Concrete and Clay Roof Tile

JULY 2006 ICC ES ESR-2015 $10.00

Installation Manual for Moderate Climate Regions

Design Criteria

Imagine the Possibilities

Realize the Benefits

TILE ROOFING INSTITUTE

Western States Roofing Contractors Association

FOREWORD

The Tile Roofing Institute is the premier resource for technical information on the proper design and installation of concrete and clay roof tile systems. The Tile Roofing Institute in partnership with the Western States Roofing Contractors Association (WSRCA) assembled a task group in 1991 to develop a single installation manual that would provide a representation of the best installation practices, industry standards, and code requirements. These recommendations have provided successful installations of roof tile which have endured the test of time.

During the last year the TRI technical committee reviewed the existing manual and solicited valuable input from the entire roofing community. The culmination of those efforts has been the creation of the Second Edition of the Moderate Climate Guide.

As with the first edition, the TRI has submitted the manual for formal review and issuance of an ICC Evaluation report number to help provide a stronger foundation to the practices and recommendations included.

The Tile Roofing Institute offers additional installation manuals for the Cold Weather and High Wind tile applications. All of our publications can be ordered through the publication page on our website (www.tileroofing.org). The TRI will be offering formal installer training programs based upon this manual to allow roofing professionals to become certified tile installers.

TRI continues to provide the leading edge technology for roof innovations that will provide the highest quality, energy efficient roofing systems available in the market today. Tile roofing systems provide the most durable, energy efficient roofing systems found anywhere in the world.

Updates and Bulletins - The Tile Roofing Institute would like to make sure that we provide the latest information and updates available directly to you. If you would like to receive notices of any changes, updates, or provide comments on this manual please visit our website **www.tileroofing.org** or email us at **info@tileroofing.org** and ask to be placed on our email listing for future notices.

LIMITATIONS ON USE AND DISCLAIMER FOR THIS TRI/WSRCA INSTALLATION MANUAL

These drawings and recommendations are the compilation of the individual experiences of industry members and the Technical Committee of the TRI/WSRCA. It is intended to be used with the judgment and experience of professional personnel competent to evaluate the significance and limitations of the material contained and who will accept responsibility for its application. The TRI/WSRCA expressly disclaims any guarantees or warranties, expressed or implied, for anything described or illustrated herein; and assumes no responsibility for error or omissions.

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INTRODUCTION

These recommendations are meant for areas with moderate climates that may experience occasional storms. In locations where the January mean temperature is 25 deg. F (-4 deg C) or less or where ice damming can occur, the TRI /WSRCA suggests reference to the Concrete and Clay Tile Roof Design Criteria Manual for Cold and Snow Regions. While generally considered the minimum standard, proper adherence to these recommendations and attention to detail and workmanship provide a functional roof in all but the most severe conditions. Local building officials should be consulted for engineering criteria or other special requirements.

The manner in which tile roofs are installed makes them a highly effective water shedding assembly that affords years of service and protection. The effectiveness of a tile roof system as a weather resistant assembly however depends on the proper installation of all the tile roof components, and installing them properly is critical to the performance of the installed system.

Since tile is installed across a wide range of climatic and geographic conditions, there are a variety of details that must be considered in preparing an effective installation. The minimum recommendations shown for moderate regions are effective for a wide range of conditions including occasional heavy storms or snow. While it is not practical to prescribe precise solutions for all conditions, the following has been provided to offer suggestions for various treatments in a moderate climate application. Local building officials should always be consulted to learn of special requirements that may exist. Some of the changes contained will require code approval.

This manual provides the minimum design recommendations with optional upgrades for the installation of underlayment, flashings, fastening and related measures to provide a weather resistant roofing assembly for concrete and clay tile.

Designers should be familiar with local climatic conditions and make sure that they are reviewing the proper design manual. Please see the following list of reference publications for additional information.

TOOLS REQUIRED

Basic Hand Tools

Tape Measure	Crayon	Hammer
Tin Snips	Felt Knife	Nail Bag
Chalkline	Chalk	Pry Bar
Metal Crimper	Mortar Trowel	Mastic trowel
Caulking Gun	Hand Saw	Roller
Brush	Broom	

Specialty Tools & Equipment

Forklift	Conveyor	Tile Cutter
Ladder	Tile Nippers	

Power Tools

Drill	3/16” Masonry Bit	Screw Gun
Power Cords	Compressor w/ Hose	Nail Gun
Tile Saw	Diamond Saw Blade	

Safety & Personal Protective Equipment Per Federal & State OSHA Requirements

Eye Protection	Dust Mask	Gloves
Ear Protection	First Aid Kit	Hard Hat

Approved Fall Protection

SAFETY WARNING - TILE DUST

Roofing tiles contain crystalline silica (quartz) and traces of other hazardous substances which are released as dust and can be inhaled when dry-cutting or grinding this product.

WARNING: Crystalline silica is a substance known to cause cancer. Other chemicals contained in these products are know to cause cancer, birth defects and other reproductive harm. Please refer to Federal and State OSHA requirements for proper compliance.

REFERENCE PUBLICATIONS

Standard Installation Guides for Concrete and Clay Roof Tile in Cold Weather Applications. Published 1998 by the NTRMA/WSRCA

Concrete and Clay Roof Tile Installation Manual Third Edition (For Florida only) Published June 2001 by the FRSA/TRI

CAN/CSA-A220.1-M91 – Installation of Concrete Roof Tiles, Published May 1991 by the Canadian Standards Association

The European Standards Association, Australian Standards Association, Japanese Standards Association

TERMINOLOGY

Please see Appendix C for a listing of terms associated with roof tile.

GOVERNING CODE BODIES

Information contained herein is based on values and practices consistent with provisions of the major building codes such as the International Building Code (IBC), International Residential Code (IRC), as promulgated by the International Code Council (ICC). For ICC-ES evaluation reports for concrete and clay roof tiles that specifically reference this manual, installation shall be in accordance with this manual and the applicable code, unless otherwise noted in the ICC-ES roof tile evaluation report.

ENVIRONMENTAL STATEMENT

The members of the TRI/WSRCA are environmentally conscious companies who's policies and practices reflect a commitment to the preservation and welfare of our environment. Our roofing tiles are manufactured in accordance with all prevailing environmental guidelines and are composed of sand, cement, natural clay materials and natural pigments. Because roofing tile are designed to last long term, they will not add to the tremendous volume of other roofing materials that burden our landfills.

Specifications

SUGGESTED MATERIAL CHECKLIST

Decking: Sheathing must be adequate to support the loads involved, but not less than nominal 1-inch-thick lumber or nominal 15/32-inch-thick plywood or other decking material recognized in a code evaluation report or by the local building official.

Underlayment: ASTM D226 Type II (No. 30 felt) /ASTM D4869 Type IV.

Battens: Nominal 1" x 2" complying with IBC Chapter 23, section 2302.

Eave Treatments: Bird Stop/Eave riser.

Valley Flashing: No 26 Gauge (G90) Galv., 24" Flashing.

Wall Trays (Pans): No. 26 Gauge (G90), Galv., minimum 6" trough.

Roof To Wall: No. 26 Gauge, Galv. (G90) or flexible flashing to provide minimum 3" coverage.

Pipe Flashing: No. 26 Gauge, Galv. (G-90) Deck flashing installed with underlayment. Flat tile flashing – No 26 Ga. Galv. (G-90).
Profile tile flashing – 2 1/2 lb lead, dead soft aluminum or copper.

In wall Counter Flashing: No 26 Gauge, Galv. Z bar flashing recommended or surface mount reglet (pin) flashing for reroof.

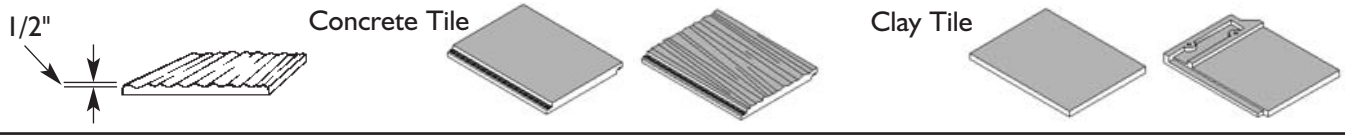
Fasteners: See page 5 and Table 1A/1B for requirements.

Ventilation: Per local building code requirements.

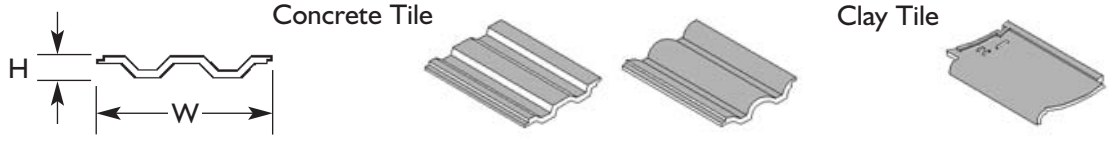
ROOF TILE CLASSIFICATIONS

Roof tiles manufactured are typically of the following types:

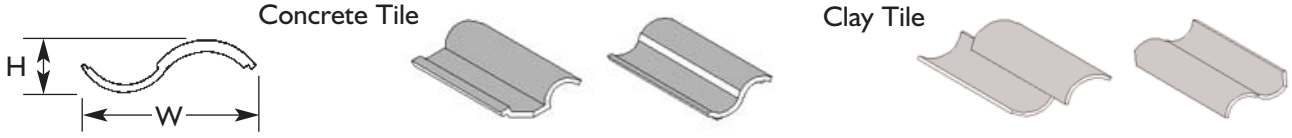
Low Profile Tile – Tiles, such as flat tile that have a top surface rise of ½" or less.



Medium Profile Tile – Tiles having a rise to width ratio equal to or less than 1:5



High Profile Tile – Tiles having a rise to width ratio greater than 1:5 (measured in installed condition)



Accessory Tile – Shall include those tile such as ridge, rake, hip, valley and starter tile used in conjunction with those tile listed above.

TILE SPECIFICATIONS/ RECOMMENDATIONS

Freeze Thaw – Different climatic conditions will result in the need for different roofing materials that will allow the success of the roofing system over the long-term. Resistance to freeze/thaw is very important in weathering situations where the roofing material is expected to withstand repetitive freezing and thawing cycles. Both Concrete and Clay Tile must have passed the requirements of ASTM C1492 (Concrete) ASTM C1167 (Clay) for freeze thaw regions.

Strength – A Concrete (ASTM C1492) or Clay tile's (ASTM C1167) transverse strength will meet or exceed requirements of the specified codes.

Thickness – Roof tile typically ranges in thickness from 3/8" to 1 1/2", depending upon composition, type and style.

Quantities of Tile Per Square – The size of the tile and the exposure of each course of tile determines the number of tile needed to cover one square (100 sq. ft.) of roof area. When the tile is installed at the manufacturer's maximum exposure, the number of tile needed to cover one square of roof area may range from 75 to over 400 pieces.

Tile Weight – The size of the tile and the exposure of each course will determine the installed weight of the roof tile. In general, the amount of tile to cover one square (100 sq ft.) set at the standard 3 inch head lap, will depend on the thickness, length, width, shape and aggregate materials used in the manufacturing process of the tile. Please consult with the tile manufacturer when determining the weight of the specific tile that will be used. As with any roofing material the designer should always consider the weight of the underlayment, fastening system, roof accessories and special hip/ridge treatments.

MATERIALS AND MANUFACTURE

Concrete Tile – Cementitious materials such as portland cement, blended hydraulic cements and fly ash, sand, raw or calcined natural pozzolans and aggregates shall conform to the following applicable ASTM specifications.

Concrete Tile ASTM C1492 Specifications:

Portland Cement – Specification C150 or Performance Specification C1157
Modified Portland Cement – Specification C90
Blended Cement – Specification C595
Pozzolans – Specification C618
Ground Granulated Blast Furnace Slag – Specification C989
Aggregates such as normal weight and lightweight shall conform to the following ASTM specifications; except that grading requirements do not apply.
Normal Weight Aggregates – Specification C33
Lightweight Aggregates – Specification C331

Clay Tile – Tiles are manufactured from clay, shale, or other similar naturally occurring earthly substances and subjected to heat treatment at elevated temperatures (firing). The heat treatment must develop a fired bond between the particulate constituents to provide the strength and durability requirements.

Clay Tile ASTM C1167 Specifications:

Terminology for structural clay products – C43
Test methods and sampling and testing brick and structural clay –C67
Test methods for tensile strength of flat sandwich construction in flat wise plane –C297
Test method for crazing resistance of fired glazed ceramic whitewares by thermal shock method – C 554

Additional Standards for Concrete & Clay Tile may be referenced in the following additional standards:

ASCE-7	Uniform Building Code
IBC/IRC	ICC-ES AC 152 Acceptance Criteria
Standard Building Code	CAN/CSA –A220.1-M91
ICC-ES AC180 Acceptance Criteria	

Adhesive – Bonding materials designed to stick tiles to tiles, or tiles to a substrate and can include mortar, synthetic mortar, mastics, silicones, polymers, Tri-polymers, or other materials approved by the local building official. Contact the adhesive manufacturer for additional information. Refer to current ICC-ES evaluation reports of roof tile adhesives for installation requirements and conditions of use.

Batten – A sawed strip of wood installed horizontally and parallel to the eave line which is mechanically attached to

the roof deck or rafters to engage the anchor lugs to prevent slippage of the roof tile. Battens of nominal 1"x2" lumber complying with IBC Chapter 23, section 2302 may be dimensionally increased in size to accommodate structural loads for snow or unsupported spans over counter battens or rafters. Battens may also be corrosion resistant metal, or other man-made material that meets the approval of the local building official. In dry/low humidity climates moisture resistant battens are not required. See Tables 1A and 1B on pages 9 and 10.

Battens installed over counter battens or which span over rafters commonly are of soft wood, spruce, pine, or fir type species but may be of any type of lumber, metal or man-made materials that meet the approval of the local building official. See table 2 on page 11.

Counter Battens – Additional set of battens installed vertically and parallel to the roof slope and mechanically attached to the roof deck under the batten. Counter battens are commonly nominal 3/8" lath but may be dimensionally increased in size to provide a greater flow of air or moisture beneath the horizontal battens. Counter battens do not need to be of moisture resistant lumber as they do not impede moisture flow. Counter battens may also be of corrosion resistant metal or other man-made materials that meet the approval of the local building official. See table 2 on page 11.

Note: If counter battens are installed under the underlayment, caution must be used to prevent damage to underlayment or reinforced underlayment shall be used.

Note: Care should be taken in selecting the proper batten design. Excessive deflection of the batten may lead to tile breakage. See table 2 on page 11.

Caulking and Sealant

Caulking and sealants shall be suitable for exterior use and be resistant to weathering. The caulking and sealants shall be compatible with and adhere to the materials to which they are applied.

Nails and Fastening Devices

Corrosion resistant meeting ASTM A641 Class 1 or approved corrosion resistance, of number 11 gauge diameter and of sufficient length to properly penetrate 3/4" into or through the thickness of the deck or batten, whichever is less.

The head of the nail used for tile fastening shall not be less than 5/16" (.3125") and complying with ASTM F 1667 for dimensional tolerances (+0%, -10%).

Nail Length:

Nailing of Batten

Nails for fastening battens shall have sufficient length to penetrate at least 3/4" into the roof frame or sheathing.

Nailing Tile to Batten and Direct Deck Systems

Nails for fastening roof tiles shall penetrate at least 3/4" into the batten or through the thickness of the deck, whichever is less. Once the batten is installed it becomes part of the deck for fastening purposes.

Nailing Tile to Battens on Counter Batten or Draped Underlayment Systems

Nails for fastening roof tiles shall penetrate at least 3/4" but should not penetrate the underlayment.

Nailing Accessories

Where nail(s) are required for fastening accessories, such nails shall have sufficient length to penetrate at least 3/4" into the supporting member.

Screws: Corrosion resistant meeting code approval equal of sufficient length to properly penetrate 3/4" into or through the thickness of the deck or batten, whichever is less. Screw diameter and head size should be selected to meet good roofing practices and the screw manufacturer's recommendations. *See above section on nail length for additional requirements.*

Staples for Battens: No 16 gage by 7/16 inch-crown by minimum 1 1/2 inch long corrosion-resistant staples.

Metal Flashing – Flashing shall be a minimum no. 26 ga, galvanized steel sheet of corrosion resistant metal with a minimum of .90 ounces of zinc/sq.ft. (total for both sides) (G90) sheet metal or equal or better.

Underlayment Materials

Single layer underlayments shall meet the minimum requirements of ASTM D226 Type II (No. 30 Felt) (ASTM D4869 Type IV), or approved equal.

GENERAL INFORMATION

Algae/Moss – In certain climatic regions of the country, the development of algae and moss can occur on any building material. Unlike other roofing materials, the formation of these items can easily be treated and does not deteriorate the roofing tile. The growth of moss and algae form on the dirt and moisture on the surface of the tile.

Algae – Like the moss, the algae can be easily removed through the use of pressure washers. Often times a very dilute amount of bleach can help kill the algae and slow down the re-occurrence. Again, this should be left to the professionals to perform.

Moss – In most cases the use of a high pressure cleaner will remove the presence of the moss that traditionally grows in the dirt/pine needles or other debris that accumulates on the edge of the tile. Note that you may wish to contact a professional to clean your roof, since roofs can be extremely dangerous to walk on.

Shading – Slight variations in sand, cement, and color oxides (natural products) can cause minimal color shading. This slight variance is not detectable through standard quality control practices. In order to minimize color patterning, stair stepping, or hot-spots, tile should be selected and spread over the entire roof plane when loading the tile on the roof.

Broken Tile Replacement – The broken tile is first removed, if battens were used originally, existing fasteners if any, are cut, removed, underlayment repaired and the new tile is inserted. If no battens were used, a 12" x 6" by ½" plywood piece is nailed to the deck to act as a batten. As an alternative, new tiles may be inserted using roofers mastic, hooks, wires or approved adhesives to form the bond at the head of the lap area. See page 63 (Tile Repair).

Efflorescence – Efflorescence is a temporary surface discoloration common to all concrete based roofing tile. It is a nuisance not only to the manufacturer, but also those involved in specification, installation, and usage. It is however, in no way detrimental to the overall quality, structural integrity, or functionality of the tile.

Efflorescence is mostly caused by the chemical nature of the cement. Manufactured cement contains free lime, and when water is added, a series of chemical reactions take place. These reactions are accompanied by the release of calcium hydroxide which can form a white chalky crystalline salt deposit on the tile surface when reacting with carbon dioxide. This reaction can appear as an overall "bloom" (overall softening of color) or in more concentrated patches.

It is difficult to predict how long the effects of efflorescence will last. It depends on the type and amount of deposit as well as the local weather conditions. The action of carbon dioxide and rain water will gradually, in most cases, remove the deposit leaving the original color of the concrete roof tile intact without further efflorescence.

Walkability – The inert nature of tile, its characteristics of strength over age, and its durability, all will contribute to a life expectancy for tile equivalent to the anticipated life of the structure. With a good installation and reasonable precautions against severe roof traffic, a tiled roof system will require very low maintenance. Walking on a roofing tile should be done with extreme caution. Place antennas and roof mounted equipment where a minimum of roof traffic will be necessary for servicing and maintenance. If necessary to walk on the tile surfaces, pressure should only be applied on the headlap of the tile units (lower 3-4 inches). This distributes the load near the bearing points of the tile. When painting or repairing adjoining walls or appurtenances, safely cover the tile surface with secured plywood to distribute traffic loads and prevent dirt, building materials, and paint/stain from damaging or discoloring the tile.

Weather Effects On Tile – After constant exposure to nature's elements some tile can be expected to lighten to a slight degree from the original color or lose some surface texture. This is due primarily to the effects of oxidation on the surface of the tile. This will not effect the structural integrity or water shedding abilities of the tile.

Vermin Screening – Metal, honeycomb plastic, foam fillers, mortar or equivalent should be considered to seal larger access areas. This will help minimize the access of birds and vermin infiltration.

NEW CONSTRUCTION

See Tables 1A, 1B and 3 for specific code related installation requirements.

Sheathing – Sheathing must be structurally adequate to support the loads involved and of a material recognized in a code evaluation report or as approved by the local building official.

Underlayment – One layer of minimum ASTM D226 Type II (No. 30 felt) (ASTM D4869 Type IV) or approved equal, with a recognized code evaluation report, shall completely cover the decking and be lapped over hips and ridges and through valleys. Underlayment shall be lapped 6" vertical (end or side lap) and 2" horizontally (head lap).

On roof slopes below 3:12 an approved built-up roof, applied in accordance with Table 1, or a single-ply roof membrane assembly, or other underlayment systems approved by the local building official, is first installed. Tile installed at less than 3:12 shall be considered decorative.

Where roof slopes fall between 3:12 and under 4:12, underlayment will be as described in the previous paragraph, or a single layer, type 90 granular-surfaced, asphalt roll roofing, or two layers of ASTM D226 Type II (No. 30 felt) (ASTM D4869 Type IV), installed shingle fashion, or single-ply system installed per code, or other approved underlayments.

In locations where the January mean temperature is 25 deg. F (-4 deg C) or less or where ice damming can occur, the TRI/WSRCA suggests reference to the Concrete and Clay Tile Roof Design Criteria Manual for Cold and Snow Regions.

Roof Layout – To achieve the optimum performance and appearance, the roof area between the eave and ridge should be divided into equal tile courses, when possible. A minimum 3-inch overlap must be maintained for all tile, unless the tile design precludes. The actual layout of the roof courses will be determined by the length of the specific tile being installed. Medium profiled tiles can be installed either straight or staggered bond.

Please consult with the individual manufacturer for additional information.

Batten Installation – Tiles with projecting anchor lugs that are installed on battens below 3:12 slopes shall be required to have one of the following batten systems or other methods as approved by the local building officials.

Nominal 1 inch by 2 inch, or greater, wood batten strips (See counter batten system.) installed over a counter batten system are required where slopes fall below 3:12 in order to minimize membrane penetration. Nominal 1 inch by 2 inch, or greater, wood battens are required where slopes exceed 7:12, to provide positive tile anchoring. Battens are nailed to the deck with 8D corrosion resistant box nails 24 inches on center, or No 16 gauge by 7/16 inch-crown by 1 1/2 inch long corrosion-resistant staples on 12-inch centers, allowing a 1/2" separation at the batten ends. Tile installed on roof slopes of less than 3:12 are considered decorative only and must be applied on counter battens over an approved roof covering, subject to local building official approval.

Battens installed on roof slopes of 4:12 to 24:12 shall be fastened to the deck at no greater than 24 inches on center, and shall have provisions for drainage by providing ½-inch separation at the batten ends every 4 feet, or by shimming with a minimum 1/4" material of wood lath strips, 2-inch shims, cut from multiple layers of material, placed between the battens and deck to provide drainage beneath the battens or other methods approved by the local building official. Tile installed without projecting anchor lugs may be installed as provided above as an optional method of installation.

Counter Batten System – Counter battens 1/4" and larger in height will be installed vertically on the roof to provide the space between the battens, to which the tiles are attached, and the roof deck, thus facilitating air flow capability and moisture drainage.

Taking the anticipated roof loading into account, design consideration should be given to the size and quality of the wooden battens or sheathing boards used to support the roof tile covering.

If the battens are not strong enough to support the anticipated loading, including the roof tile and snow and/or ice, the battens could deflect between the support points

causing roof tile breakage and/or other roof damage. Knots and knot holes weaken the batten. See Table 2 on page 11.

Note: If a counter batten system is to be installed under the underlayment, caution must be used to prevent damage to the underlayment or a reinforced underlayment will be used.

REROOFING

Roof structure will be adequate to support the anticipated roof load of tile.

Clay and concrete roofing tiles, recognized as a Class A roof assembly passing testing according to ASTM E 108, UL 790 or recognized in accordance with IBC section 1505.2, will be allowed installed over existing asphalt shingles, plywood or OSB.

Care will be taken to ensure both horizontal and vertical alignment on the roof.

Foreign matter will be cleaned from all interlocking areas. Cracked or broken tile must be removed from the roof.

Damaged, rusted, improper flashing will be replaced.

When reroofing wood shake/shingle roofs, existing shakes/shingles shall be removed and solid decking, tile, and flashings installed as with new construction. One layer of ASTM D226 Type II (No. 30) (ASTM D4869 Type IV) felt or approved equal underlayment shall be installed on the roof prior to application of tile. When installed over existing spaced sheathing boards, underlayment recognized by the local building code, for this type of application with, or without battens, will be used.

In lieu of such underlayment's being provided, the building official has the discretion to determine if the existing roof covering provides the required underlayment protection.

Check with local building official for any additional requirements.

Follow installation requirements as listed for new construction, once these items listed have been addressed.

VENTILATION GUIDELINES

The need for proper attic ventilation is required by most building code authorities, in accordance with the IBC and IRC. These codes recognize that the proper ventilation is a necessary component of any successful steep slope roof system.

Generally building codes require that a minimum net free ventilating area for attic vents be a 1:150 ratio of the attic space being ventilated, the codes generally allow for the reduction of the ratio from 1:150 to 1:300 if the attic vents are a balanced system on a roof and/or a vapor retarder is installed on a ceiling assembly's warm side. Check with local building official for regional requirements.

TABLE 1A

ROOFING TILE APPLICATION[1] FOR ALL TILES

	ROOF SLOPE 2 ½ UNITS VERTICAL IN 12 UNITS HORIZONTAL (21% Slope) TO LESS THAN 3 UNITS VERTICAL IN 12 UNITS	ROOF SLOPE 3 UNITS VERTICAL IN 12 UNITS HORIZONTAL (25% Slope) AND OVER
Deck Requirements	Sheathing must be adequate to support the loads involved, but not less than nominal 1-inch thick lumber or 15/32 inch thick plywood or other decking material recognized in a code evaluation report or by the local building official. The use of sheathing less than 15/32-inch will require supporting data.	
Underlayment In climate areas subject to wind driven snow, roof ice damming or special wind regions as shown in UBC Chapter 16, Figure 16-1 as defined by local building official.	Built-up roofing membrane, three plies minimum, applied per building code requirements or code approved alternate.	Same as for other climate areas, except that extending from the eaves up the roof to a line 24" inside the exterior wall line of the building, two layers of underlayment shall be applied shingle fashion and solidly cemented together with an approved cementing material per UBC. As an option code approved self adhering membrane will be allowed.
Other Climates		Minimum one layer ASTM D226 Type II (No.30 Felt) (ASTM D4869 Type IV) head lapped 2 inches and end lapped 6 inches, or approved equal per UBC. For roof slopes of 3:12 to <4:12, two (2) layers of felt are required per IBC and IRC.
Attachment [2] Type of Fasteners	Fasteners shall comply with IRC section R905.3.6 and IBC section 1507.3.6 and UBC Section 1507.3. Corrosion resistant meeting ASTM A641Class 1 or approved equal, number 11 gauge diameter and of sufficient length to properly penetrate ¾" into or through the thickness of the deck or batten [2], whichever is less. The head of the nail used for tile fastening shall not be less than 5/16 inches and shall comply with ASTM F1667 for dimensional tolerances. Other fastening systems such as screws, wire, or adhesive based systems as approved by code, or local building officials will be allowed.	
Number of fasteners [1,2]	One fastener per tile. Flat Tile without vertical laps, two fasteners per tile. Tiles installed with projecting anchor lugs will be installed on counter battens, or other code approved methods.	Two fasteners per tile. Only one fastener on slopes of 7 units vertical in 12 units horizontal (58.3% slope) and less for tiles with installed weight exceeding 7.5 pounds per square foot, having a width no greater than 16 inches. [3]
Field Tile Head Lap	3 inches minimum, unless design restricts	
Flashing	Shall be a minimum of No 26 ga, galvanized steel sheet of corrosion resistant metal with a minimum of 0.90 ounces of zinc/sq.ft. (total for both sides) G90 sheet metal or equal.	

[1] For jurisdictions enforcing the:

IBC: In snow areas, a minimum of two fasteners per tile are required or battens with one fastener.

IRC: In snow areas, a minimum of two fasteners per tile are required.

UBC: In snow areas, a minimum of two fasteners per tile are required, or interlocking tiles with anchor lugs engaged on battens with one fastener.

[2] In areas designated by the local building official as being subject to repeated wind velocities to an excess of 80 miles per hour "basic (fastest mile) wind speed" per the UBC; 100 miles per hour "basic (3 second gust) wind speed" per the IBC and the IRC or where mean roof height exceeds 40 feet above grade, all tiles shall be attached as follows;

[2.1] The head of all tiles shall be fastened.

[2.2] The noses of all eave course tiles shall be fastened with clips, or other methods of attachment as approved by building code officials.

[2.3] All rake tiles shall be secured with two fasteners when required by IBC table 1507.3.7 and IRC section R905.3.7.

[2.4] The noses of all ridge, hip and rake tiles will be set in a bead of approved roofers mastic.

[2.5] Other methods of tile fastening will be allowed based upon submission of testing and approval of building code officials.

[2.6] For jurisdiction enforcing IBC and IRC, see appendix B for design considerations for high wind applications.

[3] On roof slopes over 24 units vertical in 12 units horizontal (200% slope), the nose end of all tiles shall be securely fastened.

TABLE 1B

ROOFING TILE APPLICATION FOR CONCRETE AND CLAY TILES WITH PROJECTING ANCHOR LUGS WHEN INSTALLED ON ROOF SLOPES OF 4 UNITS VERTICAL IN 12 UNITS HORIZONTAL (33% Slope) AND GREATER

	4 UNITS VERTICAL IN 12 UNITS HORIZONTAL (33% Slope) and over
Deck Requirements	Sheathing must be adequate to support the loads involved, but not less than nominal 1-inch thick lumber or 15/32- inch thick plywood or other decking material recognized in a code evaluation report or by the local building official. The use of sheathing less than 15/32- inch will require supporting data.
Underlayment In climate areas subject to wind driven snow, roof ice damming or wind regions as defined by local building codes	Solid sheathing one layer of ASTM D226 Type II (No. 30) (ASTM D4869 Type IV), or approved equal, lapped 2 inches horizontally and 6 inches vertically, except that extending from the eaves up the roof to a line 24 inches inside the exterior wall line of the building, two layers of the underlayment shall be applied shingle fashion and solidly cemented together with approved cemented material. As an option a code approved self adhering membrane may be used.
Underlayment for Other Climates	For spaced sheathing, approved reinforced membrane. For solid sheathing, a minimum single layer ASTM D226 Type II (No 30) (ASTM D4869 Type IV), or approved equal, felt lapped 2 inches horizontally and 6 inches vertically.
Attachment[1] Type of Fasteners	Fasteners shall comply with IRC section R905.3.6 and IBC section 1507.3.6 and UBC Section 1507.3 and shall comply with ASTM F1667 for tolerances. Corrosion resistant meeting ASTM A641 Class 1 or approved equal, or number 11 gauge diameter and of sufficient length to properly penetrate ¾" into or through the thickness of the deck or batten [2], whichever is less. The head of the nail used for tile fastening will not be less than 5/16 inches and shall comply with ASTM F1667 for tolerances. Other fastening systems such as screws, wire or adhesive based systems as approved by code, or local building officials will be allowed. Horizontal battens are required on solid sheathing for slopes greater than 7 units vertical in 12 units horizontal (58.3% Slope).[1,2]
Number of fasteners Spaced/Solid sheathing With Battens or spaced sheathing [3]	5 units vertical in 12 units horizontal and below (42% slope), fasteners not required. Above 5 units vertical in 12 units horizontal (42% slope) to less than 12 units vertical in 12 units horizontal (100% slope), one fastener per tile every other row or every other tile in each course. Twelve units vertical in 12 units horizontal (100% Slope) to 24 units vertical in 12 units horizontal (200% slope), one fastener every tile[4]. All perimeter tiles require one fastener[5]. Tiles with installed weight less than 9 pounds per square foot require a minimum of one fastener per tile regardless of roof slope.
Solid sheathing without battens [3]	One fastener per tile
Field Tile Head Lap	3 inches minimum
Flashing	Shall be a minimum of No 26 ga, galvanized steel sheet of corrosion resistant metal with a minimum of 0.90 ounces of zinc/sq.ft. (total for both sides) G90 sheet metal or equal.

[1] For jurisdictions enforcing the:

IBC: In snow areas, a minimum of two fasteners per tile are required or battens with one fastener.

IRC: In snow areas, a minimum of two fasteners per tile are required.

UBC: In snow areas, a minimum of two fasteners per tile are required, or interlocking tiles with anchor lugs engaged on battens with one fastener.

All tiles shall be attached as follows:

[1.1] The heads of all tiles shall be fastened.

[1.2] The noses of all eave course tiles shall be fastened with clips, or other methods of attachment as approved by building code officials.

[1.3] All rake tiles shall be secured with two fasteners when required by IBC table 1507.3.7 and IRC section R905.3.7.

[1.4] The noses of all ridge, hip and rake tiles shall be set in a bead of approved roofers mastic.

[1.5] Other methods of tile fastening will be allowed based upon submission of testing and approval of building code officials.

[1.6] For jurisdiction enforcing IBC and IRC, see appendix B for design considerations for high wind applications.

[2] Battens shall not be less than nominal 1-inch by 2-inch complying with IBC Chapter 23, section 2302. Provisions shall be made for drainage beneath battens by a minimum ¼-inch riser at each nail or by 4 foot long battens with at least ½-inch separation between battens or other methods approved by local building officials. Battens shall be fastened with approved fasteners spaced at not more than 24 inches on center.

[3] In snow areas a minimum of two fasteners per tile are required, or battens and one fastener.

[4] On roof slopes over 24 units vertical in 12 units horizontal (200% slope), the nose end of all tiles shall be securely fastened.

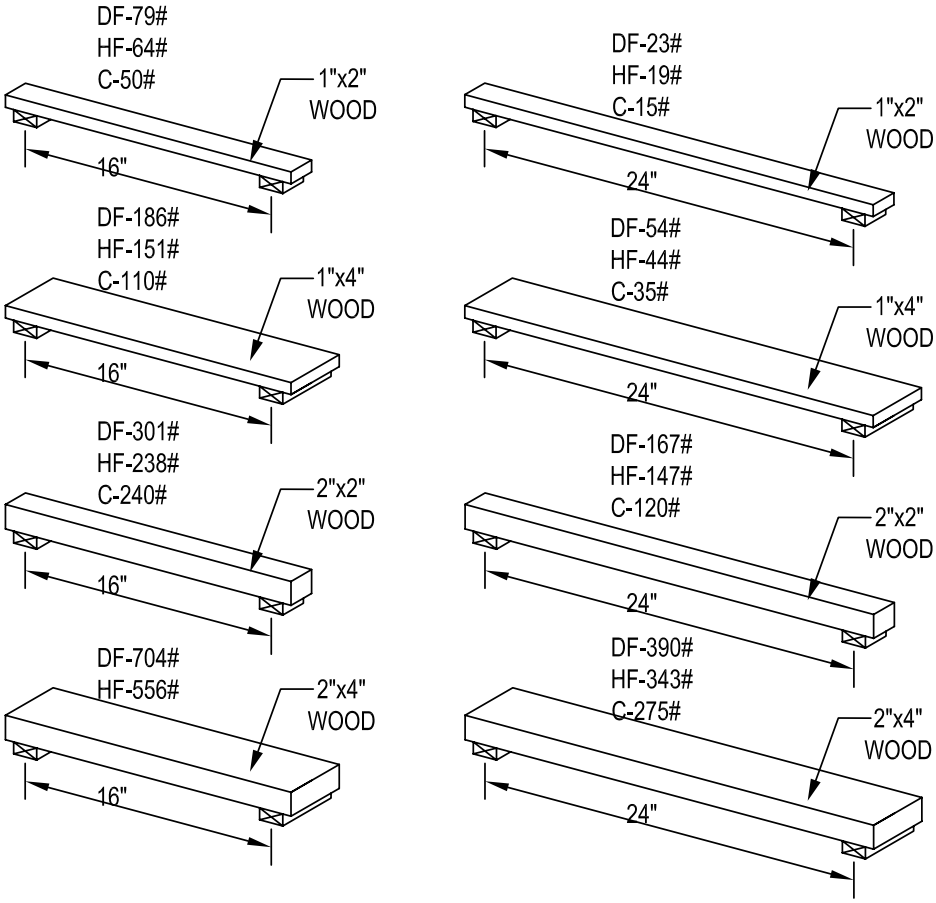
[5] Perimeter fastening areas include three tile courses but not less than 36 inches from either side of hips or ridges and edges of eaves and gable rakes.

TABLE 2
Allowable Loads

11

Batten and counter batten allowable loads according to species and dimensions

(Allowable load includes the total combined live and dead load)



Note: Allowable loads in pounds per square foot for No. 2 Grade horizontal batten boards. HF=Hem-Fir; DF=Douglas-Fir; C=Western Cedar (spaced at 1'-0" maximum on center). Above values were based upon rated boards.)

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

TABLE 3
GUIDELINES FOR BATTENS

ROOF SLOPE	STANDARD REQUIREMENT(S)	OPTIONAL UPGRADE(S)
2 1/2 / 12 (21%) TO LESS THAN 3/12 (25%)	**Counter Batten System** Refer to Counter Battens (page 5), Counter Batten Systems (Page 6) & MC-05 / MC-06A / MC-06B	**Alternates:** Corrosive resistant metal, or other man-made material that meets the allowable loads (see Table 2), or approval of the local building official.
3/12 (25%) TO 7/12 (58.3%)	**Not Required**	**Nominal* 1" x 2" x 4' or less** (min 1/2" separation between battens)
		Nominal* 1" x 2" x greater than 4' (Provision for drainage beneath batten with min 1/4" thick decay-resistant riser at each fastener)
		Counter Batten Refer to Counter Battens (page 5), Counter Batten Systems (Page 6) & MC-05 / MC-06A / MC-06B
		Alternates: Corrosive resistant metal, or other man-made material that meets the approval of the local building official.
GREATER THAN 7/12 (58.3%)	**Nominal* 1" x 2" x 4'** (min 1/2" separation between battens	**Counter Batten** Refer to Counter Battens (page 5), Counter Batten Systems (Page 6) & MC-05 / MC-06A / MC-06B
	Nominal* 1" x 2" x 8' (Provision for drainage beneath batten with min 1/4" thick decay-resistant riser at each fastener)	**Alternates:** Corrosive resistant metal, or other man-made material that meets the approval of the local building official.

Nominal:* Refer to IBC, Chapter 23 (WOOD), SECTION 2302 (DEFINITIONS).

Climactic Conditions: In dry/low humidity climates, moisture resistant battens are not required. Consideration should be given to lower slope roofs that are susceptable to wind driven snow and rain. Optional upgrades should be considerd.

Allowable Loads: When using counter battens, refer to Table 2 for allowable load considerations.

Batten Fastening: 24" OC to the deck with 8d corrosive resistant nails.
12" OC to the deck with No 16 gauge by 7/16-inch crown by 1 1/2-inch long corrosive-resistant staples.
Once the batten is installed, it becomes part of the deck for fastening purposes.

