DECLINE AND RENEWAL: PROJECTIONS FOR SLATE ROOFING IN NORTH AMERICA

COLIN MURPHY
Exterior Research & Design
Seattle, Washington

Since the turn of the century, the use of roofing slate in North America has steeply declined. North American culture, combined with abundant natural resources, such as wood and oil, have reduced the demand for long-lived roofing materials, such as slate. This decline seriously impaired the evolution of North American slate installation methods and accessories. However, there are signs of a revival, prompted by the reroofing cycle, restored demand, and advances in production and installation of roofing slate. This paper will examine the roots of the decline and hopes for a revival in North American roofing slate use. In addition, this paper will suggest measures to promote this revival.

KEYWORDS

Air-permeable, attachment, clip and track, discontinuous roof systems, life cycle, nail, roofing slate, tile, underlayment.

INTRODUCTION

Roofing slate's long history of use is testimony to its durability and architectural adaptability. This stone, split into thin sheets, has served as a primary roofing material since the eighth century. High-grade slate, with a service life in excess of 100 years, continues to set the standard for durable roof shingles. Today, after a long market decline, roofing slate is beginning a comeback in North America. However, roofing design and installation professionals will need to revisit and update standards, materials, and installation methods to sustain this growth. This paper examines the past, present, and future of roofing slate installation.

ROOFING SLATE—ORIGIN AND PROPERTIES

The American Society of Testing and Materials (ASTM) defines slate as a microcrystalline metamorphic rock most commonly derived from shale and primarily composed of micas, chlorite, and quartz.[1] Roofing slate is a dense, natural stone that is typically fire-resistant, is highly durable and has low water absorption. Like most stone, some slates becomes harder and tougher after being quarried and exposed to the elements.

Slate is formed from layers of erosion-borne mineral deposits that lay over clay beds in oceans and lakes. Pressure on the combined clay and mineral deposits creates shale, a laminated rock form. Intense pressure and high temperatures created by movement of the earth's crust align the mineral particles in a parallel configuration, turning the softer shale into slate, which can be split into thin, strong sheets.[2]

Different mineral compositions form slate with different physical and aesthetic properties. This variety permits a range of slate roof finishes. (See Figures 1A and 1B.)

Wherever it is installed, slate roofing is a unique part of the local architecture: Each region's unique mineral deposits produce slight color and texture variations in the slate; local artisans and architects add unique shapes and form to the finished roof assembly.

Slate deposits exist worldwide, with major deposits in Europe, North America, South America and Asia.

THE HISTORY OF SLATE

Slate's Heyday

The earliest slate roofs found to date are eighth-century Norman and Saxon chapels. One of these roofs, although completely covered in moss, has survived the elements for 1,100 years. The French began using slate in the twelfth century and developed a mining center at Angers.

When 18th and 19th century Americans found slate formations in the middle Atlantic states and in New England, businessmen imported installation and quarrying skills developed in Europe to mine the deposits and install the finished product.

Figure 1A. Thin French slate application using S hooks. Note the lack of underlayment over open battens.

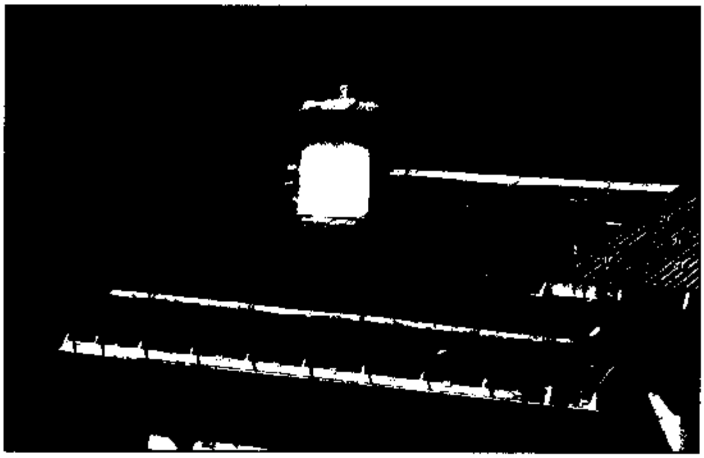

Figure 1B. Swiss application of thick slate. Note snow guard installation (Poshiavo, Switzerland).

Throughout the early 19th century, industrialization's production efficiencies combined with increased construction of single-family dwellings fueled significant growth in roofing slate usage. This growth fueled demand for a large skilled labor pool to produce and install the roof covering. Trade guilds offered apprenticeship programs and skilled installers provided on-the-job training to maintain and grow this pool of installation craftsmen.

The high-quality slate roof application provided the building owner with excellent performance and a life cycle of one hundred years or more. This long life cycle, coupled with the attractive finished product, justified the high initial cost of installation.

North American Decline

While slate roofing sustained its popularity in Europe and other parts of the world, North America became the exception. Understanding this phenomenon requires a brief discussion of older European society and the colonization of North America by European nations.

The European continent has cradled a civilized population residing in permanent structures for many more centuries than the North American continent. Because of political and geographical boundaries and local language differences, the population of Europe remained relatively static—nuclear and extended families have remained in the same location for hundreds of years, building, expanding, and renovating the same family structures. The house was intended to be handed down from generation to generation, forming the center point of traditional family life. Supplies of wood, a primary fuel in Europe for centuries, were depleted. Medium and high-density housing became common, even in early civilizations, as people grouped for self-defense and centralization of resources. The feudal system, coupled with the promulgation of small city-states, resulted in de facto and codified building

