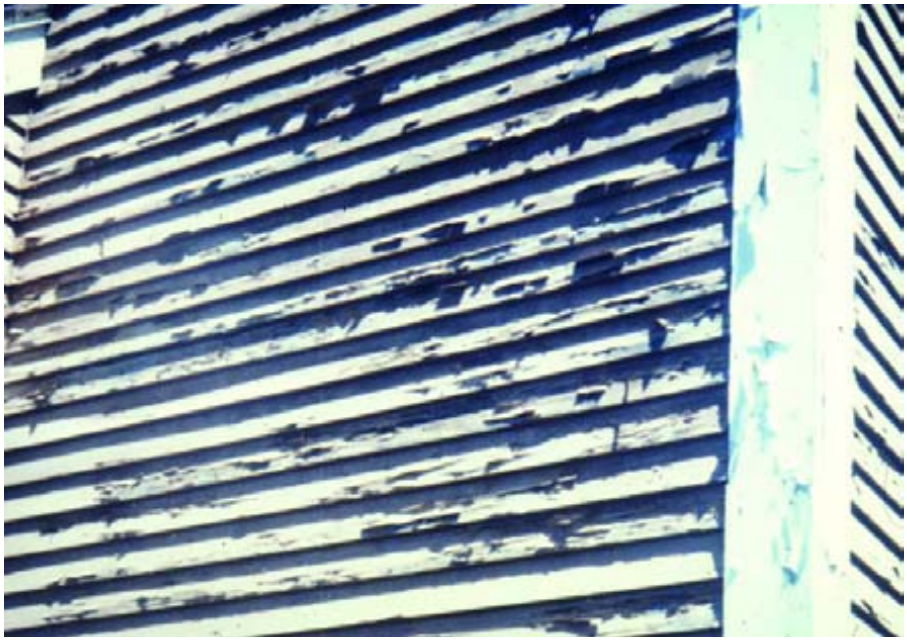

Don't get (sun) burned

Exposing exterior wood to the weather prior to painting contributes to finish failure

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Contrary to what might be called popular myth, research shows that allowing exterior wood surfaces to weather before applying paint does not help the cause of long-term coating performance. Instead, weathering prior to painting has been shown to contribute significantly to premature failure of the finish due to loss of adhesion.

The problem: adhesion loss

In the absence of adhesion failure, paint on wood exposed outdoors gradually erodes. Degradation of paint by erosion may take a decade or more, depending on the degree of exposure to sunlight and moisture and the thickness and type of paint.

While a paint system is eroding, it still protects the wood surface from degradation. Until this erosion process proceeds to the point where the primer begins to show, the paint surface can be renewed readily with an additional topcoat. With timely refinishing, painted wood can last for centuries. Many structures built in the 1700s that have been kept painted still retain much of their original siding.

If, however, the paint/wood interphase fails, the paint film will debond within a short time and the paint will blister, crack, and peel. This failure can result in damage to the wood surface and more difficult and costly refinishing.

Weathering of wood before it is initially primed (hereafter referred to as "preweathering") degrades the wood and is one cause of interphase failure. The ultraviolet (UV) radiation in sunlight degrades (or weathers) the wood's surface.

Figure 1 shows a structure that was left unpainted for several months following construction. During the time the structure was unpainted, the wood preweathered. You are seeing failure of the third paint application on an eight-year-old structure.

The effect of preweathering on paint performance has been reported in the scientific literature for more than 30 years. Studies by W.C. Feist, J.E. Winandy, and this author, conducted at the USDA Forest Service, Forest Products Laboratory (FPL), showed that exposure of western redcedar for as little as one to two weeks caused decreased paint adhesion and subsequent loss of paint service life[1-4]. Western redcedar boards preweathered for 16 weeks exhibited approximately 50 percent less paint adhesion than controls that were not preweathered.

Other species were found to be slightly more resistant to weathering but still showed decreased paint adhesion after three to four weeks of preweathering.[2] Thay and Evans conducted similar research and reported the same result.[5,6] Other work is cited in these publications.

