

DOCUMENT RESUME

ED 215 212

CE 032 131

AUTHOR Klingensmith, Robert, Ed.  
TITLE Roofing Workbook and Tests: Rigid Roofing.  
INSTITUTION California Educational Advisory Committee for the Roofing Industry, Sacramento.; California State Dept. of Education, Sacramento. Vocational Education Services.

PUB DATE 80

NOTE 87p.; This publication was planned and prepared under the direction of the Education Advisory Committee for the Roofing Industry, with the cooperation of the State Joint Roofing Industries Apprenticeship Committee. See also CE 032 130, ED 203 139, and ED 212 816.

AVAILABLE FROM Publications Sales, California State Dept. of Education, 721 Capitol Mall, Sacramento, CA 95814 (\$4.00).

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.  
DESCRIPTORS \*Apprenticeships; Behavioral Objectives; Construction (Process); \*Construction Materials; Definitions; Instructional Materials; Postsecondary Education; Programed Instructional Materials; \*Roofing; Tests; \*Vocational Education; Workbooks

IDENTIFIERS California

ABSTRACT

This document is one of a series of nine individual units of instruction for use in roofing apprenticeship classes in California. The unit consists of a workbook and test. Eight topics are covered in the workbook and corresponding multiple-choice tests. For each topic, objectives and information sheets are provided. Information sheets are illustrated with line drawings and photographs. Topics covered in the unit include the following: general description of rigid roofing; hoisting and handling of rigid roofing materials; two-piece mission barrel tile; concrete interlocking tile; slate and rigid asbestos shingles; and other rigid roofing materials. A list of required instructional materials and a glossary of terms used in the roofing trade are included in the publication. (KC)

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ED215212

CE 032 131

# Roofing

## Workbook and Tests

### Rigid Roofing

Prepared under the direction of the  
EDUCATIONAL ADVISORY COMMITTEE  
FOR THE ROOFING INDUSTRY  
and  
VOCATIONAL EDUCATION  
SUPPORT SERVICES SECTION

DEPARTMENT OF EDUCATION  
OFFICE OF ASSISTANT SECRETARY FOR  
TECHNICAL AND VOCATIONAL EDUCATION

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This publication was edited by Robert Klingensmith, Assistant Editor; prepared for photo-offset production by the Bureau of Publications, California State Department of Education; and published by the Department, 721 Capitol Mall, Sacramento, CA 95814.

Printed by the Office of State Printing  
and distributed under the provisions  
of the Library Distribution Act

1980

Copies of this publication are available for \$4 per copy, plus sales tax for California residents, from

Publications Sales  
California State Department of Education  
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A column labeled "Date Assigned" has been provided at the right-hand side of each page number in the contents. Whenever your instructor assigns a topic, he or she should write this date in the appropriate blank. When you have completed the topic satisfactorily, your instructor should place his or her initials next to the assignment date. If this procedure has been followed, and you should transfer from one school to another, you will have an accurate record of the work you have completed. It should never be necessary for you to duplicate work on topics already studied or to skip topics not previously assigned.

To provide other school records needed, be sure to fill in below your name, home address, and telephone number. Then ask your instructor to fill in the official date of your enrollment in his or her class and to sign his or her name.

NAME _____
ADDRESS _____
_____ PHONE _____
DATE ENROLLED _____
INSTRUCTOR(S) _____
_____

# Foreword

In the California apprenticeship programs, experience gained on the job is supplemented by classroom work that is closely related to the job. This balanced system of training enables the apprentice to learn the "why" as well as the "how" of the trade. Both types of training are required for advancement in today's competitive industries.

The job-related courses for the skilled trades are highly specialized, and adequate training materials are for the most part not available commercially. To meet this need, the Department of Education, in cooperation with labor and management, develops the required training materials and makes them available to you at cost. This workbook is an example. It was written to provide you with up-to-date information you must have to meet the growing technical demands of the roofing and waterproofing trade. Every effort has been made to make the workbook clear, comprehensive, and current.

I congratulate you on your choice of roofing and waterproofing as a career. The effort you put forth today to become a competent journey-level worker will bring you many rewards and satisfactions, and the benefits will extend also to your community. We need your skills and knowledge, and I wish you every success in your new venture.



*Superintendent of Public Instruction*

# Preface

The Vocational Education Support Services Section in the State Department of Education provides for the development of instructional materials for apprentices under provisions of the California Apprentice Labor Standards Act. These materials are developed through the cooperative efforts of the Department of Education and employer-employee groups representing apprenticeable trades.

This edition of *Rigid Roofing* was planned and prepared under the direction of the Educational Advisory Committee for the Roofing Industry, with the cooperation of the State Joint Roofing Industries Apprenticeship Committee. The members of this committee include representatives of the Roofing Contractors Association of California and representatives of local unions. Employer representatives serving on the Educational Advisory Committee are Herman Little, San Jose; Robert Culbertson, Sacramento; and Arthur Adams, San Carlos. Representing employees are Carl Stephens, Santa Ana; Joe Guagliardo, Fresno; and William Penrose, San Jose. Special thanks and appreciation are extended to M. Duane Mongerson of Oakland, who served as Committee Adviser.

Beverly Campbell, Consultant, Apprenticeship Education and Industrial Education, coordinated the project activities for the Vocational Education Support Services Section. Blair Hansen, former Managing Editor, and Theodore R. Smith, Editor in Chief, coordinated publications activities for the Bureau of Publications.

This publication is one of a series of nine individually bound units of instruction for roofing apprenticeship classes. These new books reflect the continuing cooperative effort of labor, management, local schools, and the Department of Education to provide the best instructional materials for California apprenticeship classes. They are dedicated to excellence in the training of roofing apprentices.

**DAVIS W. CAMPBELL**  
*Deputy Superintendent  
for Programs*

**SAM BARRETT**  
*State Director of Vocational Education*

**BRENTON R. AIKIN**  
*Acting Administrator  
Vocational Education Support Services Section*

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# Acknowledgments

Gratitude is expressed to the following manufacturers within the roofing and waterproofing industry who contributed valuable information, drawings, and photographs used in this workbook:

California Tile, Inc.  
Cleasby Manufacturing Company  
Craycroft Brick Company  
Evergreen Slate Company, Inc.  
Luna Clay Tile, Inc.  
M.J.H. Manufacturing and Supply Company  
Monier Company  
Reimann and Georger  
Steel Structures, Inc.  
Supradur Manufacturing Company

Gratitude is also expressed to Harry Engleman, Redwood City, who prepared the cartoonlike drawings used in the workbook.

# Rigid Roofing

## TOPIC 1—GENERAL DESCRIPTION OF RIGID ROOFING

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Discuss the history of the use of tile in roofing.
- Describe rigid roofing materials.
- Identify the different types of roofing shingles and tiles.
- Identify the colors of rigid roofing materials.
- Describe the advantages and disadvantages of the various rigid roof systems.

Knowledge and skills in all phases of roofing are essential to the success of the apprentice. Because of this, the apprentice should take advantage of every opportunity to work on as many different kinds of roofing jobs as possible. Among these, rigid roofing work offers several challenging variations.

Each rigid roof job presents its own layout, application, and flashing problems; therefore, the information provided in this book can include only general suggestions for solving these problems. The information can be used to advantage if applied to these problems and adapted, if necessary, to fit the individual job.

A variety of materials made from asbestos cement, clay, concrete, metal, plastic, slate, and wood can be used by the builder to create an attractive commercial, industrial, or residential rigid roof system. These materials are usually very durable and will outlast most hot or cold built-up systems or asphalt shingles. Generally, rigid roofing materials are much more expensive than those required for hot or cold built-up systems; however, this situation may change as the price of petroleum/oil-based materials continues to increase as a result of limited oil supplies worldwide.

### History of Rigid Roofing Materials

No one really knows where or when rigid roofing materials originated. Thousands of years ago clay tile was used by the Greeks, Romans, Japanese, Chinese, and Europeans. Concrete tile has been used in one form or another since the early 1900s in the United States. Tile played a major role in roofing during the early history of California. Some of the first buildings in the state were roofed with straw and then reroofed

later with tile. The Indians learned that they could fashion red clay by making a batch of mud and forming it over their thigh or over a formed section of log. The mud was allowed to dry and then fired in a mud bread oven to hasten the drying process. This process eventually became known as kiln firing.

Slate as a roofing product has been in use for hundreds of years. It is a natural stone taken from quarries. Thousands of slate roofs that were laid in the late 1800s are still watertight today.

Roofs made of metal have been used since the 1700s in heavy snow country. From the sun's heat and the warmth inside the structure, the metal heats rapidly, causing the snow to melt and slide off the roof. Today, many types of metal coverings are used in the roofing industry: galvanized sheets; aluminum shingles, shakes, or tile; and steel tile or panels. The domes of several state capitols have a gold base metal covering. Others, needing protection from salt air, have a base of copper sheets. Because of the high costs of these materials, however, they are not commonly used.

Rigid asbestos cement shingles were popular materials for several years, but because studies showed asbestos dust to be damaging to the lungs, it has almost been abandoned as a roofing product.

Plastic roofing is available in many types and is fairly new to the industry, having been developed in the 1940s. Generally, plastic materials are reproductions of tile, shakes, or metal sheeting.

### Roofing Tile Classifications

Roofing tile is generally classified in three main categories: (1) flat shingle tile; (2) interlocking shingle

tile; and (3) pantile. Pantile may be interlocking and is considered a single coverage tile; that is, it has no water channel except for the exposed surface of the tile. Some types of tile are shown in Table 1-1.

Some rigid roofs in various parts of the world are hundreds of years old and are still quite serviceable, even though a number of the tiles have had to be replaced because imperfections caused them to deteriorate. A roofer soon learns to detect a defective piece of rigid roofing material prior to installation; such pieces are either discarded or saved for use on hips and valleys, which generally require cut tiles. Tile, slate, and asbestos shingles with hairline cracks will usually break when exposed to weather extremes.

New tile-manufacturing techniques make it possible to remove all air pockets, thereby making the tile dense enough to withstand extreme temperature changes without cracking.

### Colors of Rigid Roofing Materials

Clay tile is usually "brick red" in color but may be purchased with a variation of shades of red. Tile with different tones of red in it is called variegated tile. Concrete tile is produced in a variety of colors. Colors are obtained by mixing color additives with the concrete and then baking. Some tile has a shiny surface that is achieved through a glazing process much like that used with pottery. Slate is normally green, purple, gray, red, black, or mottled (spotted). Slate colors are usually natural colors of slate rock. Metal colors range from the natural aluminum color and natural galvanized steel color to any color required for the project. The natural copper color turns green from oxidation through natural weathering. Steel tile, which is a shade of brown when applied, will oxidize to a darker brown as it ages. Plastic materials are available in practically any color desired.

### Custom Designs

All rigid roofing materials can be specifically designed and manufactured for any given roof area. In such cases, however, the materials must be applied exactly as intended by the manufacturer to achieve the desired effect. Beauty is achieved by coordinating colors and architectural styles.

### Advantages of Rigid Roofing Materials

Because rigid roofing materials are virtually termiteproof, rodentproof, and rotproof and are able to withstand extremes of temperature, roofs of these materials are said to be lifetime roofs. In fact, some of the materials will actually become stronger with age, and the roof will outlast the rest of the structure. Except for plastic and wood, all rigid roofing materials are fireproof.

Rigid roofing is generally more expensive than other types, but it is also a better investment because of its longevity, which improves the resale value of the structure.

When applied in accordance with specifications, rigid roofing materials form a watertight roof that requires little or no maintenance or repairs. Such roofs will not deteriorate, delaminate, rot, mildew, or buckle. Most rigid roofing materials have been proved to be acid resistant and unaffected by industrial elements, smog, salt air, or other corrosive materials in the atmosphere.

### Disadvantages of Rigid Roofing

When a reroofing project is considered, the structure of the building must be taken into account. The structure must be such that it can carry the additional weight that must be placed on it. Concrete tile, clay tile, and slate are very heavy, weighing from 900 to 1,500 pounds (408.6 to 681 kilograms) per square (100 square feet, or 9.29 square metres). Structures that are to have roofs of these materials should have at least 2-inch by 6-inch (5.1-centimetre by 15.2-centimetre) rafters spaced every 16 inches (40.6 centimetres) on center.

Clay, concrete, and slate tend to retain heat and are therefore less desirable than other materials where temperatures are high year round. However, the color of the material used in such areas must also be considered. Dark colored concrete, clay, plastic, or steel retains heat; light shades reflect the sun's rays.

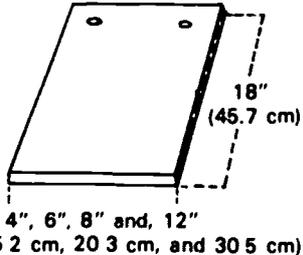
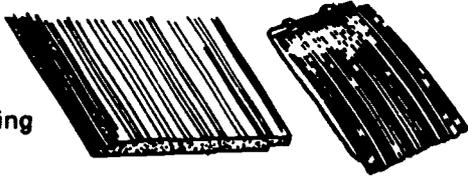
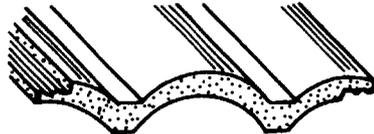
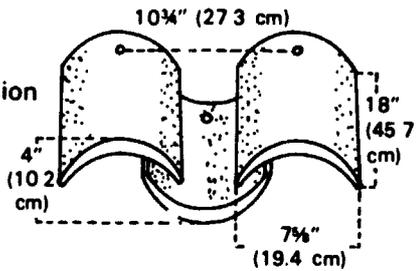
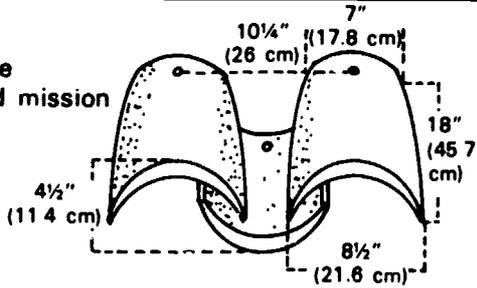
Aluminum is the most reflective of all rigid materials, but this quality can create a problem, especially if the structure is on a hill. When the sun reaches certain positions, the glare from the roof can be blinding to anyone in its path.

Although leaks are uncommon in a rigid roof, a leak in such a roof can be very difficult to locate. The water may not show up until it reaches a spot several feet from the point where it actually penetrates the roof sheathing.

A rigid roof must have all protruding objects in place before the job is finished so that no one will have to walk over the completed area. Walking on tile will crack or break it. Plastic will break and aluminum shakes will bend when walked on. Steel tile and aluminum shingles are very slippery, and one who must walk on such roofs must take precautions to avoid falling.

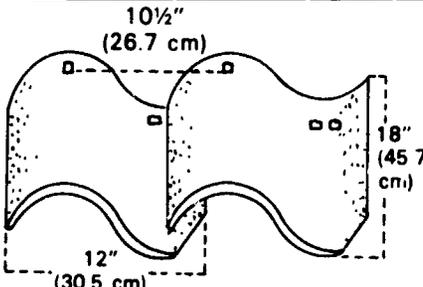
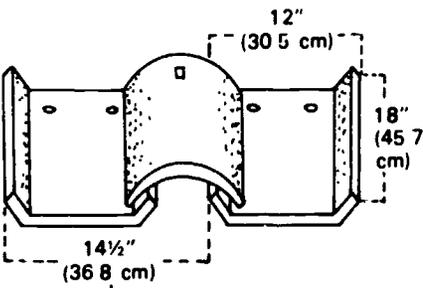
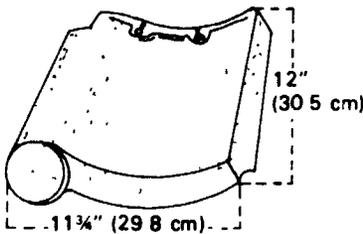
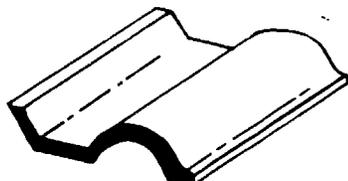
Because of the procedures used in making concrete, clay, or slate roofing, it is unwise to assume that each piece is identical in width, length, and thickness. An irregular roof pattern can be created if those who apply such roofing do not examine materials carefully to be sure that their dimensions are nearly identical.

TABLE 1-1  
Selected Types of Roofing Tile

Type of tile	Length exposed to weather (regular laying method)	Center-to-center specification	No. of pieces required per square	Average weight per square
Flat shingle 	12" (30.5-cm) widths			
	14" (35.6 cm)	12" (30.5 cm)	86	980 lbs. (444.9 kg)
	Random widths			
	13½" to 15" (34.3 cm to 38.1 cm)	Varies	4" (10.2 cm) 12 6" (15.2 cm) 26 8" (20.3 cm) 26 12" (30.5 cm) 52	985 lbs (447.2 kg)
Flat interlocking 	11" (27.9 cm)	9" (22.9 cm)	150	950 lbs. (431.3 kg)
Sculptured interlocking 	13¼" (33.7 cm)	8⅞" (20.6 cm)	90	900 lbs. (408.6 kg)
Two-piece straight mission barrel 	14" (35.6 cm)	10¾" (27.3 cm)	190	1,030 lbs. (467.6 kg)
Two-piece tapered mission barrel 	14" (35.6 cm)	10¾" (27.3 cm)	190	1,150 lbs (522.1 kg)

(continued)

TABLE 1-1 (CONTINUED)

Type of tile	Length exposed to weather (regular laying method)	Center-to-center specification	No. of pieces required per square	Average weight per square
One-piece mission, or S, tile 	15" (38.1 cm)	10½" (26.7 cm)	88	990 lbs. (449.5 kg)
Shingle (pan and cover shingle) 	Regular laying method			
	14" (35.6 cm)	14½" (36.8 cm)	144	1,100 lbs. (499.4 kg)
	Alternate laying method			
	14" (35.6 cm)	18½" (47 cm)	120	1,200 lbs. (544.8 kg)
Oriental interlocking shingle 	9" (22.9 cm)	10¼" (26 cm)	152	950 lbs. (431.3 kg)
Spanish 	10¼" (26 cm)	8¼" (21 cm)	90	900 lbs. (408.6 kg)

## RIGID ROOFING

### TOPIC 2—HOISTING AND HANDLING OF RIGID ROOFING MATERIALS

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Describe the procedure for ensuring that trucks and forklifts are in good working order.
- Describe the ways in which different types of tile should be loaded on a truck.
- Identify the strongest areas of a roof, and select a roof area where tile can be unloaded safely.
- Describe the proper procedures for walking on a tile roof.
- Distinguish among chicken ladders, roof jacks, ladder jacks, and scaffolding.

The first job to which most apprentice roofers are assigned is loading a truck for a roofing job. Such a task may seem easy, but it can be quite complex. Loading a truck requires more than merely making sure that all necessary materials are placed on the vehicle. The materials must be loaded in the reverse order in which they will be needed at the job site; that is, those items needed first should be loaded last so that they are the first items to be unloaded when the truck reaches its destination. Care must also be taken to ensure that the weight of the loaded materials is evenly distributed as much as possible over the wheels of the vehicle.

#### Checking the Truck and Equipment

Before a truck is loaded, it should be checked to make sure that it is in good working order. Loading—and then having to unload—a truck that is not functioning is both time consuming and costly. The apprentice should also keep in mind that unsafe equipment can cause serious injury or even death.

Checking the truck should include making sure that the engine will start, checking the oil and fuel levels, operating the lights and windshield wipers, and examining the tires. Every truck to be used on the job should be equipped with a first-aid kit and a fire extinguisher (preferably a powder-type extinguisher) that is in good working condition.

If a forklift is to be towed behind the truck, the towing hitch should be checked to make sure that it is safe. The worker should be sure that the hydraulic system is full and operative and that the locking brake works. The taillights and brake lights should also be checked. Before towing a forklift, the worker should make sure that the fingers are in the down position and that the safety brake is released.

Obviously, this list of items to check before loading a truck is not exhaustive; it is not meant to be. Rather, it is provided to impress on the apprentice the need for care in undertaking the loading of a truck and to serve as a basis for such work

#### Loading Materials on the Truck

The major types of tile used for roofing are shingle tile; Spanish tile; and the various types of mission tile, especially one-piece mission, or S, tile. Most manufacturers deliver these tiles already stacked on pallets and secured with metal bands to keep them from slipping. However, if these types of tile are to be loaded loose on the truck, they should be stacked on end and as straight as possible to prevent slipping and cracking or breaking. *NOTE:* Before cutting the metal bands on stacks of tile, the worker should make sure that the tile is not leaning to one side; if the tile is leaning, it will fall when the pressure from the band is released.

In the loading of loose Spanish or mission tile of any type, the field pieces should be stacked in rows, or tiers. The rows should be kept even so that when the loading is completed, a rope can be tied from one side of the truck to the other to secure the tile and help prevent breakage. Because of their fragile nature, the hip, ridge, and rake tiles should be placed on top of the rows to protect them.

Rigid asbestos tiles, slate, and plastic tiles should be loaded flat on the truck. If they are stacked too high, the weight of the stack will break those in the bottom rows.

Because tiles are very fragile, great care must be used in handling and loading them. Stacking tiles on edge can damage them to the point of rendering them useless. Care must also be taken not to bang the corners against other objects because the corners can easily chip off.

If shingles are stacked in tiers, they should be stacked in groups of three running in opposite directions; that is, the first three should be laid in one direction, the next three should be laid across the first three, the next three should be laid the same way as the first three, and so on. Stacking shingles in this manner decreases the chances of their falling. Placing strips of wood lath between tiers is also recommended to improve stability and prevent damage.

Metal tile is usually very rugged, and the package in which such tile is shipped is generally sufficient protection against bending or mashing. However, in loading aluminum shakes, the roofer must be careful not to step on exposed ends and thereby mash them. Flattened aluminum shakes are useless.

### Loading Materials on the Roof

Proper loading of roofs requires skill and knowledge of the roof structure. Unless careful consideration is given to loading properly and safely, damage to the roof and to the interior finish of the building can result. When loading a roof, the roofer must consider the strength of the roof deck, condition of the sheathing boards, weight distribution of the materials, accessibility of materials for application, and the order in which the materials will be needed.

### Checking the Roof

Before loading materials on a roof deck, a good worker will examine the deck to determine whether or not it can support the load. Cracked sheathing or sheathing with large knotholes, for example, may break under the weight of the materials.

Loads should not be placed on the roof overhang or eaves because such areas are not strong enough to support the weight. Even the weight of the roofer may be too great for these areas, and he or she should avoid walking there. Among the things that the roofer should check is the spacing of rafters and rafter supports to determine the parts that can carry substantial weight. In cases where the rafter location cannot be determined easily, such as on a reroofing job, the rafters can be located by tapping on the roof and listening for a solid sound; tapping where there is no rafter directly below will produce a somewhat hollow sound. Usually, rafters are placed every 16 or 24 inches (40.6 or 61 centimetres) apart. Rigid roofing materials should always sit on a new structure for some time before installation begins. This practice provides time for the structure to accept the weight and settle on its foundation before stucco or some other exterior finish is applied. If settling occurs after the exterior finish is applied, the finish could crack or break.

### Determining Where to Unload

A location that will be accessible from all sections of the roof should be selected to receive the material from the ground. Ideally, loads should be placed as near the edge of the structure as practical and as near as possible to its center. In this way the distances required for distributing materials to *all* parts of the roof are minimized. However, the location selected should also be clear of obstacles that may be a hin-

drance in transferring materials. Skylights, dormers, valleys, or high fire walls are examples of such obstacles.

If a liftbed truck or forklift is used to lift materials to the roof, the ground area below the equipment should be solid and level. A soft or uneven surface could cause the equipment to sink or tip to one side, causing the load to overturn. If the roofer is not sure of the stability of the ground, he or she should use heavy planks under each tire to give the truck or forklift additional support. If the liftbed truck is equipped with stabilizing outriggers, care should be taken to ensure that they are extended, with a firm support for a base. Forklifts should be equipped with roll bars, overhead protection from falling objects, and a warning back-up signal. Wheel blocks should be used as an additional safety measure to prevent equipment from moving.

### Placing the Materials

Clay tiles, concrete tiles, slate, or asbestos tiles may weigh from 750 to 1,800 pounds (340.5 to 817.2 kilograms). Caution should be used when loading such materials over an existing roof. A determination should be made as to whether the structure is sound and will be able to withstand the additional weight. Consideration should be given to the fact that the weight of some materials, such as unglazed tile, may increase from 15 to 100 percent when the materials are saturated with water. The estimator will usually examine the structure to be sure that it can accommodate the material that is to be applied; however, it is a good safety practice for the roofer to check the area also.

The specific loading procedures for each type of tile will be dealt with in the sections on application of each type. In general, however, metal, slate, and asbestos tile should be spread across the entire roof for safe weight distribution and ease of laying. Once the proper spacing from eave to ridge has been determined, the roof should be loaded so that no walking over the loaded materials is required. The rake, eave, field, and flashing pieces should be placed so as to be readily accessible from places where they will be used.

On solid sheathing a dry felt or hot-applied membrane will be laid on the deck surface. Vertical and horizontal chalk lines will be drawn across the membrane to help show where materials can best be positioned. The stacks of materials should be placed above the horizontal lines and on either side of the vertical lines. A good point to remember in placing tiles is to lay them so that the end with the nail hole points toward the ridge of the roof. If in doubt about proper weight distribution or the quantity of material to be placed in various locations, the roofer should

load heavier at the last course on the ridge than at lower locations. It is easier to move tile down than to pick it up and move it upward to get it out of the way. Such placement is also advantageous in the event that too much material has been placed on the roof. It is easier to remove extra material from the ridge, using a forklift, liftbed truck, or rope and wheel, than it is to remove it from other locations.

If a hot membrane with a glaze coating has been applied to the deck, dry cement should be sprinkled on the membrane to prevent the tile, tools, and workers' feet from sticking to the surface. If objects do stick, holes will be made in the membrane when they are removed. Care must be taken not to eliminate the chalk lines from the membrane.

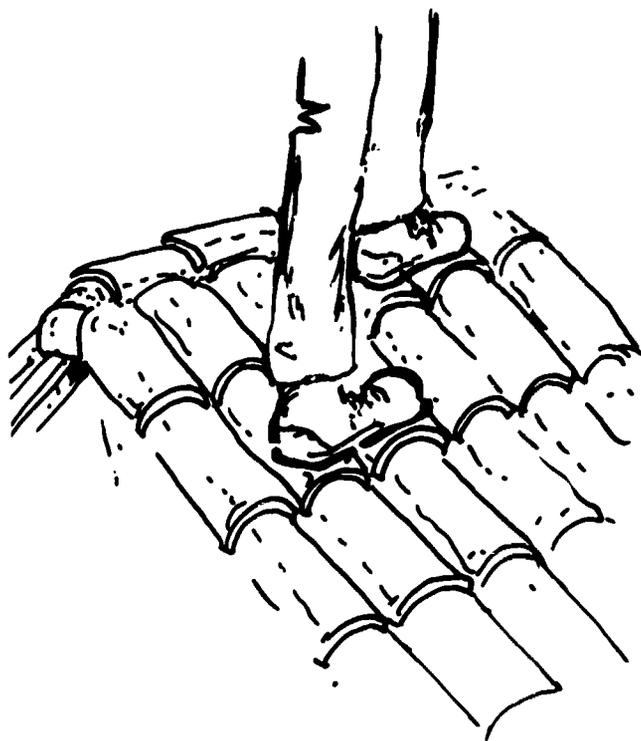
### Walking on Tile

An experienced tile layer, using an "eggshell step," can walk over a tile roof without causing any damage, but precautions should still be taken. Among the things that a roofer can do to protect roof tile (as well as slate and asbestos shingles) from damage are the following:

- Fill small burlap sacks with wood shavings or sawdust, and throw the bags ahead of her or him to walk on. These bags tend to distribute the individual's weight over three or four tiles.
- If not using the burlap bag technique, walk on two tiles at a time, rather than just one. A careful step requires a knowledge of how tiles are laid. Always step on the outer ends of a tile—never in the center.
- If one must do extensive walking, place sacks of wood shavings (or sawdust) under the two ends of a plank, and use the plank as a catwalk. Cemented hips and ridges also offer a safe route to follow.
- If necessary, lay a single course or path of tiles in cement to provide a safe access route or for a traffic walk area for maintenance of equipment by other people. Another method of access is to leave out either a vertical or horizontal (or both) course so that access is maintained to all areas of the roof for finish detail.

A roofer should never attempt to stand a ladder directly on tiles. A ladder thus situated can slip too easily, and too much weight is concentrated on each ladder leg. The tiles under the ladder legs should be removed, and a cleat should be installed to provide a level platform. The roofer must make sure that the ladder footing is completely solid and the top is tied to prevent sliding.

If a roofer has to walk on clay or concrete tile and notices an unusual amount of breakage, he or she

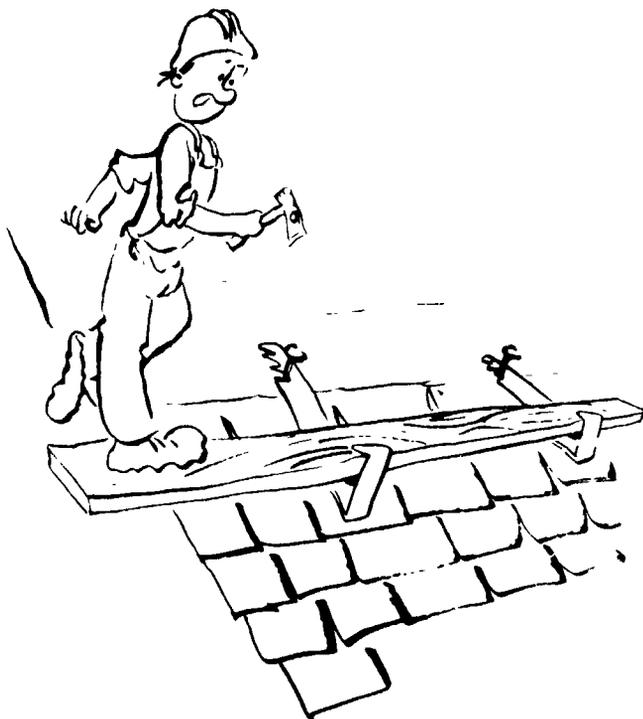


should be sure to notify the employer immediately; excessive breakage is normally caused by imperfections in the run of tile or faulty curing. The employer can then notify the manufacturer and obtain replacement material so that sufficient tile to finish the job will be on hand.

### Walking on a Steep Roof

A roof with a pitch over 8 inches (20.3 centimetres) in 12 inches (30.5 centimetres) (8/12, or one-third pitch) is considered too steep for walking on. Even roofs with less pitch may be considered dangerous if the roof is wet or covered with dust, moss, or any other substances that may act as a lubricant. Wearing shoes with leather soles and heels is an extremely hazardous practice and should not be attempted even on roofs with a pitch as low as 6 inches (15.2 centimetres) in 12 inches (30.5 centimetres), or one-quarter pitch. Gripper-type, rubber-soled tennis shoes or work shoes with foam rubber soles are most satisfactory when working on a steep roof.

When a roofer walks on a steep roof, he or she should always place the entire surface of his or her foot on the roof and stand erect (Fig. 2-1). If the roofer leans forward toward the peak of the roof when walking against the slope of the roof, the weight of her or his body will be thrust downward, and the heels of her or his shoes will normally lift off the roof,



A "chicken" ladder (or cleat ladder) is sometimes used as a safety device for walking on steep roofs. Such ladders are also used in some cases to protect the roof surface against damage from foot traffic. Chicken ladders are usually made by nailing wooden cleats at regular intervals of about 12 inches (30.5 centimetres) on a plank 15 to 20 feet (4.6 to 6.1 metres) long. A short piece of lumber—usually 2 inches by 4 inches (5.1 centimetres by 10.2 centimetres) or 4 inches by 4 inches (10.2 centimetres by 10.2 centimetres)—is nailed to one end of the plank and on the opposite side of the plank from the cleats (Fig. 2-3). This piece is hooked over the ridge to hold the ladder on the roof. A regular ladder equipped with a ladder hook (Fig. 2-4) can be used in the same way. Chicken ladders are generally light in weight but awkward to handle because of their length. A chicken ladder is most easily placed by sliding the ladder up the roof from the eave until it passes the ridge and then pulling it downward until the end cleat (or hook) catches on the ridge. *NOTE:* Before using a chicken ladder, the roofer should make sure it is securely hooked to the ridge. This can be done by pulling on the ladder as hard as possible two or three times.

reducing the traction to less than half of what it was. If one should fall, he or she should lie flat, with arms and legs outstretched for maximum resistance to slipping and rolling.

The effect of walking parallel with the slope of a roof is illustrated in Fig. 2-2. Note that the lower foot assumes the major portion of the body's weight; therefore, one should always secure good footing with the lower foot and always keep the other foot ready in case of slips.

#### Securing Material on a Steep Roof

Depending on the pitch of the roof, it may be necessary to stack the roofing material with the first piece laid flat to the surface and each succeeding piece laid on the end of the last piece. In this way, the material will be more level and less likely to slip off the roof. Materials should always be loaded on roofs in such a manner that they will not slip, fall, or otherwise endanger the roof structure or persons below.

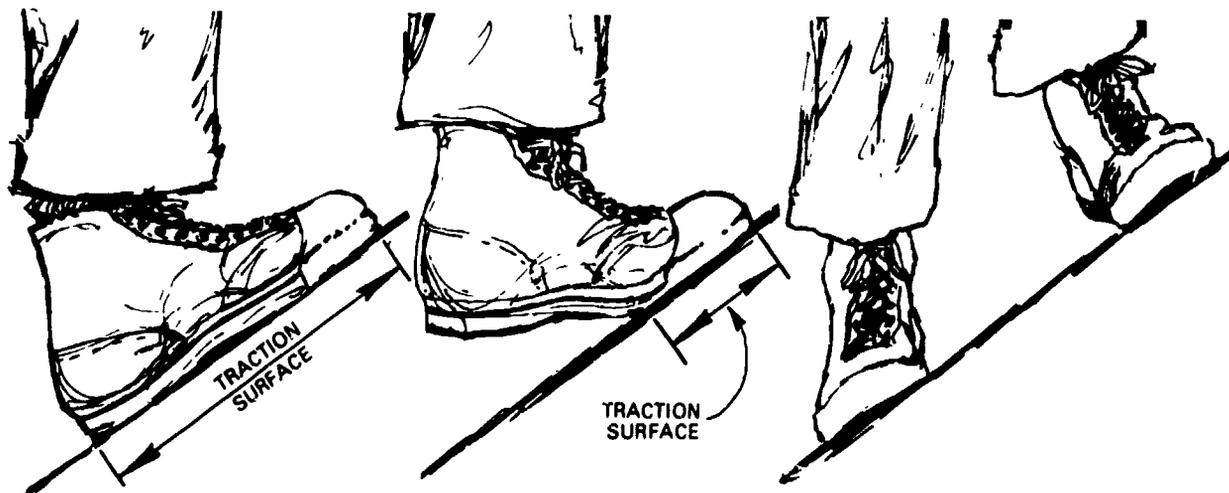


Fig. 2-1. "Flat footed" stance on a steep roof to increase traction

Fig. 2-2. Correct position of feet when walking parallel with the slope of a roof

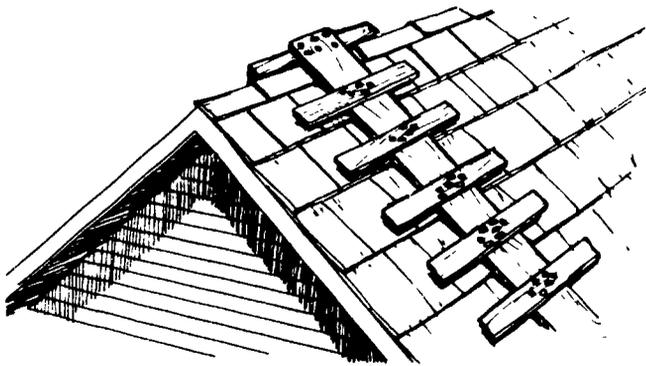
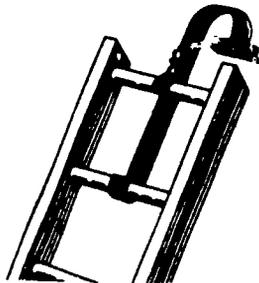


Fig. 2-3. Construction of a typical "chicken" ladder



Courtesy Reimann and Georger

Fig. 2-4. Ladder and ladder hook

### Using Roof and Ladder Jacks on a Steep Roof

When applying a steep roof, a roofer nails the first two courses in place while standing on a plank supported by two ladder jacks (Fig. 2-5). The roofer next nails roof jacks (sometimes called roof brackets) (Fig. 2-6) not more than 10 feet (3 metres) apart and in such a position that they do not interfere with the next course of material (Fig. 2-7). Planks at least 2 inches by 6 inches (5.1 centimetres by 15.2 centimetres) are placed on the roof jacks to form the platform from which the roofer will work. *NOTE:* Care must be taken to ensure that the planks are the right size and strong enough to support the load that will be placed on them.

