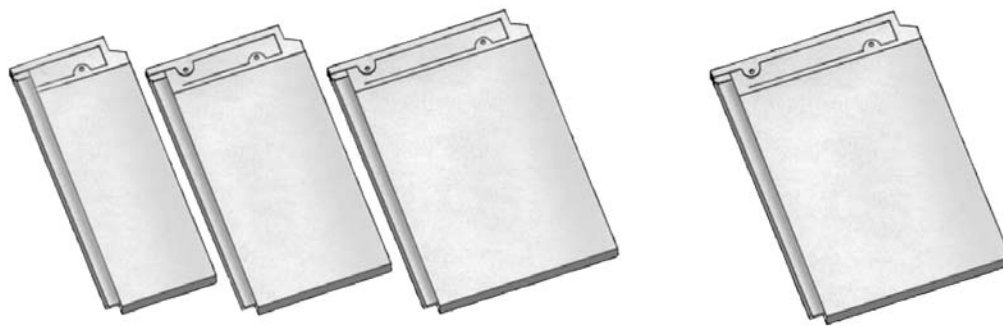




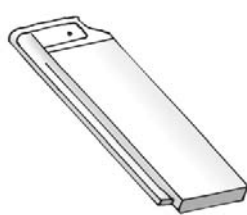
LudoSlate™ and LudoShake™ Installation Manual



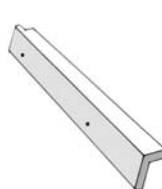
LudoSlate/LudoShake Premier

LudoSlate/LudoShake

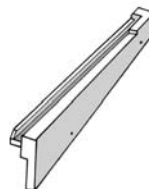
Nominal Widths	5", 7" & 10"	10"
Weight per Square	598 lbs.	598 lbs.
Pieces per Square	120 pcs. (10 pcs. 5", 9 pcs. 7" & 101 pcs. 10")	111
Overall Size	5-3/4", 7-3/4" & 10-3/4" x 16"	10-3/4" x 16"
Exposure	5", 7" & 10-1/8" x 13"	10-1/8" x 13"
Minimum Slope	3:12	3:12



End Band

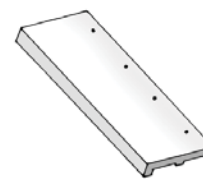


Left Rake



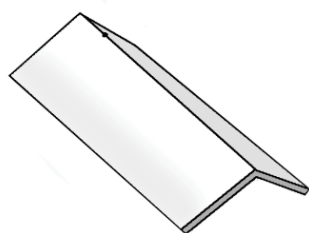
Right Rake

Detached Gable Rake

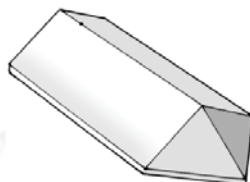


Under Eave

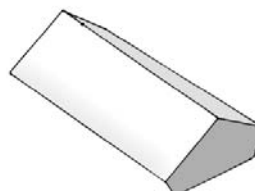
Actual Size	16"	16"	12"
Exposure	13"	13"	12"
Weight	5.5. lbs/ea.	2.8 lbs/ea.	2.3 lbs/ea.



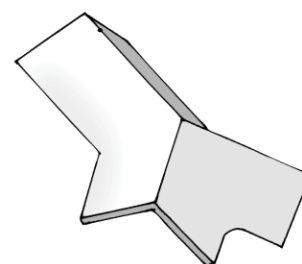
**LudoSlate/LudoShake
Hip/Ridge**



Hip Starter



Closed Ridge End Cap



Terminal 2hip/1Ridge *

Actual Size	16"	15-1/2"	14-1/2"	-
Exposure	13"	12"	12"	-
Weight	7.4 lbs/ea.	8. lbs/ea.	8. lbs/ea.	15. lbs/ea.

Ridge Angles		Hip Angles	
Degree	Roof Pitch	Degree	Roof Pitch
116°	3:12 to 10:12	116°	3:12 to 18:12
90°	11:12 to 20:12		

* Ludowici makes ridge/hip terminals to fit any roof geometry. Contact your Ludowici representative for assistance.

Roof Deck

A design standard for roofing decks is to have a maximum deflection of $L/240$ between supports. A deck will be exposed to live and dead loads. A live load is one that will only be exerting pressure on the roof deck for a short time. Example: Snow or wind loads. A dead load is one that will exert a constant pressure to the roof deck ie., underlayments, tile and battens.

For Board Plank Deck: Well-seasoned plank board (1" full thickness, maximum 6" nominal width) that is not prone to warping, cupping or twisting.

For Plywood Deck: APA rated plywood is required for a minimum of $3/4$ " thick wood decking and must be rated for structural use as roof sheathing. The expansion crack between panels shall be at least $1/16$ " but no greater than $1/8$ ". H-clips are to be used when rafters are spaced greater than 16" on center, to hold the side joints of the plywood together between supports. Un-supported end joints must be blocked.

Fastener Pullout Resistance: Minimum average fastener pullout resistance for clay roofing tile is 180 lbs., with no single value less than 170 lbs. Greater pullout values may be required depending upon the predicted aerodynamic moment expected for the tile shape, building shape, and the proximity to the coastline. An engineer should be consulted to assure local building code compliance.

Concrete Decks:

Nailable Concrete Decks - Nailable concrete decks over time may lose their plastic nature, which allows direct nailing. For old decking material, a pullout test should be performed to determine the usefulness of the deck, and the appropriate fastener. An engineer should be consulted to assure local building code compliance.

Non-Nailable Concrete Decks - For concrete decks that will not accept direct nailing, nailer boards are required. Attachment strips that allow the tile to be fastened to them should be pressure treated wood. These may be a board and batten system or pressure treated wood strips that can be embedded into the concrete deck

during construction. Other means of attaching tile to a concrete deck include wire-tie systems, foam adhesive and expanding nail-in anchors.

Note: Ludowici does not recommend applying tile over spaced board sheathing or open battens.

Underlayment

Most problems with water-shedding roof installations occur from water that migrates through the joints of the tiles through capillary action, wind driven rain, and runoff or ice damming. Because of this possibility, the underlayment is critical to the success of the roof.

Ludowici recommends the following for minimum underlayment:

- All decks shall be covered with two layers of 30# asphalt-impregnated roofing felt or one layer of 43# coated base sheet or 1 layer of self adhering modified bitumen membrane. NOTE: When using non-breathing self adhered modified underlayments to cover the entire roof the attic space MUST be properly ventilated to prevent moisture buildup.
- All hips, valleys, rakes and ridges shall be covered with a waterproof underlayment, example: self-adhesive modified bitumen membrane or two layers of No. 43 coated base sheet.

Note: Roofing felt should meet or exceed ASTM standards D226/D2626.

Fastening Methods

Attachment requirements and fastener length are referenced in Chart 4.2

Nails or Screws: Nails are the most commonly used fastener for attaching clay tiles. Nails for tiles and cleats must be copper, 11-gauge minimum, .285”-.312” head minimum and proper length to give good penetration. Screws must be stainless steel or brass, #8 or #9 with a minimum .285”-.312” diameter head.

