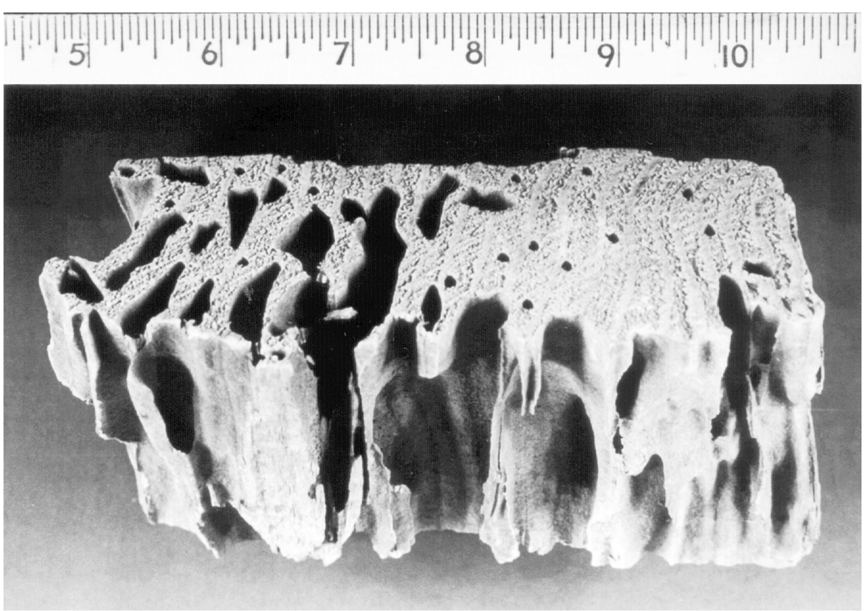


Figure 13. Carpenter ant damage to wood is different from termite damage because the former shows a preference for earlywood but removes some latewood to allow access between galleries. (Source: Forest Products Society)

Wood with large pores such as oak, hickory and ash are most susceptible, but species such as yellow poplar, sweet gum and cherry can also be infested. Most activity occurs with a wood moisture content between 10 percent and 20 percent, but attacks can occur with a wood moisture content of 8-32 percent.

Powder-post Beetle Control

Control for powder-post beetles requires one of three approaches: (1) eliminate or reduce the beetle population, (2) use a chemical treatment to protect susceptible wood or use natural decay- resistant wood or (3) control the environmental conditions in the wood to stop development of larvae.

Proper construction techniques will also help control power-post beetles (see the 8 items under termite control). Construction practices that use pressure-treated wood in hazardous areas will help prevent beetle attack. A diffusion treatment that includes boron will also stop attacks. A residual insecticide can be brushed or sprayed to control beetles. A sulfuryl fluoride fumigant can also be used to stop beetle attacks on wood in storage or in service. This is a good method if the infestation is extensive or if other methods are impractical. Fumigation is an expensive process and when performed indoors requires residents to leave for one or more days. It is sometimes used in conjunction with a home sale to certify that the structure is insect-free, but it does not guarantee long-term protection.

Powder-post beetle control can also be achieved through proper wood use. Rapid drying of sawn lumber is essential to control powder-post beetles and many other wood deterioration problems in green lumber. These beetles can attack lumber that is being air-dried because of the slow nature of the process. Also, these beetles attack lumber that has been air-dried in Louisiana because most air-dried lumber will reach equilibrium moisture content (simply stop losing moisture) when the lumber reaches 12-15 percent moisture content. Another method for avoiding favorable conditions for insect larvae and eggs is to subject the wood to extreme heat (such as in a dry kiln) or extreme cold.

Pests of Dry Wood

Lyctid Beetle

In general, wood-destroying beetles attack in the larval stage. The most common species infesting dry hardwoods is the southern lyctid beetle, which occurs throughout the United States. These beetles are pests of hardwood species, particularly ash, hickory, oak and walnut that has usually have been in service for less than 10 years. Beetles prefer these species because of their starch content and pore size. The starch content provides an excellent food source, and the large pore size allows for easy movement within the wood. The attack is usually confined to the sapwood because of the higher extractive content and greater natural decay resistance in the heartwood (Figure 15). Occasionally, infested flooring may be installed without the carpenter or home owner realizing the wood is not sound. It is often not until the beetles emerge in the spring that their unwelcome presence is recognized. Furniture and cabinet work can be attacked if there is a lag between construction and finishing. In the spring, furniture may be peppered with small, round exit holes that denote adults leaving the wood. Lyctid beetles have also been found in plywood panels and products made from plywood.

Lyctid Beetle Control

The injury caused by lyctid beetles can be prevented by denying the insects the time and place to lay eggs. These beetles are primarily pests of new hardwood lumber; infestations are rare in dry wood in use for more than five years. Prevention is the keynote of lyctid beetle control because wood infested by these insects is typically only fit for firewood. In lumberyards or secondary processing plants where large quantities of hardwood stock are kept on hand, wood should be inspected frequently. An infestation is usually indicated by small quantities of fine borings (powder) that sift out of infested pieces. Rapid use will greatly reduce the chance of an expanding infestation in storage sheds. Woodworkers should always use the oldest stock first. The simple rule for processing lumber is: first in, first out. Keep waste wood separate, and burn or haul it away to be disposed of properly. There are no circumstances in which waste wood should be allowed to accumulate near buildings and serve as a breeding ground for wood-destroying beetles!

One of the most effective means of protecting wood from lyctid beetles is with a sealer such as linseed oil, varnish, paraffin or paint. These sealers will close the pores and prevent deposit of eggs in the pores of wood. Millwork should not be treated with a wax sealer because it can affect finishes.

