DOCUMENT RESUME

ED 203 139 CE 029 273

AUTHOR	Klingensmith, Robert, Ed.
TITLE	Roofing: Workbook and Tests. Built-up Roofing.
INSTITUTION	California State Dept. of Education, Sacramento.
PUB DATE	81
NOTE	93p.
AVAILABLE FROM	Publications Sales, California State Department of Education, P.O. Box 271, Sacramento, CA 95802 ($4.00).
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Behavioral Objectives; *Building Trades; Construction Materials; Definitions; Federal Regulation; Glossaries; Instructional Materials; *Job Skills; Job Training; Labor Legislation; Learning Activities; *Roofing; Safety; Skilled Occupations; *Trade and Industrial Education; *Vocational Education; Workbooks

ABSTRACT

Designed for use in roofing apprenticeship classes, this workbook contains eight units on skills used in built-up roofing, a listing of instructional materials, a glossary, and the text of Labor Code Article 30, Construction Safety Orders, "Roofing Operations and Equipment." Each instructional unit includes a listing of performance statements and text covering skills addressed in individual performance statements. Topics covered in the units are safety, roof preparation and handling and loading of built-up roofing materials, mopping operations, application of built-up roof assemblies, insulation and its application, cutting and folding corners, sumps and drains, and flashing. A multiple-choice test is provided for each unit. (MN)

Roofing

Workbook and Tests

Built-up Roofing

CALIFORNIA STATE DEPARTMENT OF EDUCATION • Wilson Riles, Superintendent of Public Instruction • Sacramento, 1981

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.

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INSTRUCTOR(S) _____

_____

Roofing

Workbook and Tests

Built-up Roofing

Prepared under the direction of the

CALIFORNIA EDUCATIONAL ADVISORY COMMITTEE
FOR THE ROOFING INDUSTRY
and
BUREAU OF PUBLICATIONS, CALIFORNIA STATE
DEPARTMENT OF EDUCATION

4.00

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

Copies of this publication are available for $4 each, plus sales tax (6 percent in most counties; 6½ percent in four Bay Area counties) for California residents, from:

Publications Sales
California State Department of Education
P.O. Box 271
Sacramento, CA 95802

Remittance or purchase order must accompany each order. Purchase orders without checks are accepted only from government agencies in California. Phone orders are not accepted.

The following titles, each containing workbook and tests in a single volume, are available in the roofing series:

Entering the Roofing and Waterproofing Industry	(1980)	$4
Rigid Roofing	(1980)	$4
Built-up Roofing	(1981)	$4

Books on cold-applied roofing and waterproofing and dampproofing and on common roofing materials and equipment are currently in production.

A complete list of publications available from the Department of Education, including instructional materials for some 23 other trades, is available from the address given above.

Questions and comments about existing apprenticeship materials or the development of new materials should be directed to:

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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 State Department of Education, through its Bureau of Publications, 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 *Built-up Roofing* was planned and prepared under the direction of the California 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.

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.

THEODORE R. SMITH
Editor in Chief
Bureau of Publications

Contents

Acknowledgments

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

Cleasby Manufacturing Company, Inc.
Instructional Materials Laboratory, The Ohio State University
Johns-Manville Sales Corporation
Marathon Roofing Products, Inc.
Mechanization Systems Company, Inc.
National Roofing Contractors Association

Built-up Roofing

TOPIC 1—SAFETY

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

- **Describe the responsibilities that roofers have to their fellow workers.**
- **Identify the primary functions of CAL/OSHA.**
- **Describe what roofers should do if "hotstuff" (heated asphalt or coal-tar pitch) is spilled on them.**
- **List the safety precautions that the roofer should take in working with hotstuff.**
- **Identify clothing items appropriate for use on the job.**
- **Describe the general safety precautions the roofer should take on the job site.**
- **Describe the emergency first-aid procedures to be followed if a fellow worker loses consciousness, suffers sunstroke, suffers heat sickness, or the like.**

Built-up roofing jobs constitute a major portion of the work done in the roofing industry. It is not surprising, therefore, that a majority of the job-related accidents involving roofers occur during the application of built-up roofs.

Regardless of the roofer's task—spreading gravel, pumping hot asphalt or coal-tar pitch, hoisting materials, or whatever—working safely is an important part of the job. Too many workers have learned the hard way that *a good roofer is a safe roofer.*

The information contained in this topic is intended to make every roofer the safest worker possible. Those who follow the procedures and adhere to the rules described herein will find their work easier, more enjoyable, and more profitable.

Very little of the information contained in this topic should be new or unfamiliar to the apprentice. The content is provided to serve as a review of the safety information covered earlier in the roofing apprenticeship program and to emphasize the importance of safety on the job.

CAL/OSHA

As was discussed earlier in *Entering the Roofing and Waterproofing Industry,* Topic 5, "Safety in the Industry," provisions of the California Occupational Safety and Health Act of 1973 require that each employer in the state provide a place of employment that is safe and healthful for his or her employees. To help ensure that employers meet their responsibilities, the Occupational Safety and Health Standards Board in the State Department of Industrial Relations establishes standards, regulations, orders, and rules that employers must comply with. These standards, regulations, and the like cover such areas as the wearing of hard hats in specified areas and the use of ladders. The OSHA regulations even describe how many toilets should be available on the job site.

The responsibility for enforcement of regulations rests with the Division of Occupational Safety and Health. In enforcing regulations, standards, rules, and orders, the division first issues a citation to the employer found to be in violation. Subsequent actions may include petitioning the courts for an injunction to restrain operations until the hazardous condition is corrected; levying fines; and, in some cases, instigating criminal proceedings.

Sanctions against employees are not permitted, but employees must comply with safety and health standards and with all related rules, regulations, and orders. Failure to do so can result in the employee's being reprimanded, suspended, or dismissed.

The Roofer's Responsibilities

Every worker on a roofing job is responsible for his or her own safety and the safety of his or her fellow workers. A worker who is not safety conscious is a threat to the health and well-being of himself or herself and others. Leaving tools, equipment, and materials near the edge of the roof is an "invitation" for colleagues to trip over them and fall. Carelessness with hotstuff can result in burns to the careless worker and those nearby. Being sorry later is of no help to the injured party. Remember, *think safety.*

General Safety Practices

Listed below are some general safety practices that every apprentice, as well as every journey-level worker, should follow. Following these rules is a major step in being a worker who "thinks safety."

1. Always follow instructions.
2. If you are not sure that you know how to do a job, ask your supervisor or superintendent.
3. Never take chances or use dangerous shortcuts.
4. Watch out for the safety of other workers.
5. Help new employees learn safe work practices.
6. Plan your work ahead to prevent accidents.
7. Keep your mind on the job.
8. Be in good physical condition when you work each day.
9. Report all accidents and injuries to the proper authority immediately. Make sure that the victim receives proper treatment as soon as possible.
10. Do not engage in horseplay, scuffling, or practical jokes.
11. Attend periodic safety meetings.

Care in Working with Hotstuff

Burns are one of the most common types of injuries incurred by roofers. Most of these burns involve work with hotstuff, which may reach temperatures of more than 400° F (204.4°C). Burns from hotstuff are often severe not only because of the intense heat but also because of the adhesive quality of the material. Hot water will run off skin, but hotstuff sticks to skin and clothing and continues to burn until it can be removed or until it cools.

A worker who does get hotstuff on himself or herself should take steps to cool it as quickly as possible. Placing the burned area in cold water or any substance that has a cooling effect is recommended. Asphalt or clothing that is stuck to burned skin should not be pulled away; this would result in the peeling away of layers of skin, too. The recommended procedure in such cases is to bandage the burned area with a clean cloth and get to a doctor as soon as possible.

The handling of hotstuff requires great care and attention to the task. The apprentice should review the section on burn prevention on pages 21-22 of *Entering the Roofing and Waterproofing Industry.* Listed below are some additional recommended practices for working with hotstuff:

1. Before pouring hotstuff into a bucket, be sure that the bucket contains no moisture. Water or other liquid in the bucket can cause hotstuff to boil over, which could cause burns. Remember, water can condense in buckets overnight.
2. Use only OSHA-approved buckets to transport hotstuff.
3. Be careful when using flex-pipe (or flex-hose) to fill buckets with hotstuff. When pumping stops, hotstuff still in the pipe can cool and clog the end of the pipe. This hotstuff must be thawed before pumping can be resumed. When pumping does resume, the hotstuff cannot pass through the pipe until the cooled and hardened material melts. When the material finally does melt, the built-up pressure can cause an explosion, which can cause the pipe to "whip" out of control. A heavy handle fitted on the end of the pipe can be used to grip the pipe and hold it in the bucket, thereby minimizing this problem.
4. Be sure the end of the flex-pipe extends over the top of the wall and into the roof area to prevent hotstuff from spilling down the side of the building.
5. Stand away from the receptacle for the hotstuff when pumping begins. Condensation in the receptacle or the flex-pipe can splatter and cause burns when the hotstuff is pumped in.

Prevention of Falls

Falls are the most costly type of accident in the roofing industry—costly to both employers and employees. With care, however, the roofer can greatly reduce his or her chances of falling and injuring himself or herself. The apprentice should review the section on prevention of slips and falls on page 21 of *Entering the Roofing and Waterproofing Industry.*

Prevention of Electrical Shocks

Electrical shock is a source of danger on practically every construction job. It is recommended that the apprentice review the material on this type of hazard on pages 21-22 of *Entering the Roofing and Waterproofing Industry.*

Proper Clothing

Proper clothing is an important factor in the prevention of personal injury. A properly attired roofer wears the following:

1. A long-sleeve shirt with cuffs buttoned
2. Long pants that fit well and have no cuffs
3. High top shoes that are laced to the top and that have thick rubber or composition soles and good heels
4. Goggles or a safety shield where required (Kettle operators must wear a safety shield when operating a kettle.)
5. Hard hats where required
6. Respirators where required

Ladders

In working with a ladder, the roofer should observe the following practices:

1. Check the ladder for splits and missing or damaged rungs or hardware.
2. Never use a defective ladder. Report defects to the supervisor.
3. Secure ladders (other than stepladders) against slipping.
4. Be sure that ladders extend 3 feet (0.9 metres) above the roof's edge and that they are tied off to the building.
5. Overlap extension ladders at least three rungs.
6. Keep ladders away from power lines.

The apprentice should also review the section on ladder safety on page 20 of *Entering the Roofing and Waterproofing Industry*.

Kettle and Tanker Safety

Working safely around kettles and tankers requires that the kettle operator and/or other workers do the following:

1. Before firing a kettle, check hoses, gages, fuel tanks, burners, and other equipment for defects. Make sure that the kettle lid fits tightly.
2. Make sure that LP gas cylinders are tied or chained in an upright position.
3. Ensure that a fully charged fire extinguisher is readily accessible, and know how to put out a kettle fire. A dry chemical extinguisher rated at least 20BC is best for most kettle fires.
4. Follow the manufacturer's instructions for firing the burner. Do not ignite the burner near fuel or material that will burn.
5. Before lighting the burner on a tube-type kettle, be sure the tubes are covered with bitumen.
6. Crack the fill lid to relieve pressure when heating a cold tanker.
7. Have a safe place to put a burner when removing it from the kettle.
8. Avoid splashing hotstuff when loading the kettle or drawing off hotstuff.
9. Turn off the burners and the engine, and let the burners cool before refueling.
10. In residential areas, be sure the draw-off cock and kettle lid are locked when the crew leaves the job site at the end of the day.
11. If a flash fire breaks out inside the kettle, try to put it out first by closing the kettle lid and leaving it closed. The lack of oxygen may be enough to put out the fire. However, on well-used kettles the lid may be bent or twisted so much that it will not close tightly. If closing the lid does not work, try throwing baking soda (sodium bicarbonate) into the kettle and on it.
12. Keep the outside of the kettle clean of asphalt.
13. When yellowish smoke appears above the heated bitumen, reduce the heat in the kettle; this is a sign that the kettle is overheated, and a flash fire could break out.

Fire Extinguishers

Fires are classified on the basis of the type of material that is involved; and the type of fire extinguisher to be used on a given fire depends on the classification of the fire. Described below are the four fire classes:

- Class A fires involve ordinary combustible materials, such as wood, cloth, paper, and rubber.
- Class B fires involve flammable liquids, gases, and greases.
- Class C fires are electrical fires.
- Class D fires involve combustible metals, such as magnesium, sodium, and potassium.

All fire extinguishers are rated and labeled as to the type of fire they are designed to be used on. Thus, to fight a Class B fire (a fire resulting from the igniting of gasoline or LP gas, for example), the roofer should use an extinguisher with a B rating.

For additional information on the various types of fire extinguishers and their operation, the apprentice should review Chart 8-1 on page 43 of *Entering the Roofing and Waterproofing Industry*. The apprentice will note, however, that Class D fires are not discussed in that chart since fires involving combustible metals rarely occur in and around roofing operations.

First-Aid Measures

First-aid measures were discussed in some detail on pages 23-24 of *Entering the Roofing and Waterproofing Industry*. The apprentice should review that material to become thoroughly familiar with it.

BUILT-UP ROOFING

TOPIC 2—ROOF PREPARATION AND HANDLING AND LOADING OF BUILT-UP ROOFING MATERIALS

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

- **Identify the general characteristics of a built-up roof.**
- **Describe the procedure for inspecting a roof deck prior to loading built-up roofing materials on it.**
- **Identify the best locations for the materials truck and the kettle at the jobsite.**
- **Describe the special precautions that must be taken with liftbed trucks.**
- **Explain how moisture can affect built-up roofing materials stored at the jobsite.**

A built-up roof is composed of alternate layers of felt and bitumen, which together form a semiflexible, waterproof membrane that conforms to the surface of the roof deck. Built-up roofs are generally surfaced with mineral aggregate, bituminous materials, or a granule-surfaced sheet.

The bitumen (coal-tar pitch or asphalt) is the principal waterproofing element in a built-up roof. The felts, on the other hand, add strength to the system; without their reinforcement the bitumens would crack and lose their oils through evaporation when exposed to sun and weather.

Built-up roofs are classified on the basis of the number of plies of felt used in their construction. The number of plies used depends on various factors, including the type of roof deck, the need or desire for insulation, the type of surfacing desired, the slope of the roof deck, and the particular climatic conditions to which the roof will be subjected.

Four basic types of asphalt are used in built-up roofing systems: (1) dead level; (2) flat grade; (3) steep grade; and (4) special steep grade. Each is formulated to melt within a specific temperature range. Dead-level and flat-grade asphalts have low melting points and, as their names imply, must be used on flat decks or nearly flat decks. The steep-grade asphalts melt more slowly (at higher temperatures) and are designed for use on steep roofs. When using dead-level asphalt, the roofer must take special precautions to guard against asphalt leaks; felt must be extended beyond the edge of the roof and folded back to contain the asphalt. This practice is also necessary in dead-level roof applications around skylights and other holes within the roof structure. Additional information on each of the types of asphalt described above can be found in the workbook on common roofing and waterproofing materials.

As in any type of roofing work, a great deal of preparation and planning must be accomplished before application of a built-up roof can begin. The roof deck must be inspected to determine whether it is properly constructed and ready to be loaded. Decisions must be made about the best locations for unloading the materials truck and for stationing the kettle. Determinations must also be made regarding where to store materials and how best to protect them from moisture. Finally, careful planning is required to ensure that needed materials and equipment are loaded on the roof without damage to any part of the structure, damage to the materials and equipment, or injury to workers.

Inspection of the Roof Deck

Before any materials are loaded on the roof deck, the deck should be inspected by the roofing contractor or the contractor's crew supervisor to determine whether all preliminary construction has been completed and the deck is ready for loading. If unfinished or improper construction is discovered or if other flaws are found in the deck, the situation must be corrected before any materials are placed on it. If corrective measures are not taken at this time, the roofing contractor may later be faced with the costly problem of repairing or replacing the roof.

As part of the inspection of the roof deck of a new building, the roofing contractor or the contractor's crew supervisor should use the roof blueprints to determine (1) where pipes will extend through the deck; (2) where ventilators will be located; (3) where drains will be located; (4) which chimneys or stacks have been installed; and (5) what surface structures, such as supports for electric signs, are required.

Each pipe and vent extending through the roof should be examined to determine whether it is in place and properly installed and whether the required jack or flashing is in place. Electrical conduits that penetrate through the roof deck require jacks or flashings.

Ventilation outlets vary in size and sometimes terminate in a gooseneck, hood, or mobile unit. Jacks or flashings are not always needed with them, because

some have their own flanges to keep out water. However, when these flanges are used, they must be secured to the roof in a watertight manner.

Decks for flat roofs should always be leveled properly to ensure the free drainage of water. In addition, all drainage connections must be installed so as to permit the free flow of water, with all drain outlets set flush with the roof deck. On a flat roof the overflow should be placed close to the outlet and about 2 inches (5.1 centimetres) higher than the lowest part of the roof. (Local building codes may differ, however, and should be checked.) On an enclosed roof with a steep pitch, the overflow should be raised to compensate for the slope. Table 2-1 shows the proper outlet sizes for various roof areas.

TABLE 2-1

Outlet Size Requirements for Good Drainage

Drain diameter	Areas to be drained, at indicated grades	
	¼/12	½/12
3" (7.6 cm)	1,200 sq.ft. (111.5 m²)	4,500 sq. ft. (418.1 m²)
4" (10.2 cm)	2,500 sq.ft. (232.3 m²)	5,200 sq. ft. (483.1 m²)
5" (12.7 cm)	4,500 sq.ft. (418.1 m²)	6,000 sq. ft. (557.4 m²)
6" (15.2 cm)	8,000 sq.ft. (743.2 m²)	10,000 sq. ft. (929 m²)
7" (17.8 cm)	12,400 sq.ft. (1 152 m²)	15,000 sq. ft. (1 393.5 m²)
8" (20.3 cm)	18,000 sq.ft. (1 672.2 m²)	22,500 sq. ft. (2 090.3 m²)

Chimneys are generally constructed of brick or stone, while stacks are made of metal or metal-jacketed products. In addition, stacks usually have weather caps attached. Chimneys and stacks must be flashed, or jacks must be used for waterproofing.

Surface structures may include any of those items placed on a roof deck after the structure has been completed. They may include legs to support a sign, the base for a flagpole, or sleepers under an air conditioning unit. These items must be properly installed on the deck prior to the installation of roofing.

All required saddles, crickets, washbacks, and cant strips should be in place at the time of the inspection. Saddles, crickets, and washbacks are diverters placed on the high side of skylights, chimneys, and similar vertical structures to direct the flow of water away from the obstructions. (See figures 8-11 and 8-12 in Topic 8.) Cant strips may be installed to protect the base flashing wherever a vertical rise occurs. If cant strips are made of wood, they must be applied before the roofing work begins; if they are made of fiberboard, they are part of the roofing application.

On wood or plywood decks, all sheathing boards should be dry, smooth, and free from large knotholes and cracks. Large knotholes or holes with loose knots should be covered with metal and nailed down. All sheathing boards should have a bearing, and any curled edges must be nailed down securely if a good roof surface is to be attained. If thin plywood is used for decking, the joints must be blocked or clipped to avoid possible edge movement, which could result in roof damage.

A concrete or gypsum deck must be smooth, firm, thoroughly cured, free from frost or the effects of freezing, properly leveled, and free from all debris. High spots—such as sharp ridges or other projections—must be removed, and low spots must be filled with portland cement or gypsum mortar. This kind of preparation is the responsibility of the deck contractor. On precast concrete slabs all joints must be filled with mastic by the roofer.

Unloading of the Materials Truck at the Jobsite

Because competition demands efficient operation, the unloading of the materials truck at the jobsite (as well as all other loading and unloading operations) must be well organized, with materials and equipment handled as few times as possible.

Before any material or equipment is unloaded, the best locations for the kettle and truck should be determined. The best location for the kettle is the safest place that is convenient to the jobsite (but far enough away from buildings to avoid fires in case of a flash fire in the kettle). On most jobs the best location for the truck is next to the building to be roofed. If a forklift or liftbed truck is used to hoist materials directly to the roof, care should be taken to park it on level, solid ground. (Liftbed trucks and forklifts with a lifted load can easily tip if the terrain is not solid and level.) Heavy planks can be placed under each tire to provide additional support for the vehicle. If the truck cannot be parked next to the building, it should be placed as close as possible to eliminate unnecessary carrying. If the truck can be left near the building throughout the application of the roof, many roofers prefer to leave materials on the truck until they are needed. However, if the truck cannot be left, the asphalt should be unloaded immediately and placed conveniently near the kettle. Other materials should be placed near the roof-loading device.

Storage and Protection of Materials

One of the major difficulties involved in a built-up roofing job is protecting the roofing materials against

damage from moisture while they are being stored at the jobsite. Moisture may be present in the form of rain, frost, snow, high relative humidity, or dew. Moisture can be picked up from the ground or from dead-level roofs if materials are not protected by raised platforms and vaporproof ground sheets. When roofing materials leave the factory, they generally contain less than 10 percent moisture; before installation, however, their moisture content can easily increase by another 10 percent or more through natural equalization with environmental conditions or by exposure to rain. The following are some general rules for storing and protecting materials:

- Stand all roll goods on end, and store them on a clean surface to keep the ends of the rolls free from foreign matter.
- Store all cartons, insulation, and drums of asphalt on raised, level platforms, and cover them with waterproof tarpaulins. (*NOTE:* Accumulated moisture in asphalt drums can foam when heated in a kettle and possibly injure a worker.)
- Store all materials in a dry place, inside if possible. If materials must be stored outside, place them on raised platforms, and cover them with waterproof tarpaulins.
- Store solvents, emulsions, and coatings in a cool, dry place, and keep emulsions from freezing.
- Keep lids tightly sealed on all emulsions, cutback adhesives, and flashing cements to keep potentially explosive vapors from escaping.
- Unload and handle all materials with care. Dropping roll materials, insulation, and other materials can cause enough damage to result in unsatisfactory application and performance.
- If materials are received in a damaged condition, report this information to the supervisor.
- Roll materials, especially coated rolls, should be kept at a temperature above 40° F. (4.4° C) for 24 hours before application.

Loading of Materials on the Roof

Unless careful consideration is given to loading the roof properly and safely, damage to the roof and to the interior finish of the building may result. When a roof is loaded, consideration must be given to the strength of the roof deck, condition of the sheathing boards, weight distribution of the materials to be placed on the deck, accessibility of materials for application, and the order in which the materials will be needed.

A good roofer will inspect the roof deck before loading any material on it to determine whether it can support the load. Cracked sheathing or sheathing with large knotholes, for example, may break under the weight of the material. Likewise, overhangs or eaves should never have loads placed on them, and the roofer must exercise extreme care when walking or working on these areas.

Among the things the roofer should determine is the spacing of rafters and rafter supports—the parts that can carry weight. If the rafter location cannot be easily determined, as in reroofing, the rafters can be located by tapping the roof in various locations until a solid pattern of sound is found. Usually, rafters are placed every 16 to 24 inches (40.6 to 61 centimetres) apart.

A location that will be accessible to all sections of the roof should be selected to receive the material from the ground. Probably as near the edge as practical and as near the center of the deck as possible is best, because such placement allows the shortest possible distance for distributing material to all parts of the roof. However, the location selected should be clear of obstacles that may be a hindrance in transferring material. Such obstacles include skylights, dormers, valleys, and high fire walls.

As a rule material is loaded on the roof deck starting at the highest point, with care taken to distribute the weight. If too much material is loaded in one spot, the weight may cause the roof deck to collapse. The material that is to be used last, such as cap sheet, should be loaded at the highest point, thus eliminating the necessity of moving this material several times to apply the underlayers of felt. Felt should be loaded after the cap sheet and toward the lowest point. All roll roofing, such as cap sheet and felt, must be loaded in an upright position where possible. On steep roofs where this is impossible, rolls should be laid flat and parallel with the rafters. They should never be placed on top of other rolls, because this causes them to lose their shape and makes them difficult to work with.

Under all circumstances two dry chemical fire extinguishers should be provided before the roof is loaded, one on the ground and one on the roof.

Gravel or rock should be loaded after the roofing felts have been applied, and sacks must be distributed to avoid placing too much weight in one spot. All material and equipment, including sacked gravel, should be set down carefully on the deck, never dropped. If they are dropped, damage may be done to the material, roof deck, structural members, and interior. Bulk gravel or rock is usually loaded only under the supervision of the supervisor.

TOPIC 3—MOPPING OPERATIONS

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

- **Distinguish between shiplapped application and strapped application of roofing material.**
- **Describe the proper procedure for mopping hot asphalt by hand.**
- **Describe the procedure for setting felt by hand.**
- **Discuss the operation of felt-laying machines.**

One of the first things that a roofing crew must do upon arriving at the job site is to determine the type of application to be used to apply the roof covering. The type of application will depend on the pitch of the roof.

Generally, roofing felts are applied "shingle fashion" (overlapped). On roofs with gentle slopes, felt is shiplapped; that is, it is laid so that the seams run horizontal to the low point of the roof—the eave, a drain inside the roofing area, or a valley, such as on a sawtooth roof. On roofs with steep slopes, the felt is strapped; that is, it is laid with the seams running vertical to the low point of the roof.

Figure 3-1 shows a barrel roof and bullnose with the felt strapped. It is usually necessary to use a roller-type felt layer to apply felt at the ends of such a roof.

When strapping a roof, the roofer must be sure to use adequate nailing at the ridge or wherever specified, because the sheets of felt have a tendency to slide from their own weight. *NOTE:* A roofer should never step on the sheets before they are adequately nailed. Doing so could cause the sheets to slip, thereby causing the roofer to fall. The asphalt used to apply the felt must have a high melting point. If it has a low melting point, high temperatures could cause the asphalt to melt and the material to slide.

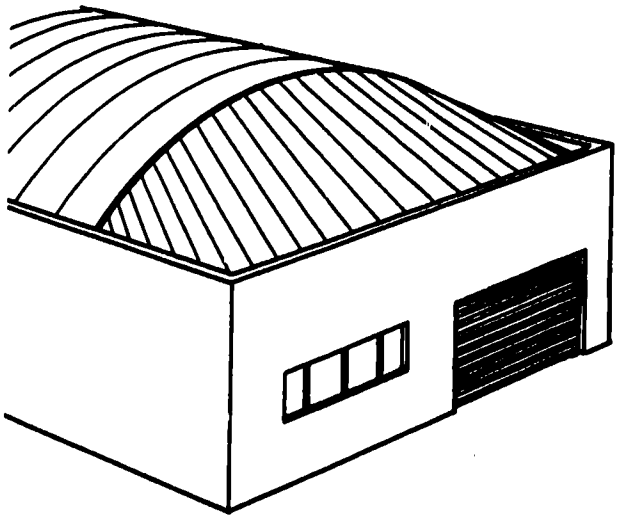


Fig. 3-1. A barrel roof and bullnose with felt strapped

Hand Mopping of Asphalt

Hot asphalt for a built-up roof can be hand-mopped or applied by machine. Some hand mopping is required on every job, however.

Hand mops consist of a handle of wood or aluminum and a fiberglass or cotton head. Cotton mops will hold a larger quantity of hot asphalt than will the fiberglass models, but the latter are more durable and easier to clean. A compression ring is the most common method of securing the head of a fiberglass mop to its handle. Fiberglass heads are made up of individual rings, and roofers can use as many as they feel safe and comfortable working with.

In mopping by hand, the roofer must be sure to soak the mop thoroughly in the hot asphalt in the mop cart or mop bucket. To begin mopping, the roofer removes the mop so that it clears the mop cart or bucket safely and proceeds to the ply line being used. The roofer should slowly turn the mop handle to squeeze the asphalt out of the mop in an even coat and proceed down the roof. The mop head must always have sufficient asphalt to allow the mop to glide; insufficient asphalt will result in "scrubbing," or merely coating the roof black. The mop cart should be placed in a position where the roofer will not back into it while mopping. Keeping the mop handle clean and turning smoothly is very important in maintaining the proper flow of hot asphalt. Wax or motor oil can be used to lubricate the mop handle.

When through mopping for the day, the roofer should be sure to use a board to press out as much asphalt as possible from the mop. A spade, shovel, or spudding bar should never be used to press out asphalt because of the danger of cutting the mop with the sharp metal edges. Afterward, the mop should be (1) spun so that it will flare out; (2) placed on a surface to which it will not stick (such as an asphalt carton); and (3) sprinkled with water so that it will cool rapidly at the core. A hot mop should never be left on the roof

deck, in the back of the materials truck, or on a flammable surface in the yard; mops thought to be sufficiently cooled have been known to ignite and burn. *NOTE:* On a windy day the mop person should be alert for fellow workers near the mop cart. Hotstuff could be blown and cause severe burns.

Felt-Laying Machines

Three basic types of mechanical asphalt dispensers are in use today: (1) the Mini-mopper (a trade name); (2) the roller-type felt layer; and (3) the combination felt layer, which is the most widely used of the three. When using any mechanical equipment on a roof surface over a dead-level pitch, the roofer should always be sure that he or she can control the machine so that it will not roll off the roof.

Combination Felt Layer

The combination felt layer (see Fig. 3-2) is a combination asphalt dispenser and felt layer. A roll of felt is placed on the rolling rod of the machine, and the felt is pulled through the bottom roller so that it comes into contact with the asphalt as the machine moves.

