

DUTCH LAP SLATE ROOFING

By Jeffrey Levine

INTRODUCTION

Dutch Lap slate roofing is a rather narrow subject. So why write a case study about it? Well, for one, very little has been written on the topic. So, if you are lucky enough to get to work on a Dutch Lap slate roof, you are not likely to find much in the way of technical assistance. Second, while attractive, the Dutch Lap roof comes with a major disadvantage: it is not very weather-tight. Designers need to be able to recognize

this. Third, the underlying approach to the issues encountered in the case study can be applied more broadly. This includes:

- Understanding and treating the roof holistically
- Researching the technical matters and, if the information needed is not available, doing some simple testing
- Recognizing/embracing the constraints imposed by the existing construction

- Trying to improve the roof system while maintaining the structure's historical integrity

The home of hardware (think hinges, screws, and locksets, not computers) magnate Barton Hoopes was built circa 1875 in the Second Empire style. Constructed of brick with marble beltcourses and foundation, the building rises to three stories, plus a mansard covered with slate shingles. The Main House and Carriage House (*Figure 1*) are listed on the Philadelphia (Pennsylvania) Register of Historic Places as a contributing resource in the Spring Garden Street Historic District.

The Main House underwent a major renovation and change in occupational use in 2017–18 from apartments to a Montessori School on the first and second floors, and office space on the third and fourth floors, with possible conversion of the third and fourth floors back to residential use at some point in the future. As part of the renovation, the slate roof was to be replaced in kind under separate bid (the modified-bitumen roof system on the upper portion of the mansard was to be retained and repaired).

The owner had two noncomparable bids in hand. One included a new black slate from Canada of unspecified size laid atop #30 felt and secured with copper nails in a pattern to match the existing slate. The other quoted a 16- x 8-in. Vermont black slate laid atop ice dam protection membrane and secured with “traditional” nails in a “fish scale” pattern. Flashing and gutter replacement details were also noncomparable. Feeling like a set



Figure 1 – Main House (foreground) and Carriage House (lower left) of the Hoopes mansion.



Figure 2 – Original Dutch Lap slates on the mansion’s convex mansard roof.

of bid documents was needed for the roofing work, just as there had been for all the other renovation work taking place, the owner decided to retain Levine & Company to prepare a streamlined set of bid documents, and quickly rebid the roofing work.

EXISTING CONDITIONS

The roof on the lower portion of the mansard consisted of grayish-black slate shingles with slightly visible ribbons—likely Pennsylvania Hard-Vein (also known as Chapman) slate from Northampton County, Pennsylvania, and presumed to date from the original construction. The 16- x 8- x ¼-in.-thick slates were laid directly atop a tongue-and-groove wood roof deck and asphalt-saturated rag felt. To better accommodate the convex shape of the lower mansard, the slates were laid in a Dutch Lap pattern with clipped corners (Figure 2).

The Dutch Lap method of installing slate can be defined as a lightweight method in which the slates are laid with a side lap and single lap at the heads of the slates. It differs from the traditional method of installing slate in that: a) there is no headlap, and b) the side edges of the slate overlap rather than abutting each other (Figure 3). The slates in a Dutch Lap roof can be rectangles, with the long dimension oriented horizontally or vertically; or rectangles with clipped corners

for added decorative effect. At the Main House of the Hoopes mansion, the 16- x 8-in. shingles were laid with the long dimension oriented horizontally and with a 4-in. side lap and 2- to 2¾-in. top lap, thereby providing an exposure of 12 x 5¼ to 6 in.

In addition to requiring less slate than a traditional slate roof (each piece of slate can be smaller and still provide for the same exposure), another significant advantage of the Dutch Lap method is its ability to more easily accommodate the curve of a convex mansard roof. For this reason, the Dutch Lap is most often seen on convex-shaped mansard roofs and domes.

Curiously, all joints between slates at the Main House and Carriage House were covered with mastic. Was this just due to a misguided repair as suggested by one contractor, or a much-needed upgrade implemented after some particularly severe weather? We needed to know and were about to find out. With the major renovation of interior spaces nearly complete, the owner was anxious to replace the aged existing roof with a new, weathertight slate roof having a 100-plus-year service life.