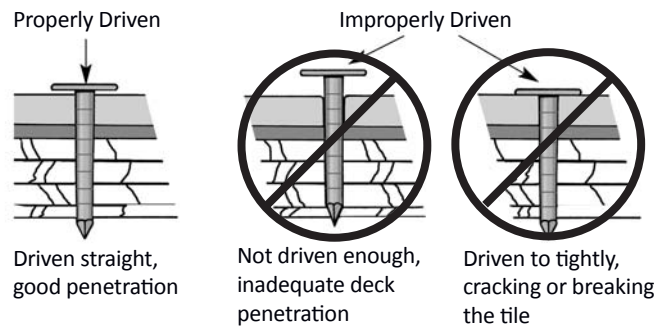


Figure 4.1 Proper Nailing Techniques for Plywood Decks

Note: Each field tile is provided with (2) two fastening nail holes. When installing field tiles, care should be taken to fasten each tile with nails or screws in every provided fastening hole.

- For a plywood deck, use ring shank copper nails of the specified length to assure good penetration through under side of deck (see Chart 4.1).
- For board plank deck, use smooth shank copper nails of the specified length. Fasteners should penetrate deck board 3/4”. Do not penetrate underside of deck.
- For gypsum plank or nailable concrete deck, use stainless steel or silicon bronze screw shank nails of length to penetrate half to three-quarters the thickness of the deck. Never penetrate underside of deck.

Fastener Lengths

- When insulation is applied over the deck, observe the following:
 - Minimum slope (per style) to 6: 12 - the tile can be nailed through underlayment and insulation into the deck with a sufficient length fastener.
 - On 6: 12 or greater, a tile-tie system should be used.

- For metal decks, use sheet metal screws and the proper mastic.
- For fibrous cement decks, use a tile-tie system.

Note: When using stainless steel screws, tile replacement will require the use of a hack saw to remove the screws. A slate ripper may be used with copper or brass fasteners.

Wire. On non-nailable surfaces or some insulated decks or where fastening through the metal flashing needs to be avoided or if underlayment cannot be penetrated, such as special low slope applications, wire and strap-ping systems are sometimes used. Wire must be solid copper, 16 gauge, with or without insulation. Wire-tieing is also usually specified in areas prone to earthquakes. Consult the manufacturer of these types of systems for specific design and installation.

Clips. Wind clips are often specified and/or required in high wind and seismic areas. They aid in holding the tiles in place and reduce stress at the preliminary fastening point (see Figure 2.2). Refer to local building codes in such areas.

Chart 4.2 Attachment Requirements

Substrate	Field Tile	Hip	Ridge	Quik-Tach Bracket	Hurricane Clip
Boards	1-3/4”	2”	2-1/2”	Type C	1-1/4”
3/4” Plywood	2”	2”	2-1/2”	Type C	1-1/4”

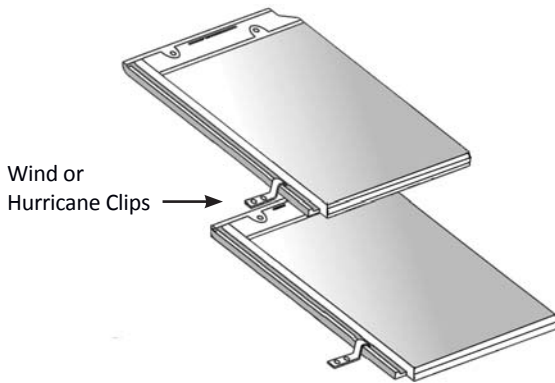


Figure 5.1 Wind Clip

Note: In high wind regions, install each tile with #8 or #9 Stainless Steel or brass flathead Phillips or square drive screws and/or use wind clips. Wind clips and sealants may be required by the local building codes.

Bedding Tile. Where freezelthaw cycles are not an issue, tile may be laid in a full or partial bed of mortar. This method is best used in combination with other means of attachment.

Foam Adhesive. This method of application is approved for use in South Florida and is being tested for use in other areas. Refer to local building codes. See Tropical Conditions on Page 84 for more details.

IMPORTANT:

Before application of Ludowici tiles in Alpine conditions, plans must be submitted to Ludowici Technical Department for approval. Ludowici will not assume liability or responsibility for damage caused by the application of clay tiles in alpine conditions.

Range of Tones

Colors within a given shipment of Ludowici clay roof tile will vary slightly due to subtle changes in clay composition and kiln firing temperatures. Such color variances are not a defect but a natural desirable feature that gives roofs depth and character.

The person responsible for the blending of the shades of color should randomly select tiles from at least three different pallets. This blending will ensure a proper blend to provide a harmonious color roof without blotches or streaks.

After the installation of about 75-100 tiles, the roof should be inspected from the ground at a distance greater than 40 feet to determine that there are no streaks or blotches. To ensure a good range of tones, this inspection must be done at regular intervals.

Color Blending with Different Color Tile

Blending different tile colors can provide a unique and aesthetically pleasing roof

Make a drawing to detail the layout and to help determine the proper number of tiles of each color.

In order to maintain the correct color blend, pull tiles from the different pallets of each color. Premix these piles in the desired percentage and load the roof one square at a time. This will provide even distribution.

After the installation of about 75-100 tiles, the roof should be inspected from the ground at a distance greater than 40 feet to determine that there are no streaks or blotches. To ensure a good color blend, this inspection must be done at regular intervals.

Note: It may be helpful to lay the tile blend out on the ground so the installer has a visual example. Make one person responsible for the ongoing and end result of the blending.

Inspecting the Deck

- Ensure that the roof deck is clean, smooth, and dry before roof tiles are applied.
- Verify that there is no significant delamination, warpage, bowing, or separation from the rafters or trusses. Check for deck rot.
- If deck is APA 3/4" rated plywood, check that panels are spaced approximately 1/16" to a maximum of 1/8" apart for expansion and H-clips are used between supports when the rafter spacing exceeds 16" o.c. Unsupported end joints must be blocked.
- Make repairs to the deck as necessary.

Note: Prior to applying any roofing material, all contractor work above the roofline must be completed.

Installing the Underlayment

Most problems with water-shedding roof installations occur from water that migrates through the joints of the tiles through capillary action, wind-driven rain, and runoff or ice damming. Because of this possibility, the underlayment is critical to the success of the roof.

