

# SLATE ROOFING: Innovation in an Old Industry

## Part I – Materials and Methods

By **Julie Palmer**

*Figure 1 – At one time, #30 felt was the most common underlayment used below slate.*

**S**late has been used as a roofing material in this country for hundreds of years (and many more hundreds of years in Europe). Domestic slate production began in 1734 in the Peach Bottom district of Pennsylvania. Even before that, though, imported slate from Europe was available in the United States, to a limited extent. The first documented use of roofing slate in Philadelphia was on a residence built circa 1687. At the time, slate was such an extravagant material that the house was known locally as the Slate Roof House.

In a broad sense, not much has changed in regard to slate roofing since those early years. Slate is still a naturally occurring metamorphic rock characterized by linear arrangements of crystals that result in cleavage, the property that allows slate to

be split into thin pieces. It is extracted from the ground, sawn, split at the quarry, and installed on roofs, one shingle at a time. Taking a narrower focus, however, there have been many changes in the industry in the past 10 to 20 years that, in view of slate's long history, can be considered recent. So, while nothing is new, in some respects, much is really new!

### **MATERIALS AND METHODS**

A wide variety of new products related to slate roofing, as well as nontraditional installation methods, have been introduced in recent years. Some of these may be good options for certain projects, while others, not so much. As with all new things, some issues or problems will only become apparent through trial and error in real-life applications. The risk that these new materials and installation techniques have not

yet been fully vetted or had all their issues resolved is a very real one and should be carefully weighed against the time-tested trustworthiness of a traditional slate roof.

### **UNDERLAYMENTS**

Roof underlayment serves two primary purposes: It protects the roof until all of the slate can be installed, and it helps control moisture migration below the slates, should it occur. It can also contribute to the fire resistance of the roof.

For decades, asphalt-saturated organic felt was the underlayment of choice for slate roofs (*Figure 1*). Today, the International Building Code (IBC) still requires underlayment in conjunction with slate shingles to comply with Type 1 in ASTM D226, *Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing*, or ASTM D4869, *Standard Specification*

for Asphalt-Saturated Organic Felt Underlayment Used in Steep-Slope Roofing, specifically citing a minimum requirement of #15 felt underlayment.

The popularity of felt underlayment has waned due to the increasing availability of synthetic products. Ice dam protection membrane, introduced in the late 20th century, is probably the most well-known synthetic underlayment. It has become so commonplace since its introduction that it is required by the IBC to be installed at roof eaves in regions where “the average daily temperature during the month of January is 25°F or less, or where there is a possibility of ice forming along the eaves that can cause a backup of water” (such as at gutters).

Today, there is a dizzying array of synthetic underlayments to choose from. Unfortunately for consumers, synthetic underlayments vary greatly in their composition and characteristics. It is very important to know what you’re getting, but it can also be very difficult to figure that out. Synthetic underlayments require an evaluation report from an accredited testing laboratory to confirm their compliance with one or both ASTM standards required by the IBC, since there currently are no ASTM standards specific to synthetic roof underlayments.

Synthetic underlayments do offer some advantages over felt. These include better tear resistance (particularly if exposed to foot traffic) and slip resistance, and they lay flatter and are lighter weight than felt. That said, they also have disadvantages. For instance, if laminated polypropylene underlayments get scuffed, they tend to delaminate and leak. GAF warns that its laminated synthetic underlayment should not be used as a temporary roof, which is one of the primary purposes of underlayment in the first place.