LITERATURE REVIEW

In addition to the question about the weathertightness of the Dutch Lap, we also wanted to know more about the roof’s

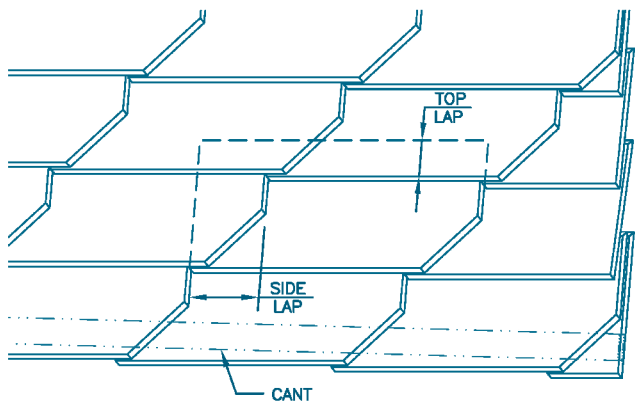


YOU CALL ME RAIN

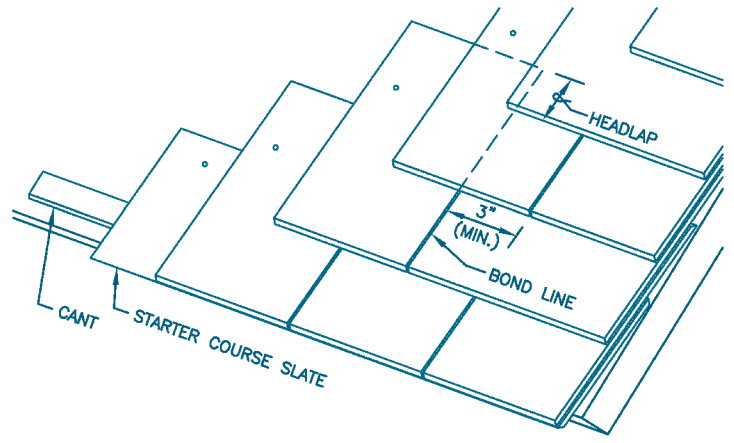


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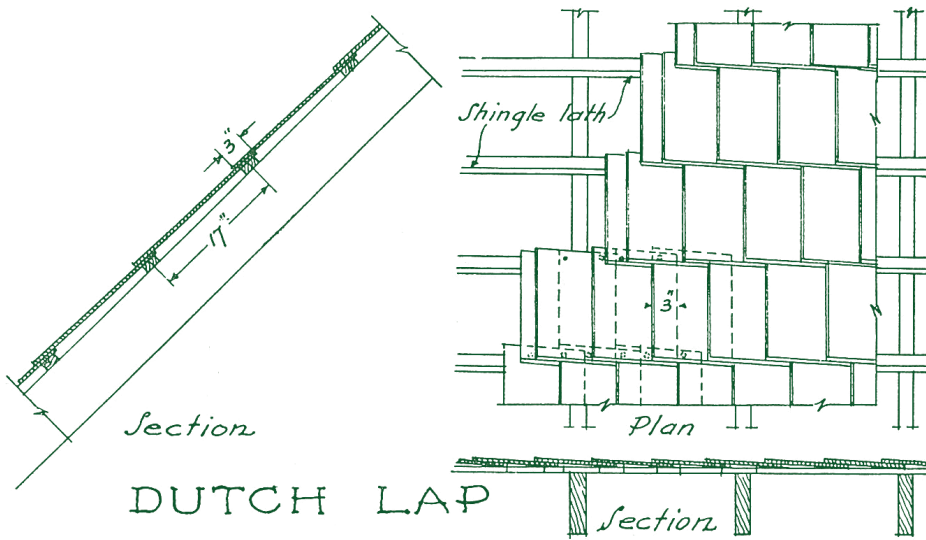


DUTCH LAP SLATE LAYOUT



TRADITIONAL SLATE LAYOUT

Figure 3 – Headlap is the amount by which the head of slate in a given course is lapped by the butt of the slate two courses above and is the key to keeping a traditional slate roof weathertight. Side lap is what allows the Dutch Lap method to have only a single lap at the heads of the slates.