Some felt machines are operated by pulling them backward; others must be pushed forward. The most commonly used type is the backward pull model. The flow of asphalt is regulated by ten to 12 valves located at the top front of the machine. These valves can be adjusted to dispense the required amount of asphalt per square. Valves can be shut off for strip-mopping, or one-third of the valves can be closed for laying a straight three-ply roof. In this way no asphalt is applied to the bare roof deck. A foot lever is used to open the valves, and a hand lever on the handle of the machine is used to close them. The flow of asphalt is spread evenly by means of a chain mesh bar located at the bottom of the machine.

Most machines have lubrication dispensers on the two side wheels to keep asphalt from sticking to the wheels. Dirty wheels will tear up newly laid felt as fast as it is laid and will make pulling the machine very difficult.

When first starting the felt machine, the operator must remember that all the valves are "frozen" shut from the cold asphalt. He or she should be sure that the asphalt is hot enough to "thaw" the valves and flow easily. Testing the machine in an area that is removed from the immediate work area is recommended. If the operator discovers a faulty valve after beginning work in the work area, he or she will have to pull (or push) the machine through the fresh asphalt after correcting the problem. This is dangerous.

In starting the first course, the operator first depresses the foot lever to start the flow of asphalt. The roll setter (tail person) holds the end of the felt, placing it on the ply line, until the machine is far enough down the roof so that the felt will not be pulled out of place. The roll setter then uses a broom or T pipe to force the air pockets out of the felt and ensure a tight bond. The roll setter also watches for any obstacles that the machine operator cannot see or is not aware of. The roll setter is also in charge of (1) cutting the felt when reaching an obstacle or the end of the roof; and (2) inserting a new roll of felt and threading it through the machine when necessary. *NOTE:* When replacing a roll of felt, the operator should place the machine over any asphalt that was not covered when the roll ended so that the worker inserting the new roll will not step in the hot asphalt.

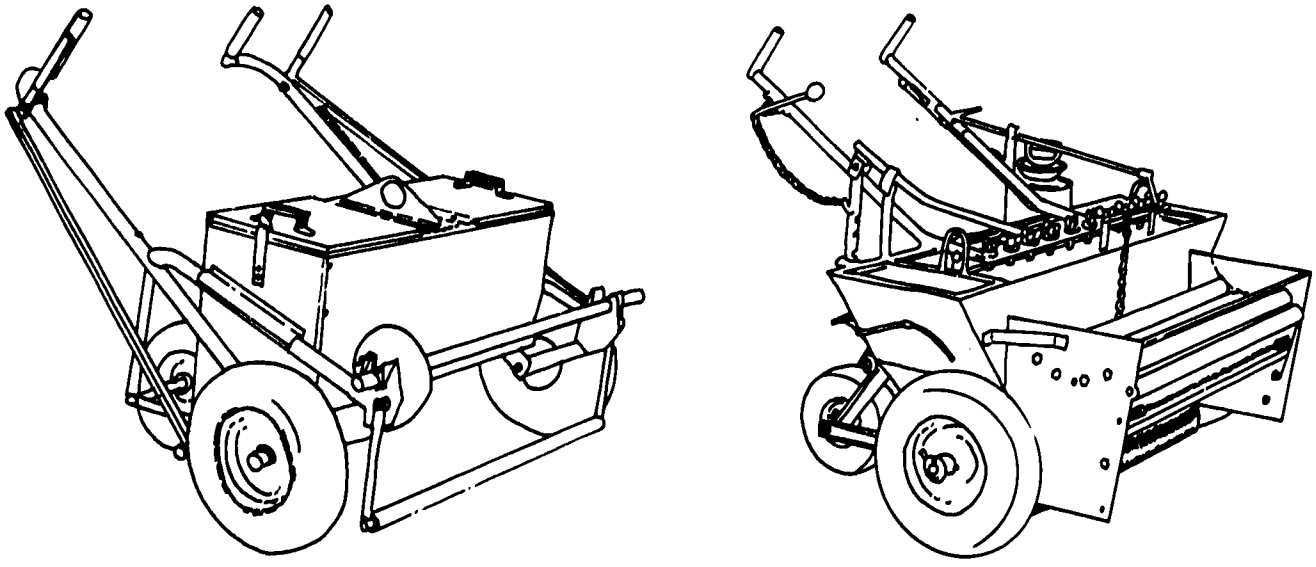


Fig. 3-2. Combination felt layers

A felt machine operator should be sure that the kettle on the job is of sufficient size to keep the machine supplied with hot asphalt. Felt-laying machines hold approximately 30 gallons (113.5 litres) of asphalt, or an amount equal to two 100-pound (45.4-kilogram) kegs of asphalt. A small kettle cannot keep pace with a felt-laying machine, because it cannot melt the asphalt fast enough to replace what is used.

The combination felt layer is designed for use on large work areas where production can be maintained. A good operator will have felt stacked where each roll will end so that the roll setter has to travel only a small distance for a new roll. Highboys or buckets of hotstuff should also be placed near each roll so that the supply of asphalt and the felt roll can be replenished at the same time.

Combination felt layers are superior for production work, but they are also the cause of some of the most severe injuries in the roofing industry. For maximum safety the following practices should be observed by a roofer working with a combination felt layer:

- Never pull a machine to the edge of the roof, regardless of how much felt is left in the roll; a hand-mopped header is usually required at the edge of the roof.
- Never pick up a wheel to move the machine over a pipe or other roof projection.
- Never use this machine on any pitched roof where the operator cannot easily turn the machine himself or herself to go up the roof for the next course.
- Never overfill the machine; a splash or a spill could burn someone.
- Never use faulty or inappropriate equipment (such as a ladder or a rope and wheel) to hoist a combination felt layer to the roof. Some machines weigh over 400 pounds (181.6 kilograms) and will place a severe strain on even good equipment. The roofer should also be sure that she or he has sufficient assistance in hoisting the machine and in taking it off the hoist at the roof level.

The combination felt layer can be used for flood coating in graveling operations, glazing, mopping for the installation of insulation, and mopping for a mineral surface cap sheet. It can be used to install up to 50-pound (22.7-kilogram) felt, but it should not be used to apply mineral surface cap sheet.

Using a combination felt layer on a windy day is not recommended.

NOTE: Whenever a roofer must walk backward while operating a machine, he or she must exercise extreme care to avoid falling off the roof or backing into skylights, roof openings, or pipes. The *Construction Safety Orders* prohibit use of a felt layer where approved barricades are not provided at roof openings and perimeters. (See Article 30, "Roofing Operations and Equipment," of the *Construction Safety Orders*, which is reproduced in the appendix to this workbook.)

The Mini-mopper

The Mini-mopper is similar to the combination felt layer. (See Fig. 3-3.) It is considerably smaller, however, and is not designed to lay felt. It is most economical to use on small jobs where the felt must be hand set. A chain mesh is used to ensure that the asphalt is spread evenly. The Mini-mopper can be used in glazing, flood coating, and mopping operations. Some roofers also use it as a mop cart when doing detail work. The wheels should be kept clean.

Roller-Type Felt Layers

The roller-type felt layer (see Fig. 3-4) is a combination felt layer and asphalt dispenser that is used primarily on steep roofs or for laying Styrofoam insulation, which requires only a light coating of asphalt. These machines consist of a roller or drum set in a trough that is mounted on four wheels. Each wheel has a height adjustment that enables the operator to keep the machine level on a sloped roof. The trough is filled with hot asphalt. The drum will turn 360°, and as it turns, it is covered with asphalt.

The felt is set on a rolling rod on the back of the machine and is pulled over the drum and laid on the ply line. The tail person pulls the felt into place, and the operator cuts it off at the desired length. The machine is then moved over for the next course. It is very important for the operator to be sure that the machine is locked and stationary, because otherwise the pressure applied by pulling the felt across the drum will pull the machine down the slope of the roof. *NOTE:* Because of the danger of the hot asphalt's splashing during this operation, the operator must be sure to wear proper clothing—long-sleeve shirt, gloves, and so forth.

The temperature of the asphalt in the trough should be approximately 400° F. (204.4° C) to ensure a sufficient coating. The higher the temperature, the less asphalt will be applied.

Since this type of machine is designed for use on steep roofs, such as barrel or mansard roofs, a chicken ladder may have to be used by the tail person to reach the bottom of the roof. This type of work should be done only by experienced roofers. Compliance with all safety regulations and practices for work on steep roofs is a must.

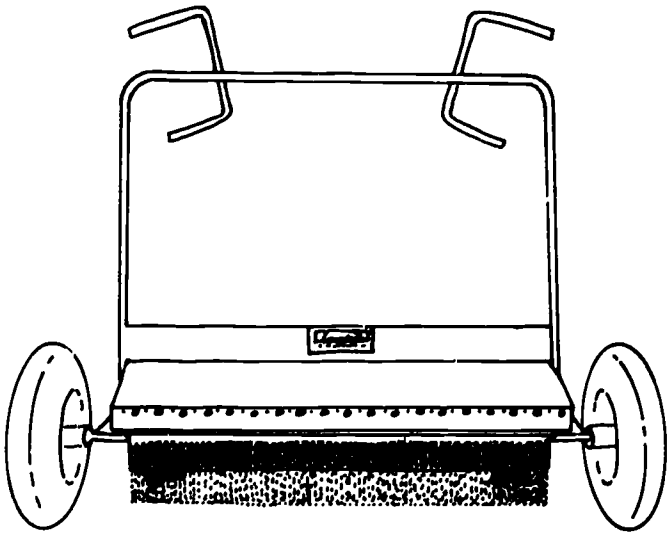


Fig. 3-3. Mini-mopper

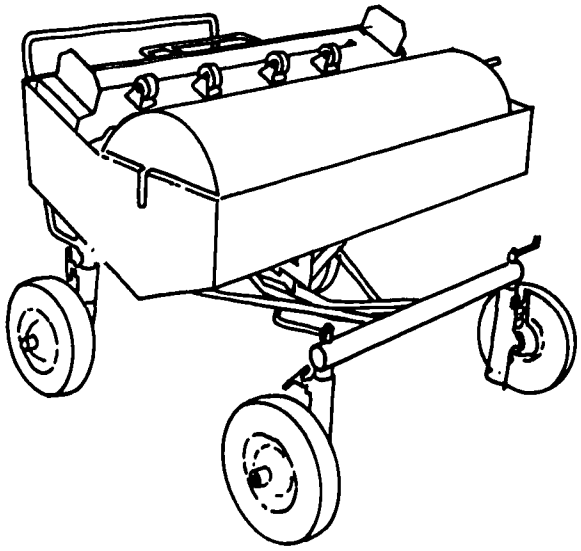


Fig. 3-4. Roller-type felt layer

Because of the safety factors involved in pulling felt that has a coating of hot asphalt on it, the felt sheets should be kept as short as possible to keep them from tearing in half. Usually, 18 feet (5.5 metres) is the maximum length to use so that the asphalt will not get cold before the sheet is set. It is recommended that roller-type machines not be used on windy days.

Setting of Felt by Hand

The roofer who sets felt by hand is one of the most important members of the crew. He or she must set the felt on the correct ply line and keep it there across the roof. He or she must also make sure to keep pace with the mop person so that when the felt is laid, the asphalt is hot enough to provide the proper bond.

One method of applying felt by hand involves a two-person crew. The mop person applies sufficient asphalt to provide a fluid base for the felt to be set in. The "roll" person then unrolls the felt a distance of about 4 feet (1.2 metres). With one hand on the end of the felt and the other on the roll, the roll person throws the felt above the ply line and then slides it down even with the ply line. The roll is then rolled out on a straight course through the mopped asphalt. This is done in consecutive courses in a stairstep fashion until insufficient room remains to set another roll. The roll person then returns to the first roll set and lays it across the roof until the roll is finished or the end of the roof is reached. If the roll is finished, the procedure should be begun again and continued.

If the pitch of the roof is greater than 1/12, the roll will have a tendency to pull downward from its own weight. The roll person must therefore exert constant pressure against the bottom of the roll to keep it in a straight line. If the felt does get off the ply line, the felt person should cut the felt, mop a lap, and start laying again. Trying to force the roll back onto the ply line will cause the sheet to buckle. If a roof projection interferes with the starting of a roll, the felt person should move down the roof past the projection, unroll enough felt to set it on ply, and then backroll the extra length of felt, cutting it to accommodate the projection. Excess felt that is at the end of the roll and that does not come in contact with asphalt should be trimmed off.

Another method of setting felt rolls is called the "fly-in" method. The mop person first covers an area with asphalt. He or she then picks up the roll of felt, and the felt layer takes the end of the felt and pulls it to the end of the roof, setting it on the ply line. Next, the mop person sets the felt roll on the ply line at his or her end of the roof. This allows for a long continuous straight line of felt. This method is also used if the felt is too heavy for one worker to set. With crews of three workers, this system works well with one worker mopping, one holding the felt, and one setting the roll on ply. The roll holder can use a rolling rod to reduce the friction between the roll and his or her hands. The fly-in method is also easy to use on steep roofs, where it is difficult to keep the roll on ply or the felt has to be strapped, and on roofs that have unusual deck designs that make keeping the felt on ply impossible. *NOTE:* The roofer should be sure to trim off any excess felt that is not secured by hot asphalt and repair any tears in the finished roof so that the required plies are maintained throughout the entire roofing area.

BUILT-UP ROOFING

TOPIC 4—APPLICATION OF BUILT-UP ROOF ASSEMBLIES

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

- **Describe the procedure for applying built-up roofs of various numbers of plies.**
- **Demonstrate the procedures for laying felt for one-ply, two-ply, three-ply, four-ply, and five-ply roof assemblies.**
- **Describe the procedure for applying a gravel surface.**
- **Demonstrate the procedure for applying a mineral surface cap sheet.**
- **List the steps to be followed in glazing felt.**

It is not practical or possible to prefabricate a roof. Every roof must be fabricated on the roof deck to be covered. Built-up roofs are made by sealing layers of roofing felt together with bitumen adhesive. Each layer of felt is called a ply.

The type of roof and the number of plies to be used on any job may be determined by the roof engineer, architect, specification writer, or the roofing contractor. The decision as to roof type and number of plies is based on a number of factors—the prevailing climate in the area, the type of deck being covered (concrete, gypsum, wood, or steel), the pitch of the roof, and applicable building codes. As a general rule, the flatter the roof, the more plies are required.

As was discussed in Topic 3, roofing felts are usually applied "shingle fashion" so as not to "buck" water and are either shiplapped or strapped, depending on the pitch of the roof. On roofs with pitches greater than 1/12, the felts must be nailed to prevent their slipping off the deck. Heavy material is either mopped or flopped into place; lightweight material can either be rolled or pulled into place. Care must always be taken to avoid wrinkling the felt, because wrinkles may later become blisters or openings through which water may enter and cause roof failure.

Felts are solid-mopped together, but never to the roof deck. They are attached to the deck by nailing, sprinkle-mopping (a random mopping in which heated bitumen beads are applied with a brush or mop), or spot-mopping (an application of hot bitumen in roughly circular areas, which leaves a grid of unmopped perpendicular bands on the roof). If only nails are used, each sheet must be held by nails. Nailing is an important skill that the apprentice roofer must learn. The various kinds of nails and nailing techniques that roofers use are discussed in the workbook on common roofing and waterproofing materials.

"Phase construction"—laying all the insulation, then all the felt, and so on—should be avoided. Whenever possible, each section of the roof being worked on should be complete at the close of the workday.

One-Ply Roofs

A one-ply roof (see Fig. 4-1) usually consists of a cap sheet with lap cement under each lap. Such roofs are very inexpensive and are found primarily on barns, chicken coops, or temporary buildings. One-ply construction is also used to provide a vapor barrier or base sheet under a built-up roof.

In applying a one-ply roof, the roofer should begin at the lowest point of the roof and apply 36-inch-wide

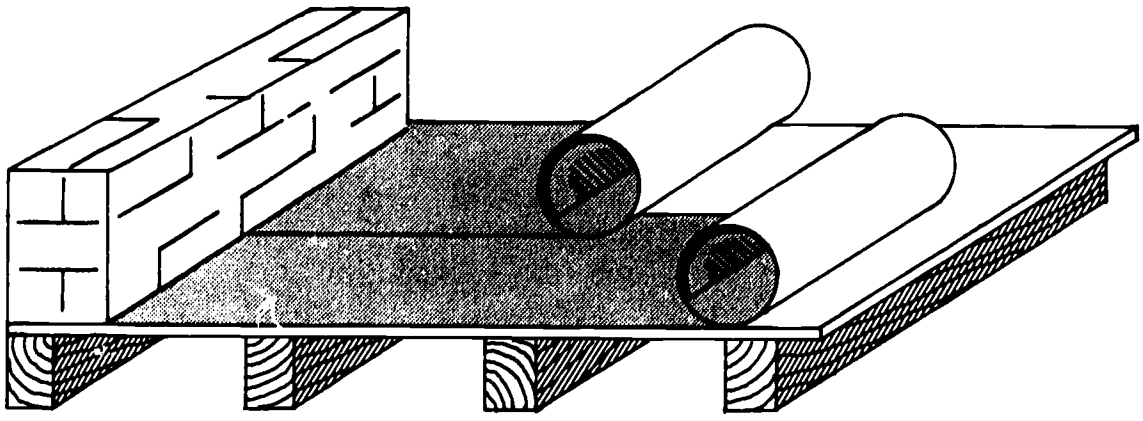


Fig. 4-1. A one-ply roof assembly

(91.4-centimetre-wide) cap sheet across the deck. Succeeding rolls should be applied so that they overlap the preceding one by 2 inches (5.1 centimetres). Thus, each sheet will have an exposure of 34 inches (86.4 centimetres). Side laps (the laps where one roll ends and another begins) should be at least 6 inches (15.2 centimetres), and they should be staggered.

Two-Ply Roofs

Figure 4-2 shows a straight two-ply built-up roof. In applying such a roof, the roofer should first lay a half sheet (18 inches; 45.7 centimetres) and then cover it with a full sheet (36 inches; 91.4 centimetres). Nails used on sloped roofs should be placed near the center of the full sheet so that they penetrate through both sheets. The layers should be mopped together in accordance with the specifications. The roofer should lay full sheets across the remainder of the deck, making sure that each sheet overlaps the preceding sheet by at least 17 inches (43.2 centimetres).

Two-ply construction is recommended for vapor barriers or base sheets on multiple-ply roofs.

Multiple-Ply Roofs

Some built-up roofs require three-ply, four-ply, or five-ply application. Such roofs may be laid with a base sheet and the balance consisting of plies, or they may be laid in straight shingle fashion with the required number of plies. For example, a three-ply system may be laid "one and two," which means that a one-ply base sheet is laid under two felts; or it may consist of three felts with no base sheet. On roofs with pitches greater than ¼/12, it is better to use the straight three-shingle fashion than the "one and two" method to minimize the gravel weight on the exposed portion of the felt. The reason for this is that the use of a base sheet leaves a 17-inch (43.2-centimetre) strip that must support the gravel. On a straight three-ply system, however, this strip is only 11⅓ inches (28.7 centimetres) wide. Thus, the amount of gravel weight that must be supported by nails is reduced.

The base sheet is sometimes referred to as a slip sheet or dry sheet. Rosin sheets are also known as slip sheets, but rosin sheets are never considered as plies or counted as such. They are generally used to keep asphalt off the roofing deck.

To find the number of inches of exposure, the roofer should divide 34 inches (86.4 centimetres) by the number of plies. For example, with a three-ply assembly, the calculation would be as follows:

$$34'' \div 3 = 11\tfrac{1}{3}'' \text{ exposure}$$

Similarly, the exposures on a four-ply and five-ply assembly would be determined in the following manner:

$$34'' \div 4 = 8\tfrac{1}{2}'' \text{ exposure}$$
$$34'' \div 5 = 6\tfrac{4}{5}'' \text{ exposure}$$

Figure 4-3 shows the application of a base sheet and two felts. To apply this roof, the roofer should start at the lowest, or drain, point of the roof, and lay a full 36-inch (91.4-centimetre) base sheet. Additional full base sheets should be laid up the incline, with a 2-inch (5.1-centimetre) lap. A 4-inch (10.2-centimetre) lap should be used at the ends. Next, the roofer should start the two-ply application at the low point by solid-mopping an 18-inch-wide (45.7-centimetre-wide) roll of felt. He or she should then solid-mop a 36-inch-wide (91.4-centimetre-wide) area and embed a full roll of felt. The upper 19 inches (48.3 centimetres) of the full roll should be solid-mopped, leaving an exposure of 17 inches (43.2 centimetres). A full roll of felt should be embedded, and the procedure should be repeated to the top of the roof. The roofer should remember that solid-mopping requires at least 20 pounds (9.1 kilograms) of asphalt per square.

Figure 4-4 shows a straight three-ply felt assembly. To make this application, the roofer starts at the lowest, or drain, point of the roof and nails or sprinkle-

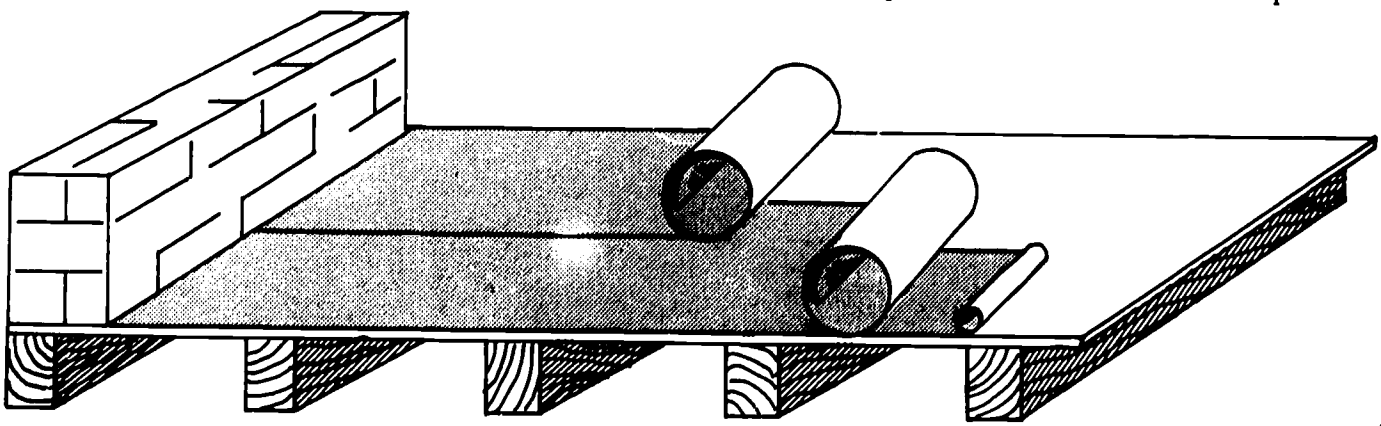


Fig. 4-2. A two-ply roof assembly

mops a one-third sheet of felt to the deck. Some contractors cut the one-third (or two-thirds) sheets of felt at the shop. Next, the roofer solid-mops the one-third sheet and embeds the remaining two-thirds sheet. Then, he or she should solid-mop the tw thirds sheet and embed the full sheet. The roofer should proceed up the deck, lapping each sheet 24⅔ inches (62.7 centimetres) and leaving 11⅓ inches (28.7 centimetres) exposed.

NOTE: When applying felts in this manner, the roofer should prevent hot asphalt from dripping through cracks in the sheathing or through joints on precast concrete. It is best to keep the mop bucket or cart close to the sheet being mopped to avoid splashing the asphalt on the unprotected deck.

Figure 4-5 shows a roof assembly with a one-ply base sheet and three felts. The base sheet begins with a half sheet so that the base sheet laps will not match those of the finished felt. The base sheet is nailed 9 inches (22.9 centimetres) on center at the laps. Two additional rows of nails are driven through the remainder of the felt at 11 inches (27.9 centimetres)

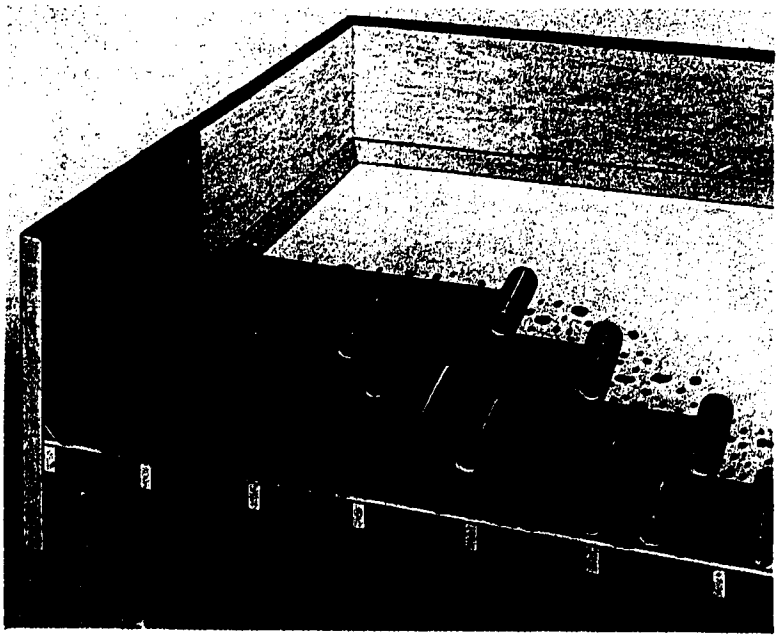


Fig. 4-3. A roof assembly with a base sheet and two felts

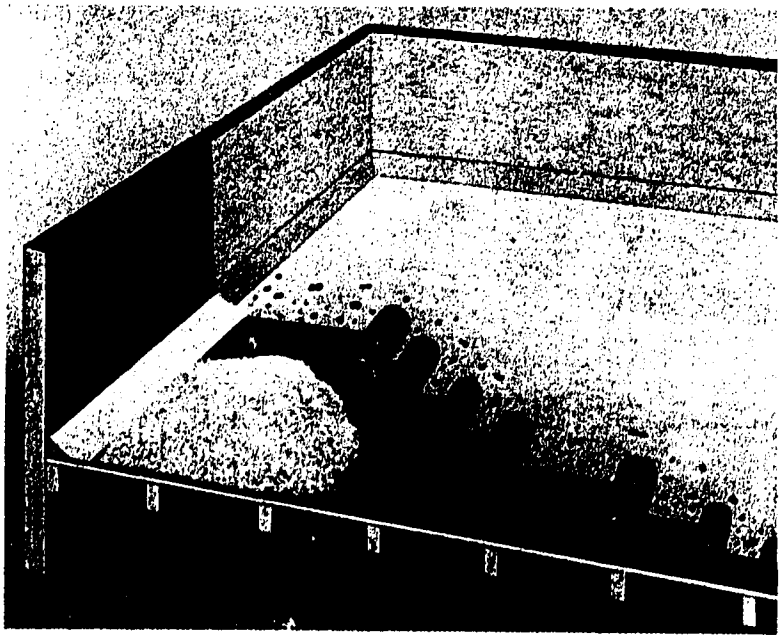


Fig. 4-4. A straight three-ply roof assembly

and 22 inches (55.9 centimetres), respectively, above the lap nails. The on-center spacing of the nails in these two rows is 18 inches (45.7 centimetres), and the two rows are staggered. The finished felt is a three-ply system. On pitches of 2/12 or greater, felt should be nailed approximately 9 inches (22.9 centimetres) on center at the back edge. *NOTE:* The roofer should always check the nailing schedule in the specifications before placing any nails.

Figure 4-6 shows a straight four-ply roof assembly over a nonnailable deck or insulation board. To apply such a roof, the roofer starts at the lowest point of the roof, and applies a 9-inch-wide (22.9-centimetre-wide) sheet of felt. Next, he or she applies an 18-inch-wide (45.7-centimetre-wide) sheet and then a sheet that is 27 inches (68.6 centimetres) wide. Finally, a 36-inch-wide (91.4-centimetre-wide) sheet of felt is applied. Each succeeding sheet should be 36 inches (91.4 centimetres) wide and should overlap the preceding felt by 27½ inches (69.9 centimetres). The exposure will be 8½ inches (21.6 centimetres). No primer is shown in Figure 3-6, but a primer is usually required on all nonnailable decks. Low-melt asphalt or coal-tar pitch should be used on relatively flat decks; medium- or high-melt asphalt or coal-tar pitch should be used if the slope is greater than ½/12.

Figure 4-7 shows some other commonly used roof assembly systems with which the roofer should be familiar.

Header sheets help to ensure that the required ply and sufficient asphalt are applied at the rake ends.

Header sheets also serve to warn the operators of felt-laying machines and other workers that they are near the edge of the roof.

Header sheets are also used as perimeter flashing against parapet walls. On multiple-ply roofs it is advisable to feather the sheets of felt where they turn up the wall. This helps to prevent the flashing from being bulky. In feathering, each sheet of felt is cut so that it is longer than the sheet directly beneath it as shown in Figure 4-8. If blocking is not used where the deck butts against the wall, each felt sheet should be turned (folded) as necessary to decrease, or soften, the angle between the wall and the deck.

On some roofs the fascia board will extend above the roof deck, and the roof drains must therefore be set behind the gravel stop. This type of roof generally includes a 2-inch by 4-inch (5.1-centimetre by 10.2-centimetre) nailing board to which the gravel stop can be secured. The header sheets should be folded carefully at the base of the nailing board and feathered at the top. (See Fig. 4-9.)

Application of the Gravel Surface

Gravel is often used in place of cap sheets as a finish material on built-up roofs. Like the granules in cap sheets, gravel helps prevent the evaporation of oils in the asphalt and felts. It also serves to decorate roofs and reflects heat and ultraviolet rays from the sun, which are the biggest contributors to roof deterioration. Because of this, light-colored rocks are often preferred to the dark-colored ones. Where asphalt is used, the use of rock is not practical on roofs with pitches greater than 3/12.