TABLE 4

ROOF SLOPE CONVERSION

Slope/Pitch	Slope %	Ratio	Angle (deg.)
4:12	33	1:3	18.4
5:12	42	1:2.4	22.6
6:12	50	1:2	26.6
7:12	58	1:1.7	30.3
8:12	67	1:1.5	33.7
9:12	75	1:1.13	36.9
10:12	83	1:1.2	39.8
12:12	100	1:1	45.0
14:12	117	1.2:1	50.2
15:12	125	1.25:1	51.3
16:12	133	1.3:1	52.4
18:12	150	1.5:1	56.3
20:12	167	1.7:1	59.5
24:12	200	2:1	63.4
28:12	233	2.3:1	66.5
32:12	267	2.7:1	69.7
36:12	300	3:1	71.6
40:12	333	3.3:1	73.1
44:12	367	3.7:1	74.9
48:12	400	4:1	76.0

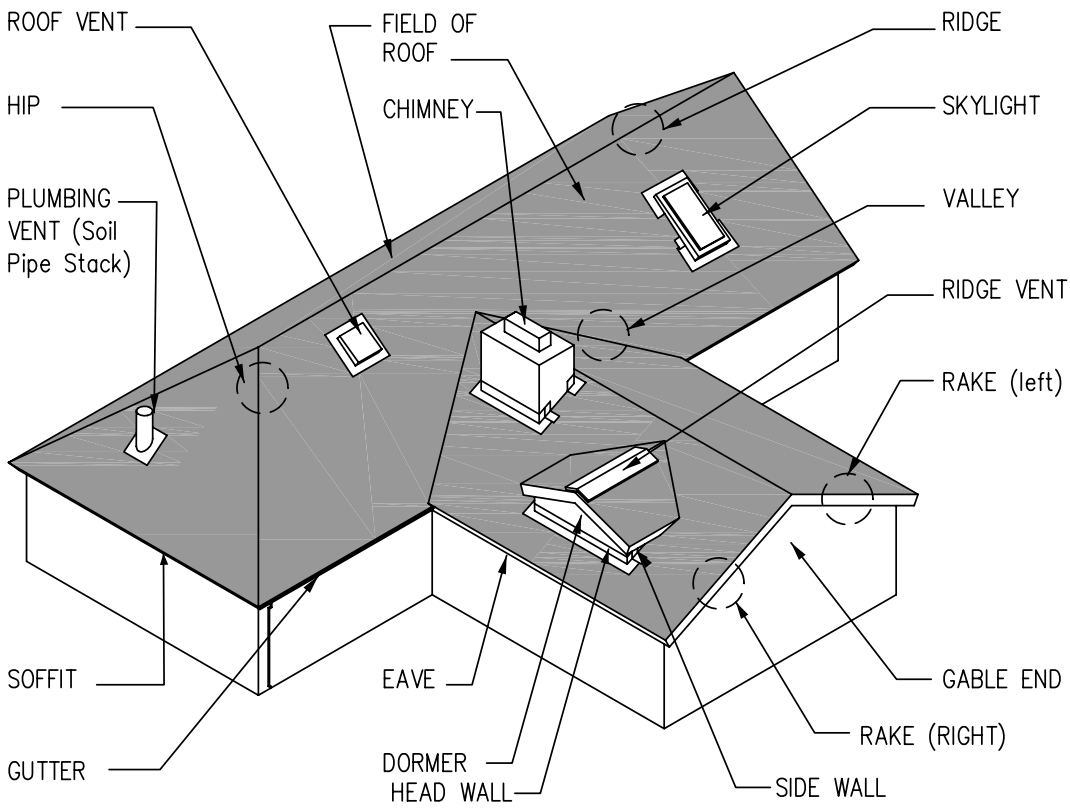
TABLE 5

METRIC CONVERSION

1 inch ..... 25.4 mm	°F ..... 1.8 x °C + 32
1 foot ..... 304.8 mm	1 pound (mass)/sq. ft. ..... 4.88 kg/m^2
1 sq. inch ..... 645.2 mm^2	1 yd^3 ..... 0.765 m^3
1 sq. foot ..... 0.0929 m^2	1 inch of water ..... 248.8 Pa
1 pound (mass) ..... 0.453 kg	1 inch of mercury ..... 3377 Pa
1 pound/ft. ..... 14.594 N/m	1 mph ..... 1.61 km/h
1 pound/sq. in. ..... 6894 Pascals (1 pa-N/m^2)	1 gallon ..... 3.785 liters
1 pound/sq. ft. ..... 47.88 Pascals	1 square (100 sq. ft.) ..... 9.28 m^2

IDENTIFICATION OF ROOF AREAS

MC-01

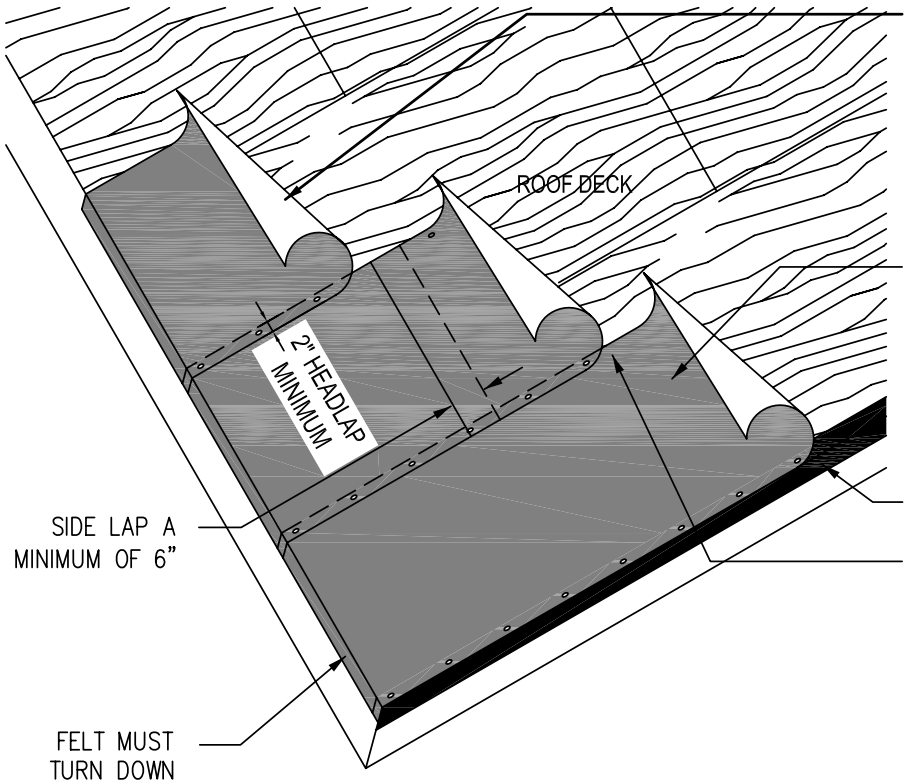


CHIMNEY: A penetration constructed of stone, masonry, prefabricated metal, or a wood frame chase, containing one or more flues, projecting through and above the roof.
DORMER: A frame projection through the sloping plane of a roof.
EAVE: A projecting edge of a roof that extends beyond the supporting wall.
FIELD OF ROOF: The central or main portion of a roof, excluding the perimeter and flashings.
GABLE: A triangular portion of the endwall of a building directly under the sloping roof and the eave line.
GUTTER: A channeled component installed along the downslope perimeter of a roof to the drain leaders or downspouts.
HIP: The inclined external angle formed by the intersection of two sloping roof planes.
HEAD WALL: Flashing installed at a horizontal roof to wall.
RAKE: The sloped edge of a roof at or adjacent to the first rafter or truss.
RIDGE: The highest point of a roof, represented by a horizontal line where two roof areas intersect, running the length of the area.
ROOF VENT: A penetration through the roof to allow ventilation.
SKYLIGHT: A roof accessory, set over an opening in the roof, designed to admit light, normally transparent, and mounted on a raised frame curb.
SOFFIT: The underside of any exterior overhanging section of the roof eave.
SOIL PIPE STACK: A sanitation pipe that penetrates the roof; used to vent plumbing fixture(s).
VALLEY: The internal angle formed by the intersection of two sloping roof planes.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SINGLE-LAYER UNDERLAYMENT

MC-01A



SUCCEEDING COURSES OF ASPHALT–IMPREGNATED FELT UNDERLAYMENT OR OTHER APPROVED MATERIAL WITH MINIMUM 2" HEADLAP AS APPROVED BY LOCAL BUILDING CODES

UNDERLAYMENT FASTENED TO RESIST WIND DAMAGE

FASTENING METHODS MAY BE USED AS APPROVED BY LOCAL BUILDING OFFICIALS.

DRIP EDGE

SIDE LAP A MINIMUM OF 6"

FASTENERS NOT DRIVEN FLUSH TO ROOFING FELT. ANY OTHER PUNCTURE AND/OR TEAR IN THE FELT MUST BE SEALED WITH MEMBRANE COMPATIBLE SEALANT OR ADDITIONAL UNDERLAYMENT

FELT MUST TURN DOWN OVER RAKE EDGE A MINIMUM OF 1"

Note:
On roof slopes from 2½:12 to below 3:12 an approved built–up roof, applied in accordance with Table 1A, or a single ply roof membrane assembly, or other underlayment systems approved by the local building official.

ICE DAM PROTECTION WHERE REQUIRED. SEE TABLES 1A & 1B

Notes:

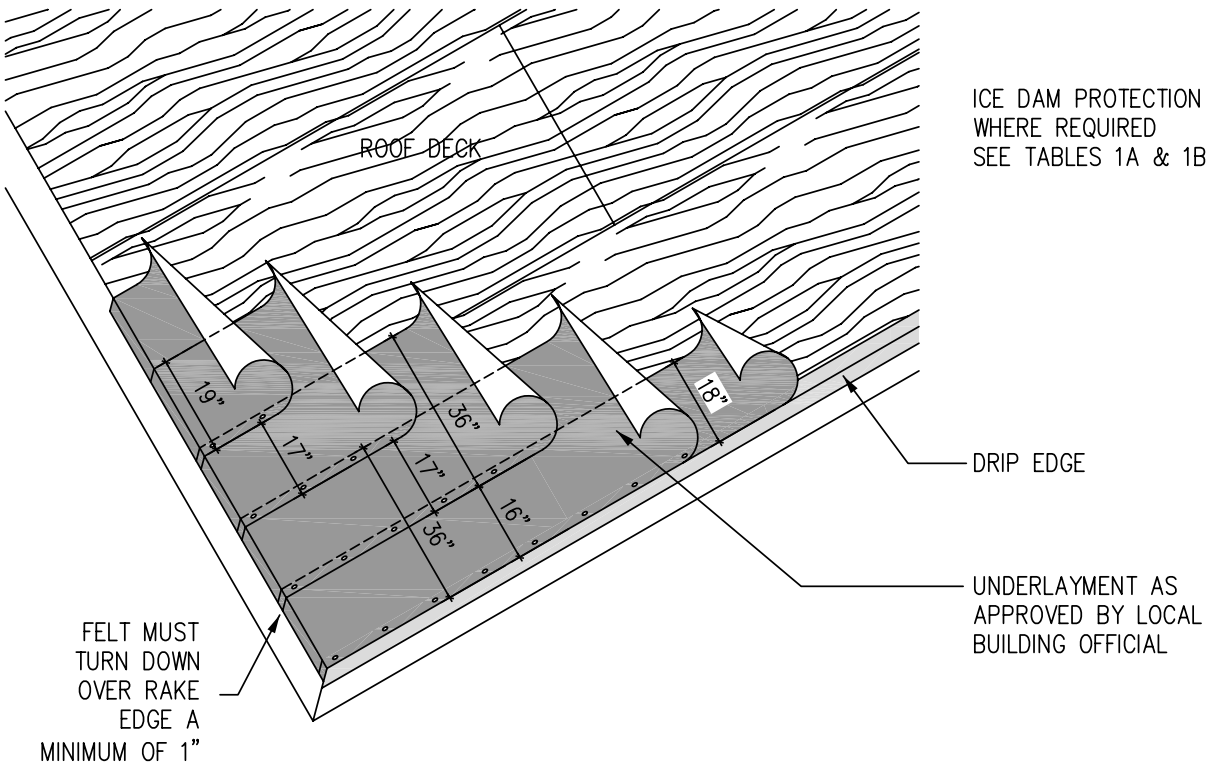
1. Ensure that the roof deck is properly fastened, clean and smooth before underlayment and roof tiles are applied.
2. Verify that the roof deck has no significant delamination, warpage, bowing, or separation from the rafters or trusses. Check for roof deck rot or damage.
3. Make sure repairs are made to the roof deck as necessary to meet local building codes.
4. Most problems with water-shedding roof installations occur from water that migrates through improper flashing of the tile, wind-driven rain or ice damming. Because of this possibility, the underlayment is critical to the success of the roof system.
5. One layer of Type II (No. 30) asphalt-saturated felt complying with ASTM D-226 Type II (ASTM-D4869 Type IV) is required as a minimum underlayment on all tile roof applications. Other underlayments may be used as approved by local building officials.
6. Underlayment should extend a minimum of 4" up vertical wood blocking or wall. Laps should be a minimum of 6" vertical lap and 2" horizontal

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

DOUBLE LAYER UNDERLAYMENT

(Required for 2½:12 < 4:12, Optional Upgrade Above 4:12)

MC-01B



DRAWING DEPICTS TYPICAL 36" WIDE ROLLS LAPPED 19"

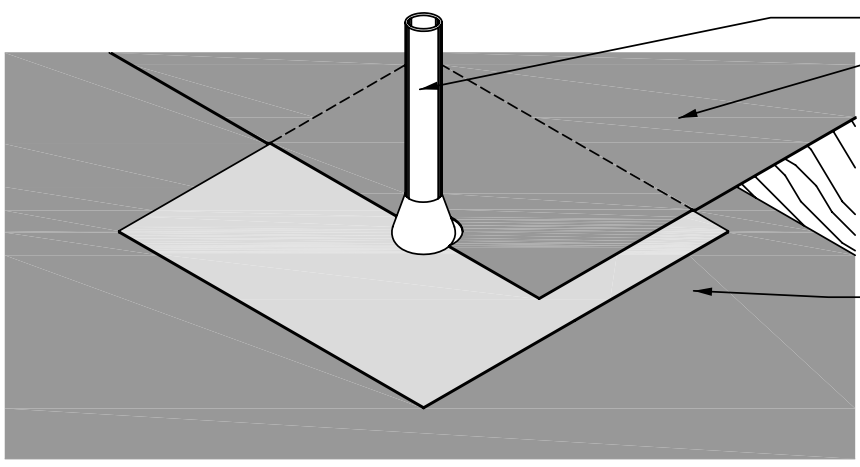
Notes:

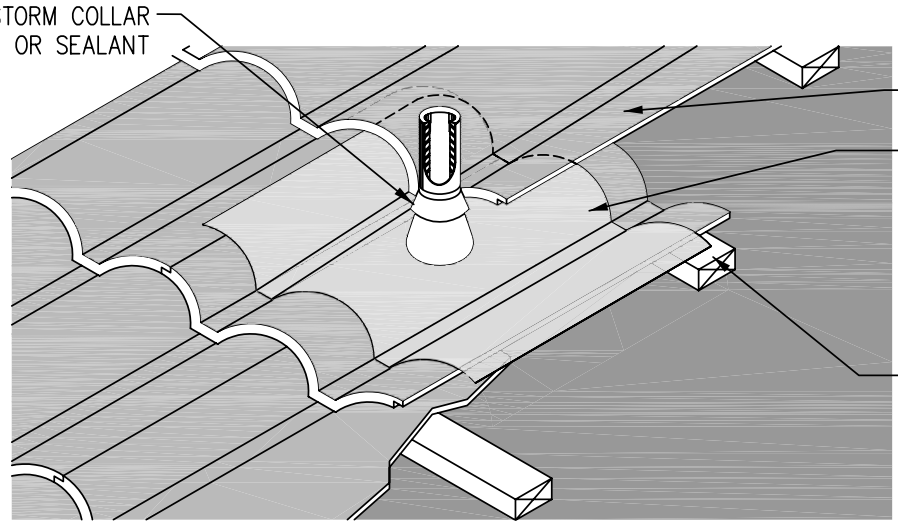
1. Ensure that the roof deck is properly fastened, clean and smooth before underlayment and roof tiles are applied.
2. Verify that the roof deck has no significant delamination, warpage, bowing, or separation from the rafters or trusses. Check for roof deck rot or damage.
3. Make sure repairs are made to the roof deck as necessary to meet local building codes.
4. Apply a half sheet parallel to eave. Fasten underlayment sufficient to hold the felt in place.
5. Completely cover the starter sheet with a full-width sheet.
6. Most problems with water-shedding roof installations occur from water that migrates through improper flashing of the tile, wind-driven rain or ice damming. Because of this possibility, the underlayment is critical to the success of the roof system.
7. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) or approved equal is required as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will allowed.
8. Underlayment shall extend a minimum of 4" up vertical wood blocking or wall.
9. Lap succeeding sheets to ensure double layers over entire roof. Side laps shall be a minimum of 6" vertical lap.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

VENT PIPE FLASHING

MC-02





Notes:

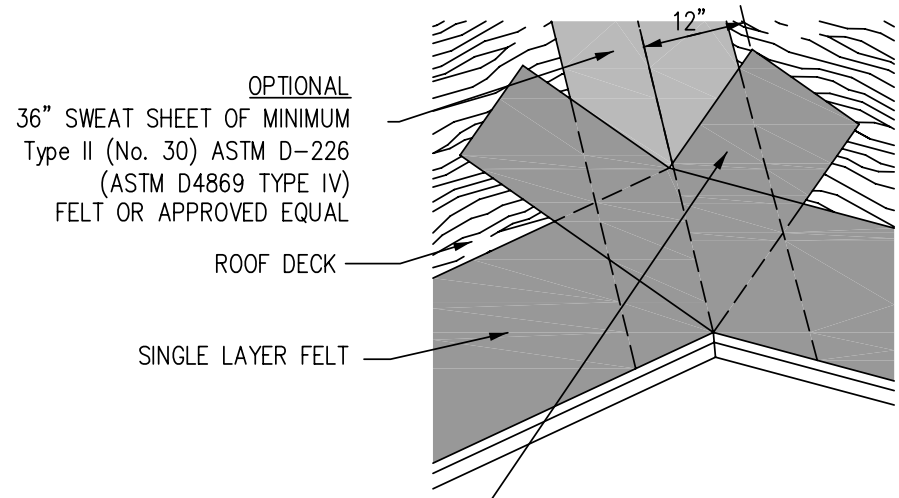
1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) or approved is required as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. All vent pipes require a roof deck and tile flashing.
3. Tile flashings shall extend onto the tile a minimum of 4" on flat tile and a minimum of 1" past the crown of a profiled tile.
4. For recommended tile fastening schedule(s) see Fastening Table 1 in Appendix 1A and 1B.
5. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. For flat tile, rigid flashing materials may be used.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

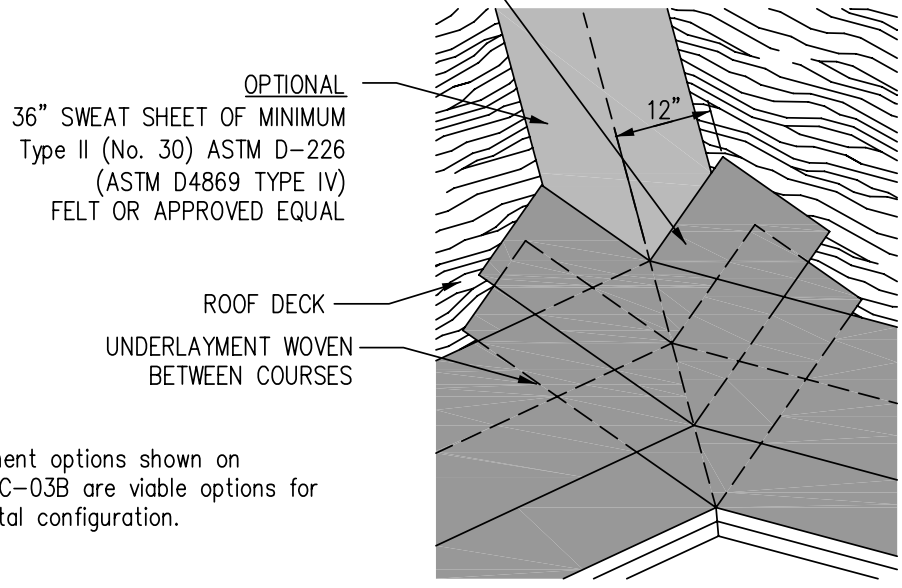
VALLEY UNDERLAYMENTS

WOVEN UNDERLAYMENT (Metal Flashing Not Shown)

MC-03



SINGLE LAYER



DOUBLE LAYER

Note:
The underlayment options shown on MC-03A or MC-03B are viable options for any valley metal configuration.

Notes:

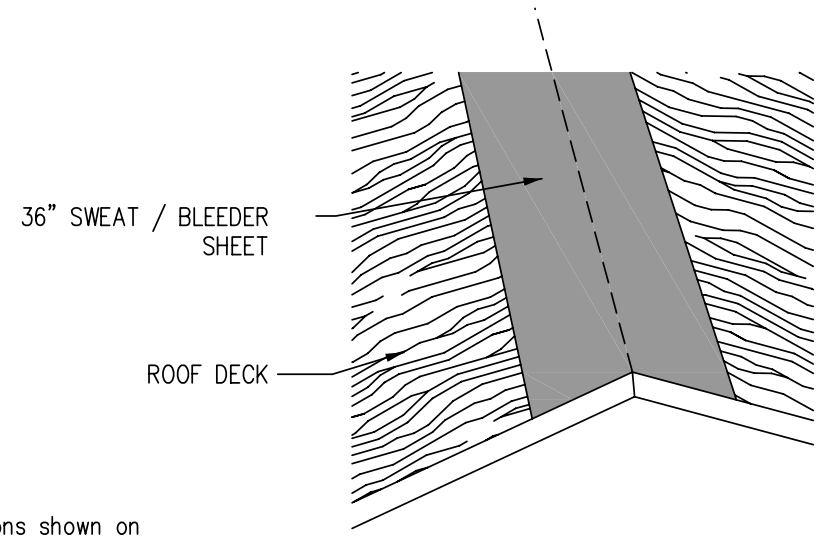
1. One layer of Type II (No. 30) asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) or approved equal is required as minimum underlayment on all tile roof applications. Other underlayments may be used as approved by local building officials.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

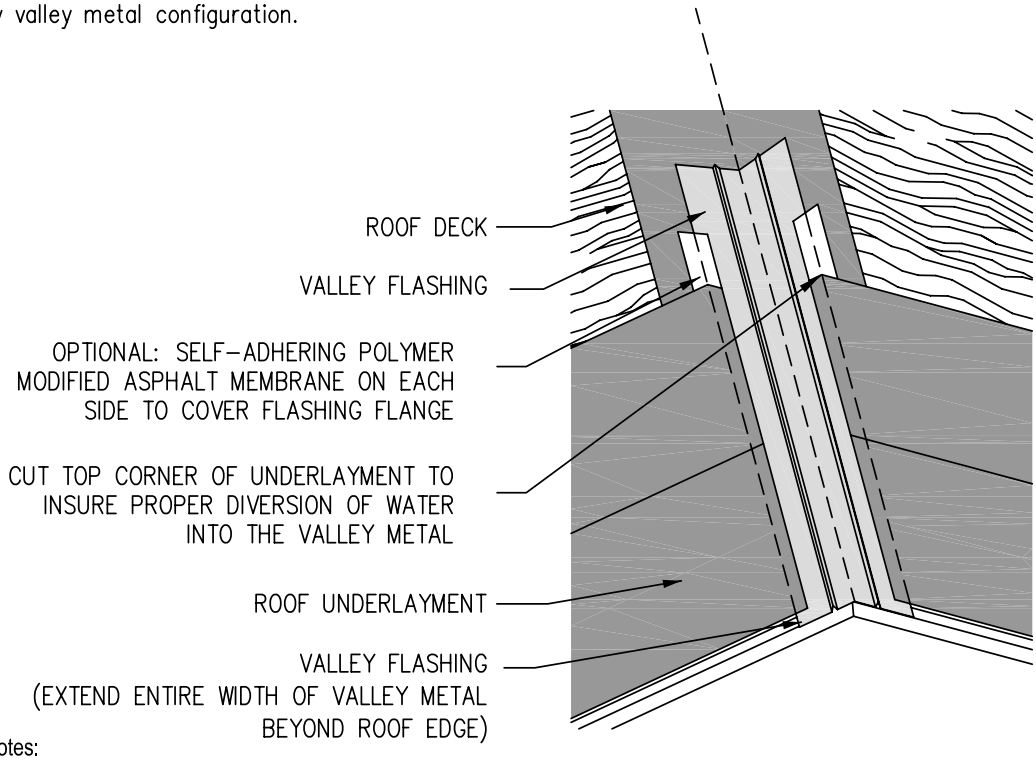
VALLEY UNDERLAYMENTS

OVERLAPPING UNDERLAYMENT

MC-03A



Note:
The underlayment options shown on MC–03A or MC–03B are viable options for any valley metal configuration.



Notes:

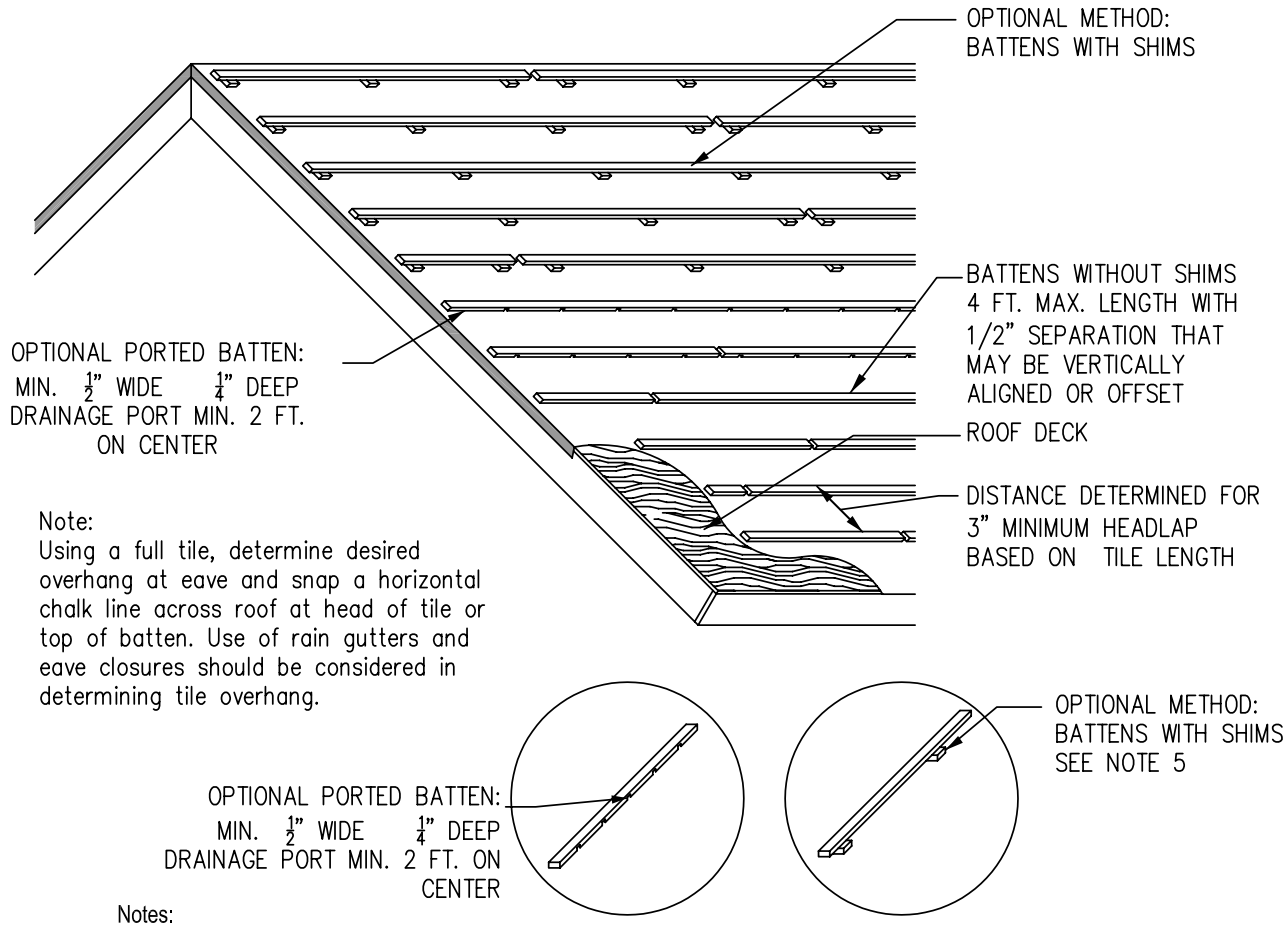
1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 TYPE IV) or approved equal is required as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials shall be allowed.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

BATTEN LAYOUT OPTIONS

(FOR TILES WITH PROTRUDING ANCHOR LUGS)

MC-04



Notes:

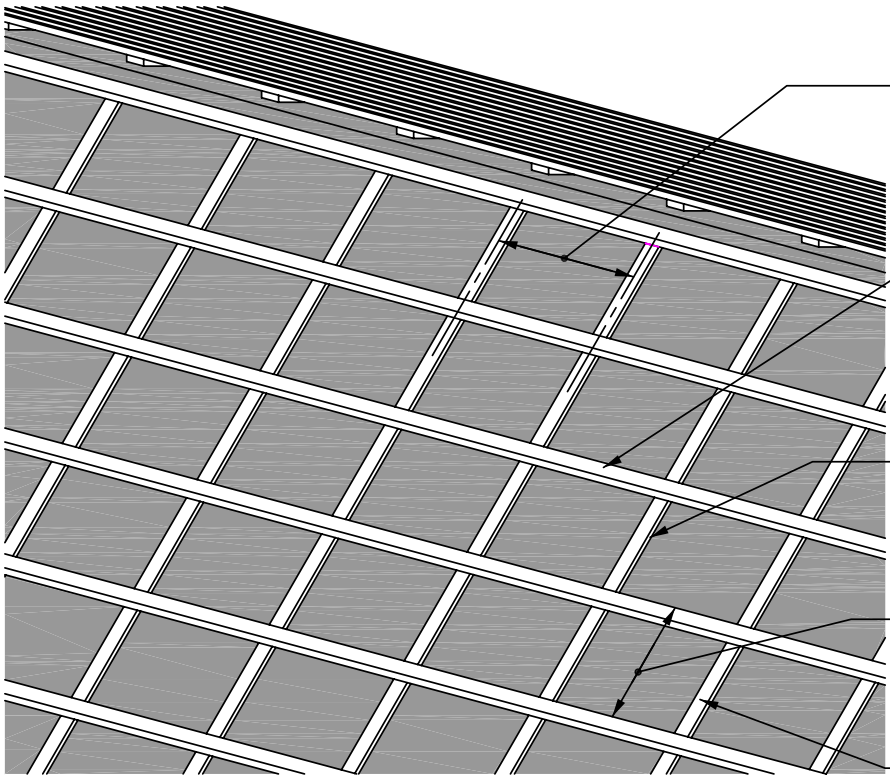
1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Battens shall not be less than nominal 1-inch by 2-inch or other code approved products.
3. Battens shall be no longer than 48" and be separated with 1/2" minimum gaps at ends to allow drainage. An alternate method permits use of longer batten strips with shims of minimum 1/4" thick decay-resistant material (e.g. asphalt shingle, wood strips or cap sheet) at each fastener to provide drainage, or other methods approved by local building officials.
4. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 and 7:12. Direct deck nailing attachment of tile will be per local building code.
5. Fasten battens a minimum of 24" on center with minimum 8d corrosion-resistant nails penetrating through decking or into structural framing. Batten attachment at 12" on center with staples a minimum of 1-1/2" long, 7/16" crown, No. 16 gage corrosion-resistant allowing for 3/4" penetration into roof deck or through the sheathing which ever is less or on 24" centers if fastened directly to structural framing.
6. Consideration should be given to climate and roof orientation to determine if it is beneficial to specify/use vertical battens over underlayment, with horizontal battens secured over the vertical battens.
7. See Table 2 and Table 3 for additional batten considerations.

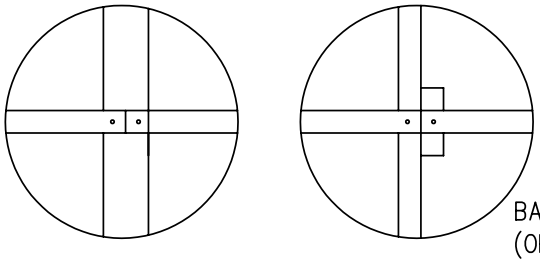
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

COUNTERBATTEN INSTALLATION SYSTEM

MC-05

Note:
Consideration should be given to climate and roof orientation to determine if it is beneficial to specify/use vertical battens over underlayment, with horizontal battens secured over the vertical battens.





SEE TABLE 3

BATTEN TERMINATION (OPTIONAL)

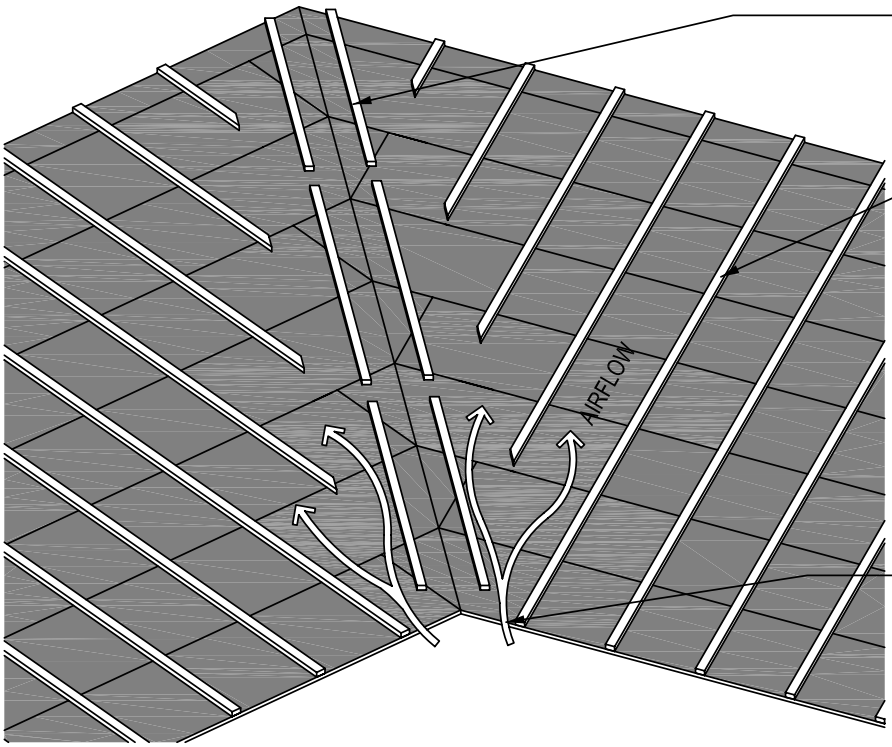
Notes:

1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as minimum underlayment on all tile roof applications. Other underlayments may be used as approved by local building officials.
2. Batten horizontal shall be sufficient thickness to fully engage protruding anchor lugs of the tile.
3. See Table 2 for additional batten considerations
4. See Table 2 and 3 for additional information

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

VERTICAL BATTENS - FOR DEEP TROUGH VALLEY

MC-06



REFER TO MC-03 FOR WOVEN UNDERLAYMENT
REFER TO MC-17 FOR FINISH DETAIL
REFER TO MC-17B FOR DEEP TROUGH DETAIL

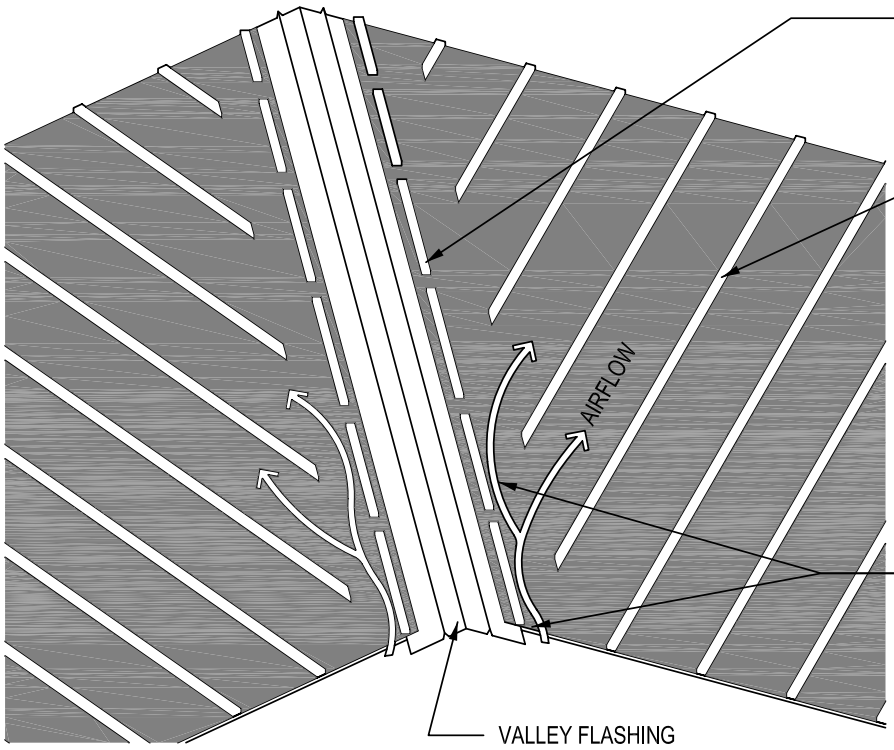
Notes:

1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869, Type IV) or approved equal as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Batten strips should be sufficient thickness to fully engage protruding anchor lugs of the tile.
3. Fasten battens a minimum of 24" on center with minimum 8d corrosion-resistant nails penetrating through decking or into structural framing. Batten attachment at 12" on center with staples a minimum of 1-1/2" long, 7/16" crown, No. 16 gage corrosion-resistant allowing for 3/4" penetration into roof deck or through the sheathing which ever is less or on 24" centers if fastened directly to structural framing.
4. Consideration should be given to climate and roof orientation to determine if it is beneficial to specify/use vertical battens over underlayment, with horizontal battens secured over the vertical battens. See table 3 for additional considerations.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

VERTICAL BATTENS - FOR SHALLOW TROUGH VALLEY

MC-06A



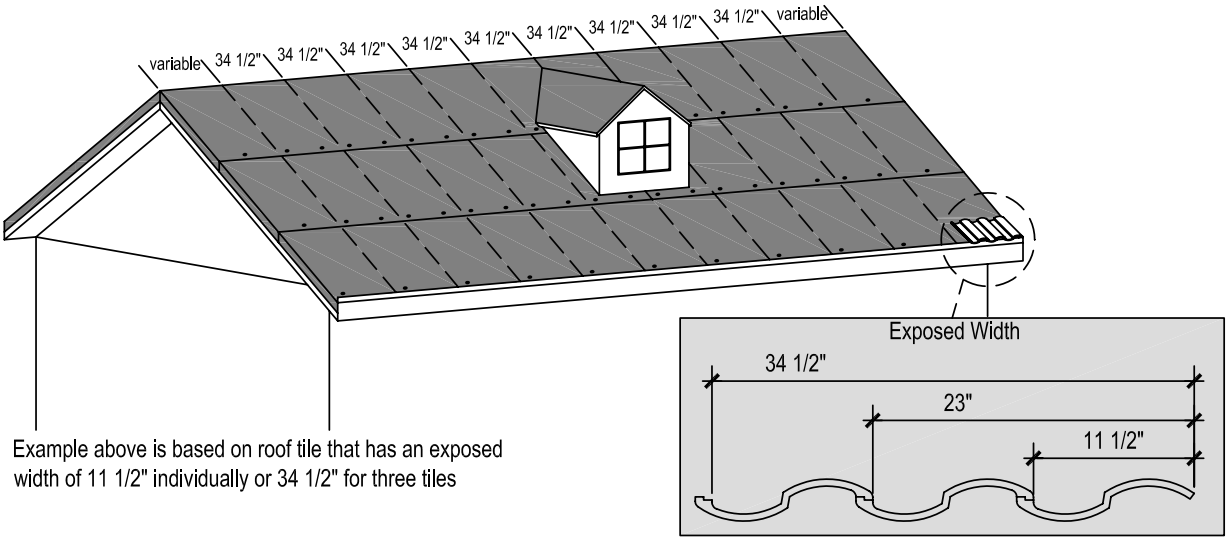
Notes:

1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 TYPE IV) or approved equal as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed
2. Horizontal battens shall not be less than nominal 1"x2" or code approved equal.
3. Fasten battens a minimum of 24" on center with minimum 8d corrosion-resistant nails penetrating through decking or into structural framing. Batten attachment at 12" on center with staples a minimum of 1-1/2" long, 7/16" crown, No. 16 gage corrosion-resistant allowing for 3/4" penetration into roof deck or through the sheathing which ever is less or on 24" centers if fastened directly to structural framing.
4. Consideration should be given to climate and roof orientation to determine if it is beneficial to specify/use vertical battens over underlayment, with horizontal battens secured over the vertical battens. See table 3 for additional considerations.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

ESTABLISHING VERTICAL ALIGNMENT

MC-07



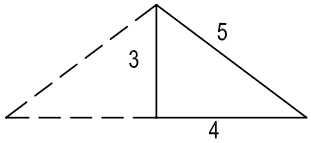
Example above is based on roof tile that has an exposed width of 11 1/2" individually or 34 1/2" for three tiles

Vertical alignment on interlocking tiles is, for the most part, controlled by the natural seat of the interlocking channels of the adjacent tiles. It is important however to establish a true vertical alignment prior to application of field tiles to assure a symmetrical installation. Proper roof layout greatly enhances the appearance and performance of the installed roof and serves to simplify and speed the application of the tile. A few minutes devoted to layout at the beginning of the job can result in significant savings of time and effort as the job progresses.
On a gable roof installation, the first vertical guideline is established by installing the first three tiles of the eave course and measuring the distance from the leading edge of the third tile back to the rake edge. This increment is then marked at the ridge course and a chalk line is snapped to delineate the vertical guide.

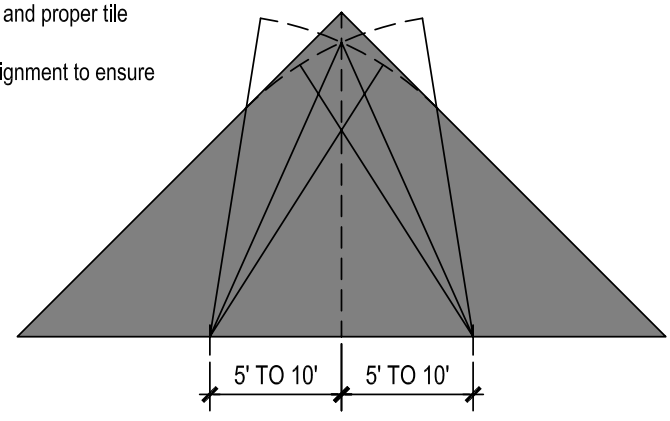
The exposed width dimension of the tile is then determined and measured from the vertical guide as frequently as needed to maintain proper alignment. Most often this measurement is marked in three-tile increments.
Vertical lines shall be perpendicular to the eave

Mark a point at the eave line as close to the center of the hip section as possible. Measure a point away from either side of the center point (5'-10' if possible) making sure that both marks are the same distance from the center line. Using a tape measure or lines of exactly the same length. Swing an arc away from each mark to intersect as high on the hip as possible. The intersection point of the arcs represent the high point of the vertical line above the mark made near the center of the eave line. A chalk line may be snapped to provide vertical reference Incremental measurements may then be taken in either direction from this center line to provide guidelines for vertical alignment.

On small hip sections, careful attention to horizontal alignment and proper tile placement is usually adequate to maintain vertical alignment.
On larger roof sections, it is helpful to establish solid vertical alignment to ensure uniform appearance and ease of application.



ALTERNATE METHOD LAYOUT



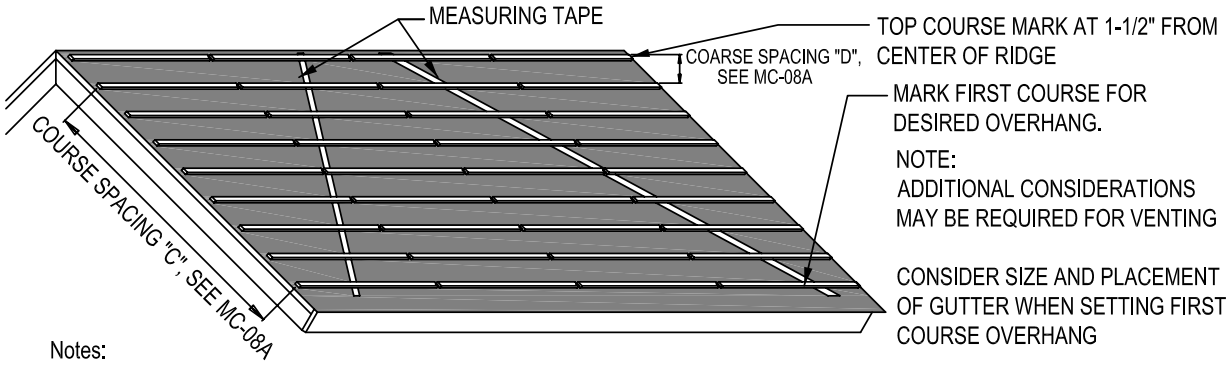
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

ROOF LAYOUT

UTILIZING SPECIALLY MARKED MEASURING TAPE

MC-08

To achieve optimum beauty, the area between the eave and ridge should be divided into equal tile courses, when possible. Minimum 3" overlap must be maintained for all tiles unless design of tile precludes. (See MC-04 for batten applications)



Notes:

1. Using a full tile, determine desired overhang at eave and snap horizontal chalk line across roof at head end of tile or top of batten. Use of rain gutters and eave closures should be considered in determining tile overhang.
2. Snap a horizontal chalk line at the top of the roof 1-1/2" from the center of the ridge. (Adjust for direct deck)
3. With fiberglass or metal tape marked for maximum "exposed length" of tile being installed measure vertically from the bottom line near the ridge at either end of the roof. (i.e. 14" for a 17" length tile)
4. If a mark on your tape does not fall exactly upon top line, move the tape to the left or right until the next mark intersects the line.
5. Mark the deck at every mark on the tape.
6. Repeat this process at other end of roof.
7. Snap lines between marks on the deck. All courses will be equal with minimum recommended headlap maintained.
8. Repeat above steps on all roof planes.
9. Nail top of battens or tiles at each horizontal line.

