United States
Department of
Agriculture

Forest Service

Forest
Products
Laboratory

General
Technical
Report
FPL–GTR–215

Build Green: Wood Can Last for Centuries

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Abstract

This report updates and revises information from the 1976 Forest Service publication by Rodney C. DeGroot, "Your Wood Can Last for Centuries." It explains why wood decays, alerts the homeowner to conditions that can result in decay in buildings, and describes measures to prevent moisture-related damage to wood.

Keywords: moisture, decay

Acknowledgments

The authors thank Dr. Jessie Glaeser and Steve Easley for their technical review and all contributors of photographs that are credited throughout the report.

Cover photo: The Fairbanks House in Dedham, Massachusetts, circa 1636, is the oldest reported frame house still standing in America today. (Permission from the Digital Archive of American Architecture.)

August 2012

Clausen, Carol A.; Glass, Samuel V. 2012. Build green: wood can last for centuries. General Technical Report FPL-GTR-215. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 24 p.

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The Forest Products Laboratory is maintained in cooperation with the University of Wisconsin.

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Introduction

Wood is our most valuable renewable resource and its use in home construction affects our environment in ways that are not obvious to most homeowners. Efficient use of wood as a green building material promotes healthy forests that, in turn, clean the air of greenhouse gases and purify drinking water (Ritter and others 2011). Wood is not only a versatile structural material, but its use for home construction also reduces the effects of climate change by storing carbon for as long as the home exists, so the longer the service life, the greater the benefit. One limitation that can shorten the service life of a structure is wood's vulnerability to moisture and decay. Yet wood buildings can last for centuries without decay problems. Why do some homes built of wood last for centuries while others develop decay soon after construction? Because wood is a biological material. When it is used properly, wood does not deteriorate. However, when misused, wood succumbs to the same biological process that decomposes dead trees in the forest. In other words, it is rotted by fungi or eaten by termites, or both! In the forest, decomposition is a necessary and worthwhile process, but to a homeowner it means costly repairs.

This paper is intended to explain why wood decays and to alert the homeowner to conditions that cause decay in buildings. Being alert to decay hazards can prevent future damage to your current or future home and construction projects. Often, you will find that simple procedures provide remarkable protection. Other times, more drastic repairs are necessary to correct damage and prevent recurring problems. Whatever the damage, it will surely get worse unless you locate the problem and correct it. These historic wood-framed structures illustrate that properly constructed wood buildings can last indefinitely.

The Parson Capen House was built in 1683 in Topsfield, Massachusetts. The building design and construction detail that do not allow water to collect are fundamental features that have contributed to over three centuries of service by this house. (Photo provided by the National Park Service.)

The Jonathan Ashley House was built in Deerfield, Massachusetts, in 1734. (Permission from Historic Deerfield, Inc.)

The Marrs Log House near Harrodsburg, Kentucky, was built in 1793. (Photo provided by the Library of Congress.)

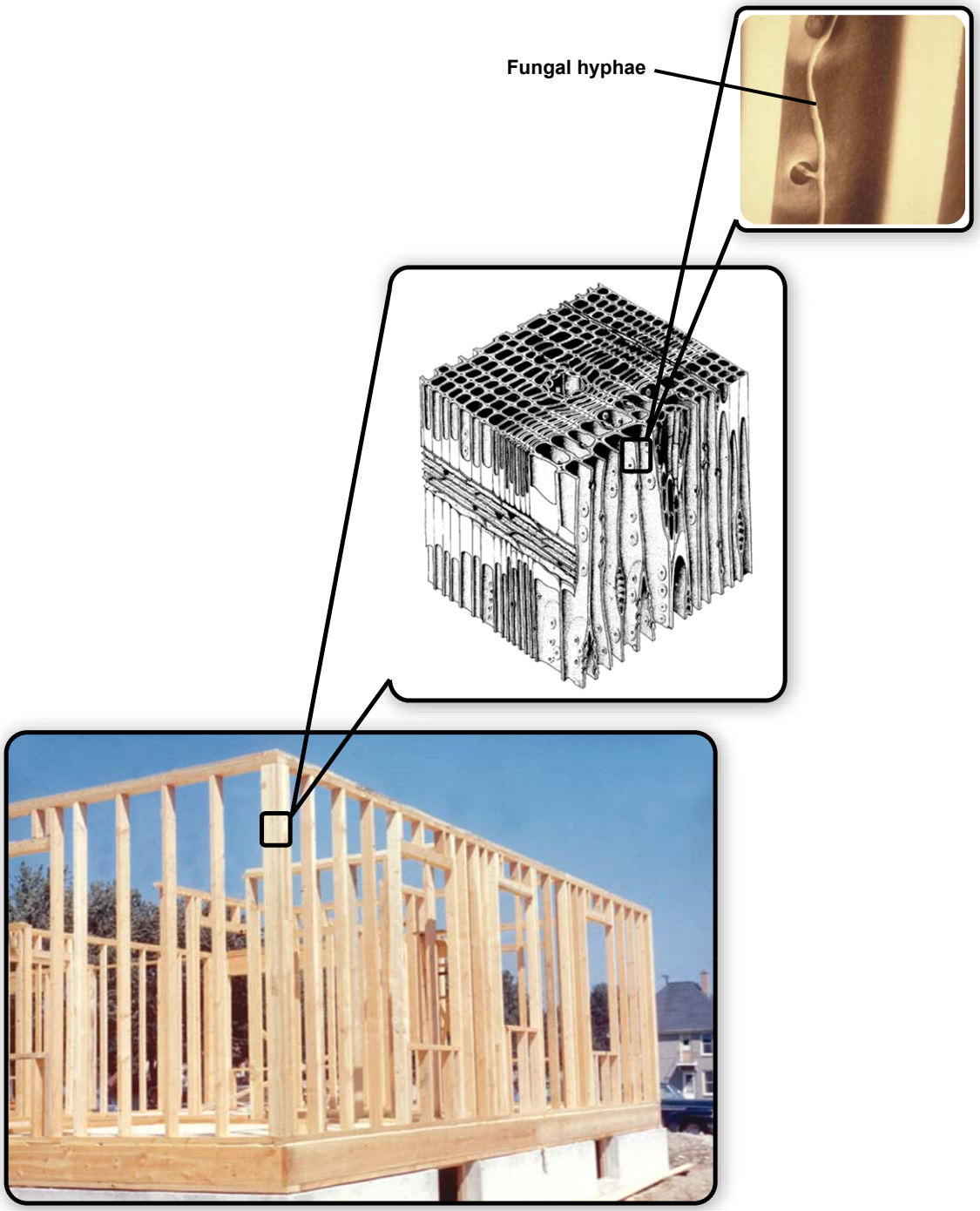
The Carson Mansion in Eureka, California, built in 1884, is just one example of magnificent west coast Victorian structures constructed during the late 19th century that are still in service. (Photo by Carol Clausen, FPL.)