From the first set of roof jacks, the roofer reaches up as far as he or she can conveniently reach and nails on another set of jacks. This process is continued until the roofer has reached the ridge.

When the job is completed, the roof jacks should be removed, and the nails should be hammered flush and sealed, starting from the top of the roof and working down. The jacks can be removed with a slight push upwards and sideways. It is necessary to leave only enough jacks and planks in place to provide access to the roof for its final inspection.

### Using Scaffolding and Other Devices

Scaffolding is sometimes required for working on spires or other roof surfaces too steep to accommodate roof jacks. On new jobs such scaffolding is usually erected by the general contractor; for repair or reroofing work, it may be put in place by a scaffolding company. A boatswain's chair may be used for minor repair work on spires and other extremely steep (nearly vertical) surfaces when access is not possible in any other way. A sling can be used for temporary traverse, but it must be properly anchored on the loose end of the line.

### Stacking Tile on the Ground

If tile is not on pallets and is delivered loose to the job site, it should be stacked on the ground in the following manner:

- For the first row stack a pile of tile flat to a height equal to the length of a tile (A in Fig. 2-8). Then stack additional tiles on end, leaning them against the flat stack (B in Fig. 2-8).
- For the second row add to Pile A sufficient tile to bring the height equal to a second tier of tile (C in Fig. 2-8). The weight of these tiles will rest partially on the first flat stack and partially on the pile of standing tile.

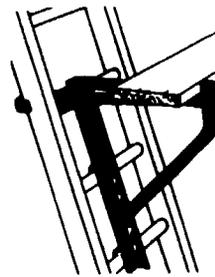
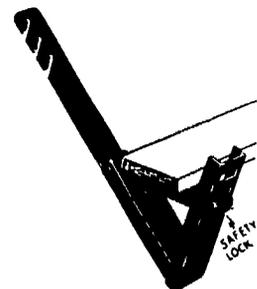


Fig. 2-5. A typical ladder jack



ROOF JACK FOR 2" x 6"  
(5.1 cm x 15.2 cm)



ROOF JACK FOR 2" x 8"  
(5.1 cm x 20.3 cm)

Fig. 2-6. Typical roof jacks

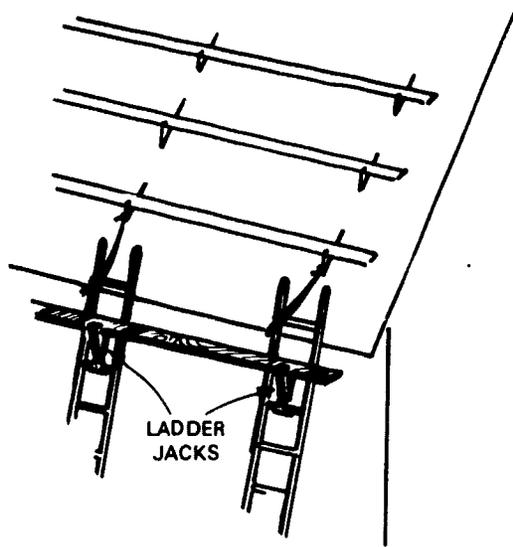


Fig. 2-7. Placement of ladder jacks and roof jacks

- For the third row proceed in the same manner as for the second.

It is not advisable to stack tile higher than four tiers; the weight may cause chipping and breakage of the lower pieces.

#### Lifting and Stacking Tile

On jobs where liftbed trucks or conveyers cannot be used for loading, tile may be pulled up to the roof with an A-frame pulley wheel and rope. Tile bundles should consist of no more than ten pieces. The rope should be wrapped around the pile at its center of balance (Fig. 2-9). The roof deck area that is to receive the material must be clear of any obstacles that could cause the roofer to trip and release the rope, thereby causing the materials to fall and break and/or injure someone on the ground.

Other rigid material may be hoisted safely in the bundle in which it is shipped. Care should be taken, however, not to drop the bundles or set them on edge on the roof deck; either action could damage the materials.

#### Reloading Materials on the Truck

When the job has been completed and the truck is being reloaded to return materials to the yard, trash items should be separated from those that can be used later. If trash is stacked on leftover material and equipment, good items may be thrown out with the trash. A common practice, and a good one, is to put tools, equipment, and leftover materials against the cab and the trash at the rear of the truck. If the material was shipped on pallets, these can be set on the trash to keep it from blowing or falling off the truck. *NOTE:* Almost all manufacturers require the contractor to put a deposit on each pallet to help ensure that it will be returned to the manufacturer for additional use. The roofer should take extra precautions to protect these pallets; they are very expensive.

If extra Spanish tile, mission tile, slate, or asbestos tile is to be returned, the pieces should be stacked on end, with a bottom cushion on the truck bed. Slate or asbestos tile should be stacked flat and securely tied.

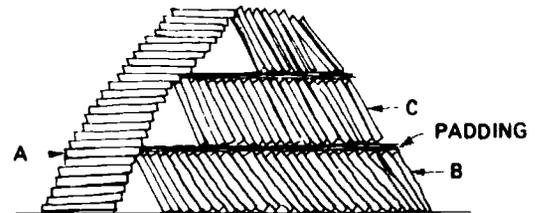


Fig. 2-8. Ground stacking of tile

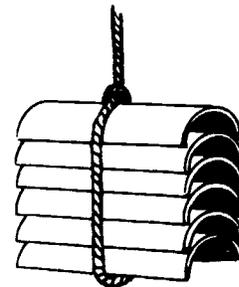


Fig. 2-9. Lifting tile bundle with rope

## RIGID ROOFING

### TOPIC 3—TWO-PIECE MISSION BARREL TILE

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Distinguish among the types of two-piece mission barrel tile.
- Identify the types of underlayment that can be used with two-piece mission barrel tile.
- Demonstrate a common layout method on a roof.
- Describe the proper procedure for loading two-piece mission barrel tile on the roof.
- Demonstrate the proper procedure for applying two-piece mission barrel tile.
- Distinguish among the various types of tile fasteners, including nails, wire, ties, and clips.
- Describe the procedures for mixing and applying mortar.

Two-piece mission barrel tile is manufactured in both straight pieces (Fig. 3-1) and tapered pieces (Fig. 3-2). Basically, both types are applied in the same manner. The primary difference between straight and tapered mission tile is that the cover tiles for the latter are wider at one end than the other. The difference in width is generally  $1\frac{1}{2}$  inches (3.8 centimetres), but it may be as great as 2 inches (5.1 centimetres). In loading tapered tile, the roofer should alternate the tapered cover stacks with the straight pan stacks.

#### Roof Preparation

Preparation of the roof for application of two-piece mission barrel tile includes all of the following:

- Broom sweeping the surface clean
- Checking to make sure that the roof deck is nailed properly
- If plywood is used on the roof deck, ensuring that all joints are blocked
- Covering all knotholes with tin
- Determining the thickness of the overhang to make sure that nails will not penetrate through exposed sheathing

#### Underlayment

The requirements for underlayment vary from one tile manufacturer to another. Local building code requirements also vary from jurisdiction to jurisdiction. The following are general "rules of thumb" for underlayment beneath two-piece mission barrel tile:

- On roofs of  $3/12$  pitch up to  $5/12$  pitch, use (1) two-ply 15-pound (6.8-kilogram) felt (the weight of the quantity of felt needed to cover a square) blind-nailed (nailed so that nailheads are not visible on the face of the work) and mopped with hot asphalt and flood coat at 25 pounds (11.3 kilograms) per square (25 pounds of bitumen per 100 square feet); (2) two-ply 30-pound (13.6-kilogram) felt blind-nailed and mopped with hot asphalt and glaze coat at 25 pounds (11.3 kilograms) per square; or (3) two-ply 40-pound (18.2-kilogram) felt blind-nailed and mopped with hot asphalt (no flood coat) at 25 pounds (11.3 kilograms) per square.
- On roofs over  $5/12$  pitch, use (1) two-ply 30-pound (13.6-kilogram) felt blind-nailed under each lap; (2) one-ply 30- or 40-pound (13.6- or

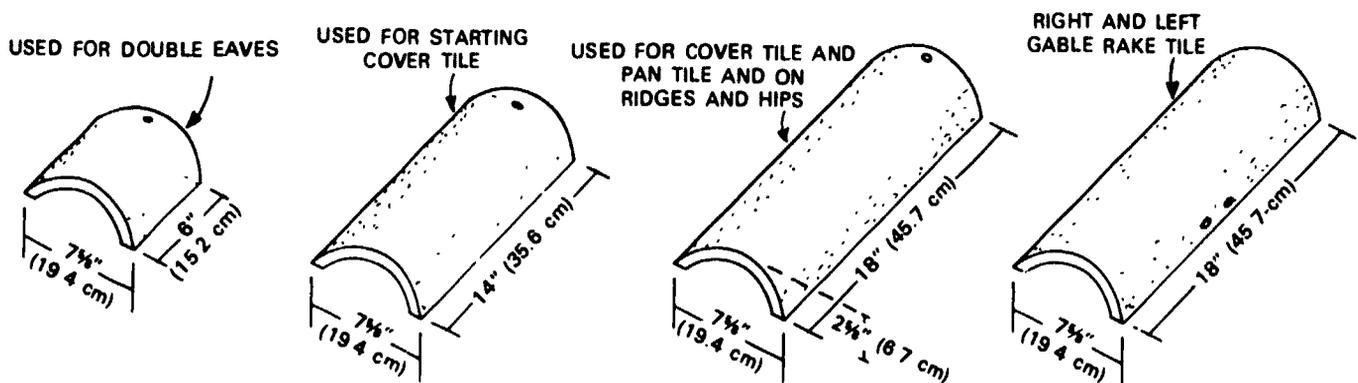


Fig. 3-1. Two-piece straight mission barrel tile

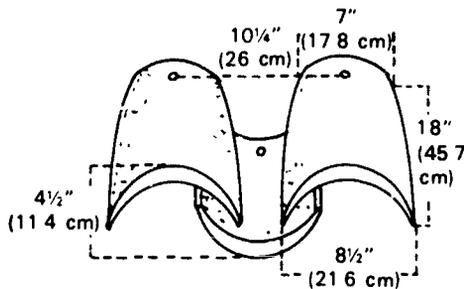


Fig. 3-2. Two-piece tapered mission barrel tile

18.2-kilogram) felt blind-nailed under each lap; or (3) one-ply 55-pound (25-kilogram) felt blind-nailed under each lap. In each instance the felt is nailed on dry and is lapped 4 inches (10.2 centimetres) at the sides and 6 inches (15.2 centimetres) at the head.

### Chalk Lines

To help ensure that tile is applied in straight lines both horizontally and vertically, the roofer draws chalk lines on the roof deck to guide his or her placement of tiles. These lines are also used as guides in the loading of tile on the roof deck. The tile supplied by each manufacturer differs in length and width from that supplied by other manufacturers, and so it is important that the roofer measure the field tile to be sure that his or her vertical and horizontal chalk lines will match the materials. The more experienced a roofer becomes in applying tile, the fewer lines she or he will have to draw.

To lay the first course of tile (the course at the eave), the roofer must know the drip edge specifications for the particular job. A 2-inch (5.1 centimetre) drip edge is common. If the tile being applied has pan tiles that are 18 inches (45.7 centimetres) long, the first horizontal chalk line should be marked 16 inches (40.6 centimetres) from the eave. The remaining horizontal lines should be evenly spaced from the first horizontal line to the ridge. The spacing between the horizontal chalk lines will depend on the tile exposure called for in the job specifications. However, because the last tiles at the ridge should be full tiles, the exposure may have to be adjusted. In such cases, the exposure should always be decreased rather than increased.

The spacing between vertical chalk lines also will depend on the tile specifications; the spacing should be equal to the on-center specification for the tiles being used. The vertical chalk lines will serve as the vertical nailing guide. On a straight gable roof, the roofer should measure from gable to gable at the eave and at the ridge to make sure that the dimensions are the same. The width measured should be divided by

the on-center specification to determine the spacing between vertical chalk lines. The roofer must be sure to allow for the pan tiles to butt against the rake nailing boards so that the rake cover tiles will fit properly. As necessary, the vertical chalk lines will have to be adjusted so that the pan tiles fit both rakes.

Sometimes, 1-inch by 4-inch (2.5-centimetre by 10.2-centimetre) nailing boards serve as vertical guidelines. The pans are placed between the boards, and the cover tiles are nailed to the nailing boards (Fig. 3-3).

On a hip roof or any other roof where the rakes and rake nailing boards are not parallel to each other (or perpendicular to the ridge and eave), the vertical chalk lines must be established at a 90-degree angle to the horizontal chalk lines. This can be done as described below.

- Measure from the point edges of both hips at the eave line to find the total length of the eave. Divide this figure in half to determine the exact center of the eave (Point Z in Fig. 3-4).
- Measure a randomly selected number of feet (for example, 10 feet [3.0 metres]) to each side from the center point, and mark the points (points X and Y in Fig. 3-4).
- Scribe above the eave line two arcs from points X and Y, which are equidistant from Point Z. Scribing may be done by using as a trammel a strip of wood that is longer than the distance from Point Z to Point X and Point Y. (If points X and Y are 10 feet [3.0 metres] from Point Z, the strip of wood must be longer than 10 feet.) *NOTE:* Never use a chalk line to scribe arcs, because a chalk line will stretch.
- Strike a chalk line from Point Z to the intersection of the arcs. From Point Z on the eave, strike a vertical line through the intersection of the arcs and on to the ridge. This line will be perpendicular to the eave line.
- Strike similar vertical guidelines on each side of the center line, making sure that they are all parallel and that they are equidistant from the center line. As many lines as desired may be made, perhaps one for every three or six courses.
- Horizontal chalk lines may be struck as course guidelines; again, the number of lines to be struck will depend on the desires of the roofer. Some roofers use only a few lines, and others may snap a line for every third or fourth course.

The following is another method that can be used to mark vertical guidelines on a hip roof or other roof

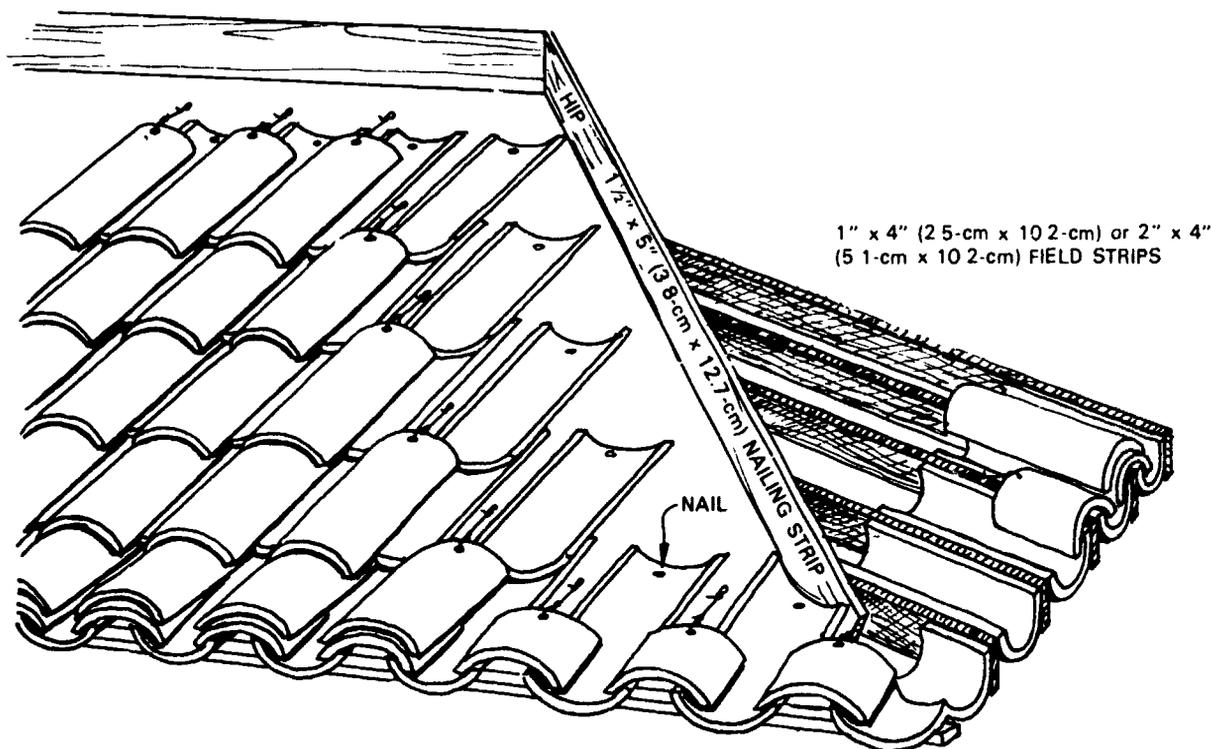


Fig. 3-3. Two-piece mission barrel tile used with nailing boards

where the rakes are not parallel to each other or perpendicular to the ridge and eave:

- Beginning at the points of both hips at the eave line (points A and B in Fig. 3-5), mark off distances equal to the width of the hip nailing boards (usually 1 inch [2.5 centimetres]).
- Determine the on-center specification for the tile being used. From the two points determined in the preceding step, mark off segments equal to the on-center specification; continue marking these segments to points approximately one vertical course past the points where imaginary perpendicular lines from the points of hip/ridge intersection (points C and D in Fig. 3-5) would meet the eave line (at points E and F in Fig. 3-5). (Points G and H in Fig. 3-5 represent the points approximately one vertical course past the imaginary perpendicular lines.)
- Measure the distance between these two points (points G and H), and divide the distance by the on-center specification. The result of this division will be the amount of space to be used between vertical guidelines for the field tiles.
- Chalk the balance of the vertical guidelines.

Another method of determining where to apply tiles is to lay one full row and one full course of tile on

the roof to determine how they can best be placed. Marks are then made on the roof to indicate tile positions, and guidelines are struck in the first method described in this section.

If the roof includes a projection (such as a chimney, skylight, or dormer) that will not allow continuous chalk lines (horizontal, vertical, or both) from gable to gable, it is necessary to have the exact measurements on all sides of the projection to maintain even courses.

#### Loading of Tile on the Roof

When loading mission tile, the roofer should keep in mind that it may weigh from 900 to 1,200 pounds (408.6 to 544.8 kilograms) per square; smaller stacks should be loaded on the weakest areas of the roof, such as the valleys. Any necessary valley metal and pipe jacks should be placed where they will be used. The specialty tile (birdstops, boosters, starters, left and right rake tiles, and hip and ridge tiles as required) should be unloaded in the areas where they will be used.

Field tiles should be loaded starting with the fourth course (as shown in Fig. 3-6) to allow sufficient work area for installation of the initial courses. The roofer should place ten tiles to a stack and should place the stacks side by side horizontally across the roof. The

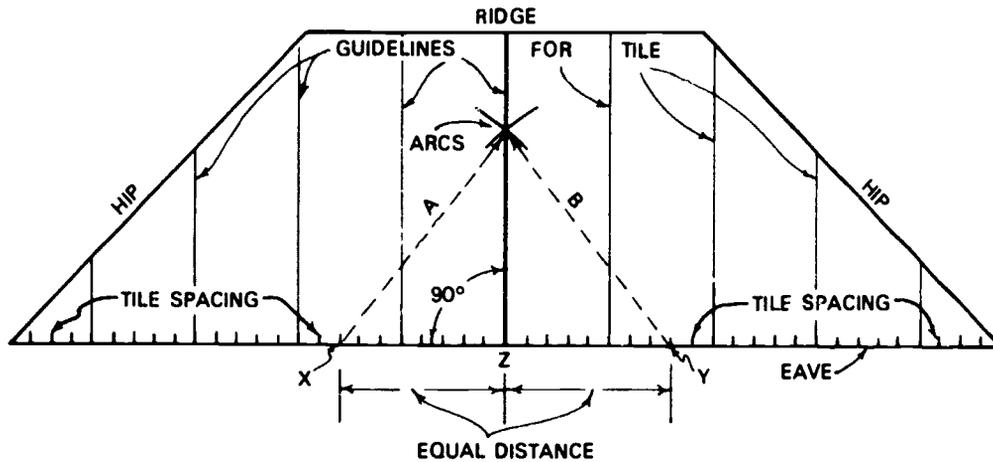


Fig. 3-4. Layout of guidelines on a hip roof

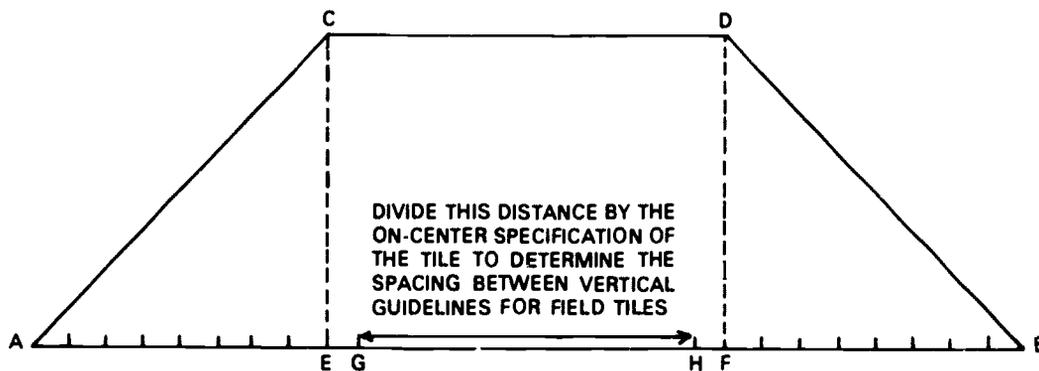


Fig. 3-5. Alternate method of laying out vertical guidelines on a hip roof

size of the stacks may vary depending on conditions (for example, the roof pitch or position of tile on the roof). The rows of stacks should be spaced five courses apart up to the ridge. The roofer should remember that it is easier to pull tile down to a bottom course than to move extra tile up. On a steep roof one tile should be turned sideways (parallel to the eave), and two stacks of tile should be placed on it so that the stack will stay level and tiles will not slide off.

On a hip roof inadequate space is available to load tile for the point of the hip; this triangular portion (Triangle XYZ in Fig. 3-6) should be loaded from the eave to the point at which the fourth course will meet the hip line (Point X in Fig. 3-6).

If underlayment is torn during loading, it should be repaired with a hot asphalt patch or with felt set in roofing mastic.

### Application

To begin applying two-piece mission barrel tile, the roofer nails the eave closures, or birdstops (Fig. 3-7), in place. Next, he or she nails the pans in place, using the horizontal chalk lines to keep the tiles straight and the nail holes on center with the vertical guidelines. The booster tiles, or double eave tiles, are then placed over the pans. *NOTE:* Some manufacturers make booster tiles as separate pieces; others provide tiles that look like regular mission barrel tiles but that have two nail holes and are scored 4 inches to 6 inches (10.2 centimetres to 15.2 centimetres) from the top. Breaking these tiles on the score lines yields a booster tile and a starter tile. Generally, starter tiles are 14 inches (35.6 centimetres) long as shown in Fig. 3-8.

If a booster tile is not used, it may be necessary to use a 1-inch by 2-inch (2.5-centimetre by 5.1-centimetre) wood strip to elevate the front of the tile. This allows

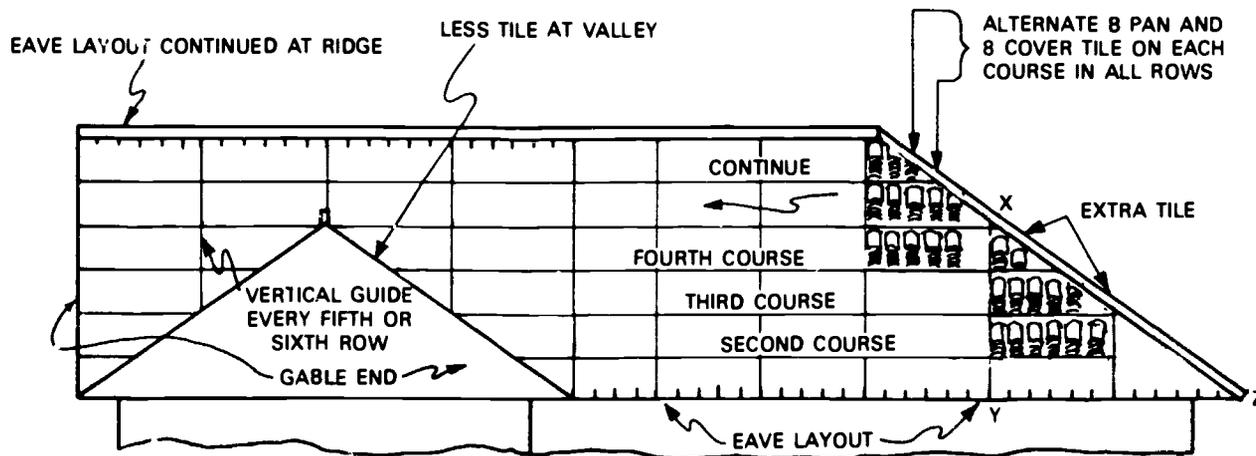
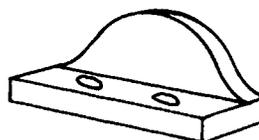


Fig. 3-6. Loading tile on a hip roof with a valley



METAL OR PLASTIC BIRDSTOP



CLAY BIRDSTOP

Fig. 3-7. Birdstops

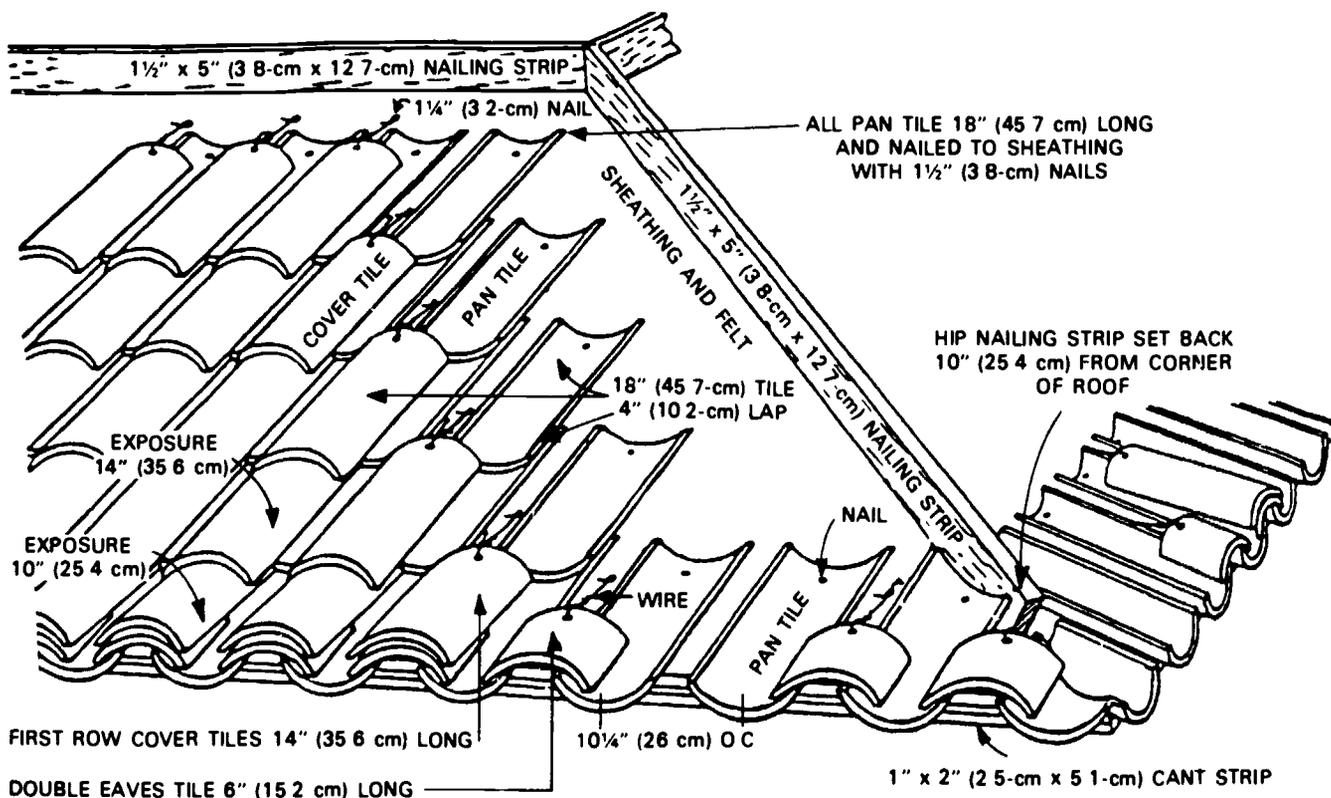


Fig. 3-8. Application of two-piece mission barrel field, starter, and booster tiles

for the following courses to fit better. The starter tile is then layed over the booster tile and secured.

For the second course the roofer should set the pans inside the first pans and apply a full-length cover tile, using approximately a 4-inch (10.2-centimetre) lap and 14-inch (35.6-centimetre) exposure. The channels created by the pans must be kept continuous and unobstructed, although not necessarily in a straight line. The remaining courses up to the ridge should be applied in the same way. (See Fig. 3-8.)

### Laying Tile to a Hip

When laying to a hip, the roofer must be sure that the hip nailing board is set back at least 10 inches (25.4 centimetres) from the eave so that tile can be set around the corner. All tile is to be miter cut flush and tight to the hip nailing board. Hip cuts are usually set in mortar so that water will run down the pan instead of on the underlayment beneath the tile. Some workers do all the cutting and mortaring work last so that they do not have to walk across the finished roof. **NOTE:** When using mortar, the roofer should either soak the tile in water for two or three minutes before applying the mortar or soak a few gunny (burlap) sacks, fold them into 6-inch (15.2-centimetre) widths, and lay them out ahead of him or her to wet the tile.

Cement does not bond well to tile unless the tile is damp; the cement will dry too quickly and crack, or it will not provide the watertightness that it is designed to provide.

Figure 3-9 shows a hip completely roofed except for the hip tiles, ridge tiles, and birdstops. Eighteen-inch (45.7-centimetre) hip and ridge tiles will be nailed and mortared to the exposed nailing strips. Figure 3-10 shows the same hip with the hip tiles and ridge tiles in place. The birdstops are also shown in Figure 3-10.

### Laying Tile to a Gable End

When laying tile to a gable end, the roofer must be sure that the pan tile is butted against the rake nailing board and parallel to it (Fig. 3-11) so that the cover tile will fit smoothly and evenly over the gable tile and pan tile.

### Laying Tile to a Ridge

When laying tile to a ridge, the roofer must make sure to butt the pan and cover tiles against the ridge nailing board. As described earlier, the roof layout should be such that full tiles can be placed at the ridge. If this is not possible, the tiles must be cut evenly and long enough to lap the last course prop-

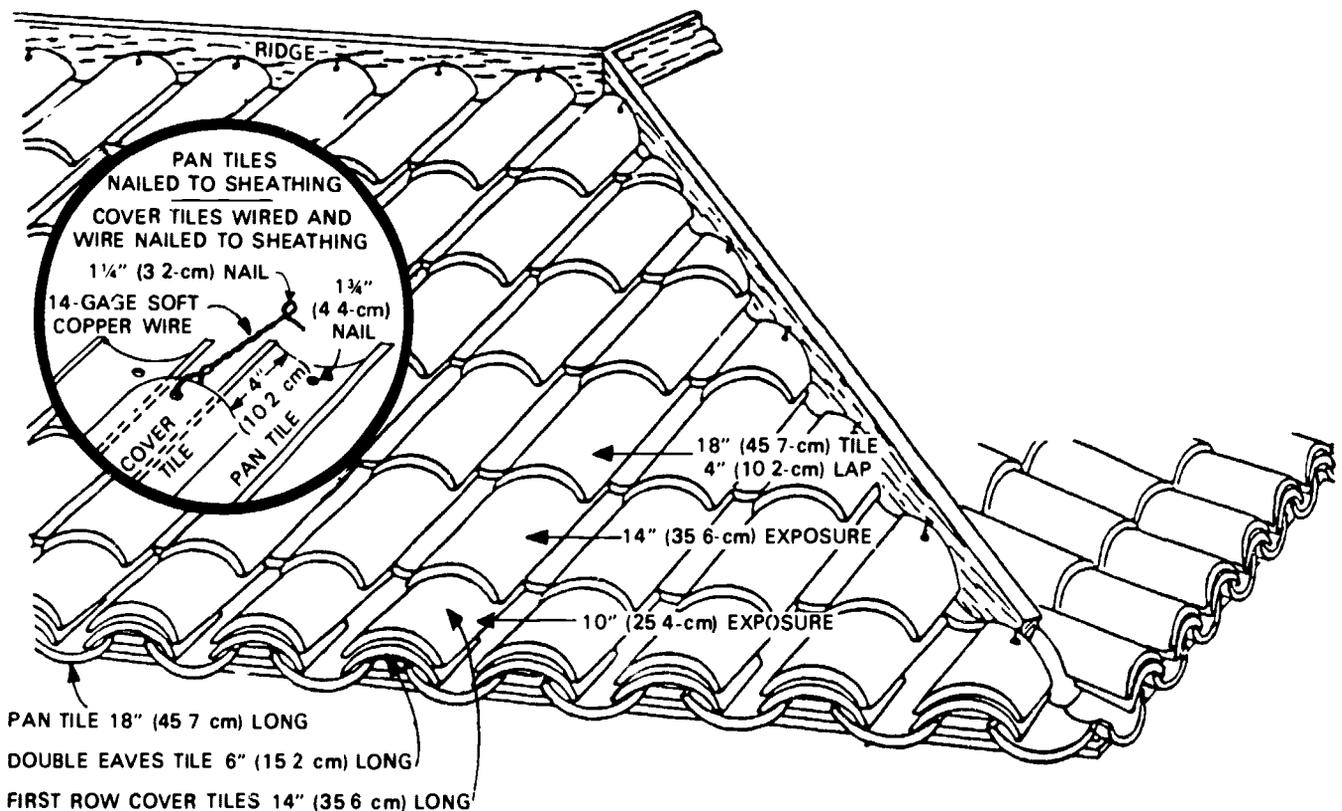


Fig. 3-9. Completed hip except for hip and ridge tiles and birdstops

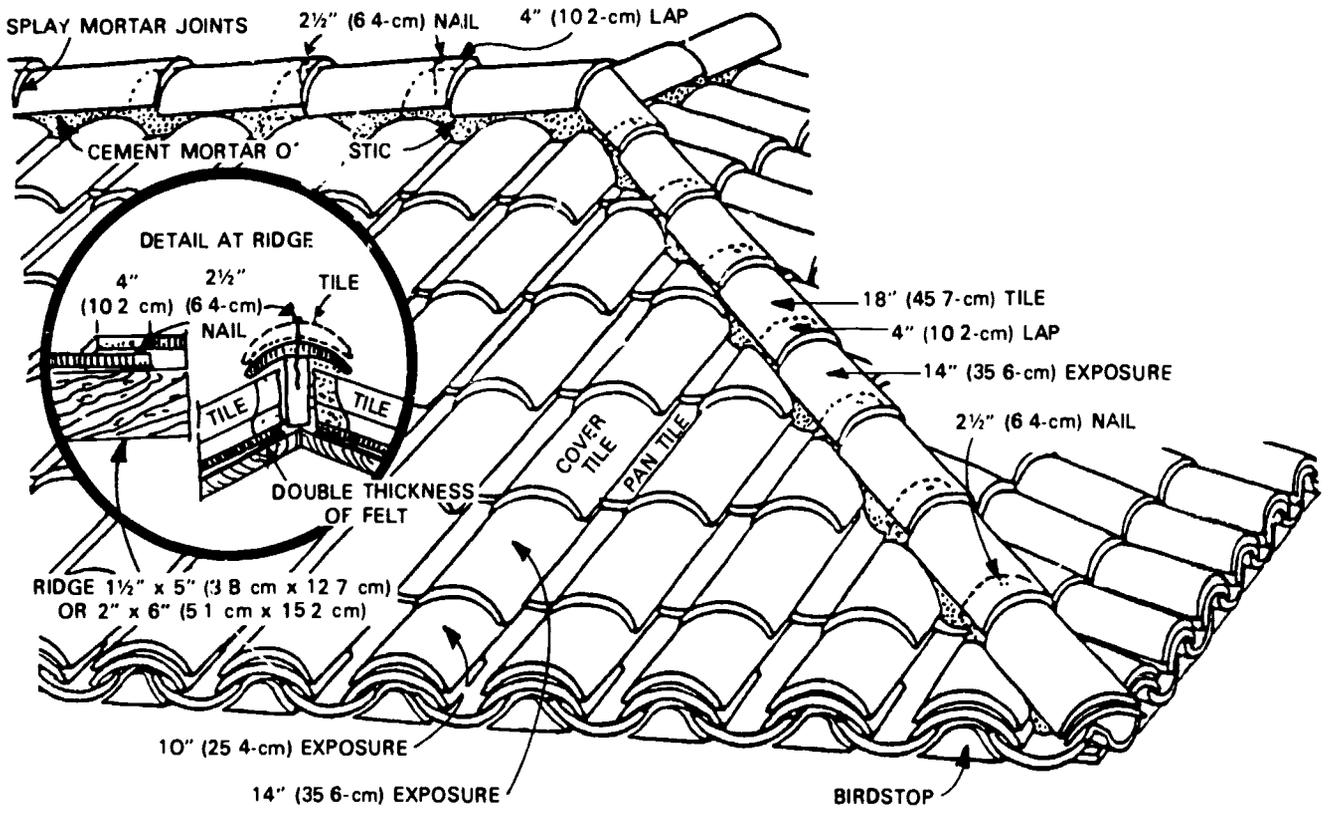


Fig. 3-10. Completed hip

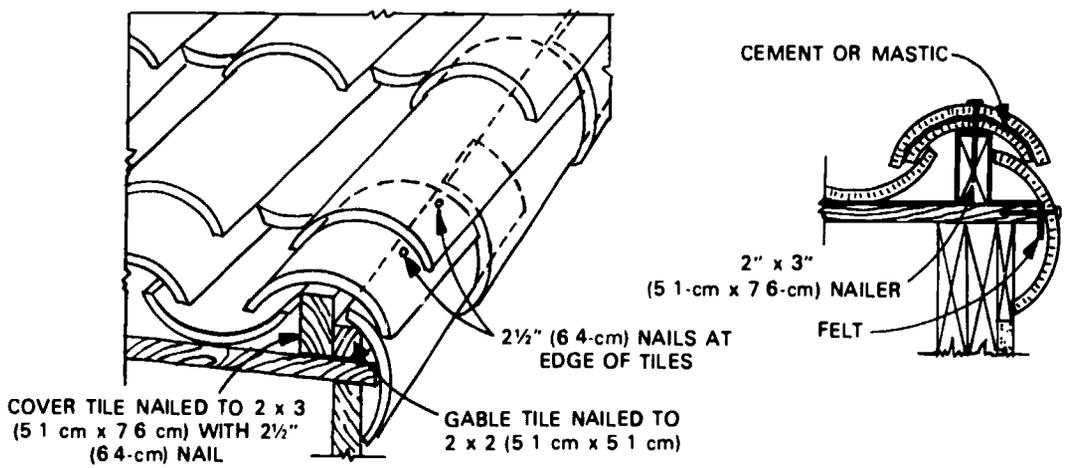


Fig. 3-11. Application of two-piece mission barrel tile at a gable rake

erly. Figure 3-12 shows a ridge with one open end, and Fig. 3-13 shows a ridge with two open ends. The spacing on ridges may be adjusted, but an adequate lap must be maintained.