ROOF LAYOUT FOR CLAY DIAGONAL CUT ONE-PIECE S TILE

Horizontal Lay-Out

1. Using a full tile, determine desired overhang at eave and snap a horizontal chalk line across roof at head end of tile. Use of rain gutters and eave closures shall be considered in determining tile overhang.
2. At the top of the roof deck, mark a reference point by measuring 1 1/2" from the center of the ridge, plus the distance of one full course (i.e. 15" for a 18" length tile).
3. Measure up the roof slope to the reference point and divide by the manufacturer's maximum exposure in an effort to determine if the roof section will terminate with a full tile. Mark roof deck for each course of tile and snap chalk lines over entire section.
4. If roof section does not terminate with a full tile at the ridge, decrease the course exposure in small increments (typically 1/4") in attempt to finish with a full tile at the ridge (see note below).
5. If the last course does not terminate with a full tile, cut to dimension, as required and fasten with a mechanical fastener or other approved fastening method.

Vertical Lay-Out

1. To ensure proper vertical alignment, determine the manufactures stated maximum on-center spacing requirements and snap chalk lines as a reference point, typically the inside of the tile.
2. For gable end roof sections, determine the proper distance from the left and right rakes and mark the eave and ridge section to align the edge of the tiles.
3. Measure between the two marks and divide by manufacturer's stated maximum on-center spacing. If required, decrease the on-center spacing, slightly in an effort to terminate with a full tile at gable end(s). Ensure that the installed tile are within the manufacturer's minimum/maximum on-center spacing requirements.

Note: Tiles are allowed, by ASTM C1167/C1492 for a plus or minus 5% variance from the manufacturer's stated "nominal dimensions". It is the installer's responsibility to verify the "delivered" roof tiles dimensions prior to commencing with roof layout and to ensure that the tile is installed within the manufacturers minimum headlap and on-center spacing requirements. Most diagonal-cut tiles will allow slight course exposure adjustments typically 1/4" per tile.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

ROOF LAYOUT - QUICK REFERENCE

MC-08A

Course Spacing Table - For Tiles 16 1/2" to 17" in Length

To achieve optimum beauty, the area between the eave and ridge should be divided into equal tile courses, when possible. Minimum 3" overlap must be maintained for all tiles unless design of tile precludes.

17" - ONLY

16 1/2" - NOT TO EXCEED 13 1/2"

Coarse Spacing "C" from MC-08

12½"	12⅝"	12¾"	12⅞"	13"	13⅛"	13¼"	13⅜"	13½"	13⅝"	13¾"	13⅞"	14"
2' 1"	2' 1¼"	2' 1½"	2' 1¾"	2' 2"	2' 2¼"	2' 2½"	2' 2¾"	2' 3"	2' 3¼"	2' 3½"	2' 3¾"	2' 4"
3' 1½"	3' 1⅞"	3' 2¼"	3' 2⅝"	3' 3"	3' 3⅜"	3' 3¾"	3' 4⅛"	3' 4½"	3' 4⅞"	3' 5¼"	3' 5⅝"	3' 6"
4' 2"	4' 2½"	4' 3"	4' 3½"	4' 4"	4' 4½"	4' 5"	4' 5½"	4' 6"	4' 6½"	4' 7"	4' 7½"	4' 8"
5' 2½"	5' 3⅛"	5' 3¾"	5' 4⅜"	5' 5"	5' 5⅝"	5' 6¼"	5' 6⅞"	5' 7½"	5' 8⅛"	5' 8¾"	5' 9⅜"	5' 10"
6'3'	6' 3¾"	6' 4½"	6' 5¼"	6' 6"	6' 6¾"	6' 7½"	6' 8¼"	6' 9"	6' 9¾"	6' 10½"	6' 11¼"	7' 0"
7' 3½"	7' 4⅜"	7' 5¼"	7' 6⅛"	7' 7"	7' 7⅞"	7' 8¾"	7' 9⅝"	7' 10½"	7' 11⅜"	8' ¼"	8' 1⅛"	8' 2"
8' 4"	8' 5"	8' 6"	8' 7"	8' 8"	8' 9"	8' 10"	8' 11"	9' 0"	9' 1"	9' 2"	9' 3"	9' 4"
9' 4½"	9' 5⅝"	9' 6¾"	9' 7⅞"	9' 9"	9' 10⅛"	9' 11¼"	10' ⅜"	10' 1½'	10' 2⅝"	10' 3¾"	10' 4⅞"	10' 6"
10' 5"	10' 6¼"	10' 7½"	10' 8¾"	10' 10"	10' 11¼"	11' ½"	11' 1¾"	11' 3"	11' 4¼"	11' 5½"	11' 6¾"	11' 8"
11' 5½"	11' 6⅞"	11' 8¼"	11' 9⅝"	11' 11"	12' ⅜"	12' 1¾"	12' 3⅛"	12' 4½"	12' 5⅞"	12' 7¼"	12' 8⅝"	12' 10"
12' 6"	12' 7½"	12' 9"	12' 10½"	13' 0"	13' 1½"	13' 3"	13' 4½"	13' 6"	13' 7½"	13' 9"	13' 10½"	14' 0"
13' 6½"	13' 7⅞"	13' 9¾"	12' 11⅜"	14' 1"	14' 2⅝"	14' 4¼"	14' 5⅞"	14' 7½"	14' 9⅛"	14' 10¾"	15' ⅜"	15' 2"
14' 7"	14' 8¾"	14' 10½"	15' ¼"	15' 2"	15' 3¾"	15' 5½"	15' 7¼"	15' 9"	15' 10¾"	16' ½"	16' 2¼"	16' 4"
15' 7½"	15' 9⅜"	15' 11¼"	16' 1⅛"	16' 3"	16' 4⅞"	16' 6¾"	16' 8⅝"	16' 10½"	17' ⅜"	17' 2¼"	17' 4⅛"	17' 6"
16' 8"	16' 10"	17' 0"	17' 2"	17' 4"	17' 6"	17' 8"	17' 10"	18' 0"	18' 2"	18' 4"	18' 6"	18' 8"
17' 8½"	17' 10⅝"	18' ¾"	18' 2⅞"	18' 5"	18' 7⅛"	18' 9¼"	18' 11⅜"	19' 1½"	19' 3⅝"	19' 5¾"	19' 7⅞"	19" 10"
18' 9"	18' 11¼"	19' 1½"	19' 3¾"	19' 6"	19' 8¼"	19' 10½"	20' ¾"	20' 3"	20' 5¼"	20' 7½"	20' 9¾"	21' 0"
19' 9½"	19' 11⅞"	20' 2¼"	20' 4⅝"	20' 7"	20' 9⅜"	20' 11¾"	21' 2⅛"	21' 4½"	21' 6⅞"	21' 9¼"	21' 11⅝"	22' 2"
20' 10"	21' ½"	21' 3"	21' 5½"	21' 8"	21' 10½"	22' 1"	22' 3½"	22' 6"	22' 8½"	22' 11"	23' 1½"	23' 4"
21' 10½"	22' 1⅛"	22' 3¾"	22' 6⅜"	22' 9"	22' 11⅝"	23' 2¼"	23' 4⅞"	23' 7½"	23' 10⅛"	24' ¾"	24' 3⅜"	24' 6"
22' 11"	23' 1¾"	23' 4½"	23' 7¼"	23' 10"	24' ¾"	24' 3½"	24' 6¼"	24' 9"	24' 11¾"	25' 2½"	25' 5¼"	25' 8"
23 11½"	24' 2⅜"	24' 5¼"	24' 8⅛"	24' 11"	25' 1⅞"	25' 4¾"	25' 7⅝"	25' 10½"	26' 1⅜"	26' 4¼"	26' 7⅛"	26' 10"
25' 0"	25' 3"	25' 6"	25' 9"	26' 0"	26' 3"	26' 6"	26' 9"	27' 0"	27' 3"	27' 6"	27' 9"	28' 0"
26' ½"	26' 3⅝"	26' 6¾"	26' 9⅞"	27' 1"	27' 4⅛"	27' 7¼"	27' 10⅜"	28' 1½"	28' 4⅝"	28' 7¾"	28' 10⅞"	29' 2"
27' 1"	27' 4¼"	27' 7½"	27' 10¾"	28' 2"	28' 5¼"	28' 8½"	28' 11¾"	29' 3"	29' 6¼"	29' 9½"	30' ¾"	30' 4"
28' 1½"	28' 4⅞"	28' 8¼"	28' 11⅝"	29' 3"	29' 6⅜"	29' 9¾"	30' 1⅛"	30' 4½"	30' 7⅞"	30' 11¼"	31' 2⅝"	31' 6"
29' 2"	29' 5½"	29' 9"	30' ½"	30' 4"	30' 7½"	30' 11"	31' 2½"	31' 6"	31' 9½"	32' 1"	32' 4½"	32' 8"

Coarse Spacing "D" from MC-08

Notes:

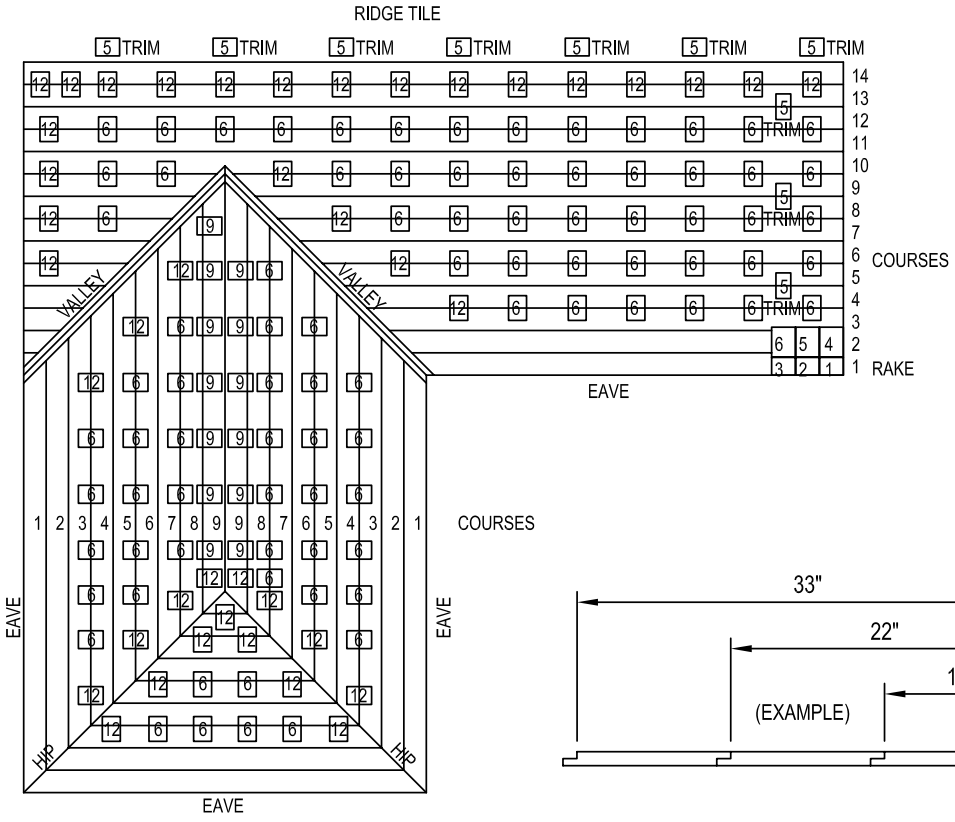
1. Using a full tile, determine desired overhang at eave and snap horizontal chalk line across roof at head end of tile on direct deck or top of batten for batten installations. Use of rain gutters and eave closures should be considered in determining tile overhang.
2. Snap a horizontal chalk line at the top of the roof 1-1/2" from the center of the ridge. (Adjust for direct deck)
3. In spacing guide, find column containing nearest figure to the measurement between eave and ridge course.
4. Mark both ends of roof at course spacing shown in column.
5. Snap chalk lines across roof at course markings.
6. Nail top of battens to chalk line.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SUGGESTED LOADING GUIDE

MC-09

The method of roof loading shown on this page represents the method of tile placement for efficient application but is not intended to suggest that this is the only method that will work. Each applicator will have personal preferences for the stack location and spacing. The important aspect of the tile loading is to spread the load evenly across the roof while using the proper increments that assure that the proper amount of tile is loaded on roof.

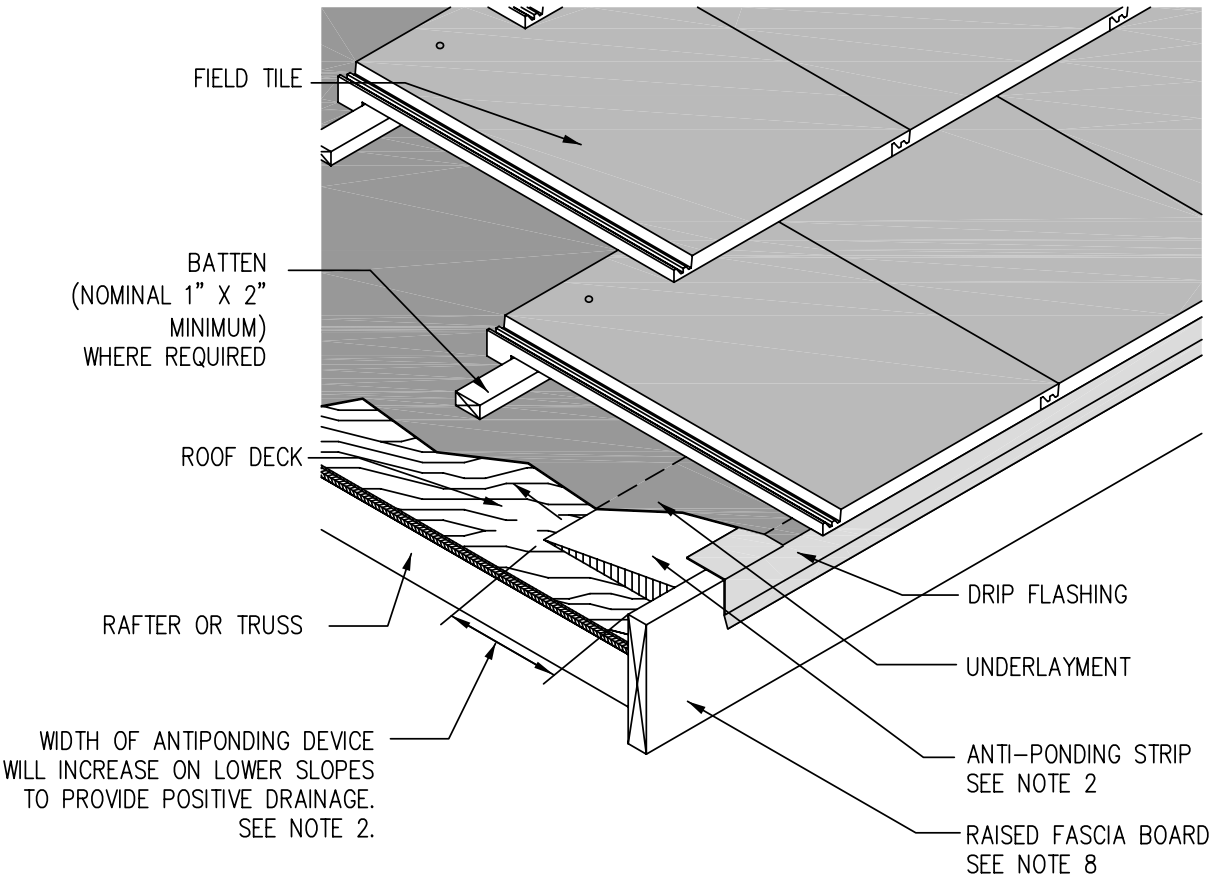


1. Course lines should be measured and chalked according to the roof layout recommendations before loading the tile.
2. Determine the approximate number of tiles needed for each section of roof.
3. Spacing of the tile stacks is determined by the width of the exposed tile times the number of tiles being fed per course, e.g. in the attached schematic, each stack of tiles will feed two courses, three tiles wide. If each tile is exposed 11", then the stack will be placed 33" o.c. If the stack feeds three courses, two tiles wide, then the stack would be 22" o.c.
4. Starting with the third course from the eave, and continuing with alternate courses, distribute tiles (usually 6 per stack) over the roof leaving approximately 20" from gable ends and between stacks.
5. When total number of courses is an even number, stack 12 tiles on ridge stacks. When total number of courses is an odd number, stack 9 tiles on ridge stack.
6. On right side of the hips and valleys, stack 12 tiles. Maintain at least 24" between tile stacks and left side of valley. Reverse for tiles layed left to right.
7. Distribute ridge and rake trim tiles when loading field tiles. Trim tiles are in stacks of 5 at 70" o.c. Load ridge tile on side of roof to be applied last.
8. To achieve a pleasant, random blend of color for your job, care should be taken upon loading to mix the tiles.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

RAISED FASCIA

MC-10



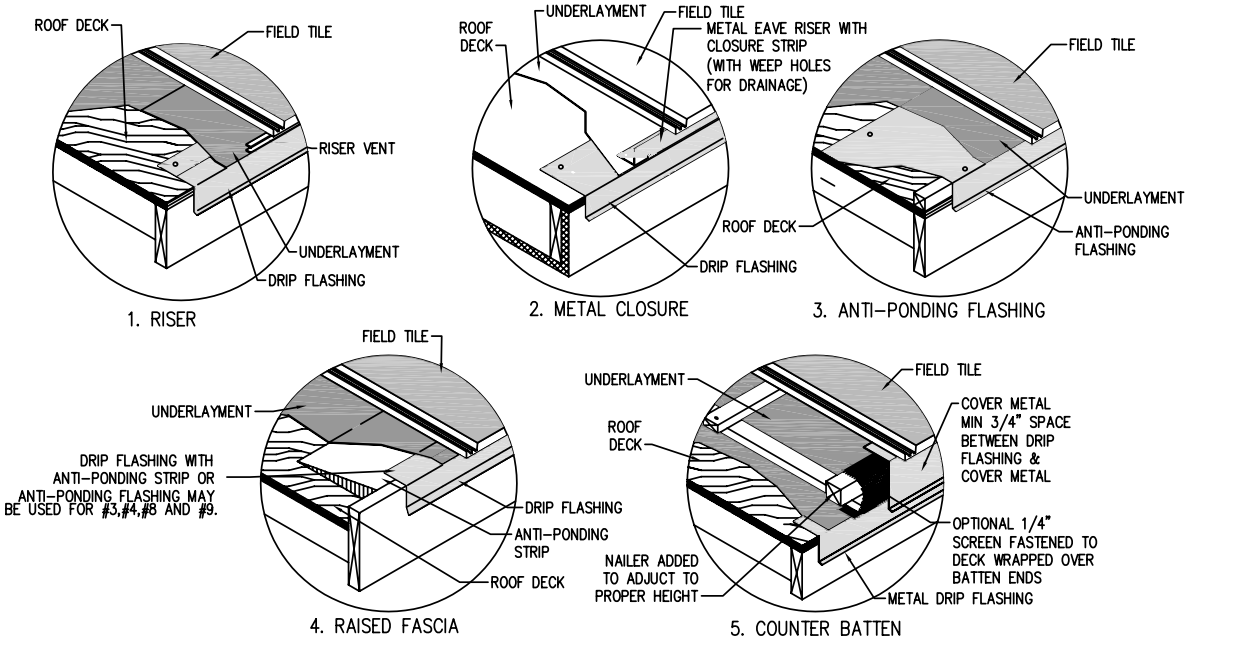
Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) is required as minimum underlayment on all tile roof applications. Other underlayments may be used as approved by local building officials.
2. An anti-ponding device such as a beveled cant strip or shop-formed sheet metal is required at all raised fascia conditions to support the underlayment and provide positive drainage.
3. The fasteners must penetrate a minimum of 3/4" into dimensional wood decking or pass through wood panel sheathing which ever is less.
4. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 and 7:12. Direct deck attachment of tile is permissible.
5. For recommended tile fastening schedule(s) see Fastening Table 1A and 1B.
6. Raise fascia board above roof deck to height equal to combined thickness of batten system and thickness of one course of tile.
7. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
8. Since raised fascia and starter strips create the same type of water dam situation, they both require an anti-ponding system to allow water to flow off the roof.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

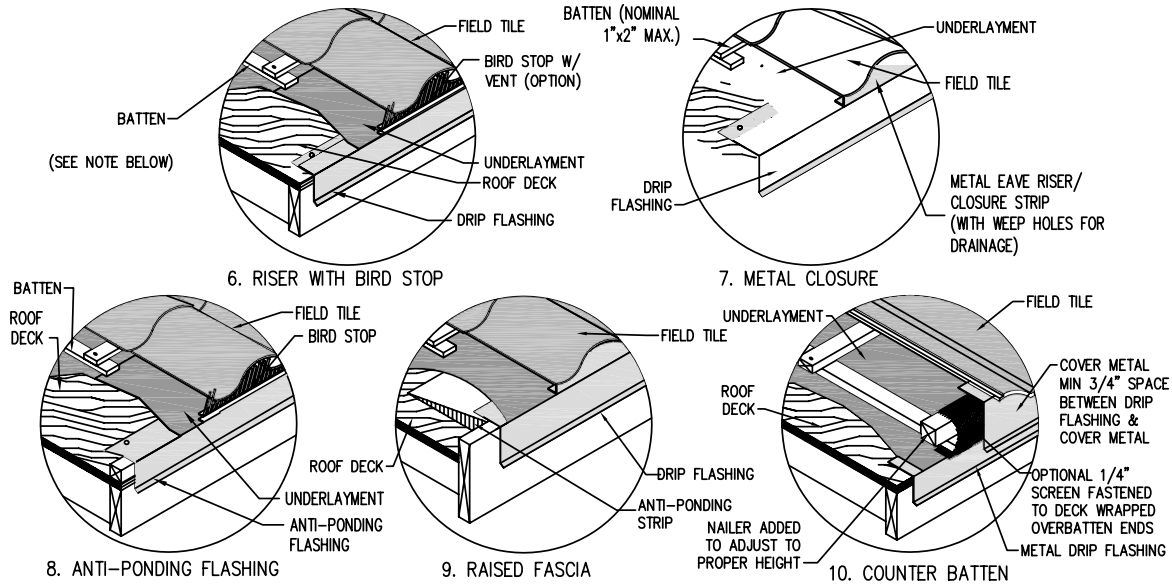
DOWN SLOPE EAVE DETAILS

MC-10A



LOW (FLAT) PROFILE TILES

MEDIUM AND HIGH PROFILE TILES

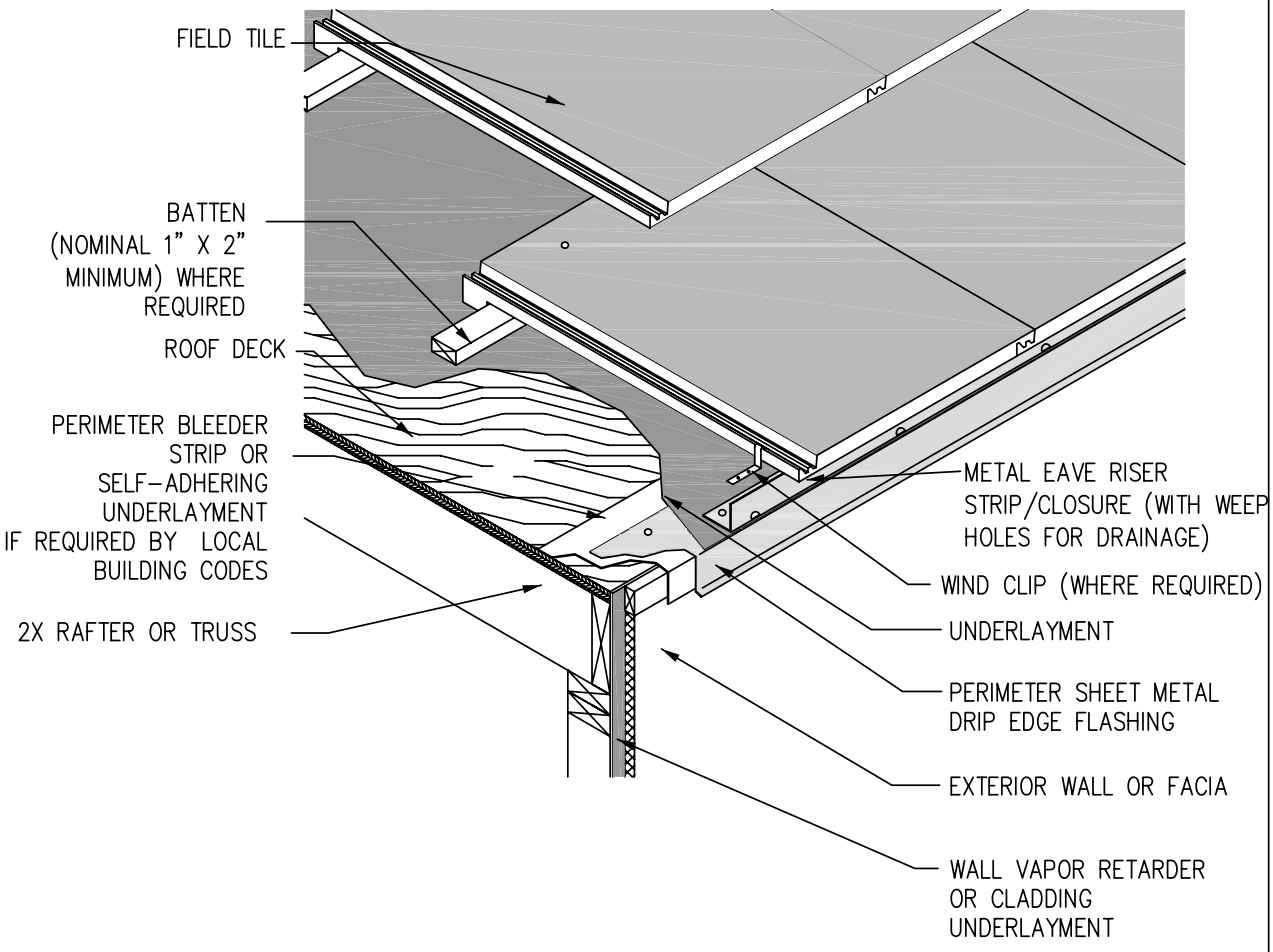


1. Notes:
   Bird stop is required on High profile tile and optional on Low and Medium profile tile unless required by local building officials.
2. Bird stop may be either solid or vented

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

EAVE AT FLUSH WALL OR FASCIA / ZERO OVERHANG

MC-10B



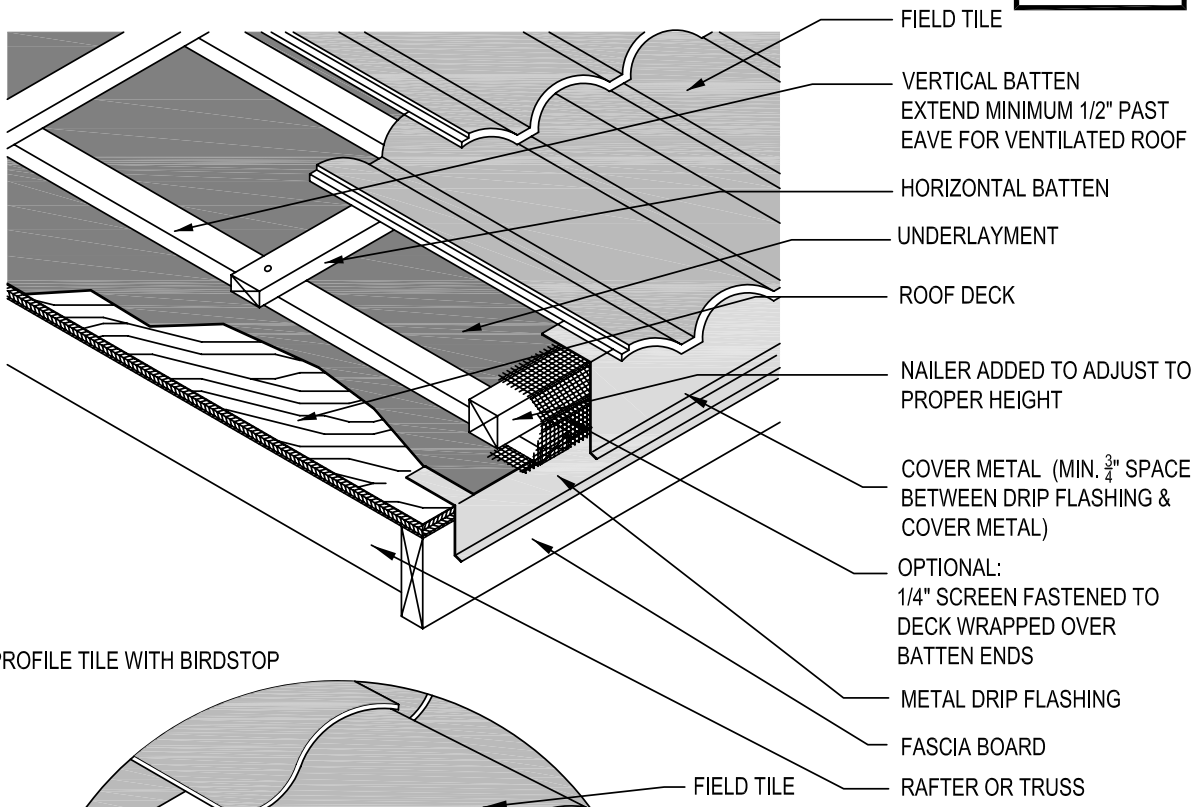
Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) is required as minimum underlayment on all tile roof applications. Other underlayments may be used as approved by local building officials.
2. A sheet metal drip edge flashing is required with: stucco fascia, EIFS (Exterior Insulated Finish System) and flush fascia perimeter edges.
3. The fasteners must penetrate a minimum of 3/4" into dimensional wood decking or pass through wood panel sheathing which ever is less.
4. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 and 7:12. Direct deck nailing attachment of tile may be permissible.
5. For recommended tile fastening schedule(s) see Fastening Table 1A and 1B.
6. Eave closure should be of height equal to combined thickness of batten system and thickness of one course of tile.
7. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

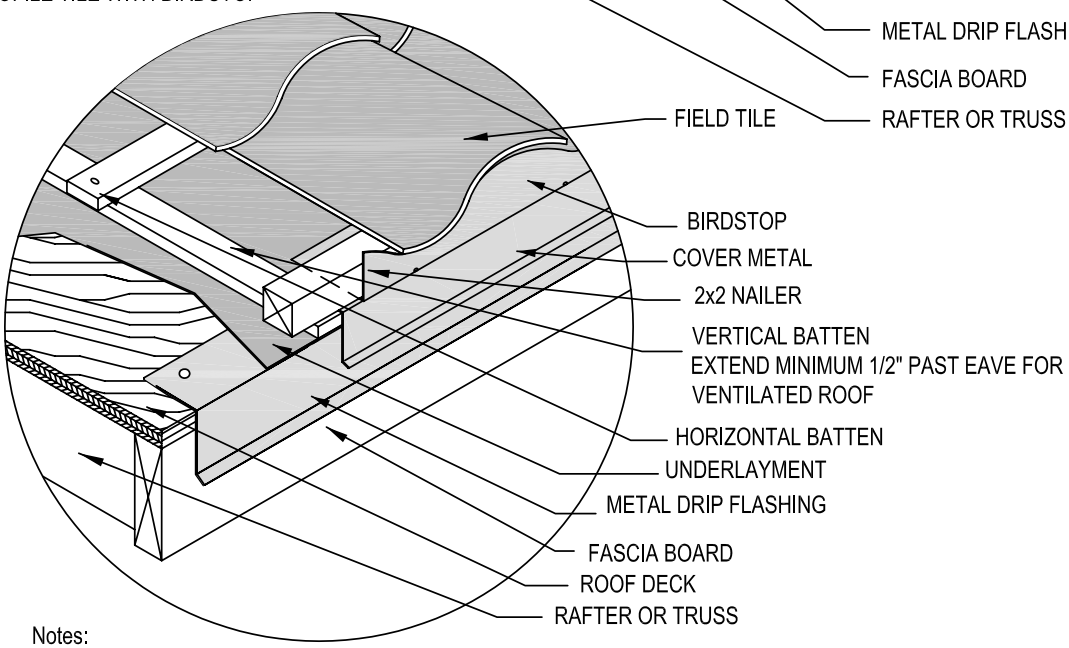
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

LOW SLOPE / VENTILATED ROOF EAVE DETAIL

MC-10C



HIGH PROFILE TILE WITH BIRDSTOP



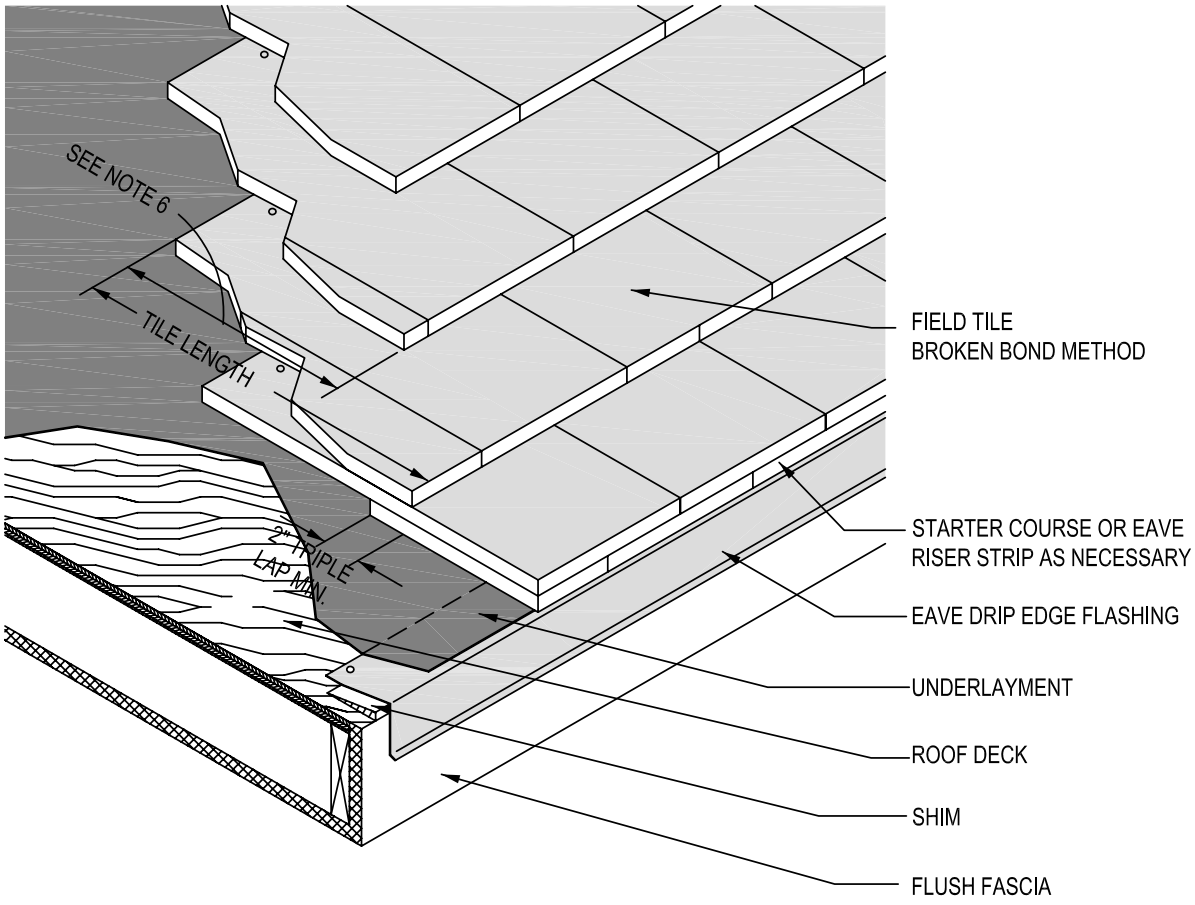
Notes:

1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. A sheet metal drip edge flashing is required with: stucco fascia, EIFS (Exterior Insulated Finish System) and flush fascia perimeter edges.
3. Eave closure shall be of height equal to combined thickness of batten system and thickness of one course of tile.
4. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

DOUBLE LAP TILE (NON-INTERLOCKING)

MC-10D



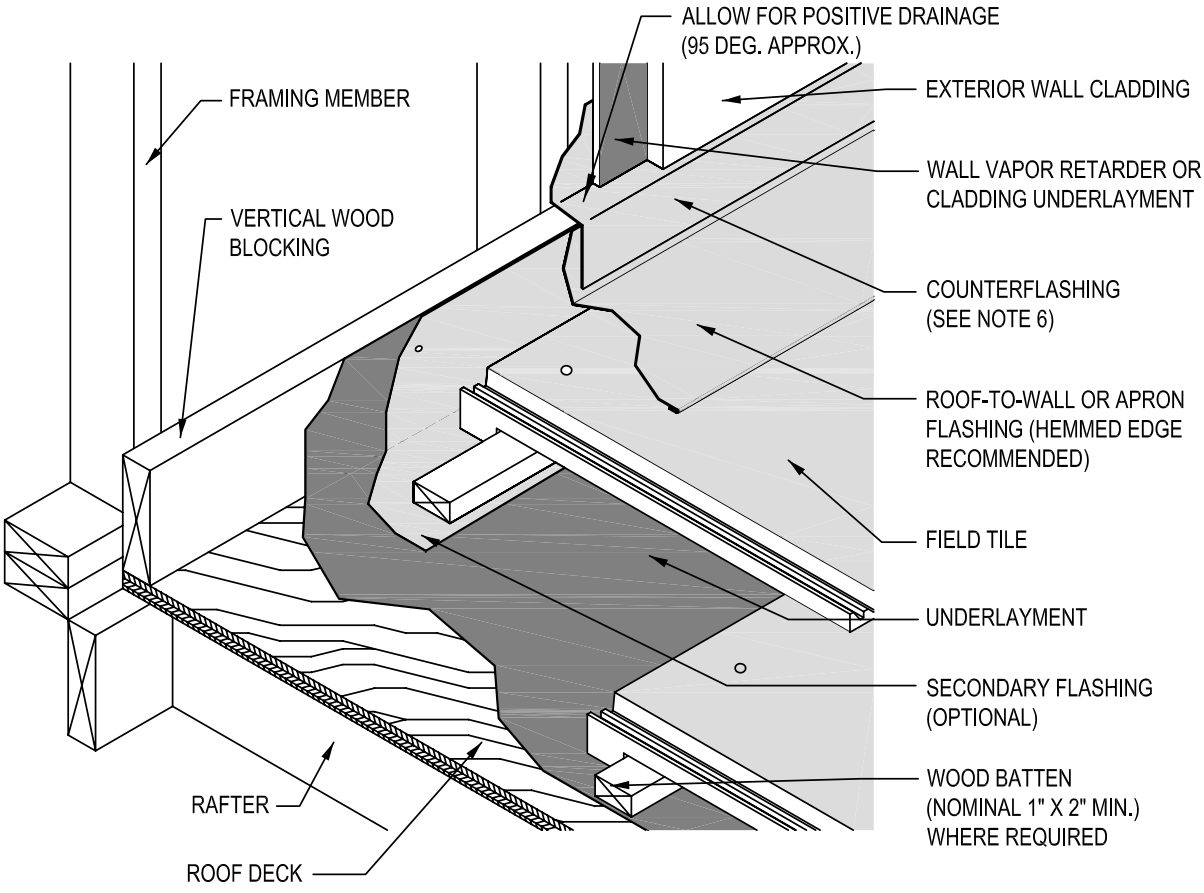
Notes:

1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. A sheet metal drip edge flashing is required with: stucco fascia, EIFS (Exterior Insulated Finish System) and flush fascia perimeter edges.
3. The fasteners must penetrate a minimum of 3/4" into dimensional wood decking or pass through wood panel sheathing which ever is less.
4. For recommended tile fastening schedule(s) see Fastening Table 1A.
5. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. Standard head lap equal to tile length minus 2" divided by 2.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

HEAD WALL METAL FLASHING

MC-11



Note:
Openings at hips, ridges and head walls including chimneys, skylights, solar panels, and downslope horizontal abutments shall be fitted with weather blocking material to keep water on the surface of the field tile. Other methods approved by local building official will be allowed. See Technical Bulletin at www.tileroofing.org