What Is Wood Decay?

A close-up look at wood through a microscope reveals that it is made up of many thick-walled cells that are like hollow tubes running through the wood. The arrangement of the cells varies to give different types of wood different properties, such as appearance, strength, or resistance to decay.

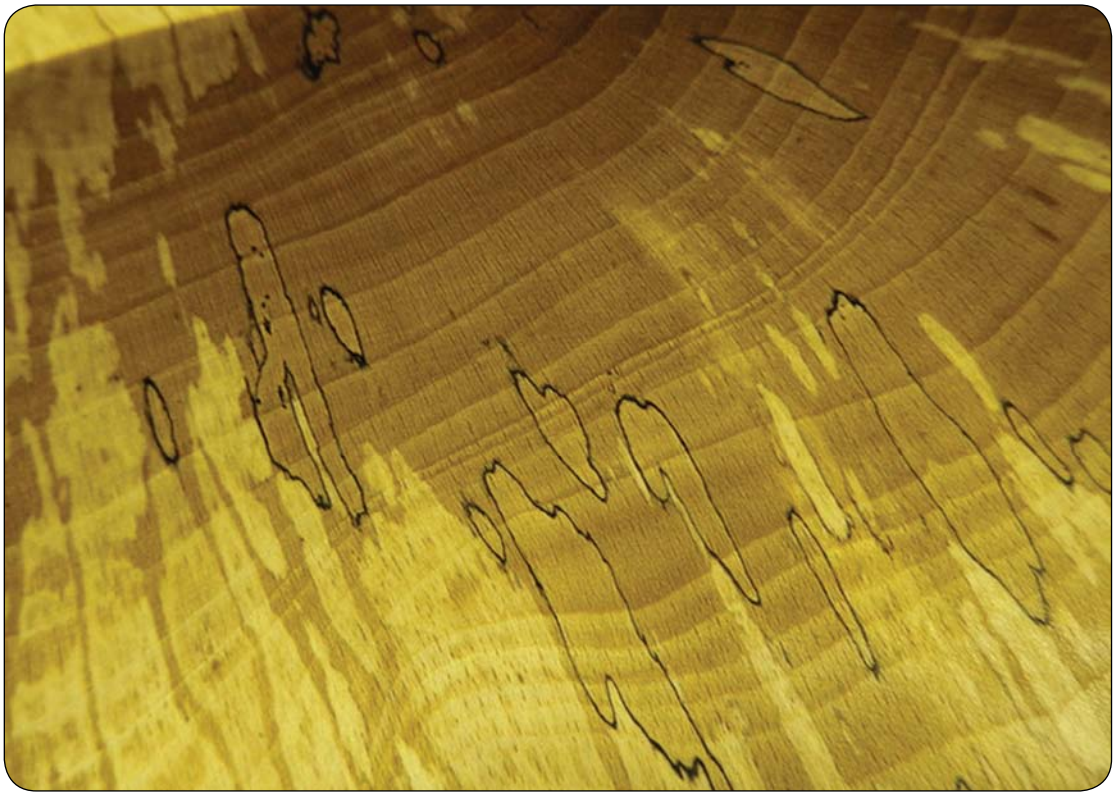
Decay is caused by microscopic thread-like fungi that attack the thick cell walls of wood. To live, decay fungi need four things: favorable temperatures, moisture, air, and suitable food material. If the other conditions are right, fungi get their food from wood. Controlling their growth usually results from depriving fungi of the one condition that is simplest to control—water. It is important to know that water by itself does not decay wood. Moist wood is more likely to decay because the spores (like seeds of a flowering plant) from which decay fungi grow and attack wood cells are everywhere in the environment. If provided with enough moisture, these fungi will destroy the cell walls and weaken the wood.

