

Finishing Wood Decks

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Abstract

Wood decks have become an important part of residential construction in recent years. However, there is considerable confusion regarding how these structures should be protected with finish. This paper summarizes the types, application techniques, and expected service lives of various finishes on both preservative treated and untreated lumber. Recommendations are made on the basis of decades of research on various wood species using a wide variety of finishes.

Introduction

For optimal long-term performance, a wood deck should be maintained with a finish after construction. The horizontal surface, foot traffic, ponding of water, and full exposure to sun and rain make deck finishing more demanding than other wood finishing (e.g., exterior walls and interior floors). A full range of both penetrating and film-forming finishes are available, but the penetrating finishes provide better overall performance and provide easier refinishing (Cassens and Feist, 1991).

The primary function of any wood finish is to protect the wood surface from natural weathering processes (sunlight and water), and to help maintain its appearance. How well the finish accomplishes this function depends on how it was formulated, particularly the type and amount of polymer (resin or binder), pigment (including extenders), solvent system, and additives used. Of these components, the type and amount of polymer and pigment most directly affect the mechanical properties and durability of the finish. Other factors that affect the durability of a finish include application technique, time between refinishing, extent to which the surface is sheltered from the weather, and local climatic conditions.

Available Finishes

Penetrating Finishes. The advantage of a penetrating finish over one that forms a film is that the wood can breathe, and the finish cannot flake, crack, or peel. Such treatments reduce water absorption, and retard the growth of decay and staining microorganisms. Penetrating finishes can be used as a pretreatment for other finishes or as a natural finish for

wood. There are three types of penetrating finish: Water repellents, water-repellent preservatives, and solvent-borne semi-transparent stains.

Water Repellents and Water-Repellent Preservatives. The difference between a water repellent (WR) and a water-repellent preservative (WRP) is the inclusion of a mildewcide in the WRP. Mildewcides inhibit mildew growth on the surface, and provide moderate protection against decay in above-ground use. The WRPs are not intended for use in wood that is in contact with the ground and should not be confused with the preservatives used to pressure treat wood. The WRPs provide short-term, aboveground protection against decay for untreated wood, and for sections of the wood that either did not take the preservative treatment (heartwood) or for the interior of large cross-sections that were exposed by cutting or drilling. The addition of the mildewcide also prevents mold and mildew growth on wood treated with waterborne preservatives, such as chromated copper arsenate (CCA). Wood treated with CCA does not resist mildew fungi. The WR and WRP finishes contain a water repellent, such as wax, and a binder, but do not contain pigments. The binder, which amounts to 10 to 20% of the formulation, consists of drying oils (linseed or tung oil) or a varnish binder. These oils or varnishes penetrate the wood surface, and cure to partially seal the wood surface. They also help bind the mildewcide and make the wood surface water repellent.

The WRPs that are formulated with nondrying oils that act as solvents (such as paraffin oil) are also available. These oils penetrate the wood, but do not dry. They protect the wood from degradation and mildew attack, just as do other types of WRPs. Because the oils do not dry, the deck surface may remain oily until the finish absorbs. This usually takes several days, but depends on the application rate and porosity of the wood.

Penetrating finishes are extremely effective in stopping the adsorption of liquid water, thereby decreasing dimensional changes in the wood. Less dimensional change results in decreased splitting, cracking, warping, and twisting, and less stress on fasteners; therefore, less nail pull-out. These finishes enhance the appearance and service life of both naturally decay-resistant wood species and species pressure treated with wood preservatives.

Several commercial wood treaters are using a WR treatment combined with CCA treatment for 5/4 radial-edged decking. This lumber is marketed under brand names such as Ultrawood, Wolman Extra, MELCO, and Weathershield¹. With this dual treatment, wood is more resistant to weathering. Although the WR should thoroughly penetrate and saturate the wood, it is still advisable to treat the ends that

are cut during construction with a WRP. Of the treated wood currently available, these treatments should improve the wood characteristics and extend the product's service life, particularly with sustained maintenance using a WRP.