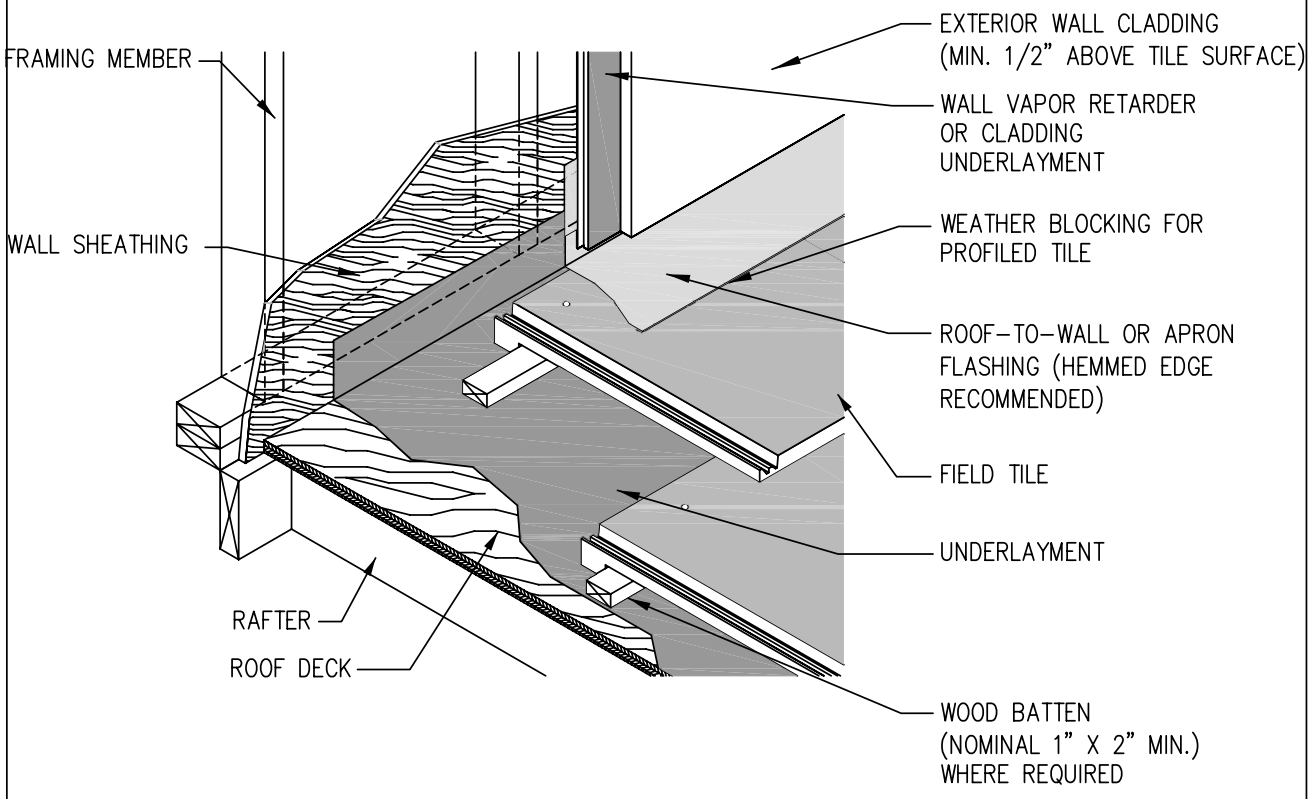
Notes:

1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Underlayment shall extend a minimum of 4" up vertical wood blocking or wall.
3. Apron flashing or other roof-to-wall closure material is necessary at roof-to-wall intersections. Roof-to-wall/apron flashing should extend a minimum of 2" up vertical walls, and provide a minimum of 3" overlap\headlap onto tile. The apron flashing is required to be overlapped a minimum of 2" by sheet metal counterflashing or wall cladding.
4. Solid wood blocking is required behind Z-metal counterflashing applications.
5. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. The bottom edge of the counterflashing height settings shall be set above the roof deck a minimum of 4" for flat tile, 5" for low profile tile, and 6" for high profile tile.
7. All roof flashing shall be a minimum of No. 26 ga. G-90 galvanized.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

HEAD WALL METAL FLASHING

MC-11A



Note:
Openings at hips, ridges and head walls including chimneys, skylights, solar panels, and downslope horizontal abutments shall be fitted with weather blocking material to keep water on the surface of the field tile. Other methods approved by local building official will be allowed. See Technical Bulletin at www.tileroofing.org

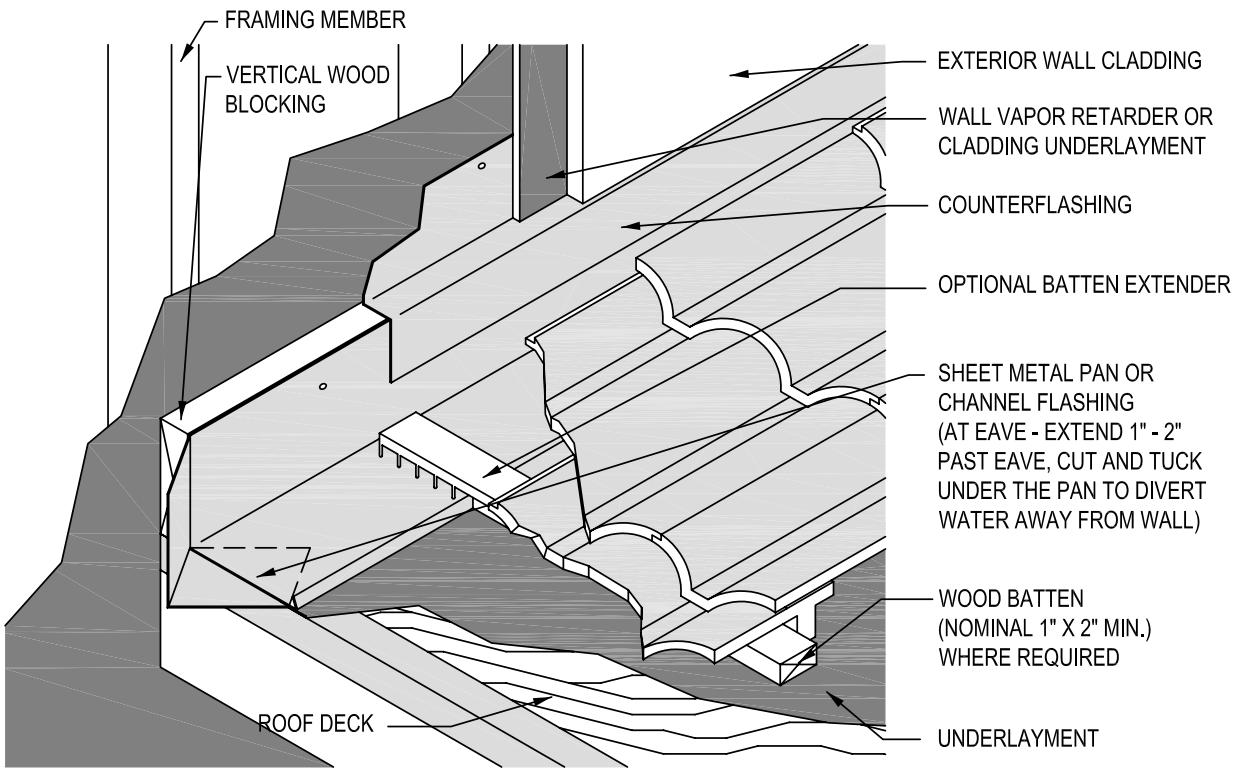
Notes:

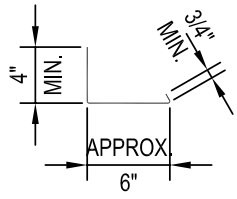
1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Underlayment shall extend a minimum of 4" up vertical wood blocking or wall.
3. Apron flashing or other roof-to-wall closure material is necessary at roof-to-wall intersections. Roof-to-wall/apron flashing should extend a minimum of 2" up vertical walls, and provide a minimum of 3" overlap\headlap onto tile. The apron flashing is required to be overlapped a minimum of 2" by sheet metal counterflashing or wall cladding.
4. Solid wood blocking is required behind Z-metal counterflashing applications.
5. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. The bottom edge of the counterflashing height settings shall be set above the roof deck a minimum of 4" for flat tile, 5" for low profile tile, and 6" for high profile tile.
7. All roof flashing shall be a minimum of No. 26 ga. G-90 galvanized.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

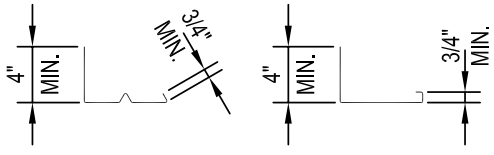
PAN FLASHING AT ROOF-TO-SIDEWALL
Where Wall Extends Past Eave

MC-12





MINIMUM PAN FLASHING



OPTIONAL PAN FLASHING

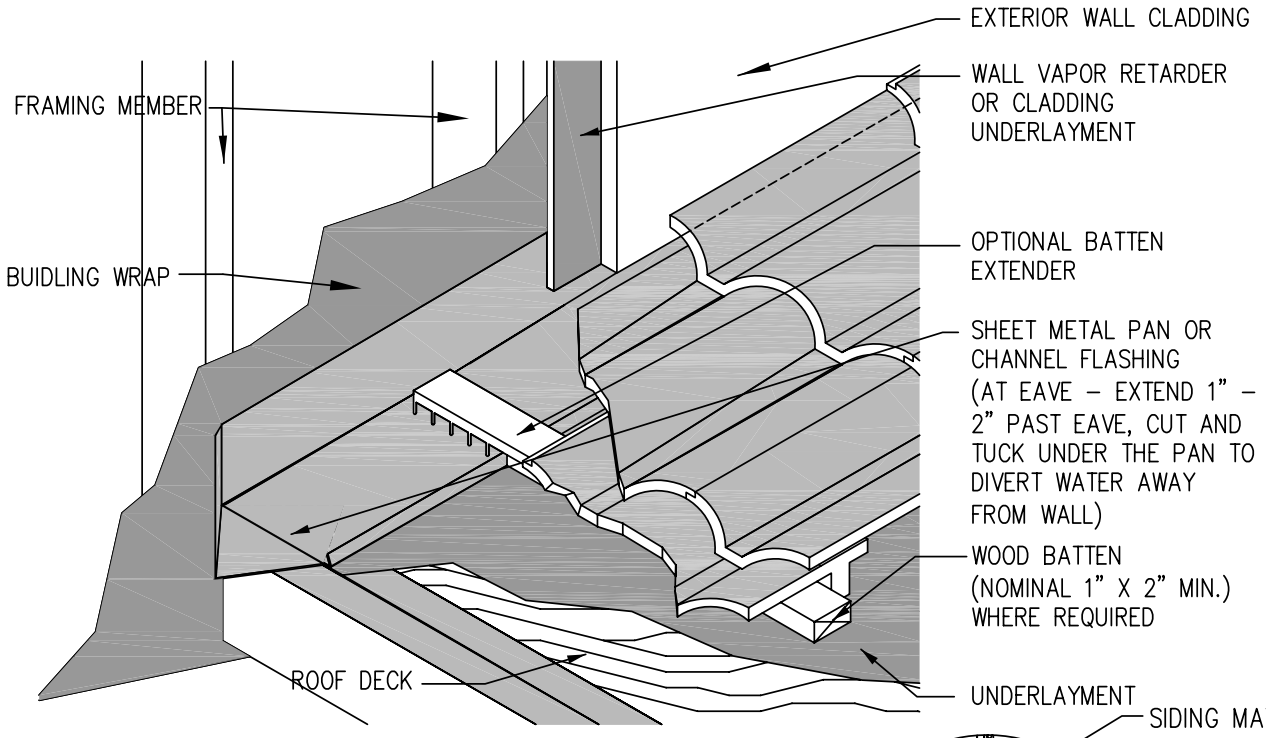
Notes:

1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Underlayment shall extend a minimum of 4" up vertical wood blocking or wall.
3. Sheet metal pan flashing shall extend a minimum of 4" up the vertical wall approximately 6" out over the deck and have a minimum 3/4" return upward.
4. Solid wood blocking is required behind pan flashing and Z-metal counterflashing.
5. At terminating tile, cut head lugs. Use a roof tile adhesive approved by the local building officials or use wire ties or batten extender to secure tile.
6. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
7. Consideration shall be given to tributary area of roof for pan flashing design.
8. All roof flashing shall be a minimum of No. 26 ga. G-90 galvanized.

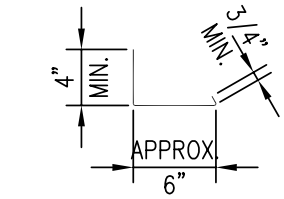
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

PAN FLASHING AT ROOF-TO-SIDEWALL
Where Wall Extends Past Eave

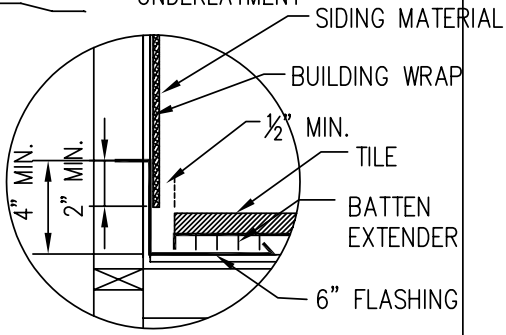
MC-12A



SEE MC–12B FOR ADDITIONAL FLASHING DESIGN INFORMATION



MINIMUM PAN FLASHING



Notes:

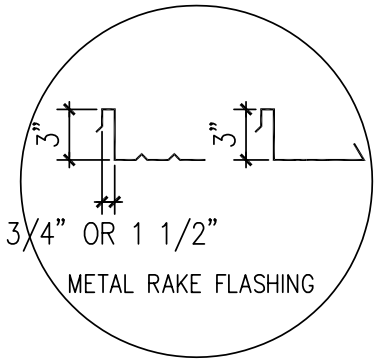
1. Provide one layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Underlayment shall extend a minimum of 4" up vertical wood blocking or wall.
3. Sheet metal pan flashing shall extend a minimum of 4" up the vertical wall approximately 6" out over the deck and have a minimum 3/4" return upward.
4. Solid wood blocking is required behind pan flashing and Z-metal counterflashing.
5. At terminating tile, cut head lugs. Use a roof tile adhesive approved by the local building officials or use wire ties or batten extender to secure tile.
6. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
7. Consideration shall be given to tributary area of roof for pan flashing design.
8. All roof flashing shall be a minimum of No. 26 ga. G-90 galvanized.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

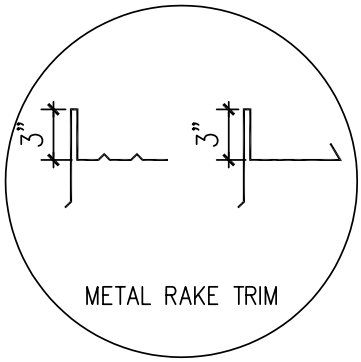
 TILE ROOFING INSTITUTE\WSRCA ICC–ES ESR–2015 01/2002, Revised 07/2006

METAL FLASHING OPTIONS

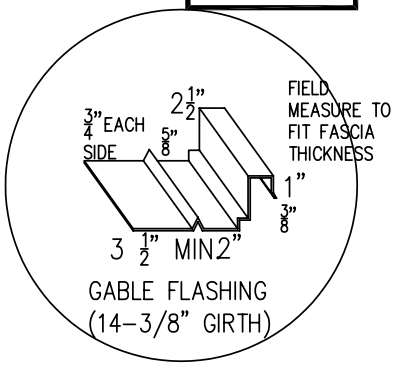
MC-12B



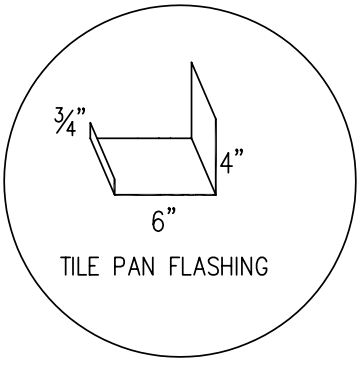
METAL RAKE FLASHING



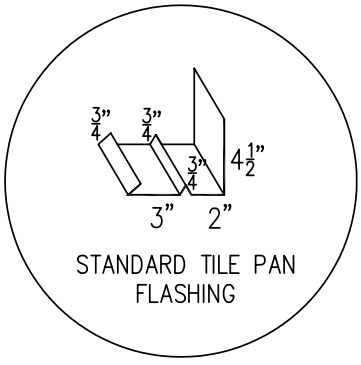
METAL RAKE TRIM



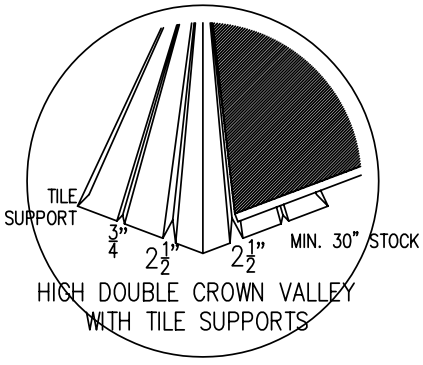
GABLE FLASHING
(14–3/8" GIRTH)



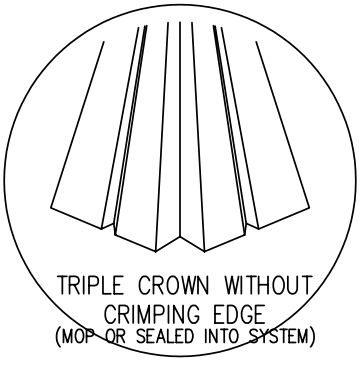
TILE PAN FLASHING



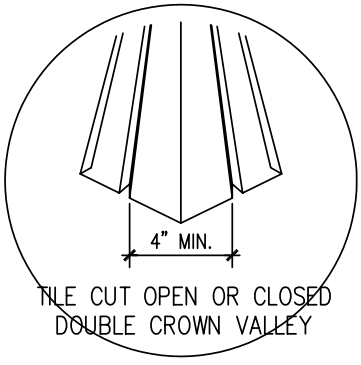
STANDARD TILE PAN FLASHING



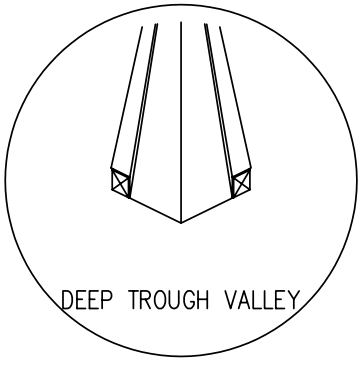
HIGH DOUBLE CROWN VALLEY WITH TILE SUPPORTS



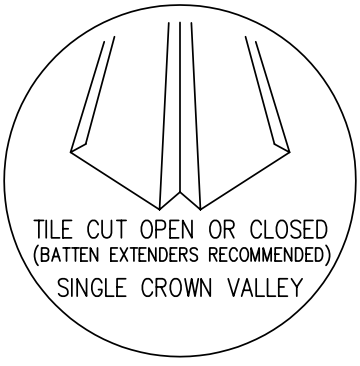
TRIPLE CROWN WITHOUT CRIMPING EDGE
(MOP OR SEALED INTO SYSTEM)



TILE CUT OPEN OR CLOSED DOUBLE CROWN VALLEY



DEEP TROUGH VALLEY



TILE CUT OPEN OR CLOSED
(BATTEN EXTENDERS RECOMMENDED)
SINGLE CROWN VALLEY

NOTES:

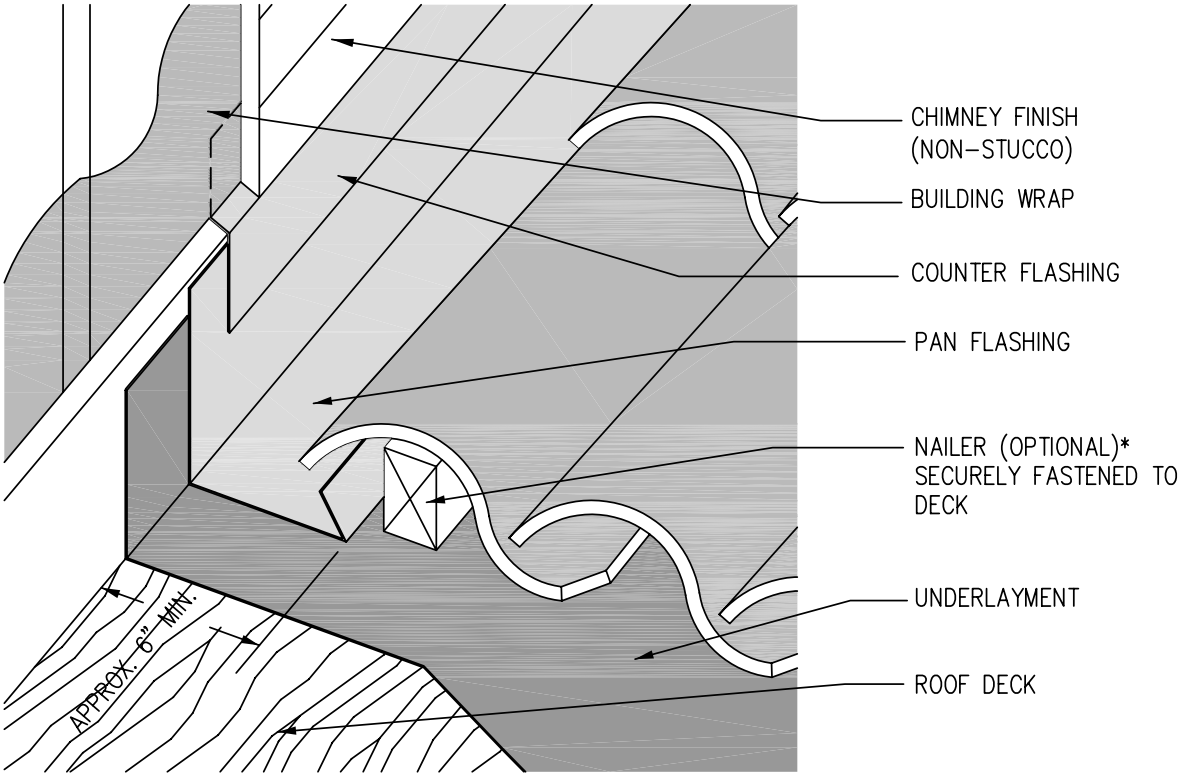
1. These pictures show options that are found in the field at this time; other designs that will handle anticipated water flows may be used upon submissions of supporting data indicating that anticipated water flows are equivalent to the code requirements.
2. Valley metals shall extend 11" each way in compliance with IBC section 1507.3.9, IRC R905.3.8 and UBC section 1508.4 unless approved by the local building official.
3. Tile valleys may be cut closed or open.
4. When flat profiled tile is installed as "Closed Valley" a ribbed valley metal or a single crown valley metal with a batten extender shall be used. Valley metals shall conform to IBC section 1507.3.9, IRC R905.3.8 and UBC section 1508.4.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

 TILE ROOFING INSTITUTE\WSRCA ICC–ES ESR–2015 01/2002, Revised 07/2006

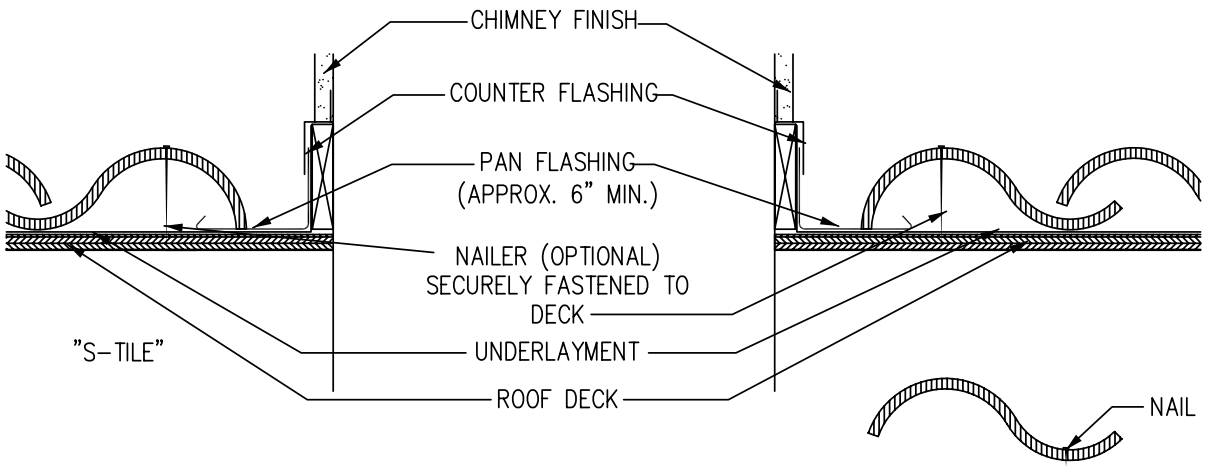
SIDEWALL DETAILS - CLAY 'S' TILE

MC-13



RIGHT END

*Note: Tiles to be installed in such a fashion as to prevent water diversion or blockage. Nail shall be of sufficient length to penetrate ¾" into or through the roof sheathing, which ever is less.



Optional nailing location in tile pan.

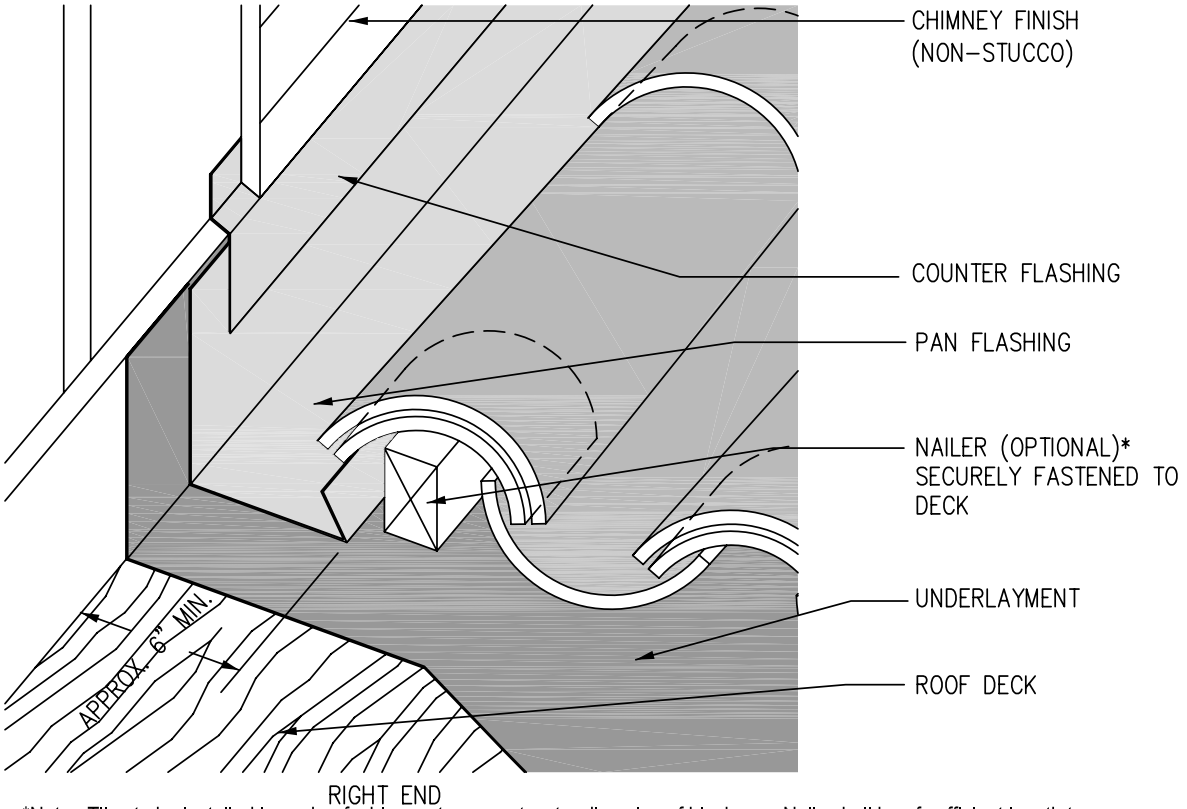
Notes:

1. Underlayment should extend a minimum of 4" up vertical wood blocking or wall.
2. See MC-12B for additional flashing details.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

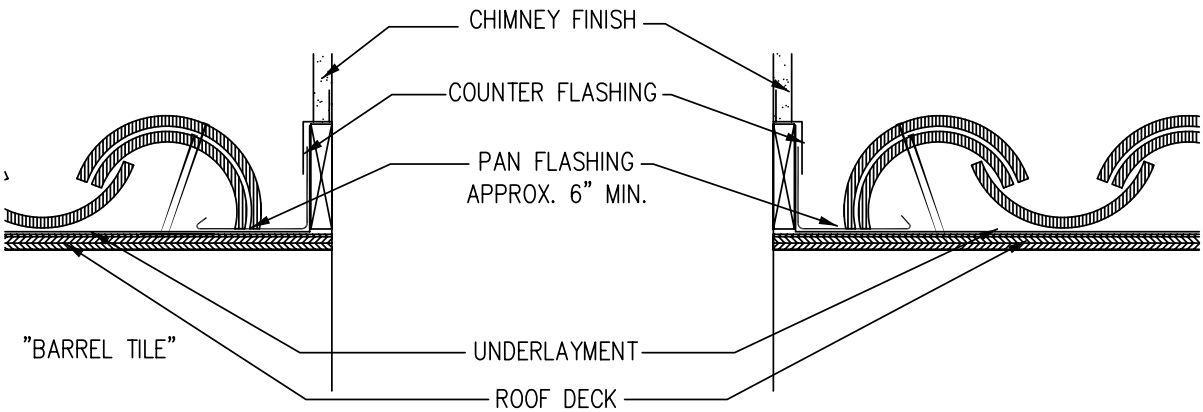
SIDEWALL DETAILS - TWO PIECE CLAY

MC-13A



RIGHT END

*Note: Tiles to be installed in such a fashion as to prevent water diversion of blockage. Nails shall be of sufficient length to penetrate ¾" into, or through the roof sheathing, which ever is less.



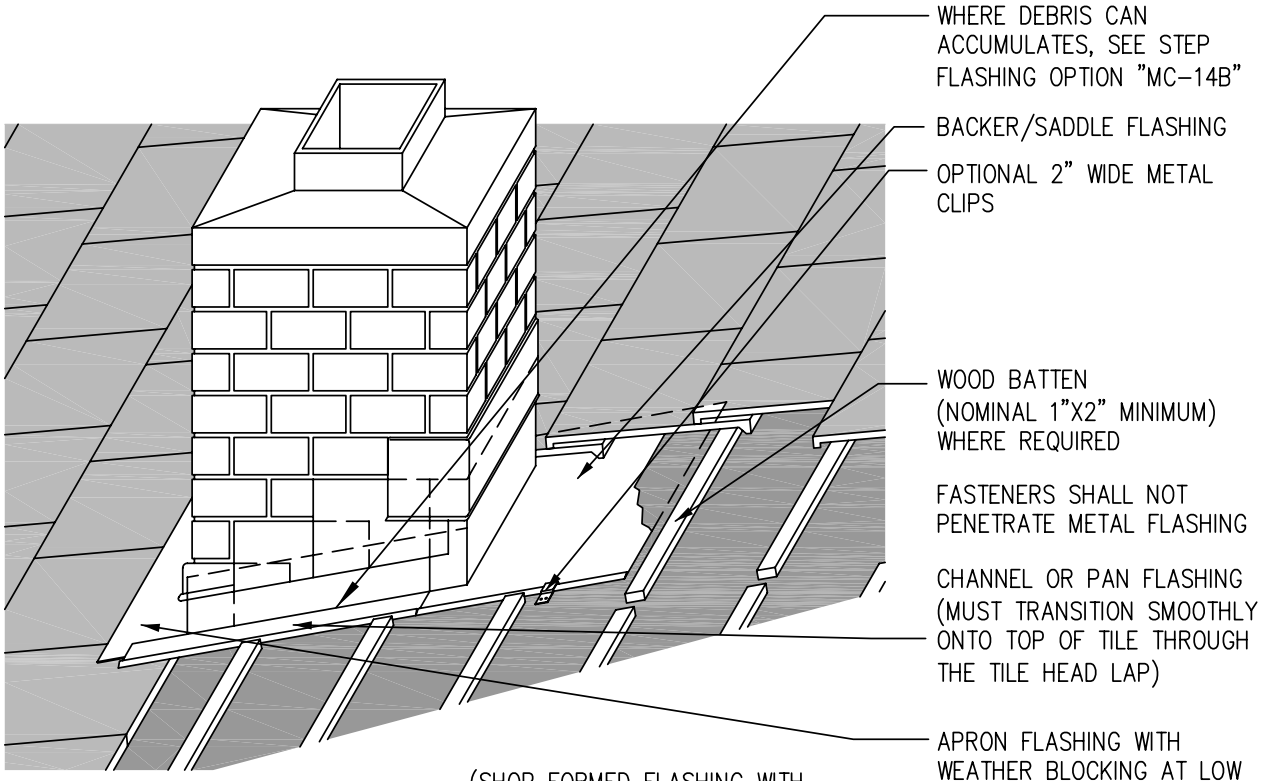
Notes:

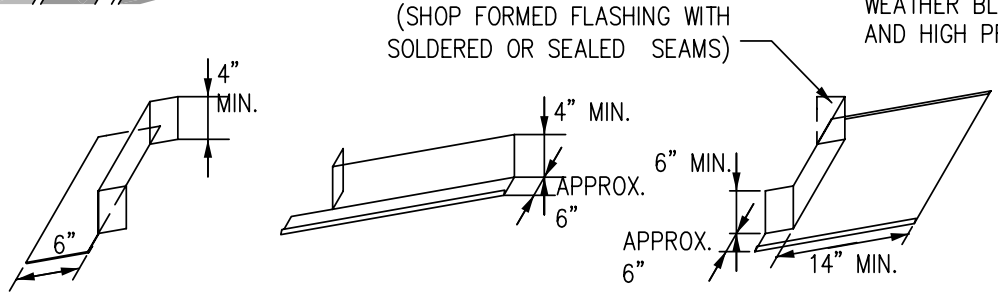
1. Underlayment should extend a minimum of 4" up vertical wood blocking or wall.
2. See MC-12B for additional flashing details.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

CHIMNEY FLASHING - PAN TYPE
(Chimney or other penetration 30" or less wide)

MC-14





APRON FLASHING | PAN OR CHANNEL FLASHING | FLAT BACKER/SADDLE FLASHING

Notes:

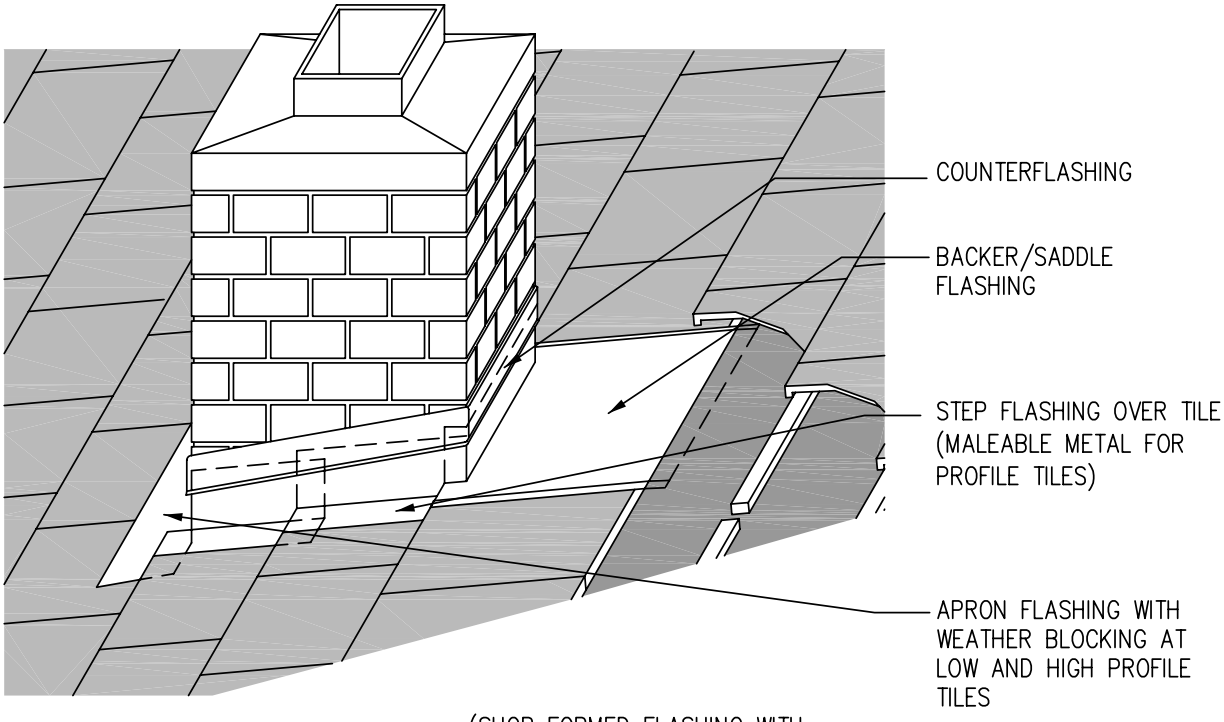
1. Chimney flashing dimensions may vary according to local weather conditions, chimney size, chimney location, slope of roof, rafter length behind chimney and tributary water area.
2. A flat saddle flashing may be used for chimneys and other penetrations less than 30" in width. Extend a minimum of 6" up chimney and 14" up roof slope.
3. A diverter or cricket flashing is recommended for chimneys and other penetrations equal to or greater than 30" in width to promote positive runoff.
4. Dimensions shown are recommended minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
5. Flashing must be securely fastened to chimney or framing
6. Underlayment must turn up chimney wall a minimum of 4 inches.

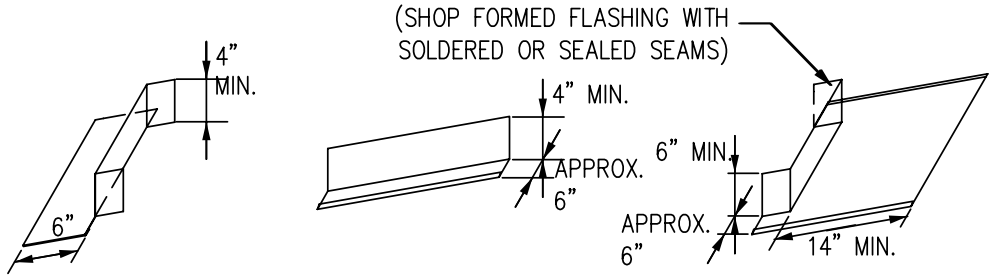
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

CHIMNEY FLASHING - STEP TYPE
(Chimney or other penetration 30" or less wide)

MC-14A

NOTE:
TYPICALLY USED IN AREAS WHERE DEBRIS CAN ACCUMULATE





APRON FLASHING | STEP FLASHING | FLAT SADDLE FLASHING

Notes:

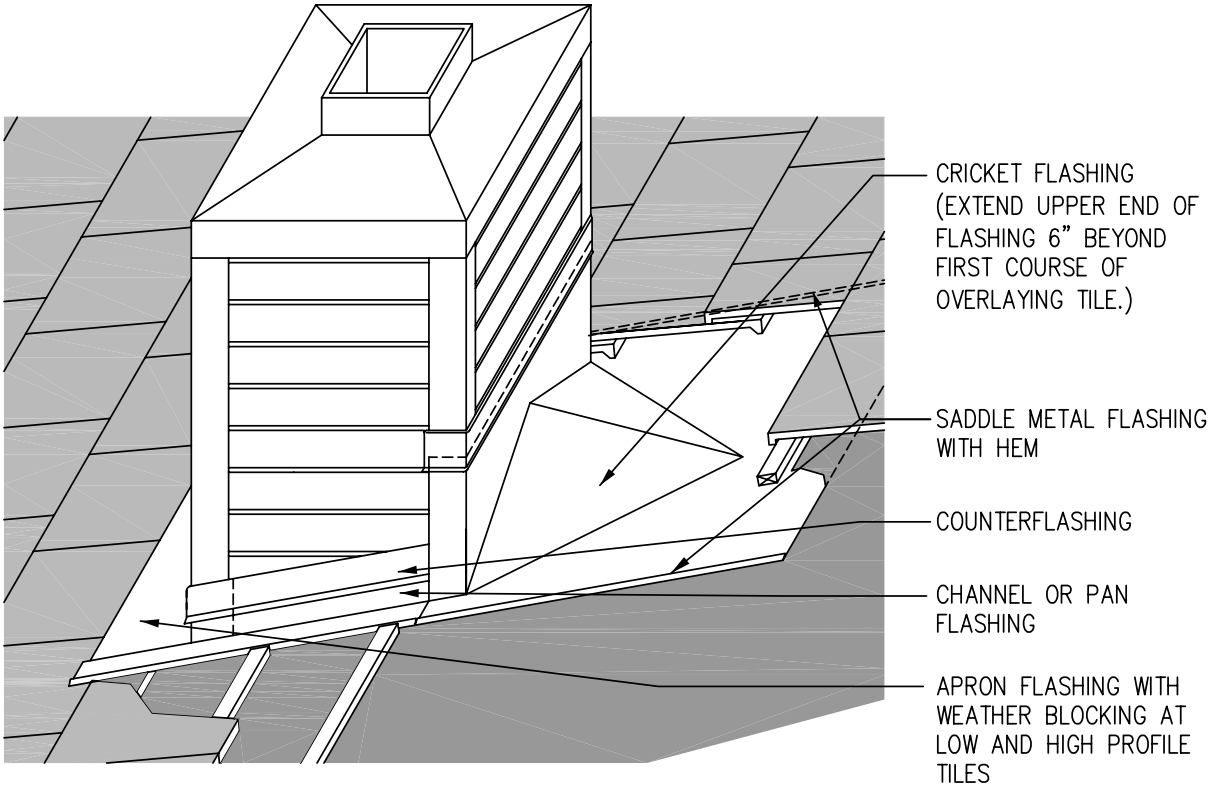
1. Chimney flashing dimensions may vary according to local weather conditions, chimney size, chimney location, slope of roof, rafter length behind chimney and tributary water area.
2. A flat saddle flashing may be used for chimneys and other penetrations less than 30" in width. Extend a minimum of 6" up chimney and 14" up roof slope.
3. A diverter or cricket flashing is recommended for chimneys and other penetrations equal to or greater than 30" in width to promote positive runoff.
4. Dimensions shown are recommended minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
5. Underlayment must turn up chimney wall a minimum of 4 inches.

