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Journal

Care and Preservation of Slate Roofs

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Accustomed as we are to the complicated roof systems of today's construction, with waterproof membranes, insulation board, ballast, and adhesives, it can be hard to imagine that simple stone slabs nailed to a plain wood roof deck could protect against the elements for upwards of a century. But that is exactly what a slate roof does, provided it has been properly designed and maintained. Although they cover buildings throughout New England and dotted around

the country, from the humble country cottage to the imposing cathedral, slate roofs have become an endangered species, not because they have reached the end of their serviceable life, but rather due to a lack of information about their repair and upkeep.

Because so many roofing professionals, while knowledgeable about contemporary roofing materials, do not have much experience with natural stone, slate roof owners are plagued with a barrage of misinformation—and incorrectly performed repairs. Walking on the roof during installation or selecting the wrong type of fasteners for replacement slates could lead to cracked stone pieces tumbling off the roof: dangerous, unsightly, and a source of leaks. Even worse is the slate roof owner who dutifully invests in a full roof replacement, only to learn that the original roof still had fifty-plus years of useful life, and that the new roof, incorrectly installed, is beginning to crumble after just a few short years.

So when is it necessary to replace a slate roof? And what maintenance is needed to keep the roof in good condition? A variety of new products are on the market, from synthetic slate to photovoltaic shingles. When would these be appropriate technologies to consider, and how do they integrate with traditional roofing?



▲ With regular maintenance and appropriate, periodic repairs, a well-designed slate roof can last upwards of a century.

As a Project Architect with Hoffmann Architects, Inc., Deborah J. Costantini, AIA has specialized expertise in the design and maintenance of slate roofs. Project Coordinator Benjamin J. Robinson, Assoc. AIA develops design solutions for slate rehabilitation that apply new technologies to the historic roof restoration process.



Broken slates

While slate rehabilitation can raise many questions, caring for a historic roof need not be a painful process. After all, the material is durable, and the construction elegantly simple. The solution lies in knowing what to look for, and how to approach any problems that do arise.

How and When to Inspect a Slate Roof

Why inspect the roof? Adequate drainage is a critical component of a properly functioning slate roof system. For this reason, slate roofs typically have a high slope, so that water runs off as quickly as possible. When leaves and other waste are allowed to accumulate on the roof or in gutters, water becomes trapped, creating a potential source for leaks. To prevent this problem, simple gutter cleaning and debris removal in the spring and fall, along with inspections for signs of damage to the drainage or snow guard systems, should be performed twice a year. Basic roofing stewardship, including the early identification



Damaged flashing

of problem areas, is essential to a slate roof's longevity.

When should major investigations occur?

Every 5 to 7 years, a more thorough inspection by a qualified roofing professional should be conducted to identify deteriorated conditions. Waiting until problems are so obvious and pervasive that they can no longer be ignored only leads to more costly rehabilitation, with the added likelihood of interior and structural damage. A detailed, routine investigation can help to identify minor deterioration and maintenance issues which can then be addressed promptly, before they become serious problems.

How should the inspection be conducted?

Such surveys should be completed initially from the ground, with the use of binoculars, to assess the overall condition of the roof. However, because some defects are only evident on closer inspection, use of a ladder or lift to access all roof areas is an important part of a thorough investigation. Avoid walking on the roof! Slate cracks easily, and some hairline



Loose gutters

fractures may not create observable problems until months or even years down the road, when the slate begins to break apart, permits water entry, and eventually slides off the roof.

Who should perform the survey?

Twice-yearly seasonal inspections for general conditions can be performed by building maintenance personnel, but more comprehensive roof system investigations should be conducted by an architect or roofing design professional experienced with slate rehabilitation.