In the advanced stages of decay, fungi produce fruiting bodies (mushrooms) on wood. Each fruiting body produces billions of spores that when released are blown about by the wind. If they land on moist wood, they may begin growing and start the decay process again.



Hyphae (pronounced “highfee”) are thread-like fungal structures that are capable of moving from wood cell to wood cell when they grow within a piece of wood. As they grow, fungal hyphae use the wood for food, causing structural damage called decay.

Some fungi cause a brownish discoloration and the wood readily breaks into small cubes. This is known as brown rot.



Other fungi cause a bleached appearance that may be surrounded by very dark lines of discoloration. This is known as white rot.

When wood decay is in the advanced stages, decay fungi often produce a fruiting body or mushroom that contains billions of spores. (Photo by Stan Lebow, FPL.)

How Do Composite Products Differ from Solid Wood?

Composite products such as oriented strandboard (OSB) are composed of pieces of wood that are held together with adhesive. Composites are an efficient way to use wood that cannot otherwise be cut into lumber or timbers. They make up a growing proportion of products such as rim board and I-joists that are used in home construction.

Composite products make up an increasing proportion of building materials in home construction.

Without Water, Decay Cannot Occur

Buildings should be designed to minimize wetting of wood or to maximize how quickly wood dries when wetted by rain. As an example, cliff-dwelling ruins at Kiet Siel in northern Arizona date back to the 13th century. Dwellings in this semi-arid region are sheltered from occasional precipitation by cliffs overhead. Wood beams and superstructures have remained sound for centuries because they have always been too dry to decay.

The cliff dwelling ruins at Kiet Siel in northern Arizona date back to the 13th century. (Permission from the Wetherill family.)

We have made the point that dry wood will last indefinitely, so it might surprise you that wood can also be too wet to decay.

Just like all living organisms, fungi require oxygen to live. When wood is submerged in water, air is driven out of all the cells, and decay fungi cannot grow. As an example, the remains of 34 Byzantine ships dating from between the 7th and 11th centuries were uncovered below sea level in Istanbul, Turkey. Wood remained intact because there wasn't enough oxygen to permit the growth of wood-decay fungi. (Buket and others 2009)

If Wood Cannot Be Kept Dry

Sometimes wood must be used where it will be continually wetted. When this happens, use wood that can resist decay, such as preservative-treated wood.

Preservative-Treated Wood

Pressure treatments force wood preservative chemicals into solid wood. Such treatments are designated for above-ground use or in-ground contact (buried in soil or touching soil). It is important that you specify the right treatment for your specific need and that you insist that the treatment be of certified quality and be labeled accordingly.

For some uses like window frames and sashes, pressure treatment is not necessary. Such items are usually sold with a surface treatment that includes a water-repellent preservative. The surface treatment doesn't penetrate deeply into the wood, but it does prevent fungal decay and reduces water absorption.

Composite products for exterior applications, such as marine-grade plywood, composite siding, or exterior grade OSB, may be treated with preservative chemicals. Wax added to the adhesive provides additional protection from water.

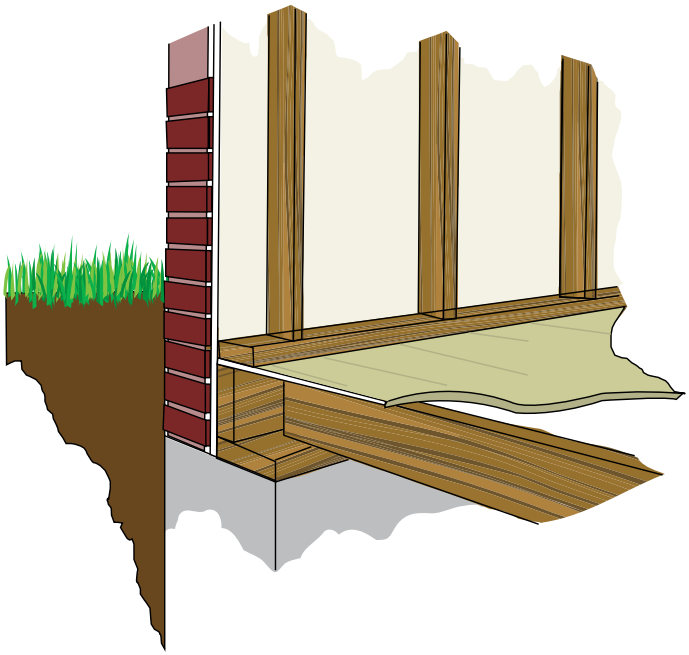
Naturally Decay-Resistant Wood

Heartwood (wood in the center of the tree trunk) of several tree species is naturally resistant to some decay fungi and is suitable for some uses. For example, California redwood and western redcedar are the principle decay-resistant woods used in U.S. construction applications.