This article reports on paint performance over 20 years of outdoor exposure on boards that were preweathered for one to 16 weeks. The results clearly show the effect of short periods of

Figure 1 (Facing page): Paint failure on an eight-year-old structure left unpainted for several months following construction. Failure following the third time the structure was painted is shown.

Figure 2 (Above): Panels exposed at the Forest Products Laboratory field site 15 km west of Madison, WI (F2, WRP/alkyd/latex; F3, alkyd/latex; F4, latex/latex).

preweathering on the performance of three different paint systems (two different primers).

Based on these findings, painting smooth-planed lumber intended for exterior exposure promptly during construction is recommended. If this is not practical or possible and some weathering occurs, the wood should be scuff-sanded prior to applying the primer and paint.

The research

Materials

The finishes were applied to smooth-planed western redcedar (*Thuja plicata* Donn) vertical-grained heartwood. The boards were finished with one of the following paint systems.

- Solvent-borne water-repellent preservative (WRP), one coat of alkyd-oil primer, and one coat of acrylic latex topcoat (WRP/alkyd/latex)
- One coat of alkyd-oil primer and one coat of acrylic latex topcoat (alkyd/latex)
- One coat of latex primer and one coat of acrylic latex topcoat (latex/latex)

All finishes were commercial formulations. For each preweathering period (0, 1, 2, 4, 8, and 16 weeks), 12 boards (four panels of three boards per panel) were exposed outdoors for 20 years (Figure 2).

Methods

Freshly planed vertical-grained western redcedar boards 410 by 100 by 10 mm (16 by 4 by 3/8 in., longitudinal by radial by tangential) were exposed outdoors, oriented vertically and facing south at a location 5 kilometers west of Madison, WI, in the summer of 1984 for 1, 2, 4, 8, or 16 weeks. For each preweathering period, 12 boards were exposed. At the same time, 12 boards (controls or 0-week specimens) were kept from exposure to sunlight in a darkened room at 27 C and 65 percent relative humidity for 16 weeks.

Following preweathering, the boards were finished with one of the three paint systems and placed back on the test fence in September 1984. Boards from all preweathering periods (1, 2, 4, 8, and 16 weeks) were used for the WRP/alkyd/latex paint system. Only boards preweathered for 0, 1, and 16 weeks were finished with the other two paint systems (alkyd/latex and latex/latex).

For convenience, three boards were mounted together to form a panel configured as lap siding. The boards were evaluated annually according to American Society for Testing and Materials (ASTM) standards for erosion, cracking, and flaking. Each board in the panel was rated individually, resulting in three observations for each panel for each category (erosion, flaking, and cracking) annually for 12 years. After 12 years, the boards were rated less often.

Results and discussion

The experiment was designed to show the effects of preweathering on the paint adhesion of alkyd- and latex-based primers, the long-term performance of paint systems using these primers, and the effect of water-repellent preservative pretreatment to restore the preweathered surface.

Erosion

Although some surface degradation undoubtedly occurred, it was not possible to distinguish any differences among the finishes for this rating category, even after 20 years. Paint erosion was determined visually, and there was no evidence of paint erosion to the point where the primer was visible. Therefore, all paint systems on all specimens were given a rating of 10 after 20 years on the fence.

A rating of 10 indicates no observable degradation, and 1 indicates complete failure of the specimen. A rating of 5 indicates sufficient degradation to warrant normal refinishing if the finish was in use on a structure.