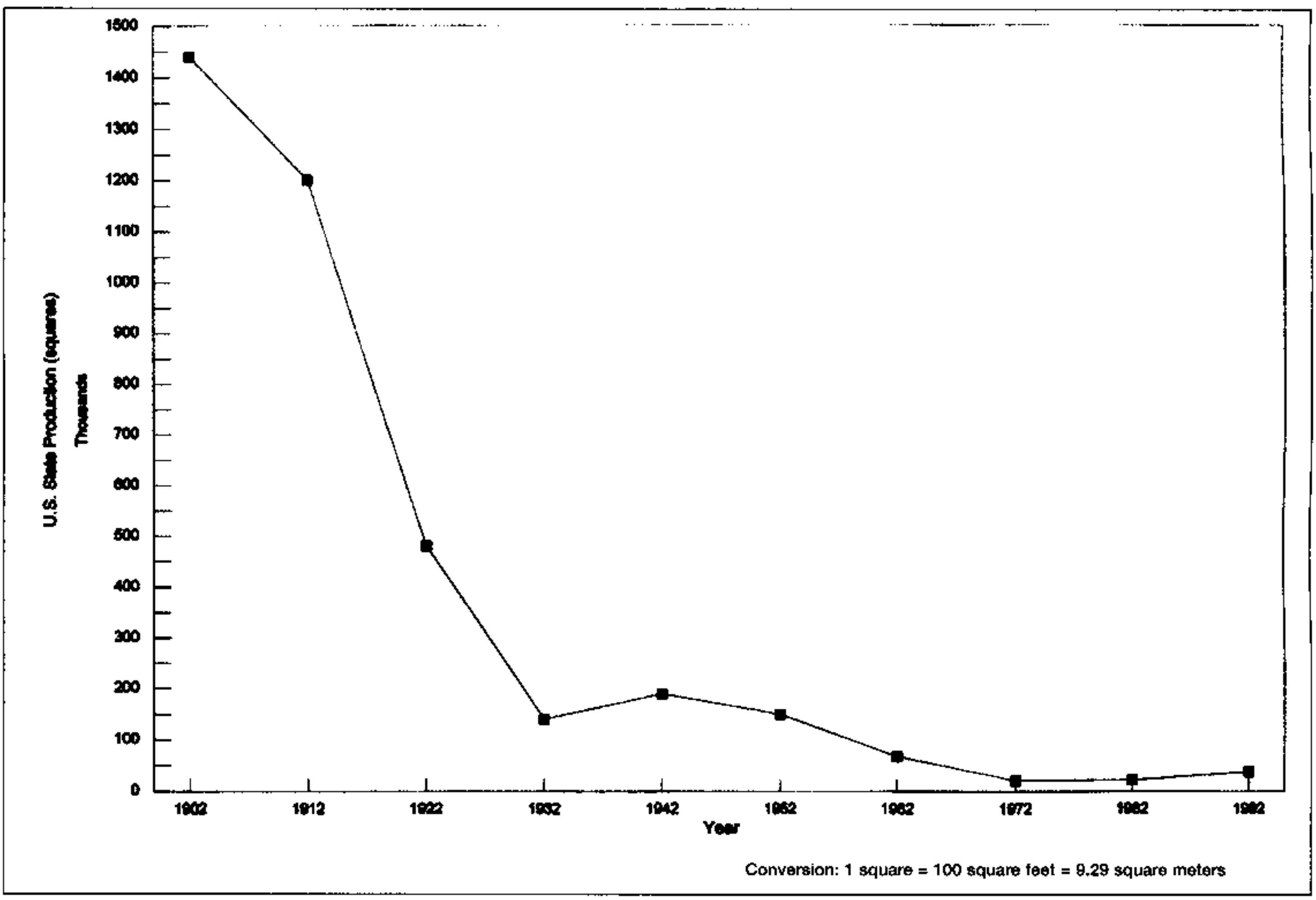

Figure 2. North American roofing slate production.

regulations favoring continuity in exterior building facades. These building restrictions continue today both in their original form and in updated local building codes.

North America was colonized centuries later, primarily by European immigrants who carried with them their traditional European construction methods. The first construction in eastern seaboard cities was based on traditional methods; some of those buildings remain standing today. However, the steady influx of immigrants, many of whom arrived with only personal possessions, required a new construction philosophy. Influenced by this pressure, North American construction began to change. With an abundant supply of timber and petroleum readily available by the 1870s, less expensive wood-framed structures became the standard, both in urban and rural areas.

The westward population shift also influenced construction as local, sometimes isolated populations needed to make do with locally available materials or purchase prefabricated components to augment those materials. Early westward migrants could even purchase a prefabricated house and have it delivered to the construction site. Much of the housing constructed by settlers moving westward was built with the assumption that the families or individuals would either move on or build better homes later. Like many intended temporary buildings, these structures often became permanent dwellings.

The increased mobility of the North American population, coupled with the availability of less expensive building materials, such as wood and oil-based products, decreased the demand for long-lived, expensive structures and increased the demand for easily constructed, less expensive housing. The general population did not want homes that would hold their families for generations—they wanted affordable housing that used the abundant natural resources of North America. These factors inevitably impacted slate usage in North America—slate was slowly replaced with wood and asphalt shingles. The Eastern seaboard remained the exception, with higher-end structures and more traditional European construction.

Bureau of Mines and industry data from 1900 to the present provides a complete picture of slate usage over the past 100 years.[3]

Roofing slate use in the United States has dropped 90 percent over the past 96 years. Slate represents only 2 percent of the reroofing market and 3.5 percent of residential new construction, according to 1995 NRCA figures.[4] In contrast, slate continues to be a primary roofing product for European roofing applications. As an example, France, which has only 18 percent of the North American population, uses at least nine times more roofing slate than the entire North American market.[5] (See Figure 3.)

THE IMPACT OF DECLINE IN USE

Declining roofing slate use in North America cascaded into all elements of the industry: While the European slate industry continued to develop and refine installation methods, training, and accessory products, those aspects of the North American slate industry languished.

Installation Methods

The National Slate Association (NSA), which disbanded in 1936, published the primary slate installation guide in 1926.[6] The 20th century has seen unprecedented, accelerating growth in new building materials and methods of construction. The NSA manual has never been updated to address these changes, such as the use of engineered wood products, plywood, or trusses, and only partially addresses spaced vs. solid sheathing. ASTM criteria for slate address test methods for raw material, neglecting design and installation standards.[7]

The North American roofing industry left slate behind as it developed and documented installation methods for other roofing materials. This led to a reliance on an old, outdated document for slate applications.