DUTCH LAP

Figure 4 – Detail drawing of the Dutch Lap method as shown in the first edition of Architectural Graphic Standards.

detailing: Is a starter course needed? Where should the slating nails be placed? Are there guidelines on the amount of lap required, similar to those for headlap? In fact, design information is quite sparse. *Slate Roofs*, published in 1926 by the National Slate Association, contains a nice graphic, but only states the following with regard to the Dutch Lap method: “Laid with regular slate on shingle lath or tight sheathing.”¹ The graphic was oft repeated in later architectural reference manuals, such as the first and third editions of Ramsey and Sleeper’s *Architectural Graphic Standards*, published in 1932 and 1941, respectively (Figure 4).²

Bennett and Pinion, in 1948, make no mention of the Dutch Lap using slate, but do devote a whole chapter to “Single-Lap

Tiling.” Although discussing clay tile, the concepts would be similar for slate. Bennett and Pinion’s words elaborate on the description previously given:

Plain tiles [slab tiles laid in the traditional manner with headlap] give lateral bond, while single-lap tiles, such as Italian, Roman, and common Pantiles, give side lap instead of bond. If plain tiles were laid in one thickness—that is, without lateral bond—they would be like a sheet covering, slotted with holes. Water would immediately find its way through the vertical joints and sink into the roof. The same would happen with single-lap tiles were it

not for the side laps. Even with the side lap, water would not be entirely kept out were it not for the curved shape (or other device) which causes water to flow down the middle of the tiles and keep away from the sides.³

That last sentence is interesting, given that all slate shingles are rather flat and the angled cut on the slates of the Hoopes mansion direct rainwater toward the laps (see Figure 3).

In addition to the Dutch Lap method, the Open Slating and French methods also reduce the amount of slate required compared to the traditional method, and in so doing, reduce the weight and cost of the roof. Jenkins, in 2003, stated: “These styles tend to be found on barns and outbuildings where the owner probably didn’t want to spend extra money on materials. ...Also, these alternative slating methods leave much of the roof covered by only a single layer of slate—a situation more vulnerable to such threats as hail damage.”⁴

Study of the *Slate Roofs* graphic (Figure 4) and discussions with colleagues suggested that 3 in. might be a good starting point for both the side lap and top lap in a Dutch Lap roof. A rule of thumb is that the side lap should be one-fourth to one-third the width of the slate. The 4-in. side lap of the 16-in.-wide Hoopes mansion slates fit these parameters. Whether a starter course or cant was needed at the roof eave remained unknown. Whether wind-driven rain would result in leakage also remained unresolved, but experience suggested the risk was too great not to investigate further.

WATER TESTING

After a day of field survey, bid documents were prepared and the project was rebid with slate shingles laid in a Dutch Lap pattern atop a double layer of #30 organic felt underlayment and ice dam protection membrane placed in the first 12 in. above the gutter. We remained concerned about the weathertightness of a Dutch Lap slate roof and getting the amount of lap correct. The amount of lap required, in turn, might impact the size of the slate and the slate order. The bid documents thus incorporated an initial order of 110 slate shingles to permit a test panel of the Dutch Lap to be prepared and water tested. Rather than creating a separate mock-up, the owner preferred that the test panel and water testing be done in situ, with the contractor working off of a bay roof. This had the added advantage of allowing us to determine how better to adjust the exposure of the slates to accommodate the curvature of the roof and end up with a more consistent lap and exposure.

In laying the slates for the test panel, we determined that a consistent 3-in. top lap and 5-in. exposure (first ten courses)—adjusted to a 3¼-in. top lap and 4¾-in. exposure at the curve of the mansard (five courses)—allowed the slates to accommodate the shape of the mansard nicely (no raised butts), yielded an acceptable exposure in the finishing (top) course of slate

(roughly 5 in.), and provided more consistent lap and exposure than the original installation. Due to the smaller and more consistent exposure, one additional course of slate was required compared to the original installation. Slate shingles in the test panel were laid atop rosin paper to make it easier to spot any water that might make its way past the slates during water testing.

Water testing was carried out using a garden hose. Water was systematically sprayed at various angles (downward, straight on, at a slight side angle [i.e., into the side laps], and at an upward angle) for durations of three to five minutes. After each interval, slates were removed. When water was sprayed at a downward angle, the rosin paper was found to be dry. Some water did extend into the side and top laps of the slate, but not enough to reach the nail holes. When water was sprayed straight on and at side and upward angles (simulating wind-blown rains), areas of wetness on the underlying rosin paper were observed, and a significant portion of the concealed areas of the slates were wet, including areas around many of the nail heads (*Figure 5*).

Water testing confirmed our suspicion that in a steady rain with no wind, slates laid in the Dutch Lap pattern with a 4-in. side lap and 3-in. top lap will shed water with little, if any, moisture penetrating below the slate shingles. In a heavy rain



Figure 5 – Wetting of rosin paper and within top lap when water was sprayed at an upward angle.