### Laying Tile to Valleys

Metal valleys should be nailed into place before any tile is laid. Either galvanized iron or copper may be used for valleys; the choice will be based on the requirements of the local building code. The nails used to fasten valleys should be of the same type of metal as the valleys and should be applied 1 inch (2.5 centimetres) from the valley edges. Usually, the valley edges are sealed with fiberglass or cotton roofing fabric and solid mopped if the valleys are in place when the underlayment is applied. With some metal valleys a metal clip, such as that shown in Fig. 3-14, attaches to the valley and is nailed to the sheathing. All valley cuts should be mitered and neatly cut to make a smooth flowing line between the two sides of the valley. (See Fig. 3-15.) The smallest gap possible should be left between the metal valley and the field tile so that little or no metal shows through.

### Laying Tile to Flashing

The lead or other flexible material used on tile roofs is woven into the tiles where needed around pipes, dormers, chimneys, parapets, and the like (Figs. 3-16 and 3-17).

Figure 3-18 shows the application of tile and metal flashing at a wall; Fig. 3-19 shows the application of tile and metal flashing at the intersection of a roof and deck; and Fig. 3-20 shows the application of chimney flashing, using channel and chimney pan.

### Nails

Tiles may be nailed directly to the roof deck. A major disadvantage of this application method is that it results in many holes in the roof deck; these may leak later when they start to enlarge through expansion and contraction of the underlayment. Nails used with tile are normally made of aluminum, copper, zinc, brass, stainless steel, or galvanized wire. Common lengths range from 1¼ inch (3.2 centimetres) to 16 penny. The size to be used will depend on the specifications or the requirements of the local build-

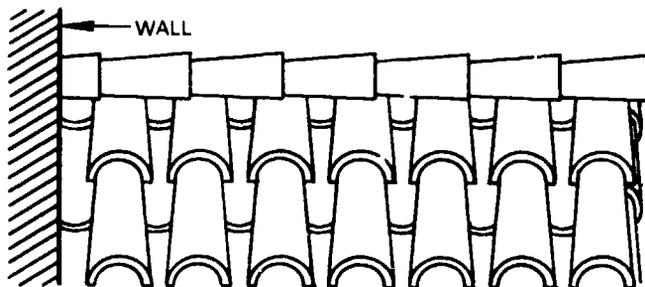


Fig. 3-12. Ridge with one open end

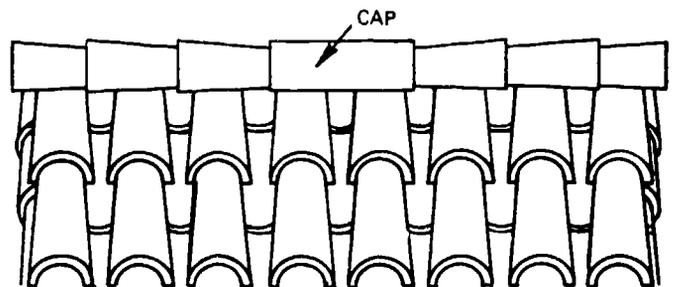


Fig. 3-13. Ridge with two open ends

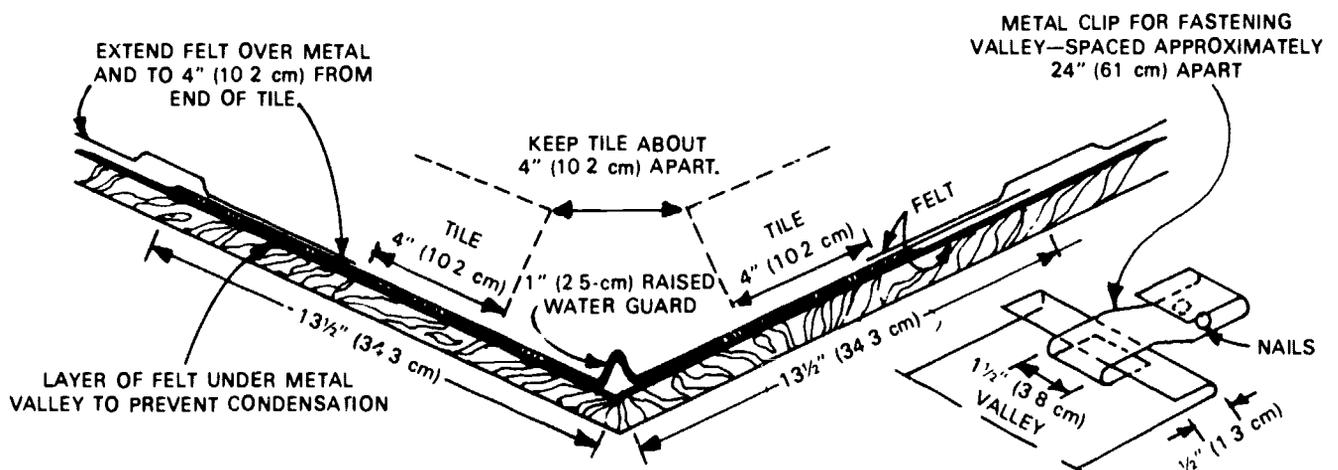


Fig. 3-14. Section at valley flashing

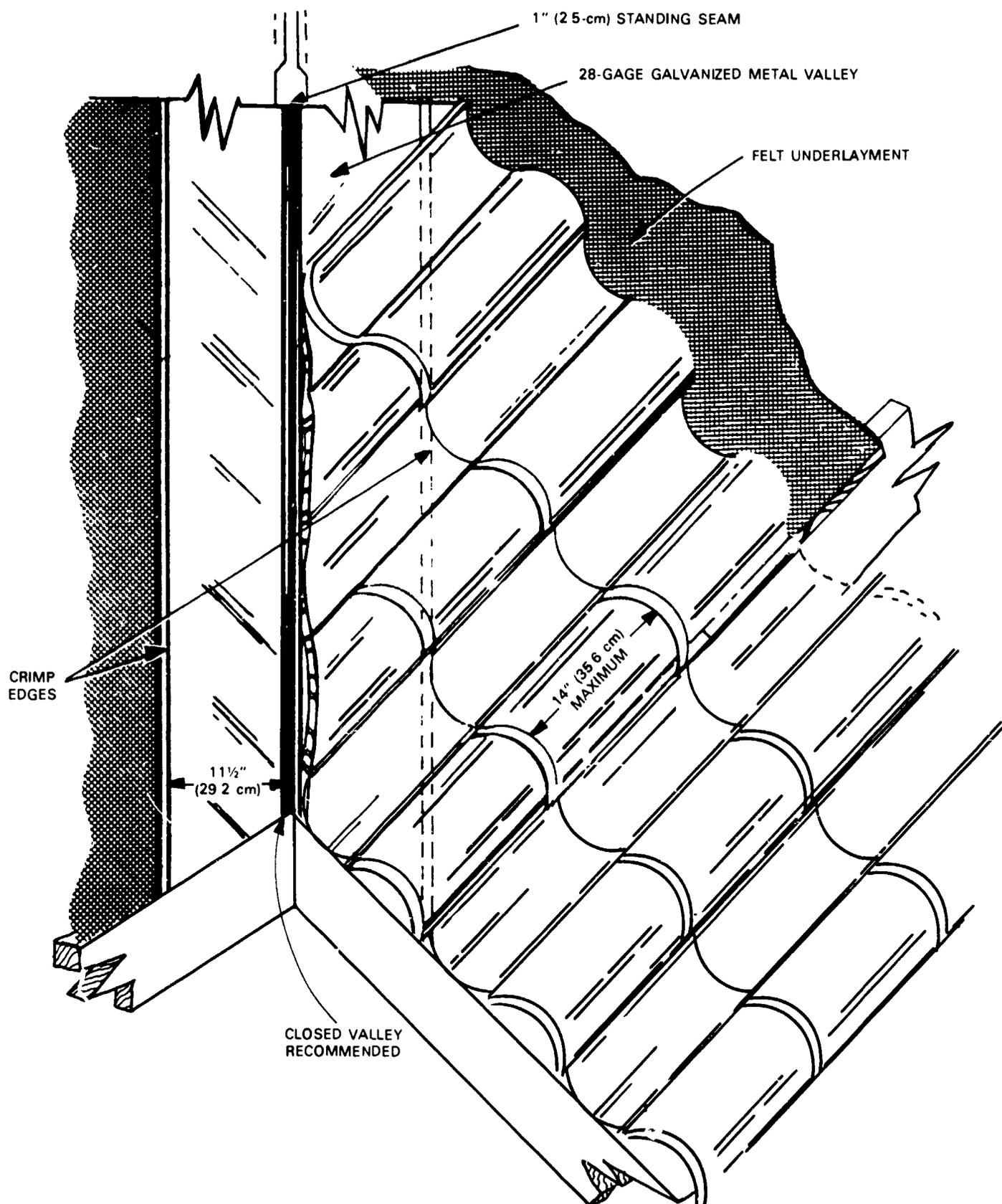


Fig. 3-15. Application of two-piece mission barrel tile at a valley

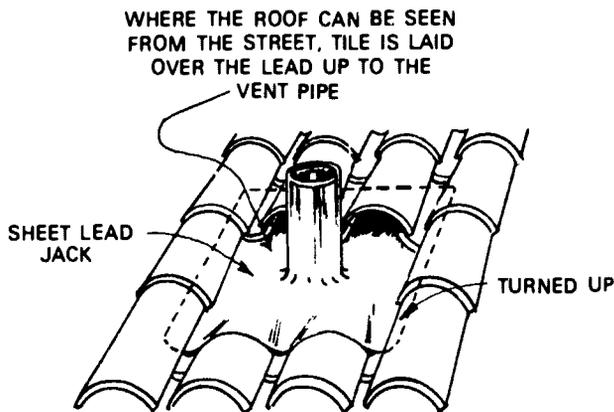


Fig. 3-16. Installation of a lead pipe flashing



Fig. 3-17. Flexible flashing

ing code. All nails should have a large head and sufficient length to allow penetration of at least  $\frac{3}{4}$  of an inch (1.9 centimetres) into the sheathing board.

#### Tile Wire Ties

Tie wire is used to secure all types of tile. Sometimes, the wire is threaded through the holes in the cover tile and fastened to nails that are then driven into the deck above each tile piece. (See Fig. 3-9.) In the application of the tile by the wiring method, each cover tile is wired, and the wire is nailed to the sheathing.

Another wiring method consists of fastening to the deck a long, twisted double strand of tile tie (Fig. 3-21) into which are lashed the ties from individual tiles (Fig. 3-22). This method is commonly used on concrete decks because it requires a minimum number of nails. A typical concrete deck anchor for use with

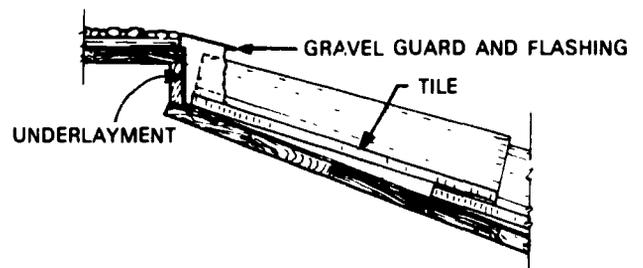


Fig. 3-18. Application of tile and metal flashing at a wall

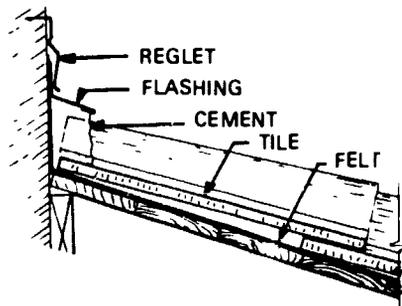
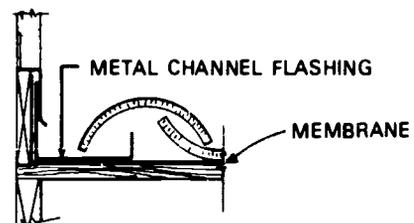


Fig. 3-19. Application of tile and metal flashing at the intersection of a roof and deck

double-strand tile ties is shown in Fig. 3-23. Fig. 3-24 shows a similar anchor for use on wood decks.

Tie wire may be 16-gage galvanized wire, 14-gage brass or copper wire, or stainless steel wire. Although galvanized wire is sometimes used, it is not recommended because the wire rusts rapidly, especially where exposed to ocean air. A copper-alloy wire has proved to be the most practical in these cases. The gage of the wire used depends on the slope of the tile, since the weight the tie must carry increases proportionately with the pitch of the roof.

Tie strips (Fig. 3-25) are used when the strength required for the job is greater than that afforded by wire. These strips, which can be applied to either concrete or wood decks, will serve the same purposes as twisted wire ties.

Special tile "nails" are also available for securing tile to the roof deck. This nail is a wire fastener

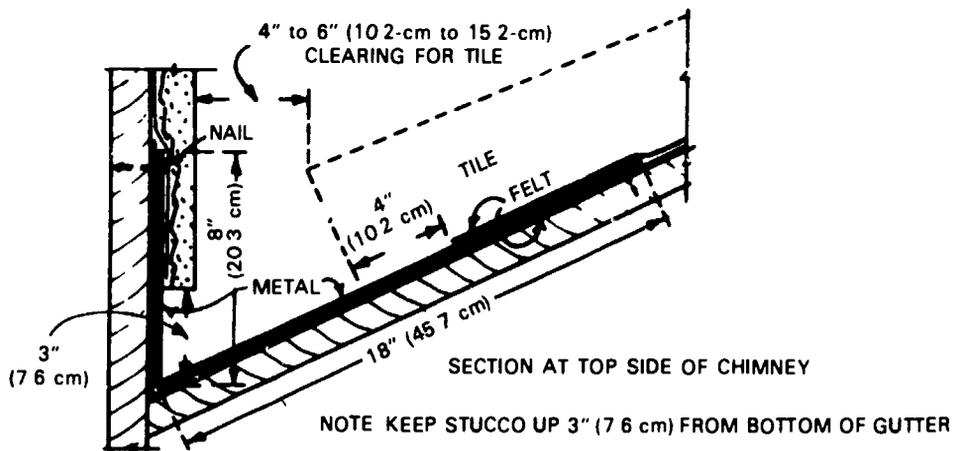
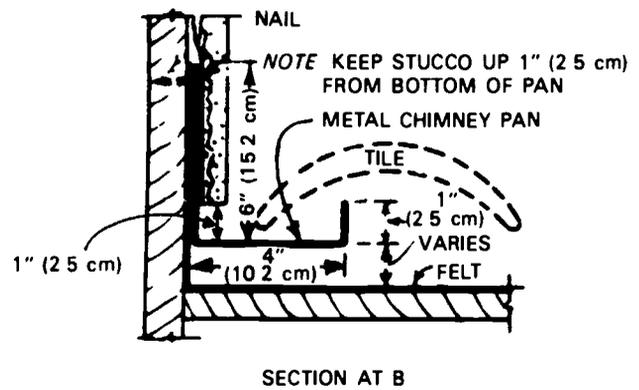
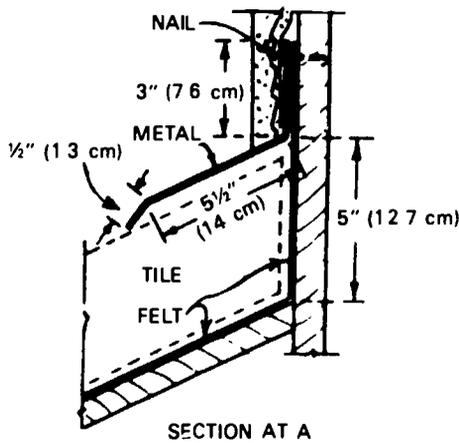
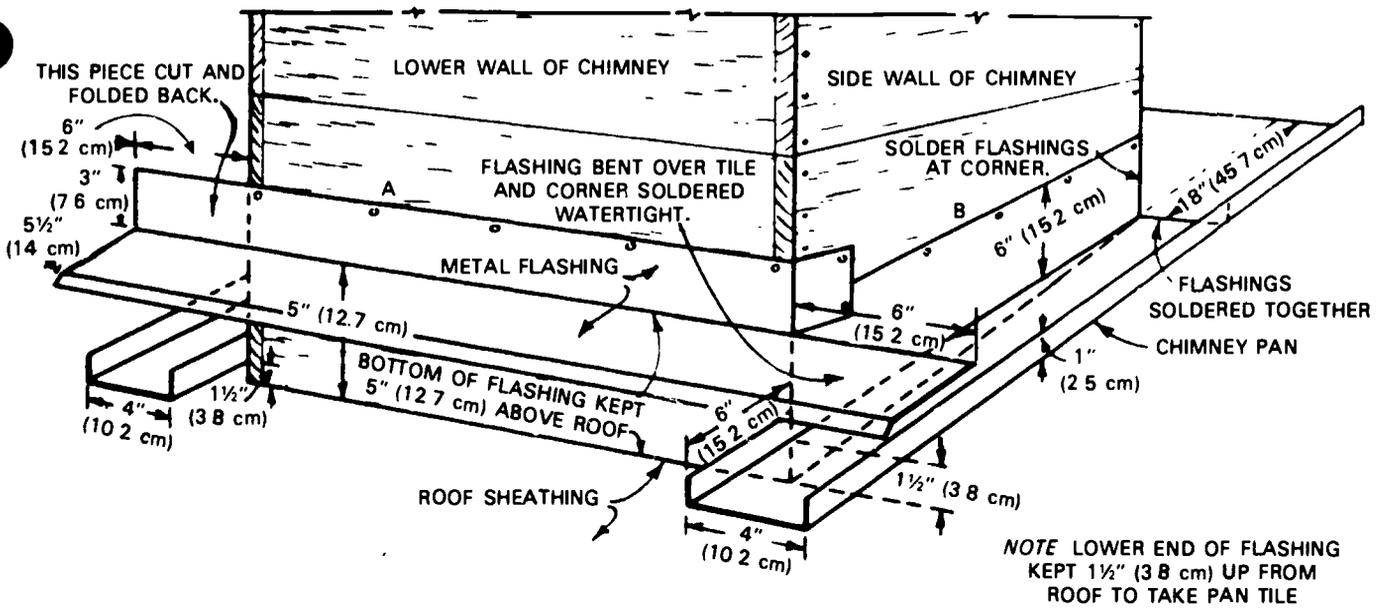


Fig. 3-20. Application of chimney flashing, using channel and chimney pan

approximately 10 inches (25.4 centimetres) long with a 1/4-inch (3.2-centimetre) nail on one end and a hook at the other (Fig. 3-26). The nail end is slipped through a hole in the tile and nailed into the sheathing 6 inches (15.2 centimetres) above the head of the tile. The next piece of tile is slipped onto the hook, which holds it securely. The tile nails ensure a 3- to 4-inch (7.6- to 10.2-centimetre) lap between successive tile courses. Tile nails are used for cover tile only.

**Mortar**

Mortar is normally used where tile meets hips and ridges and at the ends of hips and ridges. Some tile

manufacturers allow the use of either roofers plastic cement (mastic) or cement mortar. Cement mortar can be made by mixing one part portland cement and three parts damp plaster sand with just enough water to make the mixture workable. Cement mortar can also be bought in ready mixed portions. The mortar color can be made to match the color of the tile by adding oxides to the mortar during mixing.

When mortaring hips and ridges, the roofer should use damaged tile, broken into small pieces, as a filler to cut down on the amount of cement required. The small pieces should be soaked in water if possible before the mortar is laid so that the mortar will bond

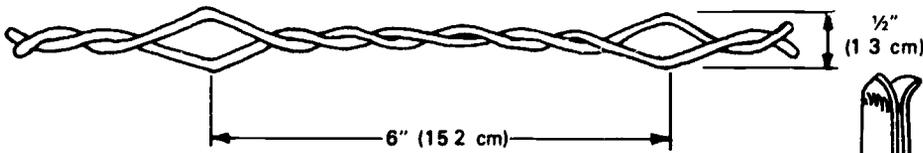


Fig. 3-21. Double-strand tile tie used to secure ties from individual tiles

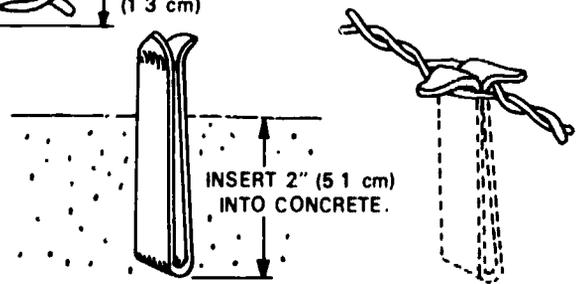


Fig. 3-23. Typical concrete deck anchor for securing double-strand tile ties

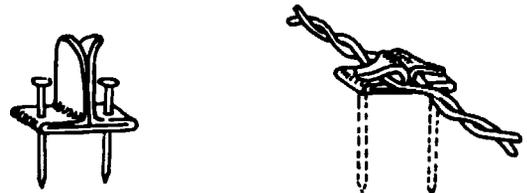
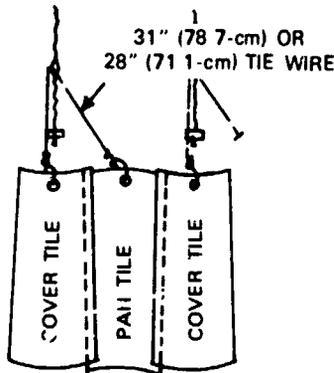


Fig. 3-24. Typical wood deck anchor for securing double-strand tile ties

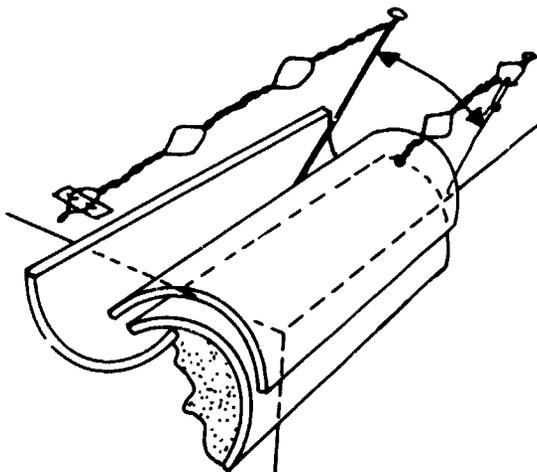


Fig. 3-22. Application of individual tile ties and double-strand tie

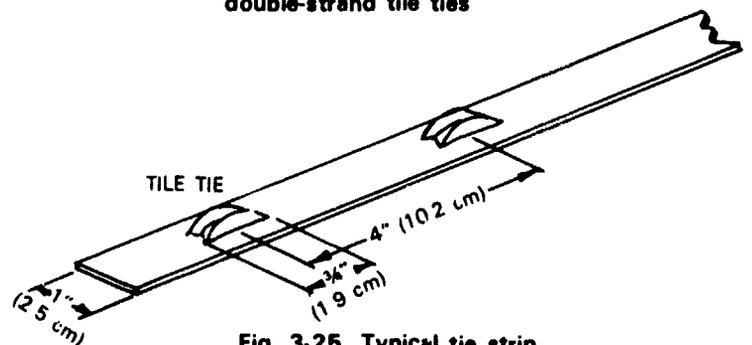


Fig. 3-25. Typical tie strip

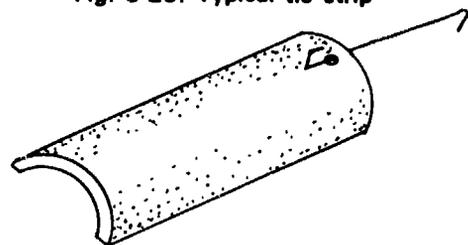


Fig. 3-26. Application of special tile "nails"

properly. The pieces should be set in only enough mortar to hold them and allowed to dry. When the mortar has dried, a second layer of mortar should be applied for a neat finished appearance.

Cement is also used to flash a parapet wall with mission barrel tile. This is known as tile coping.

Mortar can also be used to "boost" randomly selected cover tile in the field to achieve an old, rough appearance in the finished roof. This is sometimes called "mudding."

#### **Random Laying of Mission Tile**

Since part of the appeal of mission tile is its appearance of having been handmade (like the original mis-

sion tile), symmetry is not especially important in the finished roof. Allowing the vertical and horizontal lines to "wander" helps to attain the original "mission look." However, the roofer must take care to keep the pans in a continuous and unobstructed line so that water can flow through them easily. If the vertical exposure is to be changed, the exposure of the cover tile should be shortened rather than lengthened; protection of the roof is still of the utmost importance. Booster tile can also be used in different areas of the field to change the roof pattern.

## RIGID ROOFING

### TOPIC 4—ONE-PIECE MISSION TILE

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Describe one-piece mission tile.
- Discuss the procedures for laying out a roof and loading it with one-piece mission tile.
- Demonstrate the application of one-piece mission tile.

One-piece mission tile (Fig. 4-1), which is commonly called S tile, is one of the most common types of tile in use today. It is lighter in weight than other types of tile, and because the pan and cover are a single unit, less time is required for installation, which means labor costs are lower than with other tile. When finished, a one-piece mission tile roof will look as if it were covered with the more expensive two-piece mission barrel tile.

#### Roof Preparation

Preparation of the roof deck for application of one-piece mission tile includes all of the following:

- Broom sweeping the surface clean
- Making sure that the roof deck is nailed properly
- If plywood is used on the roof deck, ensuring that all joints are blocked
- Covering all knotholes with tin
- Determining the thickness of the overhang to make sure that nails will not penetrate exposed sheathing

#### Underlayment

The underlayment used with S tile will vary in accordance with each manufacturer's specifications or local building code requirements. Some general rules about underlayment with one-piece mission tile follow:

- On roofs of up to  $3/12$  pitch, use (1) two-ply 15-pound (6.8-kilogram) felt with the first sheet nailed or sprinkle mopped and the second mopped at 25 pounds (11.4 kilograms) per square and flood coated; (2) or two-ply felt with one 15-pound (6.8-kilogram) felt nailed or sprinkle mopped and one 40-pound (18.2-kilogram) felt mopped at 25 pounds (11.4 kilograms) per square (no flood coat).
- For roofs over  $3/12$  pitch, use (1) one-ply 40-pound (18.2-kilogram), 50-pound (22.7-kilogram), or 55-pound (25-kilogram) felt nailed dry.

All underlayment should be blind nailed under each lap, and the laps should be at least 4 inches (10.2 centimetres) at the heads and 6 inches (15.2 centimetres) at the sides when the underlayment is applied dry.

#### Chalk Lines

One-piece mission tile generally ranges in size from  $8\frac{1}{2}$  inches by  $10\frac{1}{2}$  inches (21.6 centimetres by 26.7 centimetres) to 12 inches by  $18\frac{1}{2}$  inches (30.5 centimetres by 47 centimetres). The roofer should always measure the tile delivered to the job to determine whether or not it varies even slightly from the size designated in the job specifications. This is especially important with S tile because the symmetry of the

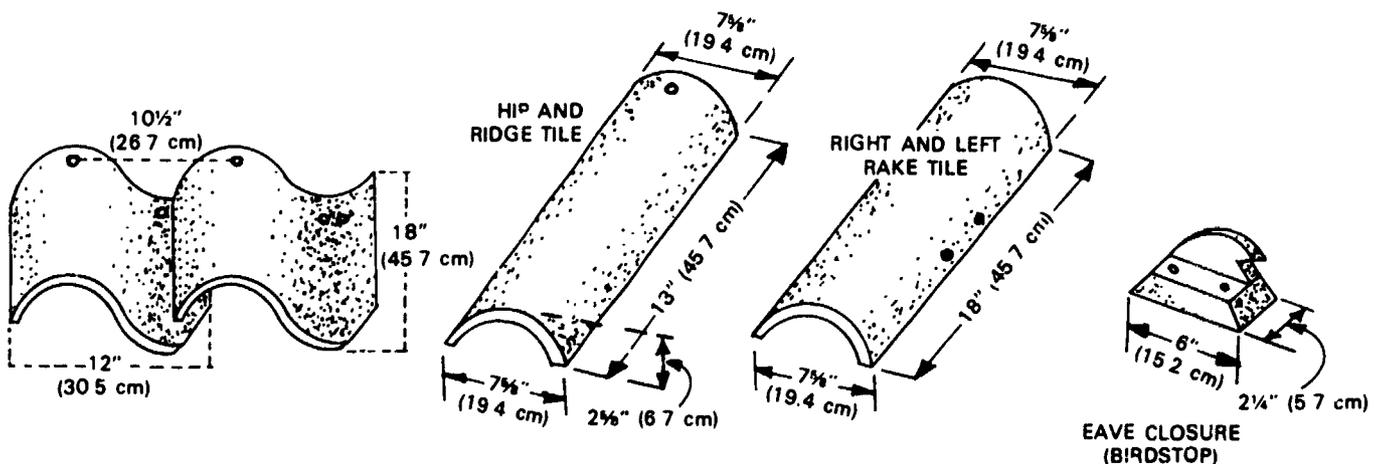


Fig 4-1. One-piece mission tile

finished roof may be spoiled by any variation in tile size or layout. Also, if the channels for directing water off the roof are not in proper alignment (which may occur if tile size varies), the course of the water may be obstructed or diverted in such a manner as to cause it to flow back under the tile.

Once the roofer has checked the size of the tile, he or she should study the details to determine how much overhang the eave tiles will have. With this information, he or she can determine and mark on the roof where the upper end of the first course of tiles will fall. If a 2-inch (5.1-centimetre) drip edge is required and the tile is 18 inches (45.7 centimetres) long, the first horizontal line will be 16 inches (40.6 centimetres) from the eave. Beginning from this initial line, the roofer should mark succeeding horizontal lines 15 inches (38.1 centimetres) apart to allow for a 3-inch (7.6-centimetre) head lap. He or she should be sure to make allowances for a full tile at the ridge so that no cutting of tile is required. Courses may be overlapped as necessary to avoid cutting tiles, but the lines must be kept parallel to the eaves and to the ridge nailing strips.

Once the horizontal lines have been marked, the roofer can determine the vertical spacing of tile rows (making necessary allowances for the rake tiles at the ends of each course). He or she must be sure to allow for the following: (1) at the right rake the pan portion set flush with the gable nailing board; and (2) at the left rake the top portion of the tile to cover the gable nailing board. *NOTE:* Some S tile has the pan on the right-hand side; in such cases, the requirements just described will be reversed.

The distance between the right and left gable courses should be measured, and the figure should be divided by the on-center specifications for the tile being used. If the specification is 11 inches (27.9 centimetres) on center, for example, the determined length is divided by 11, and vertical lines are marked accordingly from the eave to the ridge across the roof. The roofer should make sure that the measurements from eave to ridge on both ends and from gable to gable at the eave and ridge are the same. Dividers (a length of wood or metal the size of the vertical lines that will be needed) may be used to step off these distances. The dividers should be set to the width of each tile, measured from the edge of the pan side to just inside the side lap on the channel side. This is done because each pan should overlap the side lap of the adjacent tile. The spacing from row to row should not vary more than  $\frac{1}{16}$  of an inch (0.2 centimetres). Once the vertical spacing has been determined, chalk lines are snapped at these points at right angles to the eaves.

For information about snapping chalk lines on hip roofs or uneven gable roofs, see the section on chalk lines in Topic 3.

### Loading of Tile on the Roof

The loading procedures for S tile are basically the same as those previously discussed for mission barrel tile. The roofer should start stacking tile at the fourth course from the eave and load nine tiles to a stack. Stacks should be placed 3 feet (0.9 metres) apart. The size of the stacks may vary depending on conditions (the pitch of the roof or position of tile on the roof, for example). The additional rows should be spaced four courses apart to the top of the ridge, which should be loaded a little heavier than other areas because it is easier to pull tile down than to move it up. If the roof is steep, the size of the stacks should be reduced, one tile should be turned sideways (parallel to the eave), and the front of the other tiles should be loaded on it. The tiles are to be stepped back toward the ridge to prevent them from sliding off the roof. Smaller stacks should be placed closer together than larger stacks because more stacks are needed and therefore more space is required.