Peeling, however, was another matter. On some of the boards,

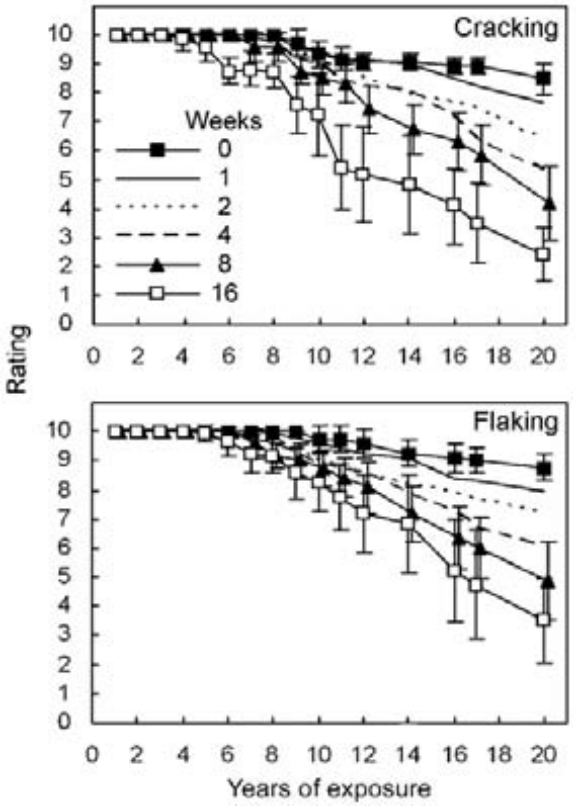

Figure 3. Paint evaluations for cracking and flaking during 20 years for the WRP/alkyd/latex system. The data points are the average of 12 observations; the bars give the standard deviation.

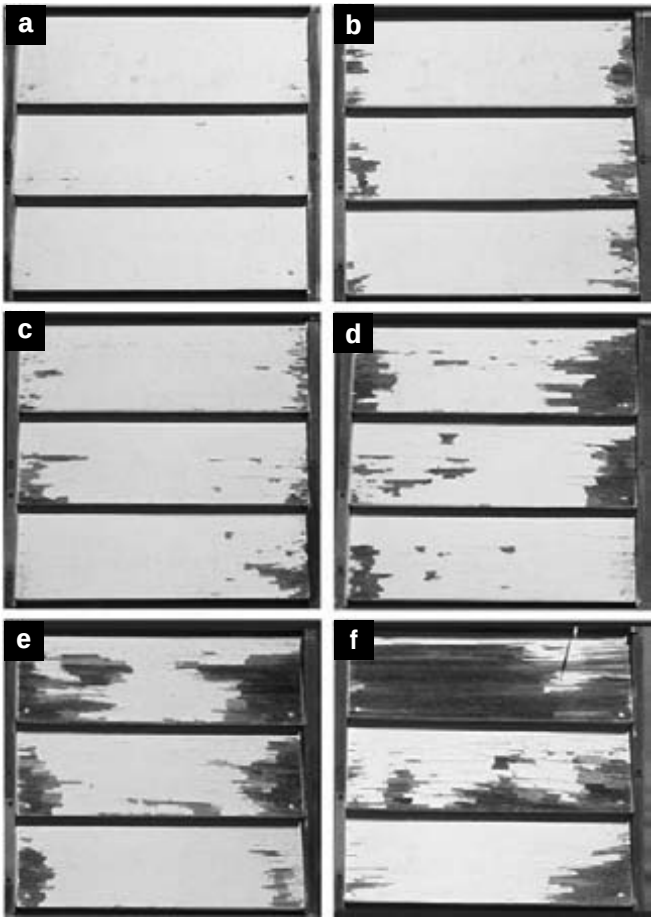

Figure 4. Examples of panels painted with WRP/alkyd/latex system after 20 years of outdoor exposure: (a) control, no exposure prior to painting, (b) preweathered 1 week, (c) preweathered 2 weeks, (d) preweathered 4 weeks, (e) preweathered 8 weeks, and (f) preweathered 16 weeks.

particularly the boards preweathered for 16 weeks, most of the paint had peeled. Paint erosion could not be detected on the small amount of paint that was still on the boards.

Cracking and flaking

The most notable differences among the finishes were found to be cracking and flaking. Depending on the amount of preweathering, the boards painted with any of the three paint systems began to show cracking during the exposure period. Flaking generally followed cracking after a year or two.

WRP/alkyd/latex system

For the WRP/alkyd/latex paint system, the effect of preweathering can clearly be seen in the evaluations of cracking and flaking during 20 years. The boards with 16 weeks of preweathering began to show signs of cracking after only three years of exposure, whereas those with 0- and 1-week preweathering periods began to crack after nine years (Figure 3).

Clearly, each preweathering period showed different performance results. This difference in performance can be seen in the photographs of the boards after 20 years of exposure (Figure 4a–f). One panel (three of the twelve boards) for each of the preweathering times is shown. The other three panels showed the same trend. Although it is not apparent in cracking results, there is clearly a slight difference in performance between the 0- and 1-week preweatherings (Figure 2a and b).