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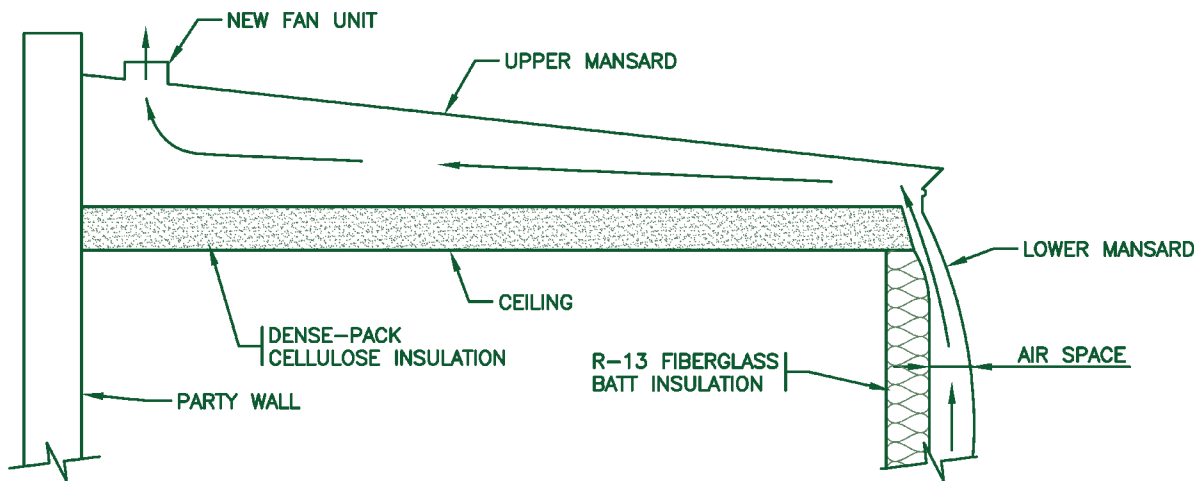


Figure 6 – Schematic section through front half of the mansion, showing continuous air space for ventilation.

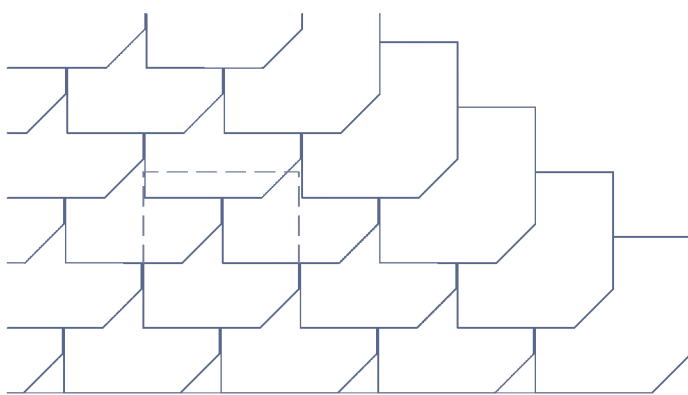


Figure 7 – Sketch provided to the owner showing what 12- x 12-in. slates with one clipped corner would look like when installed in the traditional manner. The exposure and the size of the clipped corners are the same as that of the existing slates. The appearance is quite different, however, compared to the Dutch Lap.

or rain with driving winds, however, some water will penetrate below the slates. The specified double layer of #30 felt underlayment would shed most of this water. Over time, though, the felts would likely deteriorate, and some water would find its way to the wood roof deck or possibly even leak into the building. This was unacceptable.

OPTIONS

Given the results of the water testing, Dutch Lap slate laid atop #30 felt was not a viable system for the long term. We, thus, went back to the owner with design options. These included the following.

Wood Battens

Pressure-treated wood battens, or a properly detailed batten and counter-batten system, with a continuous waterproof membrane laid directly on the wood roof deck, or

Ice Dam Protection Membrane Underlayment

Self-adhering ice dam protection membrane would seal around the slating nails and minimize the potential for water to reach the wood roof deck over time. While easy, cost effective, and suggested by many as the go-to solution, we said “not so fast.” Ice dam protection membrane is an effective vapor retarder/barrier. If placed below the slate over the entire roof deck, warm, moist air from inside the building could potentially form condensation on the underside of the roof deck during the winter and transitional months. We recommended the project architect and mechanical engineer be consulted to determine whether it was advisable to install a vapor barrier over the entire lower mansard.

The owner had gutted the interior of the house and insulated the lower mansards

draped between battens, would create a secondary drainage plane and capture any stray moisture that made its way through the Dutch Lap slate shingles. A wood batten system would add significant cost to the project and raise the plane of the roof from $\frac{3}{4}$ to $1\frac{1}{2}$ in., thereby making the flashing of the dormer cheek walls difficult, if not impossible. This option was, therefore, rejected.

mansards (Figure 6). It was agreed that we could ventilate this space and prevent or mitigate condensation on the underside of the roof decking.