On hip roofs, where available working space is inadequate, extra tiles should be added to the stacks nearest the hips.

If the underlayment tears during loading, it should be repaired with a hot asphalt patch or with felt set in roofing mastic.

### Application

If birdstops, or eave closures, are not specified or if booster tile is not used, at least a 1-inch by 2-inch (2.5-centimetre by 5.1-centimetre) wood strip should be used to raise the front of the first course of tile. Using the first horizontal chalk line and the vertical lines as guides, the roofer should secure the first course of tile into position. For information about nailing procedures, mortar, and tile ties, see Topic 3.

The second course should be laid at the required exposure. The right-hand side of the barrel portion of each tile has a notch on it; a similar notch can be found on the left-hand side of the pan portion. The pan notch goes under the notch on the cover of the last course to provide a continuous channel for water and to keep the tile lying flat on the last course. The balance of the courses up to the ridge will be applied in the same way.

On roofs with pitches of 8/12 and over, two nails should be used in the pan portion of the tile, and wire ties should be used for the cover portion; this will secure each tile in three places.

**Laying Tile to a Hip**

When laying S tile to a hip, the roofer should be sure that the hip nailing board is set back 10 inches (25.4 centimetres) from the eave so that tile can be laid to the point of the eave. All tile should be miter cut flush to the hip nailing board. If a piece of tile is too small to nail, it should be set in place with mortar or roofing mastic. The section of tile that butts against the hip nailing board may be filled in with mortar or mastic in accordance with the manufacturer's specifications. Tile must be cut and fitted to all vertical projections, such as chimneys and dormers. For information on applying tile around flashings, see the appropriate sections and illustrations in Topic 3.

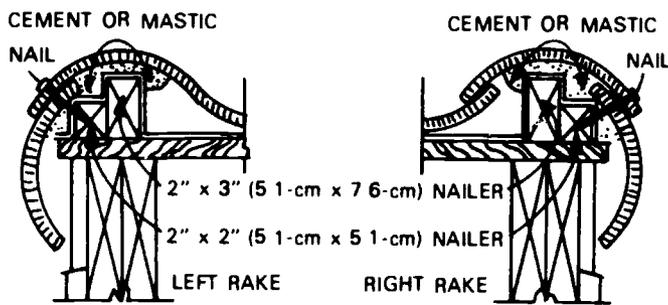


Fig. 4-2. Finished rakes

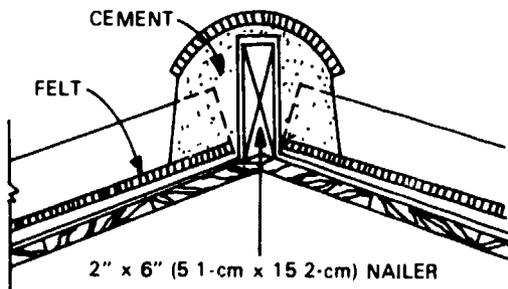


Fig. 4-3. Finished ridge or hip

If mortar is to be used, the tile to which it will be applied must be wet before the mortar is applied. Methods of wetting the tile were described in Topic 3.

**Finishing Hips, Ridges, and Gables**

Regular mission barrel tile is used to finish ridges, hips, and rakes. Mortar or mastic should be applied to the open ends of ridges, rakes, and hips to provide a neat appearance and to act as a birdstop.

The procedures for finishing ridges, hips, and rakes and for installing flashing at walls are shown in Figs. 4-2 through 4-4.

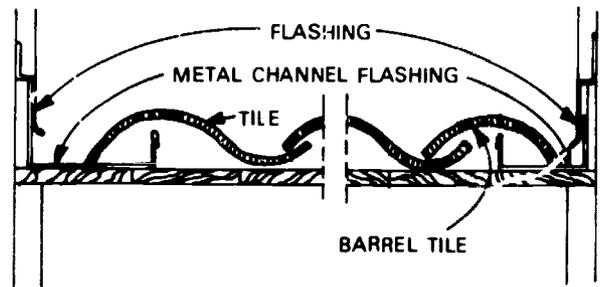
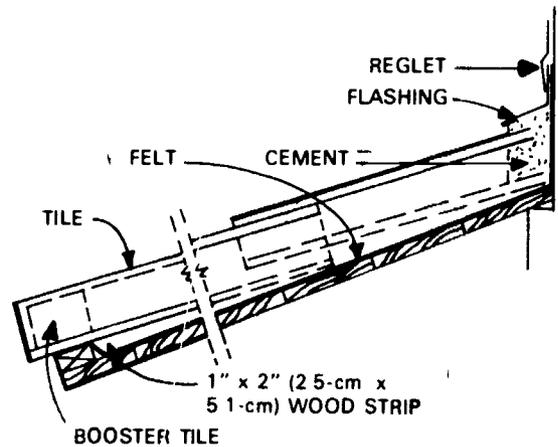


Fig. 4-4. Installation of flashing at walls

## RIGID ROOFING

### TOPIC 5—ROMAN TILE, FLAT SHINGLE TILE, AND ORIENTAL CLAY TILE

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Distinguish among the various types of shingle tile.
- Describe the procedure for preparing a roof for application of shingle tile.
- Demonstrate the proper procedures for applying Roman tile, flat shingle tile, and oriental glazed clay tile.

#### Roman Tile

Roman tile (Fig. 5-1) is applied in much the same way that two-piece mission barrel tile is applied. Like mission barrel tile, Roman tile has separate pan and cover tiles.

#### Roof Preparation

In preparing a roof for application of Roman tile, the roofer should do the following:

- Broom sweep the deck surface clean.
- Make sure that the roof deck is nailed properly.
- If plywood is used on the roof deck, ensure that all joints are blocked.
- Cover all knotholes with tin.
- Determine the thickness of the overhang to make sure that nails will not penetrate exposed sheathing.

#### Chalk Lines

The procedures for drawing chalk lines for use in applying Roman tile are the same as those previously described for two-piece mission barrel tile. The reader should review the appropriate section in Topic 3 to make sure that he or she understands the necessary procedures.

#### Loading of Tile on the Roof

In loading Roman tile on the roof, the roofer should follow the procedures outlined for loading two-piece tapered mission barrel tile. Pan tiles and cover tiles should be stacked separately, and the stacks should be alternated. If pan tiles are to be used as cover tiles also, the procedure to be followed is that outlined in Topic 3 for straight mission barrel tile.

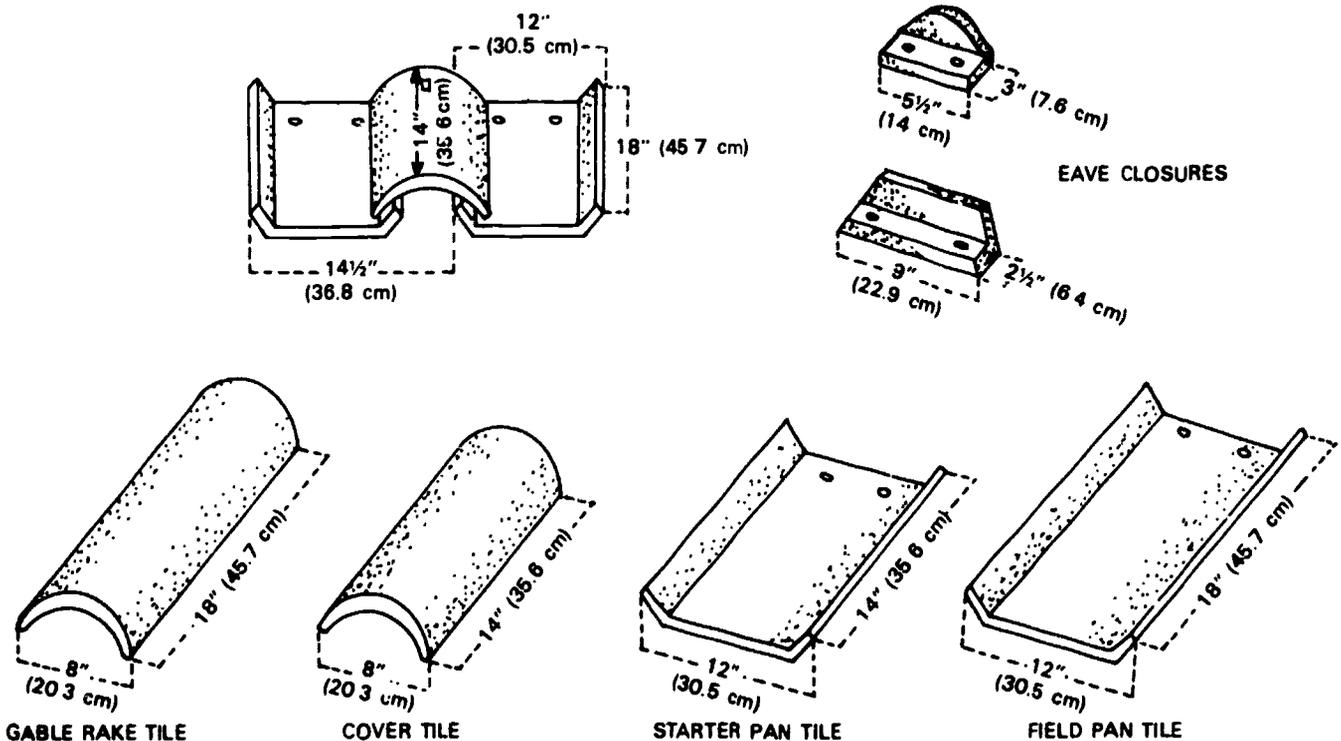


Fig. 5-1. Roman tile

**Underlayment**

Some general rules regarding underlayment used with Roman tile are given below. As with other tile the underlayment must meet the specifications of the tile manufacturer and local building code requirements.

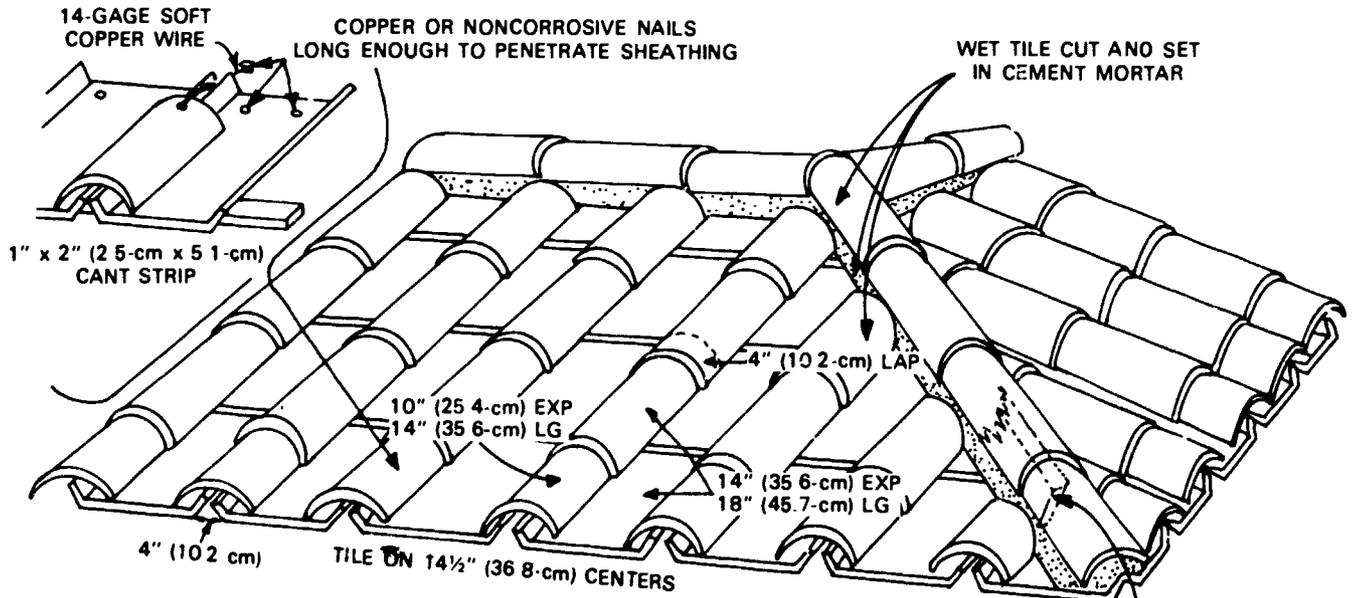
- For roofs of up to 5/12 pitch, use (1) two-ply 30-pound (13.6-kilogram) felt mopped at 25 pounds (11.4 kilograms) per square and flood coated; or (2) one-ply 45-pound (20.4-kilogram) felt nailed dry.
- For roofs with a pitch greater than 5/12, use one-ply felt of at least 45 pounds (20.4 kilograms)

nailed dry. The overlaps should be 4 inches (10.2 centimetres) on the sides and 6 inches (15.2 centimetres) at the heads.

**Application**

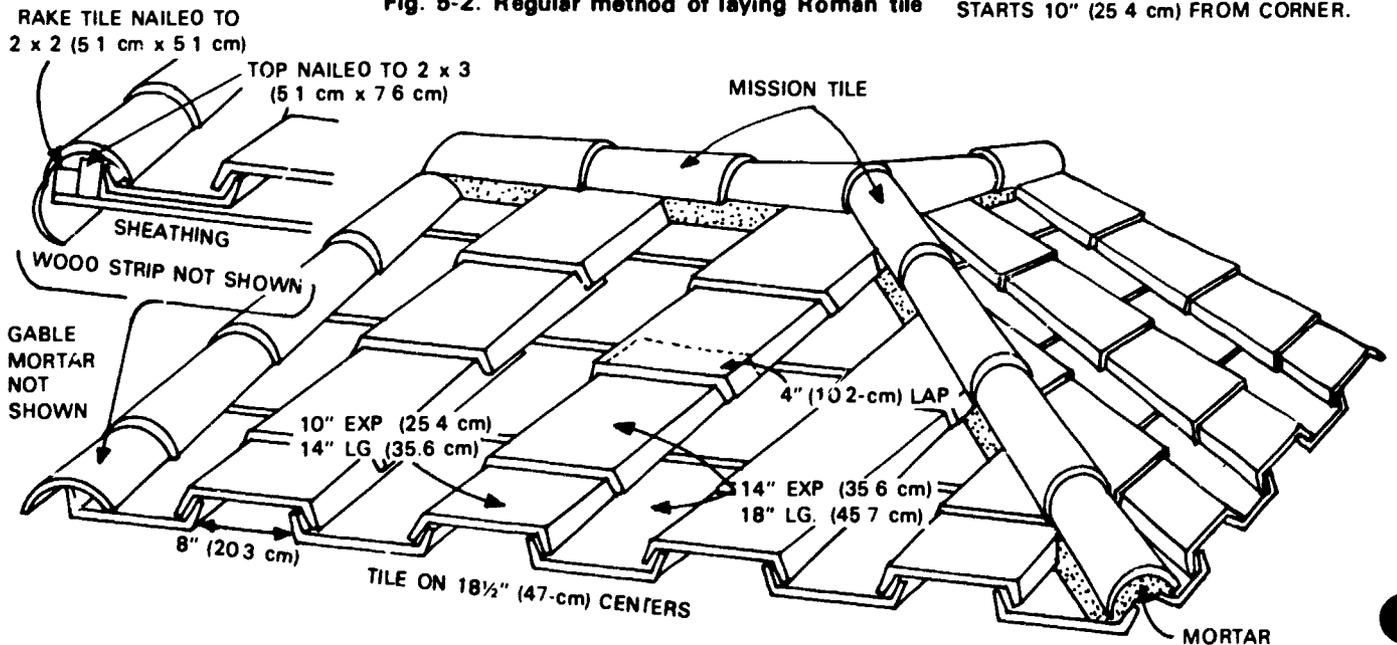
Roman tile may be laid by either of two methods. The regular method (Fig. 5-2) involves the use of both cover tiles and pan tiles. In the second, or alternate, method (Fig. 5-3), pan tiles serve as pans and covers.

After allowance has been made for the drip edge, all pan tiles should be laid even with the first horizontal chalk line. If mission barrel tiles are used as covers (regular method), the pan tiles should be spaced 4



**Fig. 5-2. Regular method of laying Roman tile**

1 1/2" x 5" (3.8-cm x 12.7-cm) HIP NAILER STARTS 10" (25.4-cm) FROM CORNER.



**Fig. 5-3. Alternate method of laying Roman tile**

inches (10.2 centimetres) apart. If pan tiles are to be used as pans and covers (alternate method), the pan tiles serving as pans should be spaced 8 inches (20.3 centimetres) apart. The head lap for field tiles should be in accordance with the tile specifications. The roofer should be sure that the tiles supplied are 18 inches (45.7 centimetres) long. If they are not and adjustments must be made, the exposure of the cover tiles should be shortened rather than lengthened.

If birdstops are not used, a 1-inch by 2-inch (2.5-centimetre by 5.1-centimetre) board should be used to raise the front of the eave tiles.

For information about laying tiles at hips, ridges, valleys, dormers, chimneys, and the like, the appren-

tice should review the appropriate sections in Topic 3. In both the regular and alternate methods of applying Roman tile, straight mission barrel tile is used on all hips, ridges, and rakes. This mission tile should always be secured to a 1½-inch by 5-inch (3.8-centimetre by 12.7-centimetre) nailing board.

**Flat Clay Shingle Tile**

Flat clay shingle tile (Fig. 5-4) is a single-coverage tile; that is, it has no water channel except for the exposed surface of the tile. Only a few manufacturers produce this type of tile. In most cases the hip and rake tiles and some starter tiles must be special ordered to meet the specifications of the particular

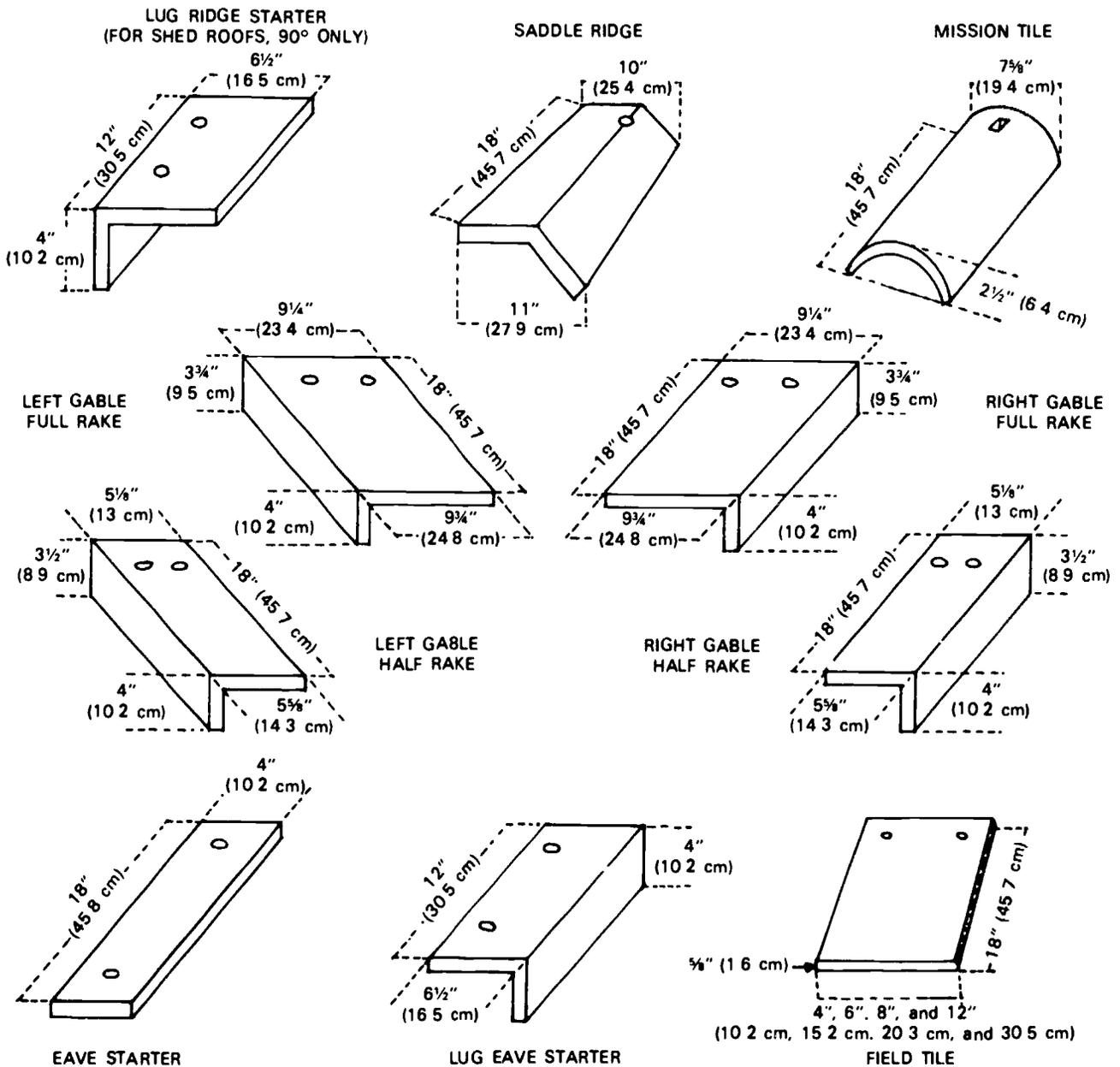


Fig. 5-4. Flat clay shingles

project. Shingle tiles are available in several sizes: 4 inches by 18 inches (10.2 centimetres by 45.7 centimetres), 6 inches by 18 inches (15.2 centimetres by 45.7 centimetres), 8 inches by 18 inches (20.3 centimetres by 45.7 centimetres), and 12 inches by 18 inches (30.5 centimetres by 45.7 centimetres).

### Roof Preparation

Roof preparation for flat shingle tiles includes the following:

- Broom sweeping the deck surface clean
- Making sure that sheathing is nailed properly
- Ensuring that joints in the deck are blocked and that knotholes are covered with tin
- Determining the thickness of the overhang to make sure that nails will not penetrate exposed sheathing

### Underlayment

Underlayment used with flat clay shingle tile may include the following:

- On roofs of 3/12 pitch to 5/12 pitch, use (1) two-ply 30-pound (13.6-kilogram) felt mopped at 25 pounds (11.4 kilograms) with a glaze coat; or (2) one-ply 45-pound (20.4-kilogram) felt nailed dry.
- On roofs with a pitch greater than 5/12, use two-ply 30-pound (13.6-kilogram) felt nailed dry.

A 36-inch-wide (91.4-centimetre-wide) felt is recommended for use under valleys, hips, and ridges and between each course of shingles to cover nail holes.

### Chalk Lines

In striking chalk lines for installation of flat shingle tile on a roof with even gables, the roofer should first determine the drip edge and then chalk the first horizontal line accordingly. He or she should be sure to measure from gable to gable at the eave and ridge lines to make sure that they are the same length. (Both rakes should also be checked to make sure that they are the same length.) This is especially important with flat shingle tiles because rake tiles are not required; the tiles will extend past the gable end to form their own drip edge. On a Boston-type ridge or hip (Fig. 5-5), neither ridge nor rake tiles are required. The field tiles butt against one another at the ridge or hip, and a bead of mastic is used to seal the joint at this point.

Using the horizontal and vertical chalk lines for the remaining courses is difficult because the asbestos felt woven between each course will cover the chalk lines. However, the felt may be laid to a chalk line to help maintain a straight horizontal line, and a few vertical

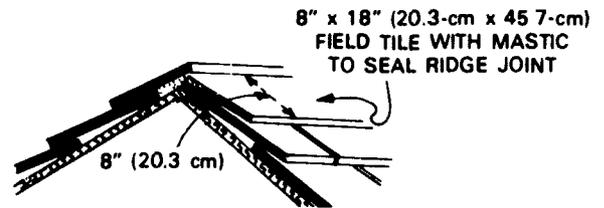


Fig. 5-5. Boston-type and ridge with flat clay shingle tile

lines can be struck to provide a rough idea of the vertical alignment of the shingles.

### Loading of Tile on the Roof

Flat shingle tiles are more difficult to load on the roof than other types of tile because of the variety of widths in which they are manufactured.

Eave starter tiles should be stacked 3 feet (91.4 centimetres) from the eave. Stacks of tiles of the same width should be placed at various locations around the roof deck. At least 60 percent of the stacks should be stacks of full tiles.

Specialty tiles should be stacked in the areas in which they will be used.

### Application

If eave starter tile is not used, a 1-inch by 2-inch (2.54-centimetre by 5.1-centimetre) board should be placed under the front of the first horizontal layer of tile to boost it at the eave. This board should be laid in 4-foot (1.2-metre) lengths with a ½-inch (1.3-centimetre) weep hole between pieces to allow backed-up water to escape. Birdstops are not required with flat shingle tile.

The breaks in each course of tile should be offset from the breaks in the course directly below by at least 2 inches (5.1 centimetres) as shown in Fig. 5-6. This can be accomplished by beginning each course with a tile whose width is at least 2 inches (5.1 centimetres) greater than the first tile in the course below. Thus, the first course would begin with a 4-inch-wide (10.2-centimetre-wide) tile, the second with a 6-inch wide (15.2-centimetre-wide) tile, and the third with an 8-inch-wide (20.3-centimetre-wide) tile. At the fourth course this pattern can be begun again, or it can be reversed; that is, the first tile in the fourth course will be 6 inches (15.2 centimetres) wide, the first tile in the fifth course will be 4 inches (10.2 centimetres) wide, and so forth. Laying tile in this manner will create a stair-step effect. This type of application is called a single-break application. As a result of the offset, the open side of a tile cannot match the open side of the tile it is laid above. This prevents exposure and deterioration of the felt, which would cause leaks. Flat shin-

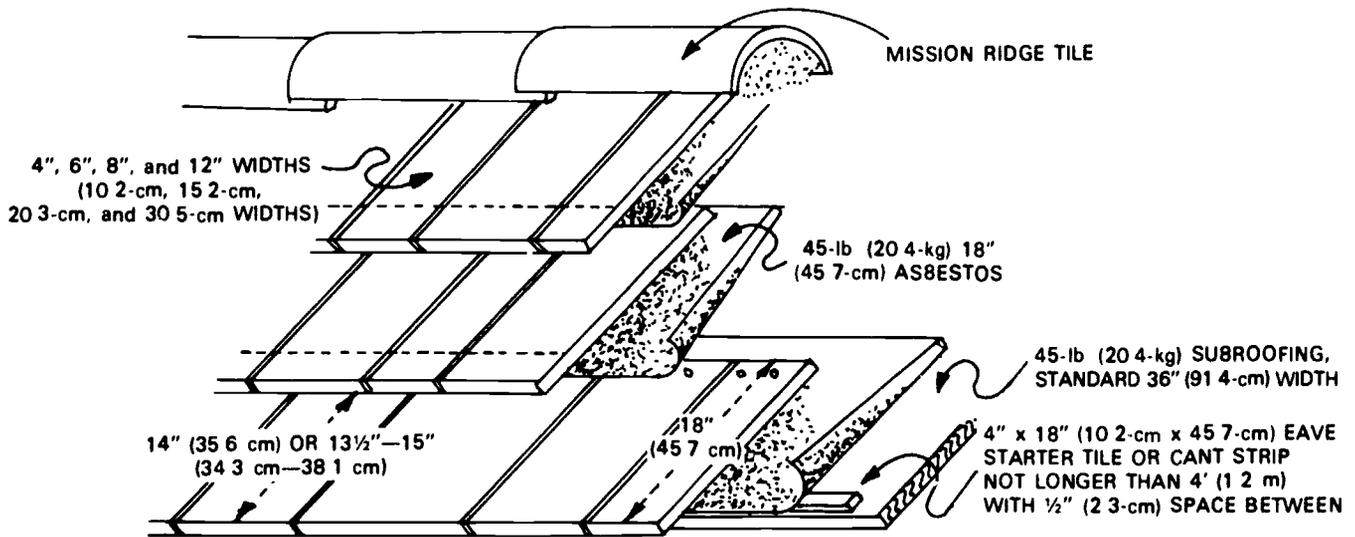


Fig. 5-6. Application of flat clay shingle tile with tile breaks offset

gle tile can be laid by alternating half tiles (6 inches, or 15.2 centimetres, wide) and full tiles (12 inches, or 30.5 centimetres, wide) in each course.

**Laying tile to hips.** All hips should be miter cut as evenly as possible and set in mortar. (Be sure that the tiles are wet enough to ensure proper bonding.) If straight mission barrel tile is used for hips, a 1½-inch by 5-inch (3.8-centimetre by 12.7-centimetre) nailing board should be installed with a setback of 5 inches (12.7 centimetres) from the eave. Mission tile covers should be set in mortar.

Special tile can be ordered for use on rakes if it is not desirable to use field tile to form a drip edge.

**Laying tile to ridges.** On ridges straight mission barrel tile can be used with a 1-inch by 6-inch (2.5-centimetre by 15.2-centimetre) nailing board, or the ends of the shingles can be butted together (Fig. 5-5), with the shingles from one side extending 5/8 of an inch (1.6 centimetres) past the ridge. In this case, the seam should be filled with mastic.

**Laying tile to flashings.** Flashings used with flat shingle tiles cannot have a lip because the tiles lie flat on the deck. The roofer should make sure that the base of metal flashing extends far enough on the roof deck to provide a proper water channel.

### Interlocking Clay Shingle Tile

Interlocking tile (Fig. 5-7) is manufactured with tongues and grooves. These tongues and grooves (1) provide a guide for accurate laying of the tile; and (2) prevent water from blowing under the tile membrane. Full tiles are generally 14 inches (35.6 centimetres) long and 9 inches (22.9 centimetres) wide. The exposure is usually 11 inches (27.9 centimetres).

Roofs of interlocking clay shingle tiles must be laid out very carefully to ensure that the tile at rakes, walls, chimneys, and the like fit evenly. Normally, the maximum leeway for squeezing or stretching a course is 1 inch (2.5 centimetres) in 20 feet (6.1 metres).

### Roof Preparation

Preparation of the roof deck for application of interlocking clay shingle tile includes the following:

- Broom sweeping the deck surface clean
- Making sure that the deck is properly nailed
- Covering knotholes in the deck with tin
- Determining the thickness of the overhang to make sure nails will not penetrate exposed sheathing
- Making sure that all joints in the deck are sealed

### Underlayment

The general requirements for underlayment beneath interlocking clay shingle tiles are as follows:

- On roofs of 3/12 pitch to 5/12 pitch, use (1) two-ply 30-pound (13.6-kilogram) felt mopped at 25 pounds (11.4 kilograms) per square with no flood coat; or (2) two-ply 40-pound (18.2-kilogram) felt mopped at 25 pounds (11.4 kilograms) with no flood coat.
- On roofs of greater than 5/12 pitch, use one-ply 55-pound (25-kilogram) felt nailed dry. Laps should be 4 inches (10.2 centimetres) at the sides and 6 inches (15.2 centimetres) at the heads.

### Chalk Lines

When working on a roof with even gables, the roofer should measure from gable to gable at the ridge and eave and from gable to eave at both gables

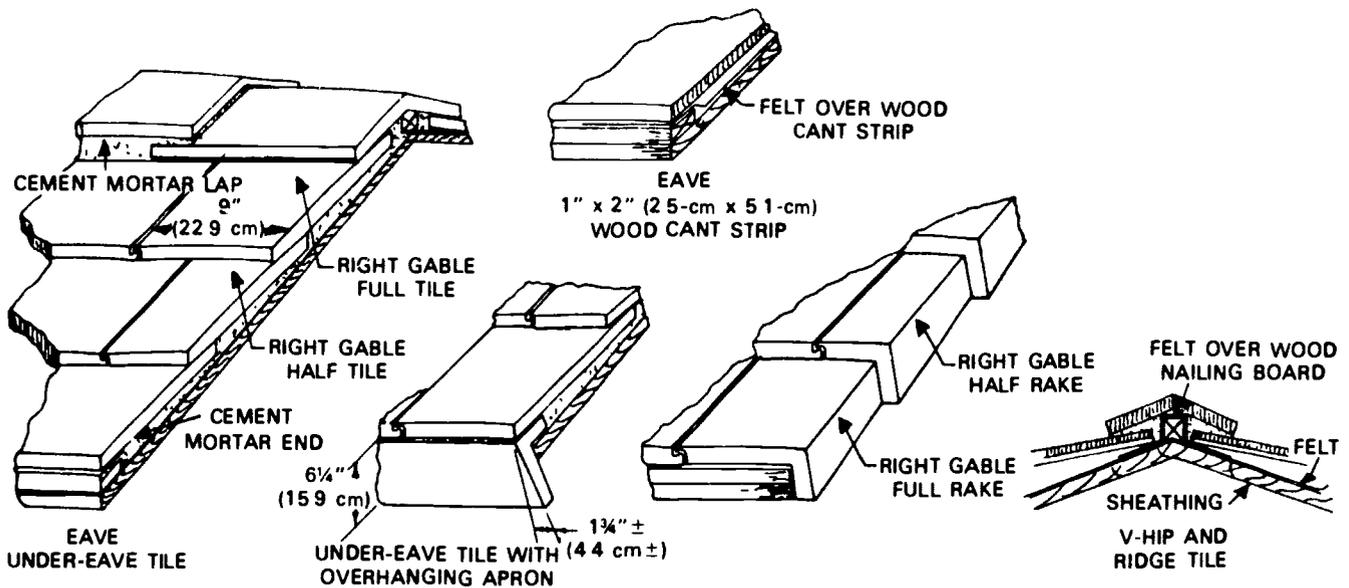


Fig. 5-7. Interlocking clay shingle tile and its application

to be sure that the ridge and eave are the same length and the rakes are the same length. Allowing for a 2-inch (5.1-centimetre) drip edge, he or she snaps the first horizontal line 12 inches (30.5 centimetres) from the eave. (The tile is 14 inches [35.6 centimetres] long.) The remaining horizontal lines will be 11 inches (27.9 centimetres) apart (allowing for a 3-inch [7.6-centimetre] head lap and an 11-inch [27.9 centimetre] exposure). Tighter spacing of the horizontal lines may be necessary, however, to allow for full tiles at the ridge. As with other types of tile, spacing adjustments should be made by increasing the head lap (or decreasing the exposure).

The vertical lines should be struck 9 inches (22.9 centimetres) apart. Before beginning to strike these lines, however, the roofer must determine whether rake tiles or full tiles will be used at the rakes. If rake tiles are used, the roofer should set one on each rake and divide the distance between them by 9 inches (22.9 centimetres) to determine the points at which the vertical lines should be struck.

For information about striking chalk lines on hips or uneven gables, see the section on chalk lines in Topic 3.

#### Loading of Tile on the Roof

In loading interlocking clay shingle tiles on the roof, the roofer should load specialty tiles first, placing them in the area in which they will be used. The field tiles should be stacked in stacks of ten beginning at the fourth course. Care must be taken not to break the water channels of the tiles. Broken tiles should be set aside and broken into small pieces later for use as filler material in areas that are to receive mortar.

#### Application

Some manufacturers sell special eave tiles called under-eave tiles (see Fig. 5-7). These tiles have an apron that extends down over the fascia. When under-eave tiles are used, neither booster strips nor drip edges are necessary. The first course of shingle tiles will consist of full tiles laid flush with the outer edge of the under-eave tiles. The second course will consist of a half tile at one rake and full tiles extending across the roof to the other rake. The third course will be the same as the first, the fourth will be the same as the second, and so on so that the patterns alternate to the ridge. In this way, the joints are always offset. If rake tiles are used, they will lie flat with the roof tile because of the tongue-and-groove interlocking system.

*Laying tile to a hip.* When laying interlocking clay shingle tiles to a hip, the roofer must be sure that the hip nailing board is set back 10 inches (25.4 centimetres) from the eave so that the eave course can be laid to the point of the hip. The tiles that butt against the nailing board must be miter cut as evenly as possible, and mortar must be applied at the points where the tiles meet the nailing board. Special V-shaped shingles are used as cover tiles at hips and ridges.