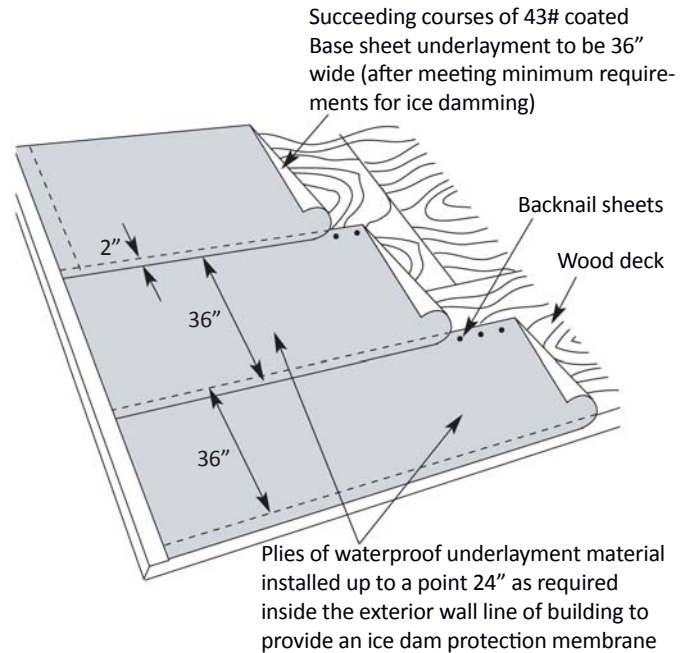
As a minimum, all decks must be covered with two layers of 30# asphalt-impregnated roofing felt or one layer of No. 43# coated base sheet.

Note: Underlayment materials must be covered with tile as soon as possible to prevent degradation from exposure.

If wood cant strips and nailers are nailed directly to the deck, they must be covered with waterproof underlayment. If nailed on the underlayment, they should be pressure treated wood.

For single layer of No. 43 coated base sheet:

Lay base sheet parallel to eave. Side lap - 2" and end lap - 6".



Note: All dimensions are approximate

Figure 6.1 Single Sheet Underlayment

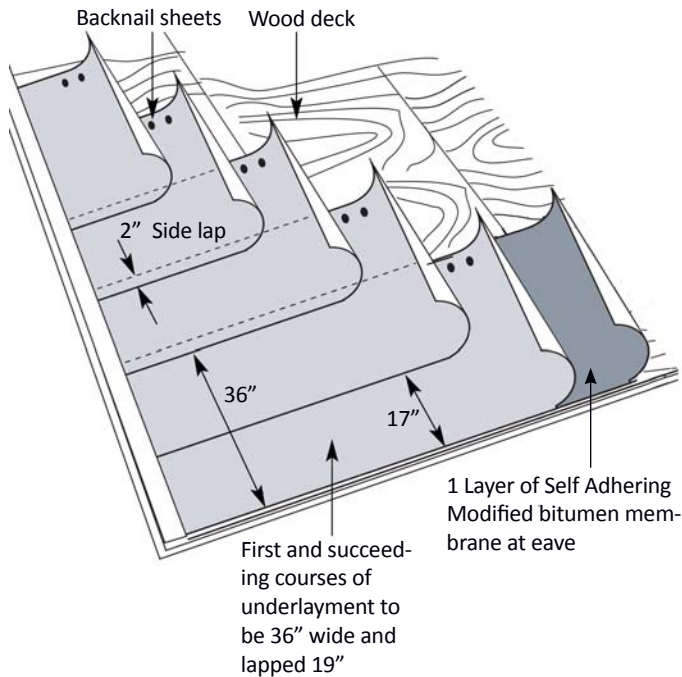
For Double Layers, follow these steps:

First apply a starter sheet of 1 layer of self adhering modified bitumen underlayment per manufacturers instructions.

Then completely cover the starter sheet with a full-width sheet of 43# roofing felt.

Lap succeeding sheets 19" over the preceding sheets, leaving a 17" exposure (2" lap). End laps should be a minimum of 6" (see Figure 7.1).

Note: All roofing underlayment materials should be carried 6" up all vertical surfaces and 4" over gutter and valley metal.



Note: All dimensions are approximate

Figure 7.1 Double Sheet Underlayment

Ice Dam Protection

Ice dam protection is recommended in areas where the January mean temperature is 30° F. or less and on all pitches below the standard minimums. This protection must be installed wherever there is a possibility of ice forming along the eaves which will cause a back-up of water and may cause building and interior damage. Consider your local weather conditions.

Apply self-adhering Ice and water shield, or equivalent, directly to the deck according to application instructions provided with the product. Self-adhering underlayment must extend up the roof to a point at least 24" beyond the interior wall line, and in areas of severe icing at least up to and above the highest water level expected to occur from ice dams (see Figure 3.5).

Please note that the 24" point beyond the interior wall line is a minimum recommendation. Self-adhering underlayment should be applied to all roof decking which past history and professional experience suggest might be subject to ice dam back-up. If considering using ice dam protection on the entire surface of the roof deck, insure that adequate ventilation is present to prevent the development of damaging condensation on the underside of the roof deck*.

If a wide eave overhang requires flashing wider than 36", the necessary 6" minimum horizontal lap must be located on the overhang outside the structure walls. End laps must be a 6" minimum. Underlayment should meet ASTM D-1970.

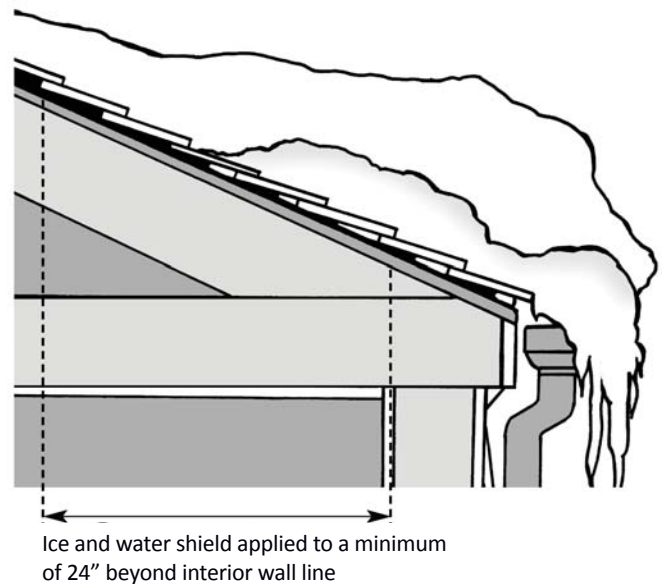


Figure 7.2 Ice Dam Protection

Measuring and Chalking the Roof

Layout and chalking the roof accurately are critical to the roof's performance and appearance. If the eaves are straight and level, all horizontal lines must be parallel to the eaves, and all vertical lines must be perpendicular to the eaves. Check the roof deck to determine if the deck is square prior to layout.

Step 1: Determine Width and Length Exposure

Clay tiles, depending on the style and profile, vary in exposure and recommended head lap. Interlocking tiles, are generally started with a half-width tile in order to offset the joints. With LudoSlate Premier's random width installation you can start with a full tile.

Before chalking the roof the installer should verify the tile pattern being installed, and measure, noting average length and width exposures of the tile shipped. The usual overhang at the eave is 2"; however, this may be adjusted slightly to accommodate full courses. Measure the roof from eave to ridge to ascertain whether the final course can be a full length tile or if a short course needs to be cut.

LudoSlate & LudoShake allow the head lap to be increased over several courses to avoid cutting a short course.

Step 2: Chalking Vertical Lines

Vertical lines are chalked first. In the case of a hip roof, the first line is struck in the center of the roof equidistant from each hip (see Figure 3.6). The remaining vertical lines are then struck to the right and left at intervals equal to your average width exposure. Care must be taken to ensure that all vertical lines are parallel to the water flow.

