Paint Failure

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Most peeling of paint is due ultimately to the effects of moisture. As dry wood is exposed to higher humidity or wetting, the moisture content of the wood rises and the wood swells. The increase in volume of the wood translates into tensile (stretching) forces on the paint. A thin, young paint film has the capacity to expand with the wood as it swells, and the paint continues to adhere to the wood. A single occurrence of ice damming, however, in which water enters a wall between the siding and the sheathing, can cause clapboard swelling that is sufficient to cause severe paint failure in a thick, old paint film.

Paint films themselves also swell when wet. The thicker a film is, the less uniform the swelling. When water flows across the outer surface of paint, the exposed film absorbs moisture at the exterior plane, causing expansive dimensional change. Due to diffusion of interior moisture, or flashing or other leakage into the wall cladding, a paint film can be exposed to higher moisture at the wood (substrate) side. In this case, the film will swell first at that side.

In a thin film, the swelling of the paint layer may not give rise to significant differential forces, but in a thick film, as the wetted plane of the film swells, it creates a cupping/bending force in the film, like that in a heated bimetallic strip. The layer can cup away or toward the substrate, depending on which plane is swelling faster. Similar forces can arise if different paint types in different layers within the paint film swell to varying extents with moisture. The "curling/cupping" forces of the paint film may exceed the bonding strength of the paint film to the wood, and the film will fail. Water running down the face of painted clapboards causes this type of failure. A flat, thick chip of paint, when placed in a glass of water, may even curl up into a tight, cylindrical spiral, due to differential expansion!

A moisture-saturated paint film exposed to the sun will dry at the surface more quickly than at deeper planes. The resulting differential moisture content can also give rise to cupping and forces that eventually tend to pull the paint film away from the substrate. Exposure of a thick, dry paint film to the sun can also give rise to cupping forces due to the temperature differentials between surfaces, causing the heated surface to expand faster than the unheated one. The opposite can also occur. One winter, I actually had all the paint peel on the interior side of outside walls within a few hours of exposing an enclosed (unheated) porch to very cold temperatures one day, while a carpenter was repairing a door. The interior had been painted a few months earlier with latex paint over a thick, old layer of oil paint on plaster lath. There was not a sign of a problem before the room suffered the sudden, full exposure to outside cold.