*Laying tile to valleys.* Valleys should be closed, with tile neatly cut to butt against the metal. For additional information about laying tiles to valleys, see the appropriate section in Topic 3.

*Laying tile to flashings.* The procedures for laying interlocking clay shingle tiles to flashings are basically the same as those described for mission barrel tile in

Topic 3. However, flashings used with interlocking clay shingle tiles must have a flat base so that the tiles can lie flat on the deck.

**Oriental Tile**

Oriental tile (Fig. 5-8) is almost flat. The pieces are designed to interlock at the sides and bottom.

**Roof Preparation**

Preparation of the roof deck for application of oriental tile includes the following:

- Broom sweeping the deck surface clean
- Making sure that the deck is properly nailed
- Covering knotholes in the deck with tin
- Determining the thickness of the overhang to make sure nails will not penetrate exposed sheathing
- Making sure that all joints in the deck are sealed

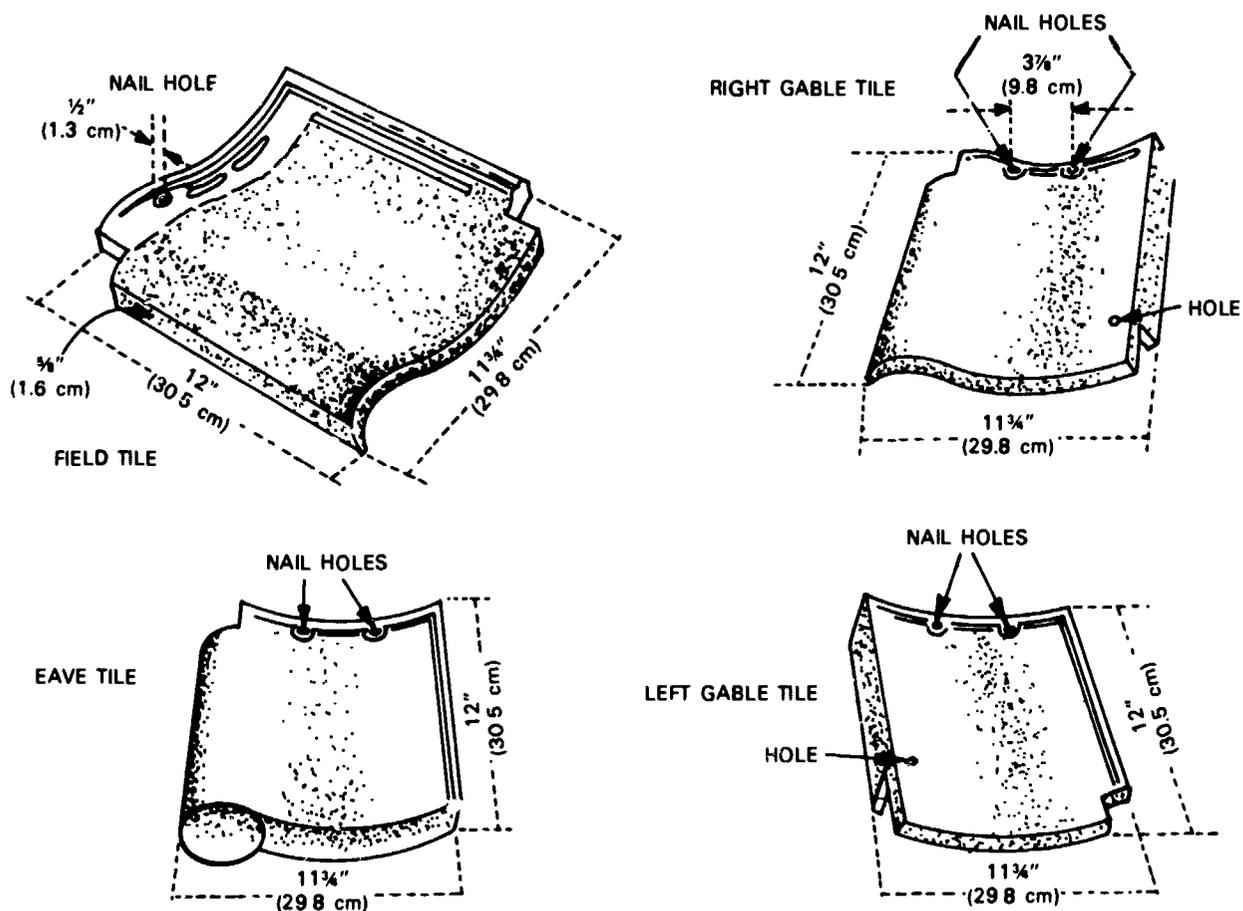
**Underlayment**

The general rules for underlayment with oriental tile are as follows:

- For roofs of up to 3/12 pitch, use two-ply 30-pound (13.6-kilogram) felt mopped at 25 pounds (11.4 kilograms) per square and flood coated. A strong underlayment is required on these roofs because the tile is used only for decoration; that is, it is not used to channel water off the roof.
- For roofs with pitches greater than 3/12, use two-ply, 15-pound (6.8-kilogram) felt, one-ply 30-pound (13.6-kilogram) felt, or felt heavier than 30 pounds (13.6 kilograms) nailed on dry.

**Chalk Lines**

In applying oriental tile to a roof with even gables, the roofer must measure the rakes from eave to ridge and the ridge and eaves from rake to rake to be sure



(continued)

Fig. 5-8. Oriental tile

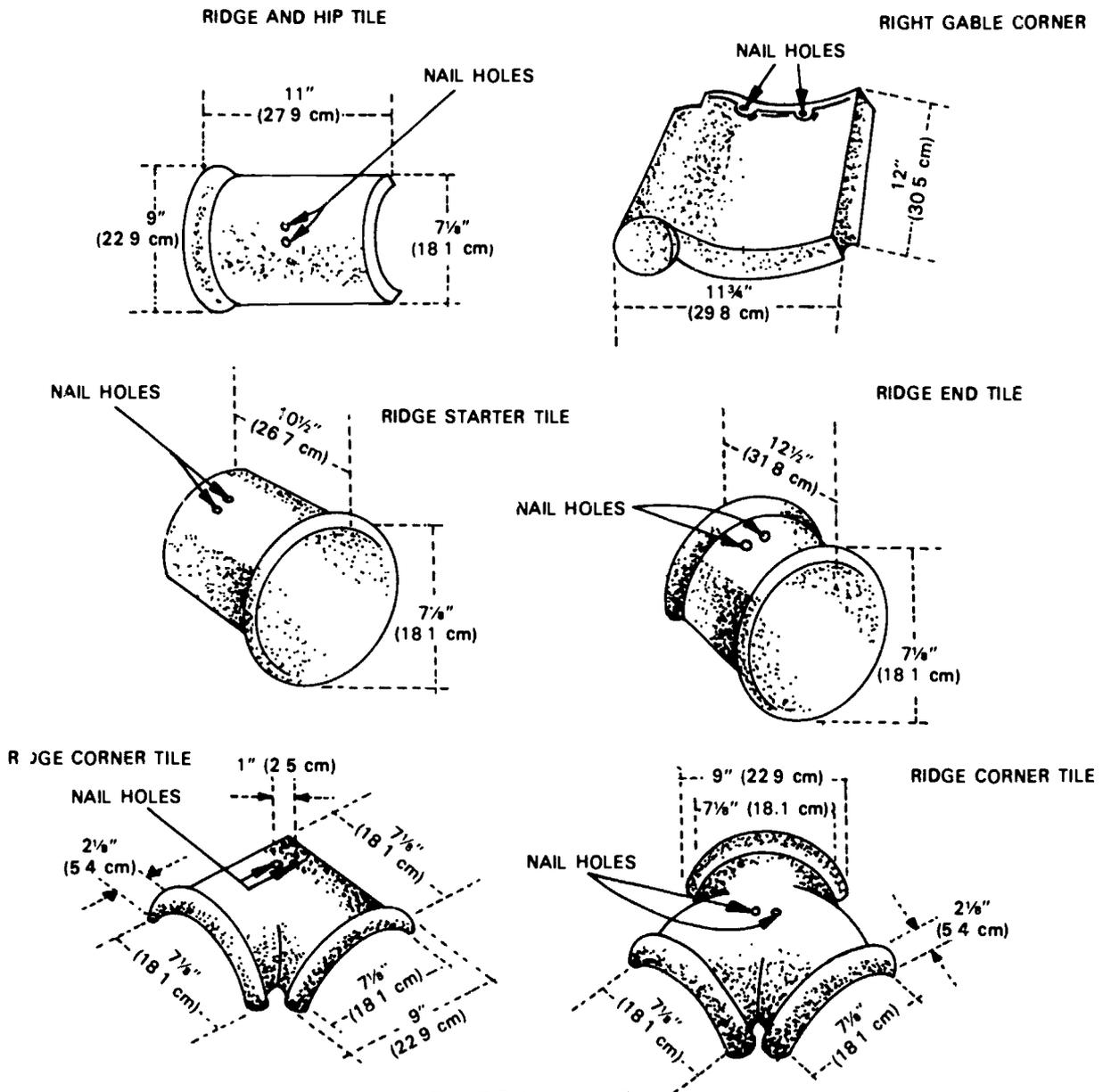


Fig. 5-8 (continued)

that the ridge and eave lengths are the same and the rake lengths are the same. Because this tile is an interlocking tile, there is virtually no margin for error.

Oriental tile generally is available in two sizes: (1) 11 1/4 inches by 12 inches (29.8 centimetres by 30.5 centimetres); and (2) 11 1/4 inches by 11 1/2 inches (29.8 centimetres by 29.2 centimetres). The roofer should be sure to determine the size of the tile to be used before beginning to lay out the roof. Since battens (wood strips 1/2 inch by 1/2 inch [1.3 centimetres by 1.3 centimetres] or 1 inch by 1 inch [2.5 centimetres by 2.5 centimetres]) are used to hold the tiles, only horizontal chalk lines are needed to guide the application of the battens.

#### Loading of Tile on the Roof

Specialty tiles should be loaded first and placed in the areas where they will be used. The stacking of eave tiles should begin with stacks of four at the third course. The stacks should be placed 3 feet (0.9 metres) apart. On the fourth course, and every fourth course thereafter, the tiles are to be in stacks of ten.

#### Application

The first step in applying oriental tile is to nail a 1-inch by 2-inch (2.5-centimetre by 5.1-centimetre) wooden booster strip along the eave to raise the front of the tiles. Using the lugs on the underside, the roofer should hang the special eave tiles and secure them in

accordance with the specifications. All other courses will be made up of field tiles. *NOTE:* Because these tiles interlock, exposure adjustments cannot be made, and it may be necessary to cut the tiles in the last course, as shown in Fig. 5-9.

Special ridge end tiles and ridge starter tiles are used to finish the ridge. The ridge may be a built-up ridge (Fig. 5-10) or a flat (normal) ridge (Fig. 5-11).

Generally, special gable corner tiles are supplied with oriental tile. These gable corner tiles should be applied with the first course.

*Laying tile to a hip.* Hips should be finished with the special hip cover tiles, and mortar should be used at laps. For more information on laying tile to hips, see the appropriate section in Topic 3.

*Laying tile to valleys.* For information on laying tile to a valley, see the appropriate section in Topic 3.

*Laying tile to flashings.* For information on laying tile to flashings, see the appropriate section in Topic 3. Fig. 5-12 shows in detail how oriental tiles and flashing are applied at walls.

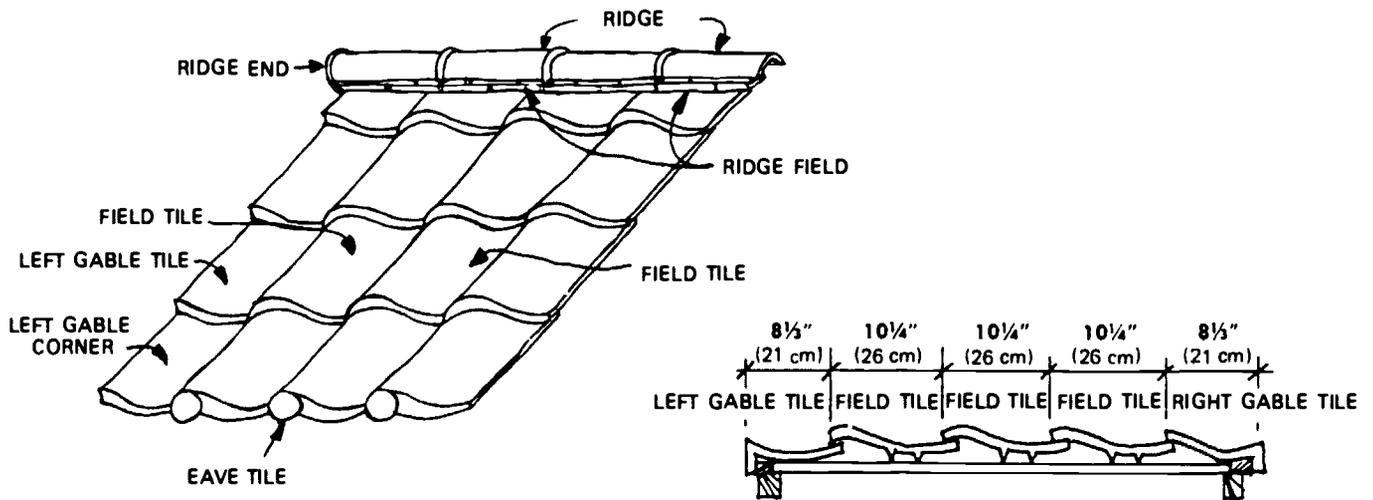


Fig. 5-9. Application of oriental tile

RIDGE TILE FIXED TO 2" x 2" (51-cm x 51-cm) BLOCKING WITH 16-GAGE GALVANIZED WIRE STAPLE

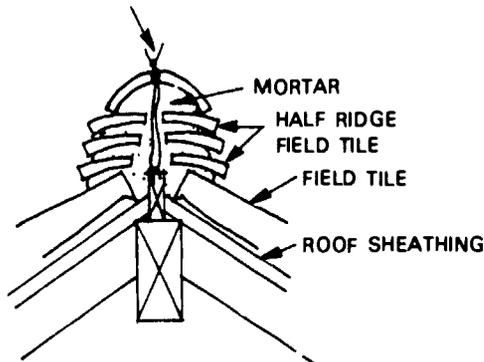


Fig. 5-10. Built-up ridge detail

RIDGE TILE FIXED TO 2" x 2" (51-cm x 51-cm) BLOCKING WITH 16-GAGE GALVANIZED WIRE STAPLE

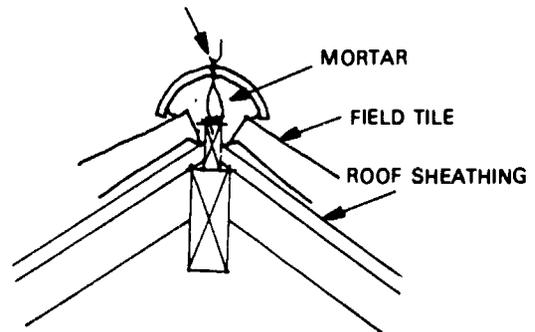


Fig. 5-11. Flat ridge detail

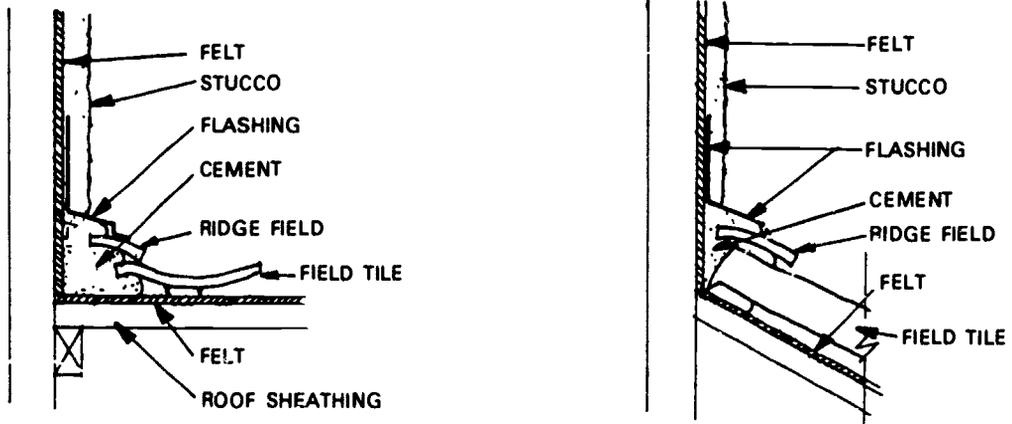


Fig. 5-12. Application of flashing and ori tile at walls

# RIGID ROOFING

## TOPIC 6—CONCRETE INTERLOCKING TILE

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Describe concrete interlocking tile.
- Identify and define common terminology associated with concrete interlocking tile.
- Use the proper procedures in laying out a roof for application of concrete interlocking tile.
- Describe the proper procedures for loading a roof with concrete interlocking tile.
- Distinguish among the common hand tools and power tools used with concrete interlocking tile.
- Describe the procedures for applying concrete interlocking tile.
- Demonstrate application of concrete interlocking tile.
- Demonstrate safety procedures to be followed in working with concrete interlocking tile.

Concrete interlocking tiles (Fig. 6-1) may be flat, sculptured, or S-shaped tiles. They may be as wide as 13 inches (33 centimetres) and as long as 16 inches (40.6 centimetres). On the average, concrete interlocking tile weighs 900 pounds (408.6 kilograms) per square.

### Roof Preparation

Preparation of the roof deck for application of concrete interlocking tile includes all of the following:

- Broom sweeping the surface clean
- Making sure that the roof deck is nailed properly

- If plywood is used for the roof deck, ensuring that all joints are blocked
- Covering all knotholes with tin
- Determining the thickness of the overhang to make sure that nails will not penetrate exposed sheathing

### Underlayment

The requirements for underlayment with concrete interlocking tile are the same as those for one-piece mission tile (S tile):

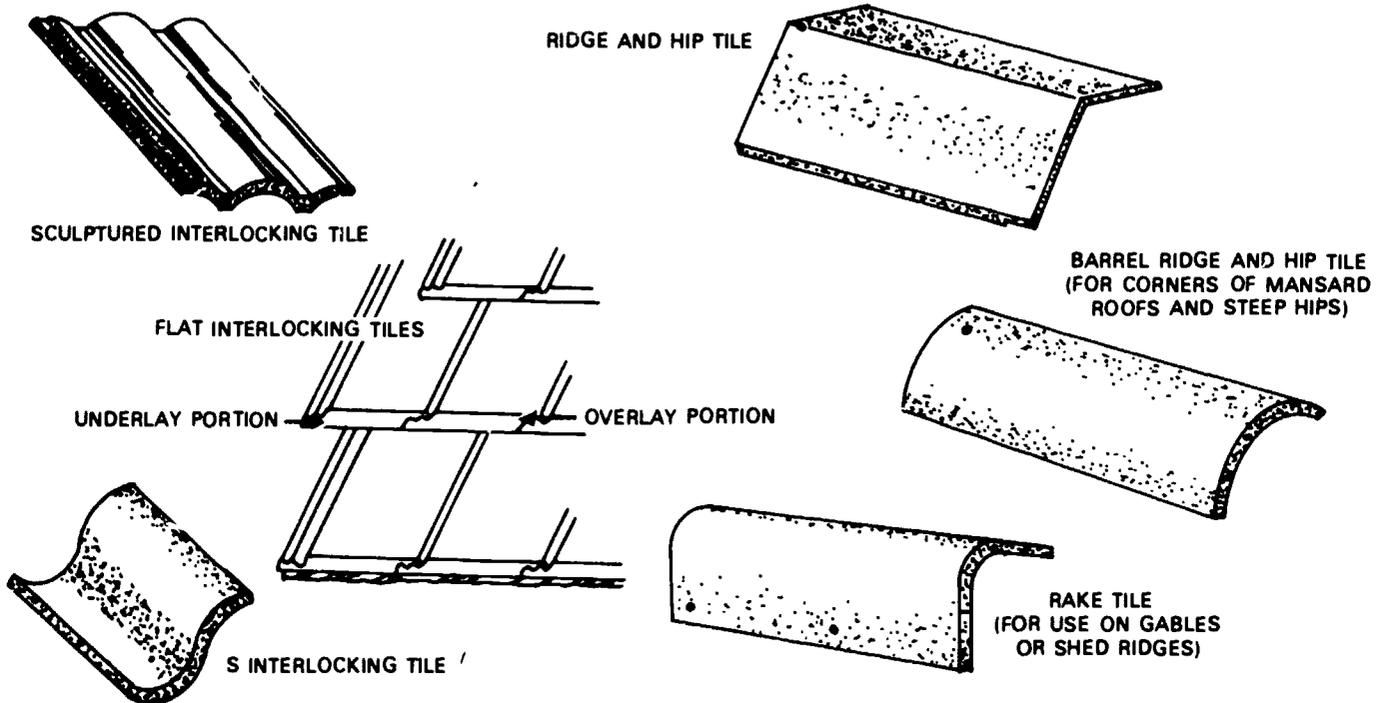


Fig. 6-1. Concrete interlocking tiles

- On roofs with up to and including 3/12 pitch, use (1) two-ply 15-pound (6.8-kilogram) felt with the first sheet nailed or sprinkle mopped and the second mopped at 25 pounds (11.4 kilograms) per square and flood coated; or (2) two-ply felt with one 15-pound (6.8-kilogram) felt nailed or sprinkle mopped and one 40-pound (18.2-kilogram) felt mopped at 25 pounds (11.4 kilograms) per square (no flood coat).
- For roofs over 3/12 pitch, use (1) one-ply 40-pound (18.2-kilogram), 50-pound (22.7-kilogram), or 55-pound (25-kilogram) felt nailed dry.

All underlayment should be blind nailed under each lap, and the laps should be at least 4 inches (10.2 centimetres) at the sides and 6 inches (15.2 centimetres) at the heads.

### Chalk Lines

Before beginning to lay out a roof for application of concrete interlocking tile, the roofer should be sure that rafters, sheathing, and flashings are in accordance with specifications. A roofer is fully responsible for any consequences if he or she installs tile over a roof that does not meet specifications.

In laying out the roof, the roofer first snaps a chalk line 15 inches (38.1 centimetres) or wherever necessary from the front edge of the fascia to allow a 1-inch or 2-inch (2.5-centimetre or 5.1-centimetre) overhang for the eave course.

Next, he or she measures down from the edge of the ridge nailing board to determine the location for the heads of the tiles in the top course. This distance is usually 1 inch (2.5 centimetres). A horizontal chalk line should be snapped across the roof at this point.

When these two lines have been established, the roofer should measure the distance between them. The appropriate lap range in the spacing guide (Fig. 6-2) should be checked to find (1) this distance (or the figure closest to it); and (2) the size of the segments into which this distance can be divided evenly. For example, the lap range might be 3 inches (7.6 centimetres) and the distance measured might be 24 feet 9 inches (7.5 metres). The spacing guide in Fig. 6-2 shows that this distance can be divided evenly into increments of 13½ inches (34.3 centimetres). Both ends of the roof should be marked off into segments of this size. The increment size given must not be exceeded. Finally, chalk lines are snapped across the roof at the marks.

Battens or sheathing boards should be nailed at the chalk lines with 4-penny corrosion-resistant box nails. If necessary, adjustments should be made on solid sheathing.

If the roof has multiple ridgelines, each ridgeline should be treated as a side. Each ridge course will

serve as a top course. If the roof is a hip roof with no ridgeline and the sides meeting at a point, the roofer should do the following: (1) snap a chalk line 15 inches (38.1 centimetres) or whatever distance necessary from the front edge of the fascia to allow a 1-inch (2.5-centimetre) or 2-inch (5.1-centimetre) overhang for the eave course; and (2) space the second and succeeding courses a maximum of 13½ inches (34.3 centimetres) apart.

### Loading of Tile on the Roof

The trim tile should be loaded first. This will help cut down on the amount of walking the roofer will have to do later because he or she will not have to walk around the field tiles to place the trim tiles.

Figure 6-3 shows how concrete interlocking tile may be stacked on a roof with straight gables. The reader should note that the last stack in a row should be doubled. A typical loading pattern on a hip roof is shown in Fig. 6-4.

### Application

Concrete interlocking tile is commonly applied on a number of different types of roofs, including gable, hip, and mansard roofs.

#### Installing the First Course on a Gable Roof

In installing concrete interlocking tile on a gable roof, the roofer should begin by laying (but not nailing) the first tile of the starter course so that the right edge is 1 inch (2.5 centimetres) from the right rake (Fig. 6-5). He or she should continue laying tiles from right to left across the roof, leaving a gap of 1/16 inch to 1/8 inch (0.2 centimetre to 0.3 centimetre) between tiles. If the tiles are too tight or too loose, the overlay may break when they are walked on. When the starter course is finished, the left edge of the last tile should be ½ inch to 2 inches (1.3 centimetres to 5.1 centimetres) from the left rake as shown in Fig. 6-6. If the last tile is closer to the rake or farther from the rake than required, adjustments must be made in the starter course. The starter course can be moved to the right by doing any of the following:

1. Starting ½ inch (1.3 centimetres) from the right rake and relaying the course accordingly
2. Knocking the overlay and/or underlay from the tiles and relaying the course if necessary
3. Breaking the last tile in half and adjusting the rest of the course accordingly

The starter course can be moved to the left by doing any of the following:

1. Starting the course 2 inches (5.1 centimetres) from the right rake and relaying accordingly

3" lap range									2" lap range (This range requires underlay)														
1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2-1¼	2-1½	2-1¾	2-2	2-2¼	2-2½	2-2¾	2-3	2-3¼	2-3½	2-3¾	2-4	2-4¼	2-4½	2-4¾	2-5								
3-1¼	3-2¼	3-2¾	3-3	3-3¾	3-3¾	3-4¼	3-4½	3-4¾	3-5¼	3-5¾	3-6	3-6¾	3-6¾	3-7¼	3-7½								
4-2½	4-3	4-3½	4-4	4-4½	4-5	4-5½	4-6	4-6½	4-7	4-7½	4-8	4-8½	4-9	4-9½	4-10								
5-3¾	5-3¾	5-4¾	5-5	5-5¾	5-6¼	5-6¾	5-7½	5-8¾	5-8¾	5-9¾	5-10	5-10¾	5-11¼	5-11¾	6-0½								
6-3¾	6-4½	6-5¼	6-6	6-6¾	6-7½	6-8¼	6-9	6-9¾	6-10½	6-11¼	7-0	7-0¾	7-1½	7-2¼	7-3								
7-4¾	7-5¼	7-6¼	7-7	7-7¾	7-8¾	7-9¾	7-10½	7-11¾	8-0¼	8-1¾	8-2	8-2¾	8-3¾	8-4¾	8-5½								
8-5	8-6	8-7	8-8	8-9	8-10	8-11	9-0	9-1	9-2	9-3	9-4	9-5	9-6	9-7	9-8								
9-5¾	9-6¾	9-7¾	9-9	9-10¾	9-11¼	10-0¾	10-1½	10-2¾	10-3¾	10-4¾	10-6	10-7¾	10-8¼	10-9¾	10-10½								
10-6¼	10-7½	10-8¾	10-10	10-11¼	11-0½	11-1¾	11-3	11-4¼	11-5½	11-6¾	11-8	11-9¼	11-10½	11-11¾	12-1								
11-6¾	11-8¼	11-9¾	11-11	12-0¾	12-1¾	12-3¾	12-4½	12-5¾	12-7¼	12-8¾	12-10	12-11¾	13-0¾	13-2¾	13-3½								
12-7½	12-9	12-10¾	13-0	13-1½	13-3	13-4½	13-6	13-7½	13-9	13-10½	14-0	14-1½	14-3	14-4½	14-6								
13-8¾	13-9¾	13-11¾	14-1	14-2¾	14-4¼	14-5¾	14-7½	14-9¾	14-10¾	15-0¾	15-2	15-3¾	15-5¼	15-6¾	15-8½								
14-8¾	14-10½	15-0¼	15-2	15-3¾	15-5½	15-7¼	15-9	15-10¾	16-0½	16-2¼	16-4	16-5¾	16-7½	16-9¼	16-11								
15-9¾	15-11¼	16-1¾	16-3	16-4¾	16-6¾	16-8¾	16-10½	17-0¾	17-2¼	17-4¼	17-6	17-7¾	17-9¾	17-11¾	18-1½								
16-10	17-0	17-2	17-4	17-6	17-8	17-10	18-0	18-2	18-4	18-6	18-8	18-10	19-0	19-2	19-4								
17-10¾	18-0¾	18-2¾	18-5	18-7¾	18-9¾	18-11¾	19-1½	19-3¾	19-5¾	19-7¾	19-10	20-0¾	20-2¼	20-4¾	20-6½								
18-11¼	19-1½	19-3¾	19-6	19-8¾	19-10½	20-0¾	20-3	20-5¼	20-7½	20-9¾	21-0	21-2¼	21-4½	21-6¾	21-9								
19-11¾	20-2¼	20-4¾	20-7	20-9¾	20-11¾	21-2¾	21-4½	21-6¾	21-9¾	21-11¾	22-2	22-4¾	22-6¾	22-9¾	22-11½								
21-0½	21-3	21-5½	21-8	21-10½	22-1	22-3½	22-6	22-8½	22-11	23-1½	23-4	23-6½	23-9	23-11½	24-2								
22-1¾	22-3¾	22-6¾	22-9	22-11¾	23-2¼	23-4¾	23-7½	23-10¾	24-0¼	24-3¾	24-6	24-8¾	24-11¼	25-1¾	25-4½								
23-1¾	23-4½	23-7¼	23-10	24-0¾	24-3½	24-6¼	24-9	24-11¾	25-2½	25-5¼	25-8	25-10¾	26-1½	26-4¼	26-7								
24-2¾	24-5¼	24-8¾	24-11	25-1¾	25-3¾	25-7¾	25-10½	26-1¾	26-4¼	26-7¾	26-10	27-0¾	27-3¾	27-6¾	27-9½								
25-3	25-6	25-9	26-0	26-3	26-6	26-9	27-0	27-3	27-6	27-9	28-0	28-3	28-6	28-9	29-0								
26-3¾	26-6¾	26-9¾	27-1	27-4¼	27-7¼	27-10¾	28-1½	28-4¾	28-7¾	28-10¾	29-2	29-5¾	29-8¼	29-11¾	30-2½								
27-4¼	27-7½	27-10¾	28-2	28-5¼	28-8½	28-11¾	29-3	29-6¼	29-9½	30-0¾	30-4	30-7¼	30-10½	31-1¾	31-5								
28-5¾	28-8¼	28-11¾	29-3	29-6¾	29-9¾	30-1¾	30-4½	30-7¾	30-11¼	31-2¾	31-6	31-9¾	32-0¾	32-4¾	32-7½								
29-6½	29-9	30-0½	30-4	30-7½	30-11	31-2½	31-6	31-9½	32-1	32-4½	32-8	32-11½	33-3	33-6½	33-10								
30-6¾	30-9¾	31-1¾	31-5	31-8¾	32-0¼	32-3¾	32-7½	32-11¾	33-2¾	33-6¾	33-10	34-1¾	34-5¼	34-8¾	35-0½								
31-6¾	31-10½	32-2¼	32-6	32-9¾	33-1½	33-5¼	33-9	34-0¾	34-4½	34-8¼	35-0	35-3¾	35-7½	35-11¼	36-3								

Fig. 6-2. A typical spacing guide

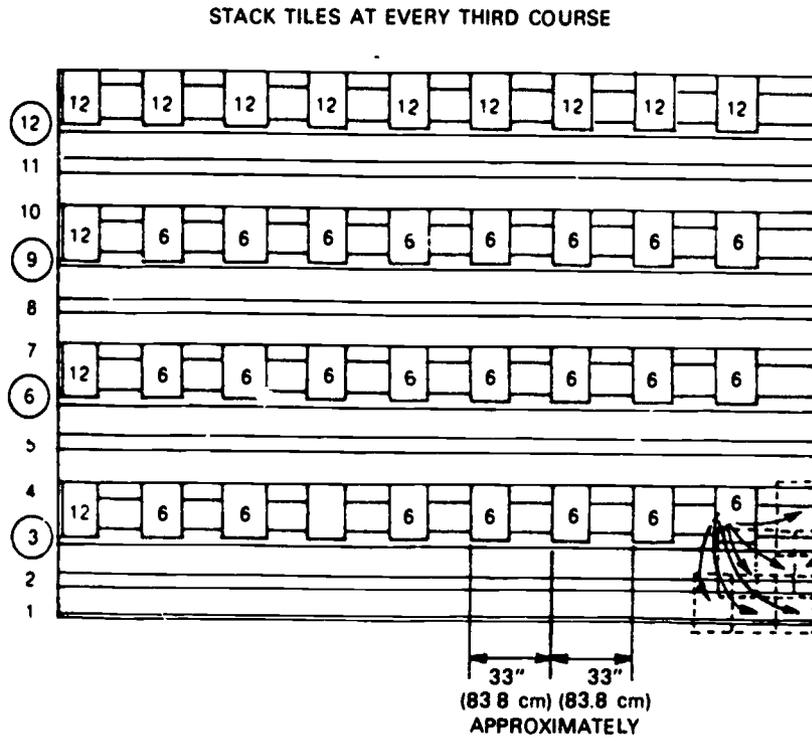


Fig. 6-3. A typical loading pattern for concrete interlocking tile on a roof with straight gables

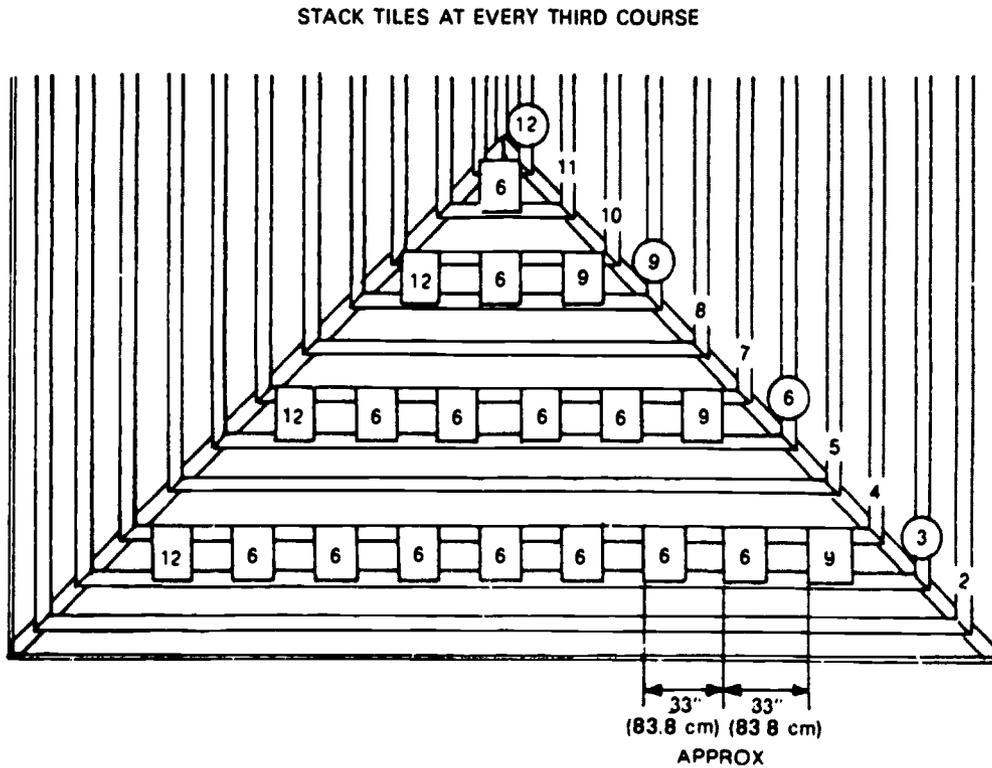


Fig. 6-4. A typical loading pattern for concrete interlocking tile on a hip roof

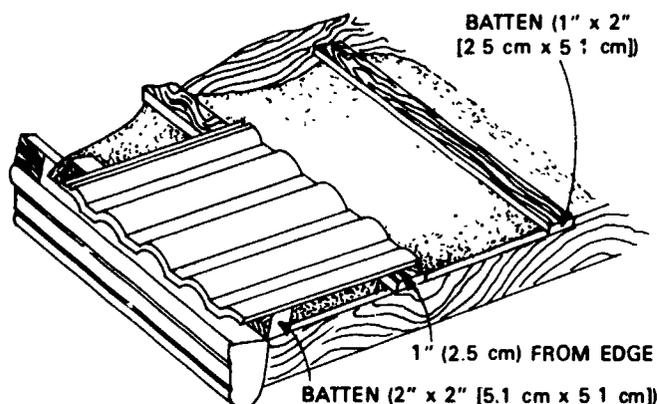


Fig. 6-5. Application of the starter course of concrete interlocking tile at the right rake

2. Leaving gaps of  $\frac{1}{8}$  inch (0.3 centimetre) between tiles
3. Adding one half-tile and adjusting accordingly

Once the starter course tiles have been laid properly, they should be nailed with 10-penny nails (8-penny if application is on an open overhang).