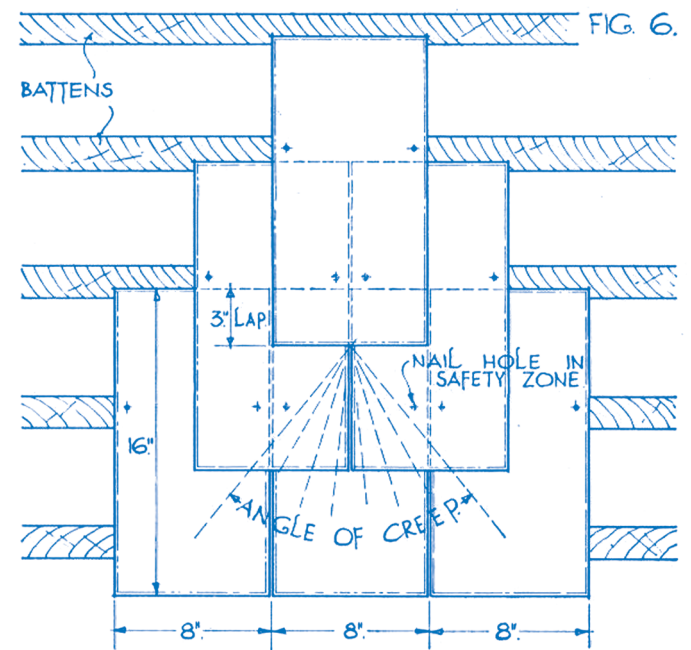
Another important consideration is that many synthetic underlayments—including ice dam protection membranes—are vapor barriers, while others are many times more permeable than organic felt (Figure 2). Balancing the vapor permeability of the underlayment with other project conditions, including the quantity and location of insulation, presence (or lack thereof) of attic ventilation, and the building’s mechanical systems, is absolutely critical. Improper underlayment selection can lead to condensation inside the attic or within the roof system.

Unfortunately, there seems to be an increasing trend toward installing slate on roofs with less than 4:12 slope (or approximately 18 degrees). This may be, in part, due to the misconception that synthetic underlayments are better able to prevent water infiltration than traditional felt. Installing slate on roofs with less than 4:12 slope is not recommended for several reasons. First and foremost, it results in a roof that is not code-compliant. The IBC prohibits the use of slate on roof slopes lower than 4:12. Roof slopes less than 4:12 also reduce the longevity of the slate by subjecting it to heavier and longer-lasting loads from snow and ice, as well as greater foot traffic. The lower the roof slope, the shorter the service life of the slate shingles will be. Also, moisture migration gets increasingly worse as the roof slope becomes shallower. Moisture migration refers to the lateral movement of rain-water below shingles, sometimes called “angle of creep” (Figure 3). The degree of creep is influenced by the roof’s slope. On steeper roof slopes, gravity overcomes capillary action, reducing the amount of lateral creep and instead pulling water down the slope. Conversely, the shallower the roof slope, the wider the angle of creep will be. On roofs with less than 4:12 slope, the area of creep is so wide that there is a very real

Figure 3 – Capillary action can cause moisture to migrate laterally below slate shingles. Source: “Notes on Slating and Tiling.” London: Langley London Limited, 1983.

	Manufacturer	Product	Permeance*	Maximum exposure
Vapor impermeable	Nemco Industries	RoofAquaGuard UDLX	0.035 perm	6 months
	W.R. Grace	Tri-Flex Xtreme	0.04 perm	4 months
	Pactiv	GreenGuard	0.04 perm	6 months
	Alpha Pro Tech	REX SynFelt	0.05 perm	6 months
	Berger Building Products	Pro-Master Roof Shield UDL & UDL Plus	0.05 perm	12 months
	InterWrap	Titanium UDL	0.05 perm	6 months
	Robetex	Tech Wrap 300	0.05 perm	6 months
	Robetex	Tech Wrap UL	0.05 perm	12 months
	Kirsch Building Products	Sharkskin Ultra	0.059 perm	12 months
	Intertape Polymer	NovaSeal	0.06 perm	6 months
	Robetex	Tech Wrap 150	0.08 perm	6 months
	Propex Operating Company	Opus Roof Blanket	0.1 perm	30 months
	SDP Advanced Polymer Products	Palisade	0.1 perm	6 months
	System Components	FelTex	0.1 perm	6 months
	IKO	RoofGard-SB	0.18 perm	6 months
	CertainTeed	DiamondDeck	0.183 perm	6 months
	Owens Corning	Deck Defense	0.23 perm	6 months
	PGI-Fabrene	Fabrene UDL and Matrix UL	0.8 perm	2 months
	Atlas Roofing	Summit	< 1 perm	6 months
	DuPont	RoofLiner	< 1 perm	6 months
GAF Materials	TigerPaw	< 1 perm	6 months	
Rosenlew RKW	RoofTopGuard II	< 1 perm	6 months	
Vapor permeable	Perma R Products	PermaFelt	> 1 perm	6 months
	GAF Materials	Deck-Armor	16 perms	6 months
	Cosella-Dörken	Delta-Maxx Titan	28 perms	ASAP
	VaproShield	SlopeShield	59 perms	4 months
	Cosella-Dörken	Vent S	120 perms	ASAP
Unknown	Nemco Industries	RoofAquaGuard BREA	146 perms	4 months
	Cosella-Dörken	Delta-Foxx	550 perms	ASAP
Unknown	Berry Plastics	Barricade Dry Step	Unknown	6 months
	PrimeSource Building Products	Grip-Rite ShingleLayment	Unknown	6 months
	Tamko	Tam-Shield	Unknown	6 months
	Tri-Built Materials	Tri-Built High Performance	Unknown	6 months