For a quality application of gravel, a minimum of 40 to 60 pounds (18.2 to 27.2 kilograms) of asphalt per square is usually needed; certain roof and weather conditions may require more. An amount this large

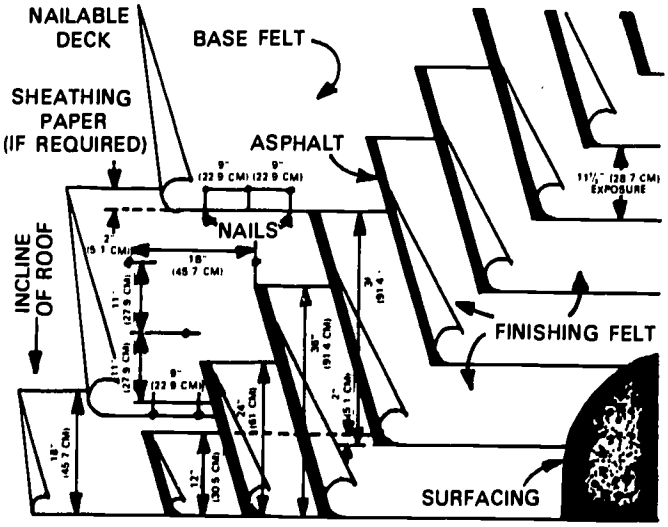


Fig. 4-5. A roof assembly with a one-ply base sheet and three felts

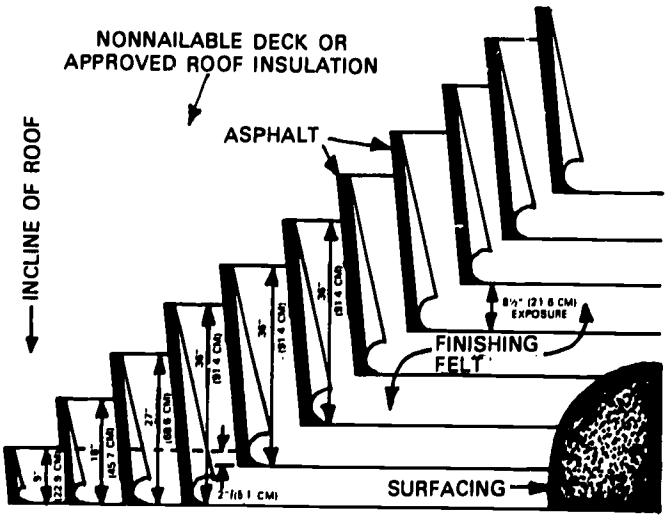


Fig. 4-6. A straight four-ply roof assembly

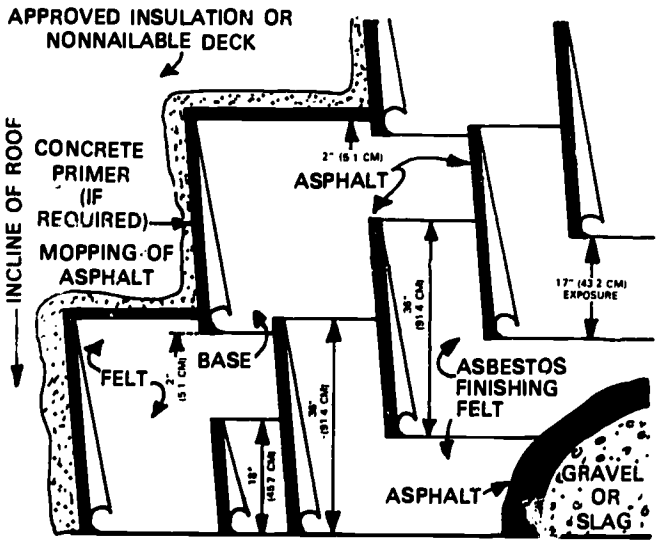
must be poured; the steeper the roof, the cooler the asphalt will have to be to keep it from running. Around gravel stops and eaves, however, the asphalt must be mopped.

Gravel is spread immediately behind the application of hot asphalt to avoid bare spots (called "holidays"). The amount of gravel (or rock) required depends on its size and type. It must be embedded in the hot asphalt evenly and smoothly and must be devoid of holidays.

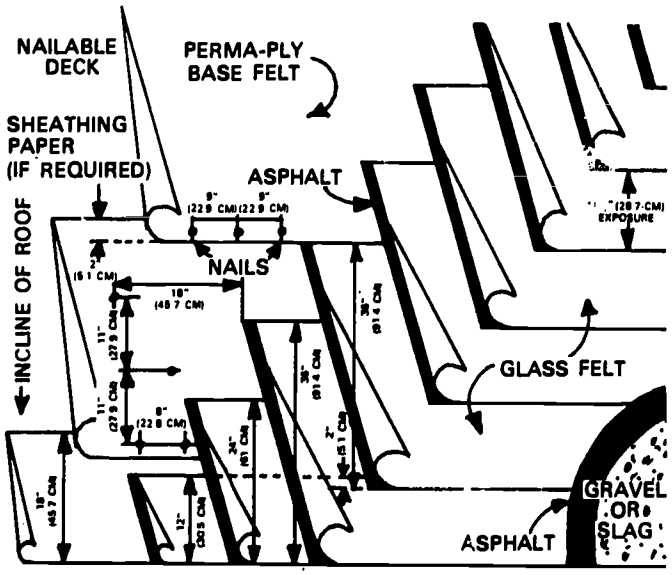
It should be noted that new developments in aggregates for roof surfacing have made possible the use of increasingly larger quantities of material with appreciably less weight, thus providing better coverage and protection without danger of roof structure failure.

Unlike asphalt, coal-tar pitch contains no oil. Thus, the molecules of pitch, if protected by gravel or slag, will tend to heal themselves and will not deteriorate when exposed to the sun. Gravel used with coal-tar pitch should be hard and opaque and not less than ⅜ inch (1 centimetre) in size. The slag used should be graded from ¼ inch (0.6 centimetre) to ⅝ inch (1.6 centimetres) in size.

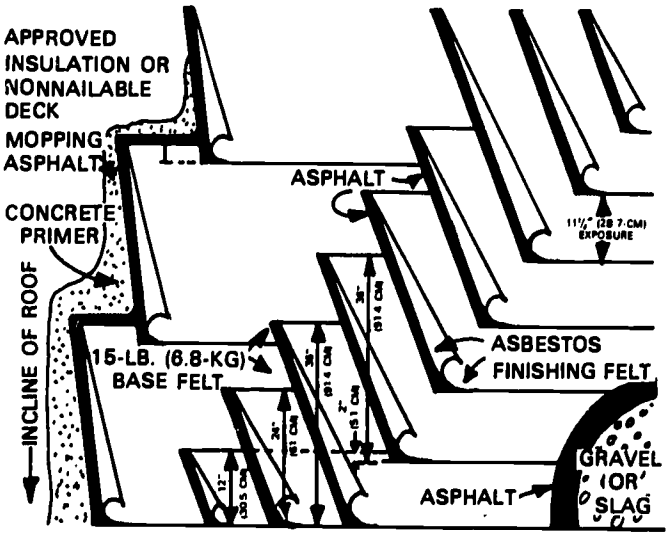
The term "gravel" is used to describe this material, but the rock may have a number of different origins, depending on the resources of the particular area



ONE-PLY BASE SHEET WITH TWO-PLY FINISH AND GRAVEL ON NONNAILABLE DECK



ONE-PLY BASE SHEET AND THREE-PLY FINISH WITH GRAVEL ON NAILABLE DECK



ONE-PLY BASE SHEET AND THREE-PLY FINISH WITH GRAVEL ON NONNAILABLE DECK

(continued)

Fig. 4-7. Some other commonly used roof assembly systems

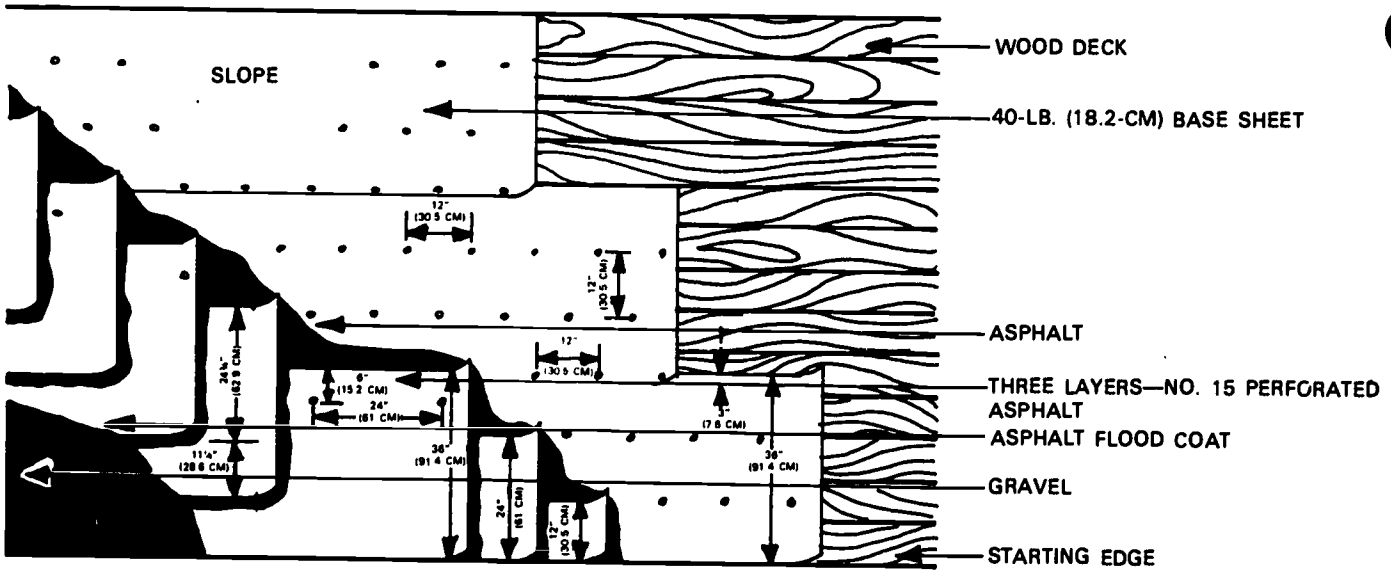


Fig. 4-7 (continued)

from which it is taken. The rock may be brought from a quarry and be crushed and screened on the basis of size before delivery, or it may be treated with a glaze and fired in a furnace before delivery. Among the quarried materials used are marble, gravel, and dolomite. In addition, a number of other materials are used on rock roofs. These include crushed china, crushed brick, and iron ore slag.

The materials used are usually delivered in bulk or bags. The materials should be free of dust and moisture. The more angular the pieces, the better they will embed themselves in the asphalt or pitch. In some areas the rock is delivered in bulk and blown up to the roof deck into a hopper. The gravel is then released into a wheelbarrow and windrowed into gravel piles. Gravel may also be spot-loaded on the roof in piles 9 feet (2.7 metres) on center. The gravel is brought to the roof by means of conveyors.

Application of a Mineral Surface Cap Sheet

Cap sheet is frequently used when the roof is steeper than 3/12, because gravel will generally not hold on such a slope.

The application of base felts for a cap sheet installation is identical to that for a gravel surface roof.

The mineral surface cap sheet on a roof is the exposed sheet. A very important step in laying mineral surface roofing is to allow the rolls of cap sheet to stretch, since they are rolled and wrapped tightly at the factory. If they are not stretched prior to laying, they will stretch afterward, causing buckles and bows. Stretching can be accomplished by stockpiling 36-foot (11-metre) lengths of cap sheet on the high point of the roof, keeping the granule side down and the roll ends even. They may then be cut into the desired lengths and brought down into place ready for flopping. Stretching by this method takes only a few minutes, especially in hot weather. *NOTE:* The thicker the material, the longer it takes for it to warm up to facilitate stretching.

There are many different ways to lay out a cap sheet roof, but it should always be done neatly, with all end laps staggered by at least 2 feet (61 centimetres) and header sheets installed around all edges. Cap sheets should always be laid so that none of the sheets will buck water.

One method of application is to "stairstep," or "stepback," as follows:

- Lay the sheets in sequence, starting with an 18-foot (5.5-metre) sheet, followed by a 16-foot (4.9-metre) sheet, a 14-foot (4.3-metre) sheet, a 12-foot (3.7-metre) sheet, and so on.
- Bypass pipes 4 inches (10.2 centimetres), and bring the next sheet to the pipe, covering the cut.
- Place all pipe jacks, vents, and the like as the material is being laid.
- If the roof has a pitch, nail the selvage edge in accordance with the specifications for the job.
- If the pitch of the roof is steep, the cap sheet may be laid vertically, with the top edge nailed 6 to 8 inches (15.2 to 20.3 centimetres) on center about 3 inches (7.6 centimetres) down from the top edge.

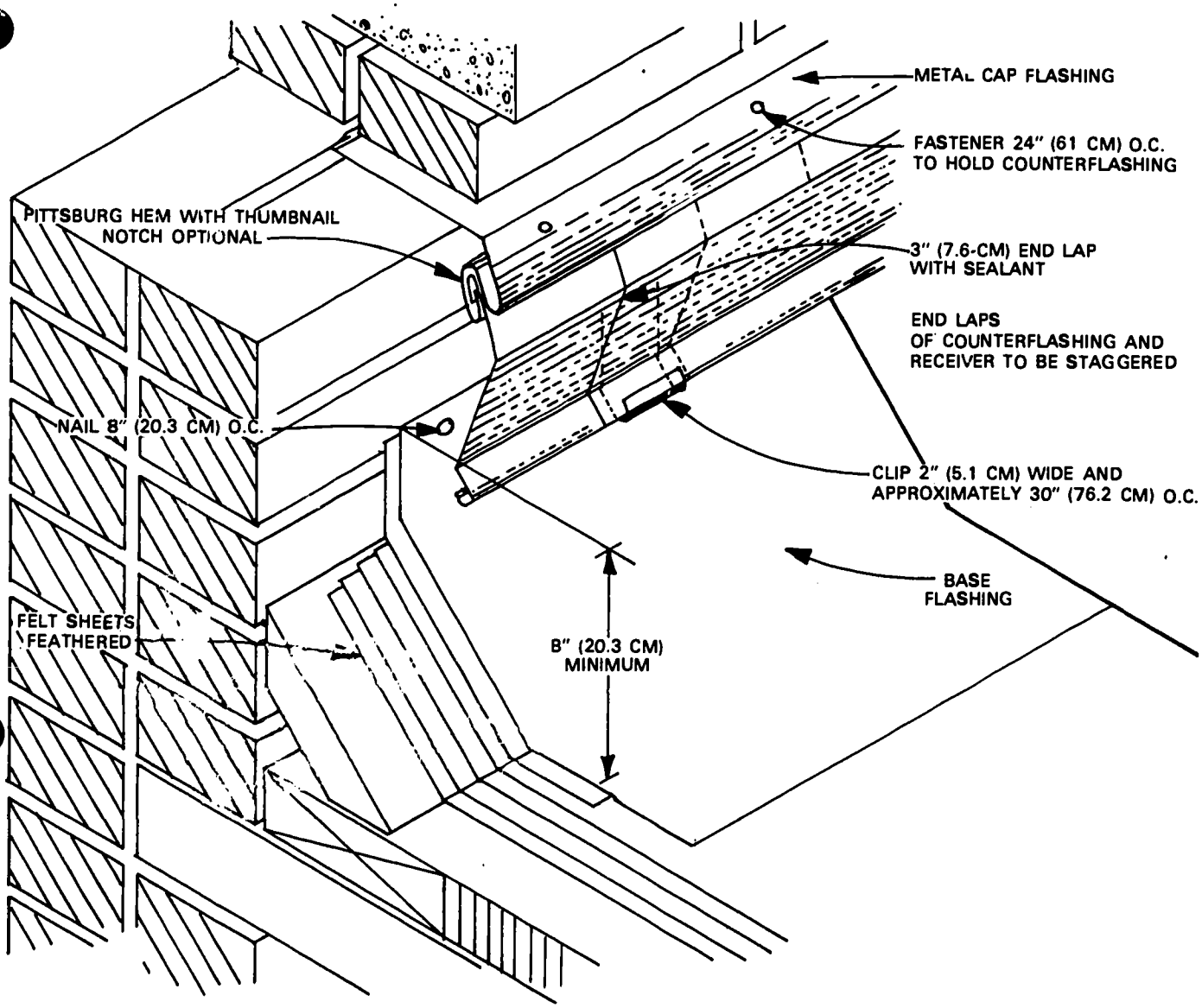


Fig. 4-8. Application of base flashing and felt sheets on a wall-supported deck

If the cap sheets used are no longer than 18 feet (5.5 metres), they will be easier to handle, and a better job can be done. However, in areas of cold weather, cap sheets no longer than 12 feet (3.7 metres) are recommended. Some roofers use a "slop" sheet to do a neater job. This is a piece of cap sheet cut straight off the end of the roll and laid at the end lap to enable the mop person to maintain a straight, neat edge. For better adhesion the end lap should be back-mopped.

For cap sheet jobs requiring an especially neat appearance, matching granules may be sprinkled on any exposed asphalt as soon as the cap sheet is flopped and while the excess asphalt is still hot enough to allow adhesion. This process is also necessary when the roof is to receive a protective coating; this provides a surface for the coating to cling to. Two roof assemblies with cap sheets are shown in Figure 4-10.

On large jobs where there is room enough to use a Mini-mopper or felt machine, the cap sheet is laid out ahead of the machine by two roofers. The mineral side is placed down, and sufficient laps are left for each sheet. A felt machine or Mini-mopper is then pulled down the roof, covering the 2-inch (5.1-centimetre) selvage and 34 inches (86.4 centimetres) on the base sheet. Two more roofers then follow behind, flopping the sheets into the asphalt and, with the use of a small mop called a seam mop, mopping in the laps as they go. This is a very efficient operation, and it can only be done on a large job. About seven roofers are required for this application. The roof will be clean and neat, with an even stairstep at the laps if

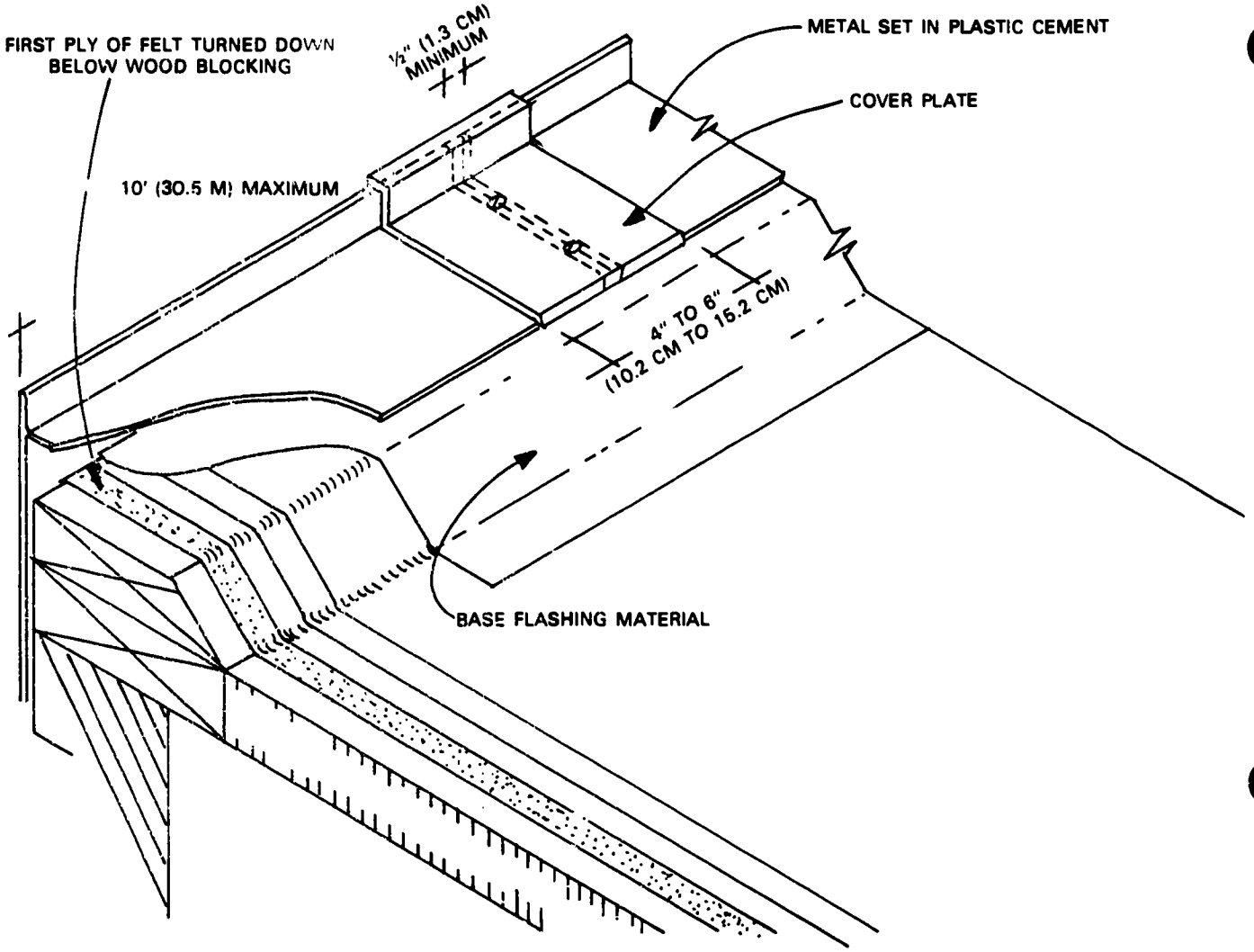
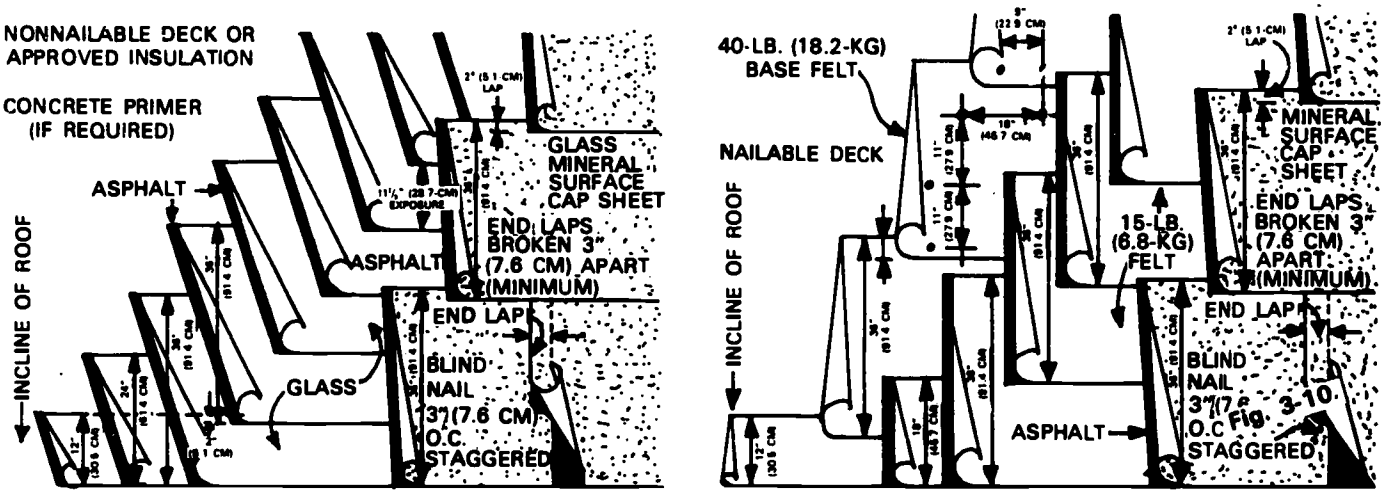


Fig. 4-9. Heavy metal roof edge detail



A THREE-PLY GLASS BASE SHEET AND A GLASS CAP SHEET

A ONE-PLY DRY SHEET, TWO-PLY BASE SHEET, AND A MINERAL CAP SHEET

Fig. 4-10. Two roof assemblies with cap sheets

the crew works away from the finished roof and does not track over it while delivering hotstuff.

Glazing

The purpose of glazing is to prevent the curling of seams of all exposed 15-pound (6.8-kilogram) rag felts when it is necessary to leave them overnight, over weekends, or during work stoppages.

Most specifications for roofing jobs indicate a standard glazing procedure, such as, "Cover exposed felts with gravel or cap sheet at the close of the day, or glaze the roof." One exception should be noted, however. If the felts are to be graveled or otherwise covered the following day, it is best to leave them unglazed, for it is difficult to walk on a newly glazed roof on a hot day. The time of year and prevailing weather conditions, therefore, have a bearing on what is done in this regard. If overnight dampness is to be expected, or if the unfinished roof is to be left more than one day, it is probably best to glaze it. This decision becomes even more difficult to make if low-melt asphalt is used, because it is difficult to walk on it or push wheeled equipment over it without tearing up the felts.

Topcoating

In areas where the weather is not severe on roof surfaces, only a topcoating is applied instead of gravel or cap sheet. A topcoating consists of about 40 pounds (18.2 kilograms) of solid mopping. In cold country the resultant "black" roof absorbs heat from the sun and helps warm the building. It also acts to melt snow at a rapid rate since heat from the building escapes through the roof. The black color of the topcoat will absorb heat at a rate of 97 percent; a similar white coating will reflect the heat and will absorb only 25 percent of it. The topcoating reduces the initial cost of the roofing, because no cap sheet or gravel is required. It may also be coated again every few years to keep the roof in good shape.

Reflective coatings may also be applied over a topcoated roof or a smooth surface roof. It is especially important that good coverage be achieved in these cases, without any holidays. Maintenance cost is reduced and roof life is expanded if the coating is done every few years. White or aluminum coatings are best when reflective roofs are desired.

BUILT-UP ROOFING

TOPIC 5—INSULATION AND ITS APPLICATION

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

- **Describe the purpose of insulation.**
- **Describe the proper procedures for storing insulation.**
- **Discuss the primary purposes of vapor barriers, water stops, and breathers.**
- **Demonstrate the proper procedures for preparing various kinds of roof decks for the installation of insulation.**

The quality of any roofing job is affected somewhat by the materials used for the job, which are usually chosen in accordance with what the customer wants or can afford. However, while it is certainly true that no roofer, no matter how skilled, can do a quality roofing job while using inferior or inadequate materials, this is no reason for lessening in any way the quality of workmanship that goes into the job.

The two prime ingredients for a quality roofing job are (1) good materials; and (2) sufficient knowledge and skill on the part of the workers. But the catalyst that turns these ingredients into a properly performed and "finished" job is the desire of the roofer to do good work. It is best defined, perhaps, as "pride of craftsmanship," and it should be a basic part of any job, large or small.

The Purpose and Selection of Insulation

Roofing insulation serves more than one purpose. Its main function is to deter the transfer of heat, either from inside the building to outside, or vice versa. Insulation also acts as a sound absorber and fire retardant.

Although the coefficient of heat transmission determines the type of insulation to use on a given roof, these calculations and determinations are not made by the roofer. His or her responsibility normally begins and ends with the application of the material. Nevertheless, proficient roofers will familiarize themselves with the methods and procedures used in these determinations.

Generally, the type of insulation to be used on a roof is selected by the architect or other person who is well informed regarding insulating qualities and the standards that must be met if the desired results are to be obtained.

But every roofer should know how insulation is selected and have a good knowledge of the insulating values of different materials, because he or she may find it necessary to make a substitution when circumstances prevent installation of the specified insulation.

Handling and Application of Insulation

The qualities and values of most insulating materials are reduced or destroyed by the absorption of moisture. Consequently, insulation must be kept dry while in storage on the job and during installation, because most types will absorb moisture readily.

Storage of Insulation

Rain, fog, and dew all pose a threat to unprotected insulation. Some types of insulation, if subjected only to overnight exposure, will curl and become unsuitable for use. Even when it is possible to use insulation that has collected moisture, it is never advisable to do so, because this moisture will turn into steam under the heat of the sun, causing blisters to form on the roofing felts. Blisters thus formed will usually crack in time and cause the roof to leak.

Insulation should be completely covered overnight and during rainy days with a waterproof material. It should always be stacked while still in its protective paper, each wrapper broken open only as the insulation is needed.

Insulating material should never be installed so that it cannot be sealed and made watertight at the end of each workday; otherwise, moisture absorbed overnight will be sealed in by the next day's application of felt, causing trouble later on when the moisture, in the form of steam, tries to escape.

Vapor Barriers

The primary purpose of a vapor barrier is to prevent moisture in the building or roof deck from entering and damaging the insulating material. Vapor barriers are not really necessary under favorable climatic conditions, but their use is generally recommended between the roof deck and the insulation. Even under ideal conditions, lightweight cement and gypsum decks require vapor barriers, however, because decks made of these materials usually contain a great deal of moisture.

The use of correct felts, sealed with coal-tar pitch or asphalt, is standard practice in building a vapor barrier. Felt by itself is not a vapor barrier; it must be coated and sealed.

Some noncombustible rubber and plastic-base materials are also used as vapor barriers. These materials are applied with a compatible adhesive. (Hot asphalt cannot be used because it will usually damage the material.) The main difference between these rubber- and plastic-base materials and those made of asphalt is that they are noncombustible, while asphalt is highly combustible.

