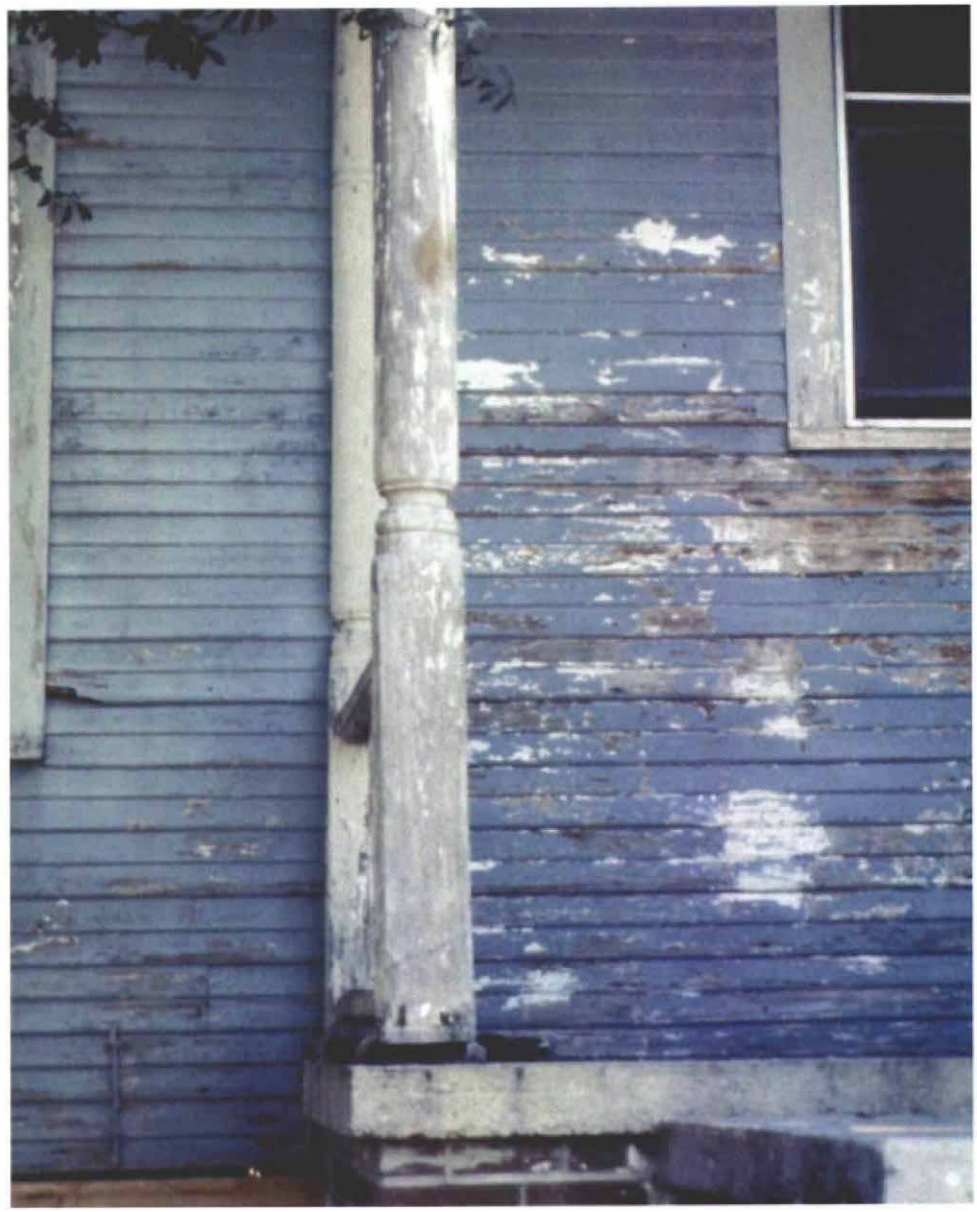
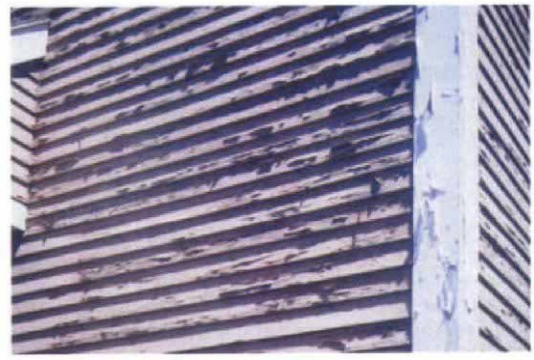
Why Exterior Finishes Fail