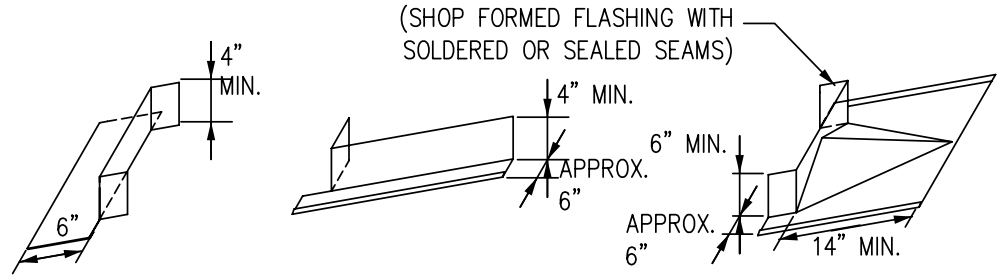
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

CHIMNEY CRICKET FLASHING - PAN TYPE
(Chimney or other penetration greater than 30" wide)

MC-15

NOTE:
WHERE DEBRIS CAN ACCUMULATE, SEE STEP FLASHING OPTION "MC-14A"





APRON FLASHING | PAN OR CHANNEL FLASHING | CRICKET FLASHING

Notes:

1. Chimney flashing dimensions may vary according to local weather conditions, chimney size, chimney location, slope of roof, rafter length behind chimney and tributary water area.
2. A saddle flashing may be used for chimneys and other penetrations less than 30" in width.
3. Extend a minimum of 6" up chimney and 14" up roof slope.
4. A diverter or cricket flashing is recommended for chimneys and other penetrations equal to or greater than 30" in width to promote positive runoff.
5. Dimensions shown are recommended minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. Underlayment must turn up chimney wall a minimum of 4 inches.

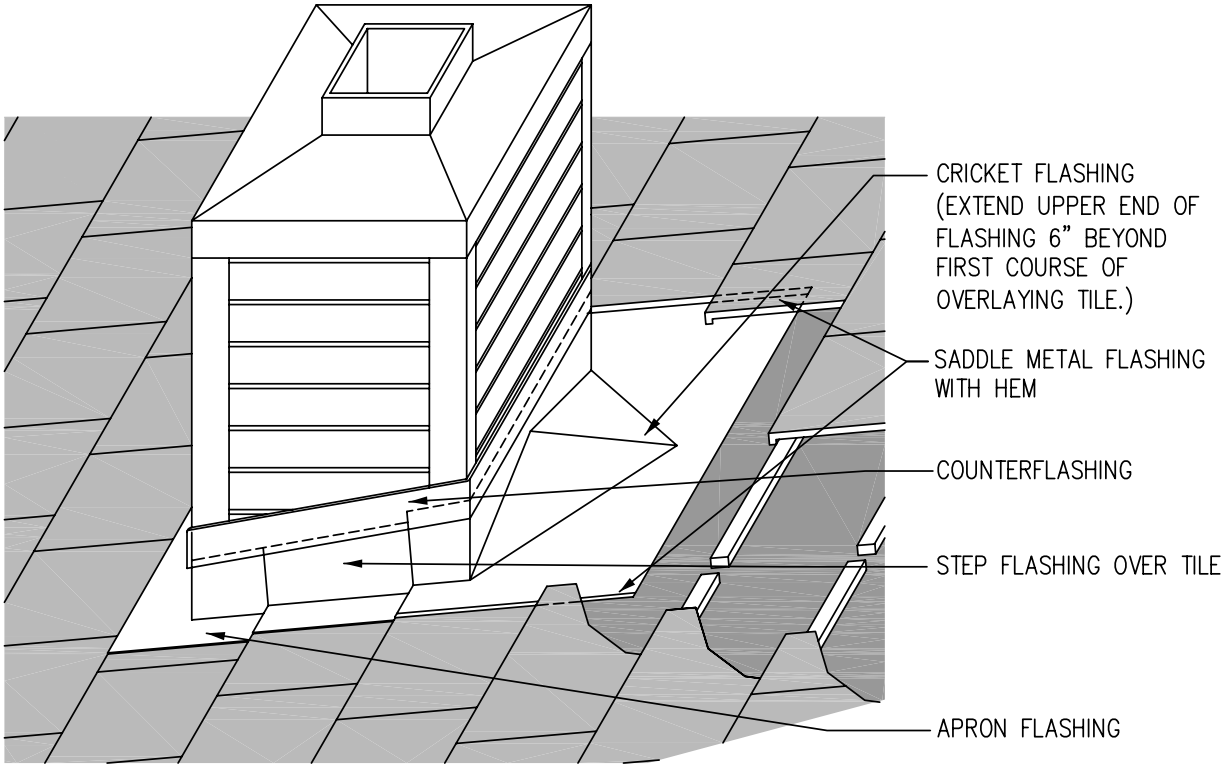
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

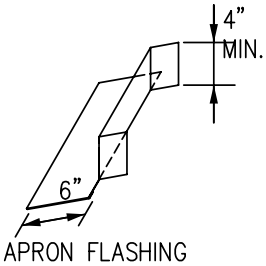
CHIMNEY CRICKET FLASHING - STEP TYPE

(Chimney or other penetration greater than 30" wide)

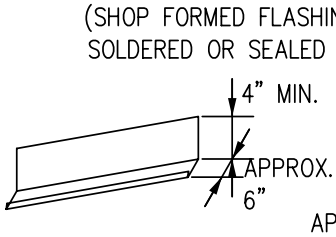
MC-15A

NOTE:
TYPICALLY USED IN AREAS WHERE DEBRIS CAN ACCUMULATE

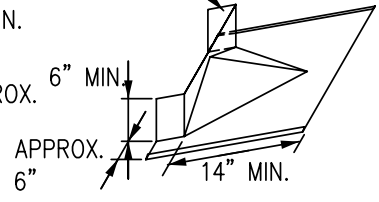




APRON FLASHING



STEP FLASHING



CRICKET FLASHINGN WITH HEM

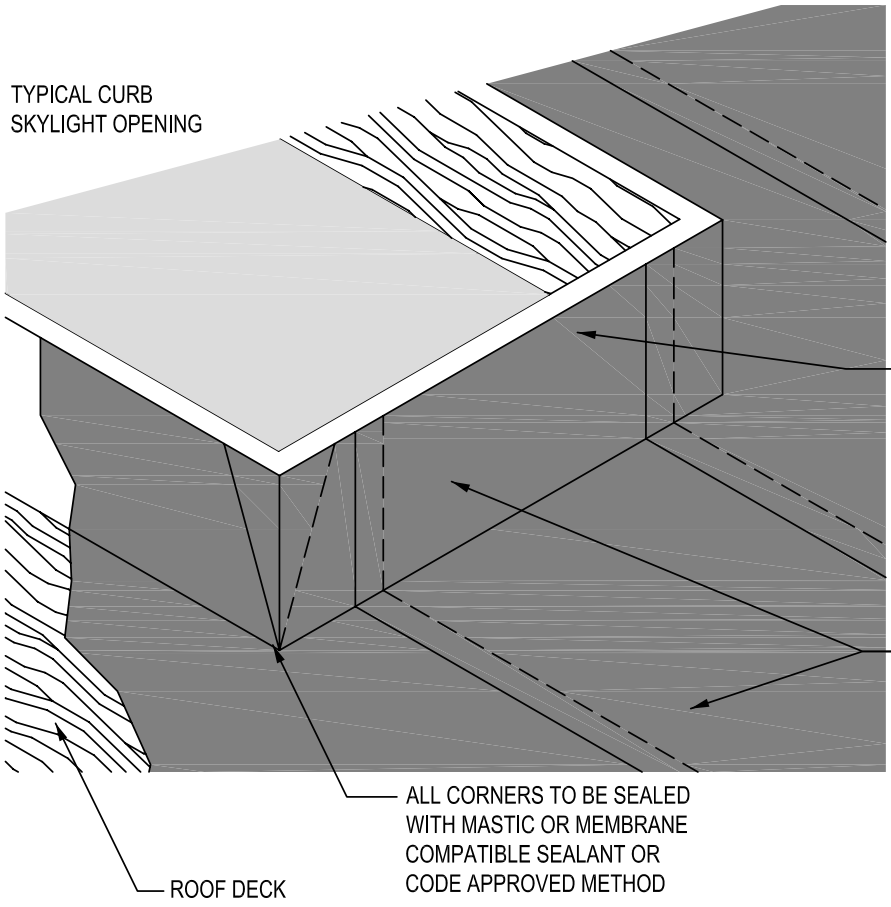
Notes:

1. Chimney flashing dimensions may vary according to local weather conditions, chimney size, chimney location, slope of roof, rafter length behind chimney and tributary water area.
2. A saddle flashing may be used for chimneys and other penetrations less than 30" in width.
3. Extend a minimum of 6" up chimney and 14" upslope.
4. A diverter or cricket flashing is recommended for chimneys and other penetrations equal to or greater than 30" in width to promote positive runoff.
5. Dimensions shown are recommended minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. Underlayment must turn up chimney wall a minimum of 4 inches.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SKYLIGHT UNDERLAYMENT DETAIL

MC-16



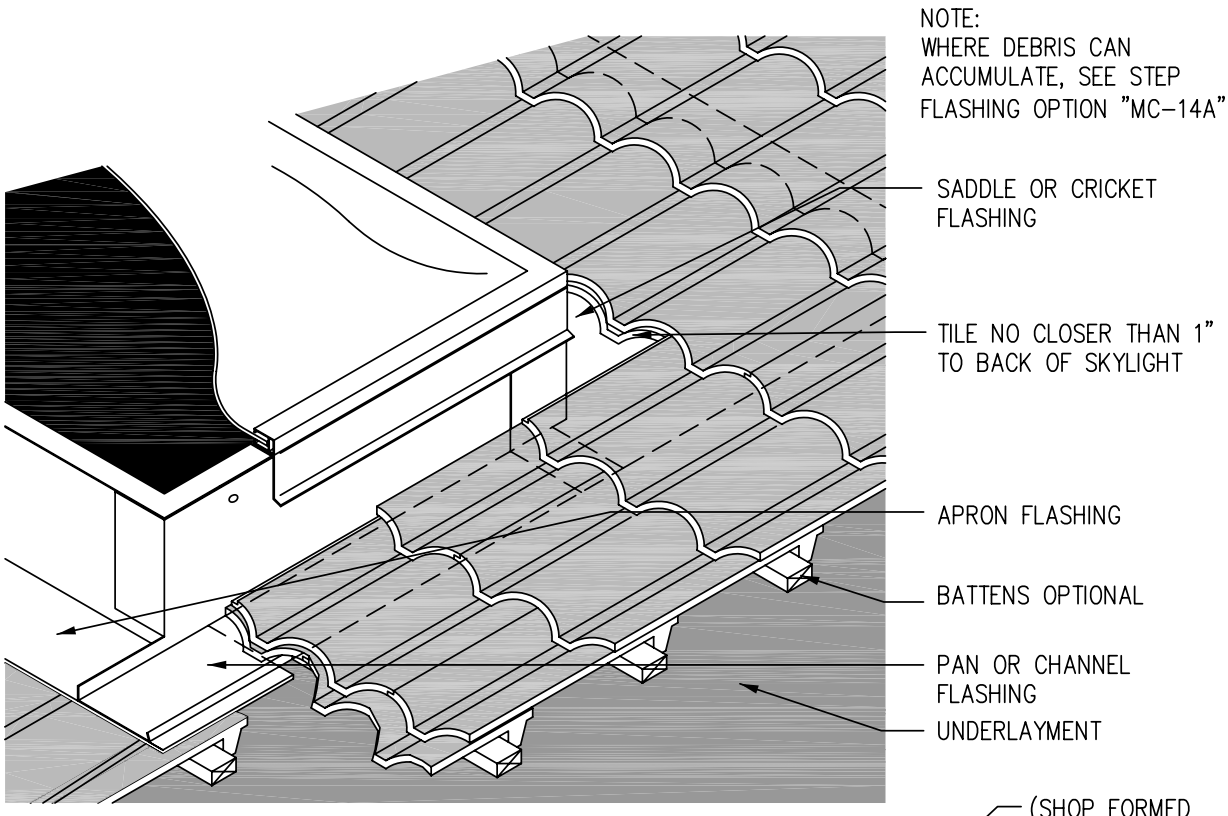
Notes:

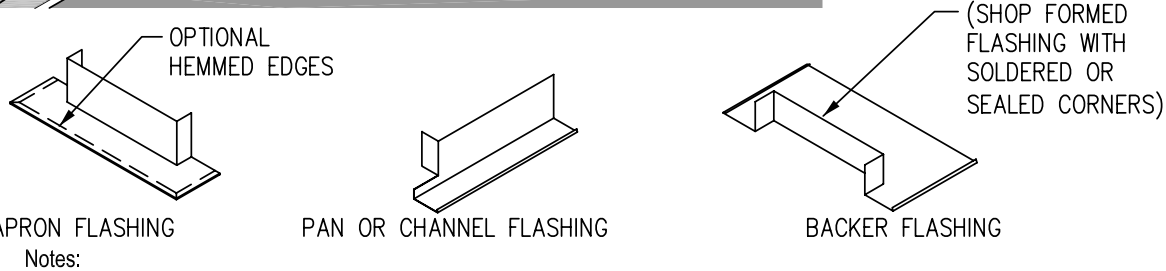
1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 TypeIV), or approved equal is required as minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SKYLIGHT FLASHING - PAN TYPE

MC-16A





Notes:

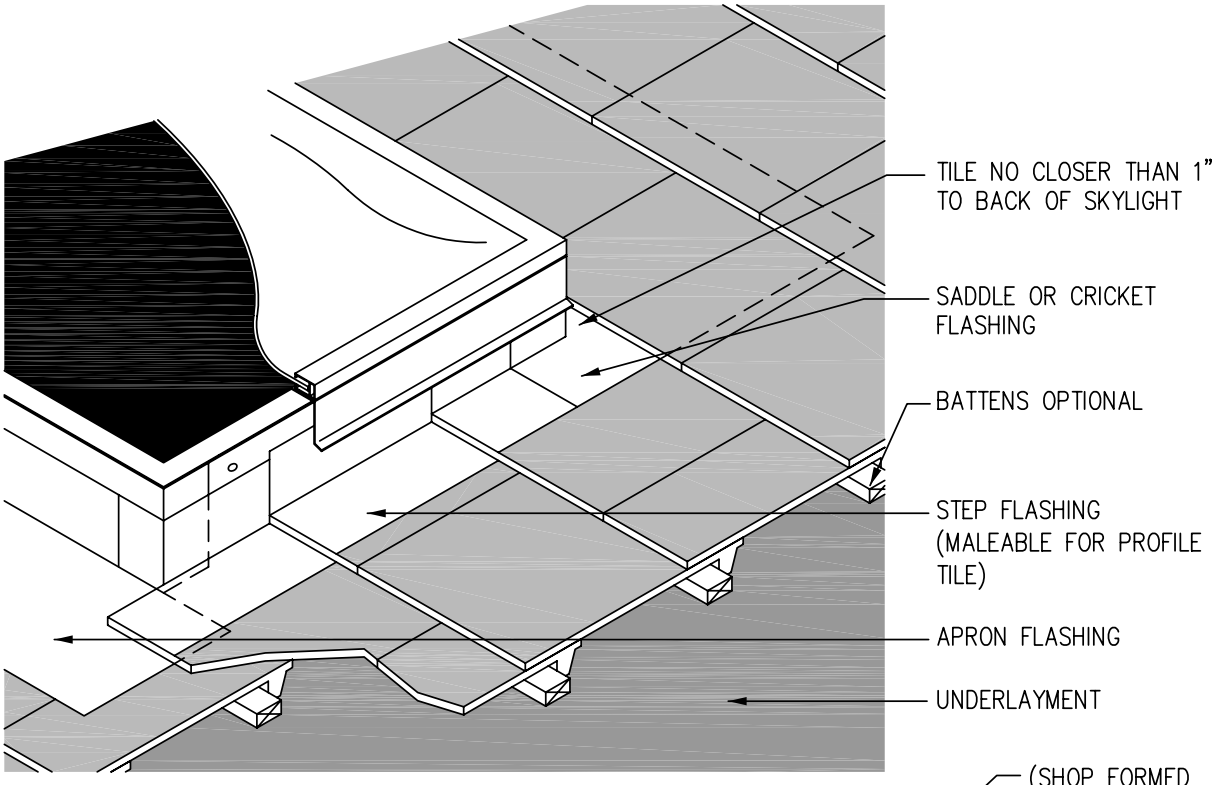
1. Skylight flashing dimensions will vary according to local weather conditions, size, location, slope of roof, rafter length behind skylight and tributary water area.
2. A saddle flashing will be allowed for skylights and other penetrations less than 30" in width. Extend a minimum of 6" or to top of curb and 14" up roof slope.
3. A cricket flashing is recommended for skylights and penetrations equal to or greater than 30" in width to promote positive runoff, unless supporting data shows otherwise.
4. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 TypeIV) as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
5. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. Maleable metal optional for profiled tile.
7. Roof to wall/apron flashing will extend a minimum of 3" over lap/head lap onto tile.

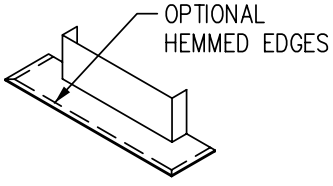
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SKYLIGHT STEP FLASHING

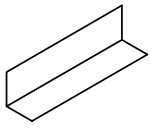
MC-16B

NOTE:
TYPICALLY USED IN AREAS WHERE DEBRIS CAN ACCUMULATE

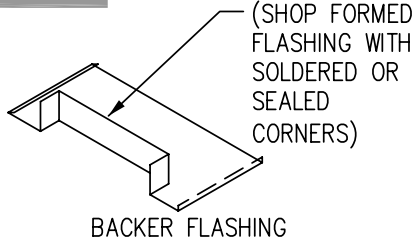




APRON FLASHING



STEP FLASHING



BACKER FLASHING

Notes:

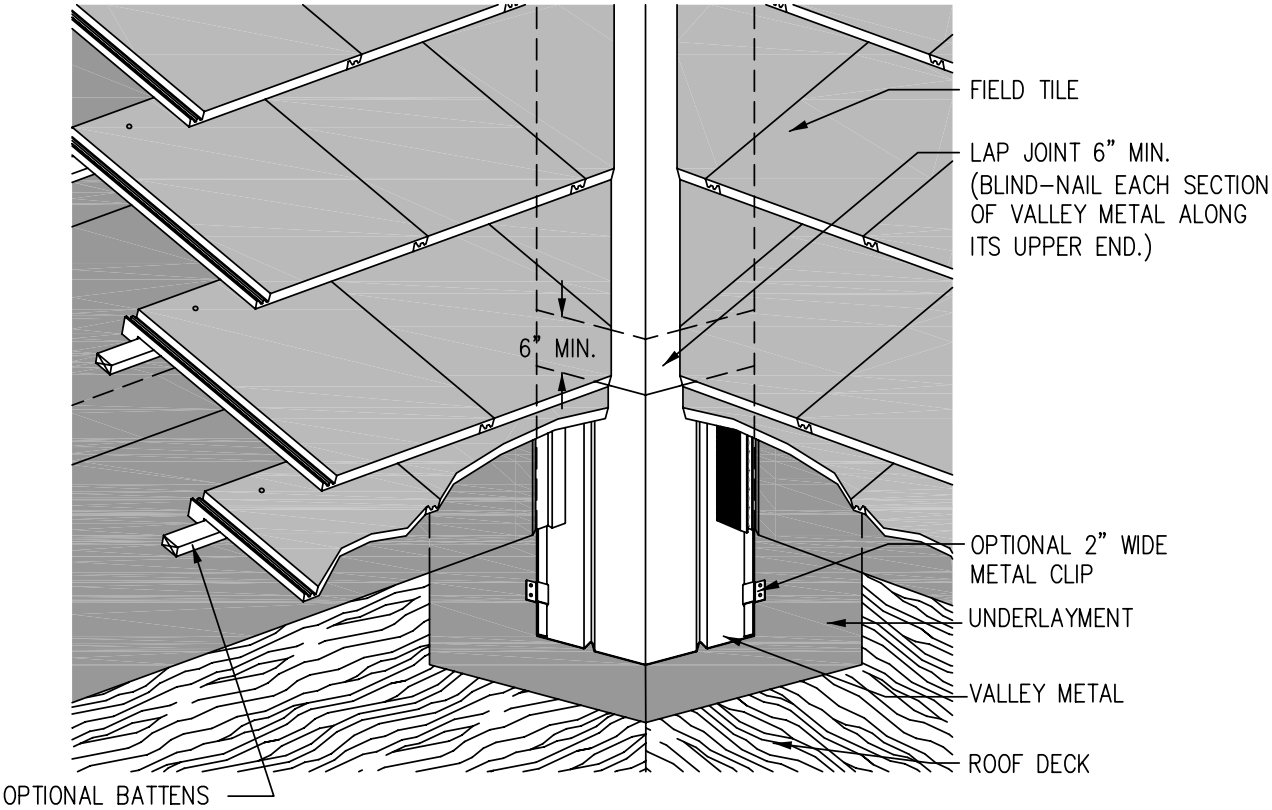
1. Skylight flashing dimensions will vary according to local weather conditions, size, location, slope of roof, rafter length behind skylight and tributary water area.
2. A saddle flashing will be allowed for skylights and other penetrations less than 30" in width. Extend a minimum of 6" or to top of curb and 14" up roof slope.
3. A cricket flashing is recommended for skylights and penetrations equal to or greater than 30" in width to promote positive runoff.
4. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 TypeIV), or approved equal as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
5. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
6. Maleable metal optional for profiled tile.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

OPEN VALLEY - TILE INSTALLED WITH GAP AT VALLEY METAL

MC-17

NOTE:
VALLEY METALS ARE AVAILABLE IN MANY PROFILES. THIS DRAWING SHOWS A GENERIC METAL FOR ILLUSTRATION PURPOSES.



Note: Tile valleys may be cut closed or open. Valley metals shall conform to IBC section 1507.3.9, IRC R905.3.8 and UBC section 1508.4. When flat profiled tile is installed as "closed valley" a ribbed valley metal or a single crown valley metal with a batten extension shall be used.

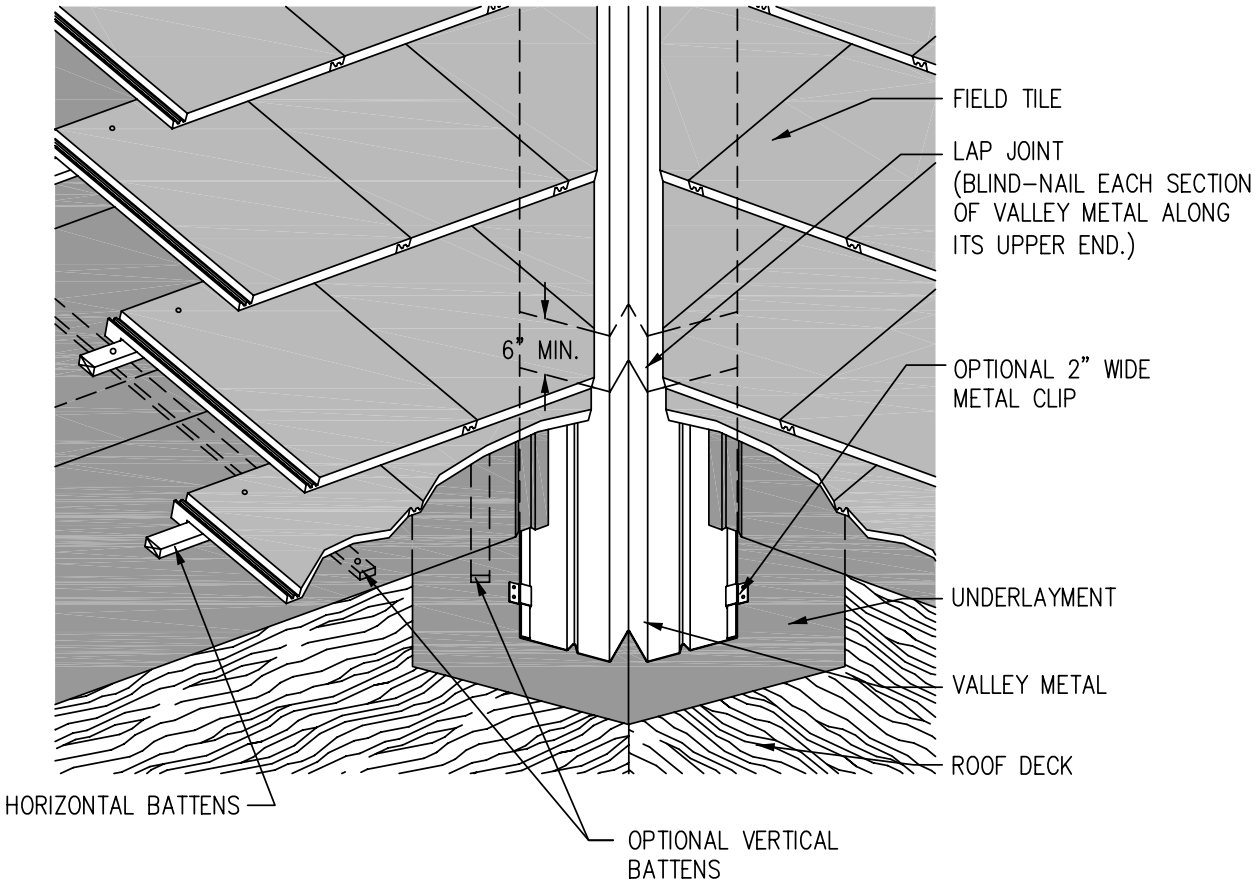
Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) or approved equal as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Cut tile pieces should be secured by one or a combination of the following: (a) code approved adhesive; (b) wire ties (c) batten extender (d) cut tile clip or (e) other code approved fastening device.
3. Metal valley flashing is required to be a minimum of No. 26 gauge G-90 galvanized steel, 16 oz. copper or an equivalent longevity non-corrosive metal. Valley flashing metal will comply with IBC section 1507.3.9, IRC section R905.3.8 and UBC section 1508.4.
4. Other valley metal profiles are available. See MC-12B.
5. For tile fastening schedule(s) see Fastening Table 1A and 1B.
6. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 and 7:12. Direct deck attachment of tile is permissible, verify with local building code.
7. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
8. Valley metal design must be able to control and discharge expected water flows.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

EXAMPLE OF OTHER VALLEY METAL PROFILES

MC-17A



Note: Metal valley flashing to comply with IBC section 1507.3.9, IRC section R905.3.8 and UBC section 1508.4 unless approved by local building official. When flat profiled tile is installed as "closed valley" a ribbed valley metal or a single crown valley metal with a batten extension shall be used.

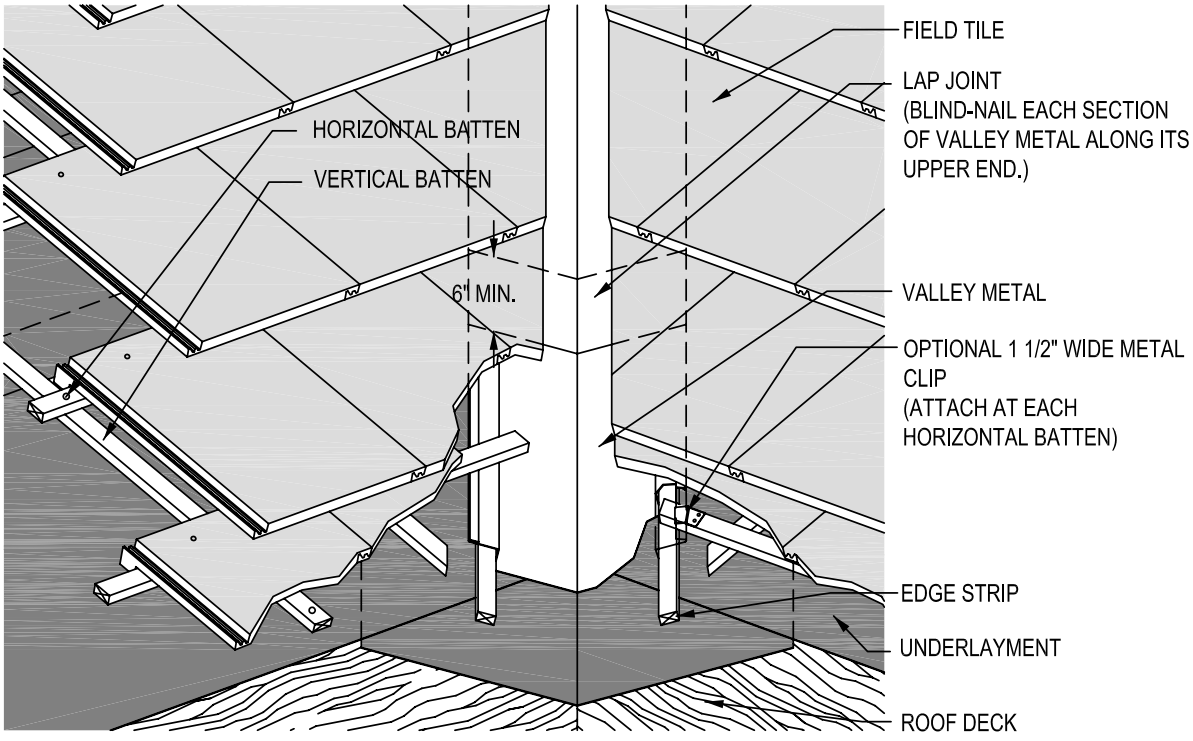
Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) or approved equal is the minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Cut tile pieces should be secured by one or a combination of the following: (a) code approved adhesive; (b) wire ties (c) batten extender (d) cut tile clip or (e) other code approved fastening device.
3. Metal valley flashing will be a minimum of No. 26 gauge G-90 galvanized steel, 16 oz. copper or an equivalent longevity non-corrosive metal.
4. Other valley metal profiles are available. See MC-12B.
5. For tile fastening schedule(s) see Fastening Table 1A and 1B.
6. Tile must extend a minimum of 4" over the valley metal
7. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 and 7:12. Direct deck attachment of tile is permissible, verify with local building code.
8. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
9. Valley metal design must be able to control and discharge expected water flows.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

VALLEY METAL - FOR DEEP TROUGH VALLEY

MC-17B



OPTION 1
HORIZONTAL BATTEN
OVER METAL

OPTION 2
HORIZONTAL BATTEN
UNDER METAL

Note: Valley metals shall extend at least 11" from center line each way and shall have a splash diverter rib not less than 1" high at the flow line formed as part of the flashing. Other designs that will handle anticipated water flows may be used upon submission of supporting data indicating that anticipated water flows are equivalent to the code requirements.

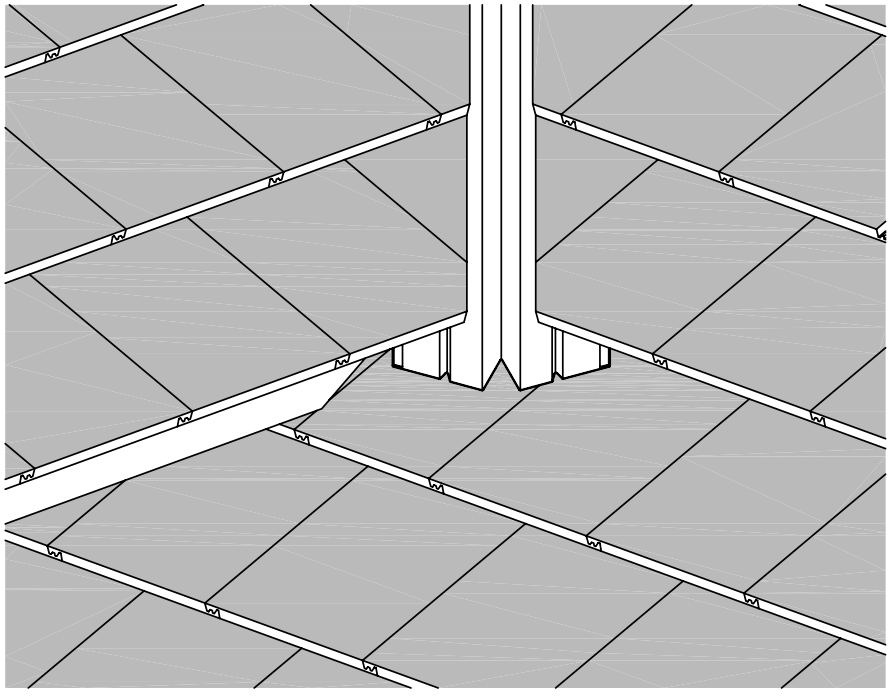
Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. An ice-dam protection membrane, where required by code, shall be used on all downslope roof perimeter (e.g. eaves), valleys, and around penetrations.
3. Cut tile pieces shall be secured by one or a combination of the following: (a) code approved adhesive; (b) wire ties (c) batten extender (d) cut tile clip or (e) other code approved fastening device.
4. Metal valley flashing will be a minimum of 26 gauge G-90 galvanized steel, 16 oz. copper or an equivalent longevity non-corrosive metal. Metal valley flashing to comply with IBC section 1507.3.9, IRC section R905.3.8 and UBC section 1508.4 unless approved by local building official. On projects with large expansive roof areas and/or long rafter lengths wider valley metal is required. Tile shall extend over valley metal into valley trough a minimum of 1-1/2".
5. Other valley metal profiles are available. See MC-12B.
6. For tile fastening schedule(s) see Fastening Table 1A and 1B.
7. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

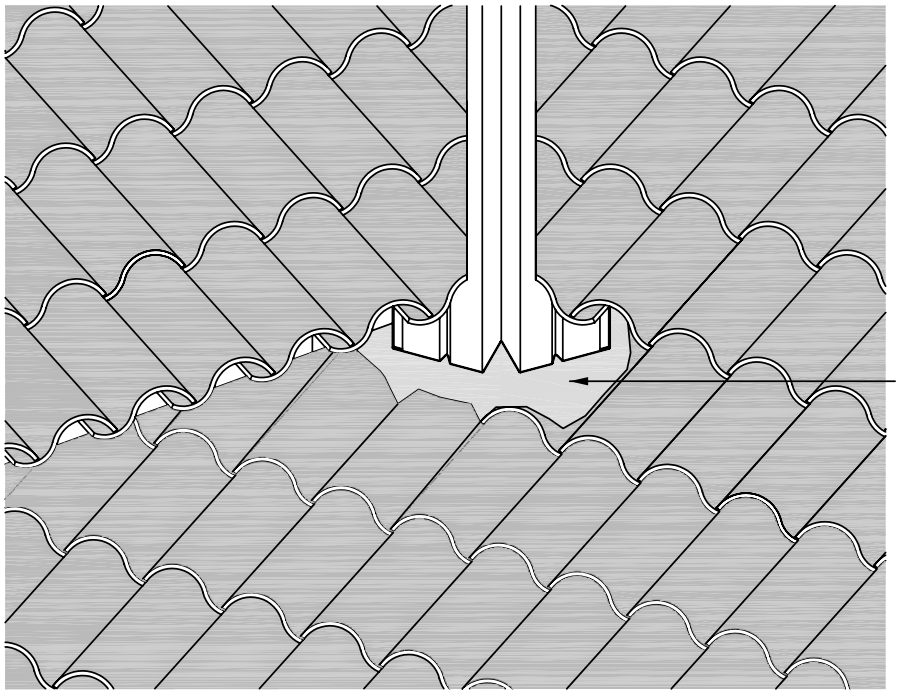
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

VALLEY TRANSITIONS

MC-17C



THE VALLEY MUST LAP ONTO THE TILE OF THE COURSE BELOW THE ROOF TRANSITION



THE VALLEY MUST LAP ONTO THE TILE OF THE COURSE BELOW THE ROOF TRANSITION

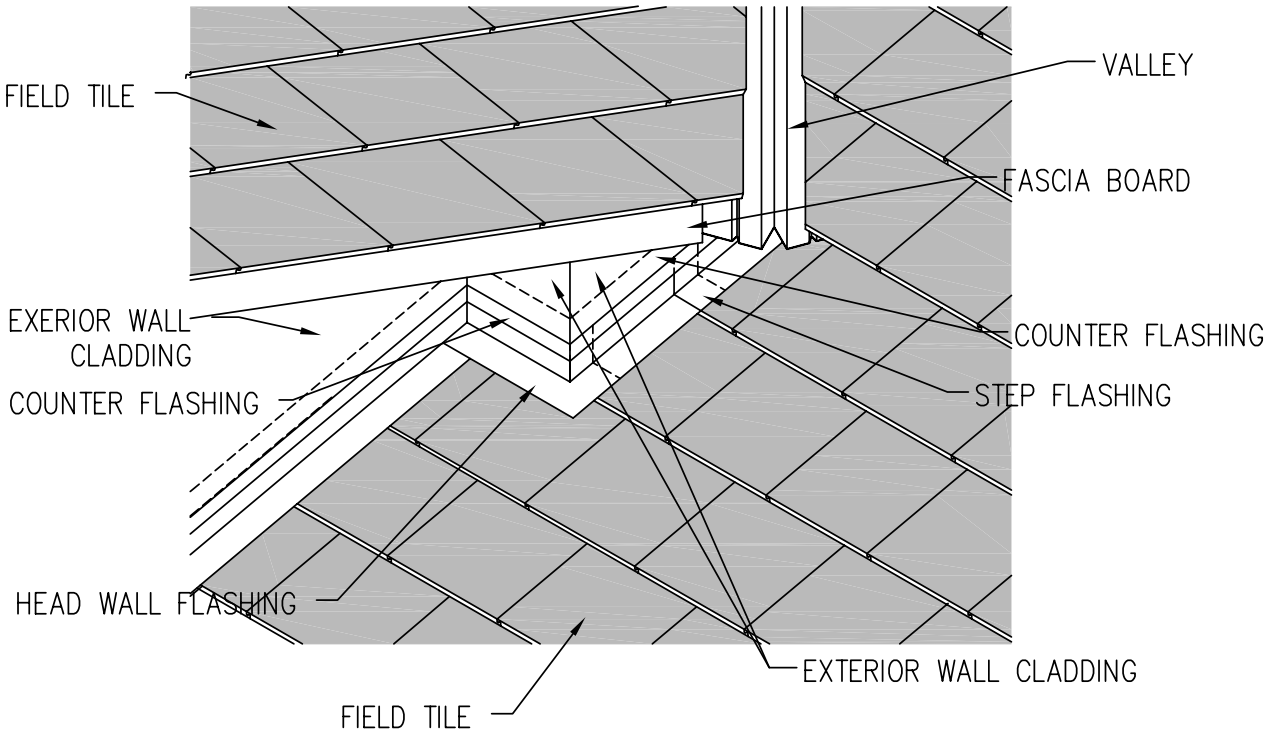
LEAD SOAKER OR OTHER MALLEABLE METAL SHOULD BE USED TO FORM A WATER-TIGHT TRANSITION

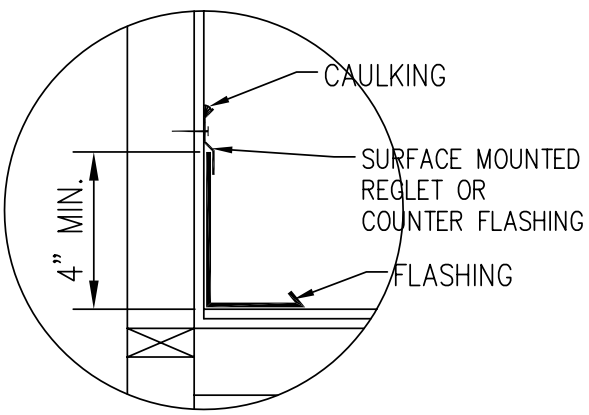
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

 TILE ROOFING INSTITUTE\WSRCA ICC-ES ESR-2015 01/2002, Revised 07/2006

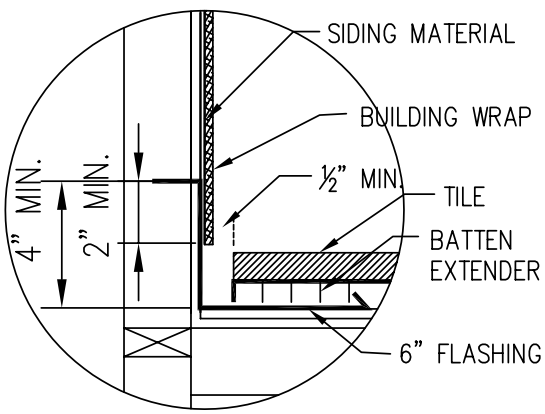
BOXED-IN SOFFIT

MC-17D





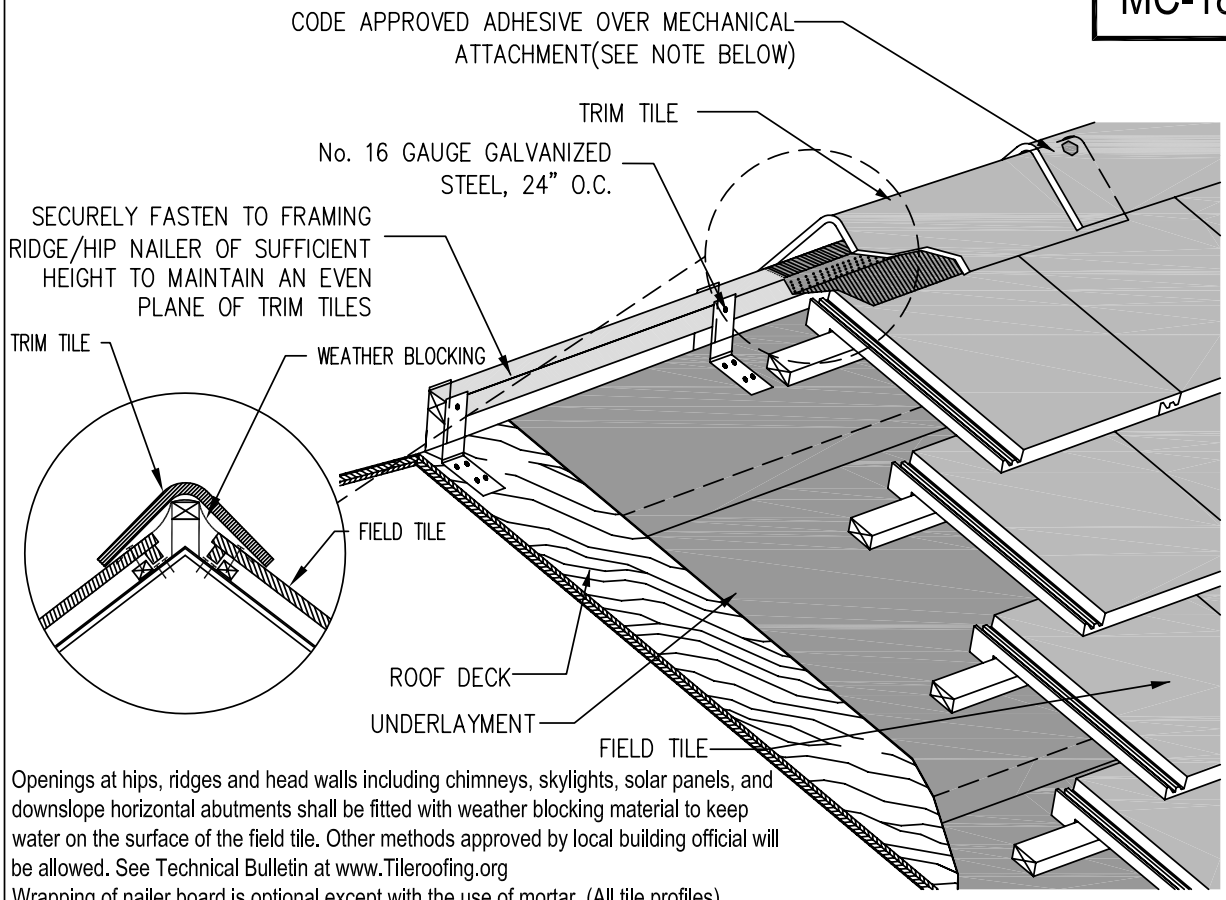
SURFACE MOUNT FLASHING



Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

HIP AND RIDGE

MC-18



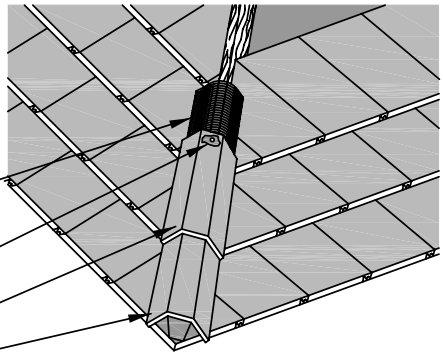
Openings at hips, ridges and head walls including chimneys, skylights, solar panels, and downslope horizontal abutments shall be fitted with weather blocking material to keep water on the surface of the field tile. Other methods approved by local building official will be allowed. See Technical Bulletin at www.Tileroofing.org

Wrapping of nailer board is optional except with the use of mortar. (All tile profiles)

Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) or approved equal as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. All hip and ridge tile are required to have a code approved adhesive between laps of trim tile.
3. For tile fastening schedule(s) see Fastening Table 1A and 1B.
4. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 and 7:12. Direct deck attachment of tile as approved by local building official is allowed.
5. Roofer's mastic or tile adhesive must be applied at hip and ridge trim headlap to cover nail hole and create a bond between ridge tiles.