Primary Sources of Moisture Leading to Wood Decay

Soil Contact

Soil usually provides a continuous source of moisture for decay fungi. This is sometimes overlooked when new rooms are added, flower beds are made, or the grade on the lawn is determined. If solid wood in a permanent structure is intended to be in contact with the soil, it should be treated with a preservative approved for ground contact. Preservative-treated wood has greater resistance to decay fungi than do naturally decay-resistant woods. A common homeowner and contractor mistake following construction projects is to set the finish grade for soil or mulch above the level of wood framing. Where untreated wood is used in a structure, it should be at least 8 in. above the finish grade for framing members and 6 in. above finish grade for siding. Composite products should never be used in contact with soil.

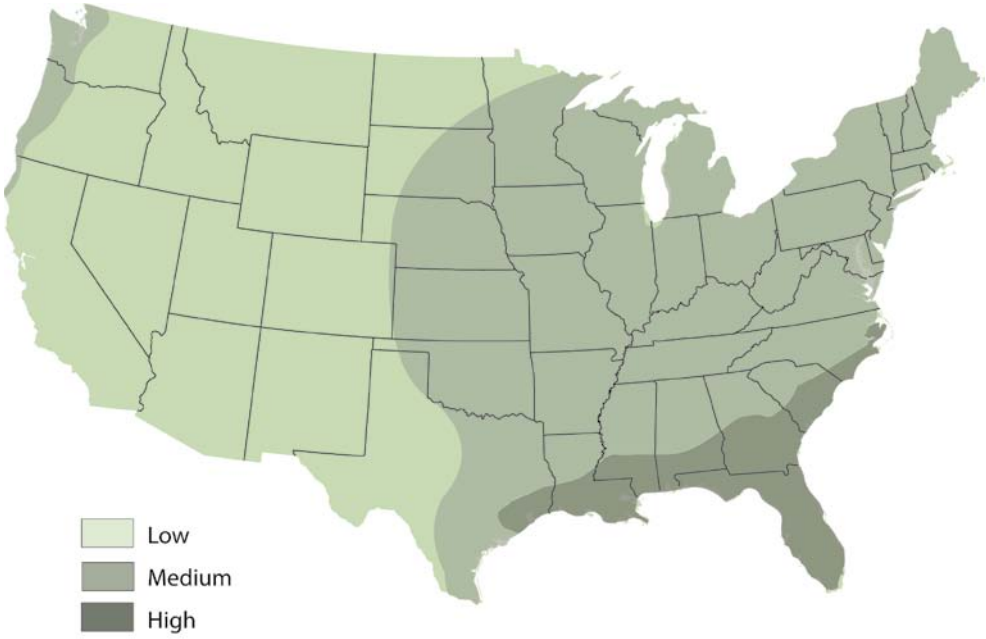


Soil graded high against the exterior brick veneer (above) will contribute to decay problems in untreated wood members below the grade line. Similar problems will occur with soil graded high against stucco and siding. The finish grade on the yard (below) is above the level of wood framing inside the wall. To make matters worse, the lawn sprinkling system is providing constant wetting of the stucco siding on this home. (Photo provided by Steve Easley, Steve Easley & Associates, Inc.)

Frequent Rains

The natural hazard for decay of wood used above ground is greatest in regions with high rainfall and mild climate. In the contiguous United States, this occurs in the Southeast and Northwest.

The decay hazard for homes is greatest on the side that is exposed to prevailing rains. This is most noticeable in the region of highest decay hazard, where greater precautions against decay may be needed on the more exposed side of the house than on the remaining sides.



Three zones of decay hazard.

A high-decay hazard can be artificially created when wood siding is repeatedly wetted by a lawn sprinkler, faucet, or vegetation that is planted too close.

Rain Seepage

Decay frequently occurs in joints, where boards or beams are joined together, while the rest of the structure remains sound. One reason is that water gets trapped in the joints. Another reason is that the ends of the boards or beams absorb water much more rapidly than the sides do because of the arrangement of the wood cells. Just as these cells conduct water up the stem of the living tree, they similarly conduct water lengthwise in boards or timbers cut from the tree stems. Each of the many thousands of cells that are exposed at the cut ends of boards behave like a soda straw. Water moves more quickly through the length of each cell than it does through the thick cell walls. So, water is absorbed rapidly from the ends of a cut board, but water is absorbed more slowly through the sides of the board.

Joints that trap water and dry slowly are prone to decay. (Photo by Lonnie Houghton.)