Government scientists explain why paint cracks, blisters and peels on your house, and how you can prevent it

by Sam Williams, Mark Knaebe and William Feist



Some peeling suggests an interior problem. Peeling paint in a protected area, such as this porch, is a sure sign of excessive moisture migrating from inside through exterior walls.



Applying paint to weathered wood can lead to early failure. Unless the surface of a weathered area is sufficiently prepared, paint cannot form an adequate bond. Sanding the area to be painted prior to priming will greatly reduce the risk of peeling.

Every neighborhood has at least one house that looks like it has a bad case of eczema—flaking paint everywhere, bare wood exposed to the elements, smears of mildew and stains. It looks awful. You might be working on this house; worse yet, it could be yours.

The normal life of a finish can be shortened in two ways: The finish can become discolored (staining, bleeding, etc.), or it can degrade (peeling, cracking, blistering). While discoloration can occur almost anywhere on a house, paint degradation is usually limited to places exposed to the weather or to water. Areas that degrade the fastest are those exposed to the greatest amount of sun and rain, usually on the south and west sides of buildings. Of course, there are ways to avoid these problems. In our

Top photo: Courtesy of Southern Forest Products Association.

Moisture from the inside will cause peeling paint on the outside. Moisture-laden air escaping from around a leaky window will cause paint to fail at the point of exit.

Excess moisture causes peeling paint. Leaking gutters and roofs, ice dams and inadequate overhangs are some of the typical causes of peeling paint.

In need of a vapor barrier. In many older homes, the combination of moist air leaking out through walls and inflexible layers of paint causes peeling and cracking.

research at the U. S. Forest Products Research Lab, we've studied the various symptoms of exterior house-paint degradation and discovered some preventative methods.

Water is the culprit behind most peeling paint—Peeling paint is usually caused by water that gets between paint and the wood's surface, especially if the surface was not clean prior to painting. In some cases, the effects of water are fairly obvious (photo bottom left). Leaky roofs, ice dams and inadequate roof overhangs are often causes of peeling paint. In other cases, sources of moisture are not so obvious. Moisture from inside a building can migrate through gaps around windows and cause paint failure (top photo). Interior moisture can also cause paint failure on house siding (photo bottom right).

Sometimes, paint failure is most severe outside a single room. This type of problem often occurs outside kitchens and bathrooms where high humidity is present, particularly in older homes that lack vapor barriers. It's sometimes difficult to determine the source of the moisture. For instance, in the top photo on p. 61, the siding is protected from rain by an overhang. Evidently then, the source of the moisture is either condensation (from a dryer vent, for instance) or a migration of moisture from inside the structure.

The first phase of paint peeling may be the formation of moisture blisters. These blisters occur where outside moisture such as rain enters wood through joints and other end-grain areas of boards and siding. After blisters appear, they dry out and collapse. Small blisters may disappear completely, but fairly large ones may leave rough spots. In severe cases, paint will peel. Thin coatings of new, oil-based paint are the most likely to blister. Old, thick coats are usually too rigid to swell and form blisters, so the paint cracks and peels instead.

Moisture may also enter wood because of poor construction and maintenance, particularly in the lower courses of siding. Paint failure is most severe on the side of a building that faces the prevailing wind, which can drive moisture into gaps or cracks. Damage appears after spring rains and throughout the summer season. Moisture blisters can occur on both heated and unheated buildings.