Semi-Transparent Stains. When pigments are added to WRP solutions or to similar transparent wood finishes, the mixture is classified as a semi-transparent stain. Addition of pigment provides color and greatly increases the durability of the finish compared with that of the WRP. Semi-transparent stains permit much of the wood grain to show through. The solvent-borne semi-transparent stains penetrate into the wood without forming a continuous layer, and consequently, will not blister or peel even if excessive moisture enters the wood. The pigment protects the wood surface from sunlight, thus increasing service life. The binder in the solvent-borne oil-based, semi-transparent stain absorbs into the wood surface, just as it does with the WRP, and there is no film formation. The durability of a stain system is a function of its pigment volume concentration, resin type and content, preservative, water repellent, wood species and surface characteristics, and quantity of material applied to the wood surface.

If the decking material was given a factory-applied WR or if it was recently finished with a WRP, a semi-transparent stain may not absorb properly. In these situations, the wood should be allowed to weather for two to three months before finishing. This is the only situation in which it is beneficial to wait this long before finishing the wood with a penetrating stain. Lumber should not be left unfinished for six months to one year as indicated by some product literature, or as recommended by some paint and lumber suppliers. A short drying period may sometimes be necessary.

Film-Forming Finishes

Film-forming finishes cover a wide range of finishes from waterborne, latex-based, semi-transparent stains to paints, and include both oil-based and latex solid-color stains (also called opaque, full-bodied, or hiding stains). Almost all of these products are unsuitable for use on wood decks. The only exception is good quality paint, but even that can fail prematurely and cause decay in the wood.

On structures that are fully exposed to the weather, such as decks, paints tend to trap moisture and can actually increase the decay hazard. The paint seal breaks at the joints between different pieces of wood. These cracks permit water to enter the wood and become trapped by the paint film. This leads to decay of untreated wood, and the paint peels at these joints. Proper pressure treatment with a preservative can eliminate the decay risk. However, it is best to avoid the use of film-forming finishes on lumber that is fully exposed to the weather, even if the lumber has been pressure treated.

Conditions that Affect the Finish

Weathering

Wood. Weathering of wood is a photochemical degra-

¹The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U. S. Department of Agriculture of any product or service.

dation of the surface caused by the combined effects of water, the ultraviolet (UV) radiation in sunlight, and abrasion by wind-blown sand. Weathering should not be confused with decay. Photochemical degradation is manifested by an initial color change, followed by the loosening of wood fibers and gradual erosion of the wood surface. Rain washes the degraded wood materials from the surface. Rain and/or changes in humidity cause dimensional changes in the wood that accelerate this erosion process. In softwoods, erosion is more rapid in the less dense earlywood than in latewood, which leads to an uneven surface. However, surface erosion proceeds slowly. The erosion rate for solid softwoods, exposed horizontally in temperate zones, is on the order of $\frac{5}{16}$ to $\frac{5}{8}$ in. (7 to 14 mm) per century, and depends mainly on the intensity of UV radiation and the wood species.

Weathering is a surface deterioration and, therefore, directly affects finish performance. A film-forming finish applied to the eroded and roughened surface of weathered wood may not adhere properly; exposure of wood for only a few weeks is sufficient to cause this loss of adhesion.

Finish. Wood finishes also undergo photochemical degradation, but the mode of degradation is different for penetrating finishes (stains and water repellents) than for film-forming finishes (paints).

The weathering of penetrating finishes, such as semi-transparent stains and WRPs, is similar to unfinished wood. The surface of the wood degrades, but at a slower rate than unfinished wood. If the finish contains a pigment (semi-transparent stain), it partially blocks the sunlight. As the wood surface and the finish undergo simultaneous degradation, the pigment particles debond. As the pigment erodes from the surface, the degradation of the wood increases. To avoid excessive wood degradation, timely refinishing is essential. The surface should be refinished when pigment loss is evident. The subsequent finish should absorb into the wood. Finishing too early leads to inadequate absorption and film formation. Finishing too late allows excessive wood degradation.

Pigmented, film-forming finishes (e.g., paints) block the damaging UV radiation and protect the wood surface. The degradation of the film occurs at the surface of the film and results in slow finish erosion. This is the most benign mode of paint degradation because, as the primer coat begins to show, another top-coat can be applied.

When painted wood of a deck is fully exposed to the weather, another type of degradation occurs. This degradation mode involves checking, cracking, and peeling, and can occur with other film-forming finishes as well. When paint has peeled, the surface of the wood is completely vulnerable to weathering. Paint peeling is the most serious mode of paint degradation and is likely to occur on painted decks.