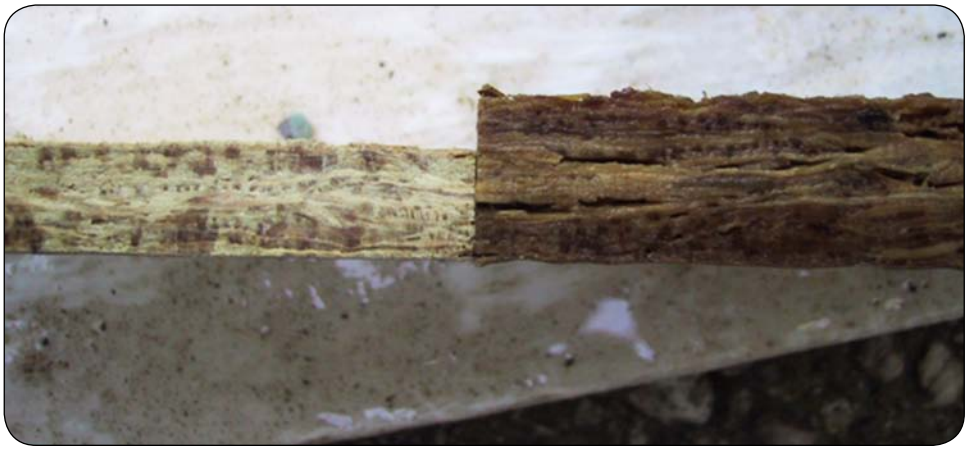
In thin wood materials such as siding or fascia boards at the edges of roofs, water is absorbed primarily through the ends. In larger beams or timbers, water is absorbed in two ways: through the ends and through checks or cracks that occur naturally in the upper surface as wood weathers. Water collects in the checks during each rain, swelling the wood, which in turn closes the checks and hinders drying. Similarly, exposed beams composed of several layers of smaller timbers nailed together may be wetted by water that gets trapped between each layer. Trapped moisture dries slowly and contributes to a decay-hazard situation. Large, load-bearing timbers that are exposed to weather should be preservative-treated. Additionally, their top surfaces should be flashed to prevent water from entering through checks.

Water running around roof edges and onto wood below can get trapped in joints and is absorbed rapidly at cut ends of wood trim and beams. Paint failure and decay begins at these points.

Preventing absorption of water at the ends of solid wood siding and entry of water around window and door openings is most important in high-decay hazard zones, especially where storms come predominantly from one direction. Butting siding against vertical trim provides maximum opportunity for rain seepage into the siding. Capping or sealing the ends of wood siding provides excellent protection against end-grain absorption. When siding is being replaced, a thorough building inspection for hidden water damage and decay is possible. Re-siding provides an opportunity to replace faulty window flashings and to install kick-out flashings and building wrap.

Improper installation of flashing, sheathing, and trim can lead to absorption of water by building materials and hidden decay inside the wall cavity of the structure. (Photo by Carol Clausen, FPL.)

Composite products, such as OSB or plywood sheathing and subflooring, can absorb water more readily than solid wood, particularly from cut edges that are wetted repeatedly. Absorbing water causes these products to swell (or in the case of plywood, to delaminate); once these products have absorbed enough water to swell, they dry very slowly and are vulnerable to decay during that time. When they eventually dry, they do not return to their original dimensions and consequently lose strength. Thus, it is very important to minimize wetting in the first place and to maximize drying when composites are exposed to water.



Close-up end view of OSB (left) and wetted OSB (right) that has absorbed water and swelled. (Photo provided by Steve Easley, Steve Easley & Associates, Inc.)

Water Flowing off The Roof

Many decay problems are caused by roof construction that does not allow rain to move off the roof and away from the house. In some houses, water flow over the roof is interrupted by chimneys, dormers, or adjoining walls. Such features are not problematic if they are flashed properly to make the roof watertight. A common water management detail that is often neglected is kick-out flashing. Kick-out flashing is used where a roof terminates adjacent to a wall to direct water from the roof away from the wall and usually into a gutter without the flashing, water runs down the wall.

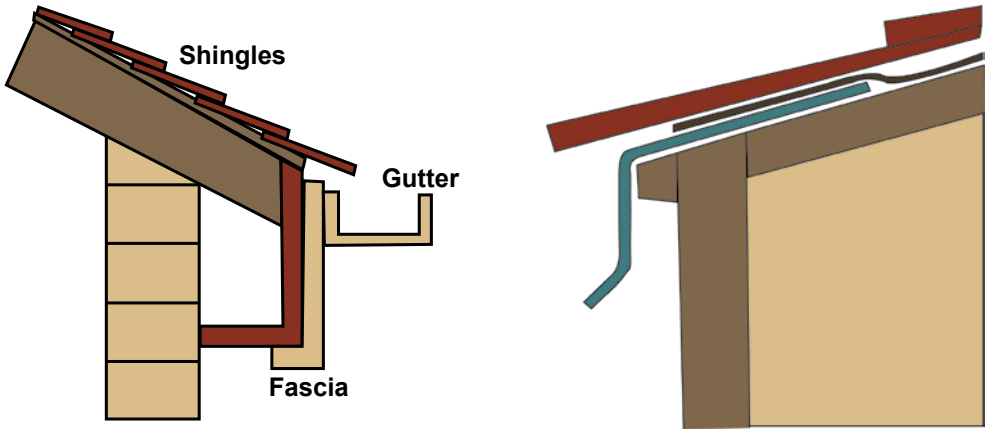
Even slight leaks can produce serious decay problems in OSB or plywood roof sheathing because a large volume of water run-off occurs during each rain, and wood that is wetted by the leak has little opportunity to dry rapidly. Adequate flashing is essential in such areas.

