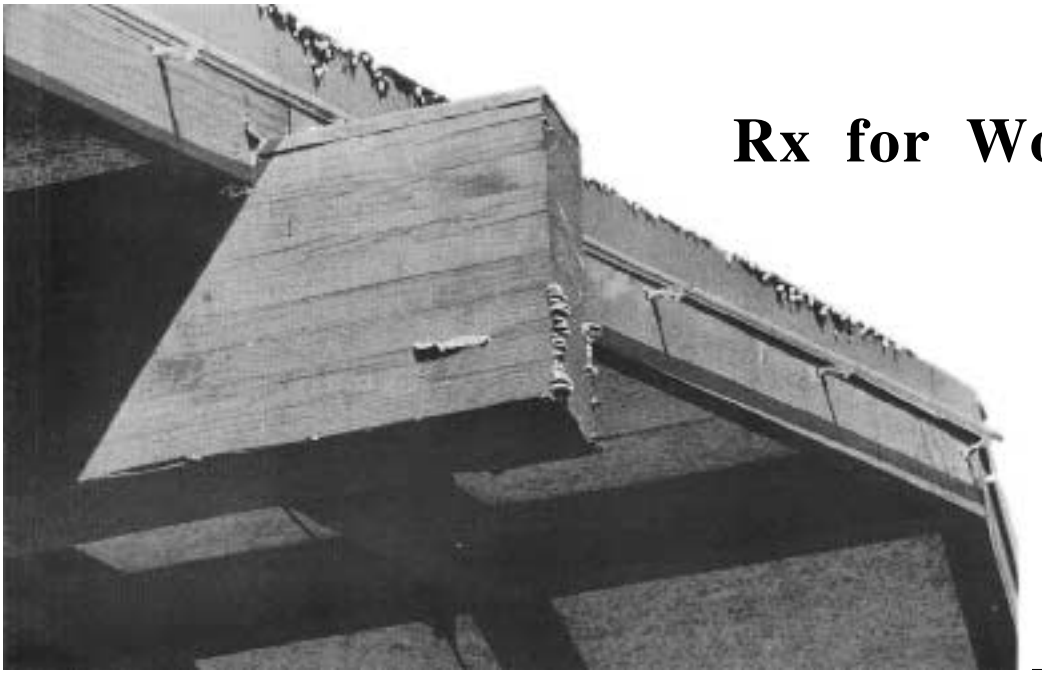


Rx for Wood Decay & Insects

Above all else, keep it dry.

by Terry Amburgey

Throughout the world, one can find wooden structures that have given centuries of service. Many buildings, however, suffer extensive damage by decay fungi and insects within a few years of completion. Why do some wooden buildings last indefinitely while others fail to outlive the mortgage?

Nearly all wood deterioration can be traced to design features that trap moisture under or within structures. The best way to protect wood in buildings from decay fungi and insects is to use properly seasoned wood and keep it dry after construction.

Two other principles follow from this: avoid contact between wood and soil, but if contact cannot be avoided use preservative-treated wood.

Water that wets building components can come from the original water in unseasoned wood, rain, groundwater, condensation, or plumbing leaks. The warmer the region is and the more rainfall it has, the greater the decay hazard will be (see Figure 1). Builders in hot, humid regions, such as the Southeast, must take the greatest precautions.

Decay fungi cannot grow in wood that has a moisture content below 28 to 30 percent, called the fiber-saturation point. Mold and sap-stain fungi cannot grow in wood with less than about 20 percent moisture. Wood in a trouble-free house will rarely exceed 15 or 16 percent moisture content.

The factors that influence the growth of wood-inhabiting fungi are moisture, oxygen, temperature, and a favorable source of food. Fungi are primitive plants that lack roots, stems, and leaves, and are unable to synthesize their own nutrients. Rather, the body of a fungus consists of thread-like strands, called *hyphae,* that grow through organic material (wood) and digest it enzymatically.

Three principal types of fungi inhabit wood: mold, sap-stain, and wood-decay fungi.

Mold and sap-stain fungi use the nutrients found in specialized storage cells in sapwood, and degrade the cell walls. The infection increases the permeability of the wood and its capacity to absorb moisture, but has little effect on wood strength.

These fungi grow best at temperatures between 75 and 80°F. Mold and sap-stain fungi can't attack lumber that has been properly kiln- or air-dried (and kept dry), but they can enter the end grain of freshly cut logs and lumber, or lumber that has become wet. When temperatures are between 50 and 100°F, unseasoned or otherwise wet wood may be attacked within 24 hours. That is why most lumber to be air-dried is first dipped in preservative chemicals.