NOTE: Vertical lines are not needed with LudoSlate Premier or LudoShake Premier.

Step 3: Chalking Horizontal Lines

Horizontal lines are struck after the vertical lines are struck.

The first line will equal the average length of the tiles minus the overhang. For example, a tile with an overall length of 16" minus a 2" overhang indicates the first line is to be 14" up from the eave. Successive lines are then struck at intervals equal to your average length of exposure.

Your eave to ridge measurement may determine the average length exposure rather than the size of the tile itself. For example, suppose the eave to ridge measurement is 125-1/2" and the average exposure of LudoSlate is 13". You might then determine to lay the first tile at an 13" exposure as usual, and 12-1/2" exposure for each of the remaining nine courses. Here is the calculation: eave to ridge measurement of 125-1/2" minus 13" for the first course equals 112-1/2"; therefore 112-1/2" divided by 9 equals 12-1/2".

Care must be taken to ensure that all horizontal lines are perpendicular to the water flow.

IMPORTANT:

The tile dimensions can vary because of clay firing temperatures. Be sure to measure tiles in your shipment to determine their average width and length dimensions, so you can chalk your roof properly.

Staggered Application

LudoSlate and LudoShake can be laid with staggered butts to achieve a more rustic appearance.

The roofer will need to snap off the waterlock knock-outs on both the lower left corner and the upper right corner to allow the tiles to be laid staggered.

Strike the chalk lines in the same method as a standard installation. Lay the first course in a straight line. On the second and above courses lay the tiles on the chalk line and randomly drop some up to $\frac{3}{4}$ " below the chalk line to achieve the random staggered look.

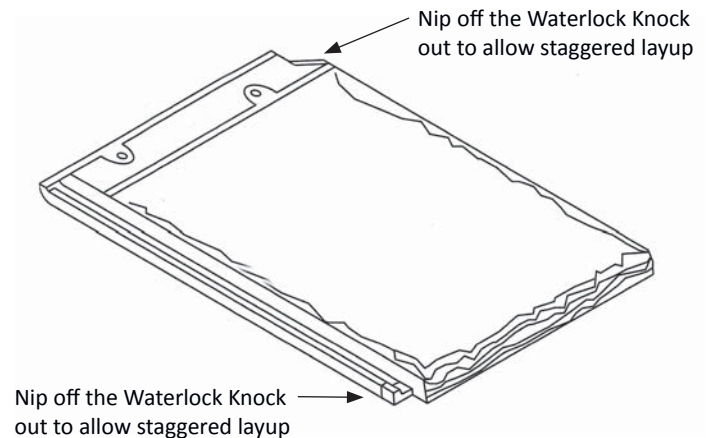


Chart 9.1 Attachment Requirements

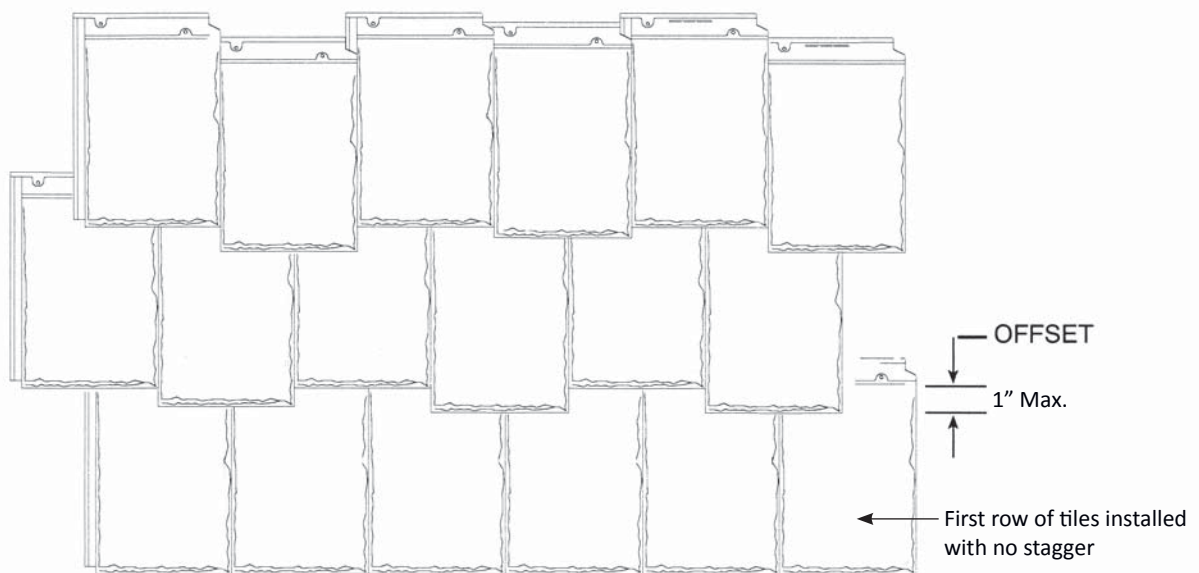


Figure 9.2 Staggered Layup

Eave Detail

At the eave either a pressure treated cant strip or Ludowici's clay Under Eave tile is used to cant the first row of tiles at the same angle as the field of the roof.

Copper flashing is needed for both details to close off the transition from plywood deck to fascia board.