Without kick-out flashing and proper gutter placement, water flowing off the roof runs down the siding. (Photo provided by Steve Easley, Steve Easey & Associates, Inc.)

Properly installed kick-out flashing. (Photo provided by Scott Butler, DryFlekt Products, Inc.)

Serious problems can occur in the roof of a house if flashing is not properly installed between the roof and dormer. Note that the wood siding on the dormer is wicking water from the roof because it is touching the shingles.

Wood trim at the edge of the roof (fascia) is continually exposed to moisture and is prone to decay, particularly in areas of high-decay hazard. Water tends to "curl" under the edge of the shingles and flow back toward the trim. Shingles must be extended far enough beyond the edge of the roof, and metal edgings must be carefully positioned so that water flowing off the roof clears the trim. Leaking and overflowing gutters further wet the trim. Homeowners should keep rain gutters clean and in good repair. In areas of high-decay hazard, use of decay-resistant or preservative-treated wood for roof trim is recommended. This is especially true for roofs with low pitch. For additional protection, wood trim is often clad with vinyl or aluminum.



If shingles and metal edging don't extend enough beyond fascia board, water that curls under the shingle will drain over wood trim and roof edge leading to paint failure and decay. To prevent this from occurring, use preservative-treated wood for roof trim, install fascia at right angles to the slope of the roof, extend shingles far enough beyond roof edge, and install metal edging so that the drip line from the roof will clear the wood trim.

Splashing Rain

Water flowing off the roof and splashing against the house may also wet wood siding enough to permit decay. This problem frequently occurs where water flows from the roof onto a hard-surfaced patio, sidewalk, or entryway parallel to the home. Sometimes this problem is inadvertently increased through the use of diverters over the doorway such as an entry canopy. If the stream of water draining from the diverter flows or splashes against exterior woodwork, wood that otherwise could provide satisfactory service may decay. Usually, this hazard can be prevented through careful design of house and entryway and through appropriate use of preservative-treated products at the time of construction. In existing houses, rain gutters should be installed with downspouts that direct water away from the house.

A wide roof overhang directs water runoff from the roof away from the exterior walls. The splash zone is also moved farther away from the building. (Photo by Carol Clausen, FPL.)

Water Collecting Against Wood

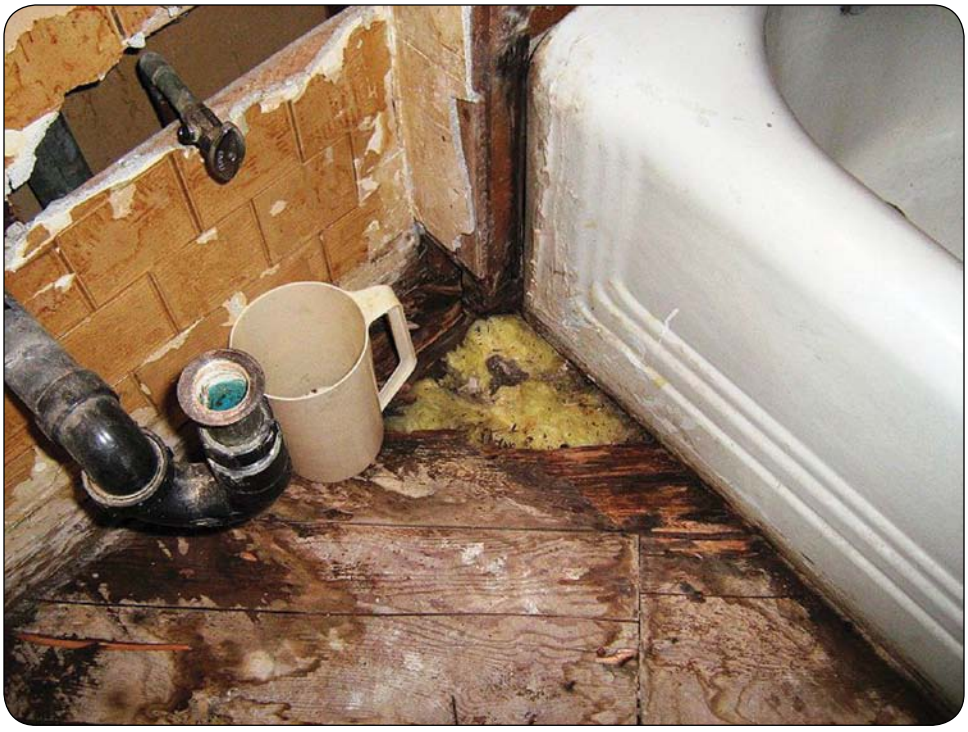
Water pooling on the hard surface of a porch, sidewalk, or patio as a result of draining from the roof presents another decay hazard.