#### Installing Field Tiles on a Gable Roof

On roofs with pitches of  $\frac{5}{12}$  or less, the roofer should lay the field tiles across three courses at a time. Nailing is required only on the perimeter tiles unless headlugs are removed to accommodate solid sheathing beside spaced sheathing.

On roofs with pitches greater than  $\frac{5}{12}$  and up to and including  $\frac{7}{12}$ , three courses should be laid at a time, and every third course should be nailed with 10-penny nails (8-penny nails over an open overhang).

If the pitch of the roof is greater than  $\frac{7}{12}$  but no greater than  $\frac{12}{12}$ , two courses should be laid at a time, and every other course should be nailed.

On a roof with a pitch greater than  $\frac{12}{12}$ , one course should be laid at a time, and every tile should be nailed.

Field tiles may be laid with a straight or broken bond. The broken bond pattern is more convenient than the straight bond pattern when more than one course at a time is being laid.

To keep the tiles in vertical lines, the roofer must do the following:

1. Seat both lugs against the sheathing.
2. Keep the top corners of the tiles aligned as he or she lays tiles across the roof.
3. Keep the gaps between tiles uniform with those used in the course directly below.

To lay field tiles from spaced sheathing onto solid sheathing (as on a solid sheathing overhang), the roofer should knock off the head lugs to maintain the flat plane of the roof.

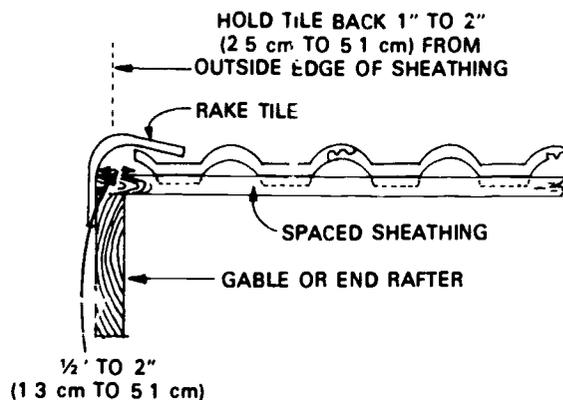


Fig. 6-6. Application of the starter course of concrete interlocking tile at the left rake

#### Installing Roof Jacks and Vent Safes

Roof jacks and vent safes must be installed so that the cone of the jack is on top of the tile (Fig. 6-7). The top of the roof jack must extend at least 3 inches (7.6 centimetres) beyond and beneath the nose of the tile above. If the roof jack does not reach 3 inches (7.6 centimetres) under the nose of the tile above, the roofer should use 2-pound (0.9-kilogram) sheet lead to extend the top of the roof jack. The sheet lead should be lapped at least 3 inches (7.6 centimetres) under the tile above and 3 inches (7.6 centimetres) over the roof jack. If local wind conditions are such that 4 inches (10.2 centimetres) of head lap is required, the roof jack should also be lapped by at least the same amount. The roof jack must be made to conform closely to the contour of the tiles and then fixed to the tiles with plastic asbestos cement.

#### Installing Rake Tile on a Gable Roof

Rake tiles (Fig. 6-8) may be installed as the field tiles are being laid or after the field tiles have been laid. If no gutter is used, the bottom rake tiles must be cut nearly flush with the bottom of the starter course.

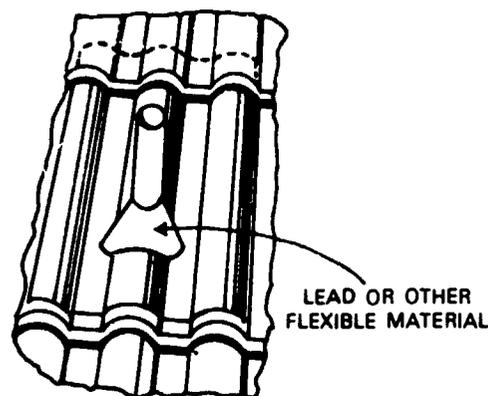


Fig. 6-7. Roof jack installed on concrete interlocking tile

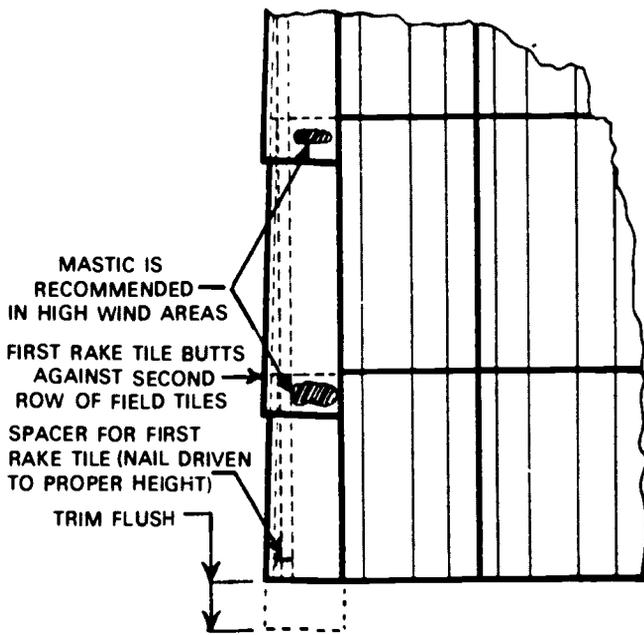


Fig. 6-8. Application of concrete interlocking tile on a gable roof

If a gutter is used, the bottom rake tiles should be left full length.

If rake tiles end at a wall or at a higher overhang, lead flashing must overlap the tops of the last rake tiles by 3 inches (7.6 centimetres) and must extend under the wall or tile above.

The heads of the rake tiles butt against the noses of the tiles above. The roofer must be sure not to allow the rake tiles to roll out; he or she must keep them on an even plane with the edge of the roof. Each rake tile should be nailed with two 10-penny nails.

#### Tile-Cutting Procedures

Because concrete roofing tiles are so hard, special tools are required to cut them. The most common and effective tool used by the roofer for such purposes is the masonry cutoff saw (Fig. 6-9). These saws resemble chain saws with a 12-inch to 14-inch (30.5-centimetre to 35.6-centimetre) Carborundum blade.

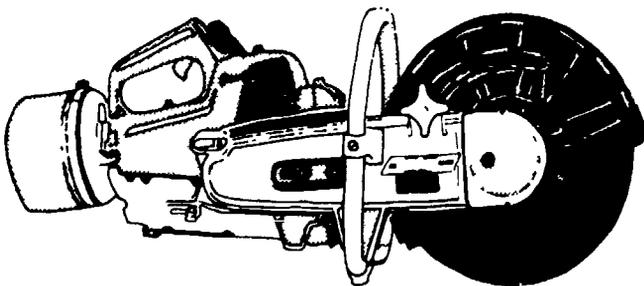


Fig. 6-9. Masonry cutoff saw

Most masonry cutoff saws are gas powered, but electric models are also available. Such saws run at an exceptionally high number of revolutions per minute. They are especially effective for making long continuous cuts, such as those required at hips or valleys.

Certain methods are recommended for cutting concrete tile at valleys, hips, vents, gables, and so forth. Proper cutting can help to save time and materials and can help ensure that the overall job will be done well.

#### Cutting Tiles for Valleys

Valleys may be either closed or open. The closed valley (Fig. 6-10) is more widely used than the open valley (Fig. 6-11) and is more aesthetically pleasing because virtually no metal is visible. Where leaf fall is heavy, closed valleys are less desirable than open valleys.

*Closed valleys.* In cutting tile for a closed valley, the roofer should do the following:

1. Lay field tiles (chipped or broken tiles if possible) at one side of the metal valley up to the splash diverter.
2. From the splash diverter, and at the top and bottom of the valley, measure out 12 inches (30.5 centimetres) or 24 inches (61 centimetres) (whichever measurement provides for cut tile at every course) parallel to the sheathing or tile courses, and chalk a line between the two points.
3. Cut the tiles along the chalk line, being careful not to score or cut through the metal valley.

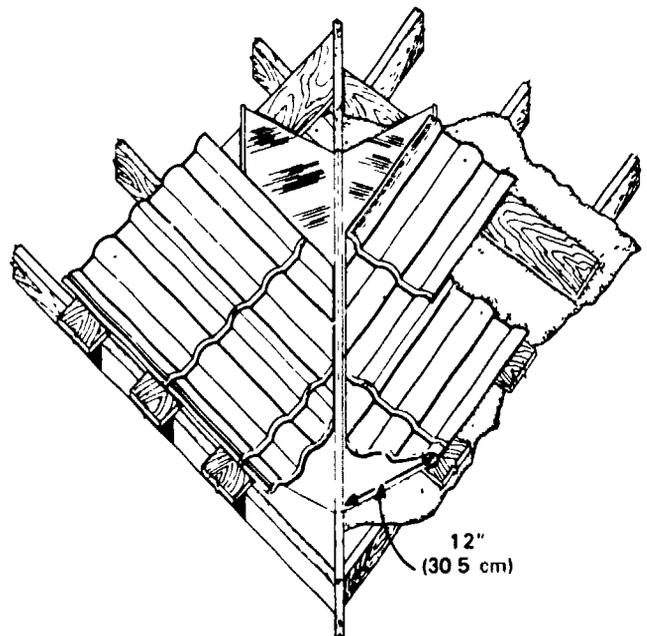


Fig. 6-10. Application of concrete interlocking tile at a closed valley

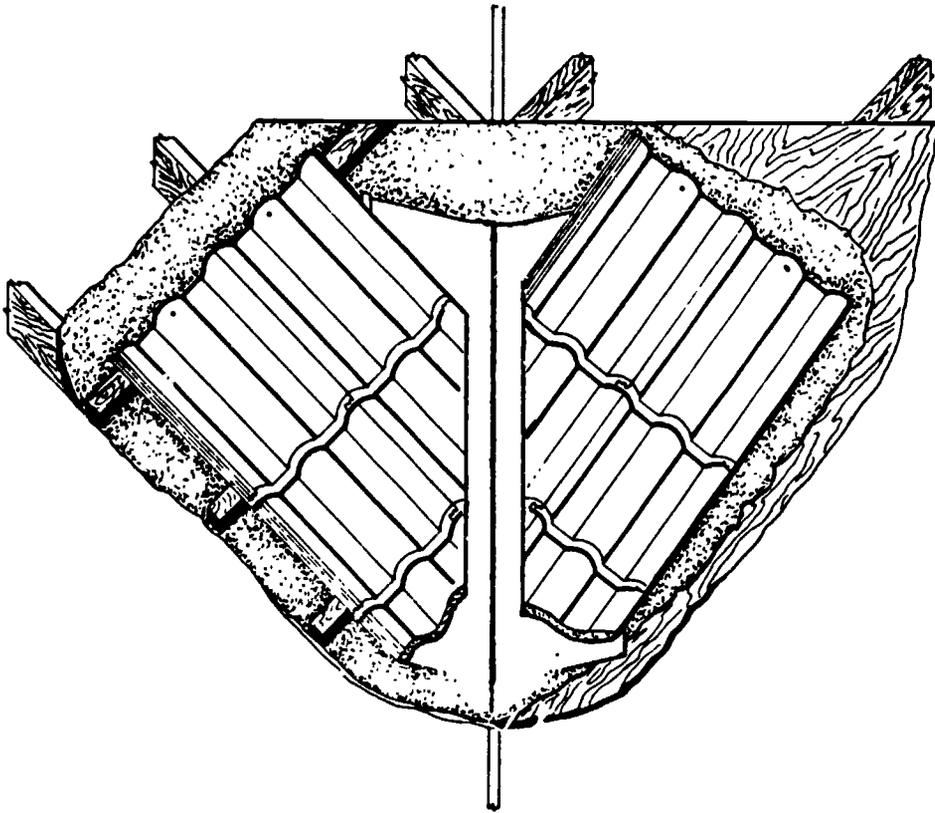


Fig. 6-11. Application of concrete interlocking tile at an open valley

Discard all unusable pieces. All the tiles that have been cut satisfactorily should be set aside until the valley is to be closed.

4. Close the valley on both sides. If tiles are to lie on the metal valley, the lugs must be knocked off so that the tiles can lie flat.

**Open valleys.** The open valley has an opening approximately 4 inches (10.2 centimetres) wide that allows any accumulation of leaves to be carried downward to the eave during rainfall.

The procedures for cutting tiles for an open valley are very similar to those used to cut tiles for a closed valley. However, the cut should be made 14 inches (35.6 centimetres) from the splash diverter (instead of 12 inches [30.5 centimetres]). Such a cut provides for a 2-inch (5.1 centimetre) opening on each side of the diverter. It is recommended that the exposed valley metal be painted to match as nearly as possible the color of the tile.

#### Cutting Tiles for Hips

Cutting concrete tiles for hips is a rather simple operation. The most important aspect of cutting tiles for a hip is to cut them as close as possible to the hip nailing board (Fig. 6-12).

The procedure for cutting tiles before the hip nailing board is installed is as follows:

1. Lay field tiles (broken or chipped tiles if possible) into one side of the hip, allowing them to extend beyond the peak of the hip.
2. With a masonry cutoff saw, make a continuous cut from the top of the hip to the bottom, using the hip rafter edge as a guide. This cut can be made "visually"; that is, it can be made without benefit of a chalk line. However, using a chalk line is recommended because if tiles slide during cutting, the chalk line can be used as a guide.
3. Discard unusable pieces of tile, and repeat the procedure on the other side of the hip.
4. After all cuts have been made, install a 2-inch by 3-inch (5.1-centimetre by 7.6-centimetre) nailing board down the center of the hip.
5. Push the tiles as tightly as possible against the nailing board. The tiles will be secured in place with mortar when the hip ridge tiles are installed. (The tiles cut for the hip can also be notched with a saw and nailed into place.)

If the hip nailing board has been installed before the cutting of the tile for the hip, the roofer should use the following procedure:

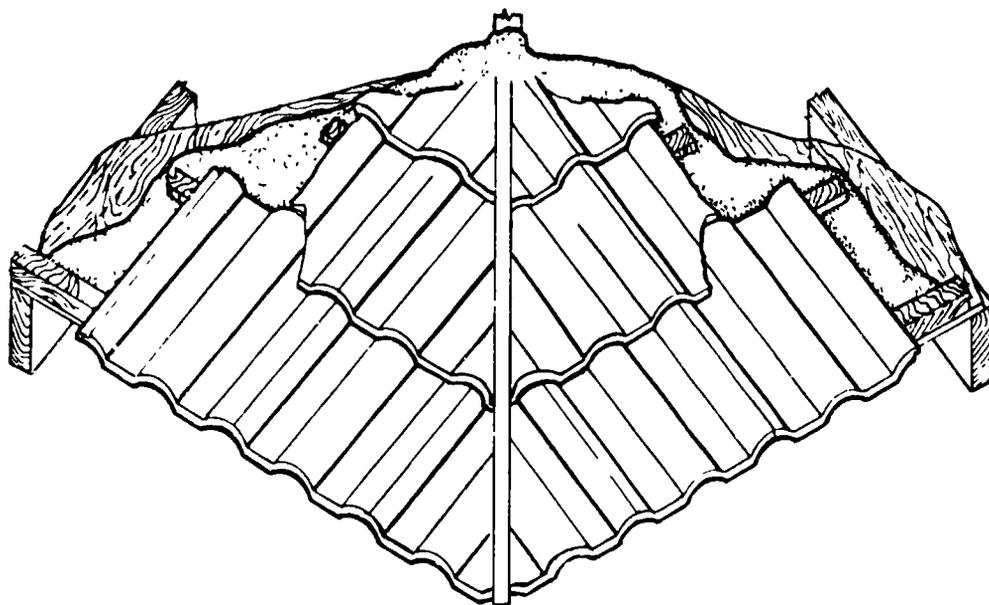


Fig. 6-12. Application of concrete interlocking tile on a hip

1. Lay field tiles to the hip nailing board.
2. At the top and bottom of the hip, measure 12 inches or 24 inches (30.5 centimetres or 61 centimetres) into the hip and mark. (Use whichever measurement ensures that every course will have a cut tile.) Be sure to measure parallel to the tile courses. Snap a chalk line between the two points.
3. Cut along the chalk line.
4. Close the hip.

#### Cutting Tiles to Accommodate Vent Pipes

When making a cut for a vent pipe (Fig. 6-13), the roofer must first determine the center of the area where the pipe is to be positioned and the diameter of the pipe. He or she cuts into the tile from the side that will be closest to the pipe. Two cuts should be made.

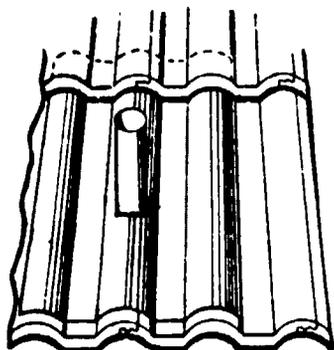


Fig. 6-13. Concrete interlocking tile cut to accommodate a vent pipe

The distance between the two cuts should be slightly larger than the diameter of the pipe so that the cut tile can be fitted around the pipe. The depth of the cuts must be sufficient to allow the entire pipe to fit into the area from which tile will be removed (at least slightly larger than the diameter of the pipe). Finally, the piece from the tile is cut and removed. *NOTE:* Making openings by breaking the tile with a hammer is not recommended because the resulting "cut" is unsightly and generally not enough tile is left to support the plumbing safely.

#### Cutting Tile for Gables

The procedure to be followed in cutting tiles for a gable depends on the type of gable (straight or tapered) and the type of bond used in the laying of the tile (straight or broken).

*Straight gables.* If tiles are being laid with a straight bond on a straight gable and if they are centered properly, no cutting will be required at the gable ends. If tiles are being laid with a broken bond on a straight gable, the last tile in every other row will have to be cut. The roofer should be sure to use two or three tiles to cushion the tile being broken. The tile is hammered up and down along the line of the cut. The edge of the tile at the break will be rough, but it will be covered when the rake tile is applied. This same method can be used when tile is to be laid to a wall, but cutting with a masonry cutoff saw is recommended because a neater cut is made and nothing is used to cover the raw edge where the tile butts against the wall.

**Flared gables.** In cutting tile for a flared gable (Fig. 6-14), the roofer should use the following procedure:

1. Lay tiles to the gable, letting them extend over the end.
2. Snap a chalk line about 1 inch (2.5 centimetres) from the gable end, and cut along the line with a masonry cutoff saw.
3. Pull the tiles back, and install special pan flashing for use on flared gables.
4. Replace the cut pieces of field tile, and install the rake tile.

The procedure used to cut tiles for valleys can also be used to cut tiles for flared gables.

### Sealing of Ridges and Hips

Before beginning to seal ridges and hips, the roofer should make sure that the ridge and hip nailing boards are the correct sizes. Ridge tiles should be laid at the level of the field tiles or slightly above them. Ridge nailing boards should be 2 inches by 3 inches (5.1 centimetres by 7.6 centimetres), and hip nailing boards should be 2 inches by 4 inches (5.1 centimetres by 10.2 centimetres) on roofs with pitches of 4/12 to 5/12.

Next, the spacing between the ridge nailing board and the first sheathing board down from the ridge nailing board must be checked. The space should be big enough for only the head lugs to fit between the sheathing board and the ridge board.

The tiles that are to butt against the hip nailing board should be cut to within  $\frac{1}{4}$  inch (0.6 centimetre)

of the nailing board. Cut pieces that have no head lugs should be fastened and supported to prevent them from sliding or to prevent the head ends from dropping. (A saw can be used to cut slots parallel with the tile course, and a nail can be used to provide support and prevent sliding.)

### Sealing Field Tile to Ridge and Hip Boards

In sealing field tiles to ridge and hip boards with plastic fiber-filled roofing cement, the roofer applies a continuous bead of cement where the field tiles meet the nailing boards. Enough cement must be used to ensure a watertight seal before the ridge and hip tiles are set in place. The roofer should remember that cement will shrink as it dries.

### Installing Ridge and Hip Tiles

Ridge and hip tiles should be nailed to the ridge and hip nailing boards with 10-penny nails, and a continuous bead of roofers mastic should be run over the nail heads and down each side of the ridge and hip tiles before the next ridge and hip tiles are placed (Fig. 6-15). The mastic acts as a seal and adhesive to hold the tiles securely. The amount of lap on V ridge tiles is automatically established by the shoulder on the underside of the tile. Mansard barrel ridges should be lapped a minimum of 3 inches (7.6 centimetres).

### Laying Mortar Under Ridge and Hip Tiles

Mortar must be applied under hip and ridge tiles as shown in Fig. 6-16. If a premixed masonry mortar mix is used, add approximately one-third of a bag of color pigment per bag of mortar mix. The color should approximate as closely as possible the color of the tiles. If mortar is mixed on the job, it should be mixed in the following proportions: one bag of portland cement, 3 cubic feet (0.1 cubic metre) of sand, and one bag of color pigment. Water should not be added until after the pigment has been mixed in. The roofer should use only enough water to achieve a pastelike consistency.

To apply mortar, the roofer should trowel it up under the ridge and hip tiles to provide a wind block in the water course of the field tile. (The roofer should remember that wetting the tiles before applying the mortar is important because otherwise the mortar will not bond properly.) The mortar should be cut back so that it does not extend beyond the edge of the ridge and hip tiles. This will ensure that water dripping off the ridge or hip falls on the field tiles; if it falls on the mortar, it will be absorbed. Care must be taken not to push mortar up beyond the heads of the field tiles. Any mortar blocking the lapped portion of the ridge tiles should be cleaned out with the edge of a trowel. Cutting back and pointing up the mortar can be facili-

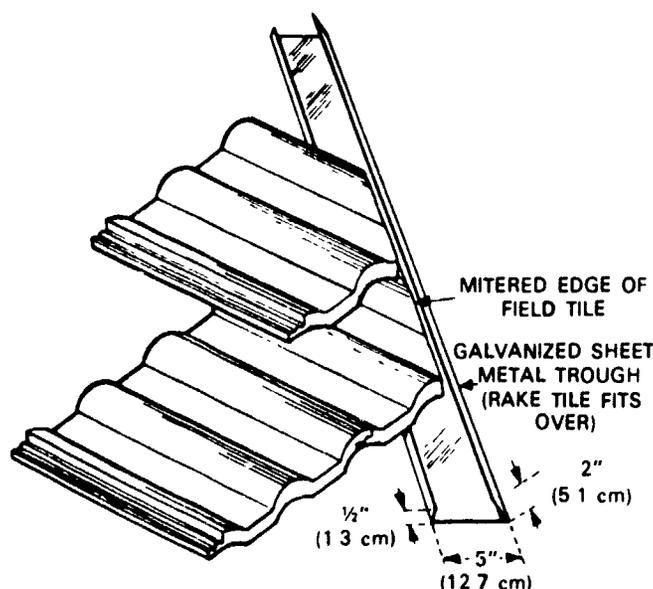


Fig. 6-14. Flared, or tapered (uneven), gable detail

tated by modifying the point of a small mason's trowel to a more rounded shape. This can be accomplished with a metal saw and a file or with a grinder. Tile should be wiped with a rag to remove mortar spots.

After the mortar has set up, but before it has hardened completely, the ridge and hip areas should be

swept to remove excess mortar from the edges of the tiles and to give the mortar a light broom finish. Weep holes should be poked in the mortar at the bottoms of both water courses on each field tile. This will allow for drainage of any water that might get behind the mortar, by absorption or in some other manner.

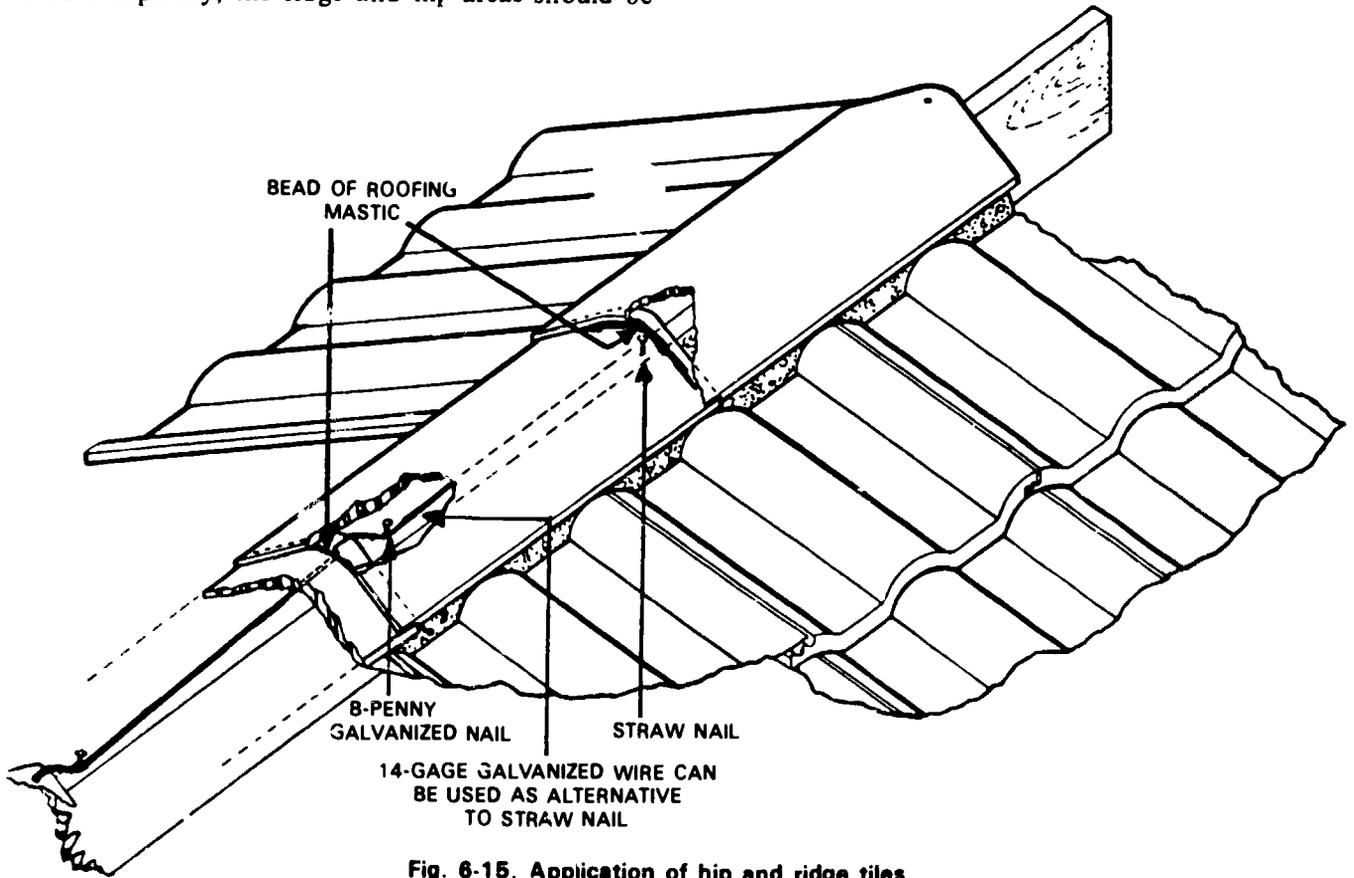


Fig. 6-15. Application of hip and ridge tiles

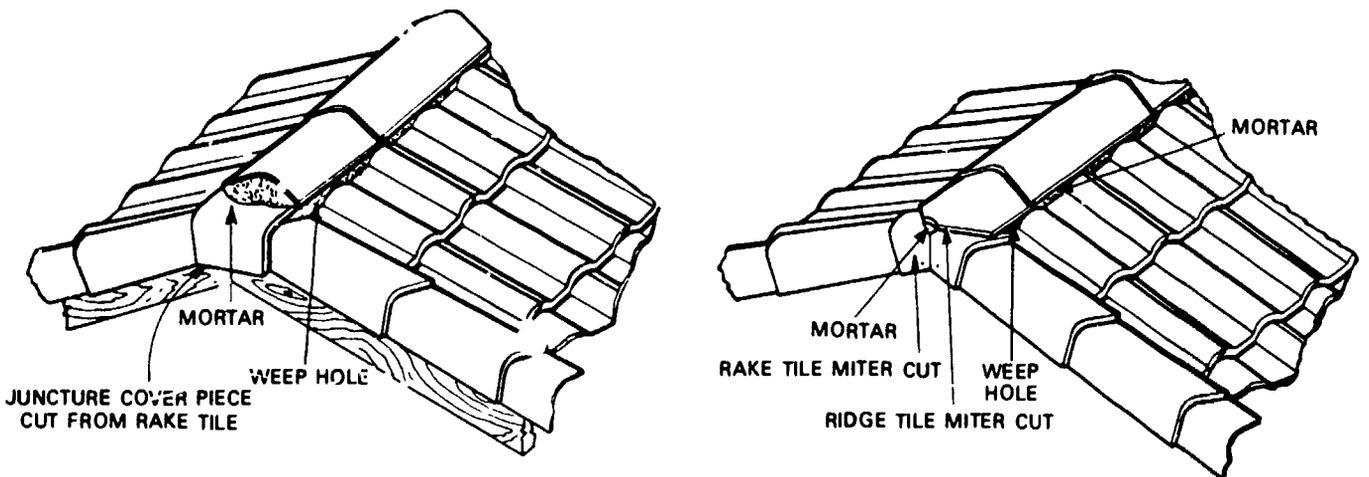


Fig. 6-16. Application of mortar under ridge and hip tiles

## RIGID ROOFING

### TOPIC 7—SLATE AND RIGID ASBESTOS SHINGLES

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Distinguish between slate and rigid asbestos shingle
- Describe the preparation of a roof for slate or rigid asbestos shingles.
- Demonstrate the application of slate and rigid asbestos shingles.

#### Slate

The procedures for installing slate (Fig. 7-1) are discussed in the following sections.

#### Roof Preparation

In preparing a roof for application of slate, the roofer should do the following:

- Broom sweep the deck surface clean.
- Make sure the deck is nailed properly.
- If the deck is made of plywood, make sure that all joints are blocked.
- Cover knotholes with tin.
- Determine the thickness of the overhang, and make sure that nails will not penetrate exposed sheathing.

#### Underlayment

On roofs that have a pitch of 3/12 or a pitch greater than 3/12, a one-ply 15-pound (6.8-kilogram) felt nailed dry, with a 6-inch (15.2-centimetre) head lap and a 4-inch (10.2-centimetre) side lap should be used. Slate is not recommended for use on roofs with pitches of less than 3/12.

#### Loading of Slate on the Roof

Eave starter slate should be loaded near the eaves. Because slate pieces vary in size, estimating the amount to place in each stack is impossible. However, the larger the slate is, the fewer the stacks required.

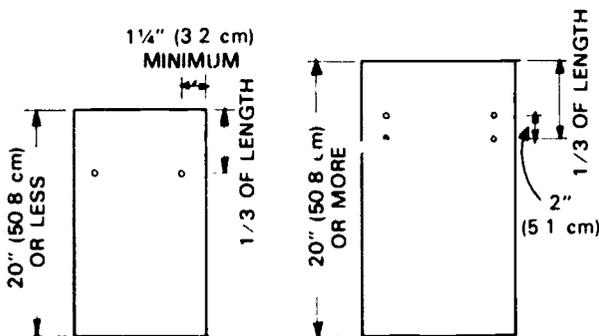


Fig. 7-1. Slate

#### Application

To begin applying slate, the roofer nails a 1-inch by 1-inch (2.5-centimetre by 2.5-centimetre) booster board along the eave of the roof deck. The slate used for the starter course is usually half the length of the field slate. A 1-inch (2.5-centimetre) drip edge is recommended.

The second course should be laid even with the starter course. Because of the various sizes of slate, describing the application course by course is difficult. A general rule to follow, however, is that the joints should be offset at least 3 inches (7.6 centimetres) from the joints of the course below. When slate of random widths is used, the overlapping slate should be jointed as near the center of the under slate as possible. If slate of one size is used for the job, every other course will begin with a half-slate. The roofer should be sure to have a 1-inch (2.5-centimetre) drip edge on gable roofs. A typical pattern of field slate installation is shown in Fig. 7-2.

An alternate method of application (Fig. 7-3) is to use an 18-inch (45.7-centimetre) 30-pound (13.6 kilogram) cap sheet between courses so that the nail holes of the last course will be covered.

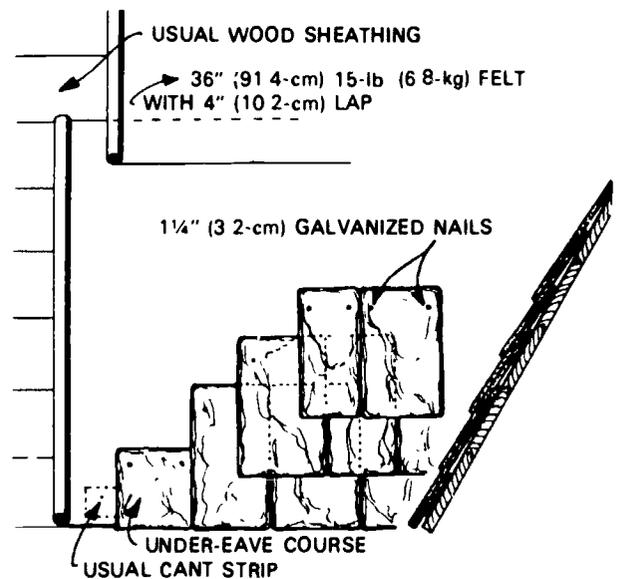


Fig. 7-2. A typical application of field slate

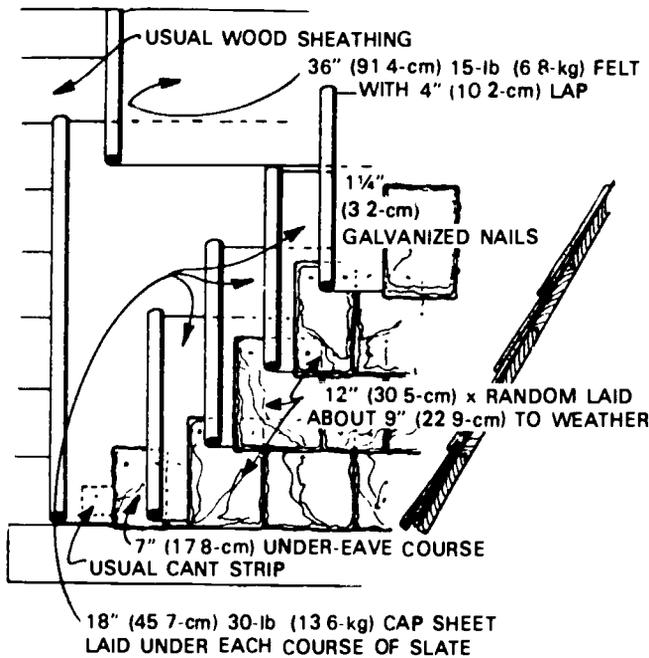


Fig. 7-3 Alternate method of applying field slate

Slate should be secured with 1¼-inch (3.2-centimetre) galvanized nails. The nail holes should be no farther from the head of the slate than one-third the length of the slate. The nails should be driven so that they just touch the slate; they should not draw the slate down.