What needs to be inspected? Assess the condition and quality of installation for each component of the slate roof system:

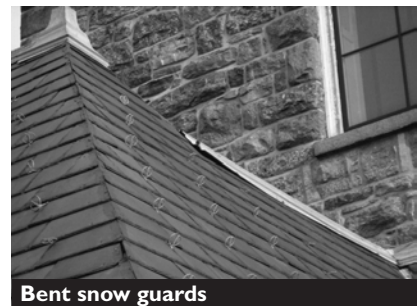
- **Slate.** Document cracked, broken, misaligned, delaminated, or missing slates. "Sounding" a slate by tapping it with knuckles or a slating hammer can help determine its integrity; a dull thud can indicate poor condition, whereas a full, deep sound generally means the slate is intact.
- **Flashing.** A slate roof is only as good as the weakest flashing detail.



Deteriorated roof deck



Missing fasteners



Bent snow guards

Slates may last centuries, but flashing must be maintained and replaced periodically. Look for loose and missing fasteners, and flashing that exhibits deformation, wearing, corrosion, or pin holes. Open seams and missing flashing members are also common sources of water entry. Areas to investigate include: ridge, hip, valley, roof-to-wall, drip edge, and step flashing.

- **Drainage system.** Deterioration of copper gutters and drainage attachments manifests similarly to flashing damage. Check for the signs of distress listed above at gutters, conductor heads, leaders, attachments, and related flashings.
- **Substrate/roof deck.** Inspect the rafters and sheathing for moisture staining. Test probes, involving removal of selected slates to expose the substrate, can be used to determine if wood rot is present when attic space is inaccessible.
- **Fasteners.** Confirm the condition and material of nails and other fasteners. Copper or steel nails are generally found on most slate roofs, but replacement slates or flashings may have been secured with inappropriate fasteners, which may deteriorate prematurely.
- **Accessories.** Check the stability, proper functionality, and correct installation of snow guards, lightning protection systems, and other safety devices.

How should information from the inspection be collected and used?

To create a record of the survey, both for immediate repairs and for long-range maintenance planning, document deterioration conditions and sites of previous repair work in a written report, supplemented with photographs and drawings where possible. Prioritizing repairs and

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Synthetic Slate Shingle Roofing: When Is It a Viable Option?

Why synthetic slate?

Because natural slate roofs can last up to 100 years or more, property owners are often surprised when roof replacement is recommended. Rehabilitation of slate roofs can be both expensive and time intensive, requiring specialized craftsmen (*slaters*), tools, and accessories. Natural slates often break during shipment, such that additional quantities must be purchased. Plus, material lead times can drastically stretch out the timeline of the project.

To circumvent these challenges, some slate roof owners have turned to synthetic slate shingles as an alternative reroofing option. Synthetic slate roofing is relatively inexpensive and can be installed quickly by a standard roofing crew, using pneumatic nail guns with standard roofing nails. Lead times for materials are shorter than those for natural slate. And, overall, the weight of the synthetic material is far less than that of traditional slate, allowing for a slate-like appearance on a structure that could not bear the load of natural stone.

What is synthetic slate?

Numerous manufacturers produce synthetic slate shingles. Product composition varies from rigid ceramic materials to semi-flexible shingles made with post-industrial waste rubber and plastics. While the real-time life expectancy of synthetic slate is not proven, laboratory testing has projected its useful life to be 40 to 60 years.

How do synthetics compare with natural stone?

Just as with natural slate, the lifespan of a synthetic roof is dependent on the quality of the weakest element. Heavy gauge metal flashings, heavy roofing underlayments and bituminous ice and water barriers are key aspects to a successful synthetic slate roof. Properly detailed conditions, such as intersections at dormers, chimneys, vent stacks, and skylights, as well as hips, valleys and ridges, are important design considerations.

Colors, textures, shingle sizes, and edge profiles of existing slate can all be mimicked with synthetic shingles. To determine if the “look” of the synthetic is acceptable when compared to the natural stone, product samples and test panels should be assessed in position on the roof. Often, synthetics have a slight sheen and in some cases appear too regular in their coursing, yielding an unnatural and potentially unappealing appearance.

Where might synthetic slate be suitable?

A design professional should be able to offer guidance in choosing an appropriate synthetic or natural slate for a specific building. Is the structure to receive the new roof in a historic district or considered to be a landmark building? Can the roof structure bear the load of natural slate? What is the budget for the project? There are many questions that an architect will answer prior to recommending a specific roofing product, whether synthetic or natural slate.