Figure 2 – Synthetic underlayment products display a wide variation in vapor permeance ratings. Source: Martin Holladay, “Synthetic Roofing Underlayments.” Fine Homebuilding, Oct./Nov. 2011: 49.



THE SLATES ARE 16" x 8" AND THE NAIL HOLES ARE WELL IN THE SAFETY ZONE IF THE SLATES WERE 16" x 6" THE NAIL HOLES WOULD BE 1" NEARER THE AREA OF CREEP ON EACH SIDE AND THERE WOULD BE A RISK OF LEAKAGE.



Figure 4 – Warped polymer shingles detract from a roof’s appearance and impact its watertightness. Photo courtesy of Alan Buohl, GSM Roofing, Ephrata, PA.

risk of water reaching the nail holes in the underlying course of slate, potentially resulting in a leak.

### SHINGLES

Synthetic shingles have long sought to be a substitute for natural slate. As early as 1912, the Standard Paint Company was manufacturing “Ruberoid” shingles. At first, these were individually cut asphalt shingles coated with red or green crushed slate granules. By the 1920s, they were being made in long strips and marketed as “Ruberoid Strip Slates.” Fast forward almost 100 years, and manufacturers today are still making asphalt shingles intended to look like slate.

What are new in the last 15 years or so are polymer shingles. Although most manufacturers keep their “recipes” tightly guarded, the most prevalent polymers in use today seem to include polyethylene, polypropylene, thermoplastic polyolefin (commonly known as TPO), and ethylene propylene diene monomer (EPDM). Manufacturers of these products claim numerous advantages over natural slate, including reduced weight, better durability, lower cost, and sustainability. These statements are often misleading, however, and can promote misconceptions about both natural slate and the polymer pretenders.

Many manufacturers claim their polymer products are more durable than natural slate. S-1 grade natural slate will last a minimum of 75 years, with some 175 years

or more. Because of natural slate’s proven history of performance, some slate quarries and suppliers offer warranties of at least 75 years for their S-1 grade North American slate. Most polymer shingles come with a 50-year limited warranty. Since polymer shingles have only been on the market for a relatively short time, it is impossible to

know if they are really capable of lasting 50 years. It seems like a no-brainer that a product that may or may not last for 50 years is not more durable than a product that is known to last 75 years or more.

Warping is a common problem with polymer shingles, and extreme heat is one condition known to cause it (Figure 4). Reflections from windows or neighboring glass-clad buildings, as well as insufficient attic ventilation, can all produce heat excessive enough to warp polymer shingles. Some manufacturers significantly reduce the warranty period, or even refuse to issue a warranty altogether, if the shingles are installed over a roof with inadequate attic ventilation. Existing and historical buildings frequently do not have adequate attic ventilation, and it can sometimes be challenging, expensive, or even detrimental to the historical character to add or upgrade attic ventilation in existing buildings.