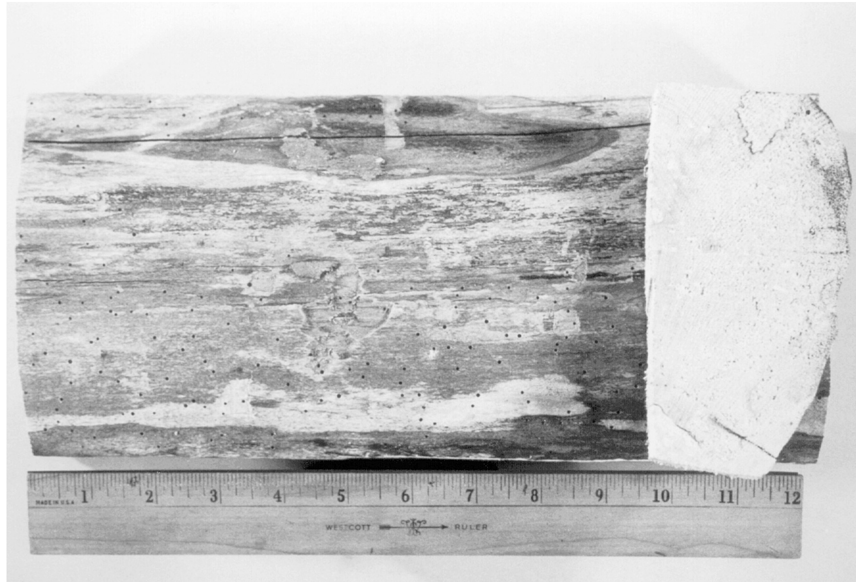


Figure 14. Anobiid beetle exit holes are round and vary in diameter from 1/16 inch to 1/8 inch. Zone lines on the end grain also indicate wood decay is present. (Source: Forest Products Society)

Anobiid Beetle

The anobiid beetles feed on both sapwood and heartwood of softwood and hardwood but usually are found in standing trees. Only a few species of this beetle attack wood products. Most infestations develop slowly and are usually not detected until after several generations of adults have emerged.

Anobiid Beetle Control

Damage from anobiid beetles can best be prevented by using dried or treated lumber and avoiding humid conditions by maintaining adequate dry air ventilation, especially within crawl spaces.

Figure 15. Ash shovel handle damaged by lyctid beetles. Exit holes are 1/32 inch to 1/16 inch in diameter. (Source: Forest Products Society)

Bostrichid Beetle

These beetles attack partially seasoned hardwoods and conifers while the bark is still on the wood. The emerging beetles are often found associated with recently made bark-covered furniture and timbers, firewood that has been brought indoors and recently processed wood that was not kiln dried or treated. The most common species in the eastern United States infests hickory and persimmon.

Bostrichid Beetle Control

Infestation by bostrichid beetles can be prevented by the prompt use of hardwood logs and lumber and the rapid debarking of wood used for sheathing, rustic furniture and house timbers. Preventing the emergence of these beetles from firewood in the home can be readily achieved by burning dry wood immediately or by stacking it out of doors before burning.

Long-horned Beetles

Wood-damaging long-horned beetles are named because their antennae are longer than half of their body length in adults. The larvae are known as round-headed wood borers because of their circular emergence holes (Figure 16). The injury is sometimes mistaken for that of power-post beetles. Damage from these beetles is usually confined to fire-, disease- or insect-killed timber that was salvaged or improperly air dried. The beetles injure the wood before it is processed and stop once it is dried. Long-horned beetles are in the wood only a limited time and do not reinfest the wood. They are not considered a serious structural pest.

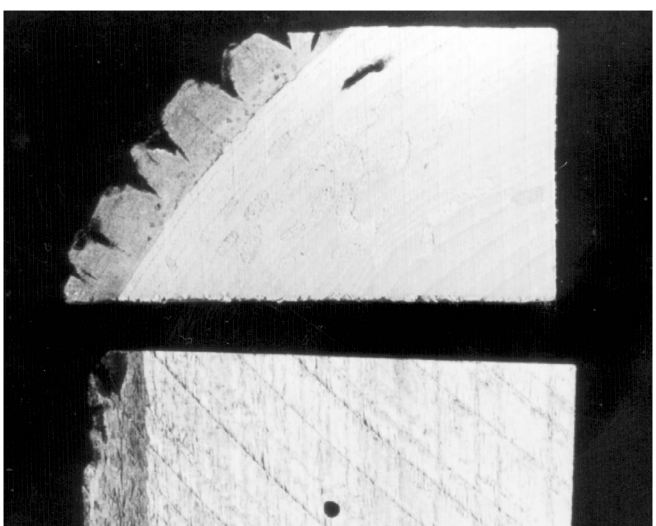


Figure 16. Long-horned beetle or round-headed wood borer damage to ash. Note the grub-shaped entrance hole on top and the round-oval exit hole on bottom. (Source: Forest Products Society)

Long-horned Beetles Control

The best method of long-horned beetle control is rapid wood use. Timber salvage operations need to be conducted as quickly as possible. Since trees killed by insects, fire or disease are ideal hosts for long-horned beetles, rapid milling and drying of the lumber are critical. Kiln drying will control eggs, larvae and adults. They are not a problem with dry lumber.

Old House Borer

The old house borer is a beetle that has spread from Europe throughout the world. It was introduced into the United States more than 100 years ago. It prefers freshly sawn softwood lumber, but its presence is usually not detected for several years because of its long life cycle. The symptoms of the initial infestation include the distinct sound of larval feeding, an occasional small amount of boring dust and the blistering of the wood surface. Their presence can be readily verified by probing the galleries and softened areas for larvae. Adults are often found against window screens within the house, especially in the attic.

Old House Borer Control

The old house borer can usually be prevented from damaging wood by using kiln dried or treated lumber that has been properly stored and kept dry while in service. Severe infestation will often require the replacement of the infested pieces. Occasionally, an entire house will be infested, possibly indicating that the wood was infested before construction. When a large infestation occurs, fumigation is recommended. Small areas can be treated by a pest control company.

Carpenter Bees

Carpenter bees are found throughout much of the southern and eastern United States and resemble bumblebees except that they have smooth and shiny (rather than hairy) abdomens and no pollen baskets on the hind legs. Although carpenter bees are usually not serious pests, their tunnels can be damaging if the bees infest the wood annually for nesting (Figure 17). The original entry hole is perfectly round and approximately ½ inch in diameter. The tunnel turns at a right angle after penetrating the length of the bee's body and runs across the grain of the wood. In Louisiana, all species of wood may be attacked, but cypress, pine and cedar are preferred.

Carpenter Bees Control

Control of the carpenter bee can be accomplished by placing an insecticide in the tunnel that the female has made to lay her eggs in the wood. Control can also be accomplished by painting or treating with borates. Wood pressure treated with preservatives such as borax, or high retention levels of water-borne preservatives is resistant to attack. Applying a surface coating of preservatives may also be helpful. Interior, unpainted wood surfaces can be protected by keeping windows and doors closed or screened during the spring and early summer to prevent bees from nesting in your house.