Regardless of the material selected, proper detailing of the roof using quality products, thorough design documents, and certified installers is what yields a successful outcome. ■

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budgeting for larger-scale remediation projects can be simplified with clear records of ongoing and emerging problems. Results of maintenance efforts can also be tracked to determine the solution's effectiveness.

Maintenance and Repairs

Documenting signs of deterioration is an important first step in caring for a slate roof, but it is insufficient to record problems yet wait until they require major rehabilitation to add them to the facility maintenance schedule. In conjunction with biannual inspection of the roof assembly, building personnel should also perform routine cleaning and repairs, guided by a maintenance agenda such as the following, but tailored to the needs of the specific structure type, occupancy demands, and exposure:

Clear debris. Remove leaves, branches, dirt, and other waste from gutters, valleys, and penetrations. Clear any obstructions in gutters and downspouts, both seasonally and after major storms.

Repair/replace flashings. Open seams and missing or inappropriate securement can be repaired, while deteriorated flashings will need to be replaced. Copper flashings can be replaced in kind, with a minimum of 16-ounce copper; although a heavier, 24-ounce weight is preferred for erosion-prone areas like valleys and gutters. Lead-coated copper is also commonly used for historic restoration, because of its durability in repair applications.

To extend the life of existing flashings, by sometimes as much as ten to twenty years, appropriate coatings can be applied, such as an elastomeric roofing membrane (e.g. GAF Topcoat). Check first to be sure the coating is compatible with the flashing material and with the slate roof system.

Install membrane flashings. Replacement of metal flashings or gutters provides an opportunity to add or replace ice and water barriers along eaves or at valleys. Although many older slate roofs were constructed without membrane flashings and remained leak-proof for decades, new developments in underlayment materials provide added security should the slate or flashing become damaged by weather events, fallen trees, or other unexpected circumstances.

Secure loose and misaligned slates. Position the slate and secure it with appropriate roofing nails in the overlying slots, covered with a bib flashing.

**“A slate roof
is only as good as
the weakest
flashing detail.”**

Alternatively, use a slate hook, which is a curved, copper or stainless steel metal device which hooks under the slate at the exposed edge. Strap hangers might seem to function similarly to slate hooks, but these are not only large and unsightly, they also tend to deflect, allowing the slate to slip out.

Replace deteriorated or missing slates. To remove a broken or damaged slate, a slate ripper can be used to extract the existing nails. The slate then slides out, and a new one can be inserted using either the nail-and-bib or slate hook techniques described above.

When multiple slates have deteriorated in a given area, substrate issues may be the source of the problem and should be addressed before replacing the overlying slates, lest the problem recur. For larger replacement

areas, slate should be removed in a pyramidal shape. A diminishing number of slates at higher courses allows for proper nail positioning at installation and minimizes the use of bibs.

To avoid a patchwork of obvious replacement slates, matching by color, size, and texture is an essential part of any slate replacement effort. When available, attic stock can be used, or extra materials can be ordered during a replacement project to maintain stock for future repairs. A knowledgeable roofing design professional should be able to identify the slate type on your roof and its origin, and should be able to locate matching slate, either salvaged or newly quarried.

Replace damaged safety accessories. Snow guards that are bent or broken should be replaced promptly, as large drifts of snow are potentially dangerous, both in themselves and in their tendency to loosen and dislodge slates, which can then fall from the roof.

For any repair or maintenance work, new materials and installation details should produce a roof area with a serviceable life comparable to that of existing sections, when possible. Appropriate and well-performed repair measures may aid in remedying immediate failures, in turn delaying—or preventing—more extensive repairs or replacement.

When to Replace a Slate Roof

A properly installed and well-maintained slate roof has a life expectancy of 60-125 years or more, depending upon the building location, slate type, and roof pitch. However, poorly performed repair work or neglected flashings and other details can significantly shorten a slate roof's lifespan. To determine the appropriateness and cost-effectiveness of repairs as compared with replacement, a roof design

professional will conduct a thorough evaluation of the roof assembly.