Most polymer shingles advertise a Class-A fire rating per ASTM E108. In many cases, however, the Class-A fire rating is only achieved if the shingles are installed over a proprietary synthetic underlayment. The potential drawbacks of synthetic underlayments have already been discussed. They also represent a costly upgrade from #15 felt, which is the minimum underlayment required by the IBC. The same polymer products generally receive a Class-C fire rat-

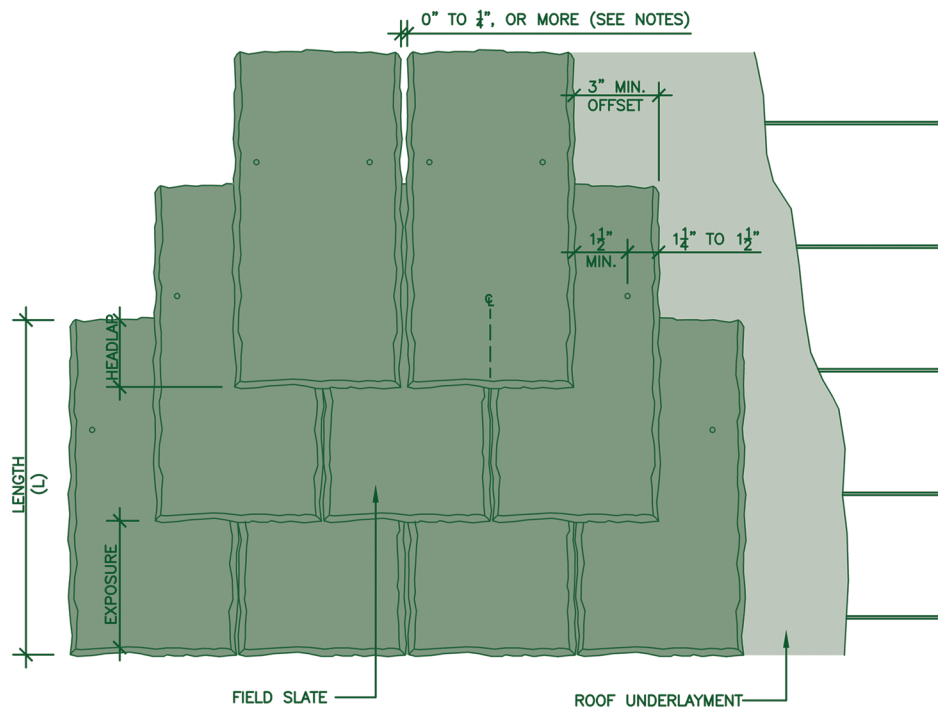


Figure 5 – Detail from Slate Roofs: Design and Installation Manual depicting exposure, headlap, and offset requirements for slate roof installation. Printed with permission from the National Slate Association.

ing if installed over a single layer of #30 felt.

The lower cost of polymer shingles in comparison to natural slate is a big marketing claim. The material cost for polymer shingles, however, is approximately the same as that of natural slate. Because the shingles are lighter weight than natural slate and can generally be dropped and stepped on without breaking, they are a bit faster to install than slate. That labor savings would equate to some cost savings.

A dramatic cost saving, however, is only possible if the shingles are installed with a nail gun, an approach that can, and often does, sacrifice quality and may even damage the shingles. With nail guns, precise placement of the nails and pressure adequate to neither under- nor over-drive the nails is challenging to achieve. When speed is the installers' primary goal, they aren't generally concerned with checking or correcting those things. For these reasons, some manufacturers prohibit the use of nail guns for installing their shingles, particularly in cold weather when the shingles may be more brittle. If a nail gun is not used, the labor savings and, hence, the cost savings, is not likely to be as great as the manufacturers advertise.

Sustainability is a big buzzword these days, and manufacturers take full advantage of that. But, how sustainable are the shingles? Although many more products with recycled content have become available just in the past two or three years, some of the best-selling brands of polymer shingles are still made from 100% virgin polymers. Polymers are chemical products usually derived from petroleum, which is a fossil fuel and is not a renewable resource. Most manufacturers advertise that their products are 100% recyclable, as well. What they don't advertise is that they are only recyclable if returned to the original manufacturer, usually at the building owner's expense. In addition, the shingles must be sorted and nails, underlayment, and other debris removed prior to shipping. All of this extra labor can add greatly to the total project cost.