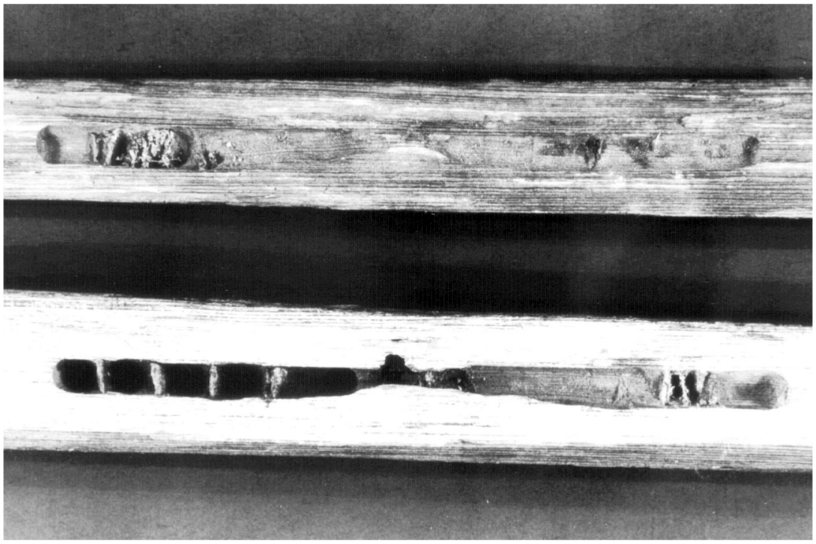


Figure 17. Carpenter bee damage showing a single entry hole (from inside) at the top center and individual cells (right) formed by the bees. (Source: Forest Products Society)

Drywood Termites

In Louisiana, these termites are found statewide. Drywood termites are extremely serious pests in the tropics and can attack wood with as low as 13 percent moisture content. They can enter buildings through unscreened air vents and over time can cause substantial injury with little evidence of their activity. They require no contact with the ground. Drywood termites will attack areas of wood where paint has peeled away, and they can even chew through several types of coatings! Their presence is indicated by the softening of the wood, blistering of the wood surface, the faint sound of moving termites and the piles of fresh, six-sided pellets ejected from infested wood.

Drywood Termite Control

Drywood termites can be serious pests (Figure 18). The first step in protection is proper construction techniques, with tight joints, wide roof overhangs and all wood pieces kept dry. This should be followed by thorough sealing or painting of all exposed surfaces. Moreover, all painted surfaces should be repainted often enough to maintain a protective covering over the wood. Back-painting (painting the interior surface) of siding and wood trim with a primer coat of paint or a wood preservative is useful in the prevention of attack by drywood termites. Be alert to detect infestation in the early stages when it is easier to control. Badly injured timbers will need to be replaced. Fumigation and borates are two treatments for control of drywood termites.

General Drywood Insect Control

The first step in controlling the numerous species of insects that infest seasoned wood is the correct identification of the insect. Correct identification is critical because the rate and extent of injury vary with species, and specific treatments are required for specific insect infestations. A pest control entomologist or LSU AgCenter entomologist can help with insect identification and control.

Marine Wood Borers

The control of any marine borer depends on proper species identification. As mentioned, wood can be maintained free of decay by submerging the wood in water and thus depleting the oxygen requirement for many wood-decaying organisms. This method prevents most insect injury but promotes injury by marine wood borers. Wood placed in a marine environment, such as boat docks, must be treated with a marine preservative. Creosote is some-

Figure 18. Example of drywood termite damage.

Figure 19. Utility poles and pilings in salt water require protection from marine wood borers. In some marine areas, the wood must be treated with an inorganic arsenical in addition to creosote.

times insufficient against some types of marine wood borers. In these cases, the wood must be protected with creosote and an inorganic arsenical in a process known as dual treatment. This is absolutely critical for the long-term integrity of the structure in these hazardous conditions (Figure 19).

Shipworms

Shipworms will attack any untreated wood submerged in salt water. The greatest injury is

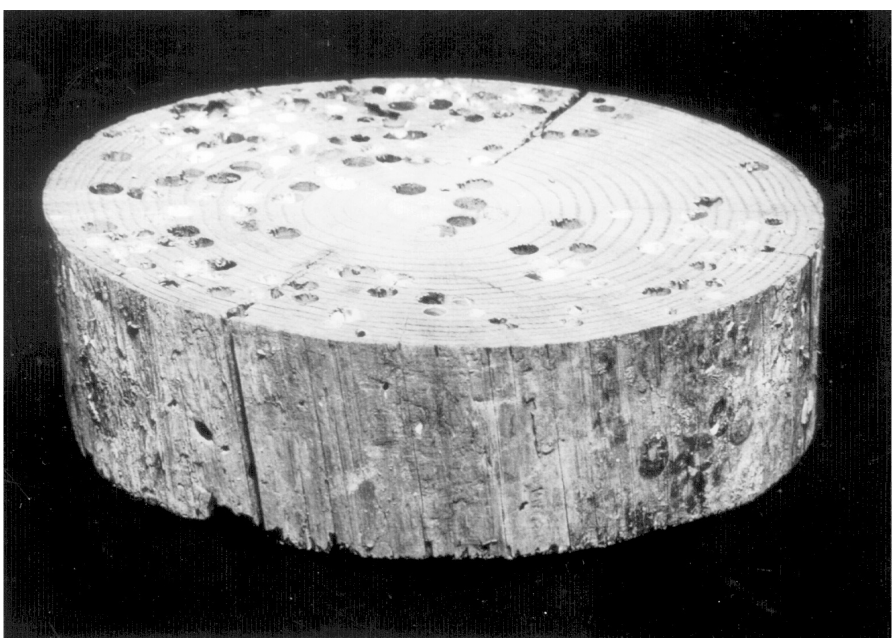


Figure 20. Shipworm damage on pilings is usually at the mud line. Larvae enter the wood at right angles to the grain and burrow with the wood grain along an irregular course. The wood often becomes honeycombed such as this piece. (Source: Forest Products Society)

done to pilings and wooden boats. Untreated pilings may last less than a month in the Gulf parishes. The replacement cost of pilings destroyed annually by shipworms is tremendous. These animals prefer warm salt waters. More than one-half of the volume of a pile may easily be destroyed without any evidence of injury being apparent on the pile's surface. Only by cutting into the piling can its condition be ascertained. The greatest damage in a piling usually occurs just above the mud line, although entrance holes may be found throughout the submerged area. Entrance holes about 1/16 inch in diameter are bored into the surface of the wood by the larvae (Figure 20).