Soffit vents were not thought to be possible at the time, but even if they were, cutting a large enough slot and installing screening the full length of the soffit would have been expensive and adversely impacted the building’s historical integrity. The mechanical engineer favored active ventilation via a fan unit placed on the roof of the upper mansard, but the owner feared power outages might render the system useless just when it was needed most. This, combined with lack of a continuous air space at the rear half of the mansion, led to rejection of the ice dam protection membrane option.

Traditional Slate

Laying slate in the traditional manner, with a 2- to 3-in. headlap, would eliminate the concern of wind-blown rains penetrating below the shingles. There were, however, at least three drawbacks to this option:

- 1) Mock-ups created using leftover slates from the water testing indicated that the butt ends of the slates would stick up significantly at 11 of the 16 courses. This would be unsightly and, potentially, expose the slating nails to wind-blown rains.
- 2) In order to accommodate the convex shape of the mansard, the slates had to be trimmed to length so much that headlap was reduced well below 2 inches in many courses, and even to 0 inches in some places. To correct for the loss of headlap, copper strips would have to be interlaid

with R-13 fiberglass batt insulation with Kraft paper facing. The upper mansards had been insulated with dense-pack blown-in cellulose insulation. At the front half of the mansion, it was determined that a continuous air space was present between the insulation and underside of the roof deck at both the upper and lower

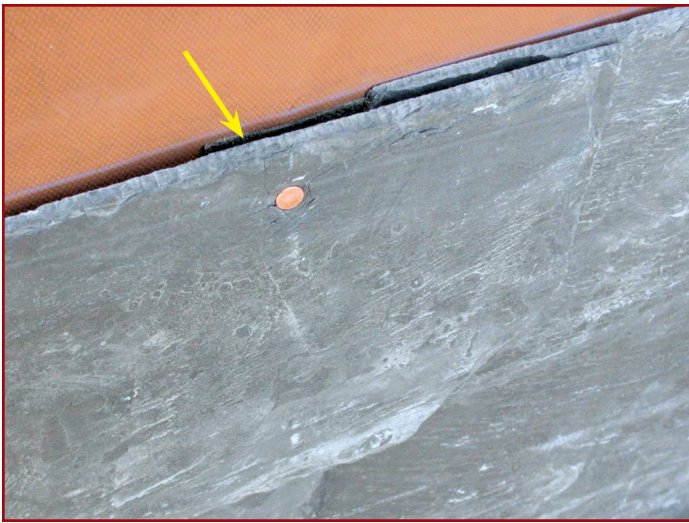


Figure 8 – Just prior to the installation of each slate shingle, a 4- x 4-in. piece of self-adhering tape was placed on the underlayment at each slating nail location to help seal around the nail holes.

lent dispersion coating, which, according to the manufacturer, can withstand repeated wet/dry cycling and still retain a service life equal to that of the slate shingles. It has a permeance of 550 perms (per ASTM E96, Procedure B, Water Method) and is supported by special tape accessories that were used to a) seal the heads of the cap nails employed to secure the underlayment to the roof deck, and b) seal around the slating nails (Figure 8).

with the slate.

- 3) The pattern of the slate would change dramatically (Figure 7).

All of these factors lead to rejection of slate laid in the traditional manner.

Asphalt Shingles

Considered the best option from a rainwater management perspective, dimensional asphalt shingles could be made to accommodate the curvature of the mansards and eliminate the concerns about wind-blown rains. There would also be a considerable cost savings versus slate shingles. Although the local historical commission indicated likely approval of asphalt shingles, the owner desired to maintain the historic integrity of the building and preferred the longer service life of natural slate. The owner, thus, decided to reject this option.

A Robust Breathable Underlayment

A permeable, yet water-repellent, underlayment turned out to be the ultimate solution. The underlayment selected is a highly breathable synthetic consisting of a thermobonded polyester, nonwoven layer, coated on one side with an acrylic water-repel-

DETAILING

Observations made during design, demolition of the existing roof, and installation of the new roof provided the following information essential to any Dutch Lap slate roof.