Kraft paper used as a vapor barrier can be installed with hot or cold adhesive. Plastic membrane, which can be installed by hand or by machine, can be applied with cold adhesive only. Fifteen-pound (6.8-kilogram) asbestos felt and 30-pound (13.6-kilogram) coated base sheet can also be applied with hot or cold adhesive.

Breathers

Under certain circumstances breathers, or vents, are required with built-up roof covering. This is especially true when the roof deck consists of a concrete slab containing lightweight aggregate over a concrete structural slab. (See Fig. 5-1.) High temperatures cause air and moisture in the lightweight-aggregate slab to change into gas and vapor. As a result, pressure builds up in the lightweight-aggregate slab between the roof covering and the structural slab. Unless adequate provision is made for the release of this pressure, air pockets and blisters will develop and distort the roof covering. (See Fig. 5-2.) Breathers, or vents, are used to relieve this pressure.

The built-up roof covering should be spot-mopped (not solid-mopped) to the lightweight-aggregate slab with hot asphalt, and vents should be installed with the roofing to release the expanding gas and vapor. Generally, one vent for every ten squares of roofing is

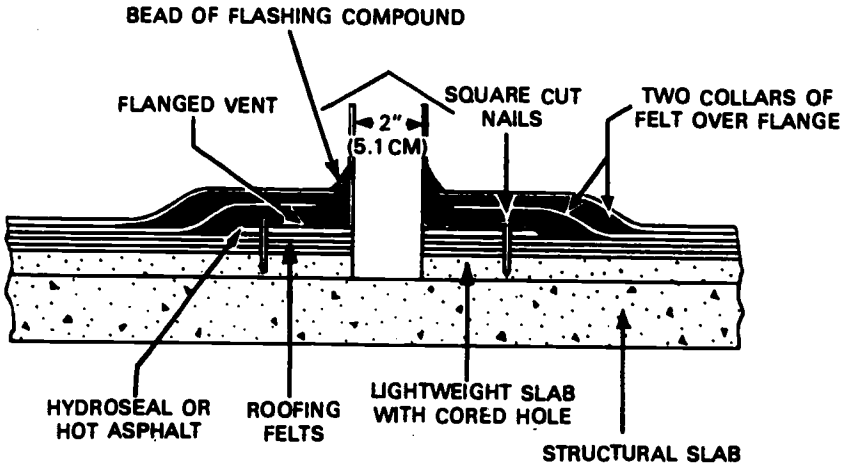


Fig. 5-1. A typical pressure release vent

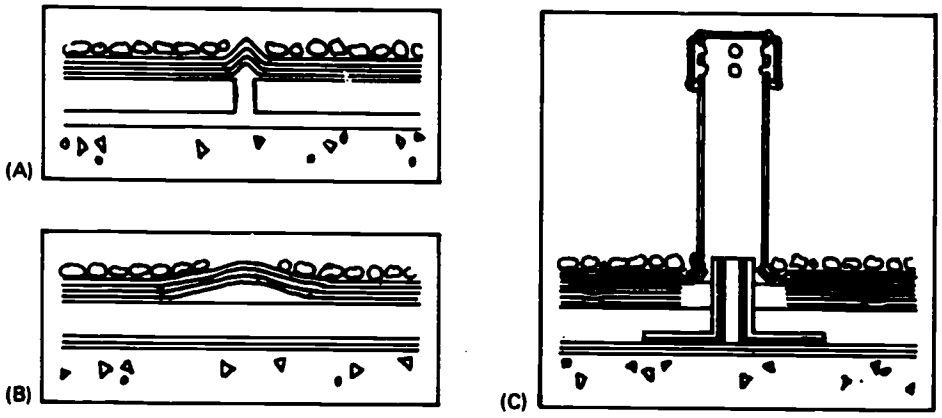


Fig. 5-2. Effects of moisture collecting at insulation joints. (A) Moisture that has accumulated at insulation joints causes ridging in the roof membrane. (B) Built-up pressure causes blisters to form. (C) Pressure and moisture escape through a breather without affecting the roof membrane.

sufficient. On small roofs edge-venting is usually adequate for releasing pressure.

Water Stops

A water stop may be applied to isolate roof areas and prevent widespread water damage from a leak caused by the puncturing of the roofing felt. Some specifications may call for water stops to be installed at all edges, walks, monitors, and the like, spaced no more than 30 feet (9.1 metres) apart in all directions. Thus, with the exception of roof edges, the insulation would be completely sealed in separate 30-foot by 30-foot (9.1-metre by 9.1-metre) areas. In this way, if a leak occurs, the water will be confined to an individual area and prevented from traveling between the roofing and the deck.

Usually, a 12-inch (30.5-centimetre) strip of felt is mopped with hot asphalt in a 6-inch-wide (15.2-centimetre-wide) strip and mopped to the deck surface or vapor barrier. The edge of the insulation should also receive a coat of asphalt. (See Fig. 5-3.) Care must be taken to make all corners square and avoid making holes in the water stop or around it. Some manufacturers require that all water stops be removed at the start of the workday to allow for a continuous air flow throughout the deck.

Application of water stops is a very time-consuming and costly process because the roofing is divided into many small sections, requiring that the insulation be interrupted every 30 feet (9.1 metres) while the water stop felt is applied. This operation also creates extra work in cutting around walks, pipes, monitors, and the like. The time, trouble, and extra cost of this process accounts for the fact that it is seldom called for in specifications.

Fastening of Insulation

Insulation can be fastened to roof decks in several ways. The method used depends on the type of deck involved. The method to be allowed is generally indicated on the blueprints or in the specifications. Some of the methods employed in this process are described below.

Preparation of wooden decks. On wooden decks insulation may be nailed with or without a vapor barrier. When a vapor barrier is used, the insulation may be solid-mopped only or solid-mopped and nailed. The fastening method depends upon the type of sheathing.

The deck must be smooth, dry, well nailed, and free from sharp projections, knotholes, and large cracks. Any such openings must be covered with tin prior to application of the insulation. A 4-inch-wide (10.2-centimetre-wide) nailing strip with a thickness equal to that of the insulation may be installed by the building contractor at all eaves. (See Fig. 5-4.)

Preparation of steel decks. Insulation may be fastened to steel decks by mopping with asphalt, nailing

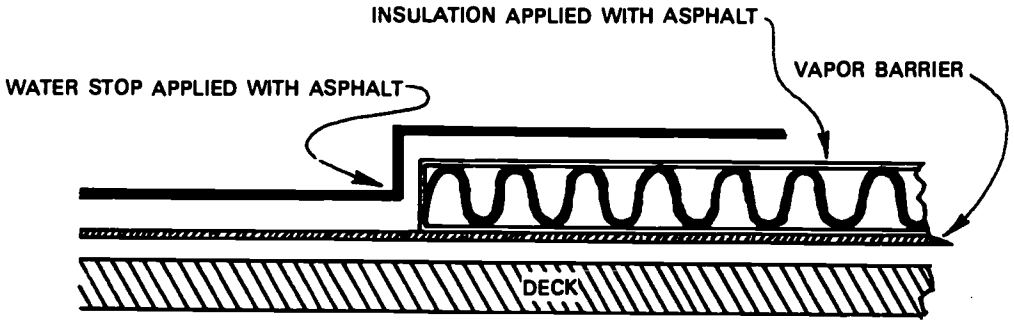


Fig. 5-3. Installation of water stop around insulation

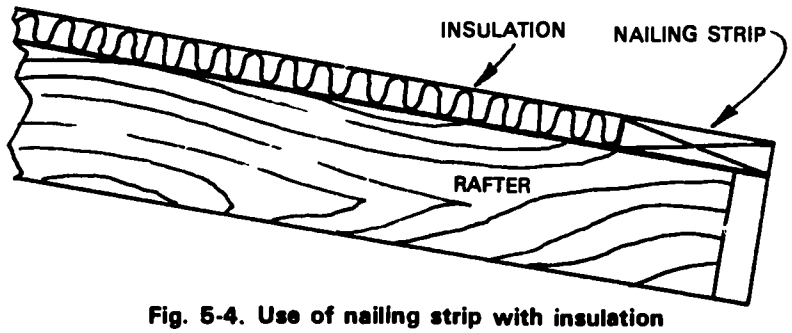


Fig. 5-4. Use of nailing strip with insulation

with steel fasteners, or applying an appropriate cold adhesive. If asphalt is to be used, the deck must first be primed. Insulation may be applied with or without a vapor barrier. When metal decks have high "ribs," the insulation should be applied so that the edges rest on the center and top of the ridges. (See Fig. 5-5.)

Several types of fasteners are available. All are designed to be driven through the insulation into the space between the steel ribs without penetrating the deck. Also available are metal clips that penetrate the deck and, at the same time, seal the puncture with a self-adjusting clip.

Where lightweight concrete or similar concrete is used, steel decks must be vented with clips to allow moisture to escape downward.

The roofer should always refer to the specifications before starting to apply insulation on a steel deck. The deck must be clean and free from sharp projections, large cracks, and welding imperfections. Steel decks must be primed and allowed to dry completely before the loading of material or the installation process is begun.

Preparation of concrete decks. A concrete deck is prepared for the application of insulation in much the same way that a wooden deck is prepared, but a few exceptions should be noted. The deck surface must be dry, clean, smooth, and free from any sharp projections and depressions. Any high spots should be chiseled down; any low spots should be built up.

The entire deck must be primed and allowed to become completely dry before any work is begun. Nailing strips may be installed by the building contractor.

Preparation of gypsum and lightweight concrete decks. The preparation of decks constructed of gypsum or lightweight concrete is the same as that for standard concrete decks, except that surface priming is not always required. A dry sheet or a vapor barrier is applied—but not solidly—to the deck.

These decks offer the most problems to the roofer. Architects and engineers are usually very deliberate in specifying the method to be used to apply insulation. The method should always include the application of one or two dry sheets (or a vapor barrier) fastened to the deck with "gyp" nails or mopped and nailed lath.

Application of Insulating Material

Although roof deck preparation varies with the type of deck, the insulation is applied in the same manner on all decks, except for variations called for in the specifications. Two variations are shows in Figure 5-6.

- Apply the insulation flush to parapet walls or nailing strips.
- Do not force the insulation into place—allow sufficient space between units to permit asphalt to ooze from the joints.
- When laying a base sheet under the insulation, allow it to extend at least 6 inches (15.2 centimetres) past the end of the insulation. After all the insulation is installed, wrap the extended felt back on top of the insulation, and seal it with hot asphalt. This is known as an envelope seam.
- If specified, apply 4-inch (10.2-centimetre) cant strips of insulation or wood in all angles where the roof deck joins vertical surfaces, such as walls and curbs. (If cant strips are made of insulation material, they should be mopped to the deck with hot asphalt.)
- Apply roofing felt as insulation is installed. This is essential because all installed insulation should be covered with roofing and sealed at the close of the workday. Such covering should be made with not less than one layer of 15-pound (6.8-kilogram) felt, solid-mopped.

NOTE: Joints between sheets of insulating materials must be staggered by starting either the first or second course with a half sheet. Insulation must be applied flush to parapet walls or wood nailers. Some insulation requires taping of the joints prior to application of the membrane.

If more than one layer of insulation is required, either of two methods can be used to ensure that the roof deck is completely sealed. The layers can be stag-

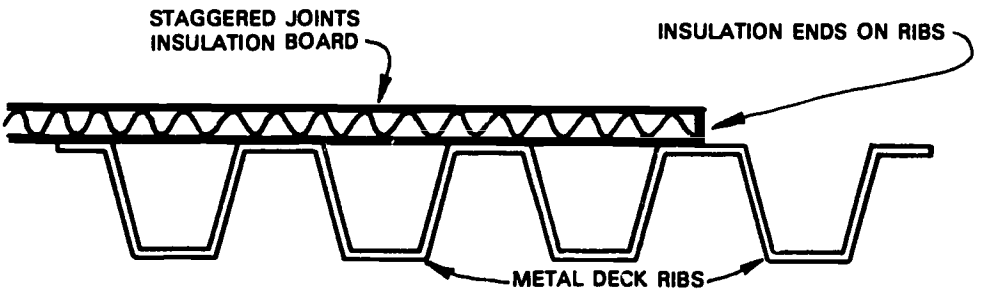
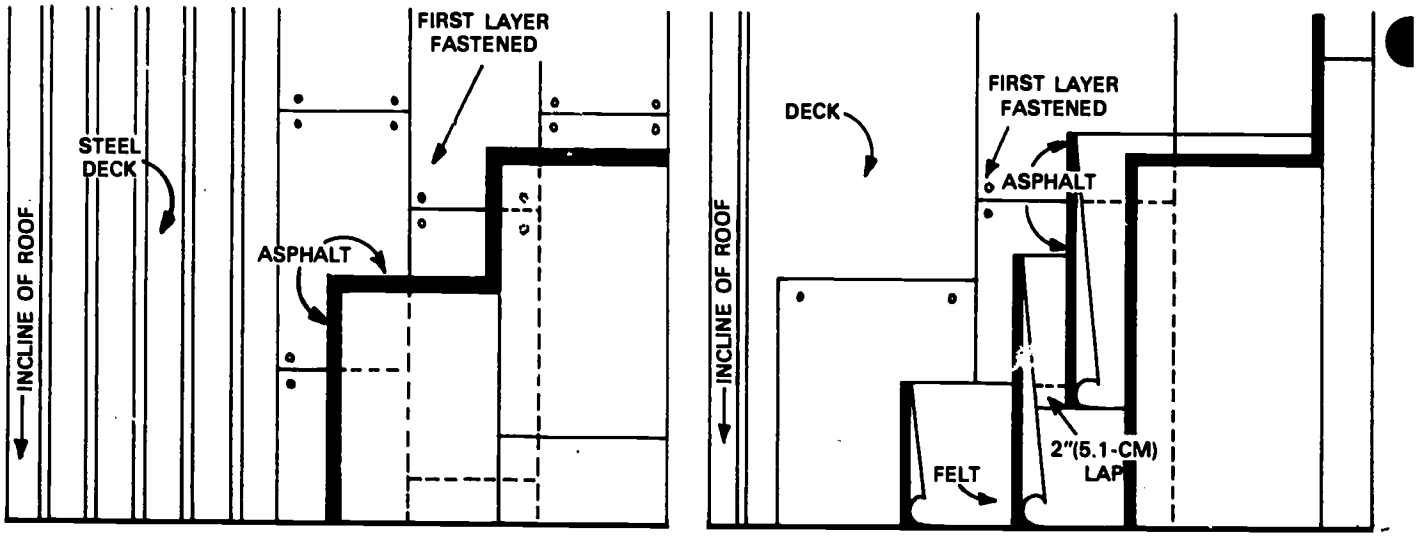


Fig. 5-5. Position of insulation on a ribbed steel deck



TWO LAYERS OF INSULATION OVER A STEEL DECK (NOTE THE NAILING PATTERN.)

ONE LAYER OF INSULATION WITH A VAPOR BARRIER AND A SECOND LAYER OF INSULATION

Fig. 5-6. Two methods of applying insulation

gered so that the top layer covers the joints of the bottom layer; or, if the joints are not staggered, roofing tape must be used to seal the joints.

Urethane foam is a new product that allows a continuous insulating surface on roof decks. After the foam is sprayed on in liquid form, it expands to approximately 30 times its thickness as a liquid. Care must be taken to avoid overlapping in the spraying pattern. When the material expands, the areas of overlapping will be thicker than the areas of single coverage, and an uneven roof deck will result.

Urethane can be used as a roofing system provided that a protective coating is applied over it to protect the material from the ultraviolet rays of the sun. Since this product is highly flammable, caution should be exercised when it is applied near heat or an open flame. Curing requires a minimum of 30 days.

Urethane is also available in board form, similar to other types of insulation. In this form, it is applied in the same manner as other insulation board. In the application of the board form with hot asphalt, care must be taken to keep the asphalt as cool as possible to prevent the board's buckling.

Ventsulation is a roll-type roofing that is generally referred to as "waffle sheet" because the material has a checkered pattern of channels to allow moisture and heat to escape. This product is basically a vapor barrier. It can be applied directly to the roof deck, and a built-up roof can be applied over it (see Fig. 5-7); or it can be laid as a base sheet under insulation (see Fig. 5-8). Ventsulation should never be mopped solid or strip-mopped, and it should be applied with the mineral surface down on the deck.

Other types of insulation are discussed in the workbook on common roofing and waterproofing materials. The apprentice should review the appropriate sections in that workbook.

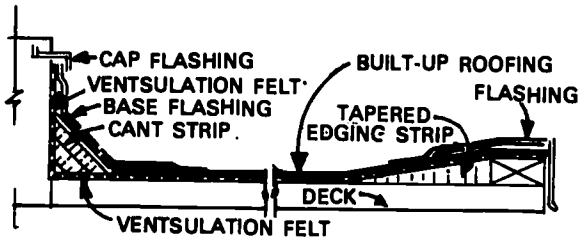


Fig. 5-7. Application of ventsulation directly to the roof deck, with a built-up roof over it

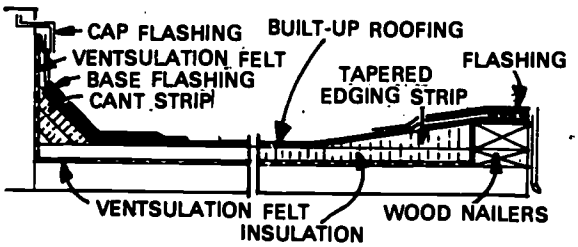


Fig. 5-8. Ventsulation as a base sheet under insulation

TOPIC 6—CUTTING AND FOLDING OF CORNERS

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

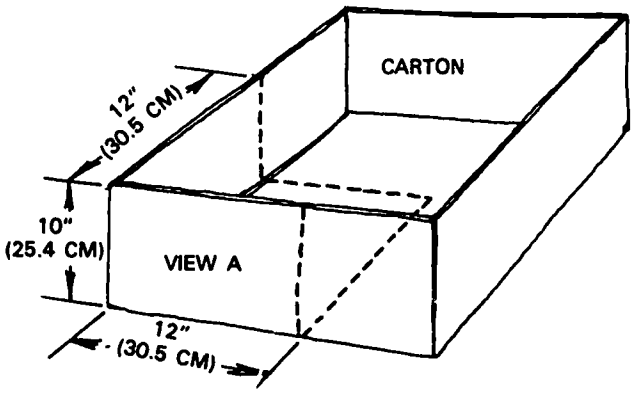
- **Describe and demonstrate the procedures for cutting and folding felts for inside corners.**
- **Describe and demonstrate the procedures for cutting and folding felts for outside corners.**

Correctly cut and folded corners are an important part of any roofing job because, like any other phase of flashing work, this is an area where leaks are most likely to occur. The correct procedures for cutting and folding corners are outlined in this topic. The apprentice should learn these procedures by practicing them in the classroom, using paper or scraps of roofing felt. In this way the apprentice should be able to cut and fold corners quickly and accurately. A cardboard carton jig that can be used to practice cutting and folding corners is illustrated in Figure 6-1.

Cutting and Folding Inside Corners Without Cant Strips

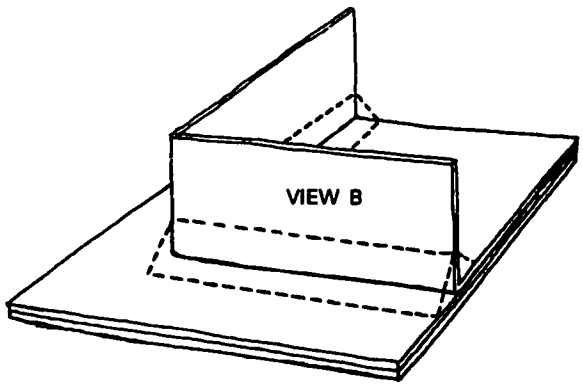
Two possible ways that felt can be cut to form an inside corner are shown in Figure 6-2. The recommended procedure is as follows:

- Lay the first sheet of felt (indicated by the dotted lines in Figure 6-2, Method A) on the deck, and turn its end up the wall 6 inches (15.2 centimetres).
- Fold the felt snugly into the corner to form a right angle.
- Fold this end back against itself so that the crease extends completely across the felt sheet.
- Without altering the position of the felt, make a second crease along the edge against the other wall, folding this edge back the same way. Thus, a 6-inch by 6-inch (15.2-centimetre by 15.2-centimetre) square is formed on the deck at the intersection of the two vertical surfaces.
- Make a cut on one crease (designated by A in Fig. 6-2), forming a tab.
- Fold both ends of the felt back against the walls, treat with fabric and mastic, and nail in place.



Step 1—Cut any suitable corrugated carton, as shown by the dotted line in View A. Use the dimensions indicated.

Step 3—Cut the corrugated cardboard in the manner shown in View C to form simulated cant strips. These strips must be accurately mitered and taped into place for practice work.



Step 2—Glue the cut-out section to a piece of rigid cardboard as shown in View B, thereby forming a cornered vertical projection on a "deck."

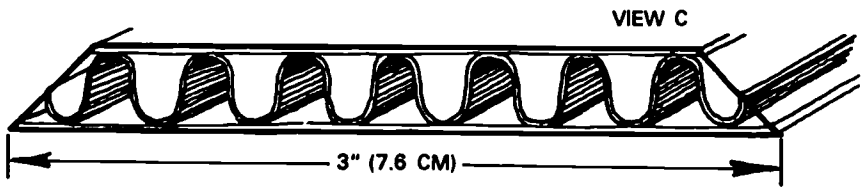


Fig. 6-1. Cardboard carton jig for practice in cutting and folding corners

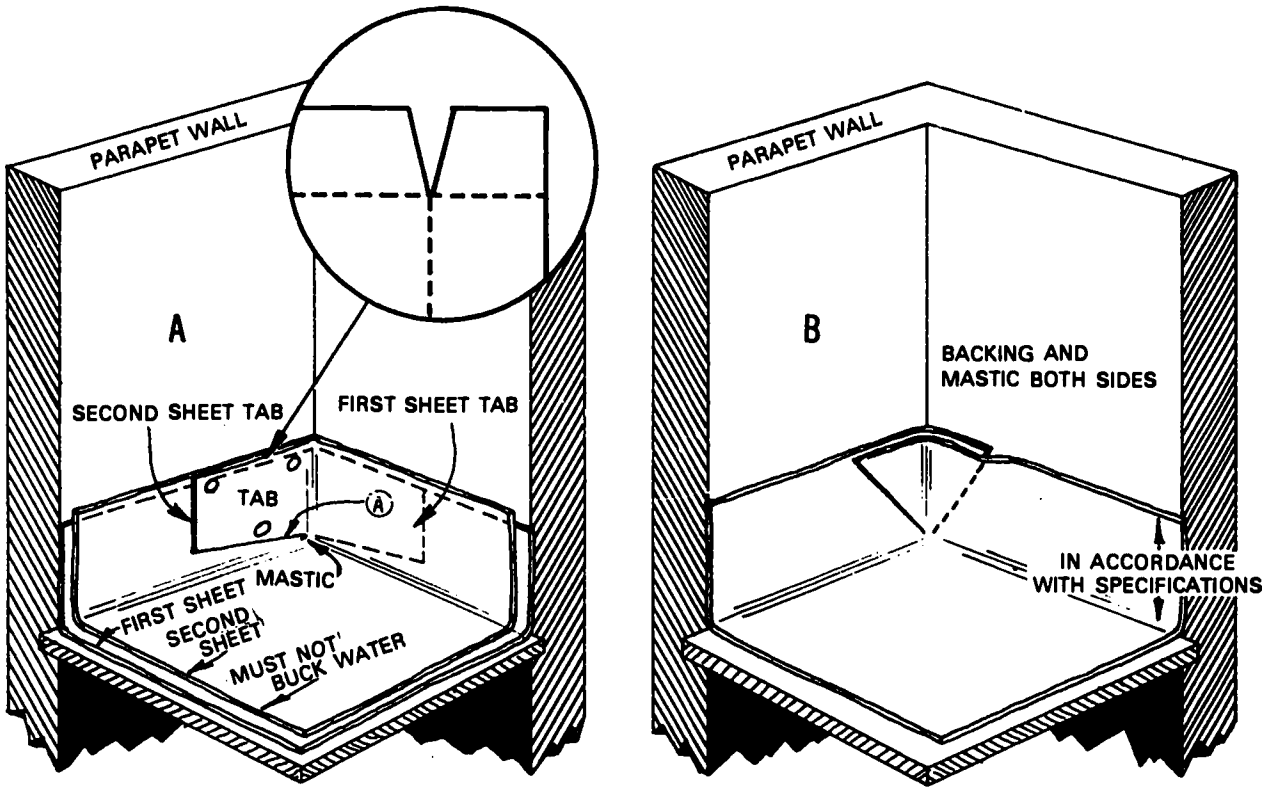


Fig. 6-2. Cutting and folding an inside corner without a cant strip

The felt tab will turn correctly to form a neat, square corner.

- Follow this same procedure with all successive layers of roofing, except that the side on which the cut is made should be alternated so that each successive tab falls on opposite walls, helping to make the corner watertight. The entire assembly may now be sealed with plastic or other flashing compound.

Another method of making this cut on an inside corner (without cant strips) is illustrated in Figure 6-2, Method B.

Cutting and Folding Outside Corners Without Cant Strips

Cuts may be made for outside corners in much the same manner as outlined for inside corners. One method used for outside corners is shown in Figure 6-3. The roofing material is laid in a position that will allow a 6-inch (15.2-centimetre) turnup at the wall. The following steps are then taken:

- Cut straight down from the top edge of the felt to the point of the outside corner at deck level (A in Fig. 6-3). Fold the roofing (the tab left after the cut is made) to the deck. (This tab will be covered with the next sheet of felt.)
- Lay the next felt on the other side of the angle in the same way, and cut from the outside edge of the sheet to the corner at deck level (B in Fig. 6-3). This cut will form a tab, or fly; bend this around the corner of the vertical surface.
- Carefully crease the felts at all angles, seal, and nail securely to the vertical surfaces.

An alternate method of cutting an outside corner is shown in Figure 6-4. An angle cut is made to form a tab, and the cuts are alternated from sheet to sheet so that the tabs will fall on opposite sides of the corner. When the final layer of felt is cut and fitted, the entire corner is sealed with mastic to make it watertight.

Cutting and Folding Inside and Outside Corners with Cant Strips

Waterproof corners depend entirely on accuracy of layout, cutting, snugness of fit, and proper sealing with flashing compound. The sequence in which the flaps should lap over each other for inside corners is shown in Figure 6-5. Care must be taken to see that they drain over each other in shingle fashion and are nailed into place. The cutting and folding sequence used on outside corners with cant strips is illustrated in Figure 6-6. The apprentice should practice making these cuts and folds in the classroom, using the cardboard carton aid previously described and wastepaper in place of roofing felts.