Shipworms Control

Metal sheathing around a piling is effective but expensive and not very durable, unless it's galvanized or made from noncorrosive metals. Cement casings are unsatisfactory because cracks develop as a result of expansion, contraction and wave action. Plastic and fiberglass coatings have been used with some success. A very successful method of protecting piling against shipworms is impregnation with marine-grade creosote treatments of 20 to 25 pounds per cubic feet (pcf). Also, 2.5 pcf of wood of chromated copper arsenate (CCA) or ammoniacal copper zinc arsenate (ACZA) may be used. Surface treatment is not sufficient, so the preservative must be pressure applied to obtain good penetration. Deep penetration is difficult if not impossible with many dense hardwoods. A softwood, such as Southern yellow pine, with a wide sapwood zone is preferred. Applying marine creosote is still the preferred treatment. Noncorrosive metal caps and coverings on pilings are beneficial because they protect against structural injury and entrance of shipworms.

Limnoria

Limnoria is the genus commonly known as gribbles, and they do considerable damage along coastal waters (Figure 21). They are confined to clear salt water and cannot endure fresh to turbid water. They can tolerate low temperatures. When these crustaceans attack a piling, their tunnels almost touch, so the thin walls between them are quickly worn away by wave action, leaving a new surface of wood ready for reinfestation.

Limnoria Control

The protection of wood from Limnoria attack is much more difficult than from shipworms. Some species are resistant to creosote, partially because of the deterioration and leaching of creosote in warm waters. The use of certain copper salts (chromated copper arsenate and ammoniacal copper zinc arsenate) provides effective protection from Limnoria attack. A heavy retention (2.5 pcf) of CCA or ACZA works well. Copper or tin salts, fungicides and insecticides, especially the chlorinated hydrocarbons added to creosote, have shown various degrees of effectiveness in preventing Limnoria attack, but their use is limited by environmental regulations. In areas where severe attack by both types of marine borers is present, or if creosote-resistant species of Limnoria are present, use a dual treatment. This method calls for pressure treatment with the copper salt (1.0 to 1.5 pcf of CCA or ACZA) followed by a pressure treatment with marine-grade creosote (20 pcf). Movable wooden structures and boats can also be protected by an unbroken covering of marine paint. When borers have gained entrance to wooden vessels, they can be killed by running the boats into fresh water or dry dock for at least 30 days.

Preservative Treatments

Factory-applied preservatives fall into two general classes: those with an oily nature, such as creosote and petroleum solutions of pentachlorophenol, and those that are dissolved or suspended in water and applied as water solutions. The main difference is the type of liquid used to carry the toxic chemicals into the wood structure. Heavy oil preservatives have some advantage in extremely wet situations, since besides being toxic to fungi, the liquid carrier retards liquid water movement. A serious drawback to the oil-based treatments is that the wood surface is oily and difficult to finish or paint. It is possible to use light organic solvents as the carrier for toxic compounds so the wood may be painted after treatment. These solvents evaporate rapidly, leaving the wood with an untreated appearance.

Wood preservatives also are classified or grouped by the type of application or exposure environment in which they are expected to provide long-term protection. Some preservatives have sufficient leach resistance and broad-spectrum efficacy to protect wood that is exposed directly to soil and water. These preservatives will also protect wood exposed above ground and may be used in those applications at lower retentions (concentrations in the wood). Other preservatives have intermediate toxicity or leach resistance that allows them to protect wood fully exposed to the weather, but not in contact with the ground. Other preservatives lack the permanence or toxicity to withstand continued exposure to precipitation but may be effective with occasional wetting. Finally, some formulations are so readily leachable that they can only withstand very occasional, superficial wetting

Oil-type Preservatives

The most common oil-type preservatives are creosote, pentachlorophenol, and copper naphthenate. Conventional oil-type preservatives, such as creosote and pentachlorophenol solutions, have been confined largely to uses that do not involve frequent human contact. The exception is copper naphthenate, a preservative that was developed more recently and has been used less widely.

Wood will not swell from the application of preservative oils, but it may shrink if it loses moisture after the treating process. Creosote and solutions with heavier, less-volatile petroleum oils often help protect wood from weathering, but they may adversely influence its cleanliness, odor, color, paintability, gluability and fire resistance. Wood treated with heavy oils should never be used inside residences or other enclosed, inhabited structures. Volatile oils or solvents with oil-borne preservatives, if removed after treatment, leave the wood cleaner than the heavier oils but may not provide as much protection. Wood treated with

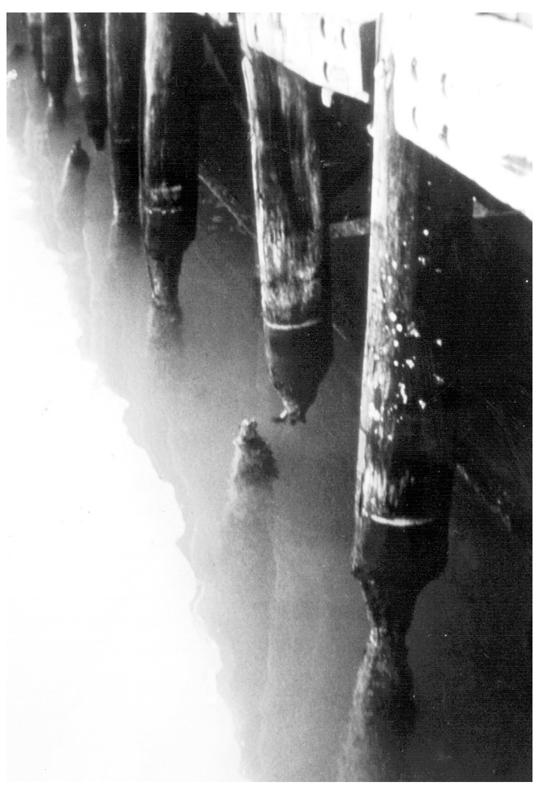


Figure 21. These boat dock pilings have been heavily damaged by marine borers, commonly known as gribbles (Limnoria). (Source: Forest Products Society)

some preservative oils can be glued satisfactorily, although special processing or cleaning may be required to remove surplus oil from surfaces before spreading the adhesive. Oils tend to retard wood moisture absorption, but waterborne chemicals do not unless they are additionally treated with a water repellent. High grade, water-repellent, pressure-treated lumber is now available.