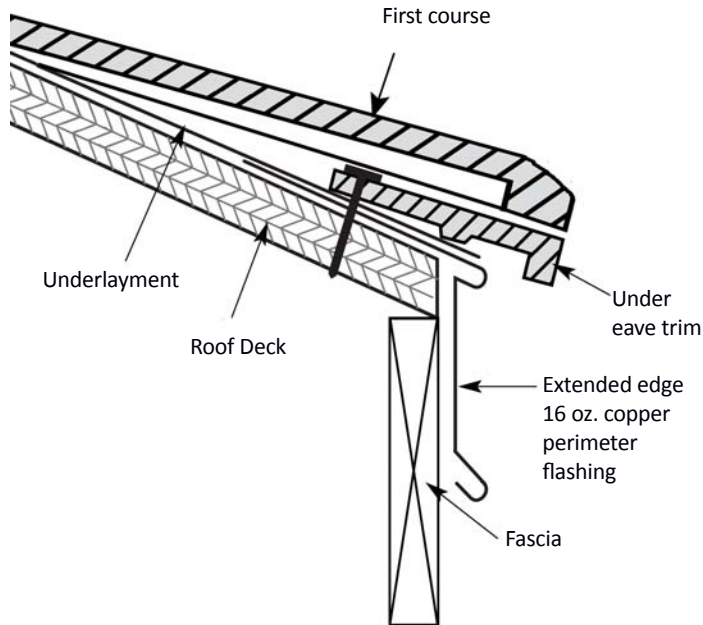


Figure 10.1 Eave Detail with Under Eave clay trim

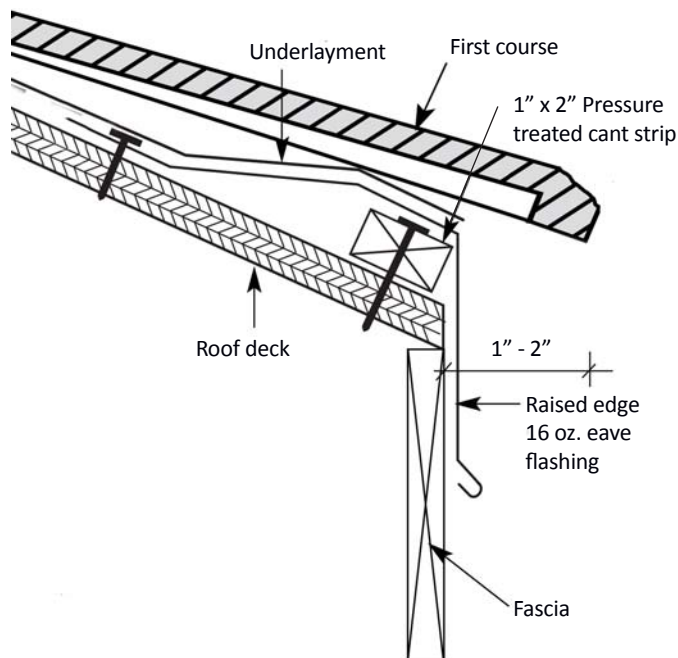


Figure 10.2 Copper Flashing Eave Detail

Rake Detail

For a more detailed and finished look close off the edge of the roof with Ludowici's Detached gable rake trim. These are made in both Left and right. For a cleaner look use a piece of copper flashing.

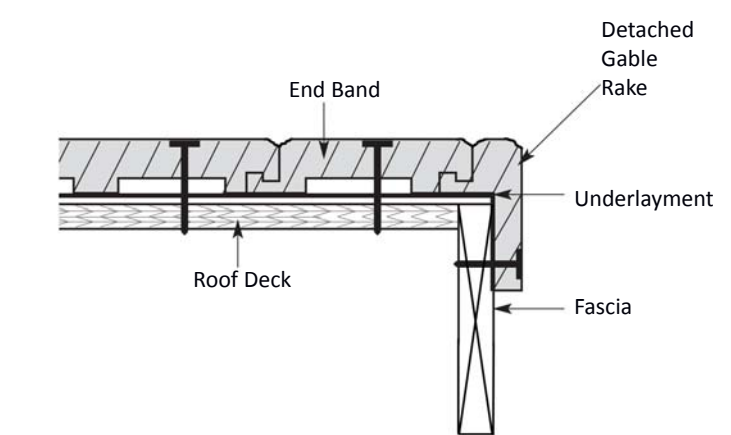


Figure 10.3 Detached Gable Rake Detail

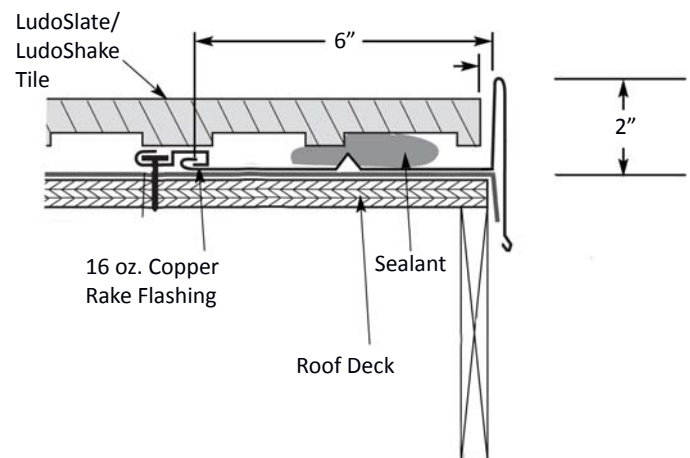


Figure 10.4 Copper Rake Flashing Detail

Valley Detail

Valleys, since they collect the water runoff from the portions of the roof sloping into them, are particularly prone to water migration and leakage. A clear and unobstructed pathway for quick water drainage is essential in valleys. There are two basic types of valleys in tile roof installation: open and closed valleys.

Open Valleys

In an open valley construction the tiles are held back from the center of the valley to expose the copper flashing. The advantage of an open valley is that it permits unobstructed drainage. Open valleys are recommended in areas with surrounding foliage where the leaves, needles, and other debris can fall on the roof and potentially slow or block the runoff of water from the roof.

The valley metal is to be secured with approved fasteners. At no time are nails to be placed in the area of the valley that will be carrying water.

IMPORTANT:

Metal exposure width shall increase 1" for every 8 feet of valley run towards the eave

Closed Valleys

In a Closed Valley, the tiles from the adjoining roof are mitered and abutted. Since water migrates through a closed valley onto the sheet copper flashing which carries the runoff, this type of construction is considered decorative. Closed valleys should not be used where foliage debris can fall onto the roof. Another area where it is strongly discouraged is where the rafter length or pitch varies on adjacent roof planes. It is important that corresponding courses align coming into the valley.

Note: Underlayment for all valleys must be a full width sheet (36") of two layers of No. 43 coated base sheet or a layer of self-adhesive modified bitumen membrane. Each course from the adjoining fields must overlap the valley underlayment by at least 12".