Moisture blisters may also result from the migration of water vapor from inside the house to outside. Plumbing leaks and improper venting of bath and kitchen areas, clothes dryers and humidifiers are sources of inside water vapor. Damage caused by this moisture movement is not seasonal.

The elimination of moisture and the use of a vapor retarder/air barrier are the best ways to prevent moisture blisters, which may lead to

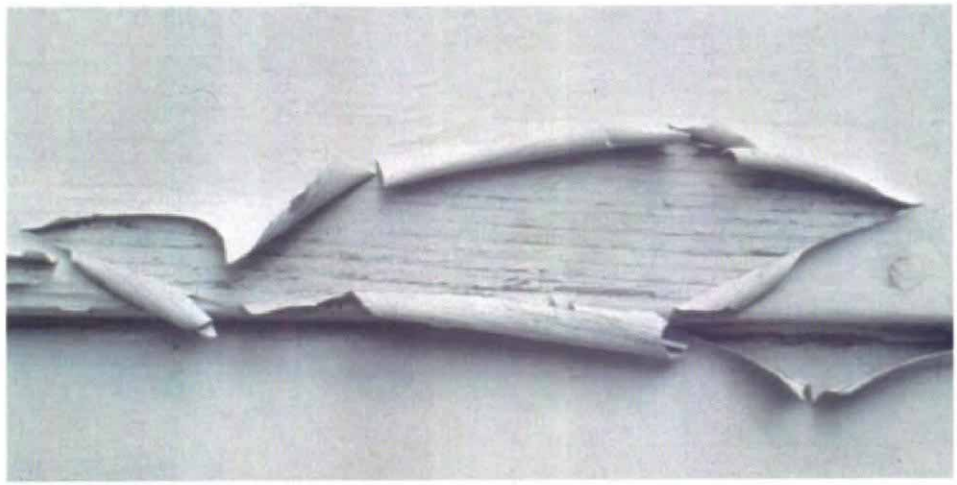
more serious problems such as rot. If no obvious source of exterior moisture is found, decrease indoor moisture. Decrease the setting on or shut off humidifiers, and increase ventilation in kitchens and bathrooms. Also, always vent dryers to the outside.

Even in the absence of water, peeling can occur if the surface of the wood or previous coat of paint was not clean and sound. Catastrophic paint failure can occur if paint is applied to bare wood that has been exposed to the weather. Two or three weeks of exposure is sufficient to cause decreased paint adhesion. Film-forming finishes (as opposed to those that soak into the wood, i.e. stains) do not form strong adhesive bonds when they're applied to weathered wood surfaces (bottom photo, p. 61). Any surface should be sanded before it's repainted.

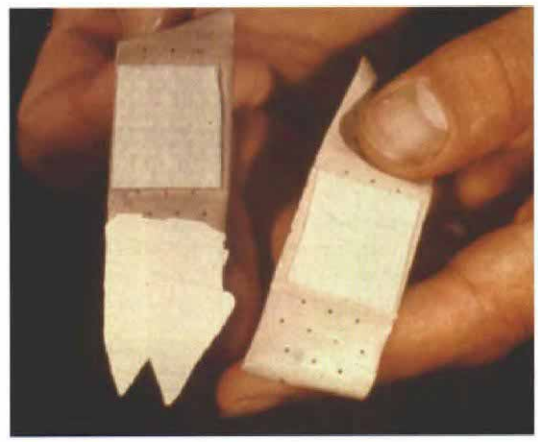
Sound paint surfaces prevent intercoat peeling—Intercoat peeling (top photo) occurs when new paint separates from old, which indicates a weak bond between two coats. Even in the absence of excessive water, these finishes can peel. If the paint surface was not properly prepared, intercoat peeling may result. It can also occur on freshly painted wood if too much time elapses between application of primer and top coat. This weakened bond usually results from painting over severely chalked (or powdery), mildewed or dirty surfaces. A good scrubbing with a detergent solution followed by a thorough rinse before repainting will remove dirt and may remove enough chalk to provide good adhesion.