Creosote

Creosote is a commonly used oil-type preservative. Because it's a mixture of many different organic chemicals in various percentages, it is toxic to many wood-destroying organisms, including Formosan and subterranean termites. For many years, either coal tar or petroleum oil has been mixed with coal-tar creosote in various proportions to lower preservative costs. These creosote solutions perform satisfactorily, particularly for poles, posts and crossties where they have been most commonly used. Coal-tar creosote has the advantages of (1) high toxicity to wood-destroying organisms; (2) relative insolubility in water and low volatility, which impart to it a great degree of permanence under the most varied conditions; (3) ease of application; (4) ease with which its depth of penetration can be determined; (5) low cost; (6) long record of satisfactory use. Creosote emits an unpleasant odor that can harm people and plants. Foodstuffs sensitive to odors should not be stored near creosote-treated material. Creosote can also burn the skin of some people. Freshly creosote-treated timber can be easily ignited and will burn readily. After the treated wood has seasoned for several months, its ease of ignition is reduced.

Pentachlorophenol

Pentachlorophenol has been widely used as a pressure-treatment preservative in the United States since the 1940s. The active ingredients, chlorinated phenols, are crystalline solids that can be dissolved in different types of organic solvents. The performance of pentachlorophenol and the properties of the treated wood are influenced by the properties of the solvent. Pentachlorophenol is effective when used in ground contact, fresh water or above ground. It is not as effective when used in seawater. The heavy-oil solvent, as specified in AWPA Standard P9, Type A, is preferable when the treated wood is to be used in ground contact. Wood treated with lighter solvents may not be as durable.

Wood treated with pentachlorophenol in heavy oil typically has a brown color and may have a slightly oily surface that is difficult to paint. It also has some odor, which is associated with the solvent. Pentachlorophenol in heavy oil should not be used when frequent contact with skin is likely (handrails, for instance). Pentachlorophenol in heavy oil has long been a popular choice for treating utility poles, bridge timbers, glue-laminated beams and foundation pilings. The effectiveness of pentachlorophenol is similar to that of creosote in protecting both hardwoods and softwoods, and pentachlorophenol often is thought to improve the dimensional stability of the treated wood.

Copper Naphthenate

Copper naphthenate is effective when used in ground contact, water contact or above ground. It is not standardized for use in saltwater applications. Copper naphthenate's effectiveness as a preservative has been known since the early 1900s, and various formulations have been used commercially since the 1940s. It is an organometallic compound formed as a reaction product of copper salts and naphthenic acids derived from petroleum. Unlike other commercially applied wood preservatives, small quantities of copper naphthenate can be purchased at retail hardware stores and lumberyards. Cuts or holes in treated wood can be treated in the field with copper naphthenate.

Wood treated with copper naphthenate has a distinctive bright green color that weathers to light brown. The treated wood also has an odor that dissipates somewhat over time. Depending on the solvent used and treatment procedures, it may be possible to paint wood treated with copper naphthenate after it has been allowed to weather for a few weeks.

Copper naphthenate can be dissolved in a variety of solvents, but for pressure treatments it is usually dissolved in a heavy oil. Copper naphthenate is listed in AWPA Standards for treatment of major softwood species that are used for a variety of wood products. It is not listed for treatment of any hardwood species, except for railroad ties.

Waterborne Preservatives

Waterborne preservatives react with or precipitate in treated wood, becoming "fixed." They resist leaching. Because waterborne preservatives leave a dry, paintable surface, they are commonly used to treat wood for residential applications, such as decks and fences. Waterborne preservatives are used primarily to treat softwoods because they may not fully protect hardwoods from soft-rot attack. Most hardwood species are difficult to treat with waterborne preservatives. These preservatives can increase the risk of corrosion from treated wood used in wet locations. Metal fasteners, connectors and flashing should be made from hot-dipped galvanized steel, copper, silicon bronze or stainless steel if they are used with wood treated with waterborne preservatives containing copper. Aluminum should not be used in direct contact with waterborne preservatives containing copper. Borates are another type of waterborne preservative; however, they do not fix in the wood and leach readily if they are exposed to rain or wet soil. Borate treatment does not increase the corrosivity of the treated wood to most metals.

Chromated Copper Arsenate (CCA)

Wood treated with CCA (commonly called green treated) dominated the treated wood market from the late 1970s until 2004. CCA has decades of proven performance and is the reference preservative used to evaluate the performance of other waterborne wood preservatives during accelerated testing. Chromated copper arsenate has been phased out voluntarily for most applications around residential areas and where human contact is prevalent. Currently, the most common uses for CCA are treatment of poles, piles and heavy timbers.

Ammoniacal Copper Zinc Arsenate (ACZA)

ACZA is a refinement of an earlier formulation, ACA, which is no longer available in the United States. The color of the treated wood varies from olive to bluish green. The wood may have a slight ammonia odor until it has dried thoroughly. ACZA is an established preservative that is used to protect wood from decay and insect attack in a wide range of exposures and applications. The ammonia in the treating solution, in combination with processing techniques such as steaming and extended pressure periods at elevated temperatures, allows ACZA do a better job of penetrating difficult-to-treat species of wood than many other water-based wood preservatives. ACZA is used frequently in the western United States to treat Douglas fir lumber and timbers, poles and piles.

Alkaline Copper Quaternary (ACQ) Compounds

Alkaline copper quat (ACQ) preservatives have become widely used in recent years as alternatives to CCA in residential applications. Several variations of ACQ have been standardized. ACQ type B (ACQ–B) is an ammoniacal copper formulation that is primarily used in the western United States. ACQ type D (ACQ–D), the amine copper formulation, is the most commonly used in most of the United States. Some manufactures are producing a "micronized" form of ACQ where very finely ground copper is suspended in water instead of dissolved in the amine co-solvent.

Copper Azole (CA–B)

Copper azole is another recently developed preservative formulation that relies primarily on amine copper, but with additional biocide (tebuconazole), to protect wood from decay and insect attack. Copper azole is an amine formulation. Ammonia may be added at the treating plant when the copper azole is used on species that are difficult to treat, such as Douglas-fir.

Copper HDO (CX-A)

Copper HDO is an amine copper water-based preservative that has been used in Europe recently introduced into the United States. The active ingredients are copper oxide, boric acid and copper-HDO (Bis-(N-cyclohexyldiazeniumdioxy copper). The appearance and handling characteristics of wood treated with copper HDO are similar to the other amine copper-based treatments. It is also referred to as copper xyligen. It is currently only standardized for aboveground applications.