*Laying slate at ridges.* Slate may be applied to saddle ridges or to comb ridges. On a saddle ridge (Fig. 7-4), one side of the roof extends just the width of the slate past the ridge; the other side butts against it to form a smooth, clean, even line. The comb ridge (Fig. 7-5) is constructed in basically the same way except that one side extends 1⅛ inch (2.9 centimetres) past

the other. All nail holes and ridge courses shall be set with elastic cement to provide a waterproof seal at the ridge joint. A bead of elastic cement should be set on the ridge line as shown in Fig. 7-5.

*Laying slate to valleys.* In applying slate at an open valley, the roofer should miter cut the slate evenly at the angle of the valley. He or she should allow for a 2-inch (5.1-centimetre) opening at the ridge and gradually increase the opening 1 inch (2.5 centimetres) every 8 feet (2.4 metres) of valley.

The closed valley must be miter cut at the angle of the valley and in line with the center of the valley. A sheet metal valley must be installed in all valleys. Each course of sheet metal is applied using a 3-inch (7.6-centimetre) lap on the ends. The butt end of the valley must be set back so that it will not be visible. The metal should extend 12 inches (30.5 centimetres) to the sides and should be nailed on the outer edges. In nailing the edges, the roofer must be sure that the nails do not penetrate the valley.

**Rigid Asbestos Shingles**

The following sections contain a discussion of rigid asbestos shingles (Fig. 7-6) and their application.

**Roof Preparation**

The procedures for preparing a roof for application of rigid asbestos shingles are the same as those described earlier in this topic for slate. The apprentice should review the procedures on page 47 before reading further.

**Underlayment**

Listed below are some general recommendations for underlayment to be used with rigid asbestos shingles.

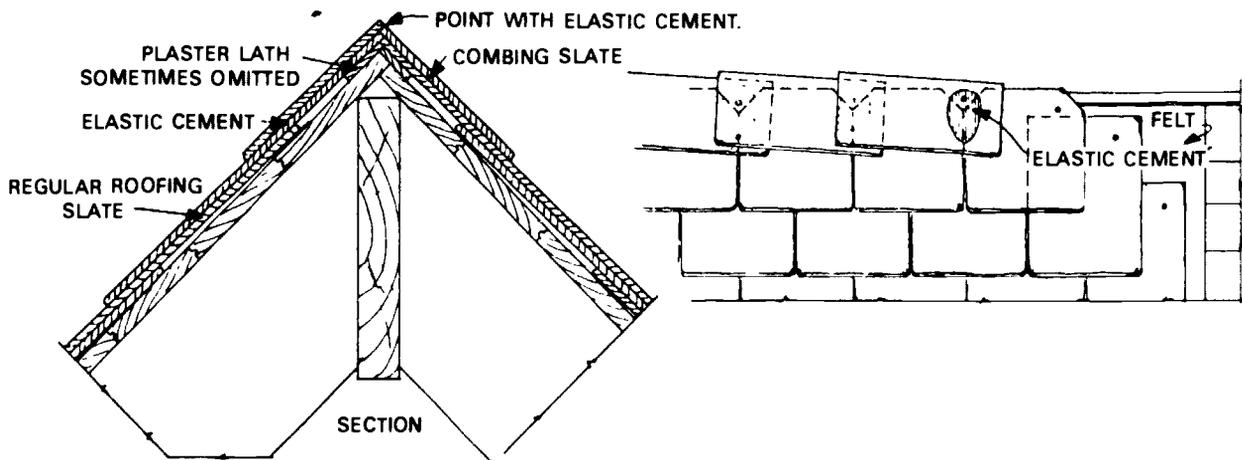


Fig. 7-4. Application of slate on a saddle ridge

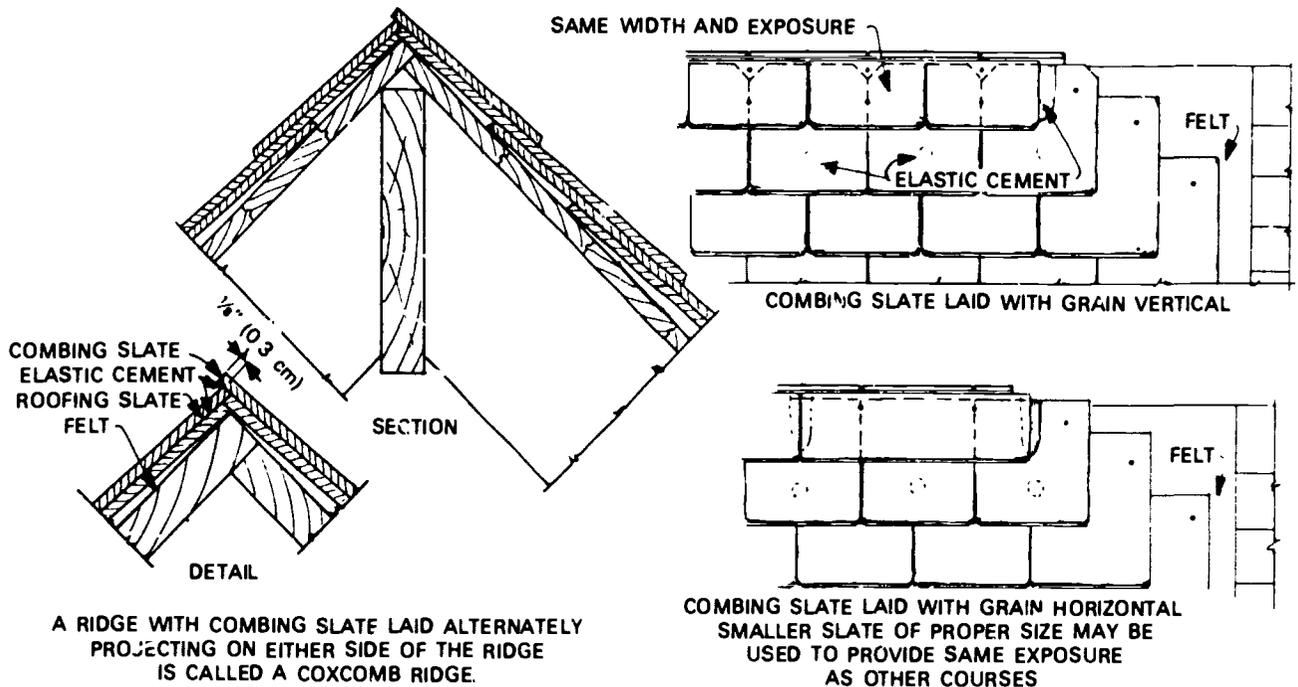


Fig. 7-5. Application of slate on a comb ridge

- On roofs of 3/12 pitch up to 5/12 pitch, use two-ply 15-pound (6.8-kilogram) asbestos or asphalt felt dry nailed.
- If the roof has a 5/12 pitch, use one-ply 15-pound (6.8-kilogram) asbestos or asphalt felt dry nailed.
- For nonwood decks with a 5/12 pitch or greater, use one-ply 15-pound (6.8-kilogram) asbestos or asphalt felt with a one-ply 15-pound (6.8-kilogram) felt between each course.

In areas where the mean temperature for January is 25° F (-3.9° C) or less, an eave flashing of black plastic cement should be applied. This flashing should be applied with a trowel at the rate of 2 gallons per 100 square feet (7.6 litres per 9.3 square metres), and it should be applied over the first layer of underlayment. The second layer of underlayment should be embedded in the flashing. On roofs whose pitch is 5/12 or less, this two-ply flashing must extend from the eaves to a point 24 inches (61 centimetres) beyond the vertical plane of the inside wall extended (beyond the point at which the inside wall would project through the roof if the inside wall were extended upward). On roofs with a pitch greater than 5/12, this flashing need extend only 12 inches (30.5 centimetres) beyond the plane of the inside wall. If single-ply underlayment is recommended, an additional layer of felt will be required with this flashing up to the point specified.

**Application**

To begin applying rigid asbestos shingles, the roofer nails a 1/4-inch by 2-inch (0.6-centimetre by 5.1-centimetre) booster (cant) strip at the eaves. Some manufacturers recommend the use of a metal drip edge nailed over the booster strip.

The starter course shingles should be secured to the roof deck with galvanized needle point nails, screw thread nails, or ring barb nails and should be covered by underlayment as shown in Figs. 7-7 and 7-8. The nails should penetrate at least 3/4 of an inch (1.9 centimetres) into the deck. (They may also penetrate through the deck.)

The first course should be laid over the starter course and should begin with a half shingle. The

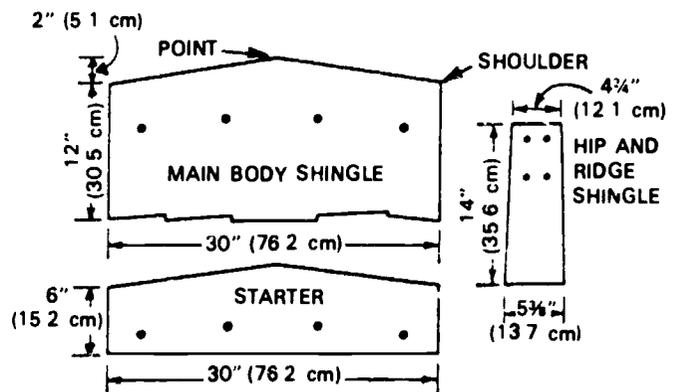


Fig. 7-6. Rigid asbestos shingles

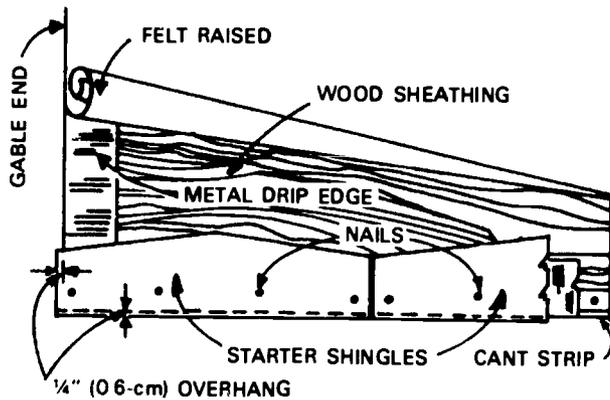


Fig. 7-7. Application of starter course of rigid asbestos shingles

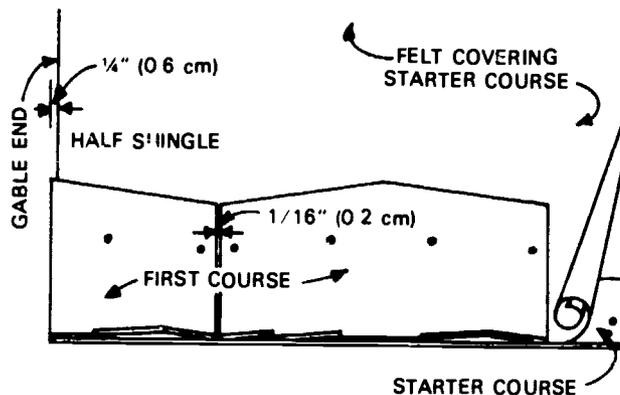


Fig. 7-8. Application of first course of rigid asbestos shingles

second course should begin with a full shingle, the third with a half shingle, the fourth with a full shingle, and so on. Fig. 7-9 shows the application of rigid asbestos shingles at the second and succeeding courses.

At the top of each shingle is a point that is used to maintain the vertical alignment. This point will be in line with the joint of the last shingle it is laid on. The roofer must remember to nail all shingles securely, but must be careful not to overdrive the nails. Black plastic cement is acceptable for pointing hips, ridges, and so on. *NOTE:* In high wind areas the first course must be started with a full shingle; therefore, the first starter shingle is a half-width starter.

On hips and ridges (Figs. 7-10 and 7-11),  $\frac{3}{8}$ -inch by  $1\frac{1}{4}$ -inch (1.6-centimetre by 3.2-centimetre) furring strips should be installed on each side of the hip or

ridge. The furring strips should be shimmed up about  $\frac{1}{4}$  inch (0.6 centimetre) at the starting point. The main roof shingles should be cut to butt against the furring strips, and the furring strips should be covered with two thicknesses of felt. Half hip and ridge shingles should be installed as starters and secured with two nails. The roofer should continue with full hip and ridge shingles, leaving a 7-inch (17.8-centimetre) exposure. The side laps should be alternated. The hip and ridge shingles should be embedded in black plastic cement at the angle of the hip and the ridge.

Figure 7-12 shows how rigid asbestos shingles should be applied at valleys. A slate and asbestos shingle cutter is shown in Figure 7-13. Figure 7-14 shows a shingle and slate ripper.

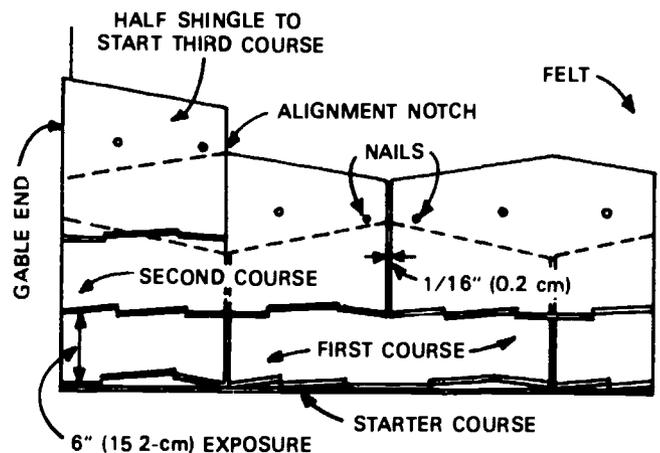


Fig. 7-9. Application of rigid asbestos shingles at the second and succeeding courses

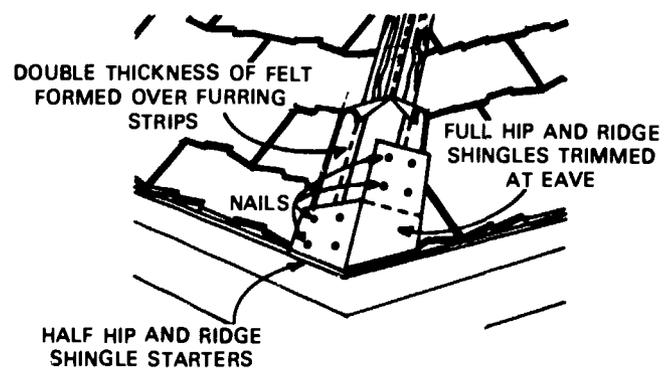


Fig. 7-10. Application of rigid asbestos shingles at a hip

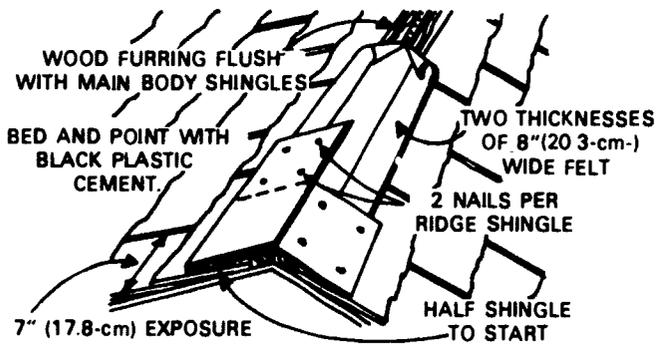


Fig. 7-11. Application of rigid asbestos shingles at a ridge

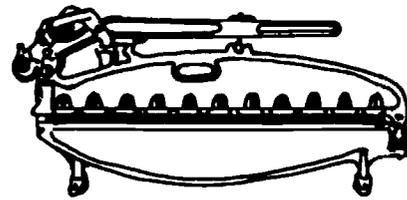


Fig. 7-13. Slate and rigid asbestos shingle cutter



Fig. 7-14. A shingle and slate ripper

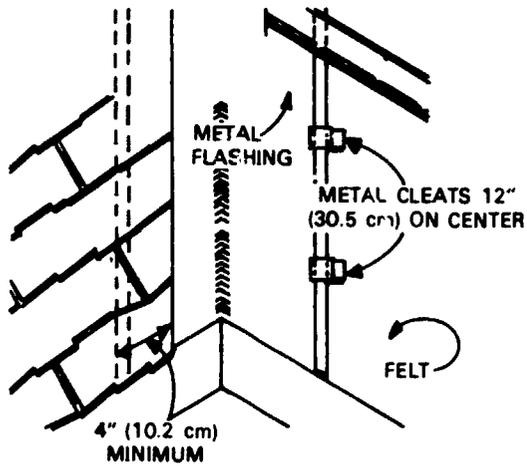


Fig. 7-12. Application of rigid asbestos shingles at metal flashing

## RIGID ROOFING

### TOPIC 8—OTHER RIGID ROOFING MATERIALS

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- Distinguish among the other rigid roofing materials.
- Describe the roof preparation for one or more of the rigid roofing materials described in this topic.
- Describe the procedure for applying one or more of the rigid roofing materials described in this topic.

#### Steel Tile

The following sections contain information about steel tile. Fig. 8-1 shows full tiles and a closure strip.

#### Roof Preparation

In preparing a roof for application of steel tile, the roofer should do the following:

- Broom sweep the deck surface clean.
- If plywood is used for the deck, check to see that it is properly nailed and blocked. (Plywood under steel tile must be at least  $\frac{1}{2}$  inch [1.3 centimetres] thick.)
- Cover knotholes with tin.
- Make sure the deck is nailed properly.
- Determine the thickness of the overhang, and make sure that nails will not penetrate exposed sheathing.

#### Underlayment

Steel tile should not be used on a roof with a pitch of less than  $3\frac{1}{2}/12$ . The underlayment used with steel tile should be a one-ply 30-pound (13.6-kilogram) felt

blind nailed with a 6-inch (15.2-centimetre) head lap and a 4-inch (10.2-centimetre) side lap.

#### Chalk Lines

The first horizontal chalk line should be snapped 12 inches (30.5 centimetres) from the eave. The remaining horizontal lines should be spaced 10 inches (25.4 centimetres) apart. Vertical lines should be 12 inches (30.5 centimetres) on center to allow for the closure strips. In establishing vertical lines, the roofer must be sure to allow for a 1-inch (2.5-centimetre) drip edge.

#### Loading of Steel Tile on the Roof

In loading steel tiles on the roof, the roofer should load five bundles of full tiles per square, beginning at the fourth course. Half tiles should be loaded so that they may be used at every other course, and the closure strips should be placed between the bundles.

#### Application

The application of steel tile is illustrated in Fig. 8-2. Steel tile must be applied with the closure strip under each tile flange so that no flange bears upon the felt.

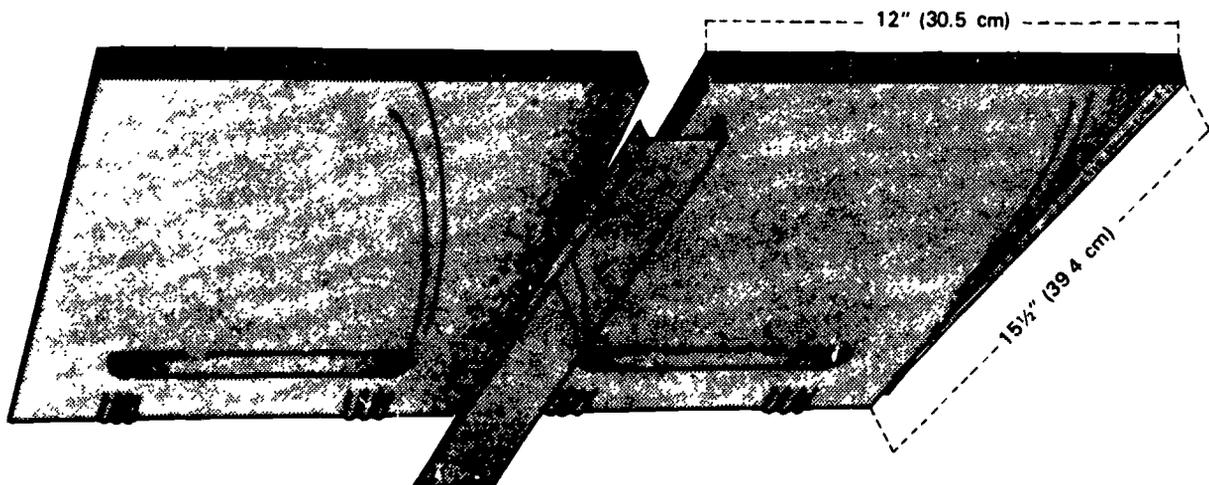


Fig. 8-1. Steel tile

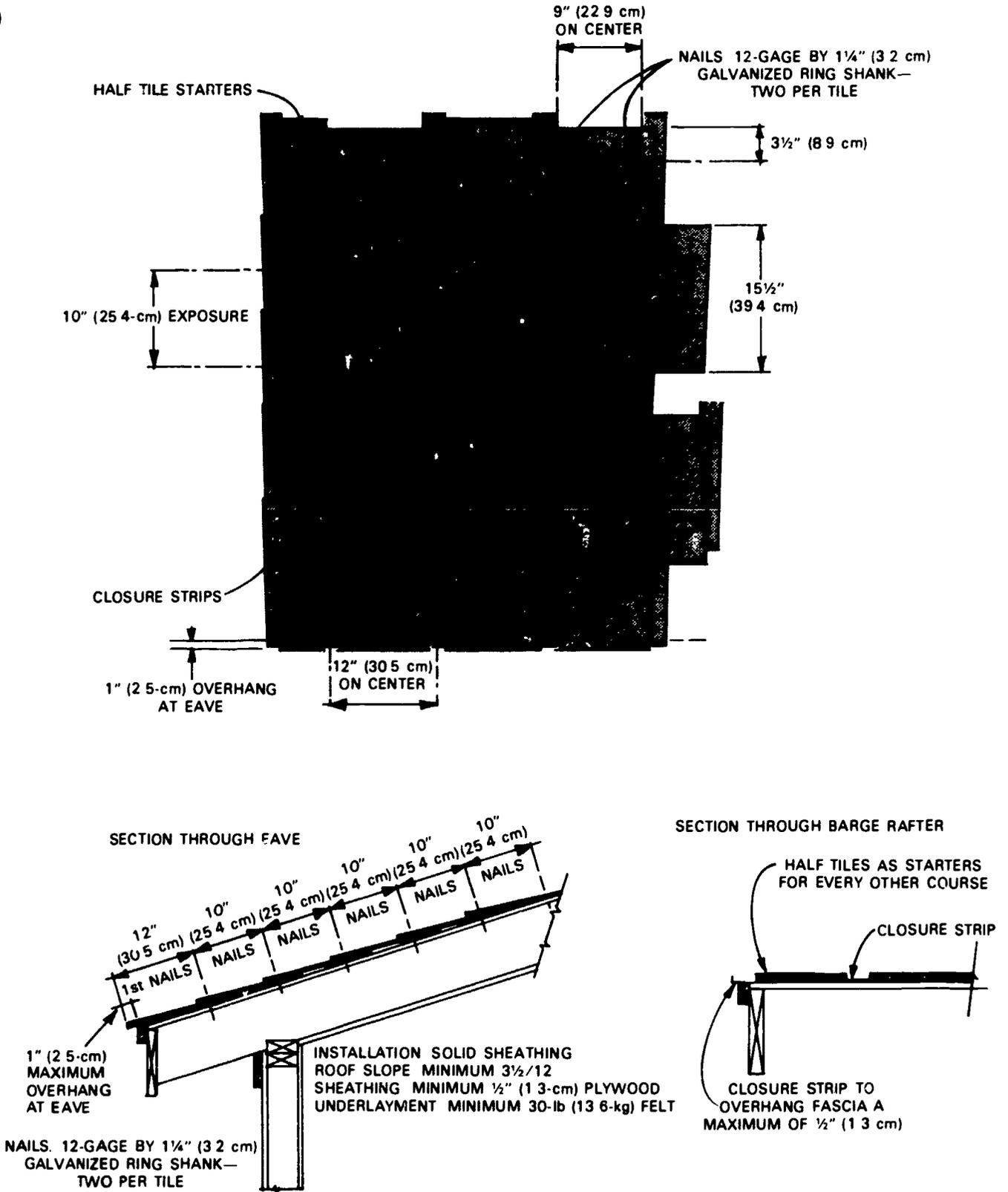


Fig. 8-2 Application of steel tile

Each tile is fastened to the sheathing with two 12½-gage by 1¼-inch (3.2-centimetre) galvanized ring shank nails. Application should begin at the rake with a closure strip overhanging the fascia by a maximum of ½ inch (1.3 centimetres). A half tile should be used against this closure strip on every other course to achieve the proper pattern.

*Laying steel tile to valleys.* Valley flashing used with steel tile must be made of no less than 28-gage galvanized corrosion-resistant metal. The metal should extend at least 8 inches (20.3 centimetres) in both directions from the center line. It must have a splash diverter rib at least ¾ inch (1.9 centimetres) high at the flow line formed as part of the flashing. Sections of flashing must have an end lap of at least 4 inches (10.2 centimetres).

*Laying steel tile at hips and ridges.* Hip and ridge caps are formed by clipping the flange of a standard 12-inch-wide (30.5-centimetre-wide) tile and folding the tile to the angle at which it conforms to the roof pitch (Fig. 8-3). These should be applied with an exposure of 8 inches (20.3 centimetres).

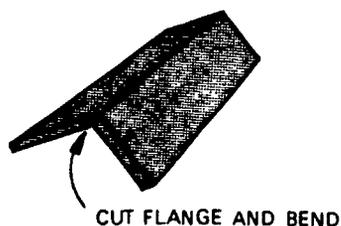


Fig. 8-3. Formation of hip and ridge caps from standard steel tiles

Metal gutters used with steel tile should be corrosion resistant. Steel tile oxidizes and turns brown. If no gutter is used, water will carry rust and cause stains on the areas below the roof.

### Aluminum Shakes

Only aluminum materials (anchor clips, nails, flashings, and so on) should be used to install aluminum shakes or shingles because aluminum corrodes in contact with steel and ferrous metals rust in contact with aluminum.

### Roof Preparation

In preparing a roof deck for installation of aluminum shakes, the roofer should do the following:

- Broom sweep the deck surface clean.
- Make sure that the deck surface is properly nailed.
- If plywood is used, be sure that it is blocked.
- Cover knotholes with tin.

- Determine the thickness of the overhang, and make sure that nails will not penetrate exposed sheathing.

### Underlayment

Aluminum shakes are not recommended for use on roofs with a pitch of less than 2½/12. The following general rules should be followed in applying underlayment beneath aluminum shakes:

- For roofs with a pitch of 2½/12 up to 4/12, use a two-ply 30-pound (13.6-kilogram) felt mopped at 25 pounds (11.4 kilograms) per square or a three-ply 15-pound (6.8-kilogram) felt mopped at 25 pounds (11.4 kilograms) per square. No glaze coat should be used in either case.
- If the pitch of the roof is 4/12 or greater, use a two-ply 30-pound (13.6-kilogram) felt nailed dry with aluminum nails.

If the roof is not too steep, the roofer should install valley metal with hot asphalt, using a 30-pound (13.6-kilogram) overlay on the outer edges of the valley.

### Loading of Aluminum Shakes on the Roof

Aluminum shakes include several components, each of which should be placed as close as possible to where it will be used: eave and gable fascia trim, eave starters, hip caps, gable starters, flashings, ridge caps, and anchor clips at a rate of 120 per square. Field shakes should be loaded one bundle per square.

### Application

The roofer begins by installing the eave and gable fascia trim and then the eave and gable starter shakes, terminating at least 7 inches (17.8 centimetres) from valleys. He or she then hooks 10-inch by 48-inch (25.4-centimetre by 121.9-centimetre) shakes over the eave and gable starters. Each shake has a male and female interlocking joint. Each piece should be secured with three anchor clips nailed with aluminum nails. If necessary, the left-hand side of the shakes should be cut. The application of aluminum shakes is shown in detail in Fig. 8-4.

*Applying aluminum shakes at hips.* To apply aluminum shake caps at hips (Fig. 8-5), the roofer must miter cut each shake and use gable starter strips secured to the hip to hold the caps.

*Applying aluminum shakes at the ridge.* Application of aluminum shakes at the ridge requires that the top flange of the shake be flattened or removed so that the ridge caps may lie flat with the deck. The caps are secured on each side with anchor clips as shown in Fig. 8-6.

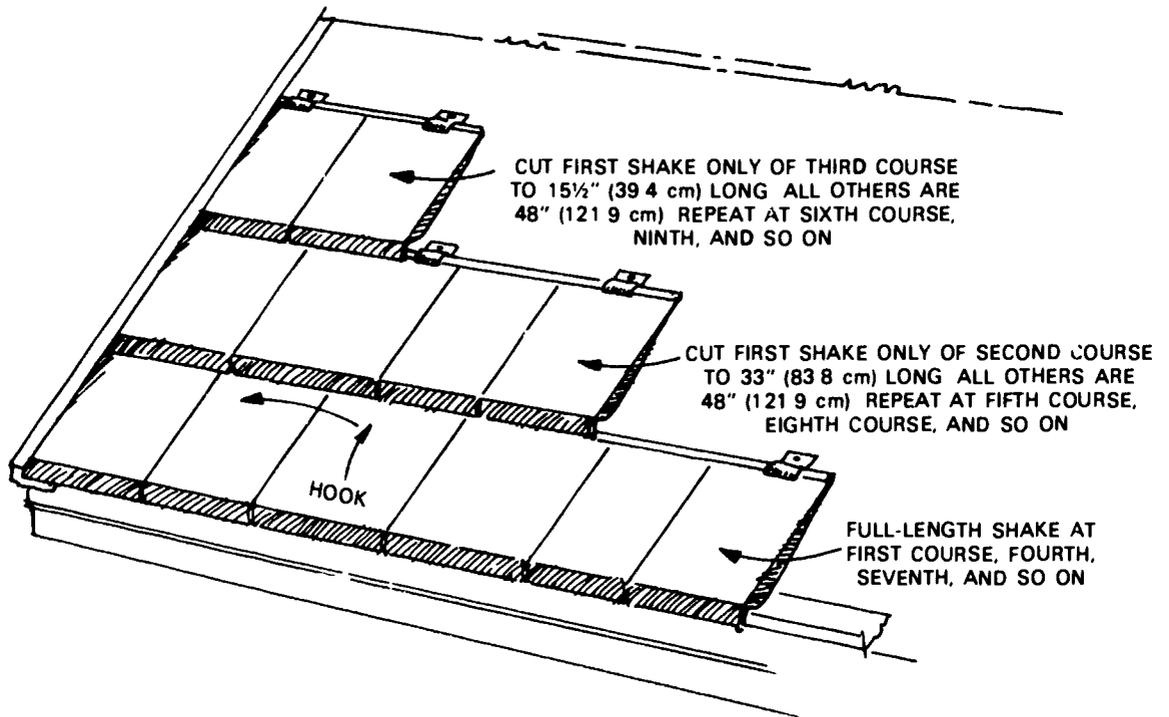


Fig. 8-4. Application of aluminum starter and field shakes

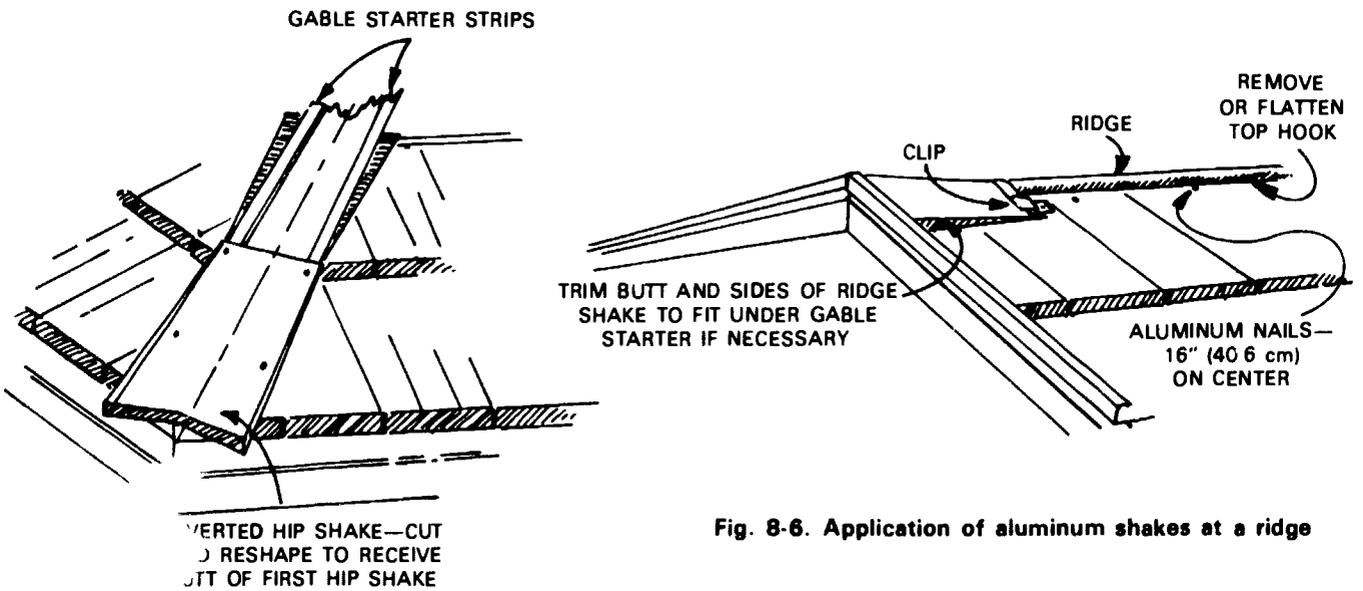


Fig. 8-6. Application of aluminum shakes at a ridge

Fig. 8-5. Application of aluminum shake caps at a hip

### Aluminum Shingles

As with aluminum shakes, only aluminum nails, flashings, and the like should be used with aluminum shingles. The shingles are usually 9 inches by 12 inches (22.9 centimetres by 30.5 centimetres). A dry sheet of 30-pound (13.6-kilogram) felt is sufficient for underlayment. When nailing aluminum shingles, the roofer must break the joints at least 3 inches (7.6 centimetres). Hip and ridge shingles are field shingles bent to the angle of the hip and ridge.

### Copper Sheets

Roofing made of sheet copper is durable, providing it is not installed on or close to a metal that will allow electrolytic action to occur. Copper sheeting is frequently called for by architects because of its durability and the fact that the green oxide patina that is formed on its surface after weathering lends an aesthetic effect to certain buildings. This material is usually applied by sheet metal workers since the sheet joints must be soldered and the material must be bent to conform to the roof structure.

### Plastic Roofing

Normally, plastic roofs are copies of products such as shakes, mission tile, S tile, and shingles. Usually, the color fades very rapidly so that the roof looks old and weathered before its time. Plastic roofing materials are usually available in large sections, such as 2 feet by 4 feet (61 centimetres by 121.9 centimetres), for fast application. To date, however, they have not proved to be dependable products. Plastic roofing is most common in the form of corrugated, curved, or flat sheets used as patio covers or skylights.

### Wood Shingles and Shakes

The application of wood shakes or shingles will be discussed in detail in the workbook on shingling; however, since these materials are classified as rigid roofing materials, a brief description is provided here.

Cedar shingles vary in grade, size, texture, and cut. Quality is graded with numbers ranging from 1 to 4. No. 1 shingles, made from 100 percent vertical-grain heartwood, are the best. No. 2 shingles are a good grade shingle that allows minimal flat grain and sap-

wood. No. 3 is a utility grade shingle, and No. 4 is used for undercourses and on interior walls. Common lengths are 16, 18, and 24 inches (40.6, 45.7, and 61 centimetres); widths vary from 3 to 14 inches (7.6 to 35.6 centimetres). It is possible to obtain shingles of one width (called "dimension shingles"), but they are usually very expensive.

Wood shakes resemble large, thick hand-split shingles. They are available in three variations: (1) hand-split and resawn; (2) taper-split; and (3) straight-split.

Hand-split and resawn shakes are thin at one end, thick at the other, rough on the face, and smooth on the back.

Taper-split shakes are also thick at one end and thin at the other, but because they are not resawn, both faces are rough.