A simple procedure will let you determine how well latex paint will adhere to a surface. First, clean the surface and refinish a small, inconspicuous area with latex paint. Allow it to dry, at least overnight. Test for adhesion by firmly pressing one end of an adhesive bandage onto the surface. Then, quickly snap the bandage from the wood (center photo). If the tape is free of paint, the paint is well bonded, and the old surface doesn't need to be primed. If the paint adheres to the tape, the old surface is too chalky and needs to be painted with an oil-based primer, which should penetrate the old surface and form a firm base for the new coat of paint. Because most contemporary paints are formulated to adhere well to chalky surfaces, intercoat peeling is not a common problem.

Paint that cannot flex is susceptible to cracking—Like peeling, cracking is usually caused by water and normally precedes peeling. Cracking can be particularly severe on smooth plywood surfaces coated with alkyd paint, which is more brittle than latex paint and is more likely to crack (photo top left, p. 64). Cracks usually begin with checks in the wood;



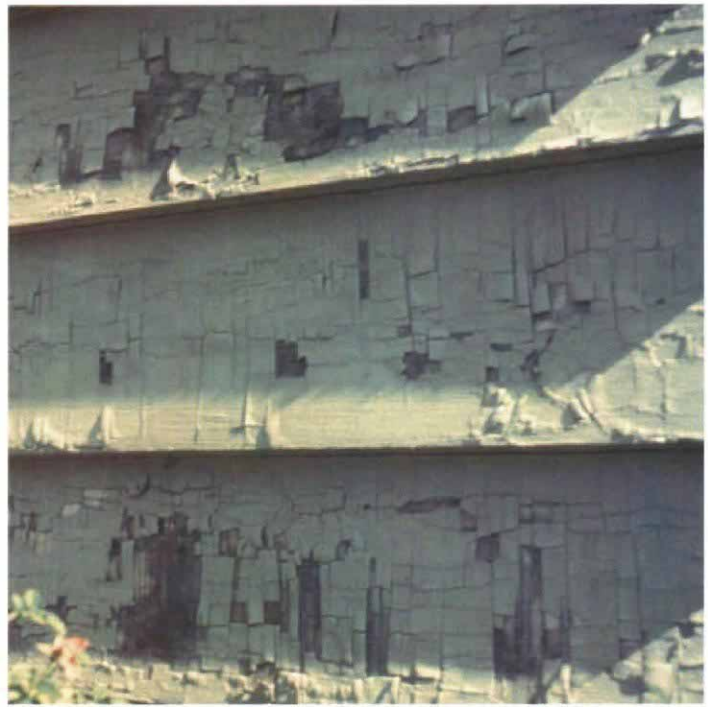
Poor surface preparation leads to intercoat peeling. Surfaces that have been painted and exposed to the elements tend to turn powdery, a process known as chalking. Scrubbing the area to be painted will remove the chalking and prevent intercoat peeling.



Adhesive-bandage test can determine the quality of a paint's bond. By pressing one end of an ordinary adhesive bandage onto a patch of freshly dried paint that has cured and then snapping the bandage off, you can test a paint's adhesion. The bandage on the left was applied to a poorly bonded coat of paint, while the bandage on the right was applied to a well-bonded coat.

