Slate Roof Weathering

By Jeffrey S. Levine

Slate is among the most enduring of all roofing materials. Eventually, however, even this dense stone succumbs to the elements and deteriorates. Knowing something about how the environment affects slate and what the signs of deterioration are can help you form a general picture of the condition of a slate roof, and with it an idea of what to expect for a remaining serviceable life.

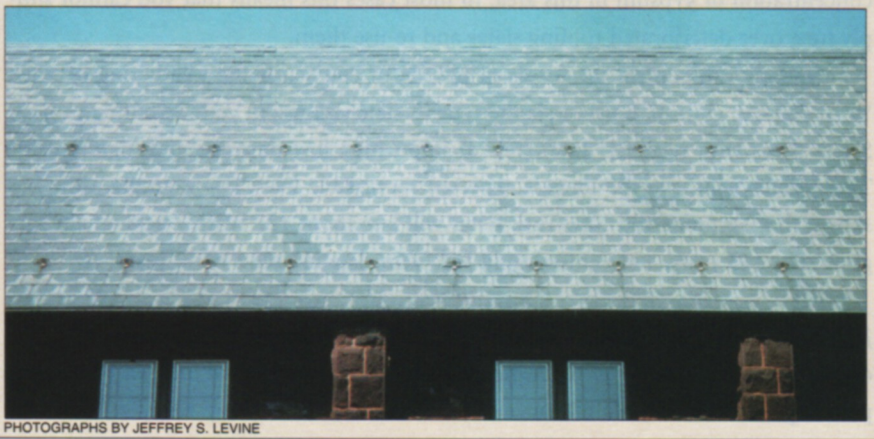
Slate, Molecularly Speaking

Slate is a natural material—a fine-grained, crystalline rock that is the metamorphic product of clay and silt sediment deposited on ancient sea bottoms. The particular minerals that compose slate, and their orientation, are quite stable. They contribute to slate's durability and its ability to be cleaved into thin roofing shingles. All slates also contain mineral impurities. These impurities are the source of changes that lead to weathering of slate, a slow process that results in the scaling of slate along its cleavage planes. As slate weathers, paper-thin laminations flake off its surface and the slate becomes soft and spongy as its inner layers start to delaminate.

Surprisingly, the forces that start the weathering process are not mechanical, but chemical. Slate roofing shingles deteriorate primarily as a result of chemical reactions over a long period of time. In general terms, the chemical changes start when free pyrite (FeS_2), an impurity in slate, reacts with oxygen and water in the air to form iron oxides (FeO/Fe_2O_3) and sulfuric acid (H_2SO_4). The latter reacts with calcite ($CaCO_3$), another impurity in slate, to form gypsum ($CaSO_4$), carbon dioxide, and water.

The only catalysts necessary for the second reaction to occur are cycles of wet/dry and hot/cold conditions, neither of which is in short supply on a roof. Ultimately, slate deteriorates because gypsum molecules take up more volume than calcite molecules. As gypsum molecules pass out of solution and crystallize, they literally push the slate laminate apart. As a result, the slate suffers from increased absorption, decreased strength, and delamination.

Slate density and porosity exert a big influence on the rate at which the chemical reactions occur. The lower the slate's density and the higher its porosity, the faster the reactions, all other things being equal. The reverse would also be true. Of course, all



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The formation of gypsum in slate roofing shingles—called "chalking out"—is most apparent to the naked eye in Pennsylvania Black roofing slate. The roof here is between 30 to 35 years old.

other things are never equal. The impurity levels in slate vary by quarry region—and even within the same quarry. Roof slope, orientation, and exposure influence the intensity of wet/dry and hot/cold cycling. For example, since water runs more rapidly off a steep slope, it's easy to see why slates on steep church spires and the near vertical pitches of mansard roofs often last far longer than slate on roofs with lower pitches.Thermal expansion and contraction, as well as freeze/thaw cycling, also influence the deterioration once delamination has occured.

Reaction Deductions

Don't worry if you don't remember all the chemistry. It's useful just to understand that the formation of gypsum is one of the agents of slate deterioration. Moreover, it's not hard to identify the manifestations of the chemical reactions and thereby gain an understanding of a slate roof's condition and its remaining service life. Distinct U-shaped, white bands on the surface of some slates, for example, are a clear indication of the presence of gypsum and the early stages of deterioration. Another way to assess the condition and possible weathering of a slate is by its sound. If you hold a slate shingle up by your fingertips and strike it with your knuckles or a slate hammer, high-grade slate will emit a clear, solid "ring." In contrast, slate that is severely delaminated will only give off a dull thud when tapped.

This Pennsylvania Hard-Vein slate has reached the end of is serviceable life. Note the numerous cracks, indicating loss of strength, and the severe delamination that allows the slate to absorb moisture.

The degree of surface scaling is another indicator. Minor scaling suggests the early stages of deterioration and a relatively long service life. Severe surface scaling suggests that the slates are holding moisture and that the time for replacement is close at hand. As a general rule of thumb, if you determine that about 20 percent or more of a slate roof is already suffering from severe surface scaling and delamination, it will probably be more practical to reroof with new slate rather than recycle or repair the existing slate (which will delaminate before too long or break during repairs.) Weathering is prominent on the underside of the roof as well, due to the leaching and subsequent concentration of gypsum in this area. In most cases this means that you cannot simply turn over deteriorated roofing slates and re-use them.

Nobody can control the forces of nature, of course, or the weathering of slate. What you can control, however, is the type of slate you use in your reroofing project. Select types with relatively low levels of impurities, low porosity, and high density. These slates will have the longest expected serviceable lives. For example, time has shown that Vermont and New York slates will last about 125 years, Buckingham Virginia slate 175 years, and Pennsylvania Soft-Vein slate in excess of 60 years.

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