Preservative Treatment

Finish characteristics of preservative-treated wood are

primarily dependent on wood species and grain orientation (flat or vertical grain) of the lumber. Preservative-treated lumber is not graded according to grain orientation. Therefore, lumber from a species group like Southern Pine generally contain wide bands of latewood, which can create finishing problems. Stain penetration is poor on these latewood bands, and early finish failure is more likely to occur, particularly in structures that are fully exposed to the weather.

Waterborne preservative treatments do not adversely affect the finishing characteristics of the wood. In fact, CCA treatment actually enhances the durability of semi-transparent stains and similar finishes. CCA contains chromium oxides that bond to the wood after treatment. These chromium oxides decrease the photodegradation of the wood surface, and can increase the durability of semi-transparent stains two to three times (Cassens and Feist, 1991). It should be noted that ammoniacal copper zinc arsenate (ACZA) and copper oxide/quaternary ammonium compounds (ACQ) do not contain chromium oxides, and therefore, stain performance on this type of treated lumber will be similar to that on untreated wood given similar finish coverage and exposure conditions.

Other preservative pressure treatments for wood, including creosote and pentachlorophenol (penta) in light or heavy oils are intended for use on retaining walls, railroad cross-ties, and other heavy industrial applications. They should not be used on wood decks. Penta in heavy oil and creosote will not hold paint, so the lumber does not absorb semi-transparent stains well. Penta in light oil or solvent can be finished after it weathers for a year or two.

Moisture Content

The main consideration in finishing pressure-treated lumber is the moisture content of the wood. In some cases, the lumber may still be wet from the pressure treatment when it is delivered to the job site, particularly during cool or wet weather. If the wood is still wet, it must be allowed to dry before finishing so that the surface moisture content is < 20%. The rate of drying depends on weather conditions; under warm, summer conditions, about two to three weeks should be sufficient. For best finish performance, the wood should have a moisture content that is typical of that which it will have during its service life. This is about 12% for most areas of the continental United States (FPL, 1987).

Methods for Finishing New Decks

The first finish on wood, whether it is a deck or any structure, is the most important. This finish should be applied as soon as the wood surface is dry. If the first finish is not applied properly, there is often little that can be done to correct problems that develop later. The choice between a penetrating and a film-forming finish should be given considerable study, because it is necessary to continue with that type of finish in the future.

If a penetrating finish is to be used, the next decision is

whether or not to use a semi-transparent stain or a WRP. The service life of WRPs is about one year on the exposed surfaces; however, WRPs are extremely easy to reapply to decks. They absorb readily into the end grain of lumber and can stop the wood from absorbing water into the end grain much longer than one year. Because they are not pigmented, problems with uneven wear and lap marks are eliminated. Lap marks occur during finishing when the finish that is being applied to an area laps over an adjacent area that has already been finished. This yields areas that have two coats of finish, whereas the surrounding area has only one coat.

To avoid lap marks in applying semi-transparent stains, brush the stain on only two or three boards, being careful to keep the edge of the stain along the edge of the board. Stain the entire length of these boards. If a second coat is desired, it must be applied while the first coat is still wet (within 30 to 45 min), or it will not absorb. If the first coat has dried, it seals the surface and the second coat cannot be absorbed. Brush the stain onto the adjacent two or three boards, being careful to avoid lapping stain on the boards previously stained.

If you are unsure whether to stain or use a WRP, apply the WRP to the deck first. It is possible to switch to a semi-transparent stain when the deck needs to be refinished. Even if the deck has been maintained with a WRP for many years, the semi-transparent stain will perform satisfactorily, because it penetrates the wood and will not fail by peeling, as can film-forming finishes.

The easiest finish to maintain on a deck is a WRP. The next best is a semi-transparent, oil-based stain. Film-forming finishes, such as paints, are prone to fail by peeling and are not recommended. The WRP requires frequent application, but the ease of refinishing compensates for the additional applications.

Summary

Long-term performance of horizontal wood structures exposed to the environment and foot traffic is improved if maintained with a finish after construction. The role of the finish is to protect the surface from the natural weathering processes. Lumber should be finished as soon as moisture content conditions permit; additional weathering beyond that necessary for drying will not improve the finish performance. The surface should be refinished when some pigment loss is evident. Premature and delayed finishing can lead to inadequate absorption or excessive wood degradation, respectively. Ease of finishing should be considered in the selection process. Film-forming finishes, such as paints, are generally not recommended for horizontal exposures because water can be trapped and actually improve the conditions for decay fungi.

References

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