Straight-split shakes are uniformly thick and are rough on both sides.

All wood shakes are No. 1 grade. The thickness varies from  $\frac{3}{8}$  inch (1 centimetre) to  $\frac{1}{2}$  inch (1.9 centimetres); the length may be 15, 18, or 24 inches (38.1, 45.7, or 61 centimetres). Widths are random. Not all types of shakes are available in all sizes.

Wood shakes or shingles should not be applied on roofs with less than a 3/12 pitch without a waterproof membrane beneath them. Courses of shakes should also have felt laced between them.

### Solar Roof Panels

Because of the need for energy conservation, solar energy is being studied extensively as a low cost method of producing electricity, hot water, and heat for homes and commercial buildings. Solar roof panels, which look like skylights, have pipes running through them to trap the solar heat.

Many of the crafts are claiming jurisdiction for installation of solar panels, but it is the roofer who must ensure that the units are watertight. The installation of units on already existing roofs and reroofing work where solar panels have already been installed can be especially troublesome. As the use of solar energy increases, an increase in reroofing jobs can be expected to increase also. On the other hand, solar panels installed on new structures greatly reduce the area that must be roofed.

# Instructional Materials

## Materials Required for Each Apprentice

*CAL/OSHA, State of California Construction Safety Orders* (Current edition). Los Angeles: Building News, Inc. (Orders to: Building News, Inc., 3055 Overland Avenue, Los Angeles, CA 90034.)

*Uniform Building Code* (Current edition). Whittier, Calif.: International Conference of Building Officials. (Orders to: International Conference of Building Officials, 5360 S. Workman Mill Road, Whittier, CA 90601.)

# Glossary

The definitions of terms included in this glossary are those pertinent to the roofing trade and are not necessarily those found in standard dictionaries. Some of the terms included are colloquial in nature and are used with the meanings applicable only to the roofing trade.

- A-frame.** A portable frame built in the shape of a letter "A" and used by roofers to hoist materials.
- Apex.** The point, tip, or summit of anything; the highest point of any roof or structure.
- Arch.** A curved or pointed structural member that is supported at the sides or ends; to cover with a curved structure or to form a bent top or covering.
- Architect.** One who plans or designs buildings.
- Architecture.** The art or science of designing buildings; the style of a building.
- Asbestos.** A fibrous, noncombustible mineral used to make fire-retardant roofing.
- Asphalt.** A brownish-black, natural petroleum residue used in applying roofing.
- Backing.** Lumber placed behind or between other members to give support and strength.
- Base sheet.** The first layer of roofing applied on the deck. Also, a dry or slip sheet.
- Beam.** A long piece of timber or iron used to support the rafters of a building; a horizontal timber or support.
- Bevel.** To give a sloping edge; to slant or incline. (T bevel: a tool used to test the accuracy of beveled edges.)
- Boom.** A strong chain, cable, or line; a long pole attached to a derrick to steady or guide in hoisting.
- Brace.** A piece of wood or other material that holds anything tightly or supports it firmly; a prop.
- Butter.** To smooth on plastic with a trowel.
- Building code.** Governmental rules and regulations for building.
- Cable.** A heavy rope or chain.
- Canopy.** An overhanging covering.
- Cantilever.** A projecting beam supported at only one end.
- Caulk.** To make watertight by plugging with mastic.
- Chalk line.** A heavy string or cord used for lining purposes.
- Chicken ladder.** A lightweight ladder that can be hung over the ridge for work on a steep roof.
- Circumference.** The perimeter of a circle; a line that bounds a circular plane surface.
- Cleat.** A strip of wood or metal fastened across other materials for additional strength; may be nailed against the wall for supporting an object.
- Concealed gutter.** An eaves trough installed or lowered into the roof in such a way that it is invisible.
- Connection.** The act or means of joining or uniting.
- Coping.** The top covering of a wall; may be metal, tile, masonry, or wood.
- Cornice.** A horizontal molded projection at the top of a building; also, the plastered underside of the eaves.
- Counterflashing.** Flashing that extends over another flashing.
- Course.** A continuous row or layer of shingles or other roofing material.
- Cupola.** A hemispherical roof; a small structure above the roof.
- Curb.** A protective rim.
- Cured.** Completely dry; moisture free.
- Debris.** Accumulated rubbish, trash, and fragments of roofing.
- Deck.** The roof surface to be covered; a small platform used for walking.
- Derrick.** A framework, with a long beam, ropes, gear, and pulleys, used for hoisting heavy weights.
- Detail.** One of the minor parts into which a building may be divided; a drawing of such a part.
- Diagonal.** Crossing obliquely as from corner to corner.
- Diameter.** A line through the center, as of a circle or sphere, terminated at the boundary thereof.
- Diverter.** A piece of metal bent at right angles to change the flow of rain water.
- Dormer window.** A vertical window rising from a sloping roof.
- Downspout.** A pipe or conductor to carry the water from a roof.
- Drain.** A pipe to drain water from the roof.

- Drip.** Roofing extended over the edge of a roof; a projecting member shaped to throw off rain.
- Dutchman.** A piece of roofing placed or fitted over a poorly made corner or cut.
- Eaves.** The projecting lower edge of a roof.
- Eaves trough.** A gutter along the eaves of a roof for carrying off rain water.
- End lap.** The material lapped at the point at which the ends of two pieces of roofing material are joined.
- Expansion joint.** A metal flashing installed on a roof to compensate for expansion and contraction.
- Exposure.** The portion of roofing exposed to the weather.
- Fabric.** Cotton or glass cloth saturated with asphalt.
- Felt (dry).** A roofing material manufactured from cellulose fibers of rags, paper, wood, and asbestos.
- Firewall.** A wall erected above the roof to block fires between sections of the building.
- Flashing.** Sheets of metal or other suitable materials used to make watertight joints in roofs.
- Flue.** A channel or passage for smoke or gases of combustion; a chimney.
- Flush.** A term applied to surfaces that are level and form a single, unbroken surface.
- Gable roof.** A ridged, double-sloping roof.
- Galvanized iron.** Iron coated with zinc.
- Gambrel roof.** A gable roof with its slopes broken by an obtuse angle; a gable roof with two pitches in one field.
- Girder.** The large supporting, spanning beam of a roof; a main spanning beam.
- Glaze.** To apply a very thin mopping of hot material; to sprinkle a roof with water and mop with hot asphalt.
- Gutter.** A trough installed along the eaves to carry off water.
- Hand line.** A rope used by hand to hoist light loads.
- Hanger.** A metal strap used to secure or hang gutters along the eaves.
- Hatch.** An opening in the roof; an access hole to the attic.
- Hexagon.** A figure with six sides.
- Hip roof.** A roof having sloping ends, and thus, four sloping sides. The line where adjacent sloping sides meet is called a hip.
- Hoist.** A hoisting machine; to pull up.
- Horizontal.** In the direction of the horizon or parallel to it.
- Incline.** A slope; a sloping surface.
- Insulation.** A material to prevent the passage of heat or sound; also used to reduce fire hazard.
- Inverted.** In an opposite position, or turned upside down.
- Jack, roof.** A device used in scaffolding a roof; a flashing used to cover pipes and vents.
- Joint.** The point at which two or more surfaces are united.
- Joist.** A horizontal timber to which the boards of a floor or lath on a ceiling are fastened.
- Lead.** A bluish white metal used for pipes, roofs, and gutters.
- Leader.** A downspout that carries water from the roof to ground level.
- Lean-to roof.** A roof sloped one way; a shed roof.
- Lightwell.** A shaft or opening in the center of a building used to provide light and ventilation for inside rooms.
- Lining.** Marking of a roof with a chalk line.
- Marquee.** A covered roof extending out from a building.
- Mastic.** Thick adhesive mixture of preparations such as asphalt; used for repairing roofs.
- Membrane.** An asphalt-impregnated fabric; a material used for flashing.
- Metal edging.** A metal trim used around the outside edges of a roof.
- Mission tile.** A curved tapering tile unit.
- Monitor.** A small tower rising from the roof of a factory or other buildings, with windows or louvers, or both.
- Mortar.** A mixture of sand and lime or cement and water.
- Molding.** A cornice or projecting decorative member used on any part of a building.
- Mud.** A colloquial term used for mortar.
- Nailing strip.** A strip of wood set in concrete along the eaves or gable of a roof.
- Nail (cut).** Nails, rectangular in section, cut by machines from sheet metal.
- Nail (roof).** A nail with a large head.
- Nail (straw).** A galvanized nail 6" (15.2 cm) long used for nailing on tile.
- Nipper (tile).** A tool with jaws for gripping and cutting tile.
- Nosing.** The part of the tread of a step projecting beyond the riser; a drip mounding or mold along eaves or gables.
- Offset.** A recess in the plane of a wall or a broken line in the eave or gable of a roof.
- Outlet.** Roof drain.
- Overhang.** Length of rafter projecting beyond the wall line.
- Pan tile.** A terra cotta roof tile that is laid under a cover tile.
- Parapet.** A low wall above roof level.
- Pencil rod.** A heavy copper rod, about ¼" (0.6 cm) in diameter, sometimes used in anchoring roof tile.
- Penthouse.** A room or house built upon the roof of a larger building.

- Pitch** The slope of a roof, indicated by the relation of the rise to the span; also, a coal-tar roofing material.
- Plans.** Drawings showing the proportions and relations of parts of a building
- Plastic** Waterproofing material, composed of coal tar, asphalt, asbestos fibers, and so forth.
- Plumb.** True as indicated by a plumb line; upright, vertical, or perpendicular to the horizon
- Ply** Layers or thicknesses of roofing material.
- Portal** An entrance way, especially one that is grand and imposing.
- Portico** An open space with the roof upheld by columns, often attached to a building.
- Prv bar.** A long, heavy steel bar, pointed or wedge-shaped at the working end
- Pulley** A wheel grooved to receive a rope, used for hoisting
- Purlin.** One of several horizontal timbers that support rafters
- Putty** Whiting mixed with linseed oil to the consistency of dough (Plastic is sometimes referred to a putty.)
- Rafter.** A sloping timber giving support to a roof.
- Rake** The slope of a roof; the sloping edge on a gable roof that may be covered with a bargeboard, or vergeboard.
- Ramp** A sloping road or corridor. Also, the concave part at the top or cap of a railing, wall, or coping.
- Recover (reroof)** To apply a new roof over an old roof
- Reglet, or ragglet** Beveled nailing strips for flashing set into the masonry wall in concrete construction.
- Return.** A part of the face of a building at an angle with the main part of the facade.
- Ridge.** The point on a double-sloping roof at which the rafters meet the ridge pole.
- Ridge roll.** A rolled metal cap to cover and finish the ridge.
- Ridge shingles.** Units of roofing made for ridge covering.
- Rise.** The vertical height of the top of a roof above the plate line or the increase in height of a rafter per foot (metre or centimetre) of run.
- Roofing** Roofs collectively; materials for roofs, the act of covering a roof
- Rot.** Decay that attacks wood. The two major types are dry rot and wet rot
- Run.** Usually, one-half the distance of the span of a roof; a row of tiles or shingles running from the eave to the ridge.
- Rung.** A cross strip, as of a chair or ladder.
- Saddle.** A water diverter located behind a chimney (Sometimes referred to as a cricket.)
- Sawtooth roof.** A roof built in the shape of saw teeth, the vertical positions are well supplied with sash to admit light.
- Scab.** A cleat nailed over a joint or the like
- Scaffold.** A temporary elevated structure for the support of workers and materials during the construction of a building
- Screen.** A metal wire screen or basket used on outlets or downspouts.
- Scupper.** A hole or gutter bordering a deck, to let water run off.
- Shake.** A rough, unshaved wood shingle
- Sheathing** The boards or other material used for covering the frame or roof structure.
- Shingle** A unit of roofing, usually wood, composition, tile, or slate
- Siding** Asbestos, pressed board, or lumber used in covering the exterior walls of a building.
- Skylight.** A window facing skyward, usually located on the roof. An opening in the roof containing a window for light and ventilation.
- Slate.** A fine-grained rock that splits into thin, even layers used for roofing; a tile.
- Slip sheet** A light sheet of paper applied over roof sheathing to prevent the roofing from bonding to sheathing. May be called dry sheet
- Slope.** See "pitch"
- Soffit** The underside of a beam, lintel, archway, cornice, or stairway.
- Solder** Equal parts of tin and lead used to joint or patch metal
- Span** A space or distance between supports; in roof framing, the width of the frame between outside edges of the building.
- Specifications** Written information augmenting the plans of a building.
- Spire.** A tapering or pyramidal roof of a tower; a steeple
- Splice** To unite in such a way as to form one continuous piece. To join two ropes or parts of a rope by intertwining the strands
- Square** A unit of measure of roofing area equal to 100 square feet (9.3 m<sup>2</sup>).
- Square butts.** A type of double-coverage shingles
- Starter tile** A beginning course of tile.
- Storm collar** A narrow strip of metal formed to fit around vent pipes
- Stud** An upright piece of lumber in the walls, usually 2" by 4" (5.1 cm by 10.2 cm), to which the lath is nailed
- Taper.** To make or become smaller toward the end, to lessen gradually, growing smaller by degrees in one direction.

- Template.** A pattern or guide of wood or metal used for shaping or marking work.
- Thatch-on.** A type of interlocking shingle; a method of laying a shingle.
- Tile.** A thin piece of baked clay used for covering roofs and available in varied shapes.
- Tile pick.** A sharp pointed hammer used to pick holes in tile units.
- Tile strip.** Wood strips used for nailing tile on top of roofing.
- Tile tie (tie).** A heavy braided wire, or flat metal strip, used in securing tile to the roof.
- Tin snips.** Cutters used for cutting light metal.
- Toe board.** A protective board placed on a sloping roof to prevent workers from slipping or falling.
- Toenail.** A nail driven obliquely to hold the foot of a stud or brace; also, to draw boards into place.
- Trowel.** A flat, bladed, pointed instrument having an offset handle that is parallel with the blade.
- Truss.** A braced framework over long spans such as found on large roof or bridge construction, also, to brace or support by a truss.
- Turn-up.** Roofing material turned up on a wall or at an opening, usually about 4" (10.2 cm) wide.
- Valley.** The gutter or angle formed by the meeting of two roof slopes.
- Valley metal.** Sheet metal used in forming a valley.
- Valley sheet.** A sheet of roofing laid parallel with the valley.
- Vapor seal.** Material placed under insulation in order to avoid condensation of moisture inside the insulation (An adequate vapor seal for cold climates should consist of two 15-lb [6.8-kg] felts and two moppings of hot bitumen.)
- Vault.** An arched structure, an arched ceiling or roof.
- Vent.** An opening for the circulation of air, an outlet, as a vent pipe.
- Vent sleeves.** Flanged sheet metal collars placed around vent pipes that go through roofs; used to seal off the roofing around the vent pipe opening.
- Ventilator.** A device for gathering a supply of fresh air.
- Vergeboard.** The outer false rafter on the rake of a gable; sometimes referred to as a bargeboard.
- Weirback.** Pyramidlike structure on a roof provided to direct water to a drain.
- Weeper (weep hole).** A small opening or hole to permit the escape of water or moisture.
- Whetstone.** A stone for sharpening cutting tools.
- Winch.** A hoist used for hauling or hoisting materials to the top of a roof.
- Z-bar.** Metal flashing used especially on walls where roof, plaster, or wood siding meet.
- Zone.** A division of a political subdivision (city, county) into districts that may have different building regulations.

# Roofing

## Rigid Roofing

### Tests

The following section contains objective tests for each topic of the workbook. The value of the tests depends to a great extent on the care taken by instructors and school supervisors in keeping them confidential.

Supervisors and instructors should feel free to modify the application of the workbook material and the tests to satisfy local needs. Also, the instructors will probably supplement the information in the workbook with other material that they themselves have developed, and they will need to augment the tests with questions based on any supplementary material they may use.

Instructors and supervisors should be aware that the test pages are perforated to facilitate removal of the tests, either individually or as a complete set, at the discretion of the instructor or supervisor.

# Rigid Roofing Tests

## TOPIC 1—GENERAL DESCRIPTION OF RIGID ROOFING

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Indians in California fashioned clay tiles by forming mud over a log or: 1. \_\_\_\_\_
  1. The bottom of a canoe
  2. Their thighs
  3. The top of a bread oven
  4. A saddle
  
2. Which type of roofing material is especially suited for use in areas of great snowfall? 2. \_\_\_\_\_
  1. Slate
  2. Concrete tile
  3. Plastic
  4. Metal
  
3. Roofing tile is generally classified in how many categories? 3. \_\_\_\_\_
  1. Two
  2. Three
  3. Four
  4. Five
  
4. Which of the following has been practically abandoned as a roofing product? 4. \_\_\_\_\_
  1. Clay tile
  2. Slate
  3. Steel tile
  4. Asbestos cement shingles
  
5. If a roofer finds defective tiles prior to installation, he or she should: 5. \_\_\_\_\_
  1. Install them as close to the ridge as possible so that they cannot be seen easily.
  2. Save them for possible use on dormers.
  3. Save them for possible use on hips and valleys.
  4. Set them aside for return to the manufacturer.
  
6. The advantages of rigid roofing materials include which of the following qualities? 6. \_\_\_\_\_
  1. They are long lasting.
  2. They are weatherproof.
  3. They are termiteproof.
  4. They are all of the above.
  
7. Which of the following roofing materials does not tend to hold heat? 7. \_\_\_\_\_
  1. Metal
  2. Slate
  3. Concrete
  4. Clay

8. A roofer must exercise great care in walking on roofs of steel, tile, or aluminum shingles because such materials: 8. \_\_\_\_\_
1. Retain heat.
  2. Crack easily.
  3. Are very slippery.
  4. Reflect heat.
9. In the roofing industry the term "square" is used to refer to how many square feet of roofing area? 9. \_\_\_\_\_
1. 75 (7 square metres)
  2. 100 (9.3 square metres)
  3. 125 (11.6 square metres)
  4. 150 (13.9 square metres)
10. If a structure is to be roofed or reroofed with concrete tile, clay tile, or slate, the rafters of the structure should be at least 2 by 6 (5.1 x 15.2 centimetres) spaced every how many inches on center? 10. \_\_\_\_\_
1. 16 (40.6 centimetres)
  2. 18 (45.7 centimetres)
  3. 20 (50.8 centimetres)
  4. 24 (61 centimetres)

## RIGID ROOFING TESTS

### TOPIC 2—HOISTING AND HANDLING OF RIGID ROOFING MATERIALS

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. In loading roofing materials on a truck for transport to the job site, the roofer should: 1. \_\_\_\_\_
  1. Make sure that the task is required in the employer-employee contract.
  2. Load first those items that will be needed first.
  3. Load last those items that will be needed first.
  4. Load items in the order that he or she finds them in the yard.
  
2. Hip, ridge, and rake pieces of Spanish and mission tile are: 2. \_\_\_\_\_
  1. Difficult to obtain
  2. Less expensive than the field pieces
  3. Very fragile
  4. Safest when stacked by themselves in a corner of the truck
  
3. Which of the following should be stacked flat on the truck? 3. \_\_\_\_\_
  1. Slate
  2. Plastic tile
  3. Rigid asbestos tile
  4. All of the above
  
4. In distributing tiles on the roof, the roofer should place them: 4. \_\_\_\_\_
  1. With the nail holes toward the ridge
  2. Horizontally
  3. Vertically
  4. With the nail holes toward the eaves
  
5. Which of the following is (are) recommended for walking on a tile roof? 5. \_\_\_\_\_
  1. Using sacks of sawdust or wood shavings to walk on
  2. Walking on two tiles at a time
  3. Walking on planks supported at both ends by sacks of soft material, such as wood shavings or sawdust
  4. Doing all of the above
  
6. Wearing shoes with leather soles and heels on a roof is: 6. \_\_\_\_\_
  1. Forbidden by OSHA
  2. Not recommended
  3. Considered a sound practice if one walks parallel with the slope of the roof
  4. Considered safe if one walks with her or his feet flat on the roof surface at all times

7. If a worker should fall while walking on a steep roof, he or she should: 7 \_\_\_\_\_
1. Attempt to lie flat and extend his or her arms or legs.
  2. Immediately try to stand up.
  3. Jab his or her screwdriver into the roof's surface, and use the tool to hang on to.
  4. Roll to his or her back, and dig the heels of his or her shoes into the roof's surface.
8. Roof jacks should be nailed no more than how many feet apart? 8. \_\_\_\_\_
1. 6 (1.8 metres)
  2. 8 (2.4 metres)
  3. 10 (3 metres)
  4. 12 (3.7 metres)
9. If tile is lifted to the roof in bundles, what is the maximum number of pieces that should be lifted at one time? 9. \_\_\_\_\_
1. 8
  2. 10
  3. 12
  4. 14
10. Generally, in how many tiers can tile be stacked on the ground without danger of the lower pieces' chipping or breaking from the weight of those above? 10. \_\_\_\_\_
1. Three
  2. Four
  3. Five
  4. None of the above

## RIGID ROOFING TESTS

### TOPIC 3—TWO-PIECE MISSION BARREL TILE

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Drip edges are generally what length? 1. \_\_\_\_\_
  1. 1 inch (2.5 centimetres)
  2. 1½ inches (3.8 centimetres)
  3. 2 inches (5.1 centimetres)
  4. 2½ inches (6.4 centimetres)
  
2. In loading field tile on the roof, the roofer should begin with which course? 2. \_\_\_\_\_
  1. Second
  2. Third
  3. Fourth
  4. Fifth
  
3. Stacks of tile on the roof deck should generally include no more than how many tiles? 3. \_\_\_\_\_
  1. 10
  2. 11
  3. 12
  4. None of the above
  
4. Which of the following should be applied first? 4. \_\_\_\_\_
  1. Ridge tiles
  2. Hip tiles
  3. Starter tiles
  4. Birdstops
  
5. Tile set against the hip nailing board is usually set in mortar to: 5. \_\_\_\_\_
  1. Reduce costs.
  2. Improve the strength of the hip.
  3. Ensure that water will run down the pan tiles.
  4. Make the roof look like those used in early California missions.
  
6. Tiles that are to have mortar applied to them should: 6. \_\_\_\_\_
  1. Be exposed to the sun for at least six hours before the mortar is applied.
  2. Be wet when the mortar is applied.
  3. Be special ordered from the manufacturer.
  4. Be all of the above.
  
7. Metal valleys should be nailed into place: 7. \_\_\_\_\_
  1. Before the laying of tile begins
  2. Whenever the roofer finds it convenient to do so
  3. Upon completion of the tile application
  4. At the same time that the hip tiles are applied
  
8. If tiles are nailed directly to the roof deck, the nails used should penetrate at least how far into the sheathing board? 8. \_\_\_\_\_
  1. ½ inch (1.3 centimetres)
  2. ⅜ inch (1.6 centimetres)
  3. ¼ inch (1.9 centimetres)
  4. ⅙ inch (2.2 centimetres)

9. Which of the following is (are) recommended in connection with mortaring operations? 9. \_\_\_\_\_
1. Using pieces of broken tile as fillers where mortar is applied at hips and ridges
  2. Applying mortar in two layers at hips and ridges
  3. Wetting tiles before applying mortar to them
  4. Doing all of the above
10. Ideally, the roof layout should be such that: 10. \_\_\_\_\_
1. Full tiles can be used at the ridge.
  2. No nailing boards will be required.
  3. No leftover tile will have to be returned to the yard.
  4. Underlayment will not be subject to expansion and contraction.

## RIGID ROOFING TESTS

### TOPIC 4—ONE-PIECE MISSION TILE

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Which of the following statements about one-piece mission, or S, tile is (are) true? 1. \_\_\_\_\_
  1. It is lighter than other types of tile.
  2. It is less expensive to install than other types of tile.
  3. A finished roof looks as if it were made from two-piece mission barrel tile.
  4. All of the above are true.
  
2. In loading S tile on the roof, the roofer should generally place how many tiles in each stack? 2. \_\_\_\_\_
  1. 8
  2. 9
  3. 10
  4. 12
  
3. Stacks of S tile placed on the roof deck should be spaced how many feet apart? 3. \_\_\_\_\_
  1. 3 (0.9 metre)
  2. 5 (1.5 metres)
  3. 6 (1.8 metres)
  4. 8 (2.4 metres)
  
4. In the application of S tile, how many inches should the hip nailing board be set back from the eave? 4. \_\_\_\_\_
  1. 8 (20.3 centimetres)
  2. 10 (25.4 centimetres)
  3. 12 (30.5 centimetres)
  4. 14 (35.6 centimetres)
  
5. The underlayment used with S tile on a roof with a 3 12 pitch should be 5. \_\_\_\_\_
  1. 15-pound (6.8-kilogram)
  2. 30-pound (13.6-kilogram)
  3. 40-pound (18.2-kilogram)
  4. None of the above
  
6. Which of the following statements about S tile is true? 6. \_\_\_\_\_
  1. The pan is always on the left-hand side.
  2. The pan is always on the right-hand side.
  3. The pan may be on either side.
  4. None of the above is true.
  
7. If the dimensions of S tile vary even slightly from those called for in the job specifications: 7. \_\_\_\_\_
  1. Water flow could be obstructed or diverted.
  2. The symmetry of the finished roof will not be affected.
  3. The roofer should make allowances by increasing the drip edge.
  4. The "irregular" tiles should be broken into small pieces and set aside for use as layer material in areas that require mortar or mastic.



## RIGID ROOFING TESTS

### TOPIC 5—ROMAN TILE, FLAT SHINGLE TILE, AND ORIENTAL CLAY TILE

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Which of the following statements about the regular method of laying Roman tiles is true? 1. \_\_\_\_\_
  1. Cover tiles are used as both pans and covers.
  2. Pan tiles are used as both pans and covers.
  3. Both cover tiles and pan tiles are used.
  4. None of the above is true.
  
2. If Roman tiles are less than 18 inches (45.7 centimetres) long and adjustments must be made to compensate for the variation in size, the roofer should: 2. \_\_\_\_\_
  1. Decrease the exposure of the tiles.
  2. Decrease the head lap.
  3. Use mastic to fill large gaps.
  4. Increase the drip edge.
  
3. In the application of Roman tile, which of the following should be used on hips, ridges, and rakes? 3. \_\_\_\_\_

1. Tapered mission barrel tile	3. A 14-inch pan tile
2. Straight mission barrel tile	4. A 14-inch starter tile
  
4. Tile that has no water channel except for the exposed surface of the tile is called: 4. \_\_\_\_\_

1. Dampproof tile	3. Single-coverage tile
2. SC tile	4. Double-coverage tile
  
5. Which of the following is(are) not required with flat shingle tiles? 5. \_\_\_\_\_

1. Ridge tiles	3. Birdstops
2. Rake tiles	4. All of the above
  
6. On roofs of 3/12 pitch or less, tile is used mainly to: 6. \_\_\_\_\_
  1. Prevent water from ponding.
  2. Channel water off the roof.
  3. Fulfill the requirements of the architect.
  4. Provide decoration.
  
7. Which of the following statements is true of spacing adjustments with interlocking tile? 7. \_\_\_\_\_
  1. They are more difficult to make than with other types of tile.
  2. They are less difficult to make than with other types of tile.
  3. They present about the same degree of difficulty as other types of tile.
  4. Spacing can be increased but not decreased.

8. For which of the following are special gable corner tiles manufactured? 8. \_\_\_\_\_
1. Roman tile
  2. Interlocking clay shingle tiles
  3. Flat clay shingle tiles
  4. Oriental tile
9. Flashing used with flat shingle tiles and interlocking clay shingle tiles must be: 9. \_\_\_\_\_
1. Special ordered from the tile manufacturer
  2. V-shaped
  3. Flat
  4. All of the above
10. As a general "rule of thumb," underlayment should be lapped: 10. \_\_\_\_\_
1. 6 inches (15.2 centimetres) at the sides and 4 inches (10.2 centimetres) at the head
  2. 4 inches (10.2 centimetres) at the sides and 6 inches (15.2 centimetres) at the head
  3. 6 inches (15.2 centimetres) at both the sides and head
  4. 4 inches (10.2 centimetres) at both the sides and head

## RIGID ROOFING TESTS

### TOPIC 6—INTERLOCKING CONCRETE TILE

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. The maximum width of concrete interlocking tiles is 13 inches (33 centimetres), and the maximum length is: 1. \_\_\_\_\_
  1. 14 inches (35.6 centimetres)
  2. 15 inches (38.1 centimetres)
  3. 16 inches (40.6 centimetres)
  4. 18 inches (45.7 centimetres)
  
2. In the loading of concrete interlocking tile on a gable roof, it is recommended that the last stack in each row: 2. \_\_\_\_\_
  1. Contain the same number of tiles as the other stacks.
  2. Contain twice as many tiles as the other stacks.
  3. Be placed 3 feet (0.9 metre) from the rake.
  4. Contain only half tiles.
  
3. A typical loading pattern for concrete interlocking tiles on a hip roof requires that tiles be stacked for every: 3. \_\_\_\_\_
  1. Second course
  2. Third course
  3. Fourth course
  4. Fifth course
  
4. Which of the following is (are) used to fix roof jacks to concrete interlocking tiles? 4. \_\_\_\_\_
  1. 4-penny corrosion-resistant box nails
  2. 8-penny nails
  3. 10-penny nails
  4. Plastic asbestos cement
  
5. In cutting tiles for a closed valley, the roofer should: 5. \_\_\_\_\_
  1. Use broken or chipped tiles if possible.
  2. Install each tile as soon as he or she cuts it.
  3. Be sure that lugs have *not* been knocked off the tiles that she or he intends to cut.
  4. Do all of the above.
  
6. The opening on an open valley is approximately how many inches wide? 6. \_\_\_\_\_
  1.  $3\frac{1}{2}$  (8.9 centimetres)
  2. 4 (10.2 centimetres)
  3.  $4\frac{1}{2}$  (11.4 centimetres)
  4. 5 (12.7 centimetres)
  
7. Tiles that are to butt against the hip nailing board should be cut to within at least what distance from the nailing board? 7. \_\_\_\_\_
  1.  $\frac{1}{4}$  inch (0.6 centimetre)
  2.  $\frac{3}{8}$  inch (1 centimetre)
  3.  $\frac{1}{2}$  inch (1.3 centimetres)
  4.  $\frac{5}{8}$  inch (1.6 centimetres)

8. Which of the following statements about roofing cement is important for the roofer to remember? 8. \_\_\_\_\_
1. It expands as it dries.
  2. It shrinks as it dries.
  3. It neither expands nor shrinks as it dries.
  4. It is unaffected in temperatures ranging from 30° F. to 80° F. (-1.1° C to 26.7° C).
9. The head of the top course of concrete interlocking tiles should be about how far from the ridge nailing board? 9. \_\_\_\_\_
1. ¼ inch (0.6 centimetre)
  2. ½ inch (1.3 centimetres)
  3. ¾ inch (1.9 centimetres)
  4. 1 inch (2.5 centimetres)
10. Spacing guides are used to determine: 10. \_\_\_\_\_
1. The amount of space to leave between stacks of tile loaded on the roof
  2. The on-center spacing for concrete interlocking tiles
  3. The size of the segments into which a given distance can be divided evenly
  4. None of the above

## RIGID ROOFING TESTS

### TOPIC 7—SLATE AND RIGID ASBESTOS SHINGLES

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. It is recommended that the drip edge used with slate be: 1. \_\_\_\_\_
  1. 1 inch (2.5 centimetres)
  2. 2 inches (5.1 centimetres)
  3. 3 inches (7.6 centimetres)
  4. 4 inches (10.2 centimetres)
  
2. Generally, the joints of slate should be offset at least how many inches? 2. \_\_\_\_\_
  1. 2 (5.1 centimetres)
  2. 3 (7.6 centimetres)
  3. 4 (10.2 centimetres)
  4. 5 (12.7 centimetres)
  
3. On which type of ridge does one side of the roof extend  $1\frac{1}{8}$  inches (2.9 centimetres) past the other side? 3. \_\_\_\_\_
  1. Saddle ridge
  2. Overlapping ridge
  3. Mission ridge
  4. Comb ridge
  
4. Metal valleys should extend how many inches to the sides? 4. \_\_\_\_\_
  1. 8 (20.3 centimetres)
  2. 10 (25.4 centimetres)
  3. 12 (30.5 centimetres)
  4. 14 (35.6 centimetres)
  
5. Galvanized nails of what length should be used to fix slate to the roof deck? 5. \_\_\_\_\_
  1. 1 inch (2.5 centimetres)
  2.  $1\frac{1}{4}$  inches (3.2 centimetres)
  3.  $1\frac{1}{2}$  inches (3.8 centimetres)
  4. None of the above
  
6. Which of the following are used to boost the starter course of rigid asbestos shingles? 6. \_\_\_\_\_
  1. Cant strips
  2. Half shingles
  3. Coxcomb strips
  4. Battens
  
7. Eave flashing of black plastic cement should be applied in areas where the mean temperature for January is: 7. \_\_\_\_\_
  1. 35° F. (1.7° C) or less
  2. 30° F. (-1.1° C) or less
  3. 25° F. (-3.9° C) or less
  4. 20° F. (-6.7° C) or less
  
8. Which of the following is(are) recommended for use in securing the starter course of rigid asbestos shingles to the roof deck? 8. \_\_\_\_\_
  1. Needle point nails
  2. Screw thread nails
  3. Ring bar's nails
  4. All of the above

9. In high wind areas the first course of rigid asbestos shingles should be: 9. \_\_\_\_\_
1. Nailed with nails  $1\frac{1}{2}$  inches (3.8 centimetres) long
  2. Started with a full shingle
  3. Embedded in black plastic cement
  4. Shimmed up about  $\frac{1}{4}$  inch (0.6 centimetre)
10. The butt end of a sheet metal valley used with slate must be set back so that: 10. \_\_\_\_\_
1. It is not exposed to elements that would cause the metal to weather.
  2. The juncture cover piece can be fitted easily.
  3. It cannot be seen.
  4. Birdstops can be installed.

## RIGID ROOFING TESTS

### TOPIC 8—OTHER RIGID ROOFING MATERIALS

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Plywood used for the roof deck under steel tile must be at least how thick? 1. \_\_\_\_\_  
1.  $\frac{1}{4}$  inch (0.6 centimetre)                      3.  $\frac{3}{4}$  inch (1.9 centimetres)  
2.  $\frac{1}{2}$  inch (1.3 centimetres)                      4. 1 inch (2.5 centimetres)
2. Steel tile should not be used on a roof if the pitch of the roof is less than: 2. \_\_\_\_\_  
1. 3/12    3. 4/12  
2. 3½/12    4. 5/12
3. In applying steel tile, the roofer should make sure that: 3. \_\_\_\_\_  
1. Tile flanges do not touch the underlayment.  
2. Only galvanized ring barb nails are used.  
3. Each course begins with a half tile.  
4. No course begins with a closure strip.
4. Aluminum shakes are not recommended for use on a roof with a pitch less than: 4. \_\_\_\_\_  
1. 2½/12    3. 3½/12  
2. 3/12    4. 4½/12
5. The anchor clips, nails, and flashings used with aluminum shakes and shingles should be made of: 5. \_\_\_\_\_  
1. Lead    3. Steel  
2. Zinc    4. Aluminum
6. A waterproof membrane is required under wood shakes or shingles if the pitch of the roof is less than: 6. \_\_\_\_\_  
1. 2/12    3. 4/12  
2. 3/12    4. 4½/12
7. If a roof is not too steep, the valley metal used with aluminum shakes can be applied with: 7. \_\_\_\_\_  
1. Metal nails 1 inch (2.5 centimetres) long  
2. Hot asphalt  
3. Zinc anchors  
4. All of the above
8. When steel tile oxidizes, it turns a shade of what color? 8. \_\_\_\_\_  
1. Yellow    3. Brown  
2. Green    4. Red

9. A major disadvantage of plastic roofing materials is that they \_\_\_\_\_ 9. \_\_\_\_\_
1. Fade and weather quickly
  2. Are expensive
  3. Cannot be installed very quickly
  4. Are difficult to load on the roof deck
10. Which of the following roofing materials is generally the most durable? 10. \_\_\_\_\_
1. Steel tiles
  2. Sheet copper
  3. Aluminum shingles
  4. Mission barrel tile