Mold and sap-stain fungi differ in the way they disfigure wood. Mold fungi have colorless hyphae, but they produce green, yellow, or black spores that discolor the wood surface; this discoloration can be removed by light sanding. With sap-stain fungi, on the other hand, the colored hyphae cause a penetrating stain throughout the sapwood that cannot be removed by sanding. When enough moisture is present, both groups can grow on or through paint films. They frequently discolor house paint.

Decay fungi attack both the heartwood and sapwood, except for the heartwood of species—bald cypress and red cedar, for example—that have high natural resistance. Like mold and stain fungi, decay fungi increase wood's permeability. In addition, they degrade the walls of wood-fiber cells and thus cause significant loss of strength. The optimum temperature for decay fungi varies from species to species, but most grow best between 68 and 97°F. Wood whose moisture content is below the fiber-saturation point or near total saturation cannot be attacked by decay fungi.

Wood whose moisture content is below the fiber-saturation point or near total saturation can't be attacked by decay fungi.

Which Kind of Rot

Fungi can be classified by the type of decay they cause: white rot, brown rot, or soft rot. White-rot fungi prefer to attack lignin, and cause a gradual loss in wood strength as decay proceeds. The wood looks bleached and feels spongy. Brown-rot fungi, on the other hand, prefer to degrade the cellulose of cell walls and cause a rapid loss in strength, even in the early stages of decay. The wood becomes brown and crumbly and breaks into small, cubical pieces.

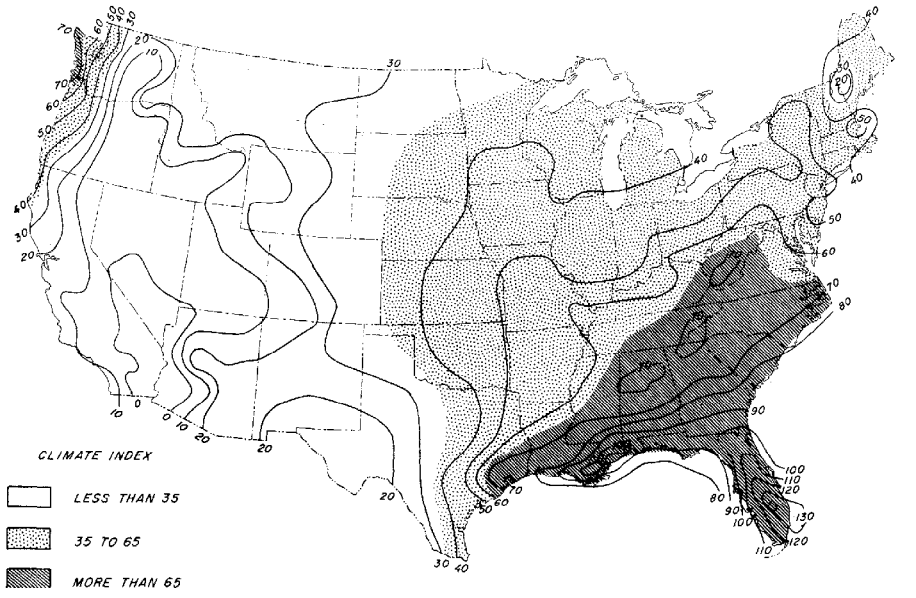


Figure a. *The warmer a region is and the more rainfall it has, the greater its climate index, as shown on the map. Hot, humid areas—such as the Southeast—have the greatest decay hazard.*

Specifying Preservative-Treated Wood

Use pressure-treated wood for all building components that will be in contact with soil or water. Wood that is used structurally should be pressure-treated, even if it is wetted only periodically.

When specifying pressure-treated wood, remember that a preservative treatment is no substitute for the proper grade of wood. If a building component must be of a given grade, treated wood *of at least that grade* should be specified. All treated wood should be grade-marked and bear a treatment-quality stamp from the American Wood-Preservers' Bureau (AWPB) or equivalent.

Since the heartwood of many species is virtually untreatable with preservatives, pressure-treated lumber that is used in severe exposures should have no heartwood faces. Lumber used in preserved-wood foundations should have no heartwood at all.

To avoid exposing heartwood, all cut faces of treated wood should be brushed with or dipped in a water-repellant preservative (WRP). If possible, do not use the cut surfaces in contact with soil.