Model building codes give slate performance and installation standards only cursory attention. Section 3208(b)(9) of the Uniform Building Code (UBC) merely states: "Slate shingles shall be installed in an approved manner."[8] Building Officials and Code Administrators International, Inc. (BOCA),[9] Section 1507.2.7, and Standard Building Code (SBCCI),[10] Section 3210.1.1, merely set forth slope and headlap limitations and minimum underlayment and nailing requirements.

In contrast, European countries, where slate application continues to play a significant role in both the new construction and reroofing industry, application standards are continually updated and codified in government standards. Industry trade organizations and formal apprenticeship programs continue training in slate application, taking into account current construction techniques. For example, the French continue to offer a formal apprenticeship program at the Centre Perfectionment de Couverture in Angers.[11] In addition, code and standards bodies, such as the British Standards (BS) in the United Kingdom, have continuously updated testing, application and design considerations for slate.[12]

The fourth edition of the National Roofing Contractors Association steep roofing manual contains an expanded version of the original NSA manual, rather than the short section in the previous NRCA guide.[13] This new version contains almost 50 pages of guidance in traditional installation techniques. However, updates of all application issues will require a great deal more, and efforts to improve upon traditional techniques deserve consideration.

Components

As discussed, the North American housing market favored wood-framed construction with a comparatively shorter life cycle than European construction methods. The majority of

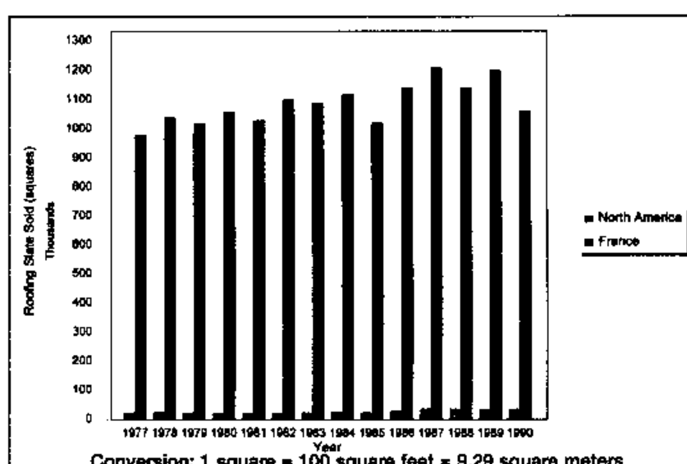

Figure 3. Comparison of roofing slate sold from 1977 to 1990, France vs. North America.

roofing materials sold in North America shortly after the turn of the century were of a lower initial cost, with a life cycle of 20 to 30 years. Wood products, both shakes and shingles, presented a readily available, less expensive option than slate—these products subsequently competed with asphalt composition shingles for a majority of the market.

Logically, accessories such as nails, underlayment, sealant materials, and edge metal were designed to match the shorter life cycle of the completed roof system. This rendered these materials unacceptable for use with longer-lived products, such as slate. Accessories designed for use with slate became less available in local markets. Therefore, certain accessories designed for slate's longer service life are not readily available and carry the enhanced cost of a specialty or custom item. In modern slate applications, this lack of local availability and higher cost encourages the use of more readily available, shorter-lived components, many of which are not compatible with slate.

This problem was noted as early as 1926, when the NSA noted only asphalt-saturated rag felt should be used for slate installation: "The so-called slaters felt includes many types of materials which cannot be recommended."[14] Similar warnings regarding nail usage also appeared in the 1926 publication.[15]

Testing Standards

Current ASTM published documents neglect application techniques, addressing only raw materials test standards. By contrast, European countries have continuously focused on design and application techniques, as well as the physical property requirements of the product.

For example, the United Kingdom has continuously updated standards for slate roof systems. In 1978, British Standard BS 5534 set forth testing, design, and application standards for slate roof assemblies.[16] BS 5534 and other British standards establish minimum application requirements and benchmark slate and tile roof assembly wind resistance. The standard determines wind resistance criteria based on the concept of air permeability. BS 5534 recognizes that air can flow through the rigid, discontinuous elements of slate and tile roof assemblies. Wind loads incurred by air permeable roof systems are, therefore, distributed differently than those incurred by a continuous, monolithic roof assembly.

This method of testing and design was introduced to North America in December 1991 through a document titled *Fixing Studies for MRTI Normal Weight Tiles—SBCCI Submission.* Known as the Redland Report, this document proposed a method to quantify the effects of wind flowing over a rigid, discontinuous roof component through establishment of an aerodynamic multiplier.[17] A designer can use this multiplier, which is a function of the component's dimension and a moment coefficient, to convert calculated uplift pressures for a particular building, expressed in force per unit area, to the required overturning moment resistance, expressed in force-length. This allows comparison of static uplift test results for air permeable roof assemblies using different attachment methods.

The current method uses an equation of motion on a rigid component and sets forth a static condition criteria (i.e., the sums of forces about a given axis are equal to zero). The method considers the calculated uplift pressure as an upward force vector acting at the leading edge of the rigid component rather than over its entire exposed surface area. BS 5534: Part 1: 1990 states that "[The wind] load q_t (per unit area) should be taken to act on all slates or tiles over an area defined by the cover width *b* and a length at the tail [leading edge] equal to c ("step height factor") times the height of the step between courses *t*."[18]