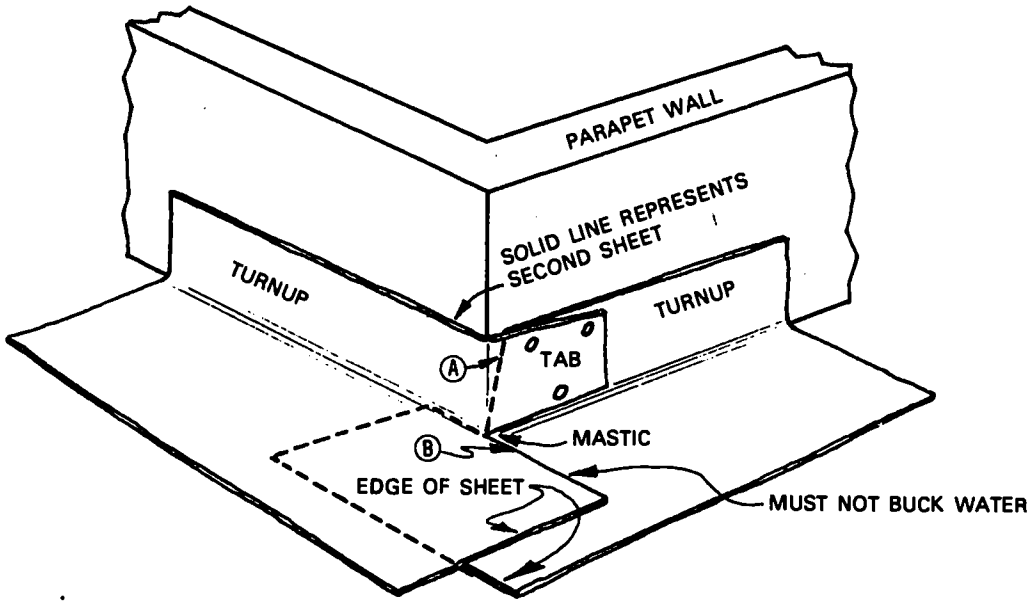


Fig. 6-3. Cutting an outside corner without a cant strip

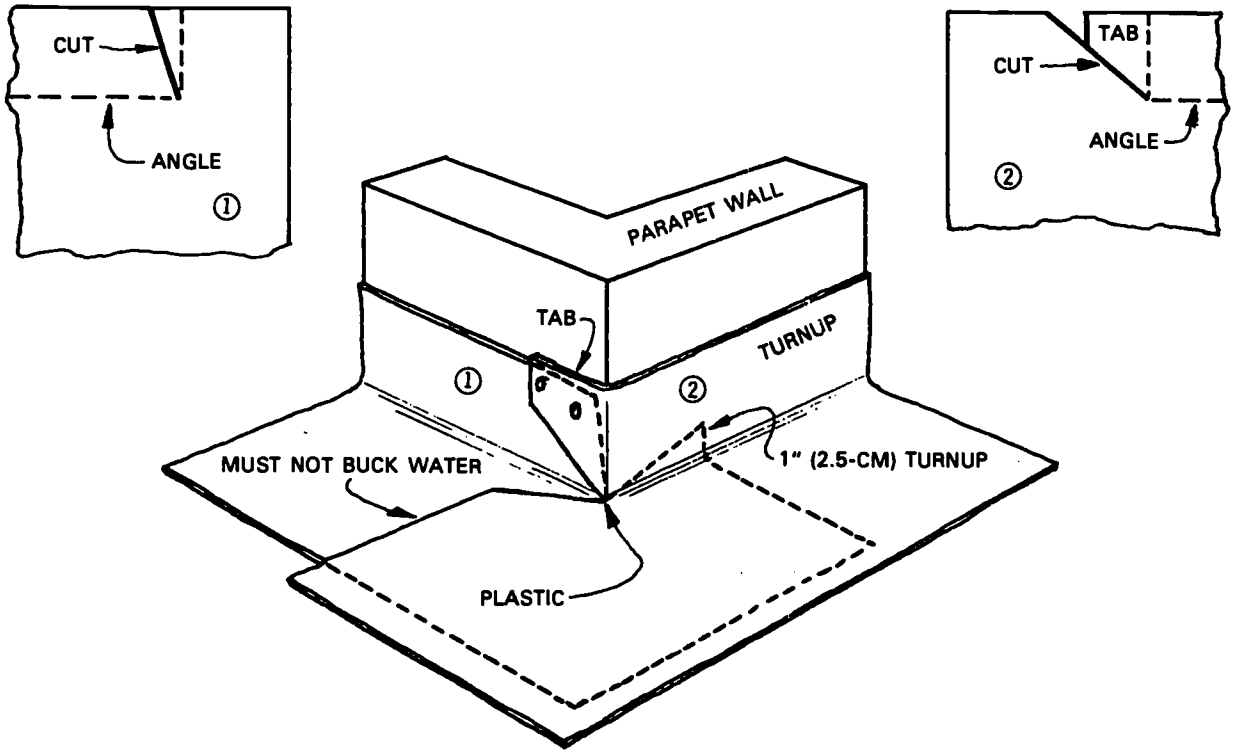


Fig. 6-4. Alternate method of cutting an outside corner without a cant strip

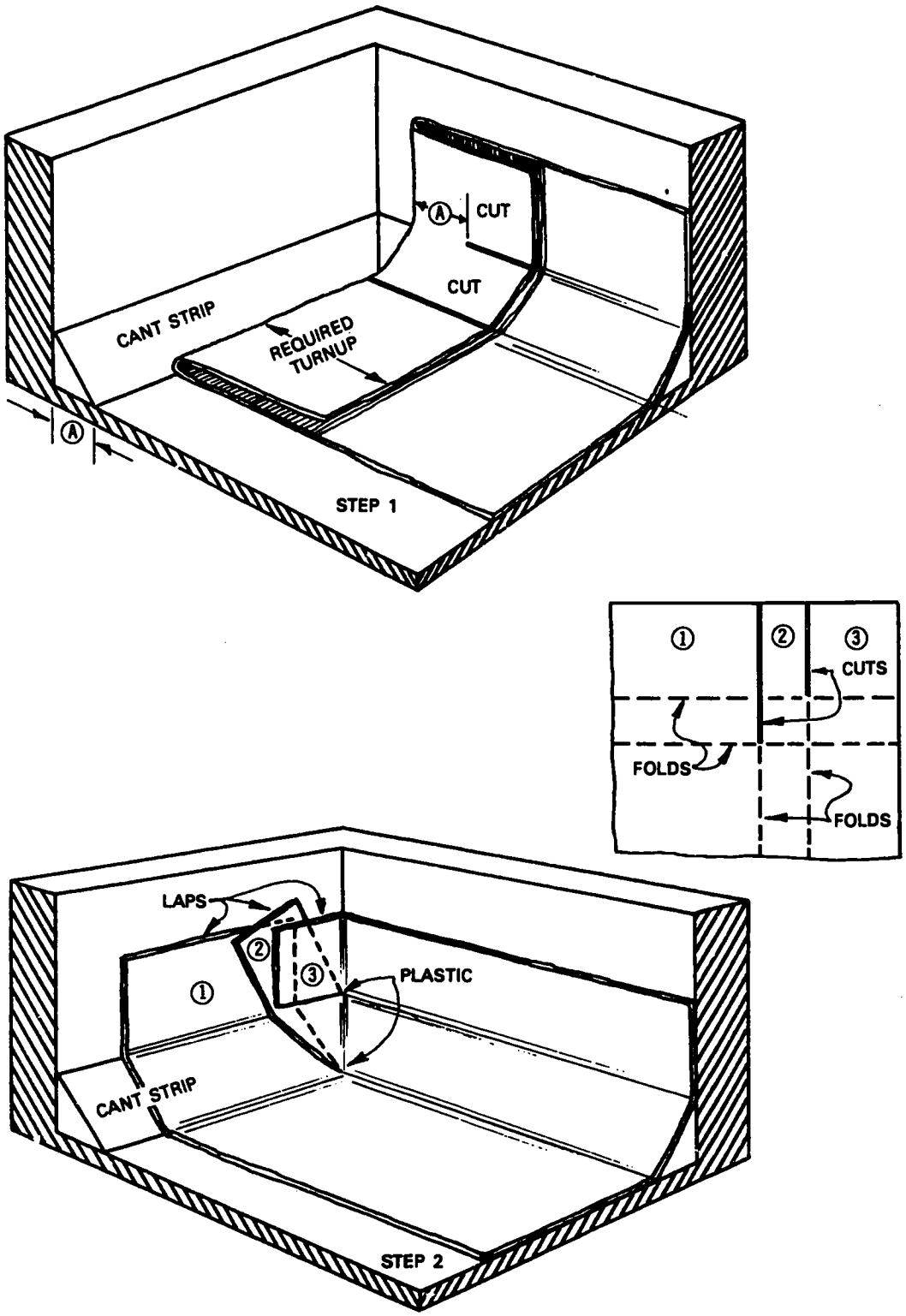
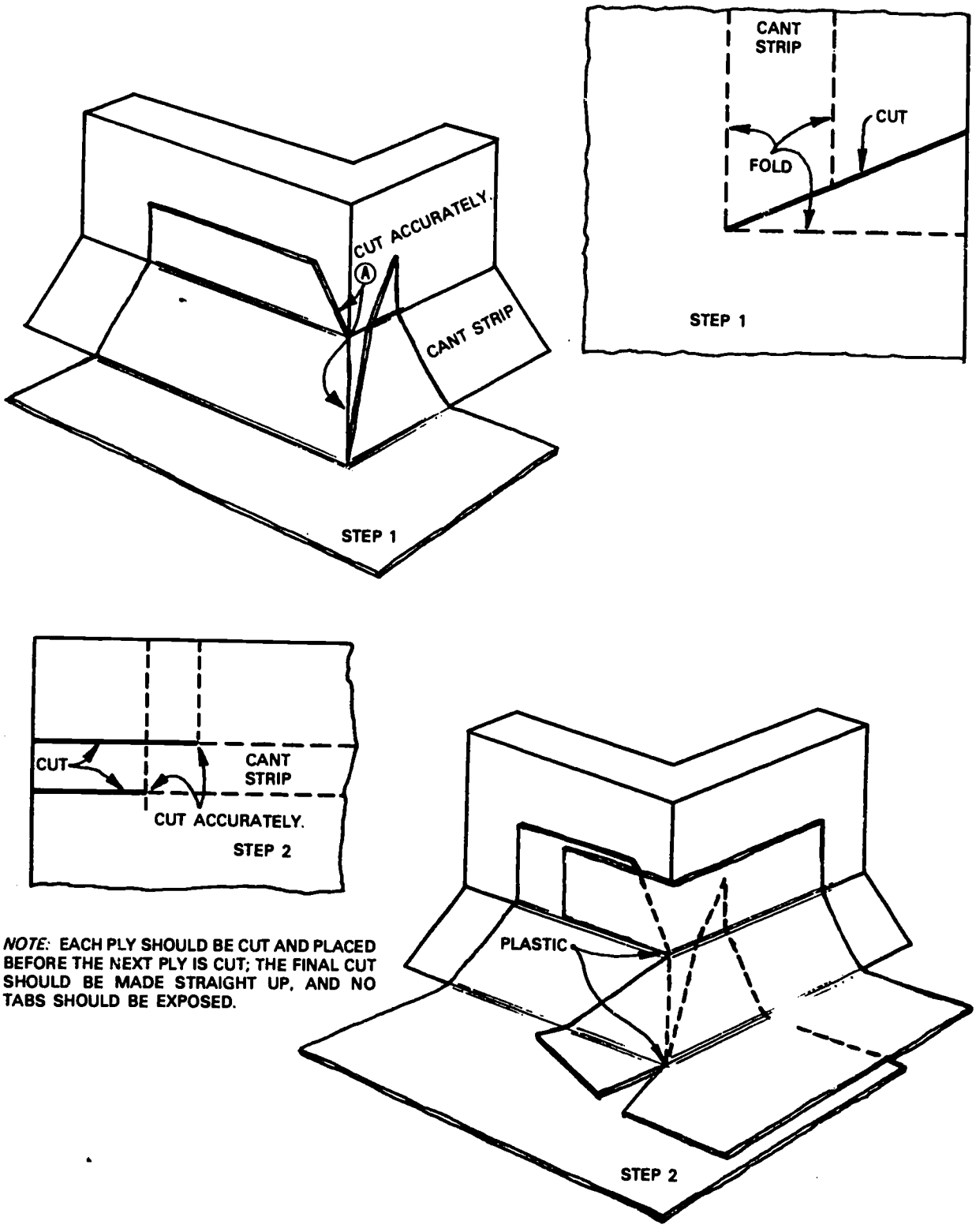


Fig. 6-5. Cutting and folding an inside corner with a cant strip



NOTE: EACH PLY SHOULD BE CUT AND PLACED BEFORE THE NEXT PLY IS CUT; THE FINAL CUT SHOULD BE MADE STRAIGHT UP, AND NO TABS SHOULD BE EXPOSED.

Fig. 6-6. Cutting and folding an outside corner with a cant strip

BUILT-UP ROOFING

TOPIC 7—SUMPS AND DRAINS

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

- **List the various kinds of drains.**
- **Describe the procedure for installing a ring drain.**
- **Describe the similarities between sump drains and overflow scuppers.**
- **Discuss the procedure for preparing a roof for installation of a drain.**

Proper roof drainage is a prime factor in roof life. Standing water causes roofing to deteriorate; and, if left undrained, it will damage the structure itself by causing dry rot. In addition, excess water collecting on a roof in large amounts will often cause the roof to collapse because of the excess weight for which the roof structure was not designed.

The prime contractor has the responsibility of constructing the roof deck in such a manner that correctly applied roofing will allow prompt drainage. But the roofer has the responsibility of applying the roof and drains so that water flow will not be obstructed.

The steeper the roof, the faster the drainage. Flat roofs drain slowly. A dead-flat roof theoretically will drain evenly in all directions; however, a low spot anywhere in the field of such a roof can easily cause a problem of serious proportions. The correct installation of drains and the repair of drains already installed are perhaps the most critical jobs performed by the roofer.

There are four basic types of drains: the ring drain, the wall drain, the sump drain, and the overflow scupper. The application of each is described below.

Ring Drains

The ring drain is a cast-iron clamp-type drain consisting of three main parts: base, clamp ring, and strainer. These parts are breakable, and the roofer must handle them carefully. If the roof deck in which the drain is to be installed is to receive insulation, the following installation procedure is recommended:

- Apply the insulation first. (If the plumber has connected the drain pipe, be extra cautious when applying materials. It is sometimes wise to insert a rag or similar material into the pipe to keep asphalt, bits of roofing felt, gravel, or any other substances from falling into the pipe and obstructing it. Be sure to remove this material after applying the insulation or at the end of the workday.)
- Taper the insulation back at least 18 inches (45.7 centimetres) all around the opening to allow the drain to be set slightly below the deck level. (See Figs. 7-1 and 7-2.)

If the deck is not to receive insulation, the roofer should follow the following procedure:

- Follow the deck around the drain opening in the same manner as was done with insulation. The

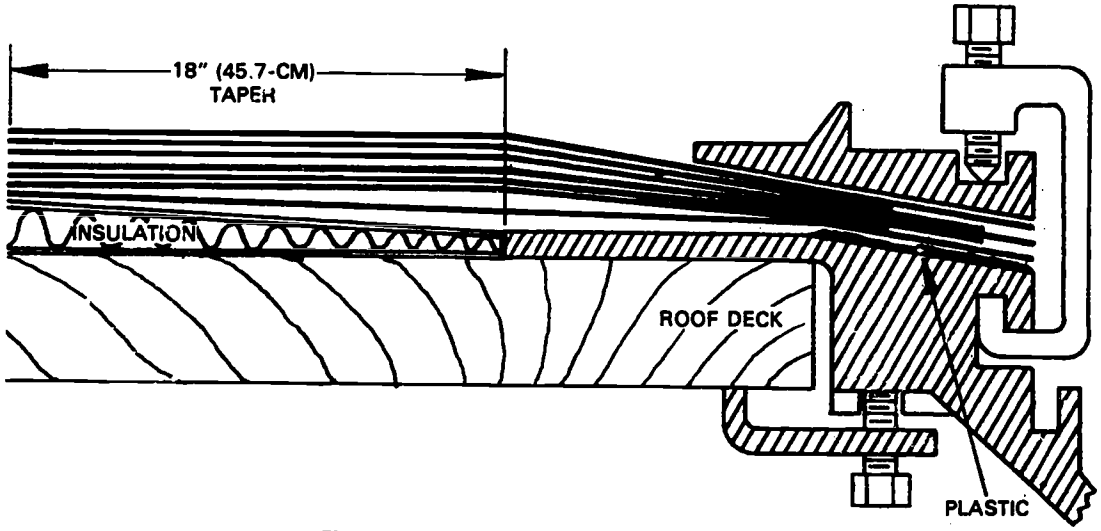


Fig. 7-1. Construction of a ring drain

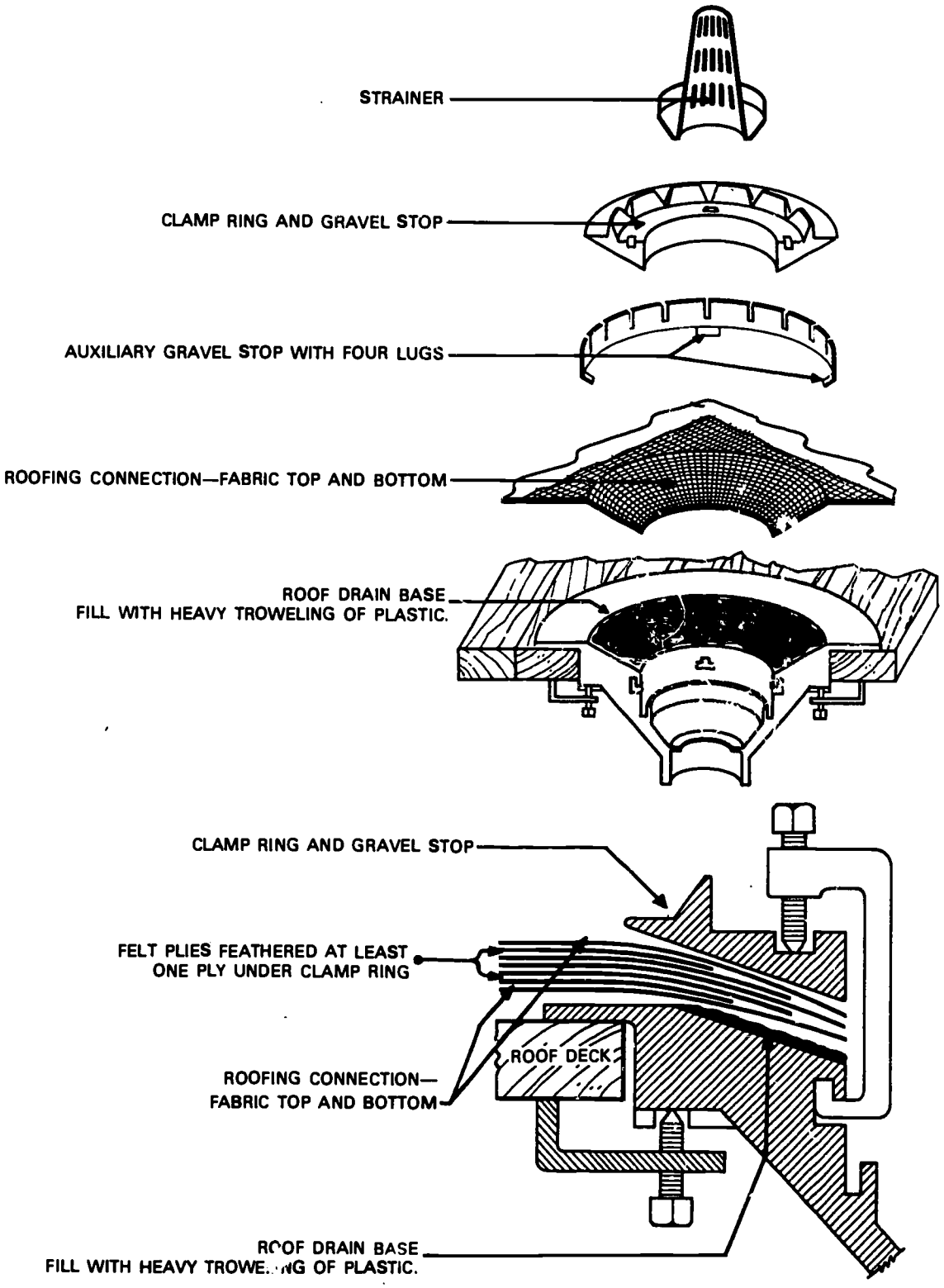


Fig. 7-2. Drain and clamp rings

drain should be set so that its outside edge is no closer than 12 inches (30.5-centimetres) away from curbs, walks, or other vertical projections at any point.

- Fill the base clamp ring groove with plastic cement before applying any roofing.
- Extend roofing felts over the ring groove during the course of roofing application.
- Trim roofing felt evenly at the inside edge of the ring after all felts and the ring are in place.
- Install the clamp ring, and tighten the clamps securely before the asphalt cools.
- Apply gravel surfacing (if specified) flush to the top of the clamp ring.
- The application of a 6-inch (15.2-centimetre) lead collar is sometimes specified. This collar will prevent the clamp ring from breaking the roofing material.

Figures 7-3 through 7-10 illustrate the installation of series roof drains on different types of decks.

Sump Drains

A sump drain is usually a recessed box made of sheet metal with a screen basket at the bottom. (See Fig. 7-11.) This type of drain usually empties directly into the street or sewer. Sump drains are usually installed on wooden decks.

A sump drain should be installed as follows:

- Apply a layer of felt around the drain opening in the roof deck. This opening will contain the outlet box.
- Trowel a coating of plastic cement over this felt, being certain to cover the area surrounding the opening and the entire flange area.
- Drop the outlet box into place, and nail the flange around its outside edge.
- Apply an additional layer of flashing compound with fabric on top of the drain flange to ensure watertightness.
- Apply the built-up roofing. The felts used should be tapered back away from the drain on all sides in accordance with the specifications.

Overflow Scuppers

Scuppers are used for much the same purpose as sumps; and the installation is quite similar, except that the scupper is installed on a vertical surface (an

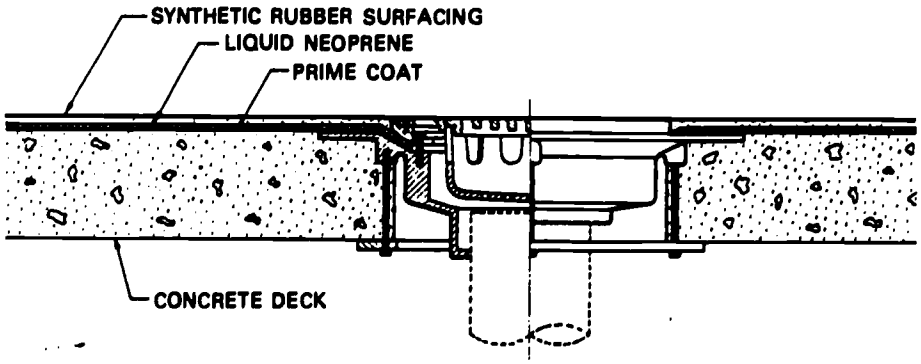


Fig. 7-3. A series drain installed in a concrete slab or deck

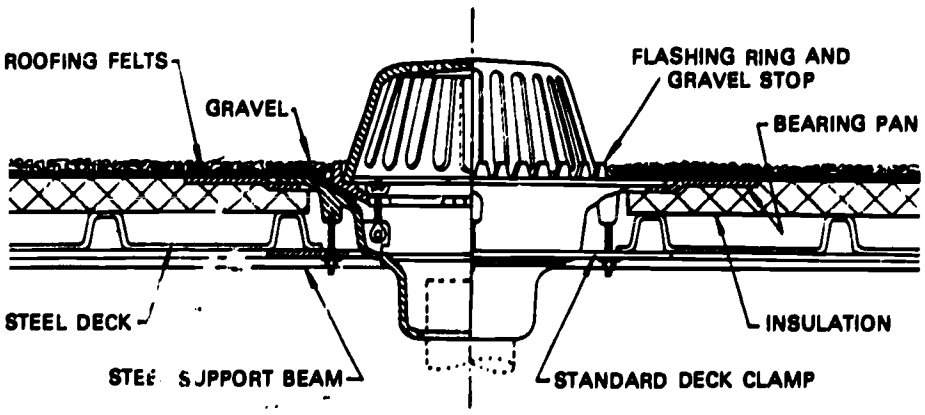


Fig. 7-4. A series roof drain installed in an insulated steel deck with built-up roofing

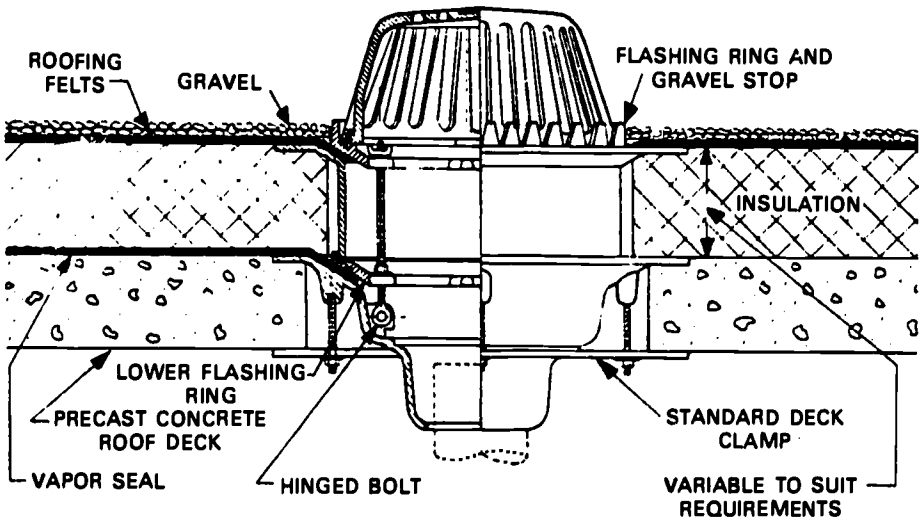


Fig. 7-5. A series roof drain installed in a concrete roof deck with built-up insulation and roofing

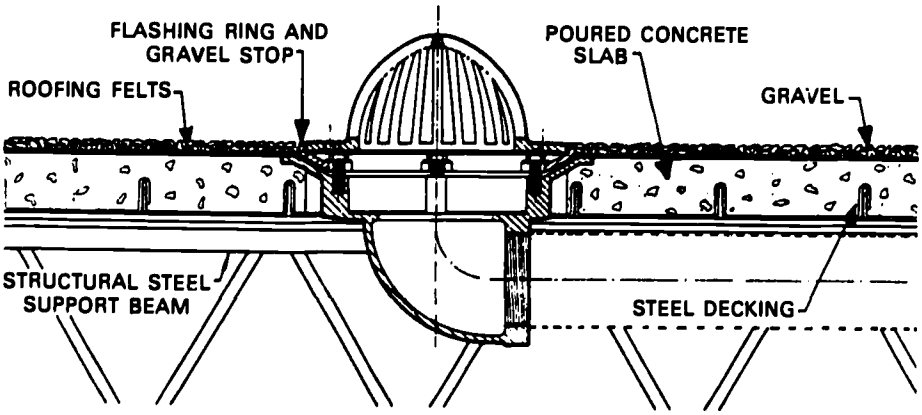


Fig. 7-6. A series roof drain installed in a steel and concrete deck

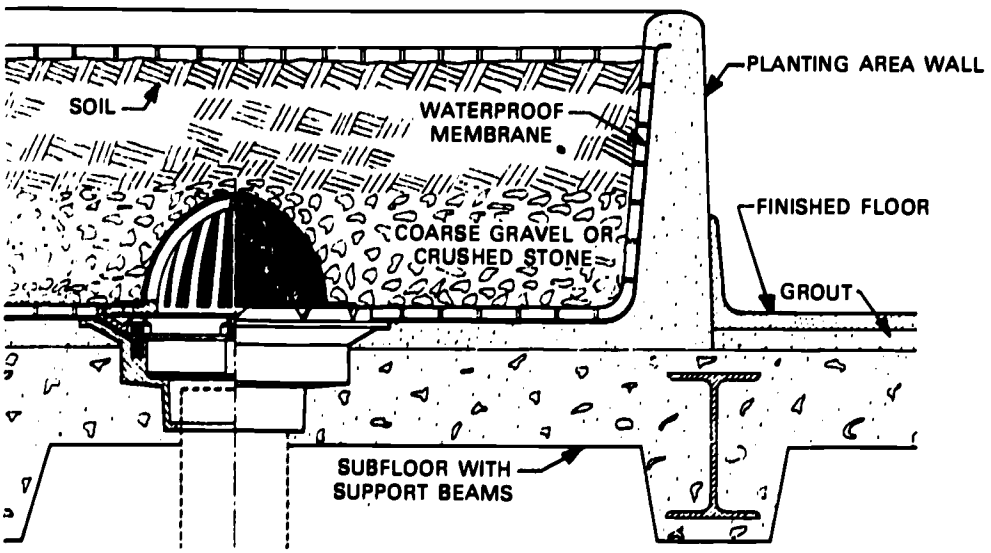


Fig. 7-7. A series drain installed in a typical planting area

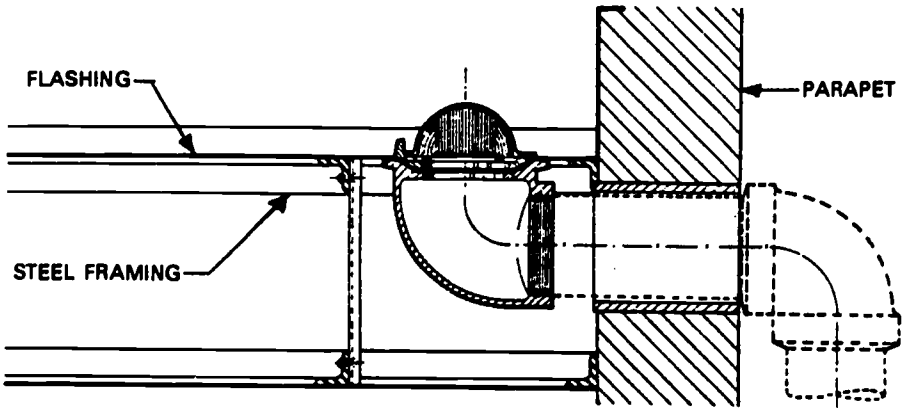


Fig. 7-8. A series canopy drain installed in a metal deck with an outlet through a parapet wall

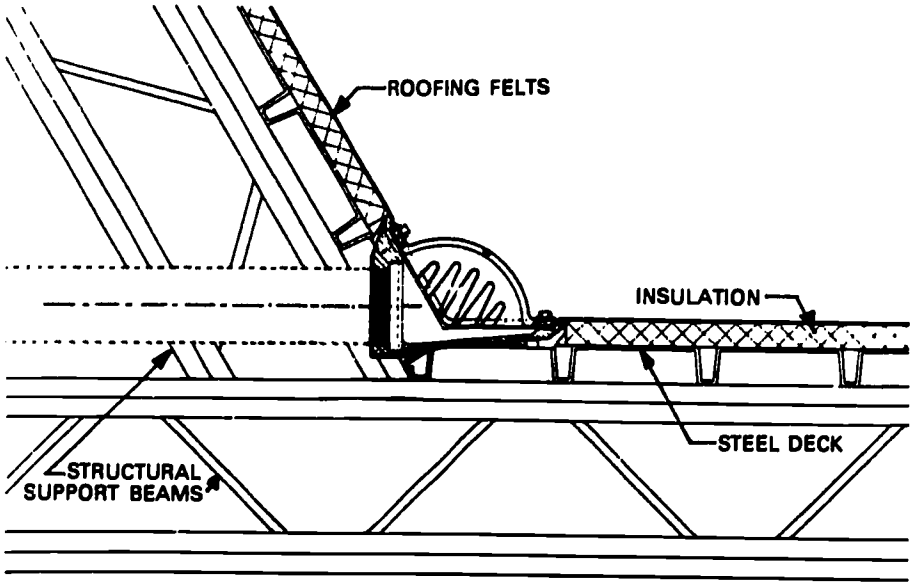


Fig. 7-9. A series drain installed in a typical overhanging balcony or cornice

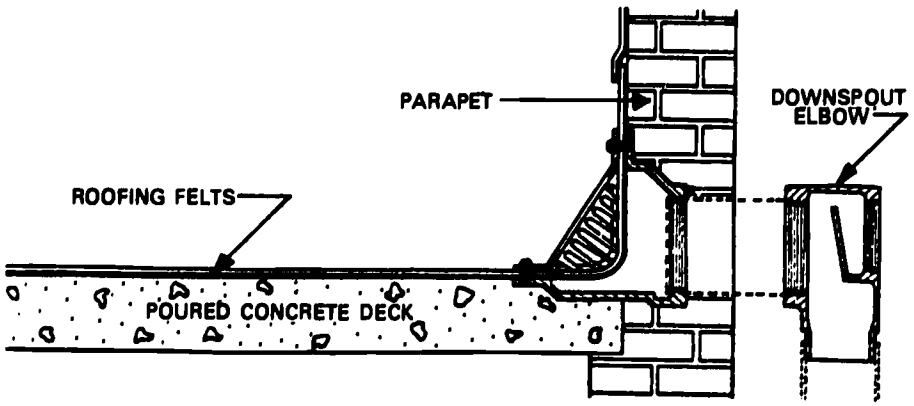


Fig. 7-10. A series parapet drain installed through a wall and used in conjunction with a downspout elbow

outside wall), and the tapering procedure is not necessary.