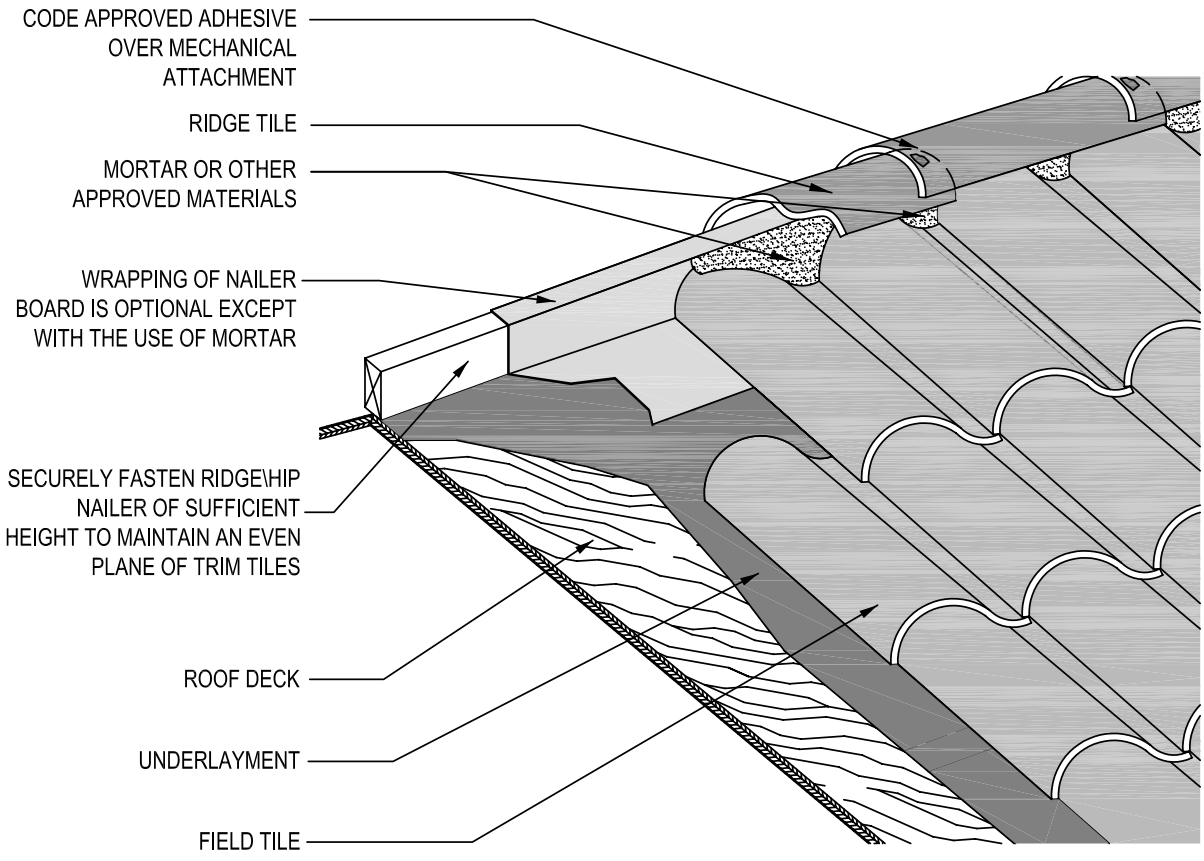
Field tiles shall be cut to within an average of 1/2" of nailer board.
Nail each trim with a corrosion-resistant fastener of sufficient length to penetrate nailer board a minimum 3/4".
Cut tiles without nail holes may be drilled, notched and nailed or affixed with tile adhesive, wire and/or cut tile clips.



Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

HIP AND RIDGE

MC-18A



Note:
Openings at hips, ridges and head walls including chimneys, skylights, solar panels, and downslope horizontal abutments shall be fitted with weather blocking material to keep water on the surface of the field tile. Other methods approved by local building official will be allowed. See Technical Bulletin at www.Tileroofing.org

Wrapping of nailer board is optional except with the use of mortar. (All profiles of tile)

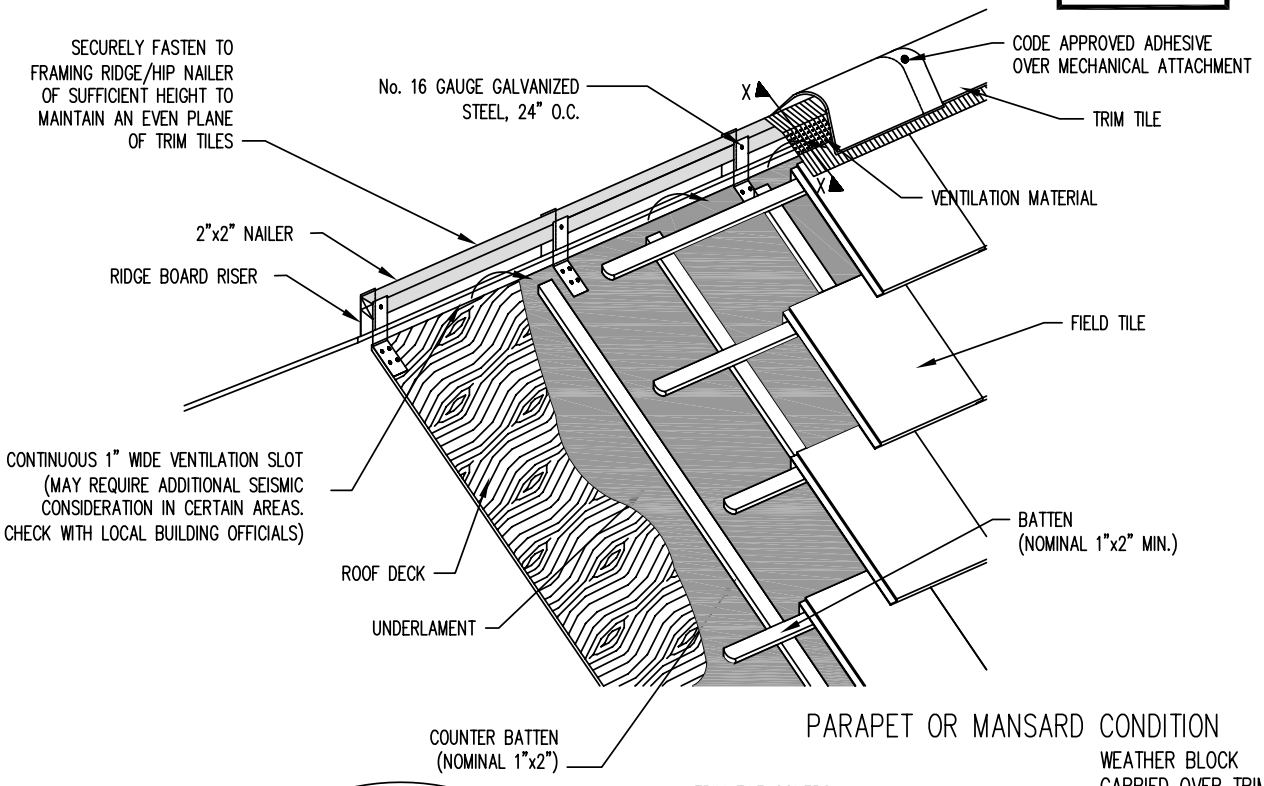
Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. All hip and ridge tile are required to have a code approved adhesive or special clip between laps of trim tile.
3. For tile fastening schedule(s) see Fastening Table 1A and 1B.
4. Battens for tiles with protruding anchor lugs are optional for slopes between 3:12 and 7:12. Direct deck attachment of tile as approved by local building official will be allowed.
5. Roofer's mastic or tile adhesive must be applied at hip and ridge trim headlap to cover nail hole and create a bond between ridge tiles.

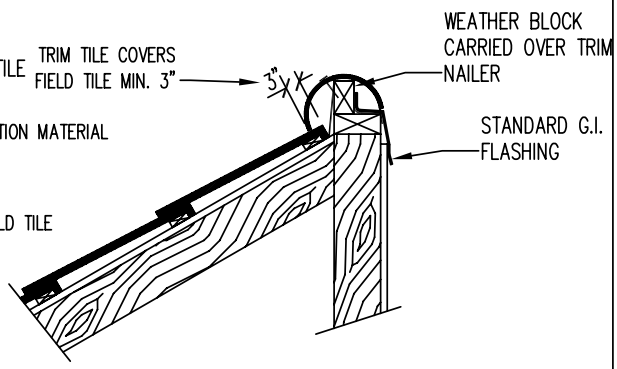
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

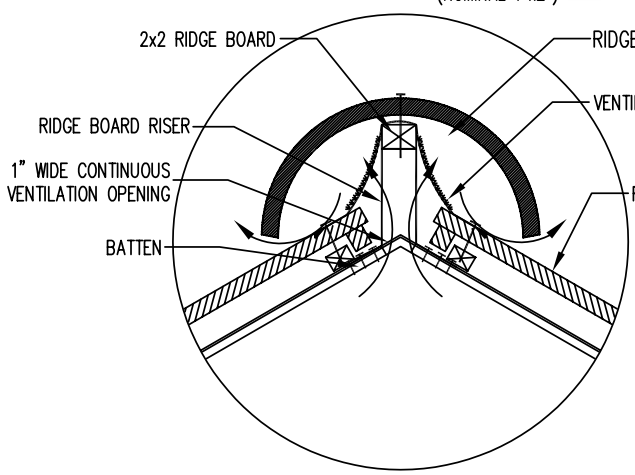
VENTED RIDGE (OPTION)

MC-18B



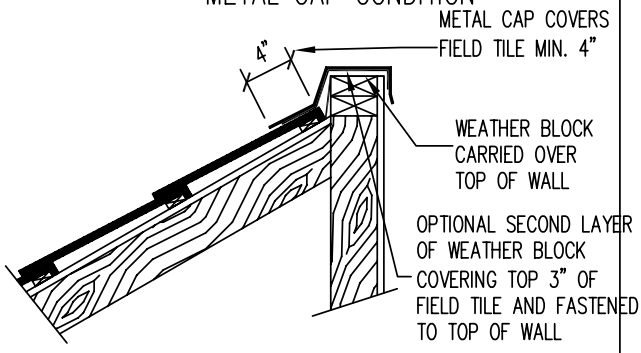
PARAPET OR MANSARD CONDITION





CROSS SECTION "X-X"

METAL CAP CONDITION

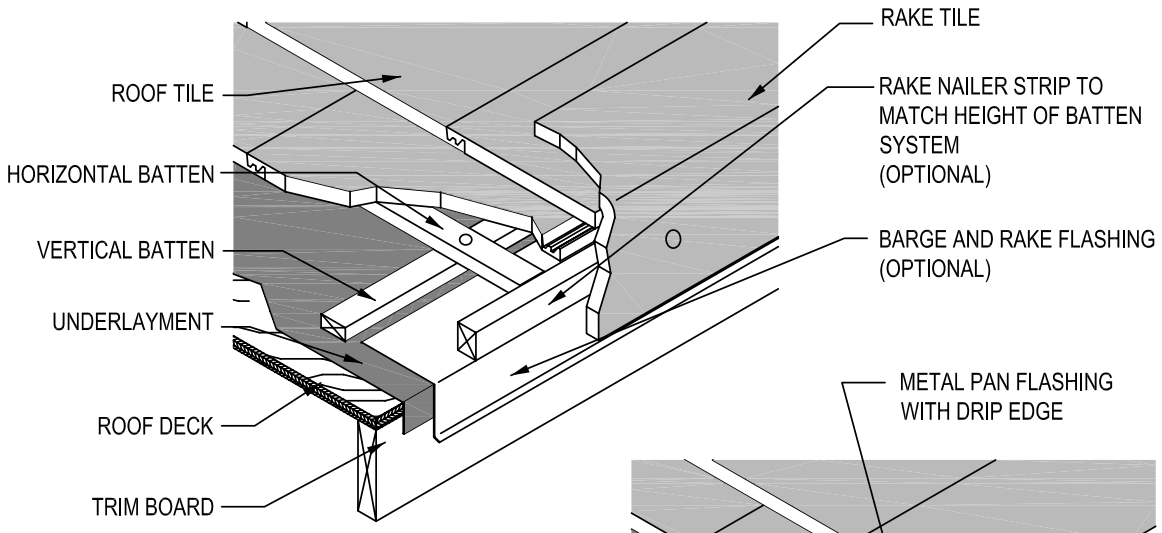


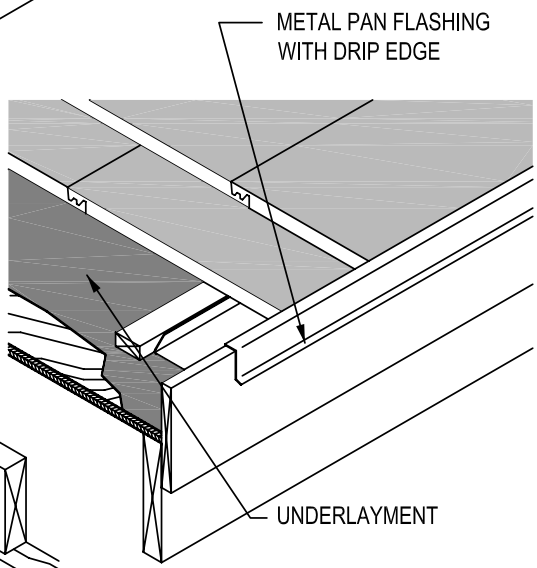
NOTE:
REFER TO VENT MANUFACTURERS INSTRUCTIONS FOR PRODUCT REQUIREMENTS AND LIMITATIONS.

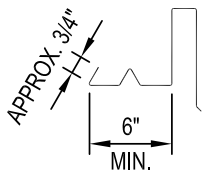
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

RAKE FLASHING - COUNTER BATTEN SYSTEM (Where Required)

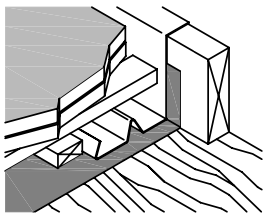
MC-19







OPTIONAL PAN FLASHING AT METAL RAKE



INSIDE VIEW OF PAN FLASHING

Notes:

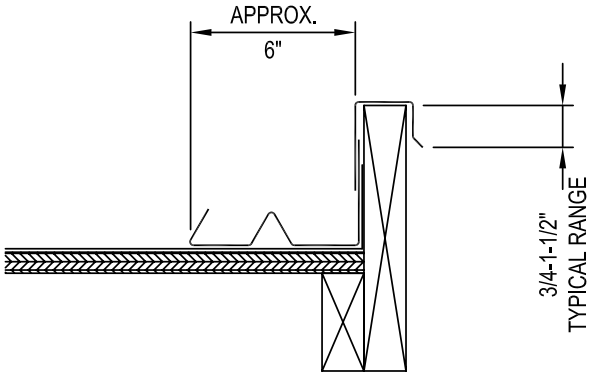
1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 Type II (ASTM D4869 Type IV) or approved equal as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. Sheet metal Flashing shall be a minimum of 26 ga. G-90 galvanized steel, 16 oz. copper or an equivalent longevity non-corrosive metal.
3. For tile fastening schedule see Fastening Table 1A and 1B.
4. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
5. Rake flashing and wood nailer/trim board shall be raised above the roof deck to a height greater than the height of the installed roof tile.
6. Rake tiles must be fastened into a minimum nominal 2" gable fascia or equivalent in dimension from multiple pieces.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

RAKE FLASHING - OPTIONS

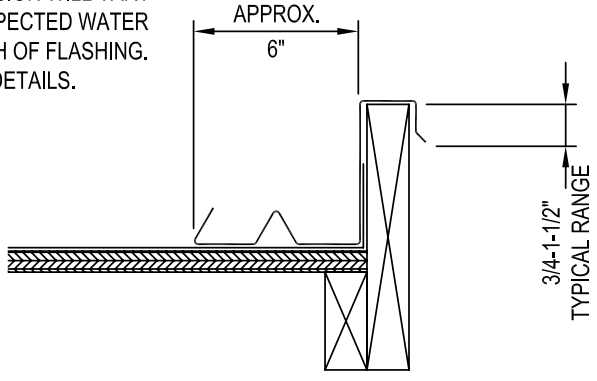
MC-19A

SEE DRAWING MC-12B FOR ADDITIONAL FLASHING INFORMATION

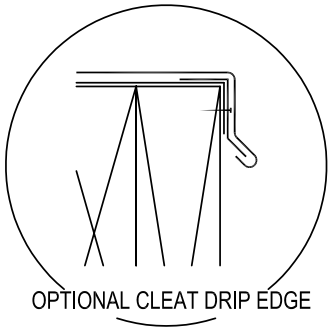


2 PIECE METAL PAN FLASHING WITH DRIP EDGE

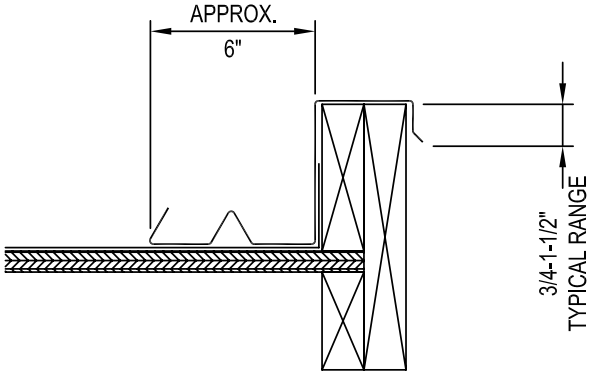
NOTE:
6" PAN DIMENSION WILL VARY BASED ON EXPECTED WATER FLOW & DEPTH OF FLASHING. TYPICAL ALL DETAILS.



ONE METAL PAN FLASHING WITH DRIP EDGE



OPTIONAL CLEAT DRIP EDGE



METAL PAN FLASHING WITH DRIP EDGE

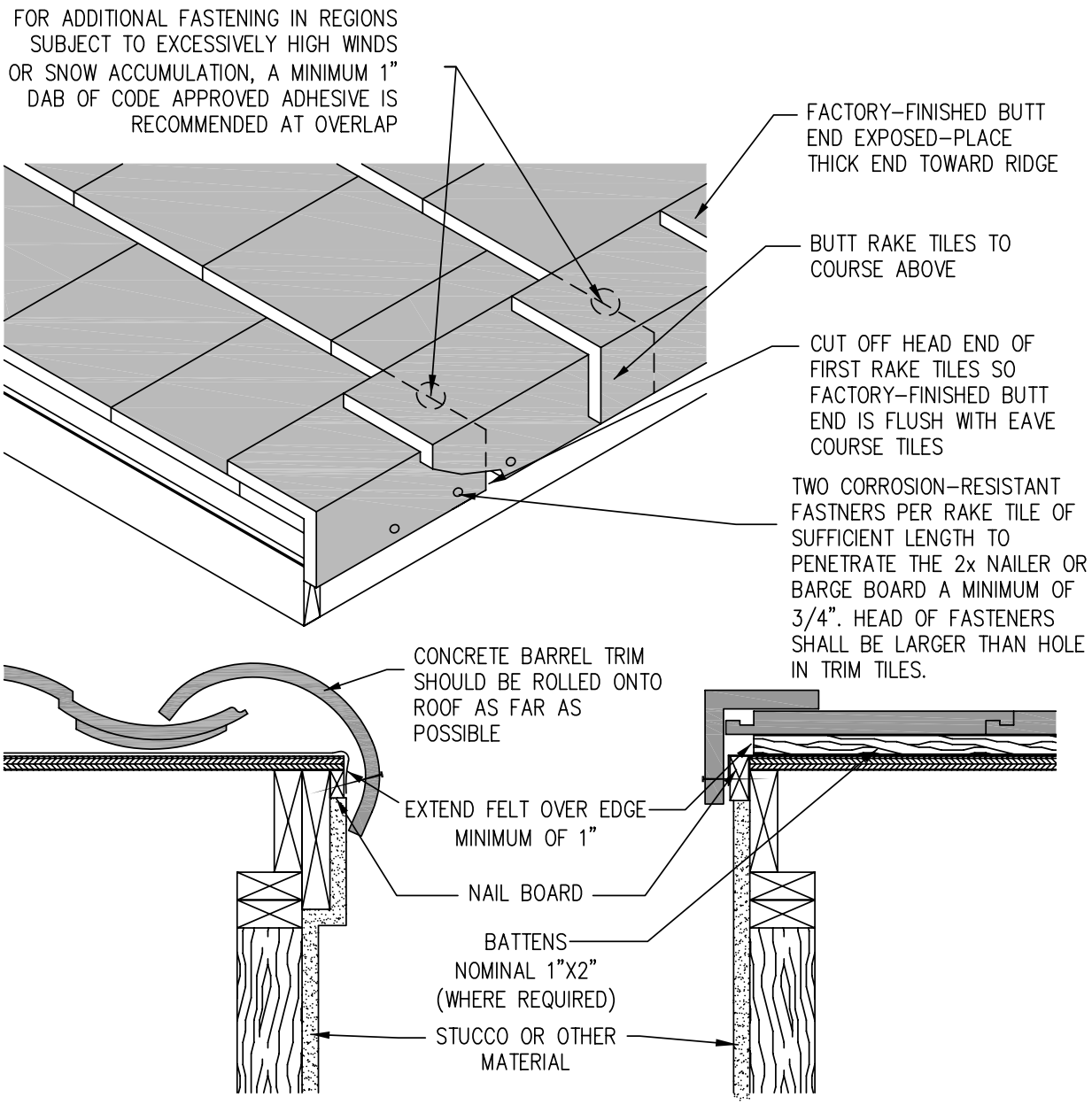
Notes:

1. Flashing details may vary according to local weather conditions, slope of roof and tributary water area.
2. Underlayment will extend a minimum of 4" up vertical wood blocking, wall, or to the top of gable facia.
3. Sheet metal Flashing should be a minimum of 26 ga. G-90 galvanized steel, 16 oz. copper or an equivalent longevity non-corrosive metal.
4. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
5. Rake flashing and wood nailer/trim board will be raised above the roof deck to a height greater than the height of the installed roof tile.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

RAKE TILE INSTALLATION

MC-19B



Notes:

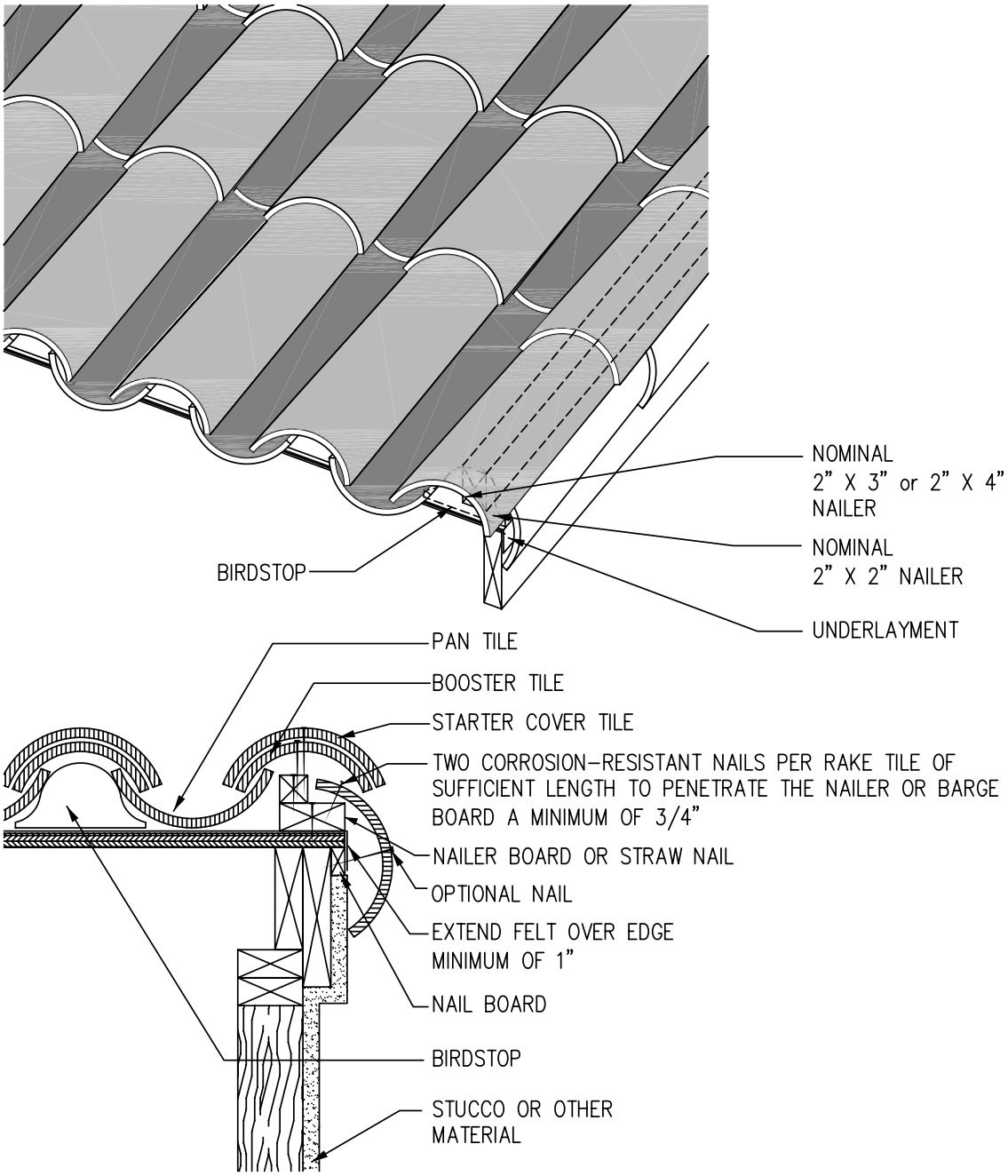
1. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
2. See Footnote 4 Table 1A for additional fastening instructions.
3. Rake tiles must be be fastened into a minimum nominal 2" gable facia or equivalent in dimension.
4. The fasteners must penetrate a minimum of 3/4" into dimensional wood lumber.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

GABLE \ EAVE INSTALLATION - BARREL TILE

MC-20

(CLAY TILE INSTALLATIONS)



Notes:

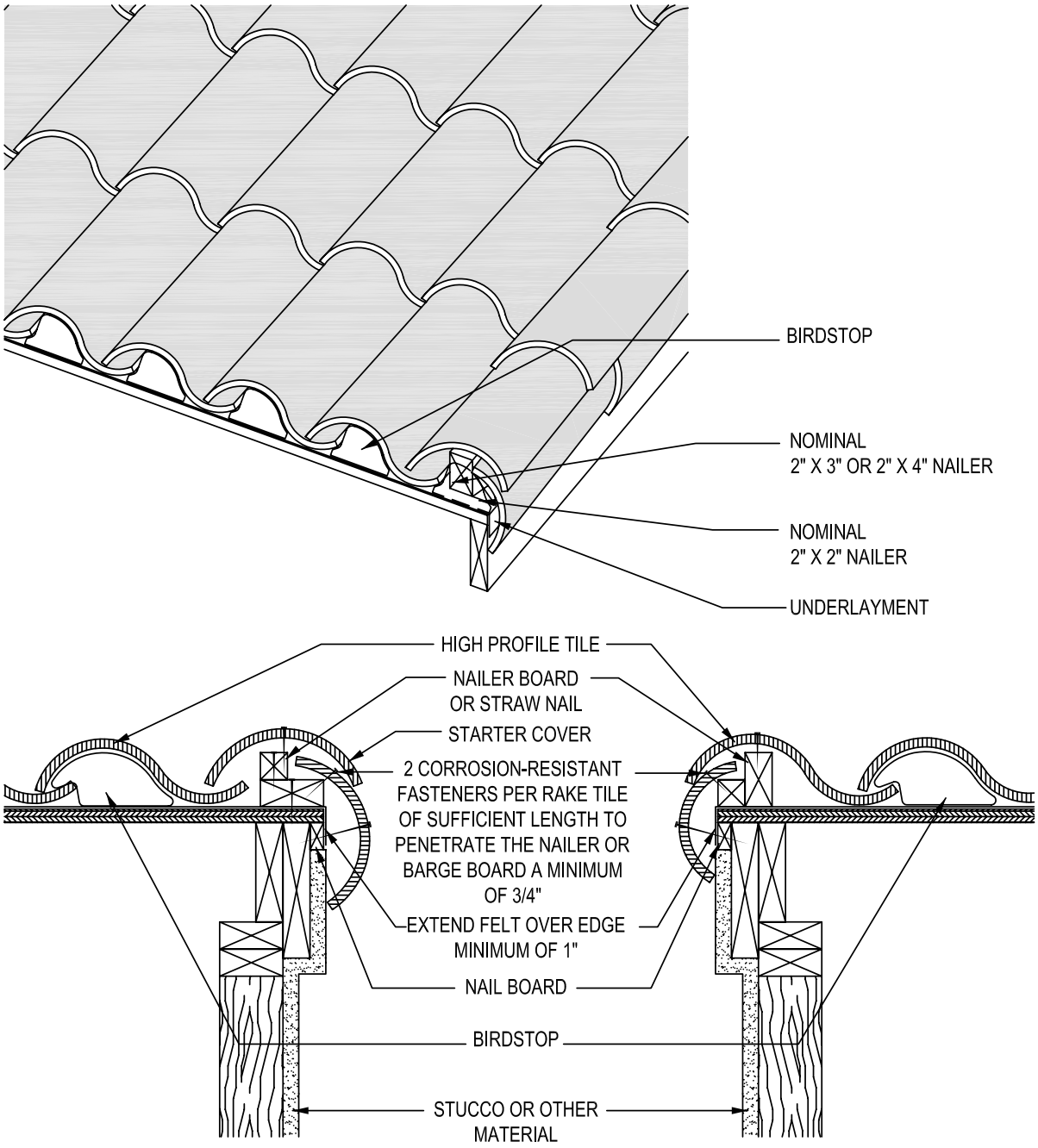
1. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
2. See Footnote 4 Table 1A for additional fastening requirements.
3. The fasteners must penetrate a minimum of 3/4" into dimensional wood lumber.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

GABLE \ EAVE INSTALLATION

(CLAY TILE INSTALLATIONS)

MC-20A



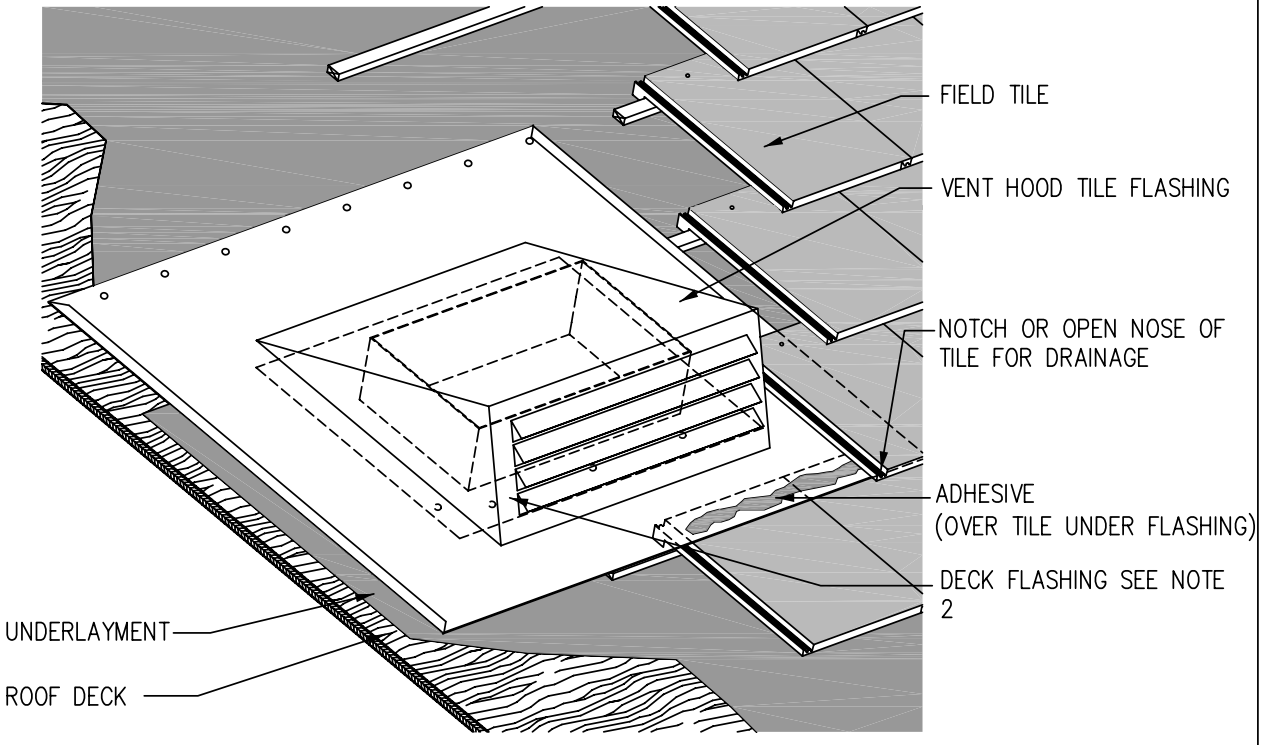
Notes:

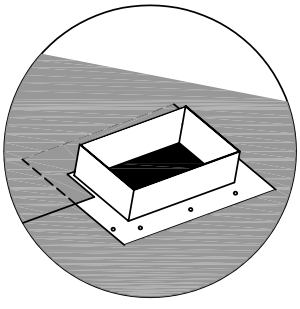
1. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.
2. The fasteners must penetrate a minimum of 3/4" into dimensional wood lumber.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

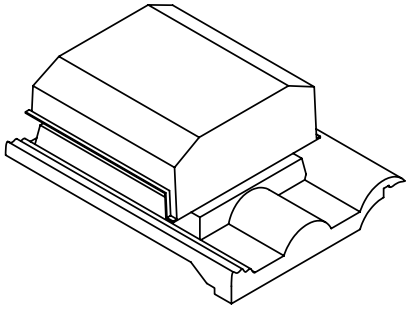
ROOF VENTS (OFF RIDGE)

MC-21





UNDERLAYMENT DETAIL
AT DECK FLASHING
HEIGHT OF FLASHING TO BE AT LEAST 1/2"



VENTED TILES AVAILABLE TO MATCH
INDIVIDUAL TILE MANUFACTURER PROFILES.

NOTE:
CHECK LOCAL CODE REQUIREMENTS FOR VERMIN SCREENING

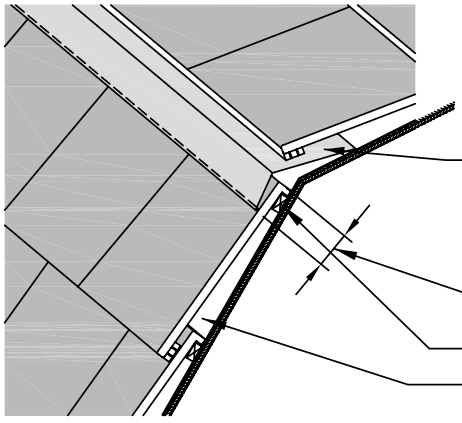
Notes:

1. One layer of No. 30 asphalt-saturated felt complying with ASTM D-226 (ASTM D4869 Type IV) or approved equal is required as a minimum underlayment on all tile roof applications. Other underlayments as approved by local building officials will be allowed.
2. A splash diverter is required on the deck around the penetration to prevent moisture intrusion should water reach the underlayment, under the roof tile. Deck flashing is required with all tiles.
3. For climates with wind driven rain or blowing snow, consult local building official for approved application.
4. Seal as required to prevent water intrusion

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SLOPE CHANGE APPLICATIONS

MC-22

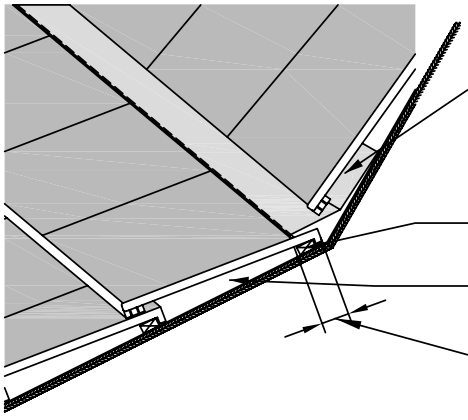


MALEABLE METAL FLASHING FOR PROFILE TILES. FOR FLAT TILES, PREFORMED METAL WITH HEM MAY BE USED OVER BREAK FLASHING TO PROVIDE A SPRING TIGHT FIT

3" MIN.

BATTEN (WHERE REQUIRED)

UNDERLAYMENT



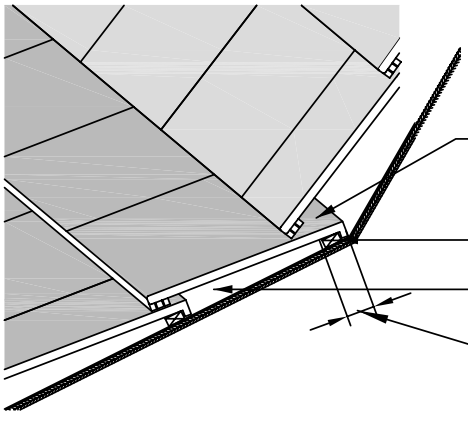
OPTION 1
WITH METAL

MALEABLE METAL FLASHING FOR PROFILE TILES. FOR FLAT TILES, PREFORMED METAL WITH HEM MAY BE USED OVER BREAK FLASHING TO PROVIDE A SPRING TIGHT FIT

BATTEN (WHERE REQUIRED)

UNDERLAYMENT

3" MIN.



OPTION 2
WITHOUT METAL

INCREASE HEADLAP OR PROVIDE WEATHERBLOCKING TO STOP BACK FLOW OF WATER AT TRANSITION

BATTEN (WHERE REQUIRED)

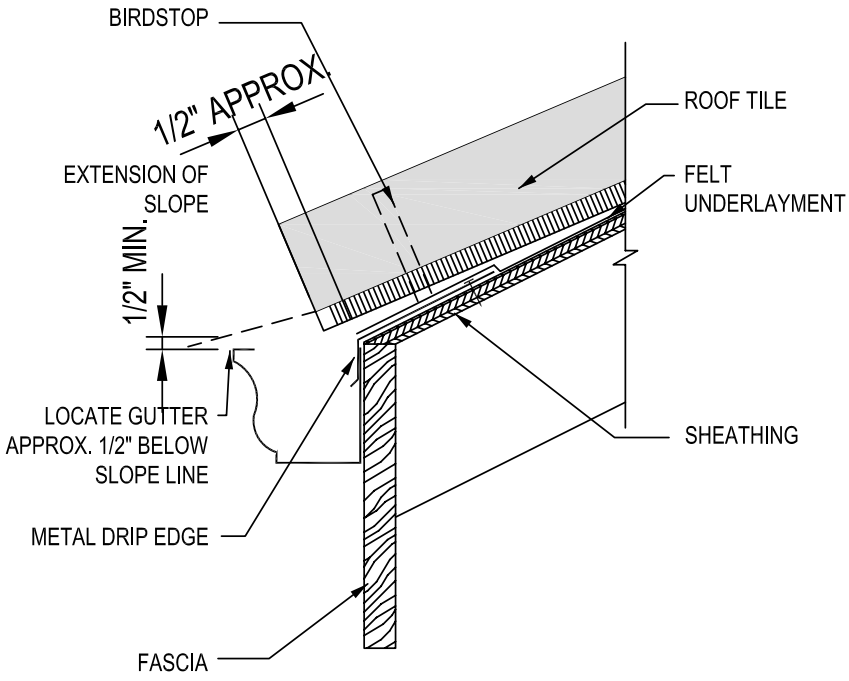
UNDERLAYMENT

3" MIN.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

GUTTERS

MC-23



GUTTER FASCIA

Notes:
This drawing is included to show one style of gutter installation since gutter conditions will vary by climate conditions.
Please contact your local gutter manufacturer for specific installation requirements.