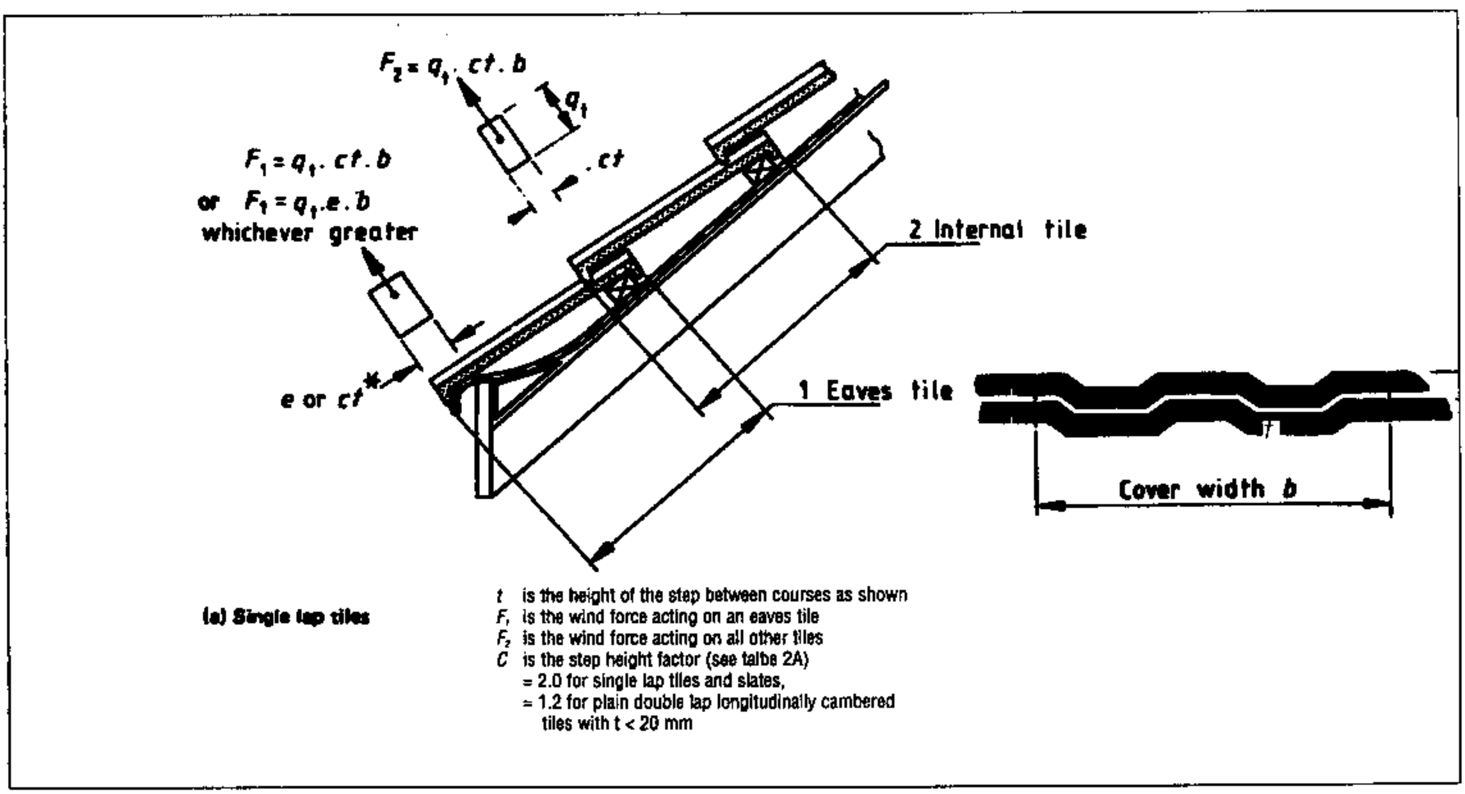

Figure 4. British Standard 5534.

This approach results in the following equation, used to determine the force F acting on the leading edge of the components:

$$F = q \times c \times t \times b$$

This interpretation of a wind load force acting at a particular location on the rigid component allows the designer to use simple vector force analysis to:

- determine the moment of resistance required of the attachment,
- analyze static uplift results for various fasteners, clips, and the locations thereof to meet this requirement.

However, the testing and design methods set forth in the Redland Report were only adopted into the 1994 Standard Building Code for tile;[19] the concept was not extended to slate. In addition, the Redland Report and its associated uplift criteria still require wind tunnel testing of the rigid, discontinuous roof system to generate an aerodynamic multiplier. While the 1990 revision of BS 5534 eliminated the need for wind tunnel testing, these aspects of the updated standard have yet to be introduced to North America.

AN END TO THE "DARK AGES"

Today, the primary slate roof applications in North America are renovations of churches, universities, historical structures, and luxury homes. However, some producers, suppliers, and installers within the industry forecast the end of the "dark ages" of slate in North America. Several factors indicate that this renaissance may be at hand: Landmark 19th-century slate roofs are now old enough to require reroofing, and designers are returning to steeper roof slopes that display the roof surface using simulated slate products and slate-look dimensional shingles, which have become more available over the past ten years. The proliferation of these products affirms the growing public appreciation for the look of slate. In addition, market statistics show an increase in slate use.

Roofing slate imports to the United States have increased significantly from countries such as Brazil, China, India, Italy, South Africa, Spain, and the United Kingdom; China is poised to become the primary slate exporter. In February 1996, the United States imported approximately $180,000.00 (U.S. dollars) in roofing slate, a 15 percent increase from the previous year.[20] The introduction of cheaper imported products has pressured domestic producers to lower costs and increase efficiency.

At the same time, dormant and new North American slate quarries have opened in recent years, increasing the variety of available slate product. For example, slate quarries in Newfoundland, Canada, have produced roofing slate since 1992, exporting the product to twelve countries on four continents, including the United States. Investment in high-technology quarrying techniques has boosted production without boosting manpower requirements, thereby reducing the cost of raw material. In addition, some distinct North American slates (such as green or purple) are sold in European markets as lower-cost alternatives to local products; this contributes to a rising demand for North American slate.

Innovations in roofing slate fabrication have also increased production and reduced prices. France, the largest market for roofing slate, has sought to reduce the cost of high-quality slate by reducing the standard thickness of its slates to 3.2 mm (⅛ inch). However, while indigenous French slate is well-suited to cleaving into thin elements, the thinner product presents some new sizing and application issues, addressed later in this paper.

Concerns about fire resistance, particularly in western states, are prompting a move away from wood shingles to alternatives, such as tile and slate.

Manufactured slate-like products, formed from fiber cement and powdered slate and resin, are also now available worldwide. The life cycle of these products are still only projected to full term, since they have been available for periods shorter than their warranty. However, products of these types may increase demand for slate and for other longer-life products.