Decay problems arise in the base of porch posts, entryway trim, and door jambs that rest directly on sidewalks, driveways, or porch and patio slabs. Wood resting in pooled water results in water wicking into the end grain of the wood through capillary action. Bases of wooden posts need protection, particularly in regions with high hazard for decay. Preservative-treated wood is recommended in these applications. Otherwise, be certain that roof runoff is directed away from these structures and that posts, trim, and door jambs do not rest directly on the hard surface.

Wood resting directly on a sill makes it prone to decay.

Plumbing Leaks

Obviously, wood that is wetted continuously by plumbing leaks will decay. The leak itself is not always as obvious. Spillage behind a washing machine, leaks in caulk at the top of a bath tub, or plumbing leaks in a shower stall often go unnoticed for a long time. If so, they can lead to a serious decay problem in the floor and lower parts of interior walls. Annual inspections and minor home maintenance can prevent this type of problem.



Leaks in plumbing can be difficult to spot since pipes are typically hidden behind the fixture or the wall. Watch for damage at corners of the floor trim and water stains on the ceiling beneath the bathroom, kitchen, or laundry room. Concealed leaks can cause serious damage over time if they are not located and fixed. (Photo provided by Steve Easley, Steve Easley & Associates, Inc.)

Condensed Moisture

Moisture can condense, accumulate in wood, and lead to decay in walls, attics, and crawl spaces if there is a

- source of moisture,
- way for moisture to be transported into wood, and
- lack of drying capability.

Many houses are built over a crawl space foundation. Crawl spaces can be built in a number of ways: 1) open pier-and-beam construction; 2) enclosed crawl space with vents; 3) enclosed crawl space without vents. Moisture management differs for each type of crawl space. The primary source of moisture is usually evaporation from damp soil under the house. In general, the soil around the foundation should be graded so that water drains away from the building.

Moisture from soil beneath the house can condense on the subfloor and floor joists in enclosed crawl spaces. Eventually, the subfloor and floor joists can become wet enough to decay in as little as 5 to 15 years.

Decayed subfloor and floor joists. (Photo provided by Advanced Energy, Raleigh, N.C.)

This problem can be prevented by placing a vapor-resistant covering, such as polyethylene sheeting, over the soil in the crawl-space area. The vapor-resistant covering should extend at least 8 in. up the foundation walls and any protrusion such as a chimney to minimize moisture as much as possible. Ground covers are recommended for enclosed crawl spaces everywhere except in the driest climates.

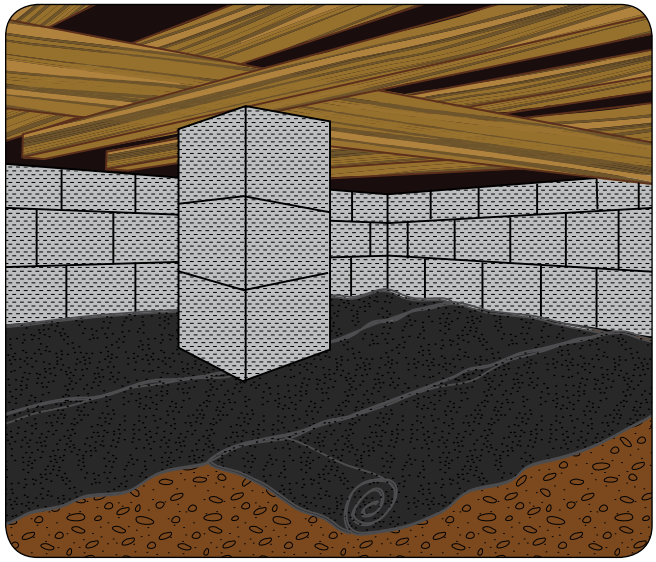
Obviously, a ground cover will not be effective against other sources of water intrusion from improper drainage. A ground cover does little good under a house if water collects on top of the cover.

Another potential source of moisture in crawl spaces is humid outdoor air during summer months, particularly for air conditioned houses in humid climates. At times, venting will introduce moisture to the crawl space rather than get rid of it. This can lead to moisture issues when the crawl space is cool relative to the warmer, humid outdoors.

Polyethylene ground cover professionally installed. (Photo provided by Advanced Energy, Raleigh, N.C.)

Enclosed crawl spaces without vents are designed to keep the humidity out. They rely on supplying conditioned, dehumidified air to maintain a dry crawl space.

Open pier-and-beam construction generally does not require a ground cover because the amount of air flowing under the house is sufficient to carry away excess moisture.