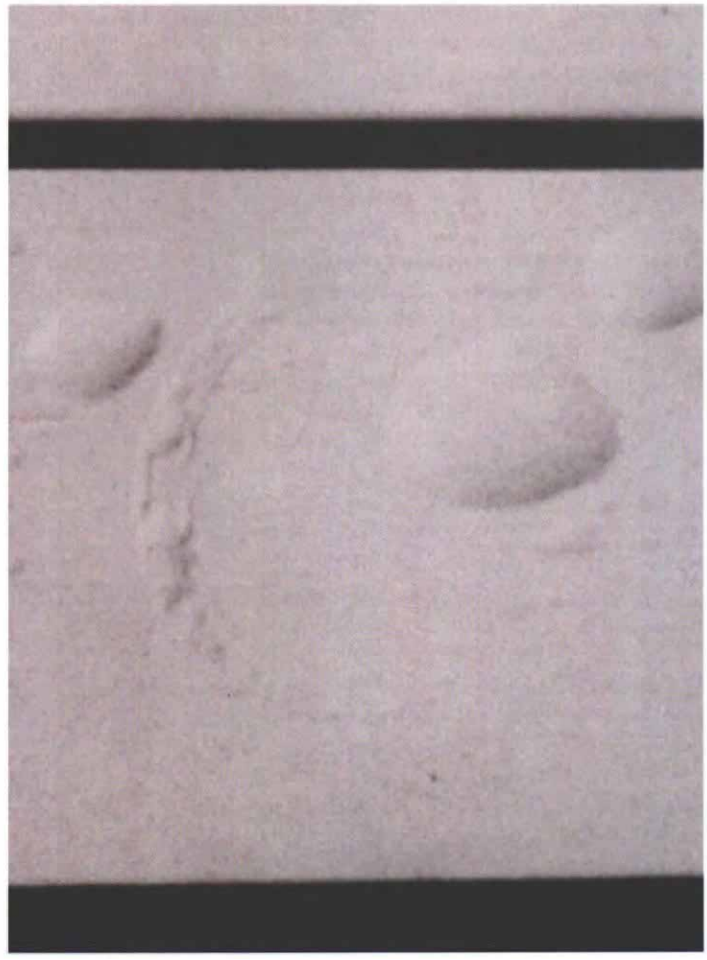
Discoloration can be an early sign of paint degradation. This protected corner shows the early stages of paint degradation caused by interior moisture. Typically, the stained areas will begin to peel if the moisture's source is not eliminated.

Moisture absorbed into the surface checks of the plywood caused this paint to peel. Exterior plywood should be painted with an acrylic-based paint, which is flexible and resists cracking caused by the seasonal movement of the plywood veneer.



Cross-grain cracking is the result of too many coats of paint. This type of failure is usually seen on older homes that have been painted many tunes with oil-based paints. The only solution to this problem is to remove the old paint completely and to repaint the bare wood.

Sanding before painting can prevent this type of peeling paint. Peeling paint along the grain is often caused by residues known as mill glaze, which is a result of the milling process.



If oil-based paint dries too quickly, temperature blisters may form. Vaporized solvent trapped beneath the dried paint surface causes these blisters. Avoid them by not painting overly heated surfaces.

these checks grow larger as the wood shrinks and swells from normal changes in moisture content and eventually cause enough stress to crack paint. Paint usually cracks in the direction in which it was brushed onto wood; with the grain, however, cross-grain cracks run across the grain of wood and paint.

Cross-grain cracking occurs when layers of paint become too thick (photo top right, facing page) and lose their ability to shrink and expand as temperatures dictate. This problem often occurs on older homes that have been painted many times with oil-based paints. Once this cracking has occurred, the only solution is to remove the old paint completely and apply a new finish over the bare wood. Because the accumulation of paint layers can take a long time, it is fairly safe to assume that some paint that shows cross-grain cracking is lead-based paint, which is extremely toxic and was banned from residential use in 1976. Please contact the U. S. Department of Health and Urban Development (HUD) for the latest information on the removal of lead-based paint.

To prevent cross-grain cracking, follow the paint manufacturer's recommendations for spreading rates. Do not repaint unweathered, protected areas such as porch ceilings and roof overhangs as often as the rest of the house. Latex paints, based on either vinyl-acrylic or acrylic polymers, stay flexible and are less susceptible to cross-grain cracking.