Starter Course and Cant

In a traditional slate roof, both a starter course and cant are needed (see Figure 3). The starter course ensures that rainwater passing over the bond lines in the first course does not penetrate to the roof deck

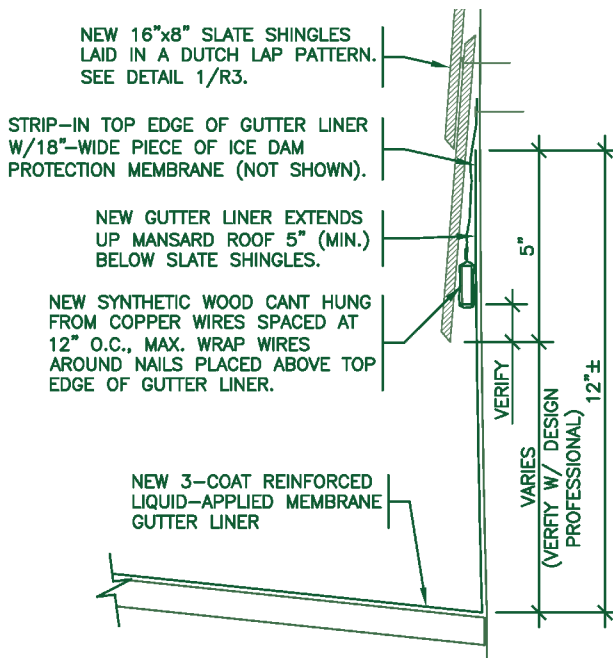


Figure 9 – Section showing cant and first course of slate above the gutter.



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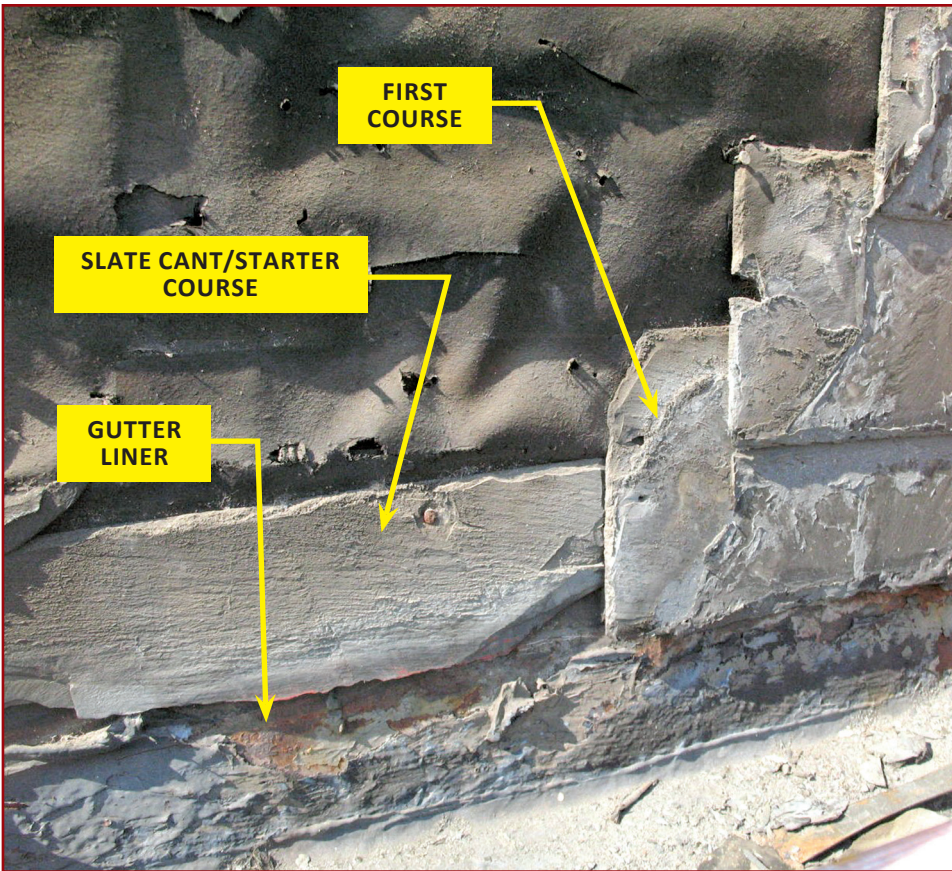


Figure 10 – Original combination cant and starter slate above the mansard’s gutter.

and provides the necessary headlap. The cant lifts the butt end of the starter and first course up off the roof deck a sufficient amount such that the second and succeeding courses of slate lie atop each other in close contact and without their butt ends sticking up.