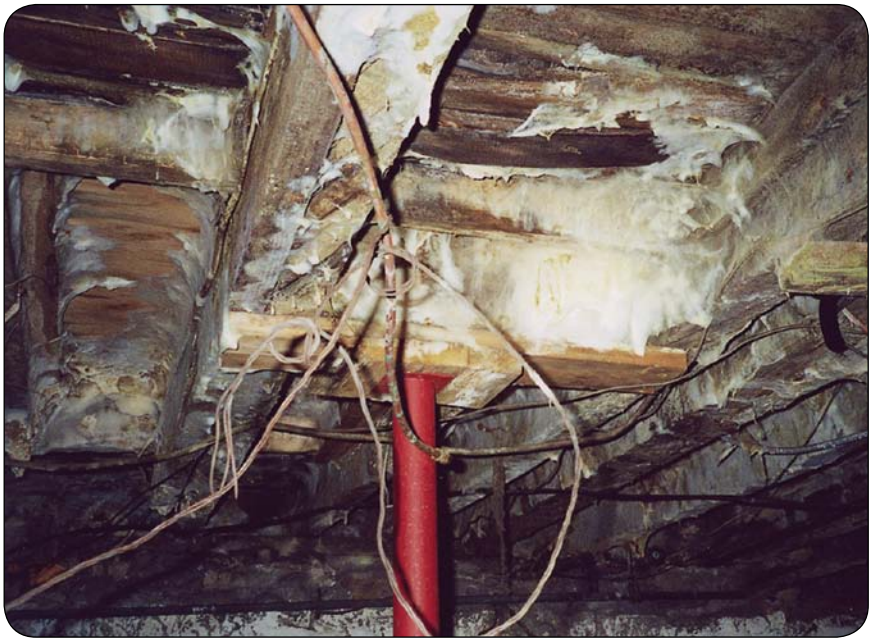


Polyethylene sheeting installed by the homeowner can be quite effective at reducing moisture in a crawl space if care is taken to extend the sheeting up foundation walls and all protrusions, such as a chimney.

Open pier-and-beam crawl space generally does not need a ground cover. (Photo by Samuel Glass, FPL.)

Keeping Wood Dry Isn't Always Enough

All wood-decay problems described so far occur only when decay fungi grow in wet wood. But one kind of fungus is uniquely capable of transporting its own water from a source of moisture (usually soil) into wood that is typically too dry to decay. Although decay by such water-conducting fungi is uncommon, when it occurs, it is devastating. Large areas of flooring and walls can be destroyed each year unless the fungus is stopped. Ironically, it may be the easiest fungus to prevent or control. Unlike typical decay fungi that start growing from airborne spores, water-conducting fungi usually start growing from previously infected lumber that forms a bridge between the soil and other wood in the house. This can happen if old, discarded beams that have been lying on the ground are used in home repairs or additions; new wood has been improperly stored in contact with soil; or infected wood waste is used as fill under a porch or addition. This type of decay can be stopped by simply breaking the contact between susceptible wood and the source of moisture. Once the water supply is broken and the infected wood dries, the fungus will die.



Dry rot starts when an infected piece of wood forms a bridge between soil and other wood in a house. (Photo by Carol Clausen, FPL.)

Does Painting Protect from Wood Decay?

Coatings that form a moisture-impervious film are effective in preventing decay if the seal where two pieces of wood are joined is kept intact. A well-maintained film of paint over the wood and good paint seals in the joints shed water, thus protecting wood by keeping it dry. Cracked paint seals permit entry of water and contribute to decay. Water seeping through the broken seal where wood is joined together will be rapidly absorbed at the ends of the wood pieces; its loss by evaporation from the sides of the wood member is retarded by the impervious, intact paint film over the rest of the wood. This keeps the wood moist and favors decay, at least near the joints. The effectiveness of a moisture-impervious paint in protecting wood from decay depends upon the quality of the seal in the joints.

Keeping the paint seal at wood junctures intact is critical. These are the points where moisture can seep into wood.

Wood Structures

The same principles of decay that are applicable to buildings also apply to wooden decks, fences, boardwalks, pergolas, gazebos, planters, and playground structures.

The greatest decay hazard exists at the ground line. Pressure-treated wood approved for use in the ground is recommended. A lesser, but still important, decay hazard exists where horizontal rails, stringers, or timbers are joined together and where vertical boards fasten to the structure. Both of these locations collect water and dry slowly. Use preservative-treated wood in these areas, and keep vertical boards off the ground.

Using treated wood for exterior applications will eliminate decay worries in decay-susceptible zones at ground line and the intersection of post and horizontal rail. (Photo by Carol Clausen, FPL.)

What Can Be Done to Promote Long Service Life from Wood?

1. Recognize the conditions that present a decay hazard for wood.
2. When new construction is planned, protect wood from moisture and decay hazard by proper design.
3. For above-ground uses where wood cannot be protected from excessive moisture, use decay-resistant wood, preferably preservative-treated.
4. Where wood in permanent structures is in contact with soil, use preservative-treated wood that is approved for ground contact.
5. When decay is detected, take corrective action to locate and stop the source of moisture, otherwise decay will only get worse!
6. Contact professionals for additional advice and assistance.

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