What preservative and retention should be specified? Wood used in residential construction should generally be treated with one of the waterborne formulations, such as chromated copper arsenate (CCA—primarily used to treat pine) or ammoniacal copper arsenate (ACA— primarily used to treat Douglas fir). Different formulations of CCA are available, but the one commonly specified for residential construction is CCA Type C.

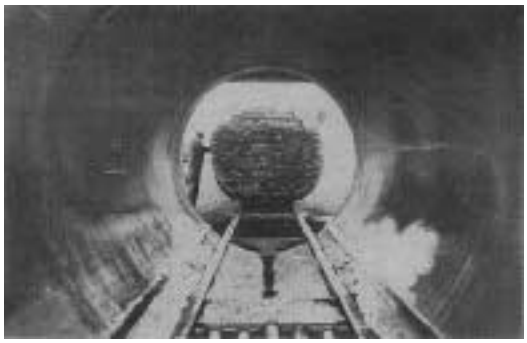
It is preferable to specify that the wood be kiln-dried after treatment (and stamped KDAT) to minimize dimensional changes in use. Applying a WRP to the surface of CCA- or ACA-treated wood that is exposed above ground (e.g., exterior decks, porch rails) will further reduce dimensional changes that cause checking and splitting.

Piles used to support homes—as long as they are not used in unvented or habitable spaces—can be treated with creosote, pentachlorophenol, or waterborne formulations.

The retention level of waterborne preservatives should be specified in pounds per cubic foot (pcf) as follows:

Item	Minimum pcf.
Framing, trim, exterior decking, porch rails	.25 CCA or ACA
Deck supports	.40 CCA or ACA
Wood foundation materials (plywood, studs, plates)	.60 CCA or ACA

—T.A



A treating cylinder at a lumber-treating plant about to receive a load.

Brown-rot fungi cause the most damage to wooden structures. They can tolerate high temperatures and can survive for years in wood that has become too dry for them to grow in. Wood colonized during seasoning or storage, and then dried before use, may still contain living fungi that will begin to grow if moisture becomes available from roof or plumbing leaks.

Soft-rot fungi degrade the middle cell-wall layers, which consist largely of cellulose. The wood softens gradually from the surface inward. This type of decay occurs primarily where wood is used in very wet conditions: water-cooling towers of air-conditioning installations, underwater, and where wood is in contact with soil. These fungi can tolerate higher wood moisture contents than the other types.

Decay fungi can only colonize wood that is above about 28 percent moisture content. However, a type of decay called "water-conducting fungi" (formerly called dry-rot fungi) form rope-like strands, *rhizomorphs,* that permit them to transport water to dry portions of wood. Provided that they have a continual source of moisture (such as contact with the soil), they can decay wood anywhere in a house, from cellar to attic.

The principal water-conducting decay fungus in the U.S. is *Poria incrassata,* a brown rotter. It occurs throughout the Southeast and occasionally as far north as Canada. Fortunately, *P. incrassata* cannot survive in wood that becomes dry. If its source of water is found and eliminated, the fungus will die after the wood begins to lose its moisture.

Termites

Subterranean termites, though most common in the South, live as far north as Canada. In colder states, they are found mostly in urban areas where they can migrate from house to house—places that we conveniently keep warm for them all year long.

Termites feed most actively on wet wood. Wood-soil contacts provide easy access to a house, but subterranean termites can also get into a building through "earthen tubes." They build these on foundation walls or in voids in foundation materials, such as foam insulation. Once they've built the tubes, the termites carry moisture to otherwise dry areas.

Termite shields slow down termites, but can't be relied on for full protection. Termites will find any breaks or seams—and they can build tubes *around* the shields.

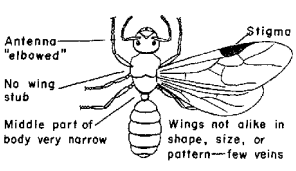
The most effective protection against termites is a toxic barrier around a building. In termite-prone areas, treat the soil under all concrete slabs (including porches, patios, and carports) with a long-lasting "termiticide." Also apply it next to all foundation walls and piers down to the footings.

The soil adjacent to wood foundations should be treated also. Termites can build tubes over the treated wood to get to the untreated wood. Treat slab and foundation perimeters after the grading and landscaping have been completed.

