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Technical Bulletin #11

NATIONAL SLATE ASSOCIATION

Reuse Of Slate Shingles Exposed To Fire

The fire-resistive properties of slate roofing have long been known. With increasing urbanization, slate shingles' resistance to fire led to increased use and the passage of regulations requiring their application. Building ordinances for New York and Boston specifying fireproof construction recommended the use of slate or tile roofing as early as the seventeenth century.[1] The c.1679 Boston ordinance requiring the use of stone in construction followed a serious fire in which 150 buildings were destroyed and decreed that:

> Henceforth no dwelling house in Boston shall be erected and set up, except of stone and brick, and covered with Slate or tyle [sic], on penalty of forfeiting double the value of such buildings.[2]

For many decades, in various building codes, natural slate shingles were considered a Class A roof assembly, effective against severe fire test exposure, over both combustible and noncombustible roof decks. In 2009, this was called into question with regard to combustible roof decks. Following fire testing by the National Slate Association (NSA) in accordance with UL 790, Standard Test Methods for Fire Tests of Roof Coverings (Figure 1), and a joint proposal by NSA and the National Roofing Contractors Association (NRCA) to the International Code Council, slate

Figure 1: Slate roof assembly undergoing the burning brand test in accordance with UL 790, Standard Test Methods for Fire Tests of Roof Coverings.

shingles installed over a combustible roof deck were once again recognized as having a Class A rating over combustible decks in the 2015 edition of the International Building Code, as well as subsequent editions.[3]

Recent research has confirmed that slate is not flammable and does not create or emit toxic substances when exposed to fire.[4] The remaining question, which comes up periodically, is: can slate that has been exposed to fire be salvaged and reused? While there can be no universal answer, as each fire is different and each slate is different (depending on its type, age, and condition), there are a number of factors to consider:

- The first consideration has to be whether the slate was in good condition to begin with. A slate nearing the end of its service life, based on age or as evidenced by significant surface delamination, cracking, and broken corners on the exposed faces, is probably not a good candidate for salvage and reuse, regardless of whether it has been exposed to fire, or not (Figure 2).

- For those slate roofs that were in good condition prior to the fire, the next consideration is proximity to the center (hot spots, or highest heat zone) of the fire. There is general consensus not to reuse slate that was subjected directly to the hottest zones of a fire, where temperatures could have reached 1,000ºF, 1,500ºF, or more. Such slates are likely to have experienced a reduction in bending strength and an increase in absorption, making them more susceptible to breakage and freeze/thaw damage.[5]

- For the remaining slate shingles, they should be assessed for obvious signs of damage, such as discoloration and micro-cracking (Figure 3). Heat-induced color change is most pronounced in slates exposed to temperatures of approximately 840ºF and upwards.[6] At such temperatures it is common for slate shingles to take on a reddish tone due to the oxidation of iron ions, or become distinctly lighter in color. Micro-cracking, if present, may be difficult to spot without the aid of a magnifying glass or wetting the surface of the slate and then looking for hairline crack lines as the slate dries. Slate shingles exhibiting color change or micro-cracking should not be reused.

- The critical test, as is often the case when attempting to determine the serviceability of a particular slate, is the ring test: tap the slate with a metal object, such as a slate hammer, or one's knuckles, and listen to the ring emitted. A clear, sharp, china- or porcelain-like ring is an indication that the slate is sound. A dull thud suggests the slate is "dead" and should be discarded. A rattling sound calls for further investigation to determine whether a) a fracture is present, and the slate should be discarded, or b) there is a small surface "flake" or "scale" that can simply be removed and the slate salvaged for reuse.

- Depending on the age and expected remaining service life of the slate (before the fire), consideration might be given to testing the slate for breaking strength, absorption, and weather resistance (depth of softening) in accordance with ASTM C406, Standard Specification for Roofing Slate. If, for example, the slate is less than, say, 25 years old and has an expected remaining service life of 75 to 100 years, or more, it might be prudent to undertake such testing, versus a 110 year old slate that might only have an expected remaining service life of 15 years.[7] The NSA website, slateassociation.org, lists a number of acceptable testing labs. To conduct the testing, a minimum of 10 sample shingles will be required. While most often employed with newly quarried slate shingles, the test results should provide an indication of the expected service life of the sample slates (see Table 1).

Table 1: **Physical Requirements for Roofing Slate per ASTM C406**

CLASSIFICATION	EXPECTED SERVICE LIFE (YEARS)	BREAKING LOAD (MIN. LBS.)	ABSORPTION (MAX. %)	DEPTH OF SOFTENING (MAX. IN.)
Grade S_1	**over 75**	**575**	**0.25**	**0.002**
Grade S_2	**40 to 75**	**575**	**0.36**	**0.008**
Grade S_3	**20 to 40**	**575**	**0.45**	**0.014**

Source: ASTM C406/C406M-15, Standard Specification for Roofing Slate, ASTM International, West Conshohocken, PA, 2015, p.1-2.