## ALTERNATIVE INSTALLATION METHODS

There are several alternative installation methods now available for natural slate. Some seek to speed up the installation process, thereby reducing the cost of the roof. Other methods seek to speed up installation and also reduce the weight of the roof system, making slate a viable option for buildings with less robust roof framing sys-

tems. The most common alternative installation methods on the market rely on strips of hooks that get nailed to the roof deck. The slates are then set into the hooks.

To understand the pros and cons of these new installation methods, it is necessary to understand some basic concepts of traditional slate roof installation. Three features are at the heart of laying a traditional slate roof correctly: headlap, exposure, and offset (Figure 5).

Headlap is the amount by which the head of a slate in a given course is lapped by the slate two courses above. Proper headlap is absolutely critical to the watertightness of a slate roof system. The amount of headlap required is determined by the slope of the roof. Industry standards and the IBC require a 4-in. headlap for roof slopes between 4:12 and 8:12, a 3-in. headlap for roof slopes between 8:12 and 20:12, and a 2-in. headlap for slopes greater than 20:12.

Exposure refers to the exposed area of each slate. The slate length and required headlap (based on the roof slope) determine the exposure by the following formula:  $\text{Exposure} = \text{Slate Length} - \text{Headlap} / 2$ .



Figure 6 – Qwik Slate installation in progress. Photo courtesy of Brian Chalsma, The Roofing Company, Hampton, VA.

Offset is the distance between the edge of a slate in a given course and the edge of the overlying slate. It is important to keep the edge of each slate at least 1½ in. away from the nail hole in the course below.

Qwik Slate™ by Newmont Slate Company uses full-sized slates set into hooks (Figure 6). The biggest difference between systems like this and a traditional slate installation is that the field slates do not need to be nailed. Instead, the hook strips get nailed to the roof deck, which speeds up the installation process, particularly if a nail gun is used. Slate shingles can be installed in this manner with exposure, headlap, and offset as required by industry standards and the IBC, and the end result will shed water

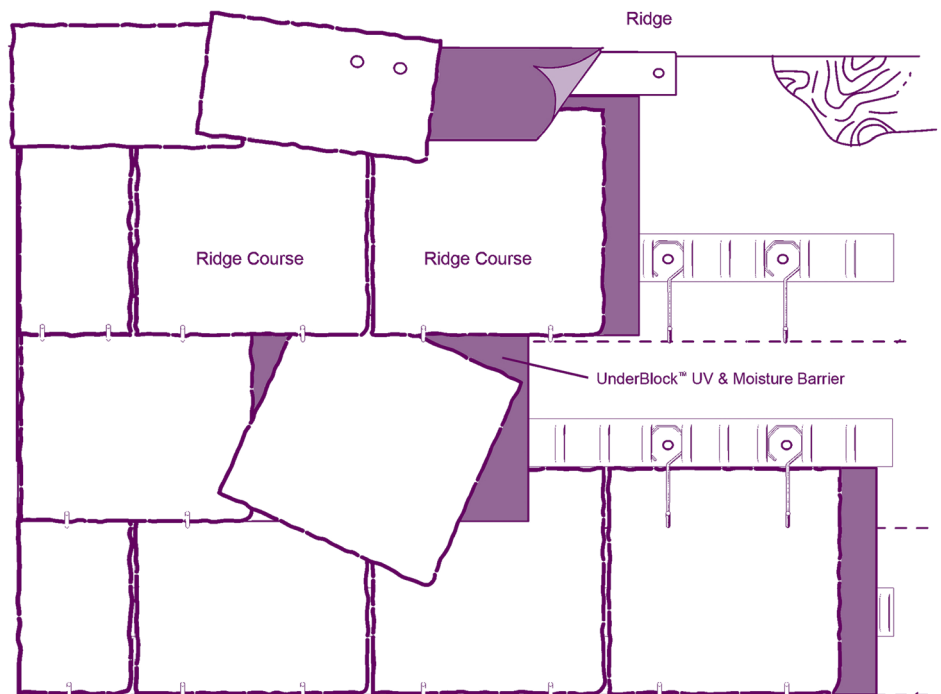


Figure 7 – TruSlate installation instructions.