The design community and the general public have recognized over the past decade that building materials must come from renewable resources, be recyclable and have little impact on the environment. The design community also recognizes the importance of a material that is cost-effective when measured based on life cycle costing. Slate is an available raw material, requiring little energy for production, and is easily disposed of in an environmentally sound manner.

All of these factors combine to suggest that roofing slate is indeed headed for a United States revival. However, obstacles remain.

REQUIREMENTS FOR A SUCCESSFUL RENAISSANCE

For slate to sustain and increase growth in the North American markets, several changes must occur:

- Prefabricated accessory components matching the life cycle of slate must be developed by industry and be readily available in local markets.
- An industry association should be established to collect, archive, and disseminate the knowledge required to update slate installation methods and train a new labor force in cost-effective slate installation methods over modern construction.
- Slate application methods must be documented, updated, and kept current with construction methods. These application methods should be adopted by model codes in summary, or by reference. Test methods to meet design requirements should be reviewed and adopted by ASTM and other industry bodies.
- Installers must build on the small body of qualified installers in North America and use the knowledge base generated by the world's most active slaters—European colleagues. This will develop a broader pool of knowledgeable North American installers with formal slate application training.
- New installation methods should be critically reviewed, tested and, if feasible, adopted. This could increase production with the use of less skilled labor for some aspects of the application. Any new methods must be documented, tested for performance and be subjected to field trials before application in the field and incorporation into model building codes.

ACCESSORY COMPONENTS

There must be a ready supply of up-to-date, prefabricated components designed to match the long life cycle of a slate roof. Developing these components may be one of the most difficult challenges. This article will use underlayment and attachment components to illustrate the challenge ahead:

Underlayment

The 1926 NSA manual states:

"It should be emphasized that a standard slate roof can be laid watertight on open lath without felt, as is done in the South or on buildings where heat is not required. The thickness of the felt has little relation to the watertight qualities of a slate roof. The opinion has been held by many that the thicker the felt, the tighter will be the roof. When it is realized that every nail used in fastening the slate is driven through the felt it will be seen how erroneous is this idea."[21]

The NSA also recognized three distinct properties for an underlayment:

- protection prior to completion of the slate
- insulation value
- to form a cushion under the slate

The NSA recommended the use of "asphalt saturated rag felt." The use of "so-called slaters' felt," it said, "cannot be recommended."[22]

These underlayment recommendations underscore the outdated nature of the NSA manual. Construction methods have changed significantly—20th century construction is far more airtight and requires greater attention to ventilation at the sheathing level. While an underlayment is no longer considered an adequate insulating or cushioning material, its role as a temporary waterproofing and long-term water shedding layer is still important. Rag felt is a historical artifact, replaced by asphalt-saturated organic (primary cellulose) carriers, which are, no doubt, the very products the NSA stated could "not be recommended."

Some modern designers have taken a "belt and braces" attitude, installing a self-adhering membrane directly to solid sheathed roofs. In fact, the self-adhering membrane becomes the primary waterproofing layer; the expensive slate is relegated to the role of a decorative covering. The majority of these self-adhered membranes are modified bitumen products. Self-adhering modified bitumen membranes have been commercially available for less than 30 years. Although they have been considered improvements to organic underlayments,[23] modified bitumen membrane adhered to a plywood deck can raise concerns relating to ventilation.[24] Moreover, the slate roof cover, while protecting against ultraviolet light, does inhibit the heat aging process, which will eventually cause material breakdown. The long-term performance of these membranes, either adhered or mechanically attached, is not fully known. More study is needed to identify a specific product that will match the life cycle of slate and have minimal impact on structural and sheathing components. Fricklas states: "Embrittlement or disintegration from loss of plasticizer, natural aging, or moisture attack will eventually require replacement of the underlayment. In cases of long lasting roof coverings, such as slate and tile, the underlayment may have to be replaced while the primary roofing has decades of service remaining."[25]

In contrast, European construction has long promoted the use of spaced sheathing covered with an air-permeable waterproofing layer. (See Figure 5.) The underlayment is secured beneath cross battens, to which the slate is attached. This shows that underlayments are not required for cushioning. The underlayment performs as a secondary waterproofing layer, which carries away the small amounts of wind-driven rain that infiltrate the slate; no elements impede drainage. The air-permeable underlayment also allows air transfer for optimal attic ventilation.

An attempt to introduce one such product into the U.S. market for use with tile was disastrous, because U.S. installers applied the product on relatively low slopes, in an area with severe weather exposure. The installers had little experience with the underlayment system over spaced sheathing. Recently, some of these products have reentered the Southeastern market for use with clay and concrete tile. The manufacturers have developed systems using adhesives and sealants to address the more common low-slope applications found in the Southeast.[26]

Although the NSA could not recommend the use of slaters' felt, asphalt-saturated products have made effective slate underlayments. Observed problems, such as heat aging and asphalt flow from the felt in elevated temperatures, can be addressed by altering the carrier mat, altering the asphalt blends, or substituting the waterproofing compound. Building changes can also be made to increase ventilation, thereby reducing temperature and moisture stagnation. This, in turn, may increase the life of the water shedding layer. An industry review of asphalt and nonasphaltic products available in both North America and Europe could establish the necessary underlayment standards for tile and slate systems with a projected life span of more than than 75 years. Any such standards should anticipate application over both spaced and solid wood sheathing. This would provide the market with a long-life underlayment to match the performance of slate and simulated slate products. The Fricklas report forms an excellent springboard for future work in this area, both with ASTM and within the industry research environment.

