

SLATE ROOFING:

Innovation in an Old Industry

Part II – Standards, Codes, Testing, and More

By Julie Palmer

Part I of this article, published in the January 2017 issue of *RCI Interface*, discussed new materials and installation techniques that have been introduced to the slate industry over the past 10 to 20 years. Those are far from the only recent changes, however. Part II will explore new and retired sources of slate, code and standard updates, new test data, and new resources that can assist with design and installation of traditional slate roofs.

SOURCES

In the industry's heyday—around the turn of the 20th century—there were as many as 219 quarries in operation in the United States.¹ Many of them have long since closed their doors. The last of the quarries producing Peach Bottom slate and Pennsylvania Hard-Vein slate closed in the 1940s and '50s, respectively. Attempts in the 1990s to reopen quarries in Monson, Maine, which originally closed in the 1950s, were unsuccessful. Within the past ten years, a quarry producing unfading purple slate in Newfoundland, Canada, closed (in fact, no slate is quarried in Newfoundland anymore). Veins of clear, unfading purple slate in Vermont have dried up in the last several years, as well. Currently, all domestic purple slate is weathering (meaning a certain percentage will turn shades of

tan and brown over time) and bears green markings. The Penrhyn quarry in northwest Wales is, at the time of this writing, the only known source in the world for clear, unfading purple roofing slate.

Given the information above, one may be tempted to think that the slate industry is gradually grinding to a halt. But that's not true. Production and installation of slate is starting to turn around, although slate still constitutes less than 1% of the multibillion-dollar steep-slope roofing market. In 1998, North Country Black slate, produced by the Glendyne quarry in St. Marc du Lac Long, Quebec, Canada, first became available in the United States. The slate is an unfading black with an expected service life of 100 years. Penrhyn purple slate, mentioned above, was reintroduced in the U.S. in 2009 after being unavailable for many decades. The James River Slate Company opened in Arvon, Virginia, in 2013, producing an unfading black slate with a micaceous sheen and an expected service life of 175 years or more. In addition, just this year, the New England Slate Company opened a quarry in Vermont producing "Eagle Purple" slate, a semi-weathering slate characterized by a range of purple shades with some green markings.

The increase in slate use in recent years is undoubtedly due, in part, to an

increase in imported slates. In this regard, the industry has come full circle. Before domestic quarries became prolific and productive in the mid- to late 19th century, the majority of roofing slate in the United States was imported from Europe. Slate was frequently used as ballast in the cargo holds of ships originating from Europe. The slate was off-loaded at U.S. ports to make room for more valuable cargo for the return trip. Even after slate began being produced in the United States, Europe remained the largest source of slate in this country until railways became extensive enough to facilitate transportation of slate from quarries to building sites. From that point on, domestic sources dominated the slate industry in the United States...until recently. Imported slate from other countries, including China, Spain, and Brazil, are becoming increasingly available in the U.S., a situation that has brought concerns about testing and quality to the forefront of the industry.

Not all slate is created equal, and not all slate is suitable for roofing. Laboratory testing, as laid out in ASTM C406, *Standard Specification for Roofing Slate*, evaluates the rate of water absorption, breaking load, and depth of softening of natural slate, assigning it to one of three grades: S-1 (over 75-year expected service life), S-2 (40- to 75-year expected service life), and S-3 (20-

to 40-year expected service life). The International Building Code (IBC) mandates that roofing slate comply with ASTM C406, and industry standards advise that only S-1 grade slate should be



Figure 1 – A cramp on the underside of this slate shingle caused it to stick up and rock from side to side when installed on the roof.

used for roofing. ASTM C406 also specifies allowable criteria for dimensional tolerances and allowances for breakage of roofing slate.

Other countries have different standard criteria and testing procedures for judging the quality of slate. As a result, slate produced in other countries may meet their standards, but not comply with ASTM C406. Reputable distributors of imported slate undertake ASTM testing on a regular basis in order to ensure compliance and will produce the test data on request. Still, it seems that a substantial quantity of slates with knots (rounded projections on the slate's surface), or cramps ("steps" in the cleaved surface of a slate; *Figure 1*), as well as warped slates (*Figure 2*) are slipping through the cracks. These problems can prevent slates from laying flat on a roof (*Figure 3*). Raised butt ends make the slate more susceptible to breaking under load and can impact the roof's watertightness by increasing the risk of wind-driven rain penetrating below the raised slates and entering the roof system through nail holes or bond lines in the underlying slates.

Another discrepancy in testing and quality control involves iron pyrites. A significant quantity of the slate produced in other countries contains iron pyrite inclusions, some of which will rust over time when exposed to the elements. ASTM C406 does not currently include a test for oxidation. Therefore, imported slate can comply with ASTM C406 and still develop rust stains after installation (*Figure 4*).