A scupper is always installed in conjunction with the application of wall flashing, and extreme care must be taken to see that it is made watertight. (See Fig. 7-12.)

Overflow scuppers are usually placed in a wall 2 to 4 inches (5.1 to 10.2 centimetres) above the lowest part of the deck. They serve as "safety valves" in the event the main drains at deck level become clogged.

Wall Drains

Wall drains are installed in a manner similar to sumps and are made for installation in left corners, right corners, or the middle of the wall. (See Fig. 7-13.) The recommended procedure for installing wall drains is as follows:

- Apply a layer of felt completely surrounding the drain area, followed by an application of plastic cement.
- Install the outlet box in the wall opening, allowing at least 3 inches (7.6 centimetres) to extend beyond the outside surface of the wall. This extension provides a suitable drip edge for water drainage.
- Apply an additional layer of plastic cement on the flange above the drain opening. This layer should not be too heavy; otherwise, it can slide down in hot weather and plug the opening.
- Apply the remaining felts in the usual manner for parapet flashing.

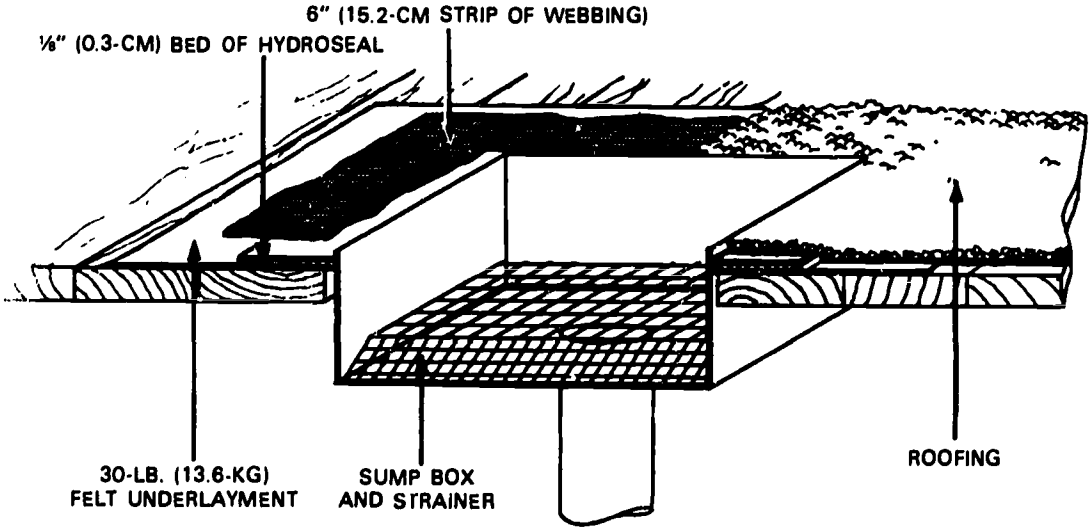


Fig. 7-11. A typical sump drain installation

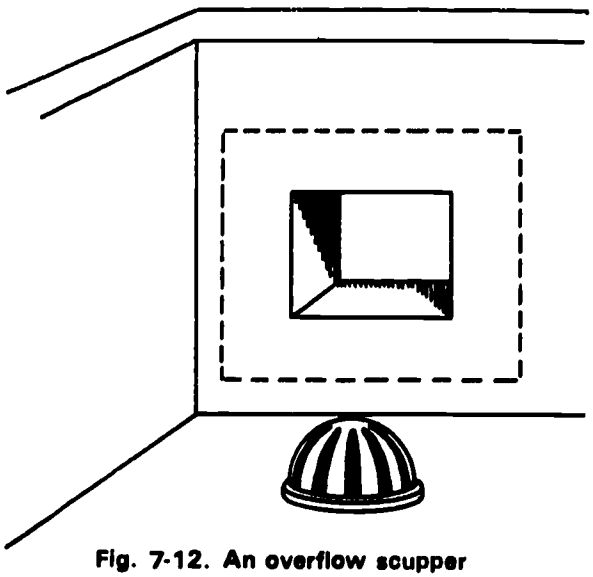


Fig. 7-12. An overflow scupper

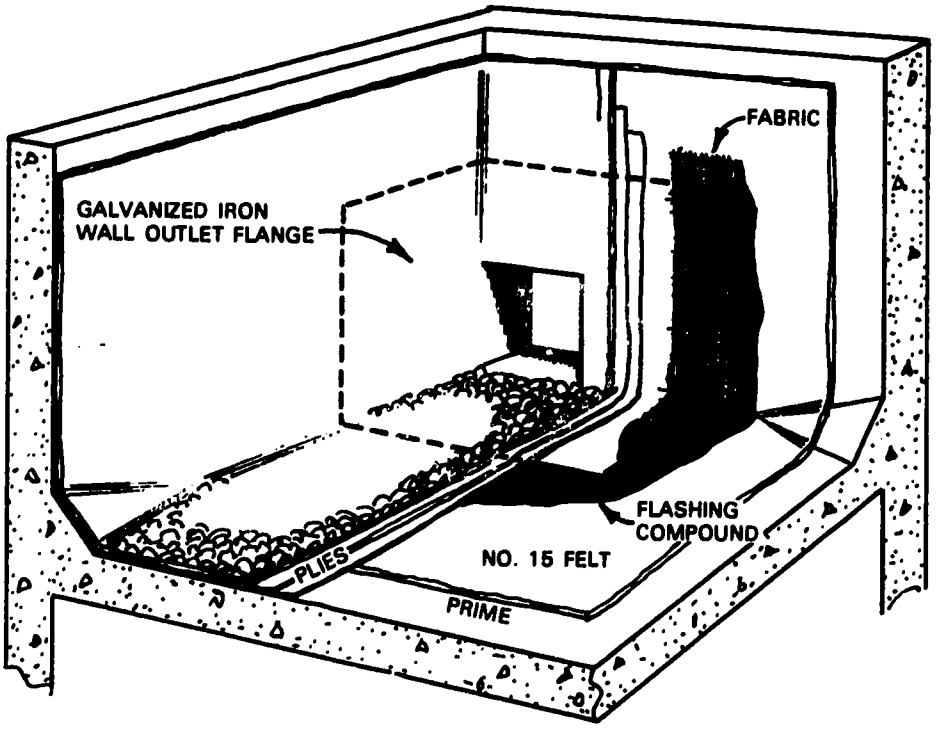


Fig. 7-13. A typical wall drain installation

TOPIC 8—FLASHING

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

- **Identify the various types of flashing used in the roofing industry.**
- **Describe the purpose of flashing in the joining of new and old roofs.**
- **Demonstrate the proper procedures for installing flashing materials.**

Flashing is used to seal off a roof at termination points or to provide drainage at those points where the roof meets various structural parts of a building (usually vertical structures) and to prevent the intrusion of moisture at all such points. The proper selection, cutting, and application of flashing materials are primary skills that a roofer must learn. Incorrect flashing accounts for most roof leaks today, and selection of the proper flashing for a job can prove to be most economical both for the client and the contractor.

Only minimal flashing is usually called for in competitive work. When quality flashing is required, the roofer must be familiar with all the materials and the principles of application of those materials normally used on this type of work.

Flashing is manufactured in finished forms; or it may be fabricated on the roof from many different materials. Among the many types of materials used for flashing are:

- Galvanized iron
- Aluminum
- Copper
- Lead
- Asphalt felts and cap sheet
- Asbestos felts and cap sheet
- Flexible vinyl
- Flexible neoprene
- Plastic (fiberglass impregnated with polyester or epoxy resin)
- Stainless steel (chrome and steel alloy)
- Monel metal (copper and nickel alloy)
- Terneplate (lead-coated sheet iron)
- Tile (clay and glazed)
- Plastic cement (mastic)

NOTE: Care must be taken to avoid using flashing materials that will allow electrolytic action to occur in the presence of other, unlike metals.

Most metal flashings are applied by sheet metal workers; however, in some cases the roofer applies the gravel stop, outlets, coping, pipe jacks, and step flashing.

Types of Flashing

There are two general types of flashing: (1) flashing that provides a metal flange for the roofer to "seal off" to (which may be considered "plain" flashing); and (2) counterflashing, which is metal (or other material) used to seal off or drain water over the exposed ends of a built-up roof assembly, or metal that is part of the flashing assembly and placed at the juncture of vertical and horizontal surfaces. Counterflashing may also extend over the top of a parapet in conjunction with metal coping.

Many kinds of flashing are included within these two types. In the following lists many are identified by name:

Plain flashing	*Counterflashing*
Flange	Three- and five-course
Drip or edging	Cap
Expansion joint	Coping or hood
Z-bar	Base
Channel	Asbestos parapet
Jack	Flat-to-steep
Elastic	Hot stack
	Fibrated plastic
	Skylight drain
	Basket drain clamp ring
	Shot-in-place

There are many expandable metal flashings designed to solve most expansion problems. However, if a problem is encountered for which there is no ready-made device, any competent sheet metal shop can fabricate one to meet the particular conditions.

Flexible Flashings

A problem inherent in metal flashings is that they expand and contract with temperature variations, causing fractures of the asphalt or pitch to which they are bonded. However, through the use of neoprene, vinyl, butyl, and other rubberlike substances for flashing, this problem can be overcome, provided that proper installation has been made.

Since many brands of flexible flashing (see Fig. 8-1) are now on the market, the roofer should study thor-

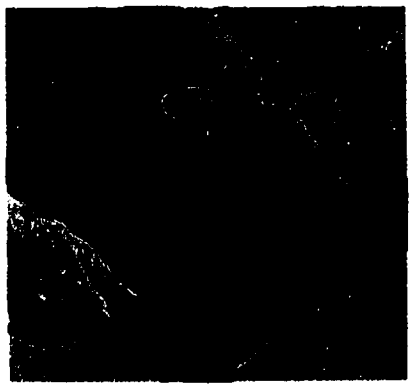


Fig. 8-1. Flexible flashing

oughly the application instructions before attempting to apply any of them. The following general steps should be taken before using any of these products:

- Clean all roofing surfaces of foreign material, including oil, dust, old roofing, asphalt, and pitch.
- Check to see that the proper material has been specified and supplied.
- When preparing the compound, make precise measurements of the catalyst and resin. (Do not let these substances contact the skin; they are both corrosive and noxious. They are also flammable—keep them away from fire, flame, and sparks.)

Fiberglass and Polyester Resin

The application of fiberglass and polyester resin is performed by only a few specialized workers, since the compounding of the material is extremely sensitive to proportion, temperature, and so forth. This compound has a limited application because it lacks the strength to withstand shock and fracture. It is used mostly for edging and gutters.

Sprayed plastic and chopped fiberglass roving material, when coated on certain parts of a roof, becomes flashing; and this material can be made to become rigid or flexible. The flexible mix is sprayed on base flashing, on expansion joints, and around protrusions. The roofing manufacturer's specifications should always be followed in regard to embedment and plying since these methods will vary. None of these materials should be confused with monolithic roof systems, which are entirely different.

Three-Course Flashing

Composed of two layers of plastic cement separated by a layer of asbestos felt, irish flax, or similar material, three-course flashing is used in lieu of metal (or other materials) around protruding pipes where jacks have not been specified.

Base Flashing

Base flashing consists of one or more membranes (asphalt-impregnated material) used to protect the upturned ends of a roofing assembly at a vertical wall or similar projection.

Pipe Jacks

A pipe jack is a flanged metal covering that fits snugly around a pipe to make a waterproof juncture between the pipe and the roof.

Coping

Coping is designed to prevent the intrusion of water at the top of a parapet. Coping may be fabricated from metal and installed by the roofer or a sheet metal worker. The roofer may also install tile coping, a special interlocking glazed coping tile with appropriate corner pieces, or clay barrel tile applied with cement mortar on top of the parapet. The barrel tile should be nailed as well as sealed with mortar.

Installation of Roofer-Built Flashing

Three- and five-course flashings are handcrafted on the job by the roofer. The following points are provided to help the apprentice understand the procedure:

- Clean new brick and concrete surfaces so that they are free of dust, dirt, sand, dampness, and irregular spots that could serve as bond breakers.
- On recover work, chop off old flashing to leave a smooth, clean surface.
- Prime the surface with a material compatible with the fibrated plastic or other flashing compound to be used. Primer should be permitted to dry.
- Nail the turnup of roofing with concrete nails and caps.
- Apply the first coat of fibrated plastic or flashing compound, embed a layer of fabric (or 15-pound [6.8-kilogram] perforated asbestos felt), and nail.
- Apply a second coat of compound (additional coats are required if five-course flashing is specified).
- Apply metal counterflashing if specified.

The installation of roofer-built flashing is shown in detail in figures 8-2 through 8-7.

Application of Gravel Guard

The correct installation of gravel guards can do much to ensure a leak-free roof and protect the supporting woodwork against rot. All roofing plies must be in place before the gravel guard is installed. The following is a common procedure for installing gravel guards:

- If the guard is made and installed by the sheet metal worker, no cutting will be required, as all

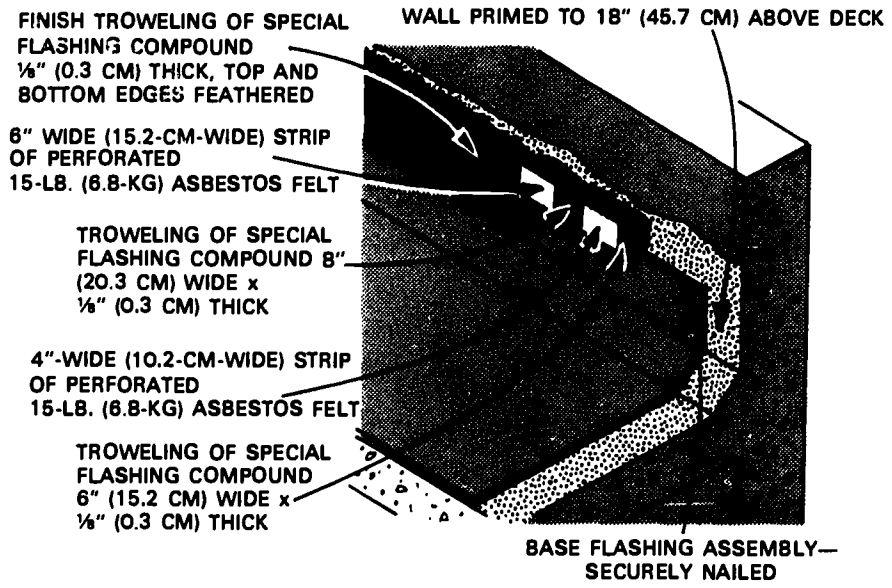


Fig. 8-2. Five-course plastic flashing for concrete walls more than 18 inches (45.7 centimetres) high

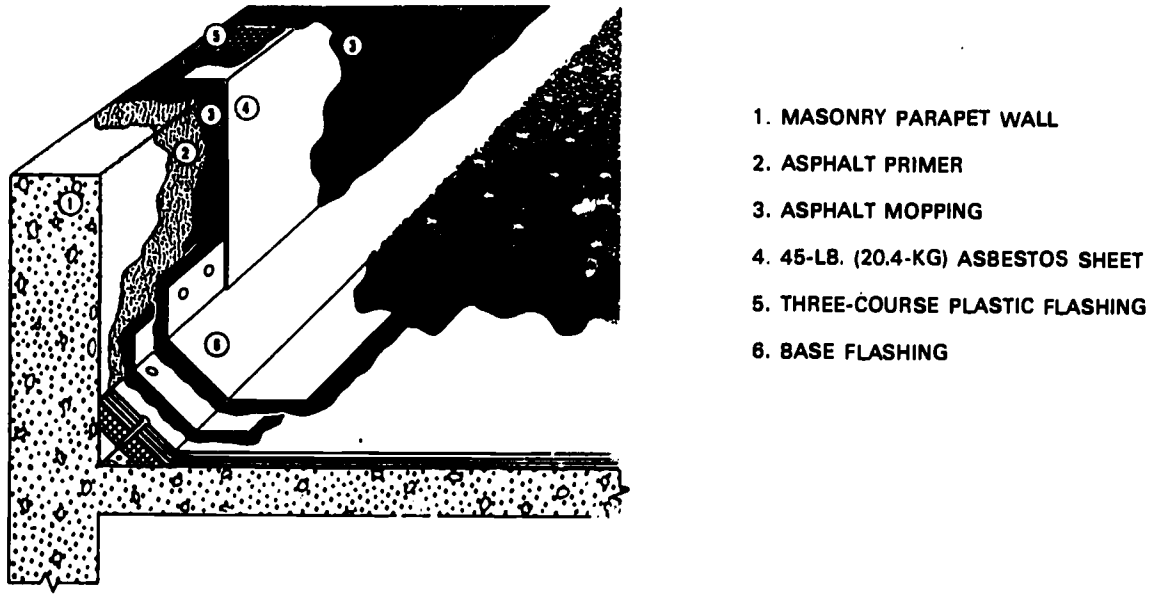


Fig. 8-3. Parapet wall flashing of asbestos felt and hot asphalt

corners will be soldered and the guard lengths tacked in place.

- Lay a 12-inch (30.5-centimetre) strip of 15-pound (6.8-kilogram) felt over the fascia.
- Lay the gravel guard straight, with an application of plastic between the joints.
- In most areas prefabricated gravel guards are stamped out in pairs, and one end is made slightly larger than the other. Therefore, start applying the gravel guard from left to right so that each piece will fit correctly and the bottom laps will be even.
- Nail only enough at first to hold the guard straight and firm against the deck and the fascia. Sight along the long runs before driving nails all the way to make sure that they are in proper alignment.
- Apply a porous fabric and hot asphalt over the metal and onto the previously laid 15-pound (6.8-kilogram) felt.

- Apply the roofing.
- If coal-tar pitch or low-melt asphalt is used, be sure that the first felt extends at least 6 inches (15.2 centimetres) past the edge of the roof. Lay the remainder of the plies, and cut them even with the edge of the roof. When all the felt has been laid, fold the extra length of the first ply back over the other plies. The resulting lap is known as an "envelope" lap. It will prevent the coal-tar pitch or low-melt asphalt from seeping out and running down the wall of the structure. Next, lay the gravel stop with a two-ply strip to bond it to the roof and to make it watertight.

The application of gravel guards is shown in detail in figures 8-8 and 8-9.

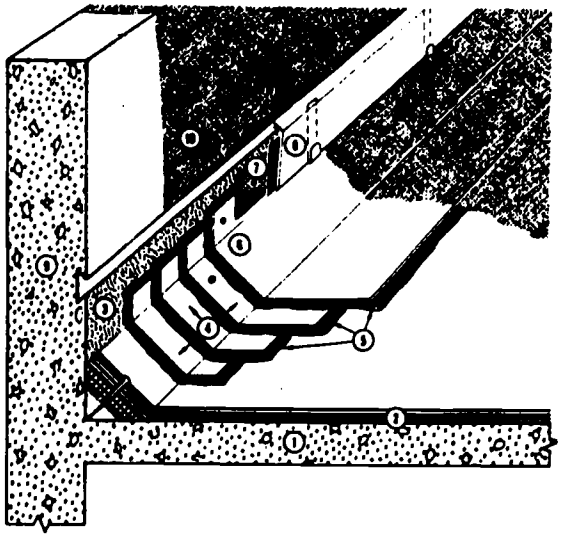
Saddles and Crickets

Saddles and crickets are used to conduct water away from chimneys, skylights, and other areas on the roof deck to the lowest point of the roof or drains. (See Fig. 8-10.) They may be made of blacktop, gypsum, insulation board, sheet metal, wood sheeting, or lightweight concrete. The saddle may look like a diamond or a half diamond. Caution must be taken to ensure that the edges of a saddle do not buck water.

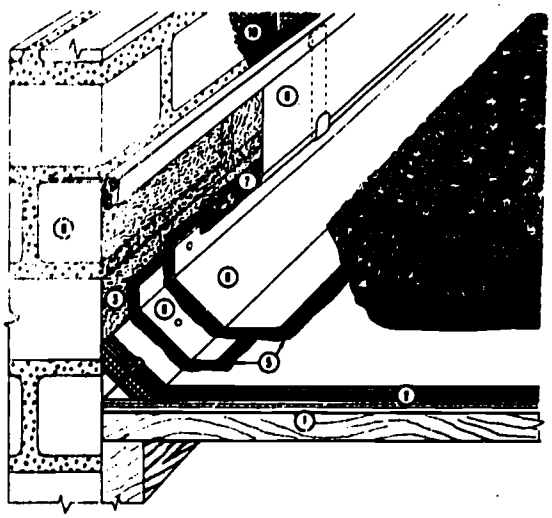
Figure 8-11 shows a roof saddle detail, and Figure 8-12 shows a roof cricket detail.

For Further Study

Figures 8-13 through 8-32 show additional aspects of flashing installation. The apprentice is strongly urged to study each drawing and become as familiar as possible with the various procedures involved in proper installation of flashings.



1. CONCRETE DECK
2. BUILT-UP ROOFING
3. ASPHALT PRIMER
4. NO. 15 ASPHALT FELT
5. ASPHALT MOPPINGS
6. MINERAL SURFACE CAP SHEET
7. THREE-COURSE PLASTIC FLASHING
8. METAL COUNTERFLASHING
9. MASONRY WALL
10. PARAPET WALL COATING



1. WOOD DECK
2. BUILT-UP ROOFING
3. ASPHALT PRIMER
4. NO. 15 ASPHALT FELT
5. ASPHALT MOPPING
6. MINERAL SURFACE CAP SHEET
7. FLASHING COMPOUND
8. METAL COUNTERFLASHING
9. MASONRY BLOCK WALL
10. PARAPET WALL COATING

Fig. 8-4. Metal counterflashing on concrete or stucco walls

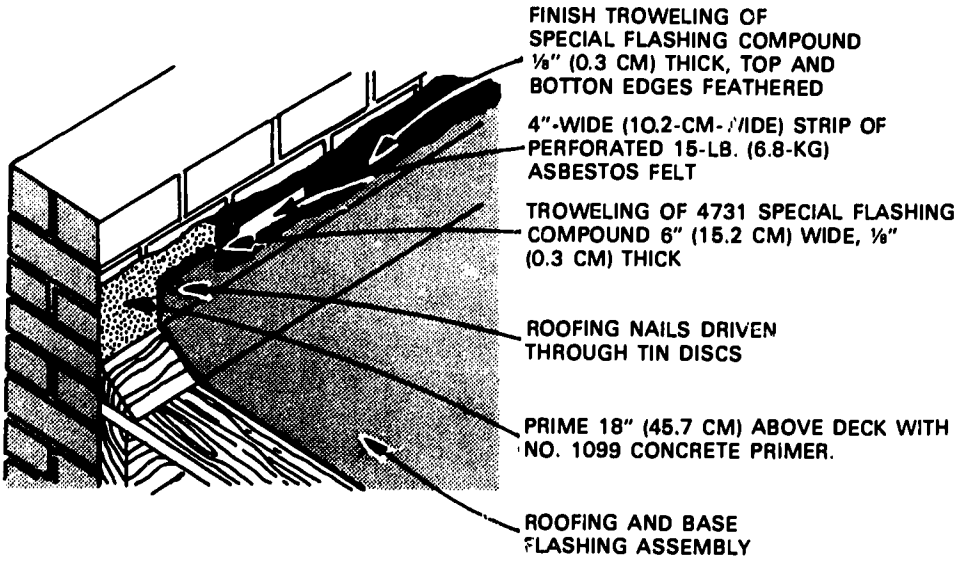


Fig. 8-5. Three-course plastic flashing for concrete walls more than 18 inches (45.7 centimetres) high

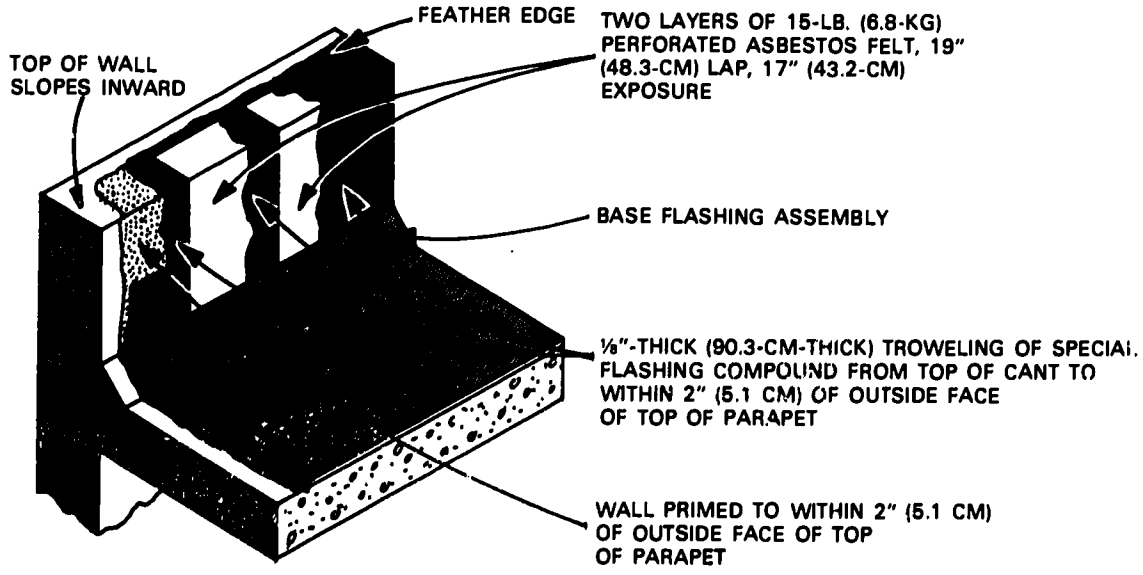
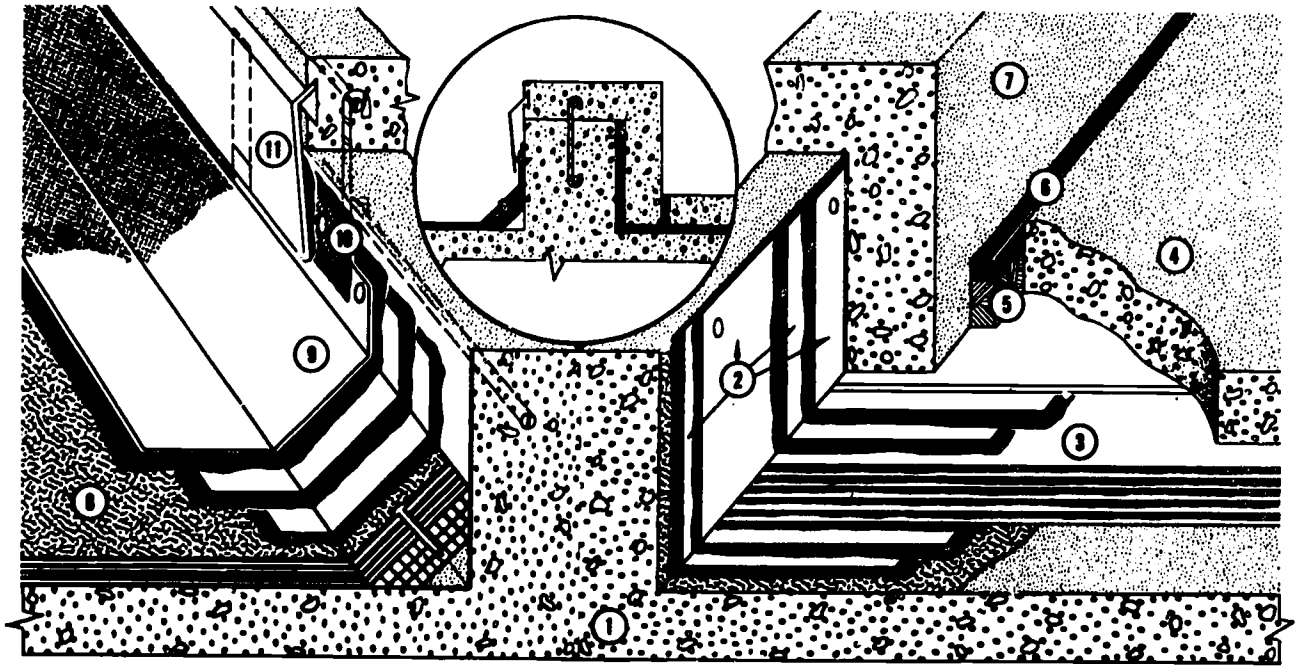