Slate Attachment

The NSA addressed both the formation of the nail hole (hand- or machine-punched) and the selection of a nail in a number of chapters of the 1926 publication.[27] "Like any other construction unit, a slate roof can only be as strong and enduring as its weakest part, and the majority of slate roof failures over a period of years may be attributed to the punch-

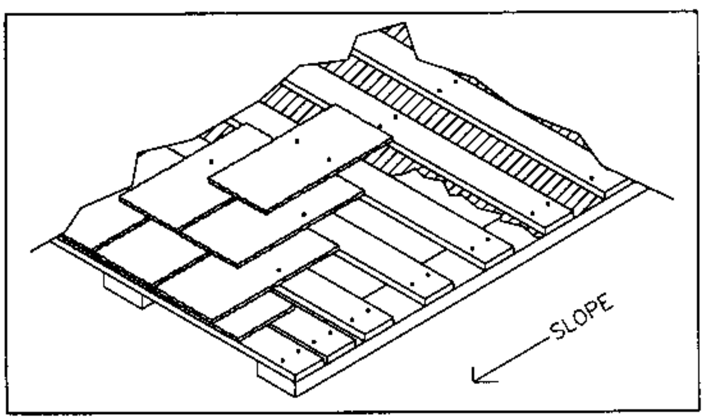

Figure 5. Spaced sheathing installation.

ing of the nail holes, nailing of the slates, or the nails themselves. As has been previously stated, the art of properly laying and nailing slate is not to be discounted and belongs to men trained especially in the work."[28]

The general warning of failures relating to the punching of nail holes and of nailing continued through the third edition of *The NRCA Roofing and Waterproofing Manual*. "The majority of slate roof failures over a period of years may be attributed to punching nail holes or nailing slates or to the nails themselves."[29]

The fourth edition makes no mention of the potential for failure due to the type of nail hole punching, because machine punching has become the standard. Although the fourth edition addresses the proper sizing, density, and installation of nails, the reference to the potential failure resulting from poor nail installation has been dropped.

The fourth edition recommends the use of a 0.120-inch (3-mm) or No. 11 gauge smooth, barbed or otherwise defined shank nail.[30] It also recommends the use of a larger diameter "for thicker slates."

Although10- and 11-gauge copper nails are produced in both smooth and ring barbed configurations by the two primary copper nail producers, 12-gauge smooth shank nails, common for sheet metal applications, are the standard products on the shelves of roofing wholesalers.

Since the 1926 NSA publication, there has been little research into the performance of various nail types in engineered wood panels, a common substrate for new construction. Research carried out by the American Plywood Association documents large variations in performance, depending on diameter and shank configuration.

Before the use of nails, slate was hung from wood pegs, through holes or kerfs, or from copper wire secured to horizontal wood members. The thicker slate provided excellent strength and the hanging method allowed the slate to move independently from the roof structure. The weight of each piece and the large head lap provided adequate wind load resistance. Roofs of this configuration and application were subjected to the winds of the west coast of Ireland and Scotland, where they were subjected to wind intensities similar to those experienced in the hurricane areas of North America.

Nails became the most common form of slate attachment by the mid-19th century, when nonferrous nails became commercially available. Nailed applications created new problems: Nails holes were primarily hand-punched, and this technique often damaged the slate, which caused attachment failure after nailing. However, the NSA adopted machine punching as the standard in 1923. Machine punching created a clean, countersunk hole for nailing.

The type and sizing of nails became a problem in North America when manufacturers began producing nails for composition shingle installations. Nails were available in 10, 11 and 12 gauge. (See Figure 6.) Lower gauge and ring shank configurations nails are, for the most part, special order from the nail manufacturers.

The 1926 NSA manual detailed proper head size, shank diameter, point types, and embedment requirements and states:

"The temptation to use shingle nails should be discouraged, for the slight saving in cost on the entire roof cannot approach the cost of repairs which may result of this practice. Architects and owners should insist that the roofer use nails of proper size and kind of nonferrous metals."[32]

The NSA manual also distinguished between a copper wire nail and a large, flat headed copper slating nail.[33] *The NRCA Roofing and Waterproofing Manual*, 4th Edition, makes a similar recommendation and eliminates the warning about the use of the more available, higher gauge, and smaller head nails.

Today, all copper nails are generally referred to as copper slating nails and are available with a head size of 8.73 mm ($^{11}/_{32}$ inches) in a 12-gauge shank. For effective, long-lived slate applications, installers must have a ready supply of copper nails in the correct size.

INSTALLER TRAINING

Slate roofing firms lack up-to-date guidance from codes and industry manuals and, in many markets, face a crushing shortage of skilled labor. The firms also face a void of information on the most recent improvements. Furthermore, public slate projects do not include certification or other skill benchmarks for slate installers. The result: Unqualified roofing contractors installing slate on public works projects, because of the attractive margins when lower-paid, lesser-skilled workers are employed. Designers must either carefully describe the installation methods specific to the project or rely on the few roofing contractors that have maintained a corps of skilled slaters.

There is an aesthetic impact, as well: Lack of clear guidance, combined with a lack of skilled slaters, has led to conservative slate applications without the flair and style of past slate roofs. This can reduce public desire to use the material.

Countries in which slate roofing remains a prevalent form of steep-slope roofing have current industry and government design, material and installation standards available for reference by designers and building owners. As noted earlier in this paper, the United Kingdom publishes and updates standards for design and installation. Furthermore, installers entering the trade must formally learn industry-accepted and published installation methods and develop skills associated with slate roofing. These updated installation standards and slater training requirements keep slate roofing at the forefront of the steep-slope roofing industry and allow designers to specify unique slate installations without a prevailing concern for watertightness or initial cost. High initial costs, coupled with relatively low life cycle costs, are more easily defended when the durability and watertightness issues are not a concern.

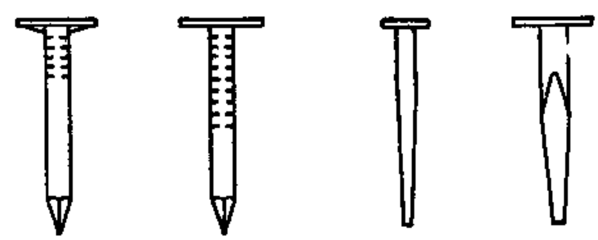

Figure 29 Copper Wire Nail. (Similar to Steel Wire Nails)

Figure 30 Large Flat-Head Copper Wire Nail. (Slating Nail)

Figure 31 Regular Cut Copper Nails

Figure 32 Large Flat-Head Cut Copper Roofing Nail

Figure 6. Examples of nails, as presented in the 1926 NSA manual.[31]

The lack of a trade association in North America to promote the use of slate and to coordinate and assist in the establishment of installation standards, the training of installers and supporting research and classification of accessory components, seriously retards the revitalization process. Without trade and industry support and without demand for product, slate roofing will be left to the specialists who will assess labor costs at a specialty rate only affordable for a select few. To correct this, installers must leverage the knowledge base developed in Europe and look to European application standards, in combination with the limited North American resources, for guidance.