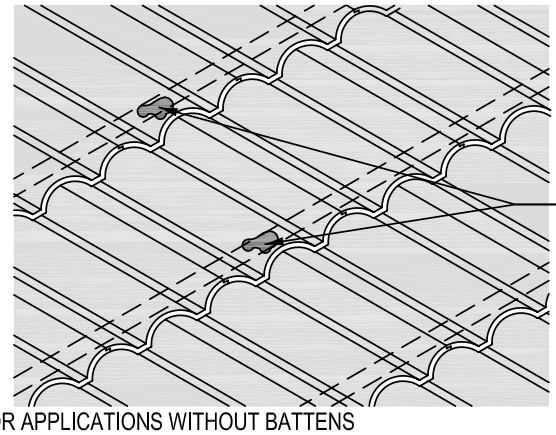
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

TILE REPAIRS\REPLACEMENT

MC-24

When replacing an individual tile, it is easiest to remove the broken tile by further breaking into smaller pieces with a hammer or other acceptable tool. This will minimize the disturbance of surrounding tiles. Once the tile has been removed, any remaining fasteners will be removed and the resulting hole in the underlayment will be cleaned and patched with roofer's mastic.

FOR APPLICATIONS WITH BATTENS



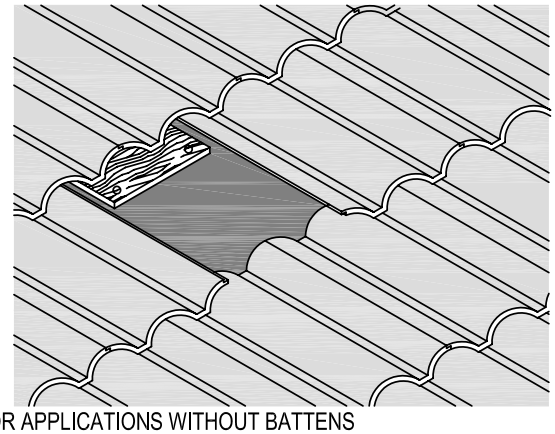
Wedge surrounding tiles up and slide new tile into place.

FOR SLOPES OVER 7:12 (Battens required)

Remove broken tile and fastener. Wedge surrounding tiles, apply code approved roof tile adhesive and slide new tile in place.

TILE ADHESIVE (CODE APPROVED, SEE PAGE 4)

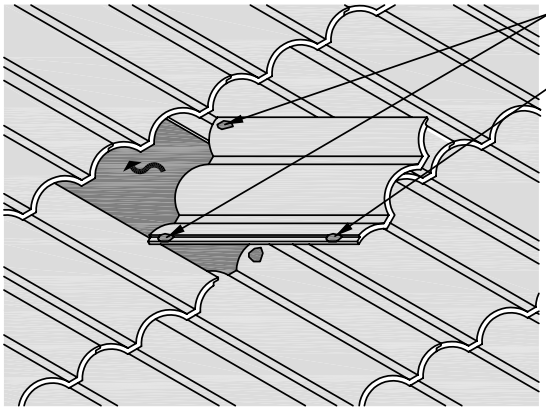
FOR APPLICATIONS WITHOUT BATTENS



Break up tile and remove broken tile and fastener. Nail approximate 12"x6" piece of 3/4" plywood to deck in position to act as a batten, then insert new tile, or apply mastic to overlapping areas of the new tile and put in place. On roof slopes over 7:12 use roof tile adhesive as illustrated above.

TILE ADHESIVE (CODE APPROVED, SEE PAGE 4)

FOR APPLICATIONS WITHOUT BATTENS



YES (PROPER LOCATION)

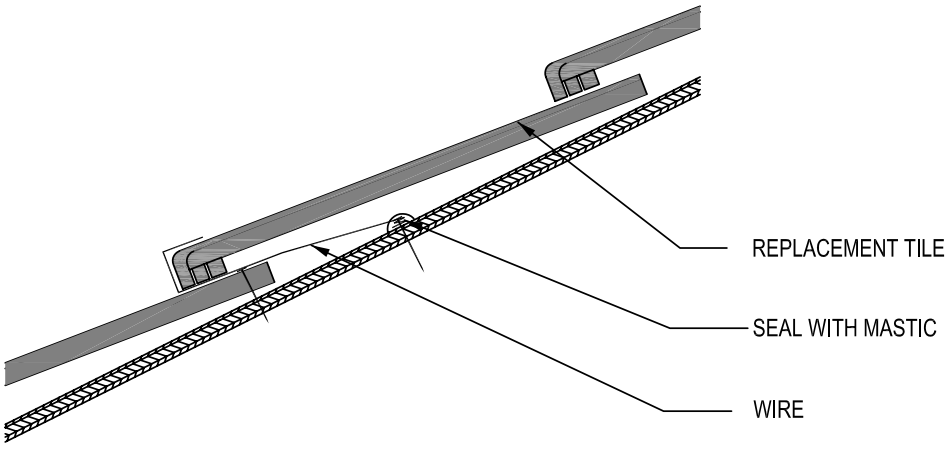
NO (IMPROPER LOCATION)

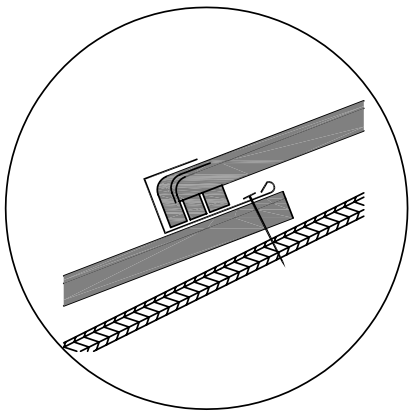
Note:
The replacement tile may be slipped into place and fastened with an approved roof tile adhesive. It is important that the adhesive is placed in a position that will assure contact with adjacent tiles without affecting the flow of water. If adhesive is applied to the interlocking water channel, it must be placed above the headlap to avoid water damming.
Remove any shim that had been used during the repair process and ensure that all tiles surrounding the replaced piece properly fit and are seated.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

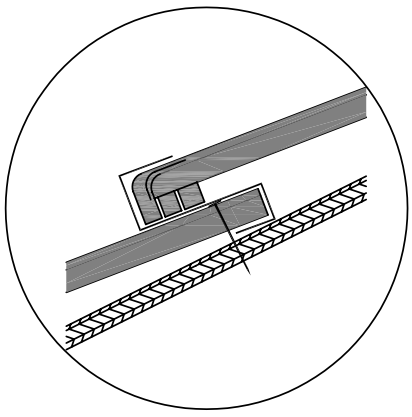
TILE REPAIR \ REPLACEMENT - CONTINUED

MC-24A





'L' HOOK



'S' HOOK

Notes:

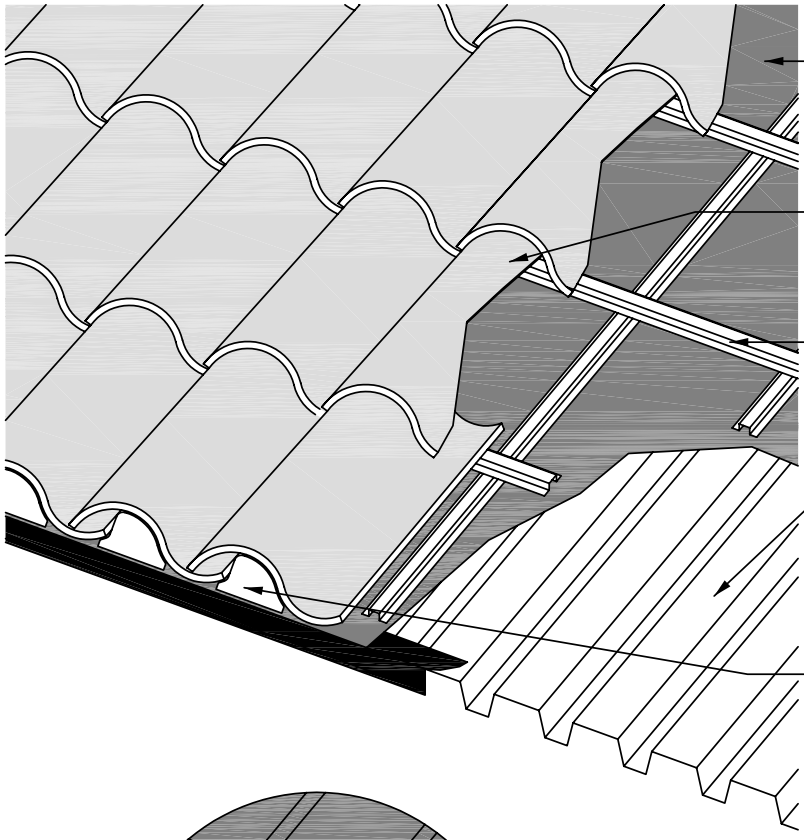
1. If during the course of installation tiles are broken, the following optional method of tile replacement may be used.
2. Clear area of debris where tile is to be replaced, including fasteners from the previous tile. These may be removed by using a slate ripper or, in the case of stainless steel screws, use a hacksaw blade.
3. Lift butt of tile in course above. Then slide replacement underneath and down until bracket "L" hooks underneath top of course below.
4. Adjust replacement tile to align or interlock (depending on the tile type) with tiles to either side.
5. An alternate for interlocking tiles is to fasten a 12 gauge copper wire into the deck, replacing the tile and then bending the exposed wire. A copper strip can also be used over the tile butt.
6. Make adjustment for field conditions.

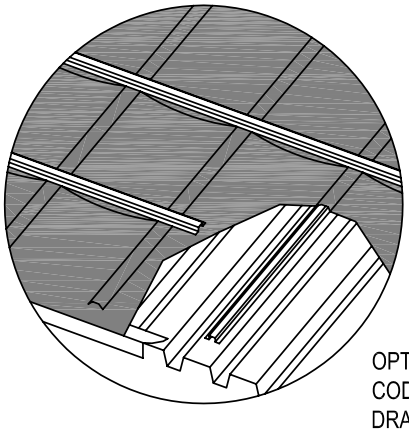
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

MC-25

Installation on Metal Deck - Considerations





OPTION:
CODE APPROVED REINFORCED
DRAPED UNDERLAYMENT

NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

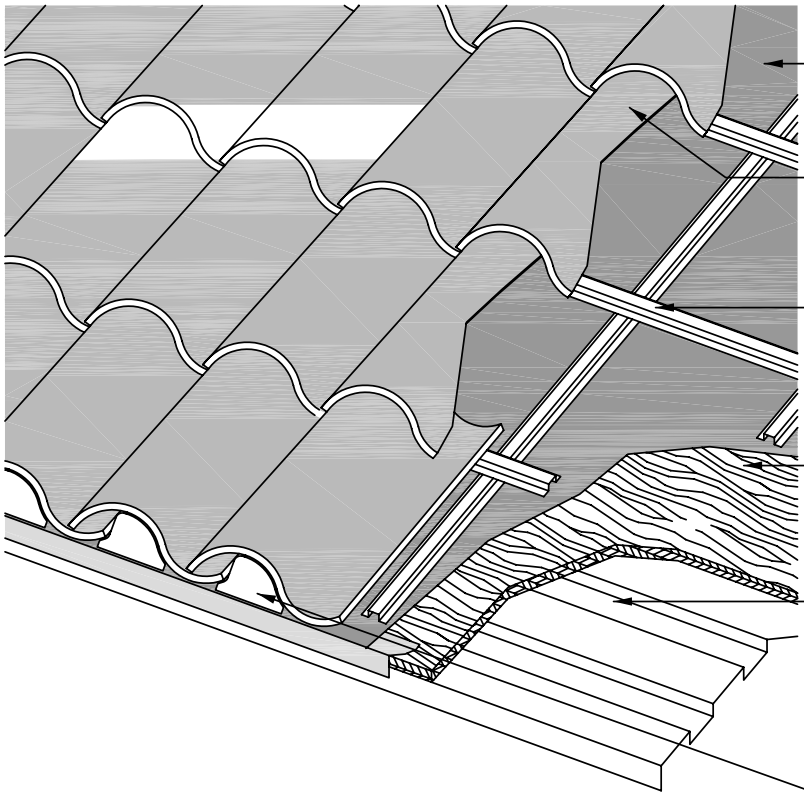
1. Vertical battens to be wood or metal as approved or designed as per metal deck manufacturer.
2. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

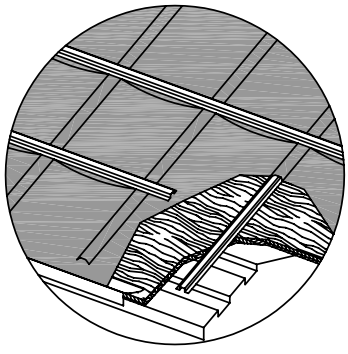
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

Installation on Metal Deck - Optional Considerations

MC-25A





OPTION:
CODE APPROVED REINFORCED DRAPED UNDERLAYMENT

NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

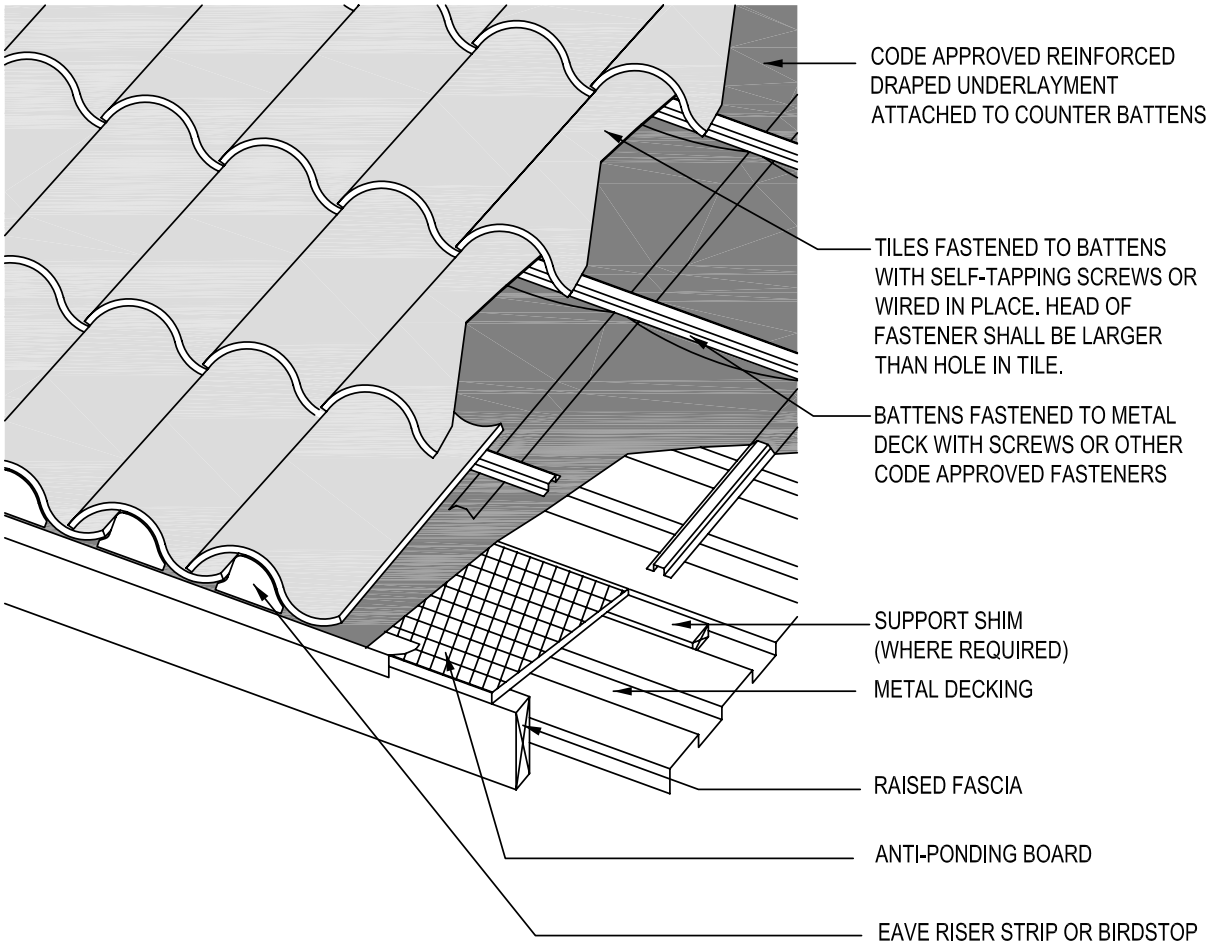
1. Vertical battens to be wood or metal as approved or designed as per metal deck manufacturer.
2. On Type I (Non-Combustible) building all components must be fire-resistant as approved by local building officials.
3. Dimensions shown are recommended minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

Installation on Metal Deck - Optional Considerations

MC-25B



NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

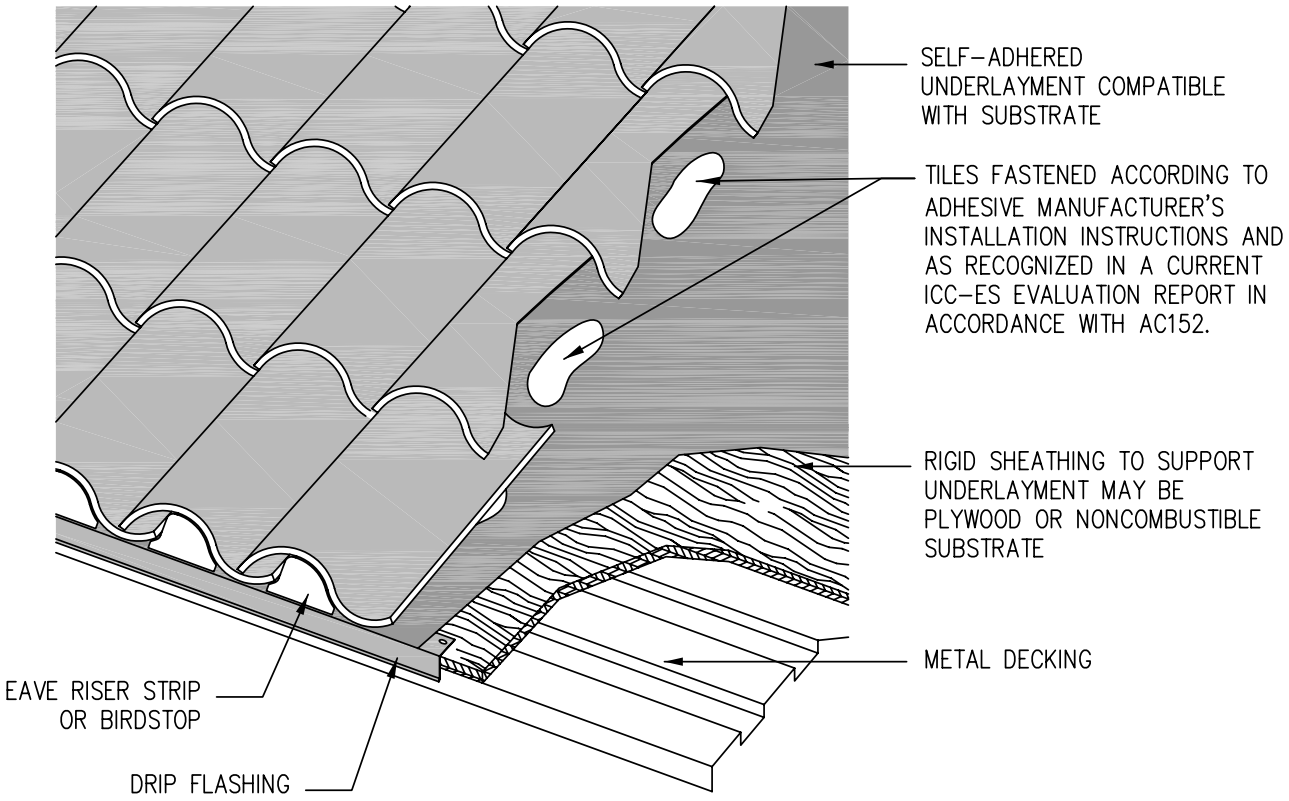
1. Vertical battens to be wood or metal as approved or designed as per metal deck manufacturer.
2. On Type I (Non-Combustible) building all components must be fire-resistant as approved by local building officials.
3. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF

Installation on Metal Deck - Optional Considerations

MC-25C



Note: Attachment of underlayment to sheathing shall be in accordance with assemblies recognized in a current ICC–ES evaluation report for roof tile adhesives evaluated to the requirements of AC–152.

NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

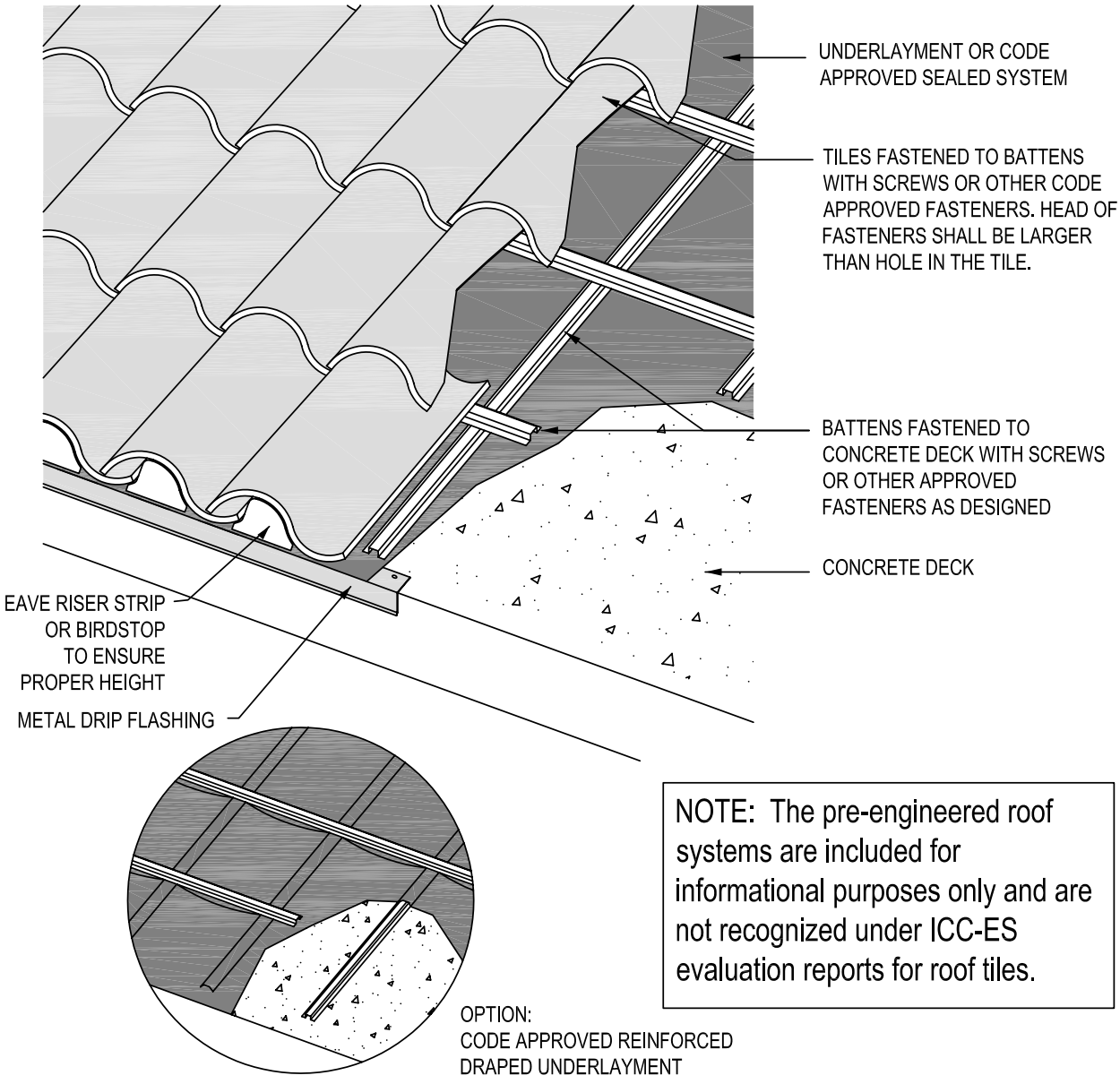
1. On Type I (Non-Combustible) building all components must be fire-resistant as approved by local building officials.
2. Dimensions shown are recommended minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED DECK

Installation on Concrete Deck Considerations

MC-26



NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

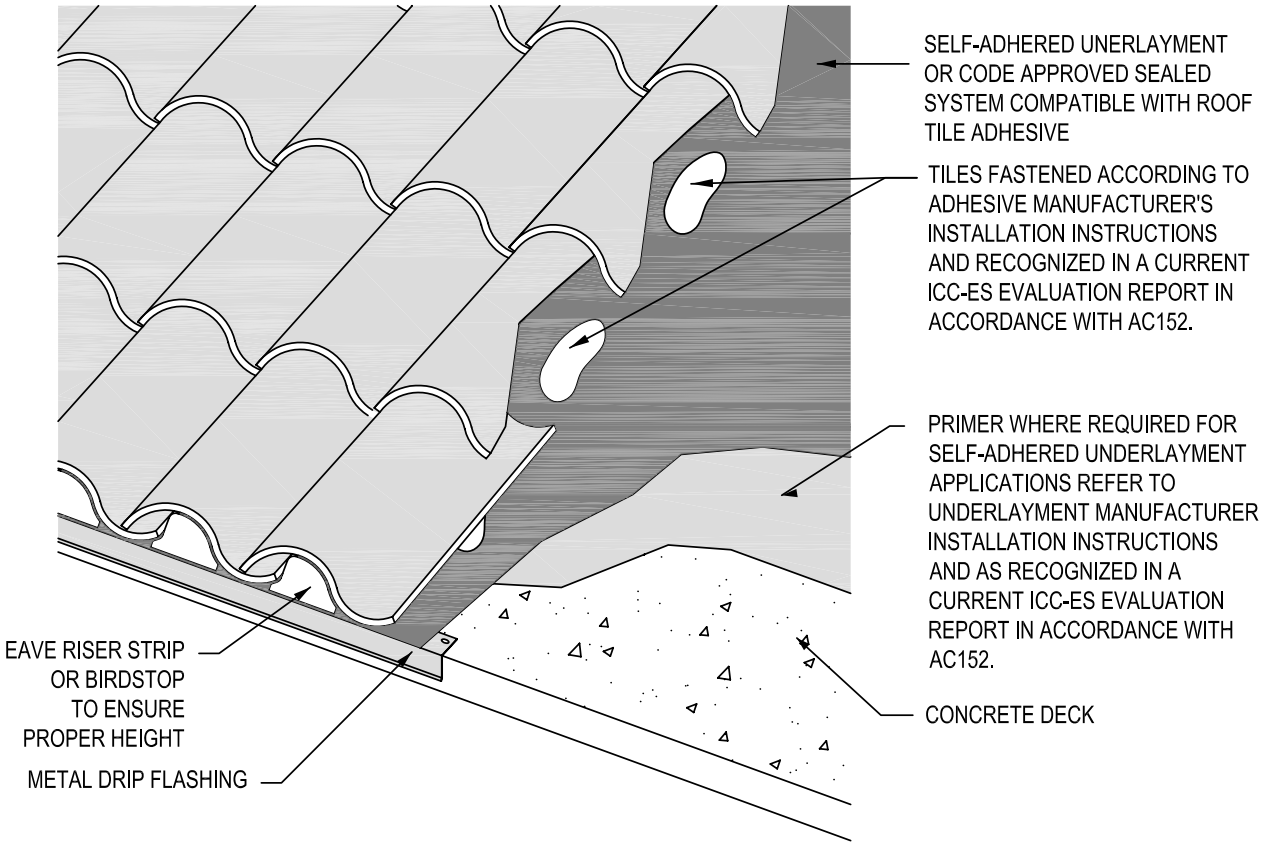
1. Vertical battens to be wood or metal as approved or designed as per metal deck manufacturer.
2. Battens attached directly to the deck shall be no longer than 48" and be separated with 1/2" minimum gaps at ends to allow drainage. An alternate method permits use of longer batten strips with shims of 1/4" thick decay-resistant material (e.g. asphalt shingle, wood strips or cap sheet) at each fastener to provide drainage.
3. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED DECK

Installation on Concrete Deck Considerations

MC-26A



Note: Attachment of underlayment to sheathing shall be in accordance with assemblies recognized in a current ICC-ES evaluation report for roof tile adhesives evaluated to the requirements of AC-152.

NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Notes:

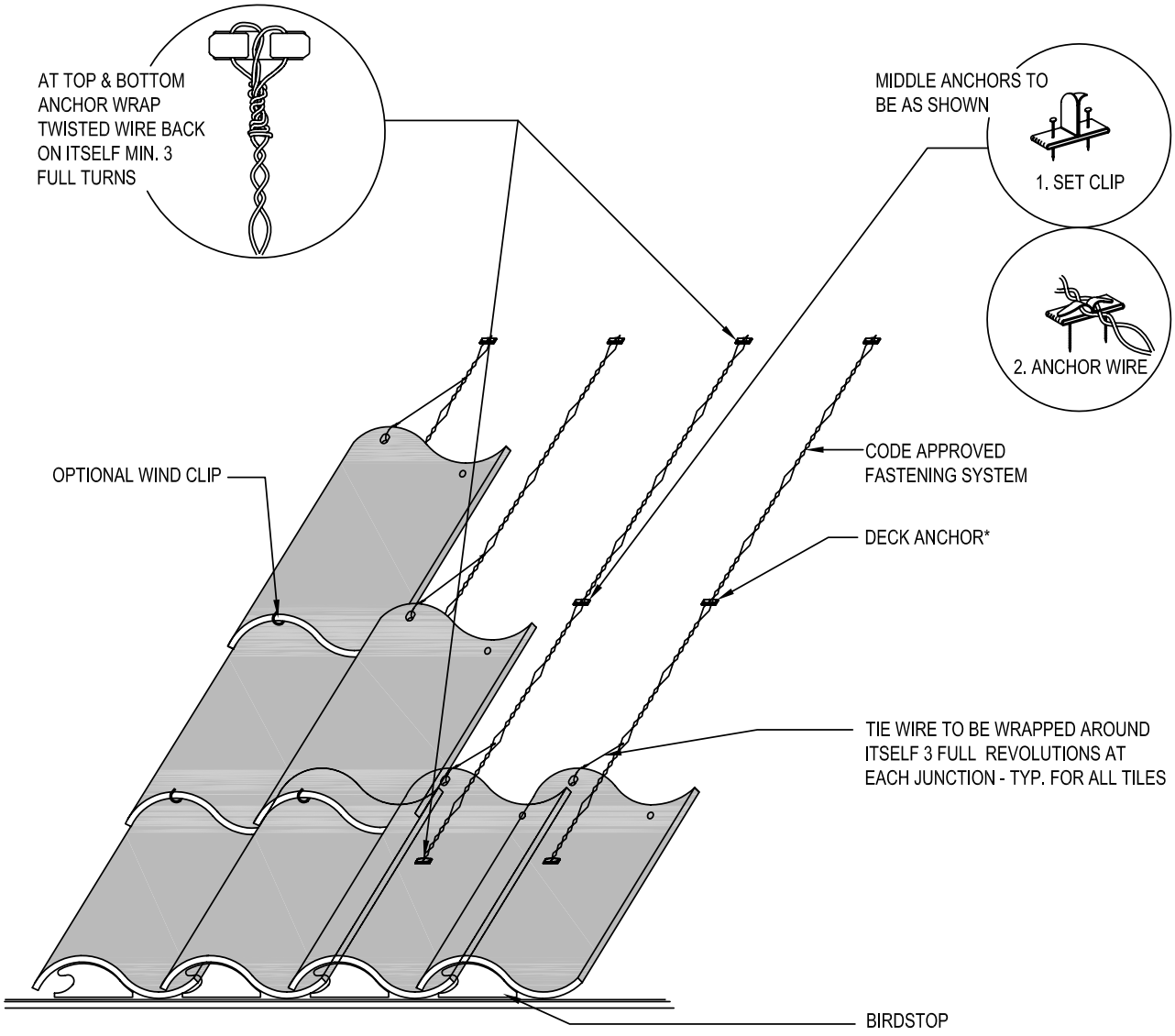
1. Dimensions shown are minimums and are intended to be approximate to allow for reasonable tolerances due to field conditions.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF SYSTEM

MC-27

Wire Attachment System



*NOTE: ANCHOR SPACING AS PER ANCHOR SYSTEM MANUFACTURERS ICC-ES EVALUATION REPORT

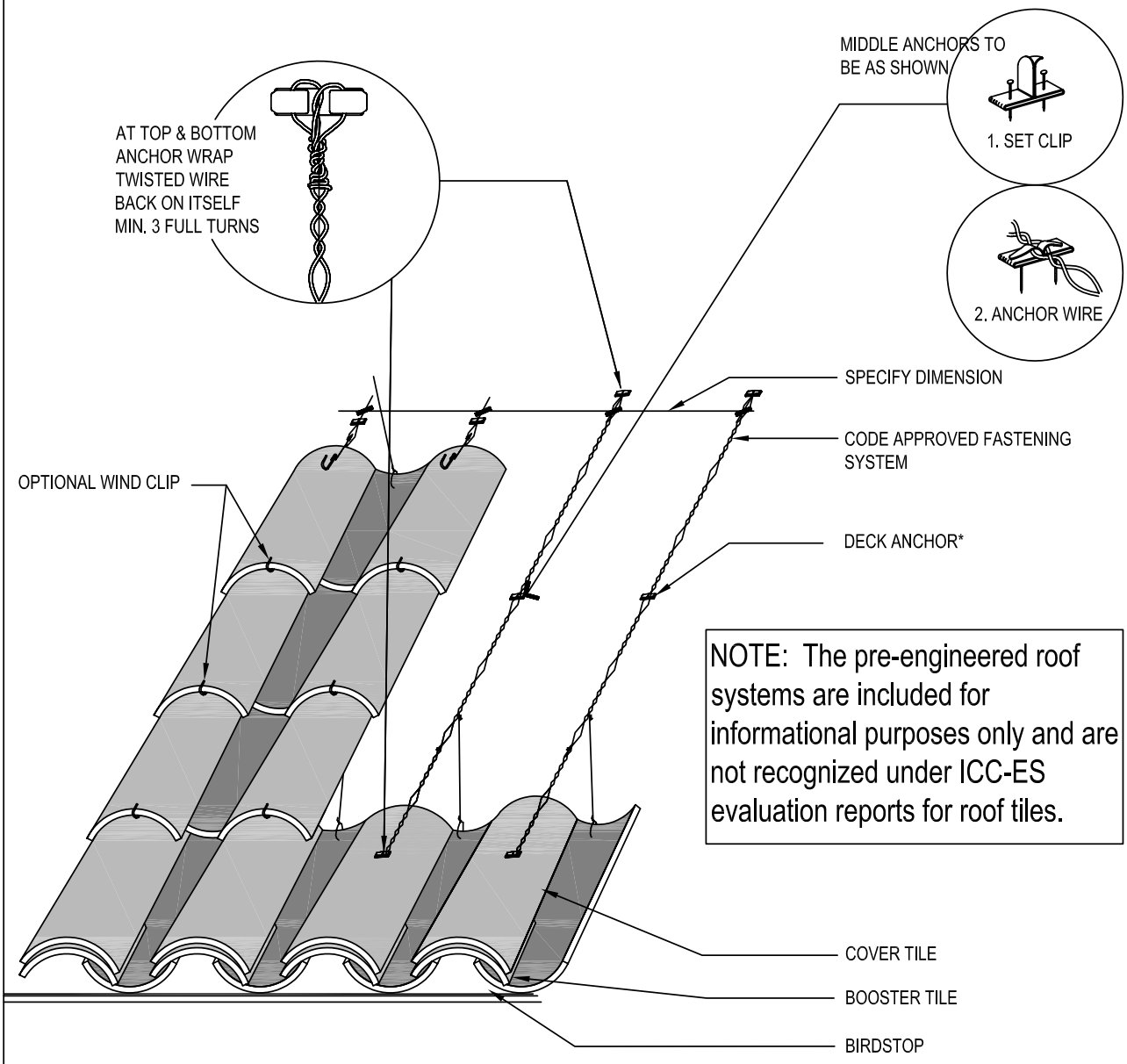
NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY CONDITIONS - PRE-ENGINEERED ROOF SYSTEM

Wire Attachment System

MC-27A



NOTE: The pre-engineered roof systems are included for informational purposes only and are not recognized under ICC-ES evaluation reports for roof tiles.

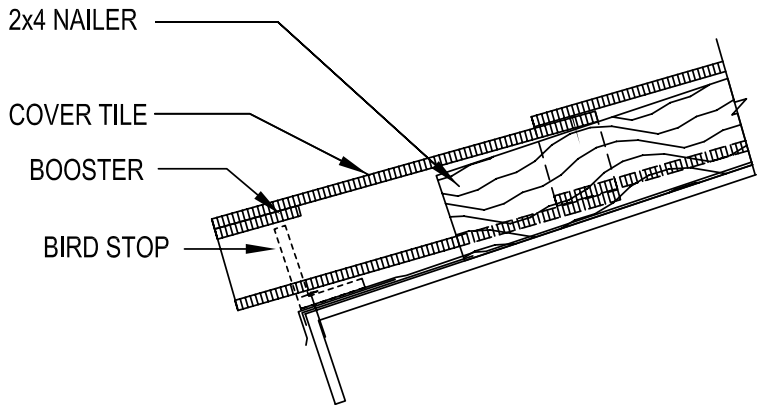
*NOTE: ANCHOR SPACING AS PER ANCHOR SYSTEM MANUFACTURERS ICC-ES EVALUATION REPORT

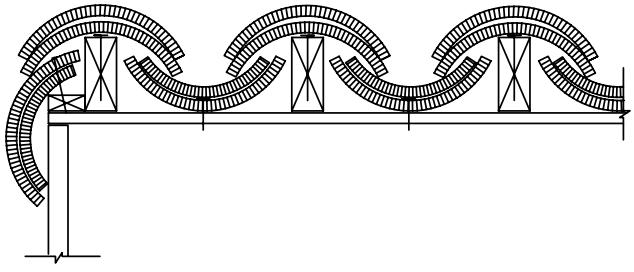
Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

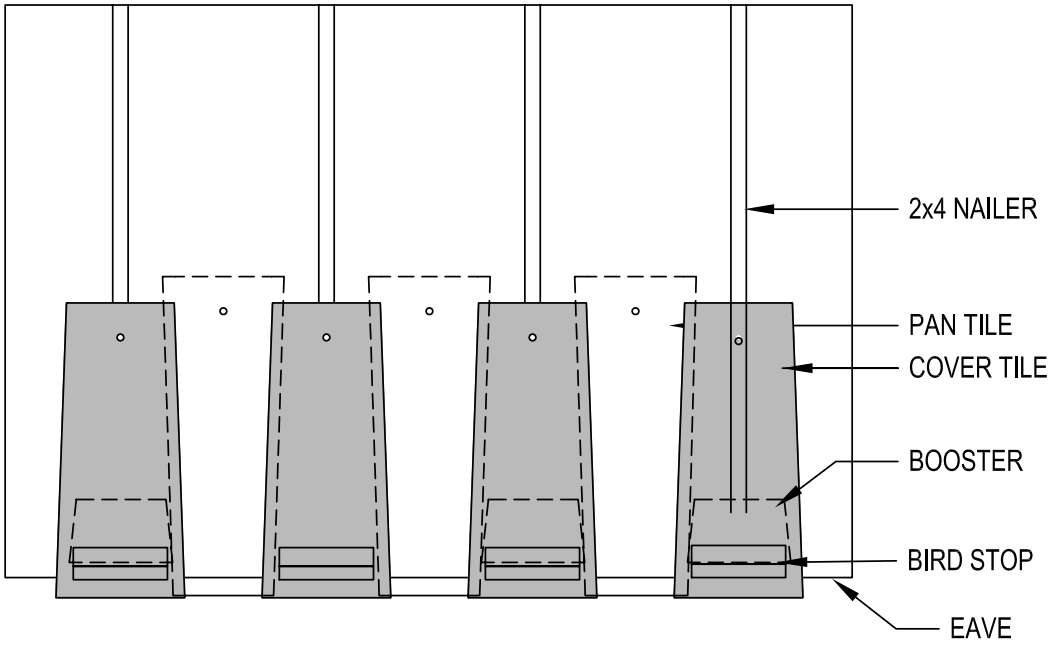
SPECIALTY CONDITIONS

Nailer Installations

MC-27B







Drawing shown depicts the application of all tile profiles. Unless otherwise noted it would apply to either concrete or clay tiles.

SPECIALTY INSTALLATIONS

FOR INFORMATIONAL PURPOSE ONLY–These have not been evaluated by ICC-ES Reports.

UNDERLAYMENT FOR SPACED SHEATHING APPLICATIONS

Underlayment for applications under spaced sheathing that meets or exceeds performance standard ICC-ES AC08 and approved by local building officials.

Two types of underlayment can be used under spaced sheathing:

Rolled underlayment (non-rigid)
Rigid underlayment (rigid board)

INSTALLATION OF UNDERLAYMENT UNDER SPACED SHEATHING

ROLLED UNDERLAYMENT

A tapered antiponding board not less than 8" x 1/2" shall be nailed to the top of the fascia board to prevent the underlayment sagging below the line of the fascia board.

The underlayment shall drape not less than 3/4" and no more than 1 1/2" between the trusses or rafters.

The underlayment shall be laid to provide a lap 6" each direction at ridges (providing a total 12" overlap).

The underlayment shall be laid to provide a minimum side lap of 6" in each direction at hips and shall be fastened at two adjacent trusses or rafters.

When ending a roll in the field or the truss or rafter, begin a new roll one full truss or rafter back creating 24" side lap and mechanically fix both end and starter rolls on a member.

At all abutments the underlayment shall be turned up not less than 6" and shall be fastened to the abutting wall.

A base sheet of underlayment shall be installed in the valley and extend not less than 24" on each side of the valley center line. Underlayment shall be laid from each side parallel with the fascia board and shall be brought to the valley centerline.

All vents and protrusions such as plumbing stacks shall be sealed to prevent water passing into the attic space.

RIGID UNDERLAYMENT

Rigid underlayment shall be installed with the longest side horizontal, allowing a minimum 2" side lap on the trusses or rafters and a minimum 4" head lap.

At the eave the underlayment shall overhang not less than 3/4" and shall be protected by an approved self adhering membrane a minimum of 6" on both sides.

Where the fascia board is used, the underlayment shall be fastened to the top of the fascia board and the junction of the trusses or rafters at the fascia.

The underlayment shall lap ridges and hips a minimum 6" in each direction, providing a total 12" overlap. At hip locations fastened to an adjacent truss or rafter.