Fig. 8-6. Five-course plastic cap flashing for parapet walls less than 18 inches (45.7 centimetres) high



1. BASE SLAB AND CURB
2. REINFORCING STRIPS
3. MEMBRANE
4. TOPPING SLAB
5. FILLER STRIP
6. JOINT SEALER
7. COUNTERFLASHING CURB
8. BUILT-UP ROOFING
9. BASE FLASHING
10. THREE-COURSE PLASTIC FLASHING
11. METAL COUNTERFLASHING

Fig. 8-7. Combination roof and concrete topping flashing

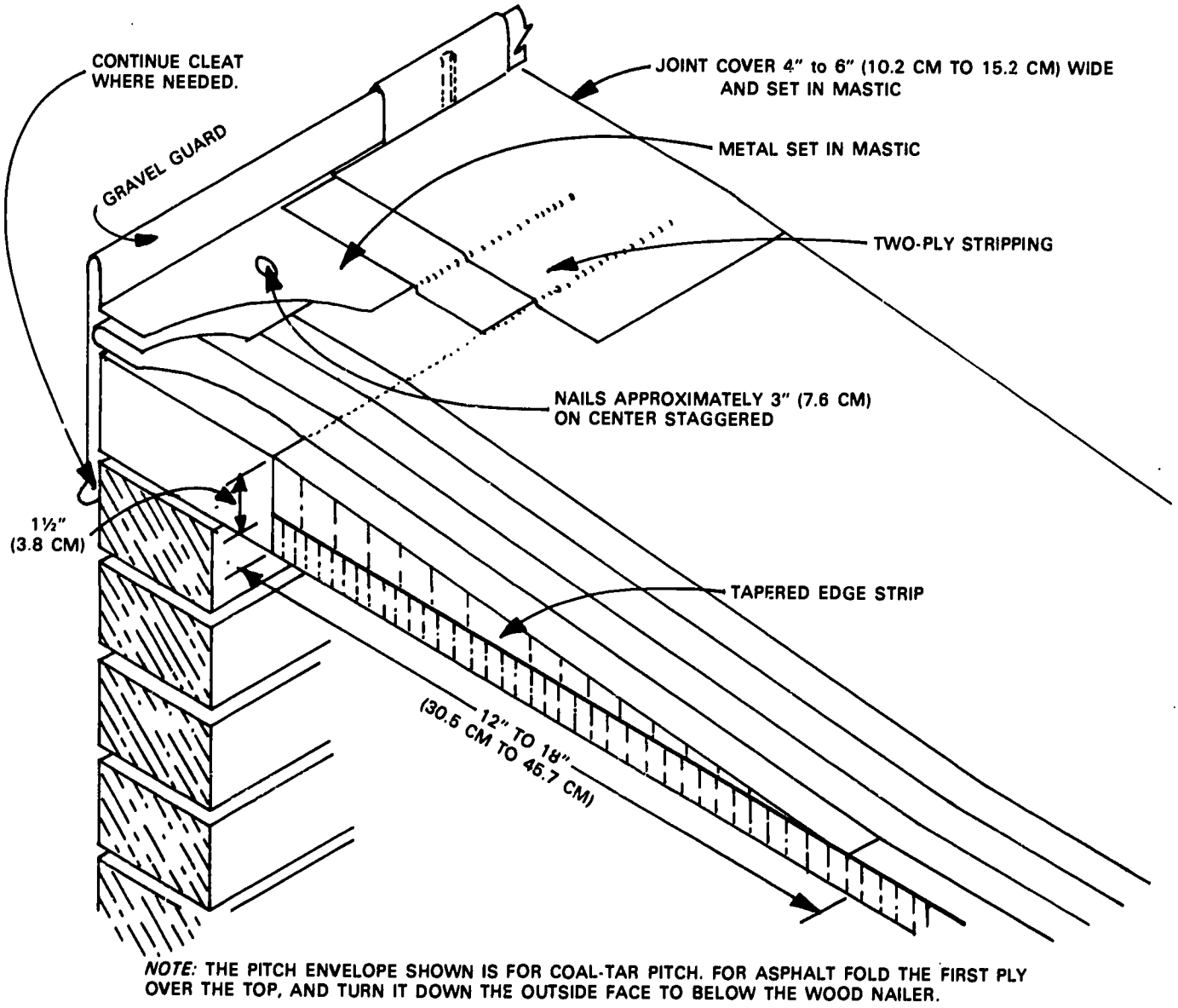
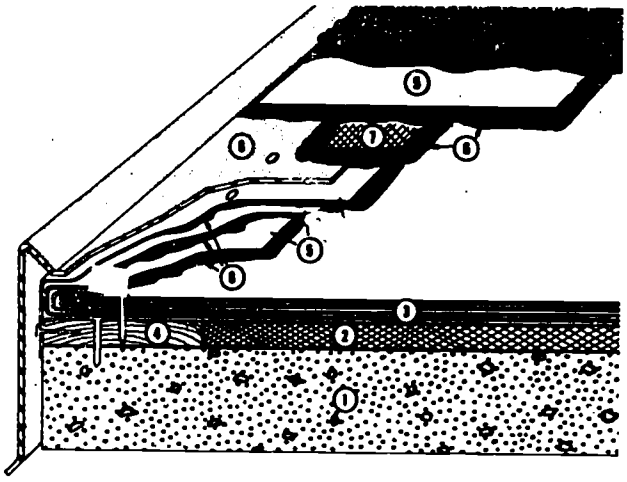
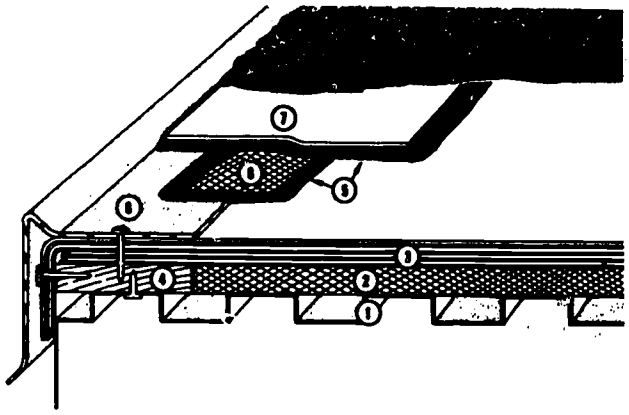


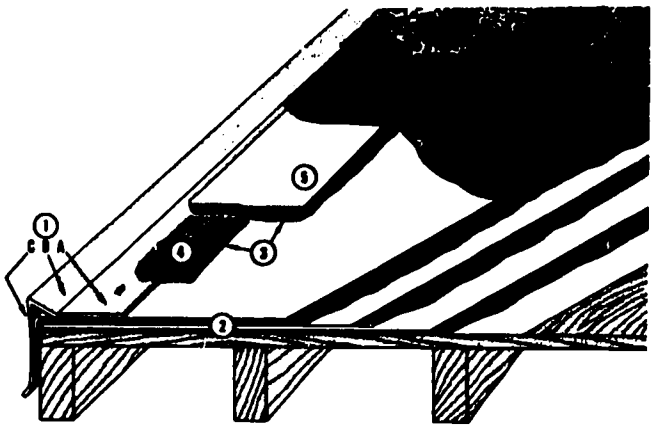
Fig. 8-8. Lightweight metal roof edge detail



1. CONCRETE DECK
2. INSULATION
3. BUILT-UP ROOFING
4. WOOD NAILER
5. NO. 15 ASPHALT ENVELOPING FELTS
6. ASPHALT MOPPING
7. YELLOW JACKET GLASS FABRIC
8. GRAVEL STOP



1. STEEL DECK
2. INSULATION
3. BUILT-UP ROOFING
4. WOOD NAILER
5. ASPHALT MOPPING
6. YELLOW JACKET GLASS FABRIC (6" [15.2 CM] WIDE)
7. NO. 15 ASPHALT FELT (12" [30.5 CM] WIDE)
8. GRAVEL STOP



1. GRAVEL STOP
   - A. ROOF FLANGE—4" TO 5½" (10.2 CM TO 14 CM)
   - B. RISE—¾" (1.9 CM) MAXIMUM
   - C. FASCIA—3½" (8.9 CM) MAXIMUM (24 GAGE)
2. ROOFING FELTS
3. ASPHALT MOPPING
4. YELLOW JACKET GLASS FABRIC (6" [15.2 CM] WIDE)
5. NO. 15 ASPHALT FELT (12" [30.5 CM] WIDE)

Fig. 8-9. Gravel stop details

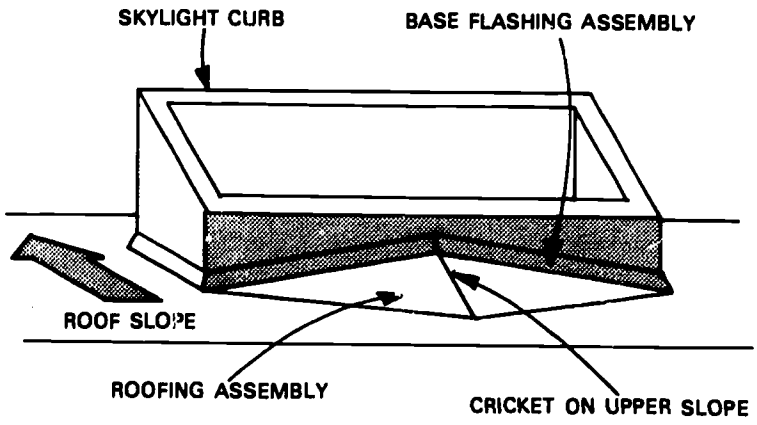


Fig. 8-10. Large ventilators, skylights, and similar structures

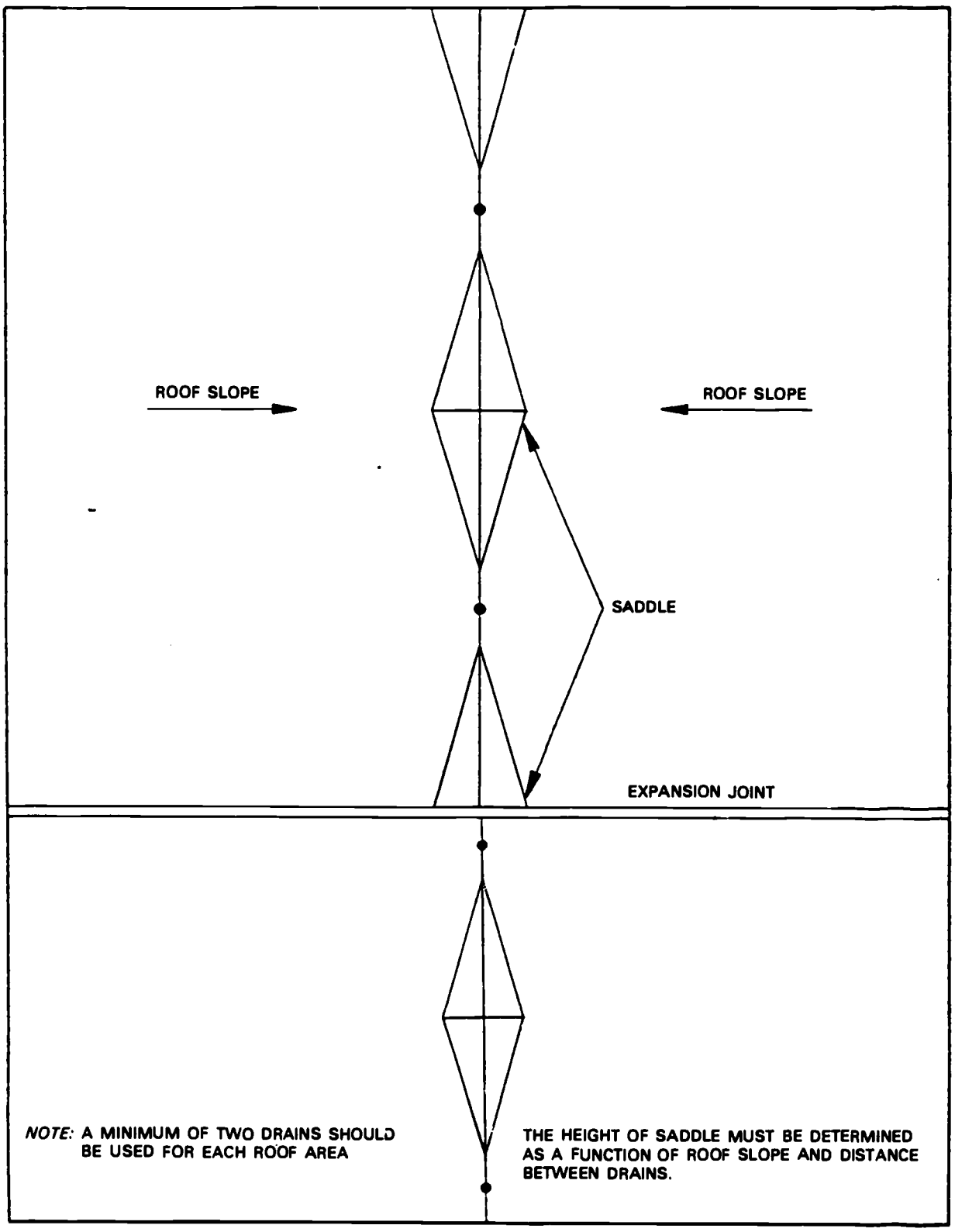


Fig. 8-11. Roof saddle detail

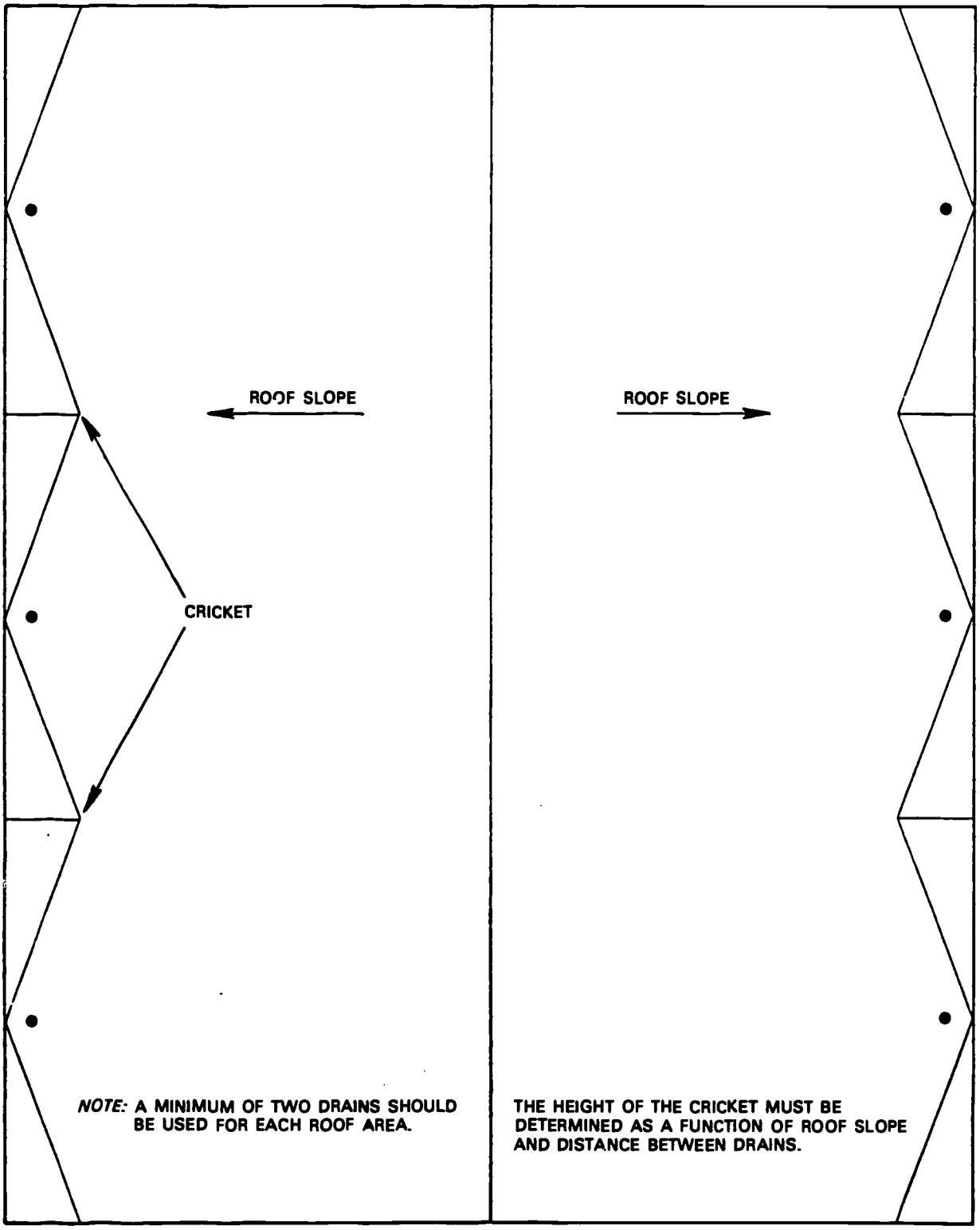


Fig. 8-12. Roof cricket detail

1. WOOD ROOF DECK
2. BUILT-UP ROOFING
3. METAL PROJECTION
4. METAL PAN COLLAR FLASHING
5. YELLOW JACKET GLASS FABRIC (6" [15.2 CM] WIDE)
6. NO. 15 ASPHALT FELT (12" [30.5 CM] WIDE)
7. ASPHALT MOPPING
8. FLASHING COMPOUND