CHANGES IN INSTALLATION

Advances of recent years may, in combination, remedy some of these problems.

As noted earlier in this paper, the French slate industry began to form slate as thin a 3.2 mm (⅛ inch) to produce a lower cost product. Unfortunately, such thin slates could not well withstand the stress of nailing. Furthermore, thin slates became excessively fragile if rendered in larger dimensions. French producers required compliant, forgiving attachment if lower cost, thin slates were to be used. So, they borrowed a Canadian invention: S-shaped hooks that were hung from horizontally spaced battens. Lead by local quarries and assisted by the slate application schools, the French committed themselves to the production of thin, small slates, shifting away from nailing altogether. The small dimension of the slates reduces the unsupported span and maintains comparative support for load resistance. (See Figure 7.)

Outside of France, beyond the influence of French slate suppliers and French slate schools, hooks have not generally been adopted. Detractors generally cite the appearance of the hooks and the potential of the S-hook trapping debris. Importantly, the preferred double-ended form of the hook does not lend itself to installation on the solid decking that prevails in North America.

In the early 1990s, a collaborative effort by North American slate industry members was begun to develop an easy method of attachment that would improve the integrity of completed installations and reduce labor costs. The collaborators focused on the problems inherent in nailing and the potential for misapplication. They developed a clip and track

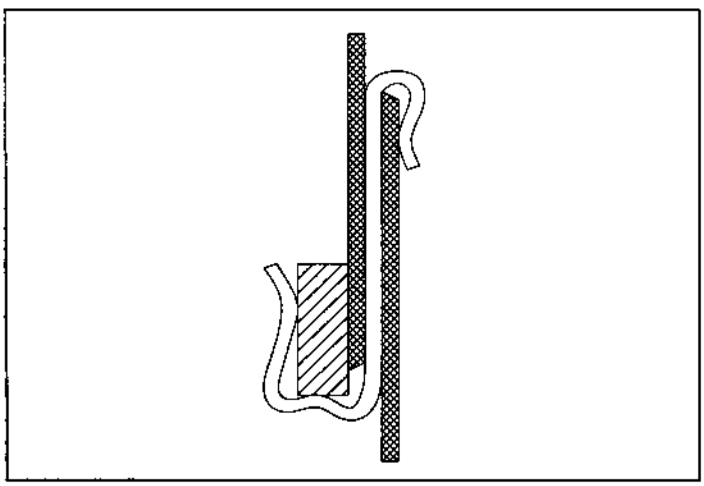

Figure 7. S-shaped hook installation.

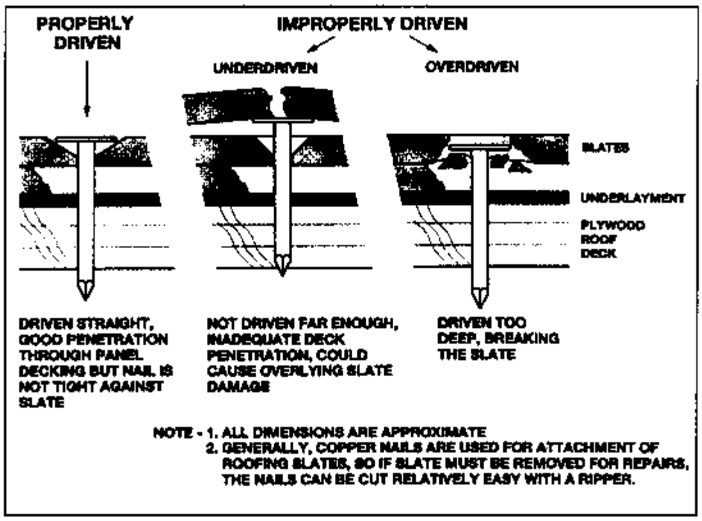

Figure 8. Over- and undernailing.

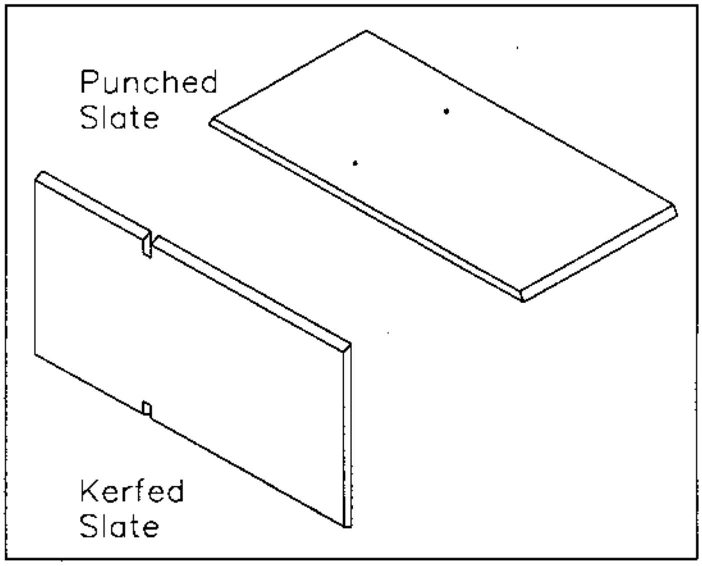

Figure 9. Kerfing.[35]

system utilizing kerfed (notched) slate. This eliminated the problems associated with nailing, including breakage from under- and overnailing. The installation system was designed for use over both spaced and solid sheathing, to meet North American and European installation preferences.

The new system design improves air circulation around the slate, reduces breakage, simplifies repair and reduces wind chatter while using material that will match slate's life cycle. The system can be used with both natural slate and simulated slate products to maintain a traditional appearance.