Repair is usually indicated when:

- Less than 20% of slates on a given roof or roof slope are damaged;
- The roof is not complex, with minimal flashing details;
- Overall, the slate is in good condition, and flashings are at least in fair shape;
- The roof still has a significant balance of its expected serviceable life remaining; and/or
- Historic significance makes preservation a priority.

Replacement should be considered when:

- 20% or more of slates on a given roof or roof slope are damaged;
- Slate deterioration areas are pervasive and throughout multiple slopes;
- Flashings in need of replacement are complex, requiring excessive manipulation and maintenance of the slates;
- Multiple areas or challenging locations of damaged slates necessitate extensive removal, risking breakage of additional slates; and/or
- Slate is in fair to poor condition overall, with little remaining serviceable life.

Because the detailing and craftsmanship of original slate roofs contribute to the character of historic buildings, they should be repaired rather than replaced whenever possible. However, because the majority of slate roofs were installed around the turn of the 20th century, many are now reaching the end of their serviceable life. Before rushing into a full-scale replacement, however, consult an experienced slate roof design professional to rule out worn flashings, clogged gutters,

Integrating Solar Power with Traditional Stone



Is it possible to combine alternative energy roofing technologies with traditional slate roofing systems?

Surprisingly, the answer is yes. *Photovoltaics (PV)* in roofing have become increasingly mainstream; from integrated solar modules in EPDM membrane to rack mounted rigid rooftop solar panels, Building Integrated Photovoltaic (BIPV) systems harness the power of the sun and create clean and free electricity for a building owner.

One way to integrate a PV system with a slate roof is with a product called “Sunslates.” Sunslates are dimensionally the same as a slate shingle and are installed the exact same way by a roofer. They clip together in series to create a low voltage electrical circuit, and an electrician connects the system to the building’s electrical panel.

A variety of local and federal rebates and incentives are available to offset the cost of a BIPV system, generating return on the investment in a short period of time. Your roofing design professional can guide you through the process.

If a slate roof rehabilitation is imminent, and alternative energy methods desired, BIPV roofing may be the answer. Consider integrating Sunslates or another solar roofing technology with your traditional slate roof. Then, sit back, relax, and watch you electric meter spin backwards! ■

poor attic ventilation, or other sources of moisture; isolated replacements — for example, of a single roof slope — may be sufficient.

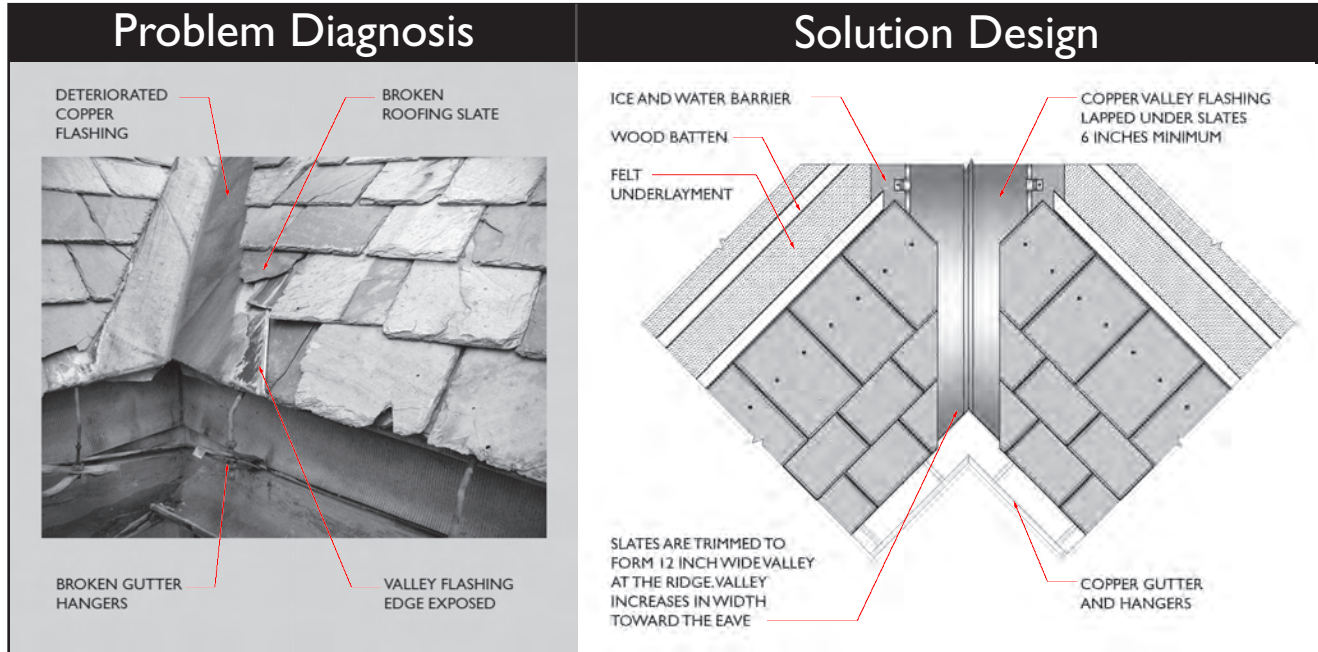
In the case of older roofs, planning ahead and budgeting for eventual replacement can prevent hasty decisions and inferior detailing when problems become urgent. An architect with experience in slate roof design can specify a new slate roof which matches, as closely as possible, the existing roof, in slate type, coursing style, and detailing, even for a complex roof. All materials used, from flashings to nails, should have a lifespan comparable to that of the slate, with a single metal, such as