Soil treatment can be a problem if the crawl space is to be used as an airflow plenum. Some experts fear that chemicals applied to the soil can enter the airstream and be carried into the living space. This remains unresolved. Sub-slab heating or cooling ducts can also pick up chemical treatments-if they are penetrated by drilling rods during re-treatment. Sub-slab ductwork should be avoided anyway.

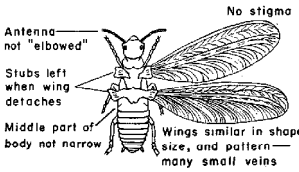
Carpenter Ants

Controlling wood moisture content in structures also reduces the likelihood of carpenter-ant damage. Although carpenter ants do not feed on wood, they frequently burrow through wood that is partially decayed in order to nest. Thus, they are usually found in rafter ends, sills, or other building components frequently wetted by rain or other sources of moisture. Ants often are mistaken for termites in the spring during dispersal flights. If one looks closely, however, the two groups can be distinguished from each other:



ANT

	Termites	Ants
Wings	4 of equal size	1 pair much larger
Antennae	straight	elbowed
Body	equal diameter	constricted in the middle



TERMITE

These groups also can be differentiated by the damage they do. Whereas both tend to remove only the springwood from each annual ring, subterranean termites usually carry some soil in the tunnels. In contrast, the tunnels of carpenter ants are clean and free of debris.

Wood Borers

Wood borers do most of their damage in wet crawl spaces. Like termites, they are most common in the South and in metropolitan areas in colder regions.

The most common wood borers, anobiid beetles, feed on seasoned hardwoods and softwoods. They typically infest crawl-space timbers in homes more than ten years old. Adult anobiids range from 1/8 to 1/4 inch long. When they emerge, they leave a 1/16- to 1/8-inch-diameter hole. Anobiid larvae will not survive in wood that has less than about 12 percent moisture, and will thrive only in moist wood.

Lyctus powderpost beetles infest recently seasoned hardwood sapwood, and often damage new homes. The 1/8 to 1/4-inch-long insects leave tiny holes of less than 1/16 inch in diameter. Lyctus damage is on the rise because more plywood products use tropical hardwood veneer for the inner plies.

Another species, old-house borers, which are up to one inch in length, prefer recently seasoned softwoods. They typically infest the framing and trim of houses less than ten years old, leaving holes of up to 3/8 inch in diameter. This damaging insect is spreading throughout the mid-Atlantic and southeastern states, and is best controlled by fumigation.

Wood in crawl spaces and basements can be protected from wood borers by applying a finish, such as a water-repellant preservative (WRP). The finish seals the pores and fissures where wood borers lay their eggs. If the crawl space is kept dry and well vented, the finish should not be necessary.

The untreated, unfinished, and unseasoned wood that is currently popular in log homes provides prime housing for beetles, as well as fungal decay. Deep checks and cracks in the logs hold water and invite pests. Wide roof overhangs and periodic treatment of log exteriors are essential in decay-prone areas.

Protecting Exposed Wood

Structural timbers are most vulnerable to decay at joints and ends, because end grain readily absorbs water. Detail the building to keep such joints dry. For joints and end grain that cannot be kept dry, use the heartwood of naturally resistant species (for instance, redwood and cedar), pressure-treated wood (see sidebar), or wood that has been protected with brush or dip treatment with a water-repellant preservative.

The bases of wood columns should be detailed to sit off the deck. Otherwise, water is wicked into the end grain.

WRP's consist of either a paraffin- or resin-based water repellant plus a preservative. (Consult the National Wood Window and Door Association for a list of approved preservatives.) All exterior millwork (windows, doors, trim) should be liberally coated with a WRP. All exposed end grain should be dipped, if possible, for about three minutes.

Foundations and Roofs

Exposure to wetting is the greatest near foundations and roofs.

Water should drain away from the building on all sides. On sloped lots, you may need flower beds, retaining walls, swales, or drains on the upslope side to deflect water around the structure. This is particularly important in homes built over crawl spaces that are excavated below the finish grade. (Such sunken crawl spaces can become swimming pools.) If you want a low-profile structure, build up the grade around the building rather than excavate in the crawl space.

The surfaces of all porches, patios, carports, and walkways should slope away from the structure to drain water. And the bases of untreated wooden porch columns should be detailed to sit up off the deck.

Pitched roofs and wide overhangs help keep siding and millwork dry. Roofs with little pitch or overhang, or with water-trapping systems such as recessed gutters, greatly increase the risk of decay. Protect the trim at eave and rake with flashing, and extend roofing shingles an inch beyond the flashing.