CODE AND STANDARD CHANGES

Even ASTM C406 has changed. The standard includes three tests: C120, Flexure Testing of Slate; C121, Water Absorption of Slate; and C217, Weather Resistance of Slate. In 2005, the test method prescribed by ASTM C120 was updated to use a breaking load requirement rather than the previous modulus of rupture. The test now requires slates to achieve a minimum break-

ing load of 575 pounds of force rather than the 9000-psi modulus of rupture required previously. The change was intended to resolve a number of problems with the modulus of rupture test, including that multiple tests on one specimen could produce widely varied results; and the mathematical formula used to derive the modulus of rupture placed slate thickness in the denominator, thereby making thicker slates appear less durable than thinner ones.

Another change in 2015 redefined the thickness of "standard" slate as nominal 1/4 in. to better reflect the sizes that domestic quarries produce. Prior to 2015, the standard had specified a nominal thickness of 3/16 to 1/4 in., which was based on industry standards dating back to the 1920s. Today, quarries in the U.S. largely produce roofing slate in the 1/4- to 3/8-in.-thick range, with very few, if any, producing true 3/16-in.-thick slates to the previous ASTM criteria.

The IBC has changed in recent years, as well. Prior to 2009, the IBC recognized slate roofs as Class A fire-rated assemblies, no matter what substrate the slate was installed over. Per ASTM E108, a Class A

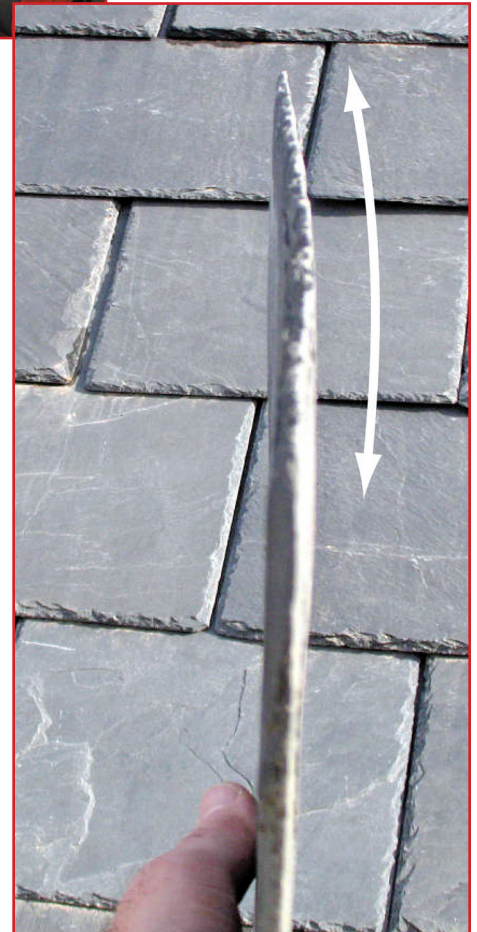


Figure 2 – Warped slates like this one do not lay flat on a roof and should not be installed.



Figure 3 – Numerous slates with raised butt ends detract, aesthetically, from a building's appearance and may impact the longevity and watertightness of the roof system.



Figure 4 – Rainwater has washed particles of oxidizing iron pyrite down the roof, leaving a very visible rust stain trail.

rating means the roof covering is “effective against severe test exposure, affords a high degree of fire protection to the roof deck, does not slip from position, and does not present a flying brand hazard.”² The 2009 and 2012 IBC only accept slate installed over noncombustible roof decks, such as concrete, as Class A assemblies. In municipalities that have adopted those versions of the IBC, slate installed over combustible roof decks, such as wood, must be backed up with ASTM E108 or UL 790 test data to document the fire rating the system can achieve.

In 2010, the National Slate Association

(NSA), in partnership with the National Roofing Contractors Association (NRCA), sponsored fire testing of slate roofing in compliance with UL 790, *Standard Test Methods for Fire Tests of Roof Coverings* (Figures 5 and 6). The sample roof assembly for the test was comprised of a ½-in.-thick plywood deck, a single layer of #30 felt underlayment, and ¼-in.-thick, S-1 grade North American slate shingles.

The assembly performed to Class A standards.³ As a result of this testing, NRCA was able to work with the International Code Council to have the Class A rating for slate installed over combustible roof decks (with ASTM-approved underlayment) reinstated in the 2015 version of the IBC. In municipalities that are governed by the 2009 or 2012 IBC, local building code officials have the authority, per Section 104.11 of the IBC, to accept slate installed over a combustible roof deck as a Class A system, if they determine that the test data indicate that the proposed slate roof system is equivalent to the Class A fire-rated systems included in the code.