Propiconazole-Tebuconazole-Imidacloprid (PTI)

PTI is a recently standardized preservative that does not contain copper. The propiconazole and tebuconazole are fungicides, while the imidacloprid helps to protect against insect attack. PTI does not add any color to the wood. PTI-treated wood is currently standardized only for aboveground applications.

Borates

Borate compounds are the most commonly used "unfixed" waterborne preservatives. Unfixed preservatives can leach from treated wood. They are used for pressure treatment of framing lumber used in areas with high termite hazard and as surface treatments for a wide range of wood products, such as cabin logs and the interiors of wood structures. They are also applied as internal treatments using rods or pastes. At higher rates of retention, borates also are used as fire-retardant treatments for wood. While boron has many potential applications in framing, it is not suitable for many applications because the chemical will leach from the wood under wet conditions. Borate preservatives are available in several forms, but the most common is disodium octaborate tetrahydrate (DOT). DOT has higher water solubility than many other forms of borate, allowing more concentrated solutions to be used and increasing the mobility of the borate through the wood. With the use of heated solutions, extended pressure periods and diffusion periods after treatment, DOT can penetrate species that are relatively difficult to treat, such as spruce.

Treatments for Wood Composites

Many structural composite wood products, such as glue-laminated beams, plywood, parallel strand lumber and laminated veneer lumber are typically pressure treated with wood preservatives in a manner similar to lumber. However, flake- or fiber-based composites are often protected by adding preservative to the wood furnish during manufacture. The most commonly used preservative for these types of composites is zinc borate. Zinc borate is a white, odorless powder with low water solubility that is added directly to the furnish or wax during panel manufacture. Zinc borate has greater leach resistance than the more soluble forms of borate used for pressure treatment and thus can be used to treat composite siding products that are exposed outdoors but partially protected from the weather. Another preservative that is used to protect composites is ammoniacal copper acetate, which is applied by spraying the preservative onto the OSB flakes before drying.

Precautions with Preservative Treatments

Creosote, pentachlorophenol chromated copper arsenate (CCA) and ammonical copper arsenate (ACZA) are all classified as restricted use pesticides by the U.S. Environmental Protection Agency. These preservatives should only be used where used where protection from insect attack and decay is important because of hazardous conditions caused by moisture, lack of wood resistance, high temperature and exposure to destructive organisms. Use or exposure to wood treated with preservatives may present certain hazards, so take these precautions when handling the treated wood and in determining where to use or dispose of the treated wood.

Use-site Precautions

All sawdust and construction debris should be cleaned up and disposed of after construction. Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such sites would be use of mulch from recycled arsenic-treated wood, cutting boards, counter tops, animal bedding and structures or containers for storing animal feed or human food. Only treated wood that is visibly clean and free of surface residue should be used for patios, decks and walkways. Do not use treated wood for construction of those portions of beehives which may come into contact with honey. Treated wood should not be used where it may come into direct or indirect contact with drinking water except for uses involving incidental contact such as docks and bridges

Logs treated with pentachlorophenol should not be used for log homes. Wood treated with creosote or pentachlorophenol should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), unless an effective sealer has been applied. Creosote- and pentachlorophenol-treated wood should not be used in residential, industrial or commercial interiors except for laminated beams or building components that are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Do not use creosote- or pentachlorophenol-treated wood for farrowing or brooding facilities. Wood treated with pentachlorophenol or creosote should not be used in the interiors of farm buildings where there may be direct contact with domestic animals or livestock that may crib (bite) or lick the wood. In interiors of farm buildings where domestic animals or livestock are unlikely to crib (bite) or lick the wood, creosote or pentachlorophenol-treated wood may be used for building components which are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site. Urethane, shellac, latex epoxy enamel and varnish are acceptable sealers for pentachlorophenol-treated wood. Coal-tar pitch and coal-tar pitch emulsion are effective sealers for creosote-treated wood-block flooring. Urethane, epoxy and shellac are acceptable sealers for all creosote-treated wood.

Handling Precautions

Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves, fireplaces or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial sites (construction sites) may be burned only in commercial incinerators, according to state and federal regulations.

It is legal to send treated wood to a landfill, and the growing shortage of landfill space is prompting many industrial users to select recycling of treated wood as their disposal option.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining, wear goggles to protect eyes from flying particles. Always remember to wear a dust mask when sawing or machining wood to prevent inhalation of dust. After working with treated wood and before eating, drinking or using tobacco products, wash exposed body areas thoroughly. If preservative or sawdust accumulates on clothes, launder the clothes before reuse. Wash work clothes separately from other household clothing.

Selection of Pressure-treated Wood

In Louisiana, Southern yellow pine is the most common preservative-treated wood. The term (SYP) lumber is a general term used to group the following species together: loblolly pine, shortleaf pine, longleaf pine and slash pine. A consumer needs to buy the appropriate quality of lumber that matches his or her end-use objective. The most common grade of SYP treated lumber found at building material dealers is Number 2 Common because it meets a wide variety of use needs and offers a good value. The grade of a piece of lumber is based on the number, character and location of growth characteristics that may affect the strength or the utility value of the lumber.

To guide selection of the types of preservatives and loadings appropriate to a specific end use, the American Wood Protection Association (AWPA) developed Use Category System (UCS) standards. The UCS standards simplify the process of finding appropriate preserva-

Table 1. Typical use categories and retentions (pcf) for preservatives listed by the American Wood Protection Association and used in pressure-treatment of Southern pine species.

		Retegntions for Each Type of Exposure and AWPA Use Category Designation					
	Interior,	Exterior Above-ground		Soil or Fresh water			
Preservative	Dry or Damp	Vertical, Coated	Horizontal	General	Severe/ Critical	Very Severe/ Critical	
	1, 2	3A	3B	4A	4B	4C	4C (Piles)
Waterborne:							
ACZA	0.25	0.25	0.25	0.40	0.60	0.60	0.80
ACQ-D	0.25	0.25	0.25	0.40	0.60	0.60	-
CA-B	0.10	0.10	0.10	0.20	0.31	0.31	0.41
CCA	NL[a]	NL[a]	0.25	0.40	0.60	0.60	0.80
CX-A	0.21	0.21	0.21	-	-	-	-
PTI	0.013	0.013	0.013/0.018[b]	-	-	-	-
DOT (SBX)	0.17/0.28[c]	-	-	-	-	-	-
Oil-type:							
Creosote	8.0/NR[d]	8.0	8.0	10.0	10,0	12.0	12.0
Pentachlorophenol	0.40/ NR[d]	0.40	0.40	0.50	0.50	0.50	0.60
CuN (oilborne)	0.04/ NR[d]	0.04	0.04	0.06	0.075	0.075	0.10

[a] NL: EPA labeling does not currently permit use of wood newly treated with these preservatives in most applications within these Use Categories.