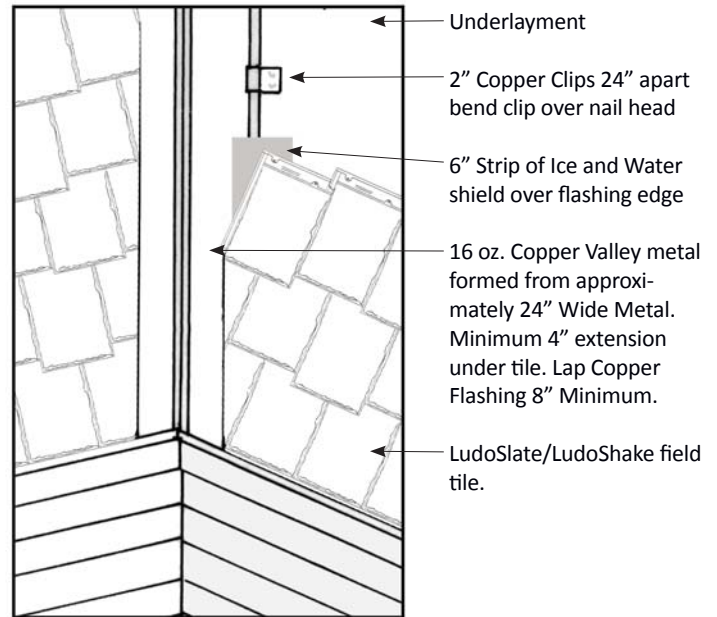


Figure 11.1 Open Valley Detail

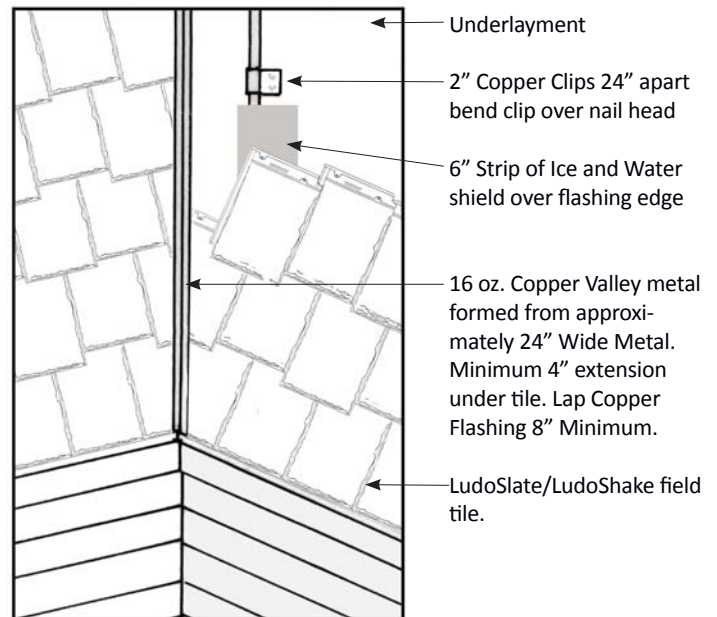


Figure 11.2 Closed Valley Detail

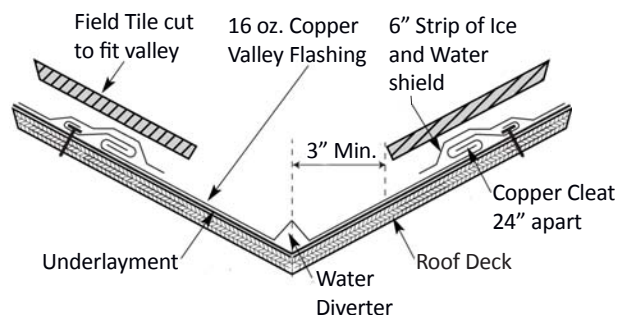


Figure 11.3 Valley Section

Flashing at Vertical Walls

Two methods of flashing at vertical walls are typically used: step flashing and Continuous pan flashing.

Step Flashing

In the step method of flashing, individual 16 oz. sheet copper flashing is applied between each course of tile. A minimum head lap of 3" must be provided from step flashing to step flashing. See Figure 4.9.

The following criteria should be used to determine the appropriate size for step flashing:

- 1) The step flashings should have a minimum of 3" overlap over each other.
- 2) The step flashing should extend up the vertical surface a minimum of 4" and a minimum of 2" overlap of the siding, cladding or copper counter flashing.
- 3) The step flashing should extend a minimum of 5" onto the roof so that there is at least a 5" overlap of the underlying tile.
- 4) The flashing should be at least 16 oz. sheet copper.

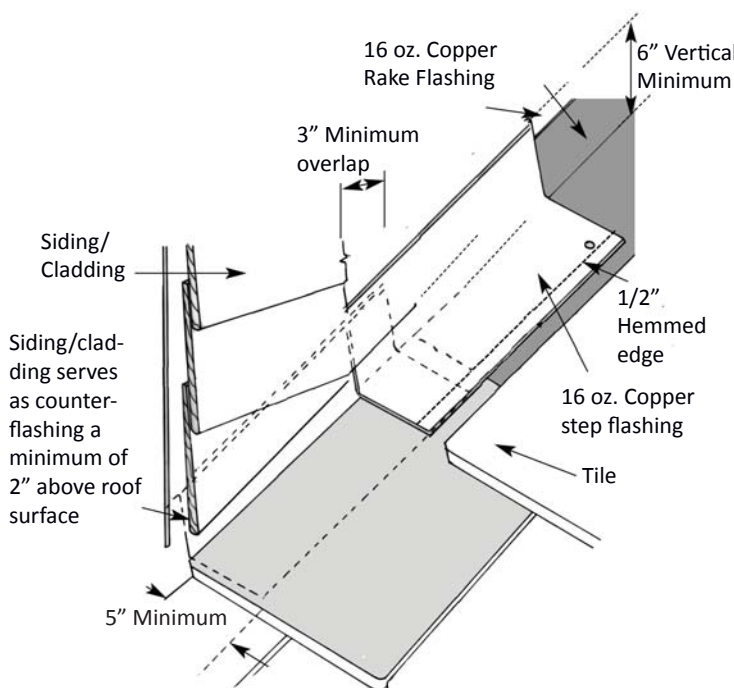


Figure 12.1 Side Wall Copper Step Flashing Detail

Continuous Pan Flashing

Continuous pan flashing is designed to extend under the tiles rather than being interwoven between courses. The following procedures are used to install Continuous Pan flashing:

- 1) Waterproof underlayment should extended 6" up the vertical wall.
- 2) The copper flashing's vertical flange should extend approximately 4" up the wall.
- 3) Each length of copper channel flashing should extend a minimum of 8" over the underlying length of copper channel flashing.
- 4) The copper flashing channel should extend a minimum 6" under the tile.
- 5) The copper flashing should be fastened through the vertical flange, near the upper portion at approximately 12" on center. (The flashing channel should not be penetrated with fasteners since it is acting as a gutter.)
- 6) The wall underlayment and the siding or cladding should be brought down a minimum of 2" over the upper portion of the vertical flange.

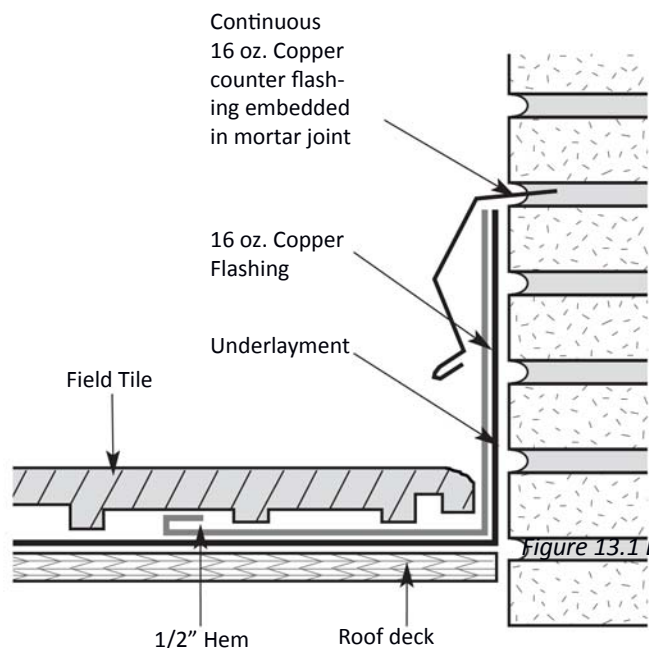


Figure 12.2 Side Wall Copper Pan Flashing Detail

Ridge Detail

It may be beneficial to layout ridge system on the stringer to determine lap (no less than 2"). This will prevent having to traverse the installed tiles later. Applying ridge tiles with the lap facing away from the prevailing winds helps the tile shed wind-driven rain. A flashing cement meeting the requirement of ASTM D-4586 must be used at the overlap of each ridge tile and where they rest on the field tile.