copper, selected for all flashings, gutters, downspouts, and metal roofs, to avoid corrosion by galvanic action between dissimilar metals.

Finally, availability of matching new or salvaged slates should also be considered in the repair/replacement decision process. Even when replacement is necessary, temporary repairs may have to suffice to allow time for locating, ordering, and delivering the slates.

Preservation of Slate Roof Character

Before major repair or replacement projects are undertaken, documentation of a slate roof’s unique detailing



and style should be made, such that new sections can cleave to the original design as closely as possible. In addition to matching the size, shape, color, and texture of the individual slates themselves, which may vary at different points along the roof slope or randomly along courses, replicating detailing along hips, ridges, and valleys is also important to preserving the character of a slate roof.

Standard grade roofs, which are the most common, use uniform slates of consistent length and width, with even cleavage at the edges. *Headlaps*, the overlap of each slate with the courses above it, and *sidelaps*, the lateral spacing of slates in relation to the courses above and below, are regular:

Random width or **textured** roofs use slates of various thicknesses, widths, and tail lengths to create a less uniform appearance. Cleavages may be uneven at the bottom, and slates may range in color and texture.

Graduated roofs employ thicker, larger slates at the eaves, and gradually diminish in slate size along the slope, with the smallest, thinnest slates at the ridge.

Hips and *ridges*, the upper unions of two adjacent roof slopes, could be covered with specially cut slates in a variety of arrangements, or might be ornamented with flashing formed of sheet metal or terra cotta. *Valleys*, at the internal angle of two roof slopes, shed the bulk of water runoff and so must be particularly well protected. As such, they may employ metal flashing, with slates overlapping at the sides (*open valley*), or they may have slates overlying a metal lining (*closed valley*).

Construction style may also vary as to type of sheathing, ranging from wood boards or battens to concrete and steel. Even where materials and slate coursing have been duplicated accurately, failure to appropriately specify and secure the substrate may threaten the longevity of a slate roof installation.

Pitfalls to Avoid

Design problems. Insufficient pitch leads to slower water runoff, which permits moisture entry into the slate by capillary action. Roof areas that are permitted to remain in prolonged contact with water, such as along

eaves or valleys with insufficient drainage, deteriorate more rapidly than do areas that can dry out quickly. Use of soft slates also shortens a roof's useful lifespan.

Installation problems. Improper nailing of slate, with nails driven in too tightly or with nail heads left exposed, can crack the stone or puncture overlying slates. Plain steel or galvanized nails used instead of solid copper or stainless steel will rust prematurely, necessitating roof replacement even while the slate itself is still sound.