[b] Higher retention specified if the preservative is used without a stabilizer in the treatment solution

[c] Higher retention for areas with Formosan subterranean termites

[d] NR: Not recommended for interior use in inhabited structures

tives and preservative retentions for specific end uses. They categorize treated-wood applications by the severity of the deterioration hazard. The lowest category, Use Category 1 (UC1) is for wood that is used in interior construction and kept dry, while UC2 is for interior wood completely protected from the weather but occasionally damp. UC3 is for exterior wood used aboveground, while UC4 is for wood used in ground-contact in exterior applications. UC5 includes applications that place treated wood in contact with seawater and marine borers.

To use the UCS standards, one needs only to know the intended end-use of the treated wood. A table in the UCS standards lists most types of applications for treated wood, and gives the reader the appropriate use category and commodity specification. The commodity specification lists all the preservatives that are standardized for that use category, as well as the appropriate preservative retention and penetration requirements. The user needs only specify that the product be treated according to the appropriate use category. The use categories and preservative retentions for some of the most common preservative treatments are shown in Table 1.

As the treating industry adapts to the use of new wood preservatives, it is more important than ever to ensure that wood is being treated to standard specifications. In the United States, the U.S. Department of Commerce, American Lumber Standard Committee (ALSC) accredits third-party inspection agencies for treated wood products. Quality control overview by ALSC-accredited agencies is preferable to simple treating-plant certificates or other claims of conformance made by the producer without inspection by an independent agency. Wood that is treated in accordance with these quality assurance programs will have a quality mark or stamp of an accredited inspection agency on the wood or on the end-tag (Figure 22). The use of treated wood with such third-party certification may be mandated by applicable building code regulations. In addition to identifying information about the producer, the stamp indicates the type of preservative, the retention level of the preservatives and the intended exposure conditions. Retention levels are specific to the type of preservative, species and intended exposure conditions.

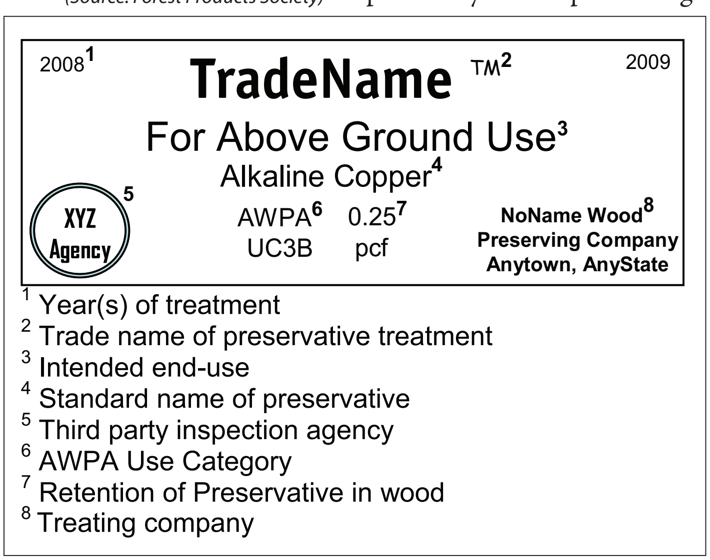


Figure 22 . Grade mark stamp of preservative-treated wood. (1) The identifying symbol, logo or name of the accredited agency. (2) The applicable American Wood Preservers' Association (AWPA) commodity standard. (3) The year of treatment if required by AWPA standard. (4) The preservative used, which may be abbreviated. (5) The preservative retention. (6) The exposure category (Above ground, Ground contact, etc.). (7) The plant name and location, or plant name and number, or plant number. (8) If applicable, moisture content after treatment. (9) If applicable, length and class. (Source: Forest Products Society)

Self-applied Treatments

The consumer of untreated lumber can apply preservatives in a do-it-yourself manner for temporary conditions. Preservatives may be applied to wood in the field by brush, spray, soak or dip treatments. The spray or brush method is by far the most common for the homeowner or hobbyist. It's important to realize that field treatments give much poorer penetration or retention than factory-treated lumber. Most exterior wood treatments penetrate only the wood surface and leave the inner core of wood unprotected. Also, the risk of toxic exposure to the individual and the environment is increased with field treatments. It is recommended that preservatives applied in this manner be accompanied by the application of a water repellant after drying. A water repellant used without a ground-contact-approved preservative will give unsatisfactory decay resistance when used in ground-contact situations. Because wood absorbs moisture approximately 20 times easier along the grain than across the grain, the application of a water repellent is critical at the end-grain region. Some self-application wood preservatives have a water-repellent component. See your local retail store for assistance. A water-repellent preservative differs from a water repellant in that the former contains a mildewcide, which provides for surface mildew resistance.

The performance of any paint depends on the condition of the wood at the time of painting, the nature of the paint itself, the application conditions and the moisture movement through the painted surface once in service. Always follow the recommendations of the paint manufacturer. Once a satisfactory paint coating is obtained, paint on treated wood surfaces will often outlast that on an untreated surface because incipient decay and mildew beneath the paint film are a significant cause of premature paint failure.

Over-the-counter Preservatives

The requirements for an ideal wood preservative include: (1) toxic to a wide range of wood-inhabiting or destroying fungi, (2) high degree of permanence (minimal leaching), (3) easy wood penetration, (4) noncorrosive to metals and nondestructive to the wood itself, (5) safe to use and handle and (6) economical. The following list contains information on some of the over-the-counter preservatives.

Copper naphthenate will turn wood green initially, but the color will often change to brown after several months of exposure. This has traditionally been an oil-based formulation, but water-based solutions are now available. Brush-applied treatments need a copper content of 1-2 percent or 10-20 percent copper naphthenate. Its strong odor can be unpleasant to some people, and it should not be used in enclosed places.

Zinc naphthenate is a clear alternative to copper naphthenate, but it is less effective in preventing decay and mildew and should not be used in ground contact. It is available in waterborne and solventborne formulations.