TESTING

The ability of slate to resist hail impact and wind uplift has also been questioned in recent years, inspiring the NSA to pursue additional test-

ing. In 2010, hail resistance testing of slate roofing was conducted in compliance with FM 4473, *Specification Test Standard for Impact Resistance Testing of Rigid Materials by Impacting With Freezer Ice Balls*. A slate roof test deck, covered with S-1 grade North American slate shingles, was subjected to impact from ice balls fired from a compressed air cannon. Three-eighths-inch-thick slate met Class 4 requirements (FM’s highest hail resistance rating), showing no signs of damage following the impact of 2-in. ice balls traveling at 76 mph; and ¼-in.-thick slate met Class 3 requirements, withstanding the impact of 1¾-in. ice balls traveling at 69 mph.⁴

Prior to 2013, there was no wind uplift test for slate. ASTM D3161, *Standard Test Method for Wind-Resistance of Asphalt Shingles (Fan-Induced Method)*, applied only to asphalt shingles. In 2013, the standard was changed to apply to a much wider array of steep-slope products. As such, the NSA was able to sponsor wind uplift testing of slate in 2015. Two test decks covered with S-1 grade slate shingles from a variety of North American quarries were subjected to 110 mph winds, which is the highest wind speed specified by the ASTM test. The slate shingles exhibited no damage at the completion of the two-hour test, thereby meeting the Class F requirements. The wind speed was then increased by 10 mph every ten minutes, up to 150 mph, in compliance with FM Approvals Class Number 4475. Both panels, again, exhibited no damage. Finally, the testing laboratory increased the fan speed to 160 mph (the highest wind speed their equipment could achieve), and the slate still did not fail.⁵

One important thing to note about these tests was that the slates were secured to the plywood substrate with smooth-shank copper nails. Smooth-shank nails, as opposed to ring-shank nails, run the greatest risk of pulling out of a wood deck under wind uplift pressure, so these tests show that even in the worst-case scenario, slate can withstand 160-mph winds.



Figure 5 – Burning brand test, per UL 790, in progress on a slate roof test deck. The “brand” burned for about 18 minutes and reached temperatures in excess of 2000°F.



Figure 6 – Slate roof test deck following the burning brand test.

RESOURCES

New resources to assist with proper design, specification, and installation of slate roofs have become available within the last six years. Until recently, *Slate Roofs*, published in 1926 by the original NSA, was the main industry reference containing technical information about installing a slate roof and flashing common details. Over the years, the 1926 book was republished by slate quarries, the flashing details showed up in other publications, and many outline specifications referred to it. The breadth of the 1926 book was somewhat limited and, as can be imagined, some of the information was a bit outdated by today's standards. For instance, at the time, there was no industry-wide consensus as to what type of nails were best for securing slate shingles. Instead, the NSA stated their hope "that research in this field may be undertaken in the near future and definite results furnished those interested."⁶ Ninety years later, practical experience has led to copper nails being the most widely used in slate roofing—both because their service life is comparable to that of slate, and their relative softness facilitates slate repairs.

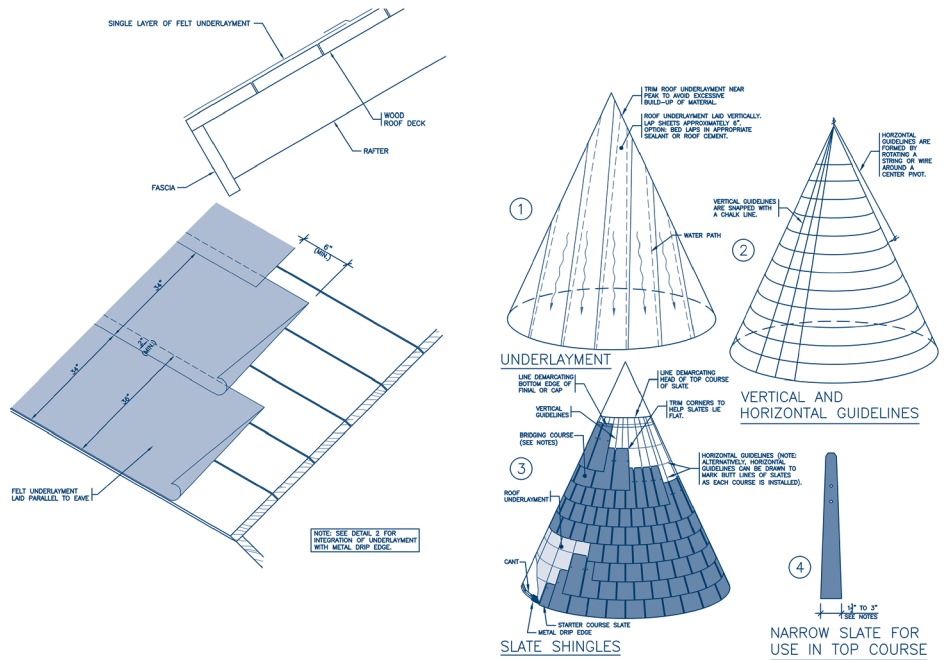


Figure 7 – Examples of detail drawings included in Slate Roofs: Design and Installation Manual. Reprinted with permission from the National Slate Association.