Slate kerfing can be accomplished in a single step using a rack and saw. Many slates can be kerfed at once, which is more efficient than individually punching slates.

The rail or track component is formed in a Z shape from nonferrous materials. The track is perforated if installed over solid sheathing to allow air circulation and weeping. The Z-shaped track is secured to the deck with nonferrous fasteners. The slate is fitted with two nonferrous clips that engage the kerfed slate to the Z- shaped track. (See Figure 10.)

The clip and track installation method raises slate from the roof deck, promoting air circulation. As a result, slates and

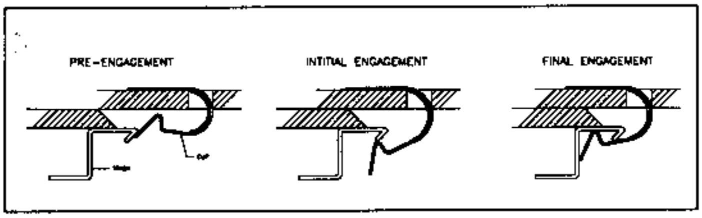

Figure 10. The clip and track system.

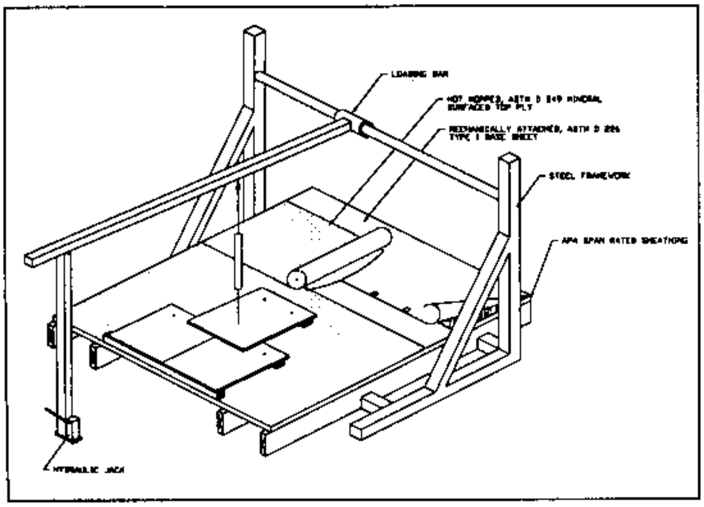

Figure 11. Static uplift testing.

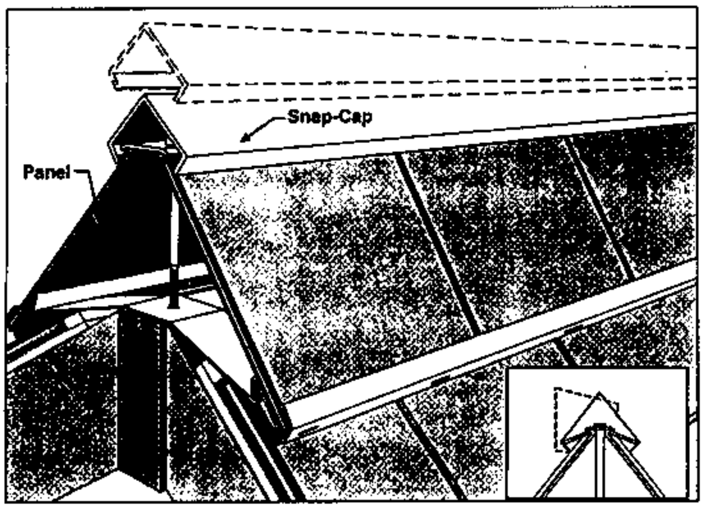

Figure 12. Ridge cap.

underlayment dry more rapidly, reducing the potential for degradation caused by environmental pollutants and freeze/thaw cycles. Moreover, the clip and track method eliminates the potential for localized points of stress that may occur in an improperly nailed installation. Immediate stress—from overnailing or undernailing, for example—as well as latent stress—from building settling, for example—are eliminated by the system's spring fit.

Recent testing of the newest clip and track designs under the 1990 British Standard shows performance that will allow use in all but the most severe North American wind zones. Further refinements have the potential to create a system capable of resisting the highest wind pressures. Because the system is new, it is too early to tell whether reduced labor costs will fully or partially offset higher component costs.

Additional Accessories

If field slate installation is being addressed by developments such as the clip and track system, perimeter slate installation, especially ridges, is also being addressed. To eliminate reliance on roof cement and respond to desire to provide low-lying ridge vents, one ridge product offers a method of firmly bolting a ridge cap or vent to the roof structure below. The metal components and fasteners used in this system are non-ferrous and have a life expectancy similar to that of the slate.

CONCLUSIONS

Following the protracted decline of this century, North American demand for natural and simulated slate is likely to grow. Lower cost imports and the growing availability of simulated slate products now challenge the domestic market to produce a less expensive product or succumb to the foreign producers.

Performance standards for slate and simulated slate products must be developed either by adopting those from countries that have maintained standards or by developing innovative domestic standards, suited to North American requirements, to ensure that future applications will provide long-lasting performance within the requirements of the model building codes. The new standards must allow for innovation in application and the use of new accessory products to enhance the performance life cycle of the slate roof assembly.

In addition, the industry must develop application standards for installation over modern building materials, using existing and improved accessories, that create roofs with a 100-year life cycle. A new organization could be helpful: An independent group or a new adjunct to an existing organization could tap the talents of the dwindling skilled labor force, accessory product manufacturers, and slate producers to develop new publications, lobby industry and government and, most importantly, promote education programs for the new labor force and research cost-effective slate installation methods over modern construction.

Other roofing industry organizations have succeeded in similar endeavors: The National Tile Roof Manufacturer's Association (NTRMA), in conjunction with manufacturers, installers and local building officials, has worked to keep codes up-to-date with present day methods and make the installation of tile a viable alternative to asphalt composition shingles.[36]

The situation is ideal for a slate renaissance. However, it will be up to the industry to encourage a permanent revival.

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