Proper protection begins with good construction practices—The wide range of wood and wood-based materials and the variety of paints, stains and other finishes give the consumer tremendous latitude and flexibility for protecting a structure. The choice of materials must be made in concert with the design, a good understanding of the materials being used and a knowledge of local weather conditions. In many cases, there is no one correct method for the selection and application of siding and finish. However, if the structure design, choice of materials and construction techniques are compatible, finished wood siding can look good and protect the structure for decades. □

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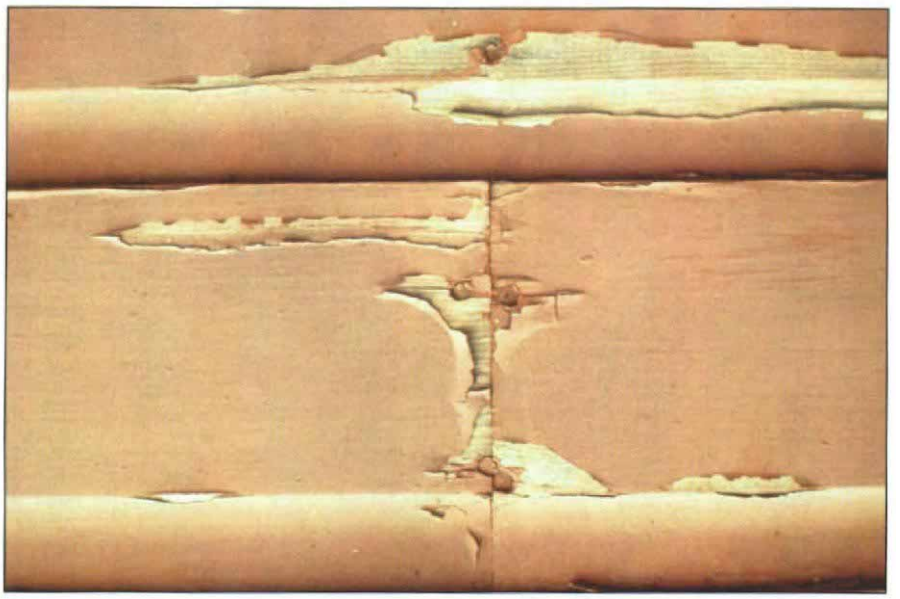
To achieve maximum paint life, follow these steps



A first coat of wood preservative will help to prevent the absorption of water. Paint usually begins to crack and peel around the end grain. An application of wood preservative before priming will make the end grain more water-repellent.

1. Seal the wood with a paintable water-repellent preservative. Preservative should be liberally applied to lap and buttjoints, end grain and the edges of panel products such as plywood, hardboard and particleboard because paint normally fails in these areas first (photo above). In addition, painting the backsides of siding and trim with a preservative (or primer) is always a good idea. Allow at least three warm dry days for adequate drying before priming, caulking joints and top-coating the treated surface. If the wood is painted before the solvent from the water-repellent preservative can get a chance to evaporate, the paint applied over the treated wood may be slow to dry, may discolor or may dry with a rough surface that resembles alligator hide. If the wood has been dip-treated, allow it to dry for at least one week during a period of warm weather.

2. Prime the wood as soon as the water-repellent preservative has cured. For woods with water-soluble extractives, such as redwood and western red cedar, the primer must seal in or tie up the extractives so that they will not bleed through the top coat. Use a good-quality oil-based, alkyd-based or stain-blocking acrylic latex-based primer; the label should clearly state that the primer can block the bleeding of extractives. The primer should also be nonporous and thus inhibit the penetration of ram or dew into wood surfaces; this decreases the wood's tendency to shrink and swell. A primer should be used whether the top coat is oil-based or latex-based paint. A primer coat that is uniform, flexible and 1.5 mils thick will distribute the swelling stresses that develop in wood and thus prevent premature paint failure. Special primers are available for knots.

3. Apply the top coat as soon as the primer is dry. Check the manufacturer's recommendations; oil-based primers usually takes 48 hours to dry. Apply two coats of a good-quality, all-acrylic latex house paint over the primer. If it is not practical to apply two top coats to the house, two top coats must be applied to fully exposed areas on the south and west sides for good protection. Areas fully exposed to sun and rain are the first to deteriorate. Pure acrylic formulas of top-coat paint have the best resistance to sunlight. In cold or damp weather, extra drying time should be allowed between coat applications. Coats of latex paint can usually be applied within a few hours of each other. One coat of a good house paint over a properly applied primer should last four to five years; two top coats over one primer coat can last up to ten years.—*S. W., M. K., W. F.*