Design flaws, such as failure to leave sufficient headlap or sidelaps, permit water to pass through joints between slates, leading to leaks.

Repair problems. Roofing mastic applied to damaged slates or flashings may be a tempting quick fix, but the black paste is not only unsightly, it is also prone to crack and to accelerate metal corrosion. Mastic is also difficult to remove, making future repairs a challenge.

Replacing solid wood sheathing with cheaper plywood or pressure-treated

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representative projects



Slate Roofing

Experience in working with historic materials, along with technical expertise in applying new technologies, makes Hoffmann Architects' project architects and engineers uniquely suited to restoring and replacing slate roofing. Resolving deterioration at the outsides of buildings is the firm's exclusive focus. As such, our project teams commit to a detail-oriented approach to roofing projects, beginning with a thorough investigation into the slate, flashing, and underlayment conditions. Comprehensive document preparation and construction administration see that installation is completed as designed.

Hoffmann Architects' specific experience with slate roofing includes:

**New York Public Library
St. George Library Center**
Staten Island, New York
Slate Roof Investigation

**Columbia University
Casa Hispanica**
New York, New York
*Slate Roof Rehabilitation, Part of
60-Building Master Plan*

Goodwin Square Hotel
Hartford, Connecticut
Slate Roof and Façade Rehabilitation

**Former Southern New England
Telephone Company
Central Offices**
Various Locations, Connecticut
*Slate Roof Replacement and Masonry
Repairs at Five Offices*



▲ **Wellesley College, Tower Court (pictured), Severence Hall and Clafin Hall** in Wellesley, Massachusetts. *Slate Roof Replacement and Building Envelope Rehabilitation*

**Queensborough Community College
Oakland Building**
New York, New York
Synthetic Slate Shingle Roof Replacement

**University of Maryland, Eastern Shore
Physical Education and Health Building**
Princess Anne, Maryland
Slate Roof Investigation

Lockwood Mathews Mansion Museum
Norwalk, Connecticut
Slate Roof Rehabilitation

Scholastic Inc.
New York, New York
*Slate Roof Replacement and Cast-Iron
Façade Rehabilitation*

**Smithsonian Institution
Arts & Industries Building**
Washington, District of Columbia
Slate Roof Repairs



▲ **Fairfield University, McAuliffe Hall (pictured), and Bellarmine Hall** in Fairfield, Connecticut. *Slate Roof and Building Envelope Rehabilitation*

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A Failure to match the color, profile, and texture of existing slates when selecting replacements can lead to an unattractive patchwork appearance.

wood can lead to shrinking and resultant displacement of overlying slates, as can uneven or loosely nailed wood boards.

Thin, substandard replacement flashings can create serious water infiltration problems, even if the surrounding slate is in excellent condition. Attempting to save money by skimping on flashing details is poor economics: the expense of duplicate repairs is greater than the cost of doing it right the first time.

Protecting Your Investment

Slate, installed correctly and maintained with due diligence, is one of the most durable of building materials. A

hundred-year-old roof is a testament to nature's endurance and to the craftsmanship and skill of its artisans and caretakers. To preserve such a historic treasure, and to avoid the unnecessary expense of repeat repairs, it's worth taking the time to find an experienced slate design professional to evaluate the roof and design a maintenance and rehabilitation strategy. Learning

the fundamentals of slate roof protection will enable the slate roof owner or facility manager to stay abreast of developing problems, to prevent premature deterioration where possible, and to budget and plan for major rehabilitation.

Investigating contemporary innovations in products and techniques may be appropriate for your roof—although there is nothing wrong with sticking to tried-and-true materials and methods. After all, traditional slate roofs use natural materials to provide distinctive character and sound waterproofing that lasts for generations. Now that's sustainable design. ■

JOURNAL is a publication of Hoffmann Architects, Inc., specialists in the rehabilitation of building exteriors. The firm's work includes investigative and rehabilitative architecture and engineering services for the analysis and resolution of problems within roofs, facades, glazing, and structural systems of existing buildings, plazas, terraces and parking garages.

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