A base sheet shall be installed in the valley and extend not less than 24" on each side of the valley center line. The head lap shall be a minimum of 4".

All vents and protrusions such as plumbing stacks shall be sealed to prevent water passing into the attic space.

TILE BATTENS FOR SPACED SHEATHING

Tile battens for spaced sheathing shall be a minimum 1" x 4" nominal spruce/pine/fir (SPF) standard No. 2 or better, or structurally equal. Fasteners and other fastening devices shall be corrosion resistant number 11 gauge diameter and of sufficient length to penetrate 3/4" into the truss or rafter.

TILING OVER SPACED SHEATHING

Tile shall not be installed over spaced sheathing in areas of high snow load as defined by the acceptance criteria for snow load design calculation procedures of the 1995 National Building Code of Canada as an alternative to those in the ICC-ES AC135.

*Note: In areas of high snow load, reference the **TRI, WSRCA** Concrete and Clay Tile Roof Design Criteria Manual For Cold Climates.*

GENERAL

The underlayment, eave and valley protection system shall:

Restrict the entry of water into the roofing space.

Provide free positive drainage of moisture down to and from the eave.

Minimize the number of fastenings exposed to water by positioning fastenings to be covered by successive layers of underlayment or battens.

Meet the requirements of the code.

Note: *Underlayment materials should be nominally fastened to maintain the required position before battens are installed.*

All tears and punctured areas of the underlayment system shall be repaired or replaced before installation of the roofing tiles with membrane compatible and approved materials, alternatively remove damaged section and replace.

ADHESIVE FASTENING SYSTEMS (ALTERNATIVE TO MECHANICAL FASTENING)

When deciding to use adhesives for the installation of tile consideration must be made on the compatibility of the adhesive to the underlayment surface. Although adhesive bonds very well to a variety of products like smooth or granulated underlayments, metal, concrete, clay, wood, etc., typically, they do not adhere to polyethylene or silicon surfaced products.

When specifying any adhesive type material, consideration must also be made on the attachment of the underlayment to the decking substrate. Since the adhesive material is being applied to the top ply of the underlayment system the load must be carried through to the decking.

Typically on nailable decks, the mechanical attachment can be determined by the resistance pullout values of the fastener, the pullover value of the underlayment over the head of the fastener (or additional tin cap/plates), and the number of fasteners used (fastener density). Self-adhered membranes must be tested to determine the resistance value of the underlayment to various substrates. If the self-adhered membrane is attached to an anchor (or base) sheet, the anchor sheet must be attached to the substrate to meet the wind loading requirements of the local building code.

Similarly, when used on batten systems, if the adhesive is applied to the batten only, the batten must be attached to the substrate to handle the entire load. Typically, on batten systems, the adhesive is applied partially on the batten and partially on the underlayment, so the entire underlayment attachment system (including underlayment and batten attachment) can be used to determine the resistance load.

Not all adhesives can meet the physical property testing needed to meet the climatic demands for a product used on roofs. Adhesives are temperature related. Some products shrink when exposed to high heat and humidity. Cold climates, wet surfaces, dry heat, high heat and humidity can play a roll in determining which adhesive will be used. Installations using adhesives must be in accordance with assemblies recognized in a current ICC-ES evaluation report for roof tile adhesives evaluated to the requirements of AC152.

There are five commonly used paddy placements used in the industry. However not all adhesives are alike. Some adhesives, typically one component adhesives, are not considered expanding adhesives and must be used under compression. Other adhesives, typically two component froth adhesives, are free rising and can be either compressed or left free rising. Those types of adhesive usually can be used with all of the five paddy placement options.

The resistance values associated with the paddy placements will vary based on the adhesive/tile contact area, the adhesive/underlayment contact area, and the adhesive placement in relation to the point of tile rotation. For compressive type paddy placements, the placement where the

adhesive is compressed at the tile to tile head lap configuration (i.e. design of the weather checks), and where the adhesive is compressed to the underlayment.

Design Considerations For High Wind Applications

Please Refer to Tile Manufacturer ICC-ES Evaluation Report for Additional Wind Design Data

The installation requirements provided in Table 1A and 1B provide the normal installation guidelines for concrete and clay tile to comply with the International Building Code (Section 1507.3.7). The installation of tile in the specific regions of the country that are identified by ASCE 7-02 as subjected to sustained wind speeds in excess of 100 miles per hour, may be required to have additional fastening options not found in Tables 1A and 1B.

The Tile Roofing Institute has derived various uplift resistance values for nails, screws and adhesive fastening systems. Each of these methods of installation may have limiting factors depending upon wind speed, roof slope and roof height. Please consult with your tile supplier or design professional for additional information about these optional systems for those unique installations.

IRC: On buildings having a maximum mean roof height of 40 feet (12.2m), tile application must comply with IRC section R905.3.7. For higher basic wind speeds or mean roof heights, installation must be in compliance with IBC Section 1609.7.2.

The following design aids are provided to the roof designer for consideration in determining the required aerodynamic uplift moment for roof tiles when the prescriptive requirements in the IBC or IRC are used. These tables were developed based on the requirements of IBC Section 1609.7.3 and ASCE 7-02. Buildings and other structures that represent a substantial hazard to human life in the event of failure are to be designed using an Importance Factor of 1.15 (See ASCE 7-02, Table 1-1 for more information).

Example:

Building is a low rise structure located in an Exposure B region where the basic wind speed is 140 mph (3-second gust). The building is a Category II structure. The mean roof height of the building is 30 feet. The roof is a gable roof with a roof slope of 3:12. The terrain around the building does not abruptly change so as to create any wind speed-up effects due to channeling, or shielding. The building is not located on a hill, ridge, or escarpment that would cause the wind to speed-up. The roof covering will be concrete roof tile with a total tile length of 16-½" and an exposed width of 11". The roof tiles weigh 9 pounds each. The roof covering is installed on solid sheathing.

Velocity Pressure:

$qz = 0.00256\ K_z\ K_{zt}\ Kd\ V2\ I$ (ASCE 7 - 6.5.10)

qz = velocity pressure elevation at height z (psf)

K_z = velocity pressure exposure coefficient at height z (ASCE 7 - Table 6-3)

$K_z = 0.70$

K_{zt} = topographic factor (ASCE 7 - Figure 6-4)

$K_{zt} = 1.00$

K_d = wind directionality factor (ASCE 7 - Table 6-4)

$K_d = 0.85$

V = basic wind speed (mph) (ASCE 7 - Figure 6-1)

V = 140 mph

I = importance factor (ASCE 7 - Table 6-1)

I = 1.00

$q_z = 0.00256\ Kz\ Kzt\ Kd\ V2\ I = 0.00256\ (0.70)\ (1.00)\ (0.85)\ (140\ mph)^2\ (1.00)$

$q_z = 29.85$ psf

Aerodynamic Uplift Moment:

$M_a = q_h\ C_L\ b\ L\ L_a\ (1- GCp)$ (IBC - Eq. 16-14)

M_a = aerodynamic uplift moment (ft-lbf)

q_h = velocity pressure elevation at mean roof height h (psf)

$q_z = 29.85$ psf

C_L = lift coefficient = 0.2 (IBC - Section 1609.7.3)

b = exposed width of roof tile (ft)

b = 11" ~ 0.917'

L = length of roof tile (ft)

L = 16-½" ~ 1.375'

cont'd on page 77

cont'd from page 76

L_a = moment arm for the roof tile = 0.76 L
(IBC - Section 1609.7.3)

L_a = 0.76 (16-½") = 12.54" ~ 1.045'

GC_p = product of external pressure coefficient and gust factor

GC_p = -2.6

Note: The external pressure coefficient for Zone 3 was selected to calculate the required aerodynamic uplift moment. The use of this external pressure coefficient is conservative for zones 1 and 2.

M_a = qh CL 1.407 ft3 (1- GCp) = (29.85 psf) (0.2) (0.917') (1.375') (1.045') (1 - [-2.6])

M_a = 28.3 ft lbf

Attachment Resistance:

Required aerodynamic uplift moment , M_a, = 28.3 ft lbf

Restoring gravity moment = 5.7 ft-lbf (TRI/WSRCA - Table 6F)

Note: The dead weight of the roof tile generates a moment that is opposite to the aerodynamic uplift moment created by the wind. This restoring gravity moment is based on the dead weight of the roof tile, the moment arm to the center of the roof tile, the cant angle of the roof tile, and the roof slope. The Tri/WSRCA - Table 6F is based on the weight of the roof tile on a roof slope of 27°. This is the roof slope that will generate the greatest aerodynamic uplift moment with the shortest moment arm for the restoring gravity moment.

Total Attachment Resistance = 28.3 ft-lbf - 5.7 ft-lbf = 22.6 ft-lbf

Attachment Resistance Based on Design Tables:

The concrete roof tile is within the combined maximum tile length and maximum exposed width listed in Table 6E, Maximum Combination of Tile Length and Tile's Exposed Width. This roof tile may be designed using Table 5A, Exposure B - Required Aerodynamic Uplift Moment.

Table 5A indicates that the required aerodynamic uplift moment for this roof covering, M_a, is 30.3 ft-lbf. This is slightly greater than the calculated required aerodynamic uplift moment for this roof covering, Ma, of 28.3 ft-lbf.

Note: The difference between the Ma's is in the tile factor. The Tables are based on a tile factor of 1.407 ft^3 while the actual tile factor for this roof tile is 1.318 ft^3.

Required aerodynamic uplift moment , M_a, = 30.3 ft lbf

Restoring gravity moment = 5.7 ft-lbf (TRI/WSRCA - Table 6F)

Total Attachment Resistance = 30.3 ft-lbf - 5.7 ft-lbf = 24.6 ft-lbf

Select a fastening system from Table 7A, Allowable Aerodynamic Uplift Moments - Mechanical Fastening Systems that is equal to or greater than 24.6 ft-lbf in order to comply with the code.

TABLE 5A
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf)
Exposure B
Gable Roof 2 ½:12 < θ < 6:12 (7° < θ < 27°)
Hip Roof 5 ½:12 < θ < 6:12 (25° < θ < 27°)

Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	11.2	12.5	15.4	17.0	18.7	22.2	24.1	26.1	30.3	32.5	34.7	44.6
40	12.1	13.6	16.8	18.5	20.3	24.1	26.2	28.3	32.9	35.3	37.7	48.5
50	12.9	14.5	17.9	19.7	21.6	25.7	27.9	30.2	35.0	37.6	40.2	51.6
60	13.6	15.2	18.8	20.8	22.8	27.1	29.4	31.8	36.9	39.6	42.4	54.4
	Importance Factor = 1.15											
0-30	12.8	14.4	17.8	19.6	21.5	25.6	27.7	30.0	34.8	37.3	40.0	51.3
40	13.9	15.6	19.3	21.3	23.3	27.8	30.1	32.6	37.8	40.5	43.4	55.7
50	14.8	16.6	20.6	22.7	24.9	29.6	32.1	34.7	40.3	43.2	46.2	59.4
60	15.6	17.5	21.6	23.9	26.2	31.2	33.8	36.6	42.4	45.5	48.7	62.6

TABLE 5B
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure B Hip Roof 2 ½:12 < θ < 5 ½:12 (7° < θ < 25°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	8.4	9.4	11.6	12.8	14.0	16.7	18.1	19.6	22.7	24.4	26.1	33.5
40	9.1	10.2	12.6	13.9	15.2	18.1	19.6	21.3	24.6	26.4	28.3	36.3
50	9.7	10.9	13.4	14.8	16.2	19.3	20.9	22.6	26.3	28.2	30.2	38.7
60	10.2	11.4	14.1	15.6	17.1	20.3	22.1	23.9	27.7	29.7	31.8	40.8
	Importance Factor = 1.15											
0-30	9.6	10.8	13.3	14.7	16.1	19.2	20.8	22.5	26.1	28.0	30.0	38.5
40	10.4	11.7	14.5	15.9	17.5	20.8	22.6	24.4	28.3	30.4	32.5	41.8
50	11.1	12.5	15.4	17.0	18.6	22.2	24.1	26.0	30.2	32.4	34.7	44.5
60	11.7	13.2	16.2	17.9	19.6	23.4	25.4	27.4	31.8	34.1	36.5	46.9

TABLE 5C
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure B Gable Roof 6:12 < θ < 12:12 (27° < θ < 45°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	6.8	7.6	9.4	10.4	11.4	13.6	14.7	15.9	18.5	19.8	21.2	27.3
40	7.4	8.3	10.2	11.3	12.4	14.8	16.0	17.3	20.1	21.5	23.1	29.6
50	7.9	8.8	10.9	12.0	13.2	15.7	17.1	18.5	21.4	23.0	24.6	31.6
60	8.3	9.3	11.5	12.7	13.9	16.6	18.0	19.4	22.5	24.2	25.9	33.2
	Importance Factor = 1.15											
0-30	7.8	8.8	10.9	12.0	13.1	15.6	17.0	18.3	21.3	22.8	24.4	31.4
40	8.5	9.5	11.8	13.0	14.3	17.0	18.4	19.9	23.1	24.8	26.5	34.1
50	9.1	10.2	12.6	13.8	15.2	18.1	19.6	21.2	24.6	26.4	28.3	36.3
60	9.6	10.7	13.2	14.6	16.0	19.1	20.7	22.4	25.9	27.8	29.8	38.2

TABLE 5D
Exposure B
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure B Monoslope Roof 2 ½:12< θ < 6 ¾:12 (10° < θ < 30°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-30	12.1	13.6	16.7	18.4	20.2	24.1	26.1	28.3	32.8	35.2	37.6	48.3
40	13.1	14.7	18.2	20.0	22.0	26.2	28.4	30.7	35.6	38.2	40.9	52.5
50	14.0	15.7	19.4	21.3	23.4	27.9	30.2	32.7	37.9	40.7	43.6	55.9
60	14.7	16.5	20.4	22.5	24.7	29.4	31.9	34.5	40.0	42.9	45.9	58.9
	Importance Factor = 1.15											
0-30	13.9	15.6	19.2	21.2	23.3	27.7	30.1	32.5	37.7	40.5	43.3	55.6
40	15.1	16.9	20.9	23.0	25.3	30.1	32.6	35.3	40.9	43.9	47.0	60.4
50	16.1	18.0	22.3	24.5	26.9	32.1	34.8	37.6	43.6	46.8	50.1	64.3
60	16.9	19.0	23.5	25.9	28.4	33.8	36.6	39.6	46.0	49.3	52.8	67.8

TABLE 6A
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Gable Roof 2 ½:12 < θ < 6:12 (7° < θ < 27°) Hip Roof 5 ½:12 < θ < 6:12 (7° < θ < 25°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	13.5	15.2	18.7	20.6	22.6	26.9	29.2	31.6	36.7	39.3	42.1	54.1
20	14.4	16.1	19.9	21.9	24.1	28.6	31.1	33.6	39.0	41.8	44.7	57.5
25	15.1	16.9	20.8	23.0	25.2	30.0	32.6	35.2	40.8	43.8	46.9	60.2
30	15.6	17.5	21.7	23.9	26.2	31.2	33.8	36.6	42.4	45.5	48.7	62.6
40	16.6	18.6	23.0	25.4	27.8	33.1	35.9	38.9	45.1	48.4	51.8	66.5
50	17.4	19.5	24.1	26.6	29.2	34.7	37.7	40.7	47.3	50.7	54.2	69.7
60	18.1	20.3	25.1	27.6	30.3	36.1	39.1	42.3	49.1	52.7	56.4	72.4
	Importance Factor = 1.15											
0-15	15.5	17.4	21.5	23.7	26.0	31.0	33.6	36.4	42.2	45.2	48.4	62.2
20	16.5	18.5	22.9	25.2	27.7	32.9	35.7	38.6	44.8	48.1	51.4	66.1
25	17.3	19.4	24.0	26.4	29.0	34.5	37.4	40.5	47.0	50.4	53.9	69.2
30	18.0	20.2	24.9	27.5	30.1	35.9	38.9	42.1	48.8	52.4	56.0	72.0
40	19.1	21.4	26.5	29.2	32.0	38.1	41.3	44.7	51.8	55.6	59.5	76.5
50	20.0	22.5	27.7	30.6	33.5	39.9	43.3	46.9	54.3	58.3	62.4	80.1
60	20.8	23.3	28.8	31.8	34.9	41.5	45.0	48.7	56.5	60.6	64.8	83.3

TABLE 6B
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Hip Roof 2 ½:12 < θ < 6:12 (7° < θ < 27°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	10.1	11.4	14.0	15.5	17.0	20.2	21.9	23.7	27.5	29.5	31.6	40.6
20	10.8	12.1	14.9	16.4	18.0	21.5	23.3	25.2	29.2	31.3	33.5	43.1
25	11.3	12.7	15.6	17.2	18.9	22.5	24.4	26.4	30.6	32.9	35.2	45.2
30	11.7	13.2	16.2	17.9	19.6	23.4	25.4	27.4	31.8	34.1	36.5	46.9
40	12.5	14.0	17.3	19.0	20.9	24.8	27.0	29.2	33.8	36.3	38.8	49.9
50	13.1	14.6	18.1	19.9	21.9	26.0	28.3	30.6	35.4	38.0	40.7	52.3
60	13.6	15.2	18.8	20.7	22.7	27.1	29.4	31.8	36.8	39.5	42.3	54.3
	Importance Factor = 1.15											
0-15	11.7	13.1	16.1	17.8	19.5	23.2	25.2	27.3	31.6	33.9	36.3	46.6
20	12.4	13.9	17.1	18.9	20.7	24.7	26.8	29.0	33.6	36.1	38.6	49.6
25	13.0	14.6	18.0	19.8	21.7	25.9	28.1	30.4	35.2	37.8	40.4	51.9
30	13.5	15.1	18.7	20.6	22.6	26.9	29.2	31.6	36.6	39.3	42.0	54.0
40	14.3	16.1	19.8	21.9	24.0	28.6	31.0	33.5	38.9	41.7	44.6	57.3
50	15.0	16.8	20.8	22.9	25.2	29.9	32.5	35.1	40.8	43.7	46.8	60.1
60	15.6	17.5	21.6	23.8	26.1	31.1	33.8	36.5	42.4	45.4	48.6	62.4

TABLE 6C
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Gable Roof 6:12 < θ < 12:12 (27° < θ < 45°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	8.3	9.3	11.4	12.6	13.8	16.5	17.9	19.3	22.4	24.0	25.7	33.0
20	8.8	9.8	12.1	13.4	14.7	17.5	19.0	20.5	23.8	25.5	27.3	35.1
25	9.2	10.3	12.7	14.0	15.4	18.3	19.9	21.5	25.0	26.8	28.6	36.8
30	9.6	10.7	13.2	14.6	16.0	19.1	20.7	22.4	25.9	27.8	29.8	38.2
40	10.2	11.4	14.1	15.5	17.0	20.2	22.0	23.8	27.6	29.6	31.6	40.6
50	10.6	11.9	14.7	16.2	17.8	21.2	23.0	24.9	28.9	31.0	33.2	42.6
60	11.1	12.4	15.3	16.9	18.5	22.0	23.9	25.9	30.0	32.2	34.4	44.2
	Importance Factor = 1.15											
0-15	9.5	10.7	13.2	14.5	15.9	18.9	20.5	22.2	25.8	27.6	29.6	38.0
20	10.1	11.3	14.0	15.4	16.9	20.1	21.8	23.6	27.4	29.4	31.4	40.4
25	10.6	11.9	14.6	16.1	17.7	21.1	22.9	24.7	28.7	30.8	32.9	42.3
30	11.0	12.3	15.2	16.8	18.4	21.9	23.8	25.7	29.8	32.0	34.2	44.0
40	11.7	13.1	16.2	17.8	19.6	23.3	25.3	27.3	31.7	34.0	36.4	46.7
50	12.2	13.7	16.9	18.7	20.5	24.4	26.5	28.6	33.2	35.6	38.1	49.0
60	12.7	14.3	17.6	19.4	21.3	25.4	27.5	29.8	34.5	37.0	39.6	50.9

TABLE 6D
Exposure C
Required Aerodynamic Uplift Moment[1]

Required Aerodynamic Uplift Moment, Ma (ft-lbf) Exposure C Monoslope Roof 2 ½:12< θ < 6 ¾:12 (10° < θ < 30°)												
Mean Roof Height (ft)	Basic Wind Speed, V (mph)											
	85	90	100	105	110	120	125	130	140	145	150	170
	Importance Factor = 1.00											
0-15	14.6	16.4	20.3	22.3	24.5	29.2	31.7	34.3	39.7	42.6	45.6	58.6
20	15.6	17.4	21.5	23.7	26.1	31.0	33.7	36.4	42.2	45.3	48.5	62.2
25	16.3	18.3	22.6	24.9	27.3	32.5	35.3	38.1	44.2	47.5	50.8	65.2
30	16.9	19.0	23.5	25.9	28.4	33.8	36.6	39.6	46.0	49.3	52.8	67.8
40	18.0	20.2	24.9	27.5	30.2	35.9	38.9	42.1	48.8	52.4	56.1	72.0
50	18.9	21.2	26.1	28.8	31.6	37.6	40.8	44.1	51.2	54.9	58.8	75.5
60	19.6	22.0	27.1	29.9	32.8	39.1	42.4	45.9	53.2	57.1	61.1	78.4
	Importance Factor = 1.15											
0-15	16.8	18.9	23.3	25.7	28.2	33.6	36.4	39.4	45.7	49.0	52.5	67.4
20	17.9	20.1	24.8	27.3	30.0	35.7	38.7	41.9	48.5	52.1	55.7	71.6
25	18.8	21.0	26.0	28.6	31.4	37.4	40.6	43.9	50.9	54.6	58.4	75.0
30	19.5	21.8	27.0	29.7	32.6	38.8	42.1	45.6	52.9	56.7	60.7	78.0
40	20.7	23.2	28.7	31.6	34.7	41.3	44.8	48.4	56.2	60.3	64.5	82.8
50	21.7	24.3	30.0	33.1	36.3	43.3	46.9	50.8	58.9	63.2	67.6	86.8
60	22.6	25.3	31.2	34.4	37.8	44.9	48.8	52.7	61.2	65.6	70.2	90.2

TABLE 6E
Maximum Dimensions to Satisfy Tile Factor of 1.407 ft^3

Maximum Combination of Tile Length and Tile's Exposed Width										
Maximum Tile Length (inches)	20	18-½	18	17-½	16-½	16	15-½	15	14-½	14
Maximum Exposed Width (inches)	8	9-1/4	9-3/4	10-1/4	11-3/4	12-½	13-1/4	13-3/4	14	15

TABLE 6F
Restoring Gravity Moment

Maximum Combination of Tile Length and Tile's Exposed Width						
Tile Weight (lbs)	5	6	7	8	9	10
M_g (ft-lbft)	3.17	3.80	4.43	5.06	5.7	6.33

Notes for Tables 5A through 6F:

1. Roof tiles shall comply with the following dimensions:
   (1) The total length of the roof tile shall be between 1.0 foot and 1.75 feet.
   (2) The exposed width of the roof tile shall be between 0.67 feet and 1.25 feet.
   (3) The maximum thickness of the tail of the roof tile shall not exceed 1.3 inches.

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2. The required aerodynamic uplift moments in these tables are based on a roof tile that has a Tile Factor of 1.407 ft^3. The required aerodynamic uplift moment for roof tiles with a Tile Factor other than 1.407 ft^3 may be determined by using the following procedure. These tables are conservative for roof tiles with a Tile Factor less than 1.407 ft^3.
   (1) Calculate the Tile Factor for the desired roof tile.
   Tile Factor = b (L) (La)
   b = exposed width of the roof tile (ft)
   L = total length of roof tile (ft)
   L_a = moment between point of rotation and the theoretical location of the resultant of the wind uplift force. For the standard roof tiles the moment arm = 0.76 L (See IBC - Section 1609.7.3)
   (2) Based on exposure, roof style, roof pitch, importance, basic wind speed, and mean roof height select the appropriate required aerodynamic uplift moment from the tables for the desired roof tile.
   (3) Multiply the selected required aerodynamic uplift moment by the ratio of the tile factor for the desired roof tile and 1.407 ft^3.
   (4) Select an attachment system that is equal to or greater than the calculated required aerodynamic uplift moment in step 3.
3. Table 6E provides a combination of exposed widths and total lengths that generate a Tile Factor of 1.407 ft^3. The table "Maximum Combination of Tile Length and Tile's Exposed Width" provides a listing of tiles that fit this Tile Factor.

TABLE 7A
Allowable Aerodynamic Uplift Moments
Mechanical Fastening Systems

Direct Deck Installation		
Roof Tile Profiler	**15/32" Sheathing (plywood or code approved equivalent)**	**Allowable Aerodynamic Uplift Resistance (ft-lbf)**
Flat/Low Medium High	2-10d ring shank nails (18-22 rings per inch)	39.1 36.1 28.6
Flat/Low Medium High	1-#8 screw	39.1 33.3 28.7
Flat/Low Medium High	2-#8 screws	50.1 55.5 51.3
Flat/Low Medium High	1-10d smooth or screw shank nail	13.5 12.9 11.3
Flat/Low Medium High	2-10d smooth or screw shank nails	20.2 19.1 13.1
Flat/Low Medium High	1-10d smooth or screw shank nail with clip	25.2 25.2 35.5
Flat/Low Medium High	2-10d smooth or screw shank nail with clip	38.1 38.1 44.3

TABLE 7A (Cont'd)
Allowable Aerodynamic Uplift Moments
Mechanical Fastening Systems

Batten Installation		
Roof Tile Profiler	**15/32" Sheathing (plywood or code approved equivalent)**	**Allowable Aerodynamic Uplift Resistance (ft-lbf)**
Flat/Low Medium High	2-10d ring shank nails (18-22 rings per inch)	24.6 36.4 26.8
Flat/Low Medium High	1-#8 screw	25.6 30.1 25.5
Flat/Low Medium High	2-#8 screws	36.1 41.9 37.1
Flat/Low Medium High	1-10d smooth or screw shank nail	10.1 8.7 8.2
Flat/Low Medium High	2-10d smooth or screw shank nails	12.8 11.9 12.7
Flat/Low Medium High	1-10d smooth or screw shank nail with clip	27.5 27.5 29.4
Flat/Low Medium High	2-10d smooth or screw shank nail with clip	37.6 37.6 47.2
Direct Deck Installation		
Roof Tile Profiler	**19/32" Sheathing (plywood or code approved equivalent)**	**Allowable Aerodynamic Uplift Resistance (ft-lbf)**
Flat/Low Medium High	2-10d ring shank nails (18-22 rings per inch)	46.4 45.5 41.2
Flat/Low Medium High	1-10d smooth or screw shank nail	16.0 15.2 13.0
Flat/Low Medium High	2-10d smooth or screw shank nails	25.0 23.4 15.4

Notes for Table 7A:

1. For attachment systems not listed in the table for 19/32" sheathing use the allowable aerodynamic uplift resistance from the table for 15/32" sheathing.
2. Fasteners shall have a minimum edge distance of 1-½ inches from the head of the tile and located in the pan of the tile to obtain the values in Table 7A. Consult the tile manufacturer for additional limitations or restrictions.

Notes cont'd on page 84

Notes for Table 7A (Cont'd)**:**

3. Ring shank nails shall be 10d ring shank corrosion resistant steel nails (3 inches long, 0.283 inch flat head diameter, 0.121 inch shank diameter, and 0.131 inch ring diameter).
4. Smooth or screw shank nails shall be 10d corrosion resistant steel (3 inches long, 0.28 inch flat head diameter, 0.128 inch screw or 0.131 inch smooth shank diameter).
5. Screws are #8 course threaded, 2.5 inches long corrosion resistant steel wood screws conforming to ANSI/ASME B 18.6.1.
6. The fastener hole nearest the overlock shall be used when a single nail or screw is required. The fastener hole nearest the underlock and the fastener hole nearest the overlock shall be used when two nails or screws are required.
7. When using eave and field clips, attachment of the tiles is accomplished by a combination of nails and clips. Tiles are nailed to the sheathing or through the battens to the sheathing with one or two 10d corrosion resistant nails (Note 2 and 3 above) as required by Tables 5 and 6. Additionally, each tile is secured with a 0.060 inch thick and 0.5 inch wide clip which is secured to the plywood sheathing or eave fascia, as appropriate, with a single nail per clip. The nail shall be placed in the hole closest to the tile for clips having more than one nail hole. The following clip/nail combinations are permitted:
   (1) Aluminum alloy clip with 1.25 inch HD galvanized roofing nail (0.128 inch shank diameter).
   (2) Galvanized steel deck clip with 1.25 inch HD galvanized roofing nail (0.128 inch shank diameter).
   (3) Stainless steel clip with 1.25 inch HD galvanized roofing nail (0.128 inch shank diameter).
8. Field clips and eave clips are to be located along the tile where the clip's preformed height and the tile's height above the underlayment are identical.
9. Counter batten values not included.

Allowable Aerodynamic Uplift Moments
Adhesive Fastening Systems

Refer to the adhesive manufacturer for the allowable aerodynamic uplift moment for the installation method used to comply with the applicable code requirements. Installation of roof tiles using the adhesive system should be done by technicians trained and having a current certification by the adhesive manufacturer to comply with the applicable code requirements.

Allowable Aerodynamic Uplift Moments
Mortar Fastening Systems

Refer to the pre-bagged mortar mix manufacturer for the allowable aerodynamic uplift moment for the installation method used to comply with the applicable code requirements. Mixing of mortar at the jobsite is not a recommended practice. Installation of roof tiles using the mortar system should be done by technicians trained and having a current certification by the mortar mix manufacturer to comply with the applicable code requirements.

Design Considerations for Installations in Earthquake Regions

The Tile Roofing Institute in conjunction with the University of Southern California, Structural Engineering Department conducted a series of testing on the Seismic Performance of Concrete and Clay Tile. The testing concluded that Concrete and Clay tile, when installed according to ICC code requirements, withstood forces almost twice the code requirements for structures.

Tile is the only roofing material to have conducted such testing on roof assemblies and is pleased to report that concrete and clay tile will not require any additional fastening requirements, other than those required under the current ICC code.

GLOSSARY OF TERMS

Abutment: The intersection between the roof and the chimney, wall or other vertical face.

Adhesives: A bonding agent to join two surfaces for the purpose of permanent attachment as approved by the local building official.

Anti-Ponding: A device such as beveled cant strip or shop-formed sheet metal is recommended at all raised fascia conditions to support the underlayment.

Batten: A horizontal fastening strip to which the roof tiles are attached.

Batten Lugs: Protrusions (anchor lugs) on the underside of the tile designed to engage over the upper edge of tiling battens.

Bedding: Refers to the installation of roof tiles to a mortar or polyurethane foam patty and is structural in nature for the basic securement.

Bird Stop: A product used at the eave of a profile tile roof to stop birds from entering below the tile.

Booster Tile: Normally 3"-4" long tile strip used to lift up the cover tile. Sometimes it is used in boosting up field tile to create an authentic looking roof.

Clay Rooftile: An interlocking or non-interlocking clay roof covering, used to cover the roof surface.

Concrete Rooftile: An interlocking, or non-interlocking concrete roof covering, used to cover the roof surface.

Counter Battens: Vertical furring strips running beneath and perpendicular to horizontal tile batten, to allow drainage and air flow beneath the roof tile. Also known as strapping.

Counter Flashing: A flashing material that provides the enclosure at the transition line between the roof to wall flashing at intersecting vertical surfaces.

Counter Batten System: A method of elevating horizontal battens above the roof deck to allow drainage and airflow beneath the horizontal battens and roof tile

Cricket: See Saddle.

Dead Loads: Nonmoving rooftop loads, such as mechanical equipment, air-conditioning units, and the roof deck itself.

Direct Deck: Those tiles fastened directly to the roof deck without the use of battens.

Eave: Outer edge of the roof downslope.

Eave Closure: A material available for S-tile or Pan and Cover tile. Eave closures are used to close the convex opening created by the shape of the tile at the eave. This accessory also provides the proper rise for the first course of tile. See Bird Stop.

Eave Riser: Method/material used for elevating the nose of the first course of tile to the plane of the field tile.

Fascia: A decorative board concealing the lower ends of the rafters or the outer edge of the gable.

Flashing: Impervious material used to cover, waterproof, and direct water away from roof penetrations and from intersections between the roof tile and other materials.

Fully Engaged: The horizontal batten material thickness shall be equal to or greater than the design depth of the anchor lug of the tile.

Gable End: The generally triangular area at the end of a sloped roof extending from the eaves to the ridge.

Head Lap: The measurement of the overlap between a course of roofing components and the course above.

Headwall Flashing: The flashing that is installed at the horizontal, intersecting wall or other vertical surface.

Hem: An edge of metal bent back on its self to give strength to the edge of the metal.

High Profile Tile: Those tiles having a rise to width ratio greater than 1:5. (Typically referred to as "S" or barrel, 2-piece, Pan & Cover tile). Measured in the installed condition.

Hip: The exterior sloping ridge formed by the intersection of two inclined roof surfaces.

Hip/Ridge Tile: Accessory trim tile used to cover a hip or a ridge.

Hip Starter: The closed hip piece which is used at the outside corner, intersecting of two eaves to start the hip tile.

Interlocking Tile: Those tiles with a system of rib(s) or groove(s) enabling the joining of adjacent tiles in the same horizontal or vertical row, with the overlapping lock covering the underlapping lock.

Length: The maximum overall dimension of the tiles as measured parallel to the water course.

Lightweight Rooftile: Roof tile of mass/unit area of less than 9. 0 lbs/ft^2 installed weight excluding all other roofing components.

Live Loads: All weighted loads, such as people, rain, and snow, exerted on a roof, other than those related to the structure of the building.

Low Profile Tile: Low profile tiles are defined as those flat tiles having a top surface rise equal to or less than ½".

Medium Profile Tile: Tiles having a rise greater than ½" and a rise to width ratio of less than or equal to 1:5.

Metal Drip Edge: Perimeter metal flashing installed to protect raw edges of roof deck.

Mortar: A mixture of cementitious material, aggregate, and water used for bedding, jointing, and bonding of masonry or roof tile and accessories.

Nail Hole: A small opening passing partially or totally through the tiles to allow the penetration of a nail, screw or other approved fastener for the purpose of fastening the tile to a support.

Nailer Board/Stringer: A piece of wood or other material of proper height, attached to a roof at the ridge and/or hips to allow for proper support and means of attachment for the hip and ridge tile. Can also be used in pan and cover applications under the cover tile for proper support. (Commonly known as a vertical stringer)

Non-Interlocking Tile: Those tile that do not have vertical rib(s) or grooves creating an interlocking tile.

Nose Clips: A fastening device designed to hold the nose (or butt) end of the tile against uplift or sliding down the slope. Also known as wind clips or tile locks.

Nose Lugs: Protrusion(s) on the underside of the tile that are designed to restrict the flow of weather between two consecutive courses of tile.

Pan and Cover Tile: Semi-circular shape tile. Also known as two piece mission or barrel mission tile. There are tapered and straight two piece mission styles available.

Pan Flashing: Metal flashing running under the tile at the side walls.

Point-up: The application of mortar to fill voids to various ends, sides and angles of a tile roof, which are non structural in nature.

Profile: The contour of the top surface of the tiles when viewed from the nose end.

Rake Trim: A roof tiling accessory used to cover the intersection between the gable end and a roof.

Ridge Trim: The piece of ridge available to close off the gable end and peak of a roof. Some ridge tile have an interlocking feature and require either a "starter" or "finisher".

Ridge Tile: See hip/ridge tile.

Saddle Flashing: The flashing at the upper intersection between a chimney or skylight and the roof. (Commonly referred to as a Cricket or Backpan)

Side Clips: A fastening device for tile with a side interlock designed to prevent rotation of the tile when subjected to uplifting forces. Also known as hurricane clip.

Side Lap: The measurement of the overlap between a roofing component and a component to one side of it.

Side Wall: The vertical intersection that runs parallel to the roof slope.

Spaced Sheathing: Sheathing boards or battens, which are mechanically attached to the rafters or framing members, with gaps or spaces between them and is used in lieu of a solid sheathing.

Standard Weight Rooftile: Roof tile of mass/unit area of 9 lbs/ft^2 or greater installed weight excluding all other roofing components.

Starter Tile: First course of cover tile for two piece misson. Normally 3"-4" shorter than the field tile.

Step Flashing: A piece of flashing material covering each course of tile at sidewalls.

Stringer: See nailer board.

Sweat Sheet/Bleeder Sheet: A layer of underlayment under the valley metal to prevent moisture/condensation from entering the roof deck.

Tile Course: The horizontal increment of exposure.

Tile Thickness: Any vertical measurement of the cross section of the tiles excluding the lapping area, head or nose lugs, and weather checks.

Tile Thickness (visual): The overall thickness of the tile profile when installed as measured from the top surface of the lower tile to the top surface of the upper tile.

Tile Batten: See Batten

Underlayment: A water shedding membrane installed over the roof sheathing, rafters, or trusses. The underlayment may be rigid or roll form.

Valley: The angle of a roof where two slopes intersect internally.

Closed Valley: Where tile(s) are cut to meet at the center of the valley metal.

Open Valley: Where tile(s) are cut to expose the trough area of the metal.

Vent Tile: A tile designed to allow air circulation from the roof space to the outside.

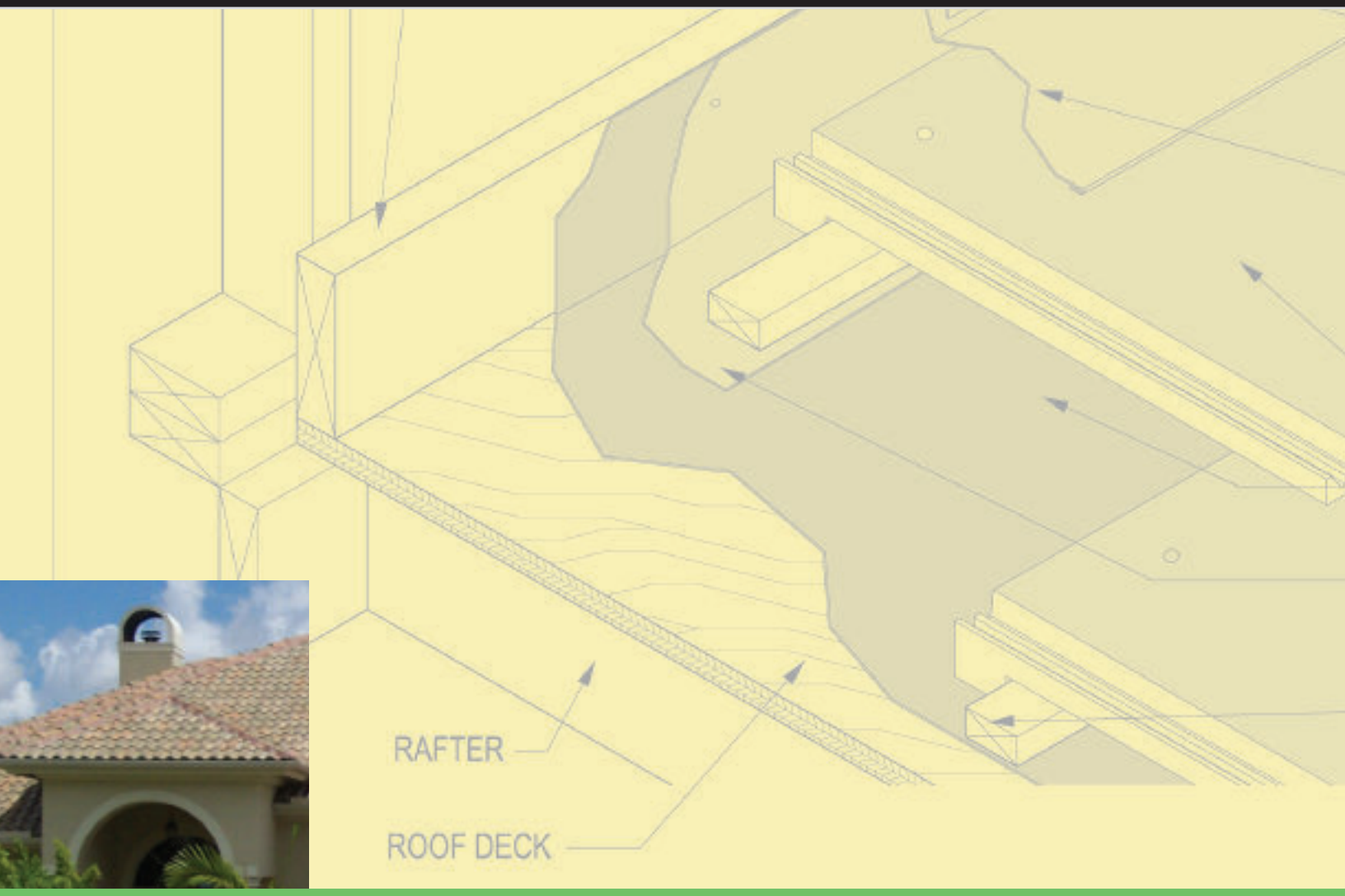
Water Course: The valley portions of profiled tiles along which water drains.

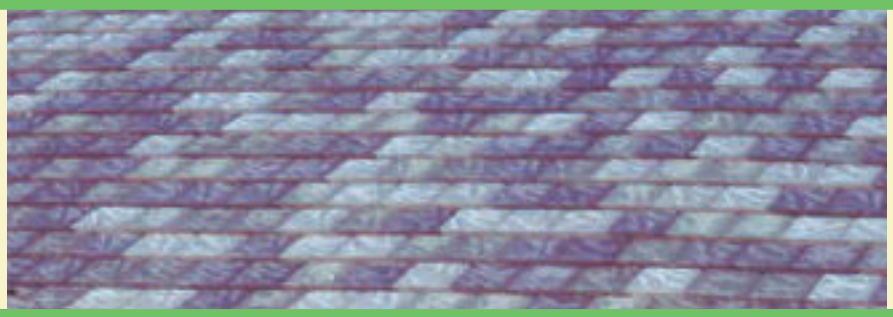
Weather Blocking: A barrier of moldable or preformed rigid material which blocks the entry of wind driven moisture at openings between the field tile and trim tile or the field tile and roof flashing.

Weather Checks: Protrusion(s) on the tile that are designed to restrict the flow of water between two consecutive courses of tile.

Width: The maximum overall dimension of the tiles as measured perpendicular to the length of the water channel.

Wire Tie System: A roof tile fastening system approved by the local building code, that limits the penetration of the underlayment and allows tile to be fastened to non-nailable roof decks.





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