Similarly, a Dutch Lap slate roof needs a cant in order to “get the slates to lay,” but does not necessarily need a starter course. At the mansion, a new liquid-applied membrane gutter liner provides sufficient waterproofing below the first course of slate, such that a synthetic wood cant hung from copper wires could be used as a cant (Figure 9). In other situations where the roof underlayment might be a single or double layer of felt, a narrow slate measuring roughly half the length of the slate can be used as a combination cant and starter course. This is, in fact, the way the original roof at the mansion was detailed (Figure 10).

Nailing

As with a traditional slate roof, each slate in a Dutch Lap slate roof should be secured with two copper slating nails. Nail locations in a Dutch Lap shingle will be covered by the top and side laps of the slates and should be positioned as follows:

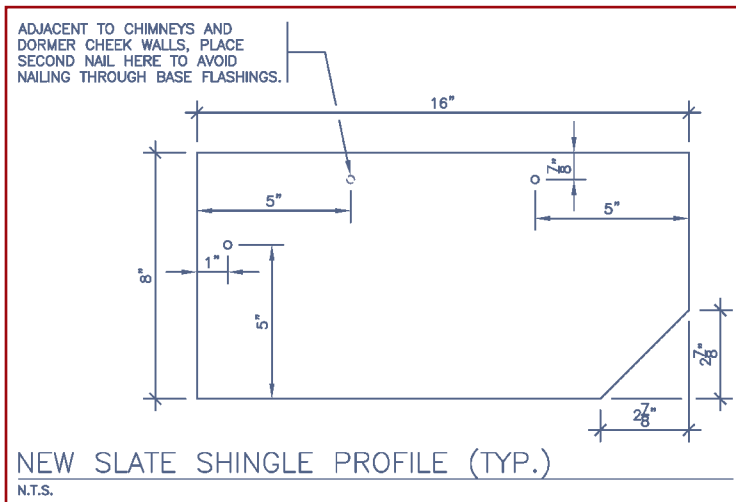


Figure 11 – Sketch of nail locations for a 16- x 8-in. slate shingle to be used in a Dutch Lap pattern.

One nail approximately $\frac{7}{8}$ in. down from the top edge of the slate and in from the leading edge of the slate a distance equal to one-third the width of the slate, minus around $\frac{1}{2}$ in. (in this case, 16 in./3 minus $\frac{1}{2}$ in. \approx 5 in.). The second nail is positioned 1 inch in from the trailing end of the slate and a distance up from the bottom edge of the slate equal to the exposure. Where slates overlap base flashings, as at chimneys and vertical walls, the second nail location at the side of the slate cannot be used. Instead, to avoid puncturing the underlying flashings, a second nail should be added along the top edge of the slate (Figure 11).



Figure 12 – View of new right-handed Dutch Lap slates at the mansion.

Laps

Given the results of our water testing, a 3-in. top lap and 4-in. side lap seem about right for Dutch Lap slate laid on a very steep roof, such as a mansard. For lower-sloped roofs, Dutch Lap is probably not appropriate due to the frequency with which rainwater will pass through the joints in the slate during rain events. If, for historical preservation reasons, a Dutch Lap is desired on a lower-sloped roof, increasing the top and side laps would be prudent. When adjusting the exposure of the slates to accommodate the curve of a mansard or to ensure the correct exposure of the finishing course of slate, adjustments should always be made so as to decrease the exposure and increase the top lap.

Slate Direction

The slates in a Dutch Lap roof are directional due to the side laps. Right-handed slates appear to point to the right and are installed from right to left. Left-handed slates appear to point to the left and are installed from left to right. Slate direction is purely an aesthetic consideration, but once selected must be continued on any given slope until a natural stopping point, such as a hip or vertical wall, is reached. The slates on the mansion were originally all right-handed, and the owner elected to replicate this aesthetic in the new roof (Figure 12).

Slate Order

Slate shingles are typically ordered by the square based on a 3-in. headlap. Since there is no headlap in a Dutch Lap roof, slate shingles are more appropriately ordered by the piece. The number of pieces can be calculated by dividing the total roof area to be covered by the slate by the exposed area of each shingle or, as in the case of the mansion, by counting the number of existing slates and making any adjustments that may be needed (for example, we added another course to account for the reduced exposure of the slates in the new roof compared to that of the existing roof). Slates will likely be ordered unpunched, as quarries are not typically set up to punch the nail holes where needed in a Dutch Lap slate. Nail holes will, thus, have to be punched on the jobsite using a template to help ensure consistency.