The control (0-week preweathering) was in almost perfect condition after 20 years of exposure. That is a service life of 20 years for a paint system consisting of a WRP pretreatment, one coat of primer, and one coat of topcoat. The slight discoloration just under the bottom edge of each board is dirt.

Alkyd/latex system

The cracking and flaking ratings for the 1- and 16-week preweathering periods are about the same for the alkyd/latex paint system with and without the water-repellent preservative.

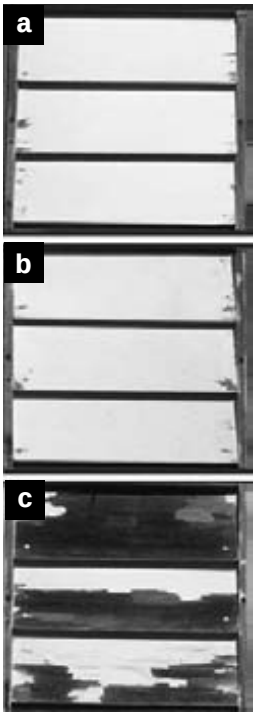

Figure 5: Examples of panels painted with alkyd/latex system after 20 years of outdoor exposure: (a) Control, no exposure prior to painting, (b) preweathered 1 week, and (c) preweathered 16 weeks.

Photographs of panels after 20 years of exposure show similar results for the different paint systems preweathered for the same amount.

From the photographs, it appears that the 0- and 16-week panels may be slightly better for the paint system incorporating the WRP (Figure 4a and e compared with Figure 5a and c); however, the boards preweathered for only one week show the opposite effect (Figure 4b compared with Figure 3b). It appears that the main effect was the time of preweathering (poorer paint performance with increased time of preweathering).

Latex/latex system

In general, the performance of the alkyd/latex paint system (Figure 5) was slightly better than the latex/latex paint system (Figure 6) for the 0-, 1-, and 16-week preweathering periods. Both the alkyd/latex and the latex/latex paint systems started cracking and flaking about the same time (after three to four years of exposure), but the latex/latex system degraded faster in subsequent years.

The latex/latex paint system on the 0-week preweathered boards cracked and flaked sooner than expected, given the inherently greater flexibility of the latex/latex paint system compared with the alkyd/latex system.

The latex primer was high-quality paint but was one of the first formulations in the new generation of stain-blocking latex primers developed in the early 1980s. Its performance in cracking and flaking may not be representative of stain-blocking latex primers available today.

Conclusions

The exposure to weather of unpainted, smooth-planed, vertical-grained western redcedar siding for as little as one to two weeks can shorten the service life of subsequently applied paints. For wood exposed and unfinished for 16 weeks prior to painting, cracking in the paint film was detected after only three years of outdoor exposure. By contrast, boards that were not exposed to the weather prior to painting were in almost perfect condition after 20 years of exposure.

The outdoor performance of painted wood that had been preweathered for short periods showed that there was undoubtedly some surface degradation caused by weather on these specimens during the preweathering. Smooth-planed lumber must be painted promptly during construction. If this is impossible or impractical and exposure to weather occurs, the wood should be scuff-sanded prior to applying the primer.

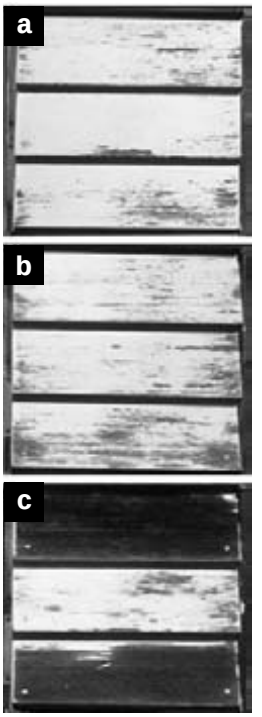

Figure 6: Example of panels painted with latex/latex system after 20 years of outdoor exposure. Panel was preweathered for 16 weeks.

Acknowledgment

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Note on copyright

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