3-Iodo-2-propynyl butyl carbanate (IPBC) is commonly used as an ingredient in anti-sapstain formulations or as a fungicide in water-repellent finishes for decks or siding. It also is used to treat millwork and may be combined with azoles to enhance efficacy against mold fungi. It may be used as either a solvent or water-based formulation. IPBC is colorless, and depending on the solvent and formulation, the treated wood may be paintable. Some formulations may have noticeable odor, but formulations with little or no odor are also possible. IPBC is not an effective insecticide and should only be used for above-ground applications.

Copper-8-quinolinolate solutions are green-brown, odorless and toxic to many wood-destroying organisms. It is not recommended for use in high degradation areas. It is permitted by the U.S. Food and Drug Administration to be in contact with food and beehives because of its low toxicity to humans and animals.

Borate preservatives or borates are among the newest preservatives available. They are derived from sodium borate, which is the same material used in laundry additives. They are effective against decay, termites, beetles and carpenter ants when used in above-ground applications protected from wetting. These preservatives are odorless, do not corrode ferrous metal fasteners and can be painted or finished. They can be sprayed, brushed or injected and are also available as boron rods that can be placed into holes drilled into the wood. They remain stable as long as they aren't exposed to standing water or do not come into prolonged wet ground contact without a water-repellent seal coating.

Installation and Inspection Tips

As stated, the appropriate selection and handling of lumber are critical for long-term service. Proper installation of preservative-treated wood will help extend the usable service life of the structure. The most problematic areas with decks and houses are areas where wood can remain wet or can trap water, such as the area between the deck and the house, joints and areas continuously exposed to precipitation. On decks close to the ground without sufficient clearance for inspection, remove a few decking boards every two to three years to inspect the supporting structure. Inspect all other outdoor wood structures yearly.

Figure 23. This poor method of assembly will allow water to wick into the end-grain of this treated post near the ground. Stain has already developed near the ground contact region as a result of excessive water absorption. (Source: Forest Products Society)

Proper installation will help prevent numerous moisture problems. Outdoor treated lumber should have a small gap of 1/8 inch to 1/4 inch between adjacent boards for proper air circulation and movement. Also, don't install the end-grain of untreated lumber in contact with another piece of lumber or place it directly on concrete. Water will wick into the end-grain. The adjacent board or concrete will prevent the end-grain from drying (Figure 23). More moisture is absorbed through the end-grain of lumber than any other location. If you observe this situation on your house or deck, monitor it closely for decay. Moisture absorption can be slowed by coating the end-grain of the lumber with a sealer such as wax. Some manufactured lumber is sold already end-coated with a bright color.

Figure 24. Inspection of posts is simply accomplished with a probe. (Source: Forest Products Society)

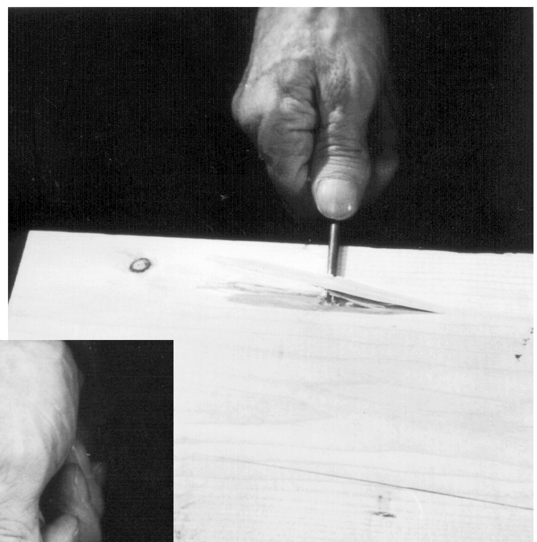
Outdoor posts can be checked for decay by using a probe such as a knife, ice pick or screwdriver (Figure 24). If the

Figure 25. Consult a professional exterminator if you observe termite tubes such as these on your house. (Source: Forest Products Society)

probe penetrates the wood easily, internal decay is present. Wood can appear sound externally but be decayed internally. If the wood is easily penetrated with a probe, remove a piece of wood and look for termite tunnels (Figure 25). Consult a professional exterminator if you see termite tubes or tunnels. Another method of determining if wood is decayed is to wet the wood and probe the upper surface (Figure 26 a and b).

Figure 27 shows mildew and advanced decay on an outdoor deck fabricated from treated wood. Mildew often indicates that conditions are favorable for decay. The decay might have been prevented if the homeowner had seen the mildew and taken action. This figure also shows the need to apply a water repellant, especially one with a mildewcide component, and monitor.

Figure 26a and b. When wet wood is probed with a pick or comparable tool, it tends to lift out as a long sliver or breaks by splintering if sound (top), but if decayed even slightly, it tends to lift in short lengths and to break abruptly without splintering (bottom). (Source: Forest Products Society)



Conclusions

The causes and control of wood decay, degradation and stain are numerous. Many problems can be eliminated or greatly reduced by using the right wood for the right job. Lumber used outdoors should always be pressure-treated to the appropriate retention level necessary for the job. Also, water-repellent preservatives applied yearly will slow weathering of privacy fences, decks and outdoor furniture. Many problems with untreated wood could be eliminated by simply keeping it dry. Contact your parish office of the LSU AgCenter for further assistance on wood decay, degradation and stain.

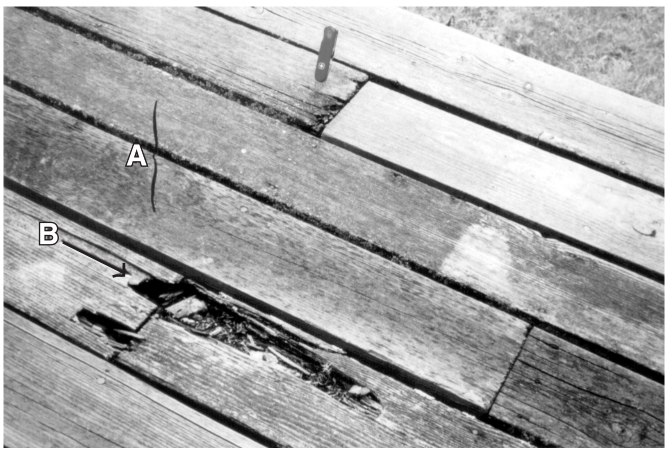


Figure 27. Decay on a wood deck showing (A) mildew and (B) advanced decay. (Source: Forest Products Society)

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