Gutters are necessary on roofs that overhang less than 12 inches, or where rainwater spills onto concrete or other hard surfaces.

Wood Roofs

In the past, wood roofs of all-heart redwood or red cedar lasted for decades. But nowadays, many wood roofs of the same species decay in five to seven years.

In old roofs, shingles and shakes were laid—without paper—on narrow, widely separated wooden strips. After a rain, this permitted rapid inward, as well as outward, drying. Wood roofs now are typically laid on solid sheathing, such as plywood, which restricts drying.

Also, modern roofs frequently have lower pitches than older roofs, so they drain more slowly and collect leaves more readily. An accumulation of organic matter promotes wetting and slows drying.

All exterior millwork should be coated with a WRP before painting. End grain—the most vulnerable part—should be dipped.

Wood shingles are failing prematurely in both moderate- and high-rainfall areas. Therefore, in areas with a climate index over 35, use only CCA-treated shingles if laid on a low-pitch roof with solid sheathing. Site-application of a WRP will also increase the life span of wood roof shingles.

An alternative to treated shingles is to fasten untreated shingles to purlins that are placed over the solid roof deck, leaving an air space under them. For purlins, use CCA-treated 1x4s.

Wood-Soil Contact

Untreated wood that touches the soil is almost always colonized by decay fungi or termites. Wood-soil contacts are an invitation to highly destructive water-conducting fungi, which can bring water to previously dry wood and thereby decay an entire house.

The HUD Minimum Property Standards recommend that structural wood members be at least eight inches, and siding six inches, above grade. Too often, however, wood touches soil in the following places: 1) sills or headers that abut earth-filled porches, patios, flower planters, or carports; 2) forms left on concrete foundations; 3) basement posts extending through the concrete floor; 4) wood piers without adequate concrete footings; and 5) siding and wood steps.

If the plans call for an earth-filled concrete porch or patio, build it as a separate structure spaced away from the house. That way, the earth fill is not in contact with wood in the main house. If you want the slab to be joined to the house, pour a structural slab that has space underneath for removing the forms and for periodic inspections. Another option is to pour a monolithic slab that extends down as a wedge against the house, protecting it from the soil fill.

Groundwater also can wet wood by migrating up through block or stone foundations. You can stop this with a capillary break, such as a termite shield, at the top of a masonry wall. In old, porous, brick foundations in the South, a capillary break was made with a layer of slate.

With slab-on-grade construction, a monolithic slab is best: it eliminates the seam between footing and slab where water and termites typically penetrate.

Condensation

If the structure is designed to handle rainwater and groundwater, then condensation problems are not likely unless the house has another strong moisture source.

Crawl spaces, however, need special protection. In the northern states, condensation in walls seldom leads to appreciable decay except around the sill area in crawl spaces. This usually occurs in the spring when the air is warm and moist, but the masonry foundation and wood that sits on it are still cold. The wood is cool enough for condensation, but the air is warm enough to promote decay.

More serious is summertime condensation in the crawl spaces of air-conditioned houses. Widespread decay of floor joists, subflooring, and finished floors can result. Also, as the moisture content of the wood increases, so does the danger of attack by wood-boring beetles.

A sunken crawl space with no vents and drainage toward the house (top) is a prescription for decay (middle). A ground cower and ample ventilation (below) are best.

Except in very dry regions, you should use a heavy poly ground cover with at least one square foot of vent per 150 square feet of crawl-space area. Place some of the vents near corners to avoid creating dead-air spaces.

The vents can be closed in winter to conserve heat, and opened in spring. Vents that automatically open at 70°F and close at 40°F can solve this problem. (One supplier is Temp-Vent Corp., P.O. Box 2030, Shelby, N.C., 704/482-0324.)

Attics should be vented at a minimum of one square foot of vent area for every 300 square feet of attic space. (Double that if there is no vapor barrier.) Half the vents should be at the soffit, and half near the peak. Mansard and flat roofs require continuous soffit vents.

In summary, wood that's kept dry will not decay, and will rarely suffer from insect attack. If you want long-lasting buildings, design and build them to stay dry both inside and underneath. And where wood is bound to be wet or is in contact with the soil, use a preservative treatment matched to the intended exposure. ■

Terry Amburgey researches and teaches wood preservation at the Forest Products Utilization Laboratory at Mississippi State University.