Chart 13.4 Ridge Angles

Roof Pitch	Degree
3:12 to 10:12	116°
11:12 to 20:1	90°

Chart 13.5 Ridge Stringer Heights

Roof Pitch	Stringer Height
4:12	1-1/4"
5:12	1"
6:12	13/16"
7:12	9-16"
8:12	3/8"
9:12	none req.
10:12	none req.
11:12	none req.
12:12	none req.

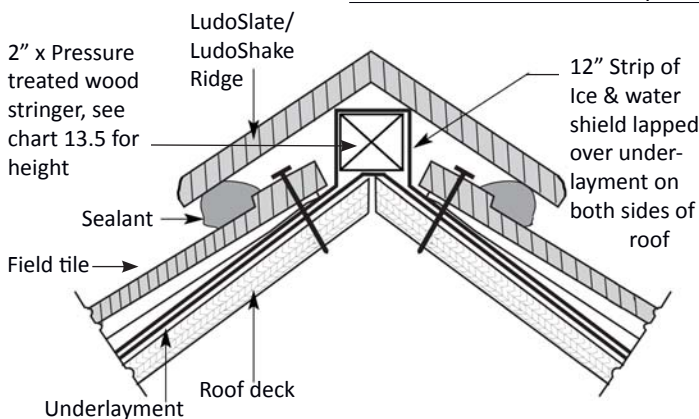


Figure 13.1 LudoSlate/LudoShake Ridge Detail

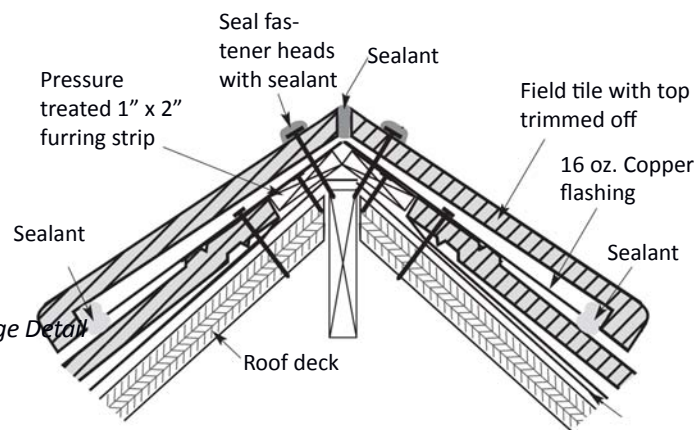


Figure 13.2 Mitered Ridge Detail

Hip Detail

Hips are started with a standard LudoSlate or LudoShake ridge or a V-Hip starter.

The Hip and Ridge is then installed by creating an approximate 3" head lap on the Hip Starter tile. This 3" head lap is continued up the hip and flashing cement is used at each hip tile overlap. The last fastener on the upslope end of the hip typically is covered with a V-Hip and Ridge Terminal which must be specified as a starter or finisher depending on the direction of the ridge layout. If this last fastener is not covered, it must be sealed with flashing cement meeting the requirements of ASTM D-4586. Some roof termination may require a combination of typical flashing details or a special tile piece. Consult the local Ludowici sales representative with the project's special roof requirements.

Chart 13.6 Hip Angles

Roof Pitch	Degree
3:12 to 18:12	116°

Chart 13.7 Hip Stringer Height

Roof Pitch	Stringer Height
4:12	2-1/4"
5:12	2-1/4"
6:12	2"
7:12	2"
8:12	1-3/4"
9:12	1-3/4"
10:12	1-1/2"
11:12	1-1/2"
12:12	1-1/2"
13:12	1-1/4"
14:12	1-1/4"