and look much like a traditionally installed slate roof. Although Qwik Slate™ does not have an ASTM or FM wind uplift rating, the system did pass a TAS 100-95 test, “Test Procedure for Wind and Wind-Driven Rain Resistance” (one of many tests required for Miami-Dade approval), in which a test deck is subjected to winds up to 110 mph and simultaneously sprayed with water simulating an 8.8 in./hr. rainfall. The system continued to be adjusted after it became available on the market, based on insights only gained through use and installations. Originally, the plastic strips to which the hooks are attached were made of black plastic. Contractors found that during installation, the black plastic heated up so much that the resulting expansion threw off the spacing of the hooks, making the bond lines between slates too wide. The manufacturer has since switched to a gray-colored plastic to mitigate this problem.

Another alternative installation method reduces the length of the slates significantly, thereby eliminating headlap, and attempts to make up for it by interweaving a synthetic sheet membrane between each course of slate. One of the earliest systems of this nature to hit the market was TruSlate®, manufactured by GAF, though other similar systems have since been introduced. These systems weigh approximately 40% to 50% less than traditional, standard-thickness slate roofs.

With lightweight systems, there is no headlap. Two layers of slate and two layers of synthetic membrane simply lap each


other at every course (Figure 7). The lap is generally 2 to 4 in., depending on the system. Water entering the bond lines between slates in the middle of any given course is shed by the interwoven membrane, rather than an underlying piece of slate, as in a traditional installation. Although S-1 grade North American slate can be used in lightweight systems, given the lack of headlap, the service life of the system is entirely dependent on the plastic membrane. The lack of headlap also makes these systems more prone to wind-driven rain or ice damming resulting in water penetration below the shingles, particularly on shallower roof slopes (several manufacturers permit installation of their systems on slopes as low as 4:12). Because of this risk, most manufacturers of lightweight systems recommend or require the use of self-adhering vapor barrier underlayments over the entire roof deck, at least when installing the systems on roof slopes of 5:12 or less. Not only is the installation of a vapor barrier over the entire roof deck not appropriate for all buildings, as previously discussed, but doing so shifts more of the water-shedding responsibility of the roof system onto the underlayment.

#### CONCLUSION

New products and installation methods related to slate roofing appear and disappear from the market all the time and continue to be adjusted even after they are in use. Keeping track can be challenging, but a thorough understanding of the potential advantages and disadvantages is essential.

Employing new technologies on a project without knowing how they compare to their traditional counterparts can have disastrous consequences.

New materials and installation methods are far from the only recent changes in the slate roof industry. Sources of slate change on a regular basis, codes and standards evolve, new material testing reflects changing concerns in the roofing industry, and new resources make it easier than ever before to design and install a traditional slate roof.

Stay tuned for the February 2017 issue of *RCI Interface* and Part II of this article for information about these topics. 



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*Association's office 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.*

## Drone Safety Research Underway by Homeland Security and PDC

The U.S. Department of Homeland Security's Science and Technology Directorate (S&T) and the Property Drone Consortium (PDC) are cooperating to advance the understanding of the use of unmanned aerial systems (UASs) for public safety missions. PDC is a collaborative group of insurance carriers, roofing industry leaders, and supporting enterprises with offices in Bothell, Washington. A Cooperative Research and Development Agreement (CRADA) has been signed between the groups to leverage the knowledge base, capabilities, and resources of the parties to the agreement in advancing the understanding of the use of UASs for public safety missions.

“UAS data can be used by first responders, as well as by insurers and owners of other properties and structures looking to assess damage and take remedial action relative to providing assistance to victims, quick assessment of claims, and urgent repairs,” said Charles Mondello, president of PDC.

It is hoped that the agreement will result in providing a “framework for collaborative public and private response in post-catastrophe events,” noted Stephen Hancock, special projects director for S&T's First Responders Group.

For more information, visit [www.propertydrone.org](http://www.propertydrone.org).



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