What Causes Wood to Rot?

Q Logs that have been under water for decades are being hauled up out of rivers on the West Coast, and the wood is usable. Yet water collecting in the space between the house and the deck ledger can result in the wood rotting. What's the difference?

A Colin McCown, executive vice president of the American Wood Protection Association (AWPA; awpa.com), responds: Wood rot is caused by several kinds of fungi. Mold and stain fungi primarily discolor wood and don't cause any significant loss in strength. Decay fungi, on the other hand, actually break down the cellular structure of wood, which does cause significant strength loss. They do this by secreting enzymes or producing chemical reactions that dissolve some of the constituents of wood cell walls. The activity of decay fungi is apparent when the wood becomes either darker or lighter than surrounding wood, develops checks and cracks in the discolored area, and is obviously softer or more brittle than solid wood.

Decay fungi are primitive plants, and like most other organisms, they require four basic conditions to survive. In some respects, they need the same things that people need to live:

Oxygen. In most cases, the air needs to contain at least 20 percent oxygen for decay fungi to operate.

Water, but not too much. Water is essential for all living things, and decay fungi are no exception. Wood is porous and can hold water, much like a sponge. If there is only a little water present in the wood, the fungi cannot survive. If there is too much, it can deprive the fungi of the oxygen it needs — as in the case of the logs in your question, which were completely submerged under water that had a low oxygen content. A moisture content of 20 percent to 30 percent provides sufficient water for fungi while allowing oxygen to be present within the wood cells.

Moderate temperatures. The ideal temperature for decay fungi is between 70°F and 90°F. Most decay fungi die when exposed to temperatures above 130°F and become dormant at temperatures below 40°F.

Food. In this case, the food for the fungi is the wood itself. In addition to being a food source, wood shelters the fungi, insulating it from temperature extremes and providing a reserve of oxygen and water.

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All of the above conditions must be met in order for decay fungi to thrive — if even one is removed from the equation, fungi cannot attack the wood. Although we can control moisture to some extent, it is difficult to completely keep water, oxygen, or favorable temperatures from affecting wood used outdoors.

Depriving the fungi of its food source by using chemical wood preservatives that make wood inedible to decay fungi is the traditional method of wood protection. The pressure-treatment process drives such preservatives deep into the wood fiber. New methods being developed seek to modify the wood fiber itself with heat or by creating a barrier that decay fungi cannot penetrate.

Wood used outdoors should always be pressure-preservative treated. This is especially so in locations susceptible to attack by decay fungi, such as at connections where moisture can accumulate and anywhere wood is near or in contact with soil.

Building codes allow the use of naturally decay-resistant woods such as redwood and western red cedar. However, this isn't as simple as it sounds. Because older trees contain a higher concentration of extractives that protect the heartwood, there is believed to be a direct correlation between the age of the tree and the natural decay resistance of its heartwood. We don't harvest centuries-old cedars and redwoods anymore, but we do harvest much smaller second- (and third- and fourth-) growth trees. These younger trees contain more sapwood and less heartwood. The outer band of sapwood, however, has little to no decay resistance. If naturally durable species are used, make sure no sapwood is present.

The American Wood Protection Association (a non-profit society that develops standards for wood-protection technologies, some of which are code-referenced) recommends — for the best reliability and performance — that you specify treated wood that meets AWPA Standard U1. AWPA Standard M4, in addition to requiring the use of pressure-treated wood, requires that copper naphthenate, a topical wood preservative, be applied to cut ends of and holes drilled in heavy timbers,

thin-sapwood species such as Douglas fir and hem-fir, and lumber that's mostly heartwood from thick-sapwood species like southern pine. Topical preservatives do not penetrate deeply into wood, so they should never be used as a substitute for pressure-treated wood.

Pressure-treatment preservatives do a great job of making wood inedible to fungi, but they don't always fully penetrate the entire piece of lumber. Heartwood is extremely difficult to penetrate, and the natural variability of wood may allow for some untreated sapwood to be present near the center of the lumber. Consequently, if water can get to the heartwood or untreated sapwood through deep checks in the surface or by absorption, the lumber is vulnerable to attack by decay fungi.

So even with pressure-treated lumber, it's important to control moisture to slow down the growth of decay fungi. Most outdoor structures are subject to rain and snow, and wood preservatives alone cannot keep the wood from absorbing water. To supplement the protection of pressure treatment, some type of water-repellent finish should be used. That will also provide the benefit of reducing checking and weathering of exposed wood.

Some pressure-treated wood has a water-repellent additive applied during the treatment process, but even then the USDA Forest Products Laboratory recommends the use of a semi-transparent oil-based stain. This particular type of finish penetrates the wood, provides UV protection, and repels water without forming a film on the surface of the wood. Routine maintenance with this kind of stain will prolong the appearance as well as the service life of the structure. It's also not a bad idea to keep water off the tops of joists and beams — and especially ledgers — with some sort of flashing compatible with the treated wood.

Wood products can last a lifetime if properly specified, used, and maintained. Wood is one of the most "green" materials available, because it's renewable and it sequesters carbon. ❖

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