Slate Repair

Repair of broken slates is more difficult in a Dutch Lap roof than a traditional slate

roof because there are no true bond lines in which to insert a nail and bib. Therefore, every effort should be made to avoid damaging the shingles during the construction process. If a shingle is broken, however, a pair of slate hooks and a couple of dabs of trowel-grade adhesive or sealant adhesive (to help prevent wind chatter) can be used to form an effective repair (Figure 13).

SUMMARY

The Dutch Lap slating method provides an aesthetically pleasing roof that can more

readily accommodate convex and concave roof shapes than a traditionally laid slate roof. The Dutch Lap is, however, prone to leakage during wind-driven rain events. To overcome this problem, a secondary or supplemental water-shedding membrane can be installed below the Dutch Lap shingles. The membrane should have an expected service life commensurate with that of the slate shingles and have some way of providing a watertight seal around the slating nails. In the case of the Hoopes mansion, the membrane also had to have a high perm

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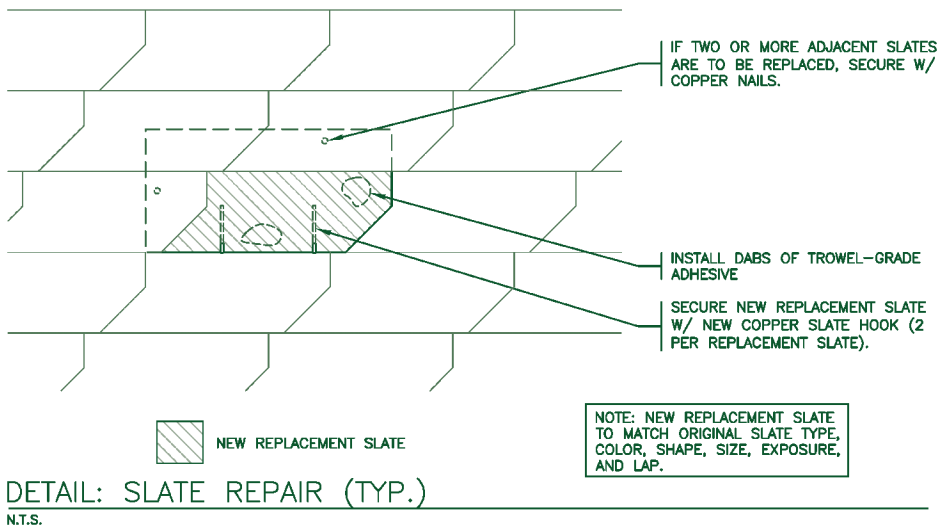


Figure 13 – Slate repair in a Dutch Lap roof.

rating in order to prevent or mitigate the potential for condensation on the underside of the roof deck. In addition, a proper cant at the roof eave, nail locations, side lap, exposure, and slate direction are important detailing considerations that must be carefully thought through and specified to help ensure a successful outcome: a 100-year slate roof.

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Jeffrey Levine has served as project manager for over 340 restoration and rehabilitation projects, preservation plans, and maintenance programs. He has an M.A. in historic preservation planning from Cornell University;

has written numerous articles on slate roofing, including Preservation Briefs No. 29, published by the National Park Service; and edited and co-wrote the National Slate Association's Slate Roofs: Design and Installation Manual, 2010 Edition, as well as its Mobile Field Guide. Formerly with Levine & Company, Levine recently joined Wiss, Janney, Elstner Associates' Philadelphia office as an associate principal. He can be reached at jlevine@wje.com.

RICOWI Deploys Hurricane Michael WIP Teams

The Roofing Industry Committee on Weather Issues (RICOWI) deployed four teams to investigate the damage to roofs from Hurricane Michael in the Panama City, Florida area. This was the sixth hurricane team deployment since the Wind Investigation Program (WIP) was established. WIP team members are wind engineers, roofing material specialists, insurance analysts, structural engineers, and consultants. A report will eventually be generated and made available online.

RICOWI Chairman David Balistreri, RRC, with Building Envelope Consultants, Ltd., stated, "RICOWI volunteers will provide factual information on the roof damage, based on wind speed and other data. Clearly, this information will improve the roofing structure and greatly help the community in the long term."

Prior to Hurricane Michael, RICOWI conducted five of the most comprehensive roofing investigations of hurricane-stricken areas: Hurricanes Charley (Aug. 13, 2004), Ivan (Sept. 16, 2004), Katrina (Aug. 29, 2005), Ike (Sept. 13, 2008), and a smaller investigation for Hurricane Irma (Oct. 31, 2017). All research reports are available online as a download at www.ricowi.com.

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