▪ Although more commonly employed with regard to fire-damaged concrete, two other laboratory tests methods may prove helpful when evaluating fire-damaged slate shingles. These are petrographic analysis and heat soak studies.[8] In petrographic analysis, experienced petrographers examine polished thin sections of the fire-exposed slate at high magnification and attempt to estimate the temperatures and alterations experienced by comparison to thin sections prepared for slate shingles taken from areas of the same roof unaffected by fire.

In heat soak studies, samples taken from slate shingles unaffected by fire are placed in ovens for up to four hours at known temperatures and then examined, pretrographically, for alterations. The heat-soaked samples are then compared to samples taken from the roof that have been exposed to fire in an attempt to determine if temperatures exceeded those at which fire-related degradation is known to occur in slate.

Given the effort involved in the careful removal and reinstallation of slate shingles, if at all in doubt, it is recommended that slate shingles affected by fire be replaced rather than salvaged and reused. Note that if only partial roof replacement is necessary and a close match to the remaining slate is desired, replacement slate shingles may be obtained from a number of sources: a) newly quarried slate of the same type, b) reclaimed slate of the same type that might be available from a salvage company, or c) slate shingles “harvested” from less visible areas of the roof, with the “harvested” slates being replaced with either new or reclaimed slate shingles.

Figure 2: While the wood shingles on the right clearly took the brunt of this fire, at the time, flames were observed coming out from under the Pennsylvania Hard-Vein (aka Chapman) slate shingles located along the eave, rake, and ridge of the roof on the left, causing damage to roof framing, decking, and underlayments. Firefighters removed slate shingles along the rake in order to combat the fire. Although the remaining slate shingles were little damaged from the fire, their overall condition, limited expected remaining service life (20 to 25 years), and anticipated high loss percentage during removal (+/- 50 percent) made salvage and reuse impractical.

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Figure 3: Discoloration (lightening; right arrow) and micro-cracking (left arrow) occurred in this slate shingle due to the heat generated when lightning struck one of its copper nails.[9] (Photo courtesy of John Chan, The Durable Slate Company, Savage, MD)

Endnotes

[1]Waite, Diana S., "Roofing Early America," in Charles E. Peterson, ed., *Building Early America*. Radnor, PA: Chilton Book Company, 1979, p. 138.

[2]Whitmore, William H., *The Colonial Laws of Massachusetts*. Boston: n.p., 1887, quoted in "Boston Building Ordinances," *Journal of the Society of Architectural Historians*, Vol. 20, May 1961, p. 91.

[3]The test involved Grade S_1 North American slate shingles installed over ASTM D226, Type II asphalt saturated organic felt underlayment. For more information on the fire testing of slate, see the Resources section of the NSA website at https://www.slateassociation.org/slate-testing/.

[4]V. Cárdenes, A. Rubio-Ordóñez, and J. García-Guinea, "Fire Resistance of Roofing Slates: Mechanical, Mineralogical and Aesthetic Changes Alongside Temperature Increase," *Construction and Building Materials*, V.368, January 2023, p.1.

[5]Cárdenes, "Fire Resistance of Roofing Slates," p.6.

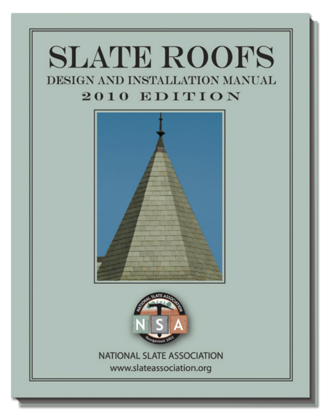
[6]Cárdenes, "Fire Resistance of Roofing Slates," p. 4.

[7]See NSA *Technical Bulletin No. 7*, "Slate Roof Condition Assessment Surveys," for the expected service lives of common North American slates.

[8]"Petrographic Assessment of Fire Damage to Concrete and Heat Soak Studies," *Update,* V.484, Janney Technical Center, Wiss, Janney, Elstner Associates, Inc., March 17, 2023, p.1.

[9]Lightning itself, being an electrostatic discharge, does not have a temperature, but resistance to the movement of its electrical charges causes the materials through which the lightning is passing to heat up. Slate, being a poor conductor of electricity, will get very hot when lightning passes through it.

For more information on slate roofing, please see *Slate Roofs: Design and Installation Manual,* 2010 Edition, available at www.slateassociation.org



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