In 2010, the NSA published *Slate Roofs: Design and Installation Manual*, consisting of nearly 300 pages of technical information, from basic geology to instructions for laying out a slate roof, descriptions of slate

roofing tools, recommendations for flashing materials, and discussion and illustration of proper soldering techniques. The book also includes more than 100 pages of detail drawings, ranging from basic underlayment

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installation, to typical flashing details, to appropriate repair techniques, and even including some unusual details like installing slate on a turret (Figure 7).

Even more recently, the NSA has launched a mobile field guide containing layer-by-layer animations of the most common installation details, which can be accessed on mobile devices.⁷ Building owners, contractors, and designers can now have slate roof details literally at their fingertips anytime and anywhere. The NSA has also introduced a double-sided illustrated card designed to be affixed to slate pallets by quarriers and distributors to give the end-user basic slate installation and handling instructions, as well as directing them to other sources of details and information. Now, more than ever, the information and guidelines needed to properly install slate roofs are readily at hand.

CONCLUSION

Sources of slate have always been, and likely will always be, a frequent variable within the industry. Some domestic quarries close, and others open on a regular basis. Today, quarries in foreign countries are providing more slate to the U.S. than they have since the early 19th century. While the importation of slate is not a new phenomenon, it is being imported from more varied countries than ever before, thereby bringing new issues and considerations to the forefront.

Testing, standards, building codes, and publications have adapted and must continue to do so in order to keep up with changing concerns and technology—even when


they focus on a roofing material or installation that has been in use for centuries. Many recent changes in the slate industry, including code and standard changes, testing, and new resources, are geared toward supporting S-1 grade natural slate and traditional slate roof installation, which have proven, over and over again, an ability to deliver service lives in excess of 75 years.

New materials and installation techniques are constantly appearing and disappearing from the market. Some may prove to be beneficial to the slate roofing industry. The best indicator of reliability, however, will always be the test of time. Until new materials and alternative installation methods are able to demonstrate a long history of successful, reliable performance, their use should be approached with caution and a thorough understanding of the potential risks.

REFERENCES

1. Jeffrey S. Levine. *A History of the United States Slate Industry*. (Thesis, Cornell University, 1988). p. 329.
2. ASTM Standard E108, 2011, *Standard Test Methods for Fire Tests of Roof Coverings*, ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/E0108-11, www.astm.org.
3. More information, official test results, and photographs of the testing in action are available at: <http://slateassociation.org/slate-testing/>, <http://levineco.net/wp-content/uploads/2010/12/RidgewalkerNews-V5N1-FireTesting1.pdf>, and <http://docserver.nrca.net/technical/9562>.

pdf. It was concluded that the felt underlayment did play a role in the Class A fire rating.

4. More information, official test results, photographs, and a video of the testing in progress are available at: <http://slateassociation.org/slate-testing/>.
5. More information is available at: http://slateassociation.org/wp-content/uploads/2016/07/whitepaper_wind.test_.pdf.
6. National Slate Association. *Slate Roofs* (Poultney, VT: National Slate Association, 1926). p. 25.
7. NSA's mobile field guide can be accessed at mobile.slateassociation.org. 



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manager for eight years and produced drawings for the Association's Slate Roofs: Design and Installation Manual and mobile field guide. Palmer has a master's in historic preservation from Columbia University and a master's in architecture from the University of Pennsylvania.

JUDGE BLOCKS OVERTIME RULE



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The U.S. Department of Labor's (DOL's) Overtime Rule, which was to have taken effect on December 1, has been blocked by a federal judge in Texas, who granted a preliminary injunction on November 22 in a lawsuit challenging the DOL's authority to raise the salary threshold. Judge Amos Mazzant of the U.S. District Court for the Eastern District of Texas granted the injunction after 50 business groups and 21 states brought a lawsuit claiming that the DOL exceeded its authority by raising the salary threshold too much and providing automatic updates to the threshold without stakeholder input. On December 1, the DOL appealed the decision to the 5th Circuit Court.

The Fair Labor Standards Act's (FLSA's) salary threshold for exemption from overtime pay would have been raised from \$23,660 to \$47,476, or \$455 per week to \$913 per week. The Overtime Rule was last updated in 2004.

Response briefs were due before January 17, 2017.