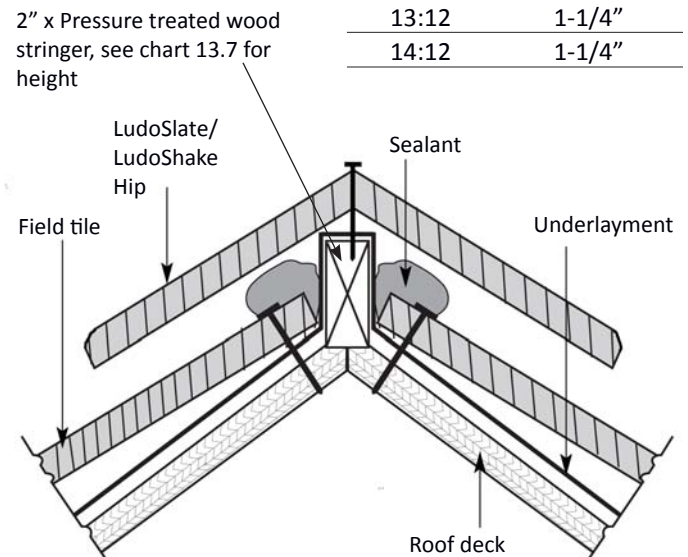


Figure 13.3 LudoSlate/LudoShake Hip Detail

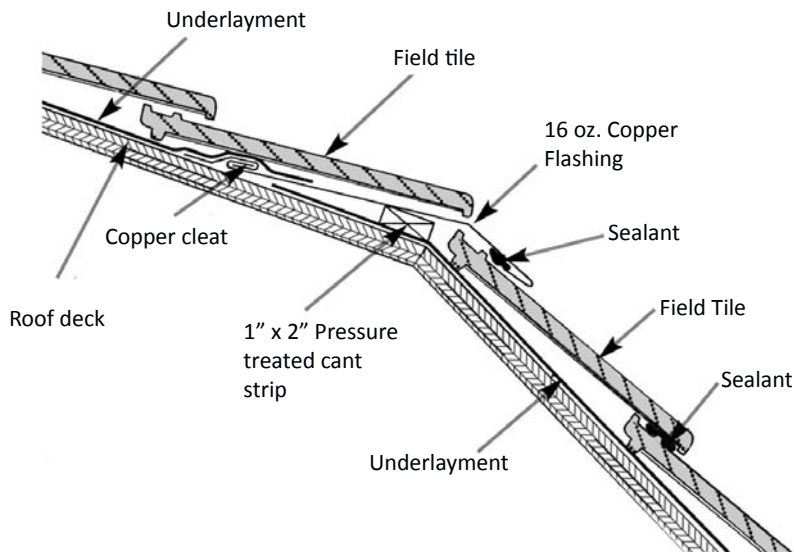


Figure 14.1 High Slope to Low Slope Detail

Flashing Dimensions

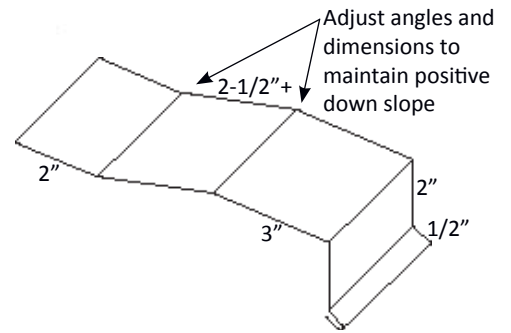


Figure 14.4 Eave Flashing Dimensions

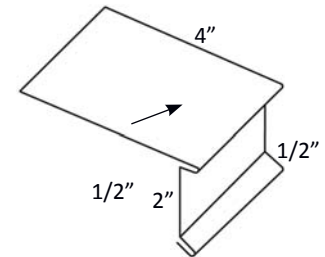


Figure 14.5 Eave Flashing with Under Eave Trim Dimensions

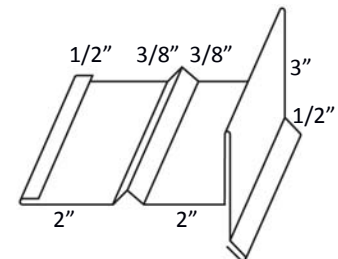


Figure 14.6 Rake Flashing Dimensions

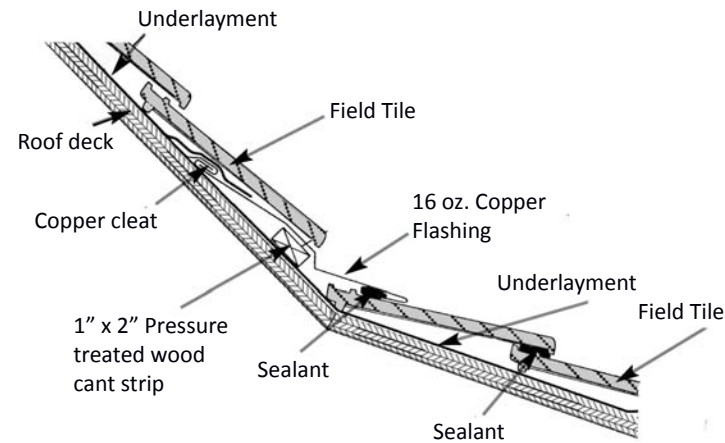


Figure 14.2 Low Slope to High Slope Flashing Detail

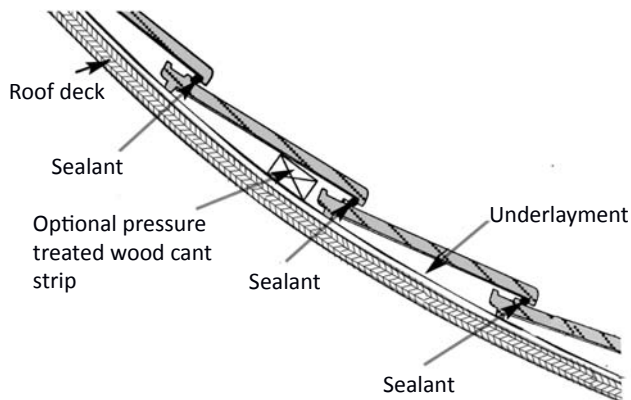


Figure 14.3 Curved Pitch Change Detail

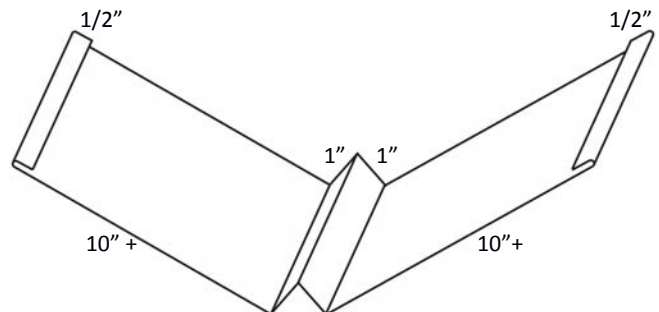


Figure 14.7 Valley Flashing Dimensions

Cutting, Notching, and Drilling

Cutting

Tiles should be cut wet on the job with a masonry or tile saw equipped with a diamond blade. Segmented blades will be the most efficient. Slight surface chipping will occur during the cutting operation. The sliding saw table and tub should be as large as possible to accommodate cutting the tiles diagonally.

Ludowici tiles are extremely hard, which provides the tiles with low moisture absorption. Dry cutting techniques used on softer tile products will not work as fast with these hard tile. Dry cutting with a good segmented "turbo" diamond blade is possible. Best results have been obtained using a 4" diamond tipped segmented blade mounted on a small right angle grinder motor.

Notching

One time saving option to drilling through the tiles is to notch it with the small 4" diamond blade saw and then nail or wire in place. If using a field tile for the starter course or ridge, "dovetail" notches are cut. Make sure cuts are wide enough for nail or screw.

Drilling

Additional nail holes may also be drilled if necessary. High torque electric drills may snap the carbide bits in the extremely hard Ludowici tile. Drills should be battery-powered, adjustable clutch-driven types. To drill out holes, the tile should be set in a pan with water to extend bit life and avoid the risk of eye injury due to fragments. Expect to drill only about 6 holes per carbide bit.

Storage, Handling, and Inspection

Field tile is generally shipped in pallets, and fittings in boxes. Upon receipt of shipment, the pallets and boxes should be examined for possible damage in transit and, if any, should be noted on the shipping papers and a claim must be filed promptly against the delivering carrier. Ludowici Roof Tile will provide information and assist you in the proper filing of a damage claim. Remember, however, that prompt inspection of incom-

ing merchandise is always important as damage claims will not be honored by the carriers if they are not filed promptly.

The pallets and boxes of tile should be placed in a level, safe place away from traffic and construction activity. Pallets of tile must not be stacked on top of each other.

If any problems are identified, notify Ludowici Roof Tile immediately. Do NOT install any of the tiles. Once the tiles are installed, they are considered suitable for use and will not be replaced except per the terms of Ludowici's warranty.

Repair LudoSlate/LudoShake with Quik-Tach brackets

Should a LudoSlate or LudoShake get broken during or following installation, it may be replaced with a Ludowici Quik-Tach Bracket.

- 1) Remove the broken tile including the fasteners.
- 2) Line up the Quik-Tach Bracket on the back of the replacement tile so that the bottom edge of the bracket lines up with the top of the tile below the replacement tile. Use copper wire to wire the bracket to the replacement tile.
- 3) Slide the replacement tile into place so that the Bracket engages with the top of the tile below.

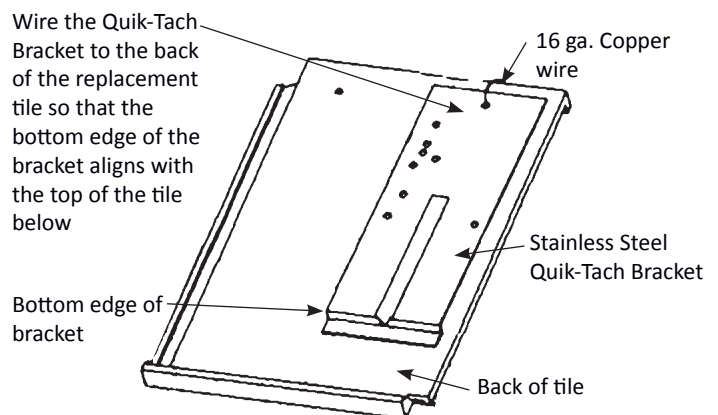


Figure 15.1 Quik-Tach Bracket Attachment