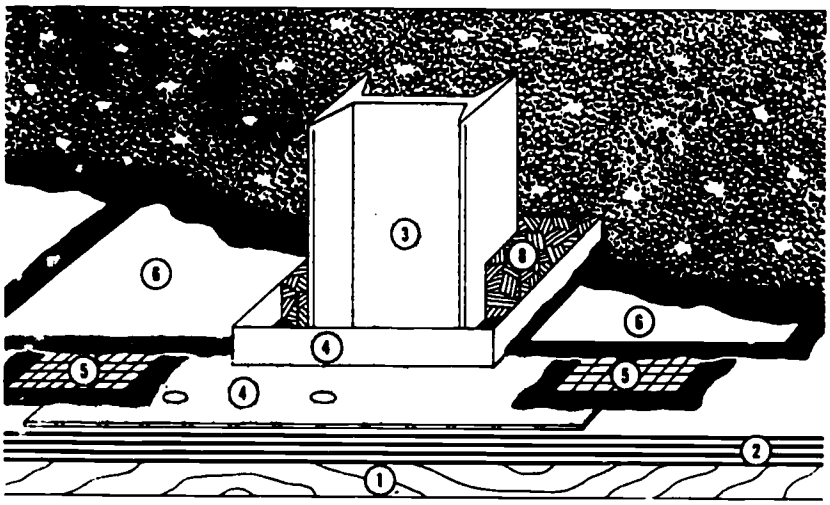


Fig. 8-13. Metal pan collar flashing

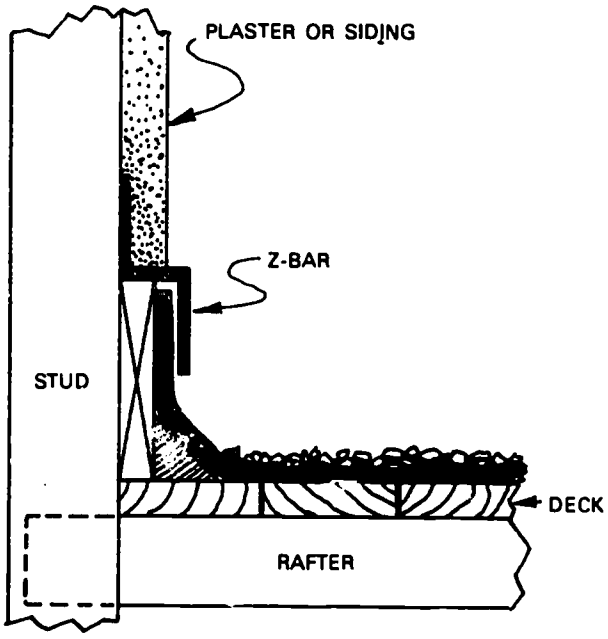


Fig. 8-14. Proper flashing procedures using Z-bar

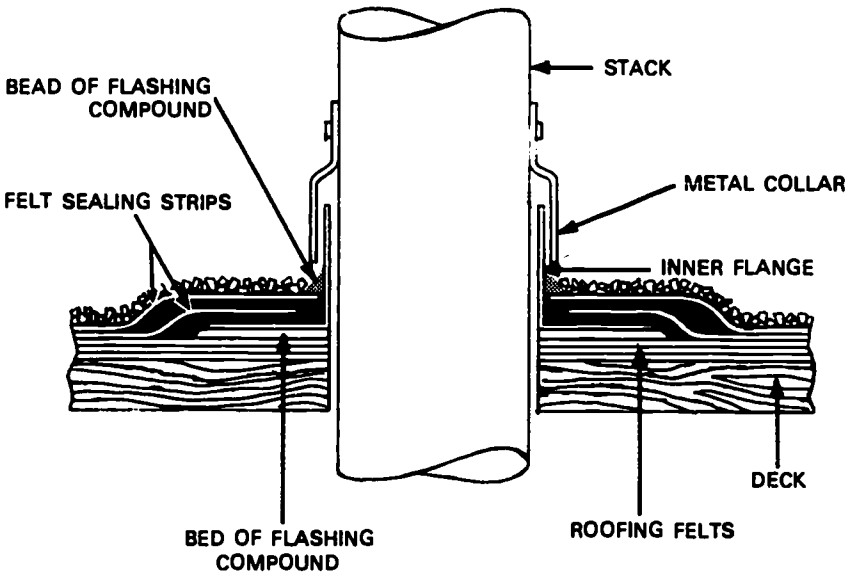


Fig. 8-15. Collars for large stacks and flagpoles

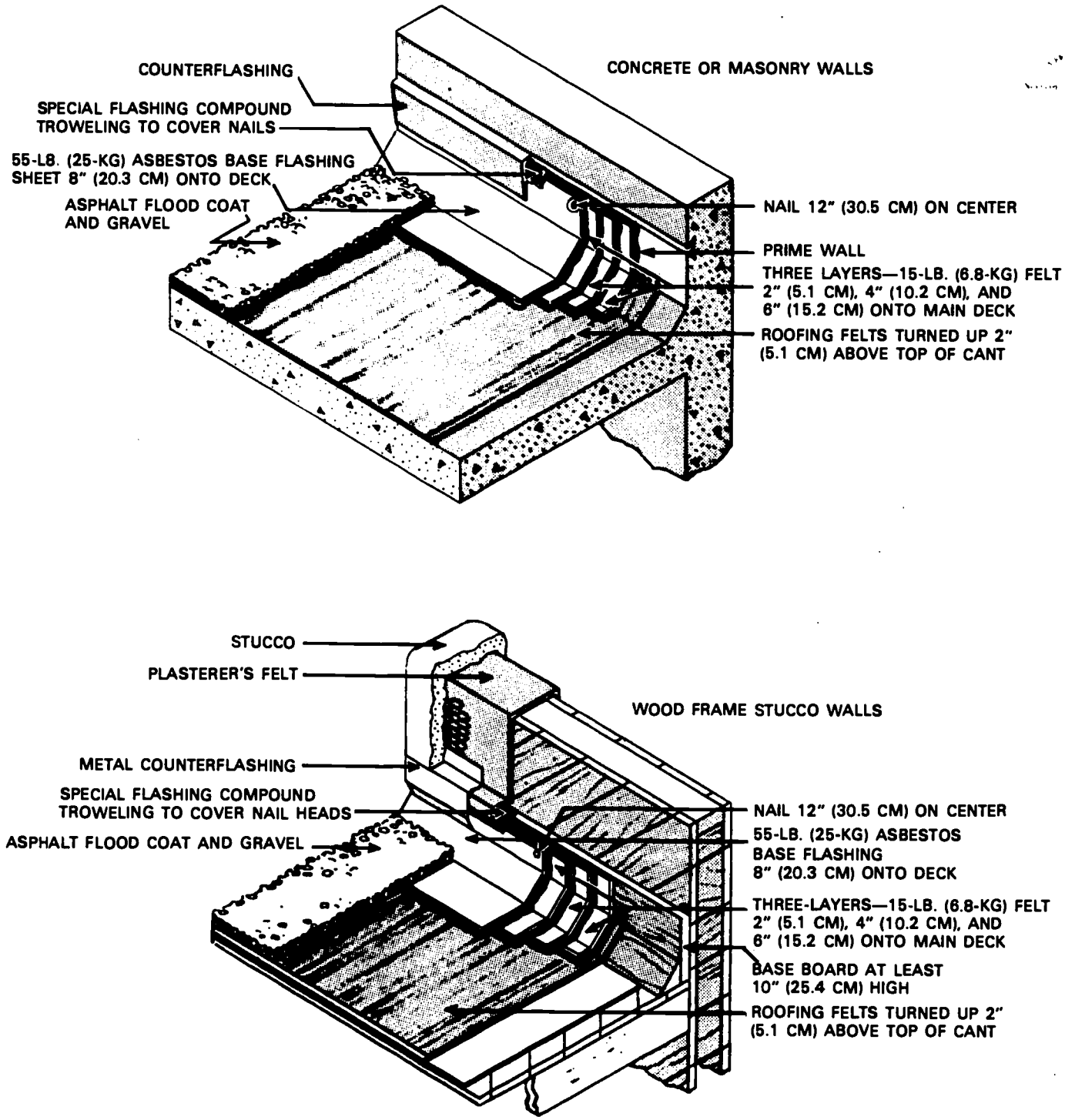


Fig. 8-16. Flashing on gravel roofs

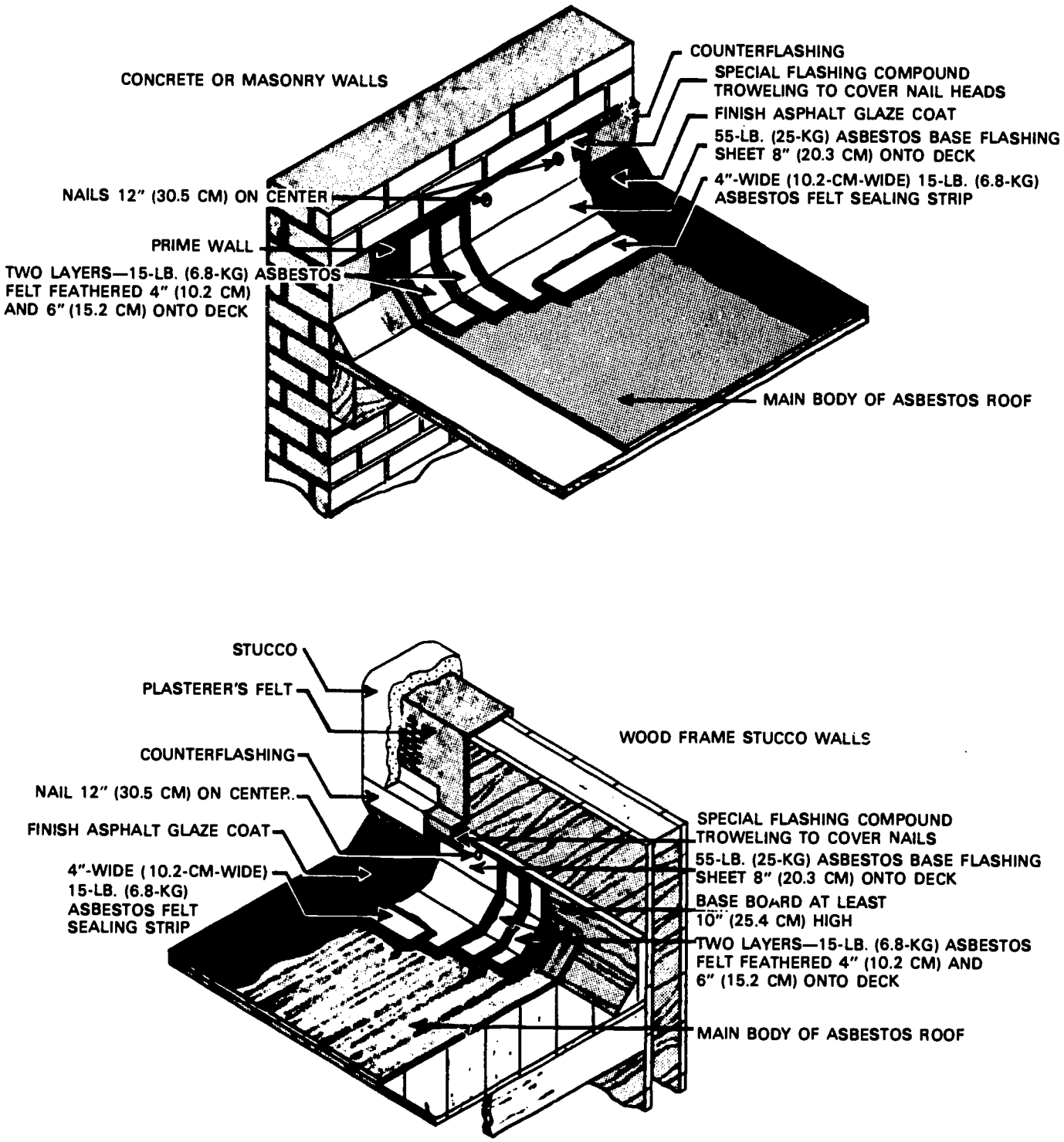


Fig. 8-17. Flashing for smooth surface asbestos roofs

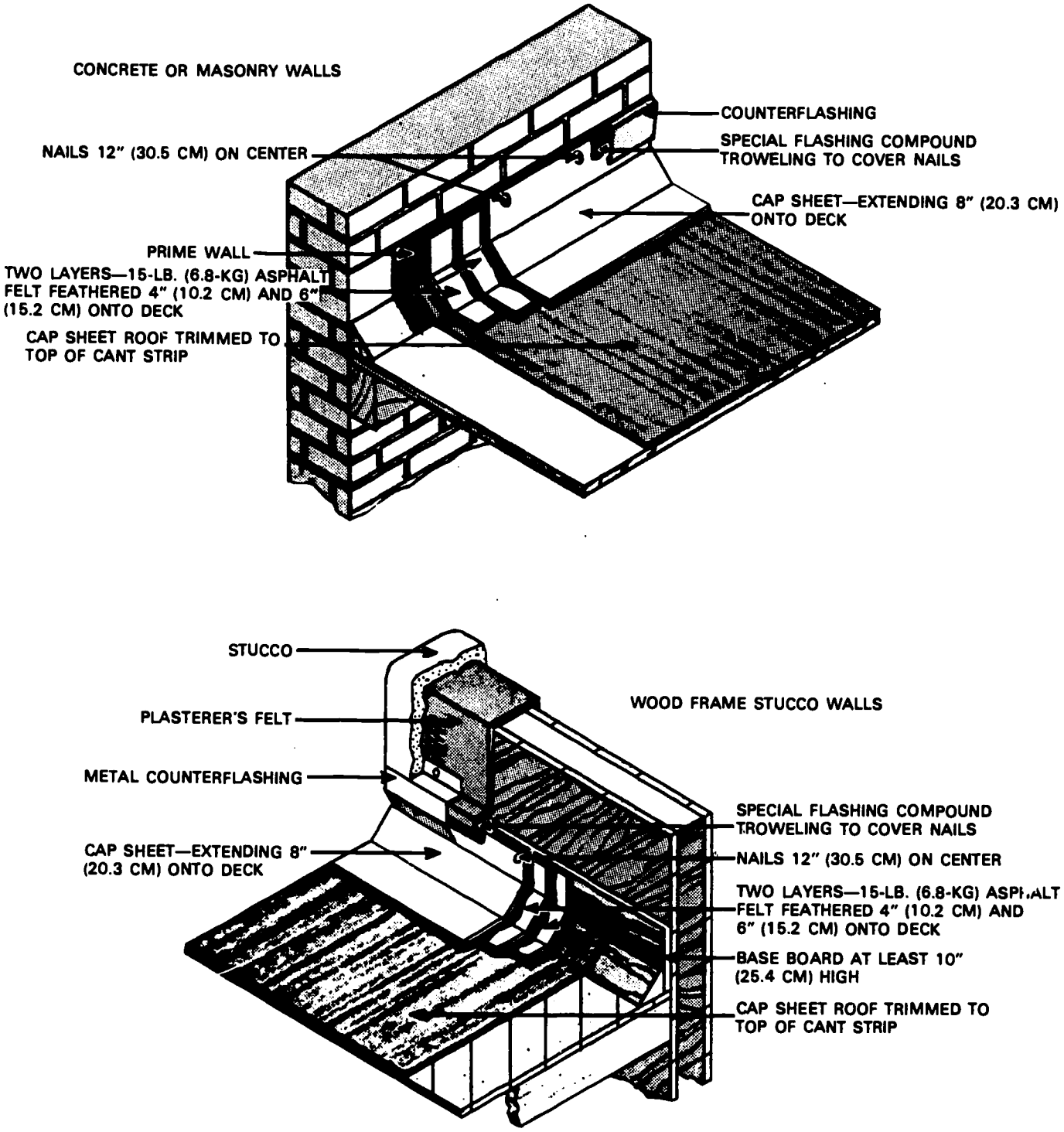


Fig. 8-18. Flashing for cap sheet, slate, mineral, and alumi-shield roofs

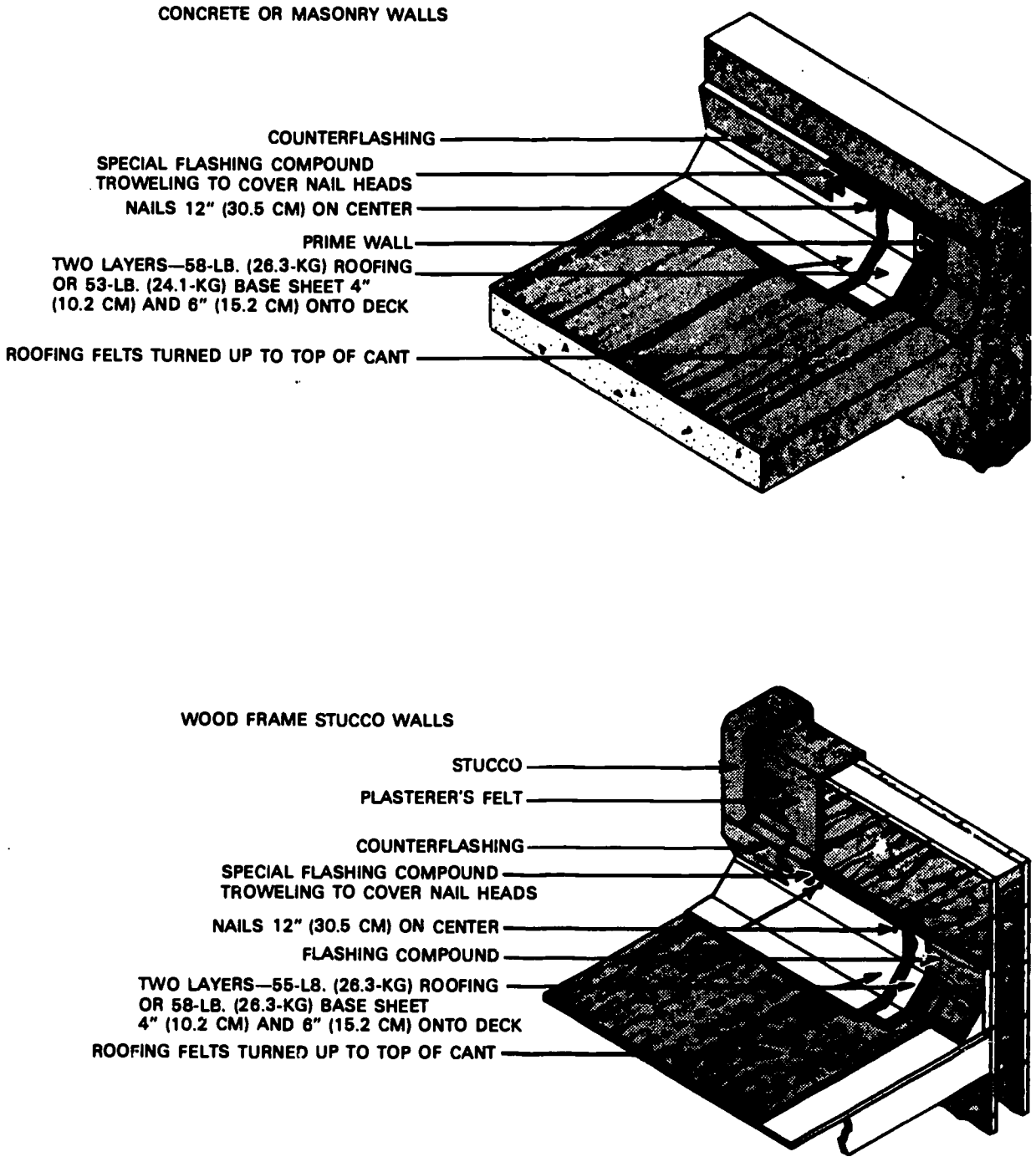
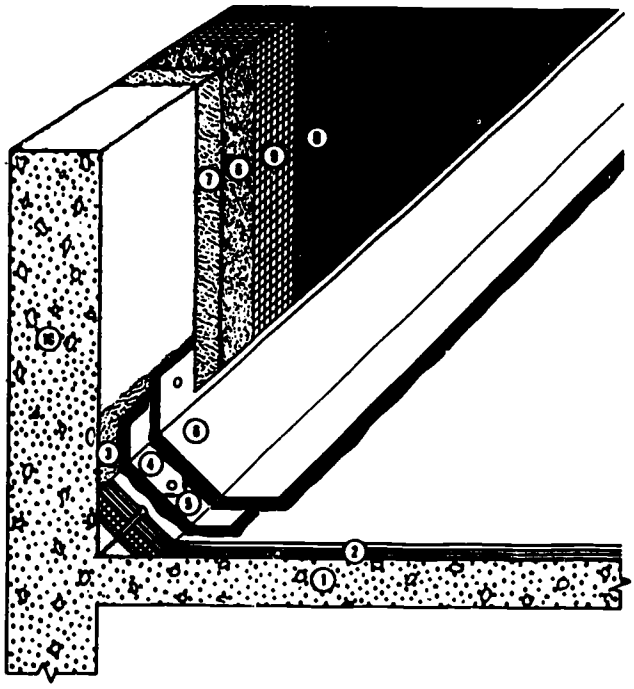


Fig. 8-19. Flashing for use with cold process assemblies



1. CONCRETE DECK
2. BUILT-UP ROOFING
3. ASPHALT PRIMER
4. NO. 15 ASPHALT FELT
5. ASPHALT MOPPINGS
6. MINERAL-SURFACE CAP SHEET
7. EMULSION PRIMER
8. ASPHALT EMULSION
9. YELLOW JACKET GLASS FABRIC
10. MASONRY WALL

Fig. 8-20. Flashing on a masonry parapet wall

1. FRAME PARAPET WALL
2. NO. 15 ASPHALT FELT
3. ASPHALT MOPPING
4. 45-LB. (20.4-KG) ASBESTOS SHEET
5. BASE FLASHING
6. STANDING SEAM METAL COPING

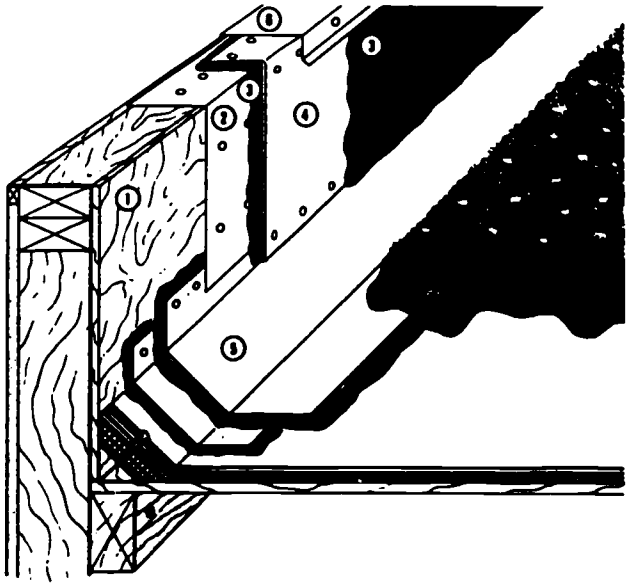
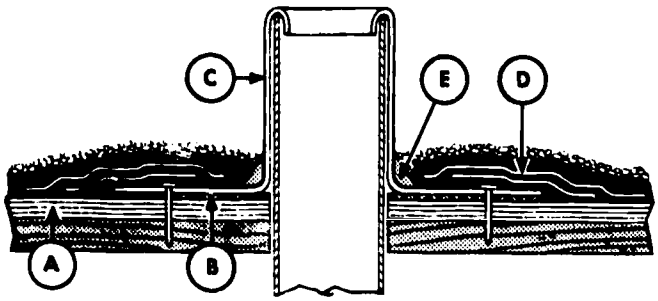


Fig. 8-21. Flashing on a wooden parapet wall

GRAVEL SURFACE ROOF, SINGLE SLEEVE



A. ROOFING FELTS

B. FLASHING COMPOUND (⅛" [0.3 CM] THICK)

C. LEAD VENT PIPE FLASHING IN BED OF FLASHING COMPOUND, TURNED DOWN INSIDE PIPE

D. TWO LAYERS OF FELT SET IN ASPHALT OVER FLANGE OF LEAD VENT PIPE FLASHING

E. BEAD OF FLASHING COMPOUND ENCIRCLING FLASHING

GRAVEL SURFACE ROOF, DOUBLE SLEEVE

A. STEEL DECK

B. INNER BOTTOM SLEEVE EXTENDING AT LEAST 2" (5.1 CM) ABOVE FINAL ROOF LEVEL

C. INSULATION

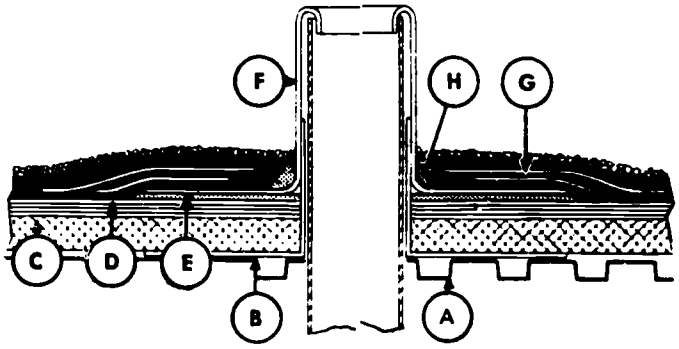
D.ROOFING FELTS

E. FLASHING COMPOUND (⅛" [0.3 CM] THICK)

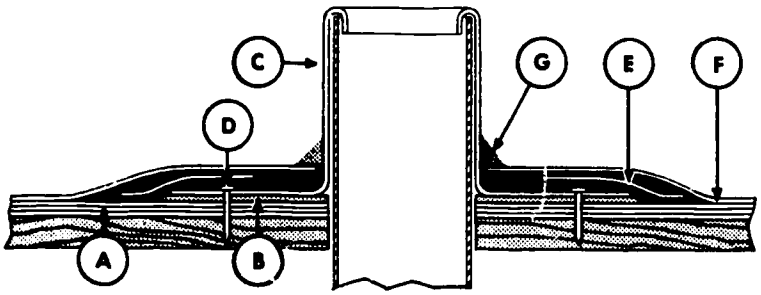
F. LEAD VENT PIPE TOP FLASHING

G. TWO LAYERS OF FELT SET IN ASPHALT

H. BEAD OF FLASHING COMPOUND



CAP SHEET ROOFS



A. ROOFING FELTS

B. FLASHING COMPOUND ⅛" [0.3 CM] THICK

C. LEAD VENT PIPE FLASHING

D. NAILS

E. 6" (15.2-CM) STRIP OF WEBBING

F. CAP SHEET

G. BEAD OF FLASHING COMPOUND

SMOOTH SURFACE ROOF WITH BASE SHEET

A. BASE SHEET

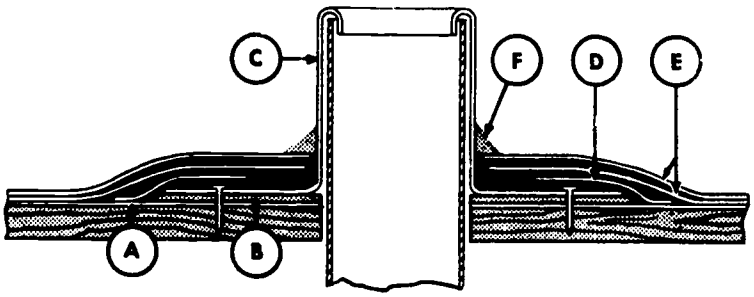
B. FLASHING COMPOUND (⅛" [0.3 CM] THICK)

C. LEAD VENT PIPE FLASHING

D. 6" (15.2-CM) STRIP OF WEBBING

E. FINISHING FELTS FOR SMOOTH-SURFACE ROOFING

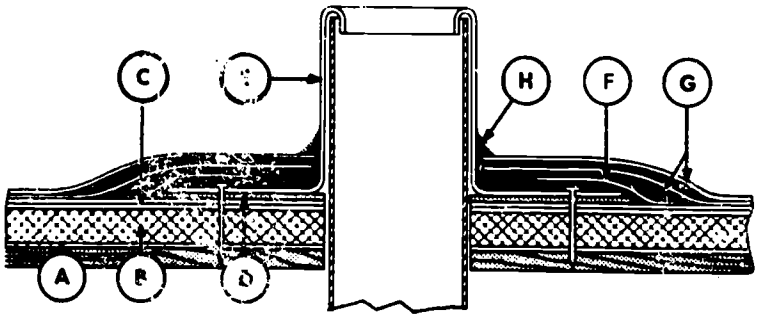
F. BEAD OF FLASHING COMPOUND



(continued)

Fig. 8-22. Lead sleeve installations

ASBESTOS FELTS OVER INSULATION



A. VAPOR BARRIER

B. INSULATION

C. BOTTOM TWO LAYERS OF 15-LB. (6.8-KG) ASBESTOS FELT

D. FLASHING COMPOUND (⅛" [0.3 CM] THICK)

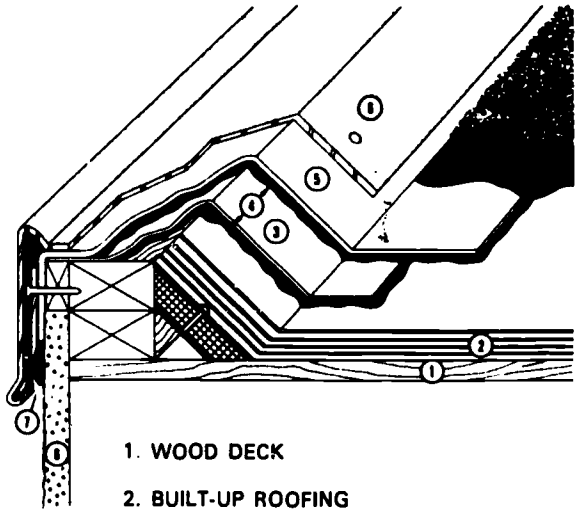
E. LEAD VENT PIPE FLASHING

F. 6" (15.2-CM) STRIP OF WEBBING

G. TOP TWO LAYERS OF ASBESTOS FELT

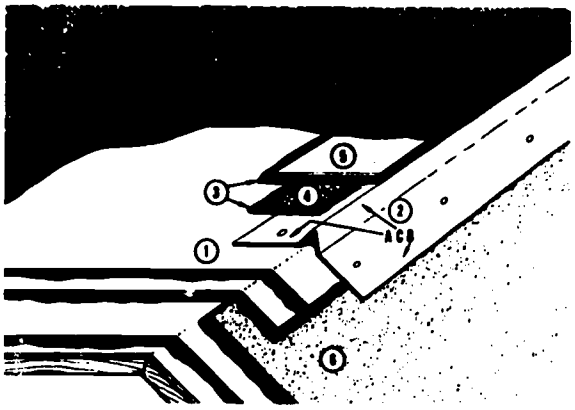
H. BEAD OF FLASHING COMPOUND

Fig. 8-22 (continued)



1. WOOD DECK
2. BUILT-UP ROOFING
3. NO. 15 ASPHALT FELT
4. ASPHALT MOPPING
5. MINERAL-SURFACE CAP SHEET
6. COMBINATION METAL COPING AND EDGING
7. METAL CLIP
8. WALL

Fig. 8-23. Low parapet wall flashing



1. BUILT-UP ROOFING
2. FLAT-TO-STEEP FLASHING
   - A. 4" (10.2-CM) FLANGE
   - B. 6" (15.2-CM) FLANGE
   - C. ¾" (1.9-CM) RISE (MAXIMUM)
3. ASPHALT MOPPING
4. YELLOW JACKET GLASS FABRIC (6" [15.2 CM] WIDE)
5. NO. 15 ASPHALT FELT (12" [30.5 CM] WIDE)
6. BUILT-UP ROOFING OR ASPHALT SHINGLES

Fig. 8-24. Flat-to-steep flashing

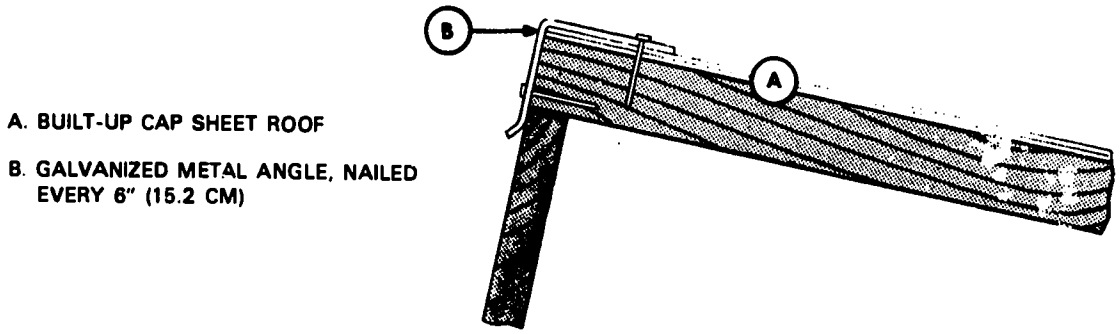


Fig. 8-25. Metal ridge cap

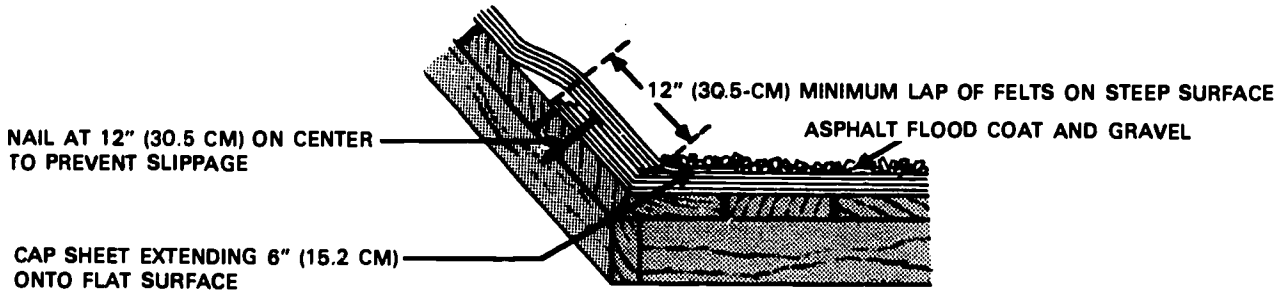


Fig. 8-26. Steep-to-flat roof transition

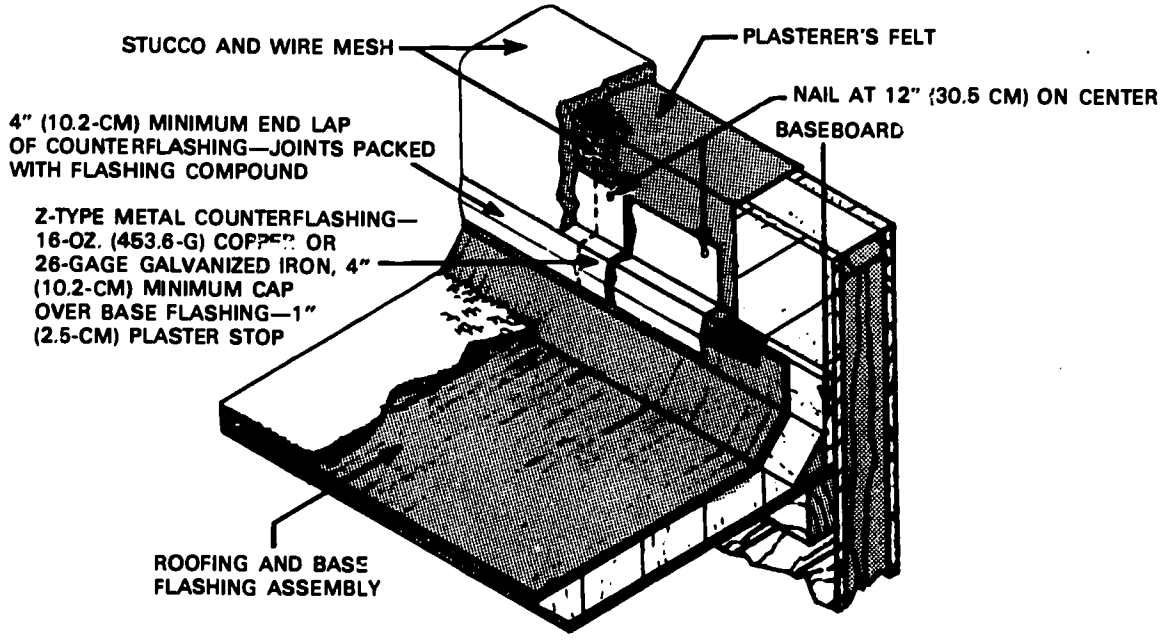
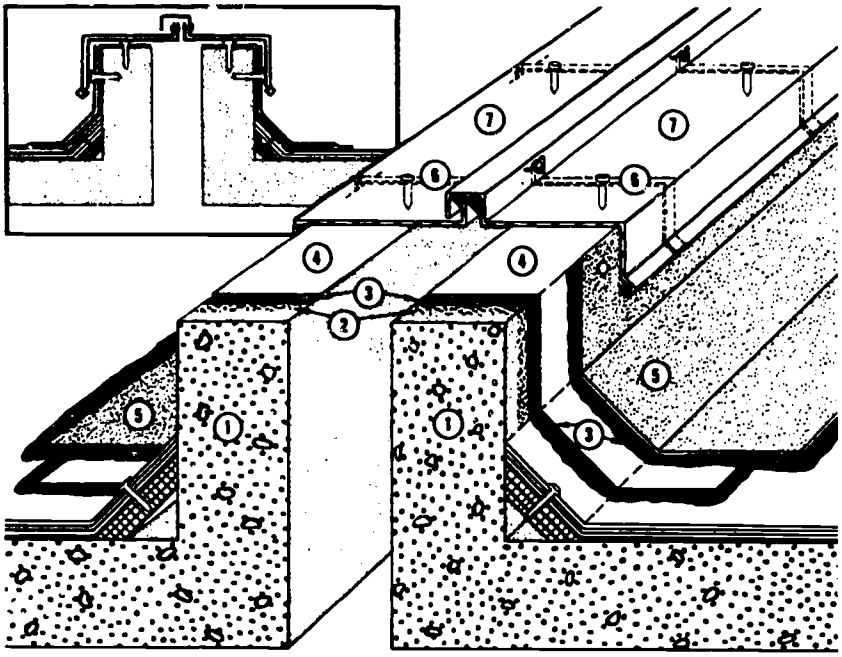
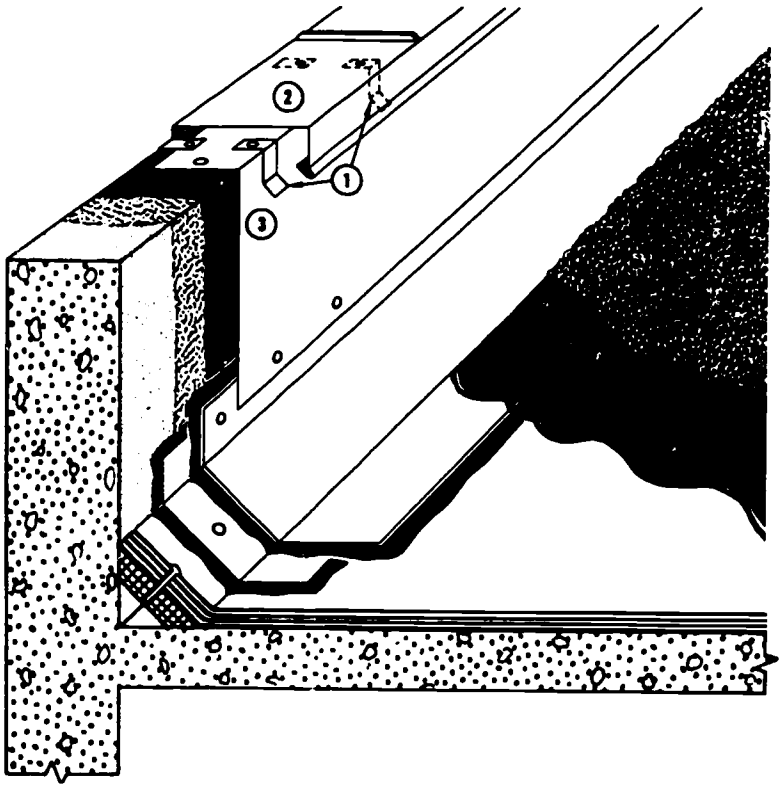


Fig. 8-27. Metal counterflashing and stucco stop for wood frame and stucco walls



1. MASONRY CURBS
2. ASPHALT PRIMER
3. ASPHALT MOPPING
4. NO. 15 ASPHALT FELT
5. MINERAL-SURFACE CAP SHEET
6. ANCHOR CLIPS
7. EXPANSION COPING



1. METAL HOLDING CLIP
2. STANDING SEAM METAL COPING
3. ROOFING FELT WALL COVERING

Fig. 8-28. Expansion joint metal coping

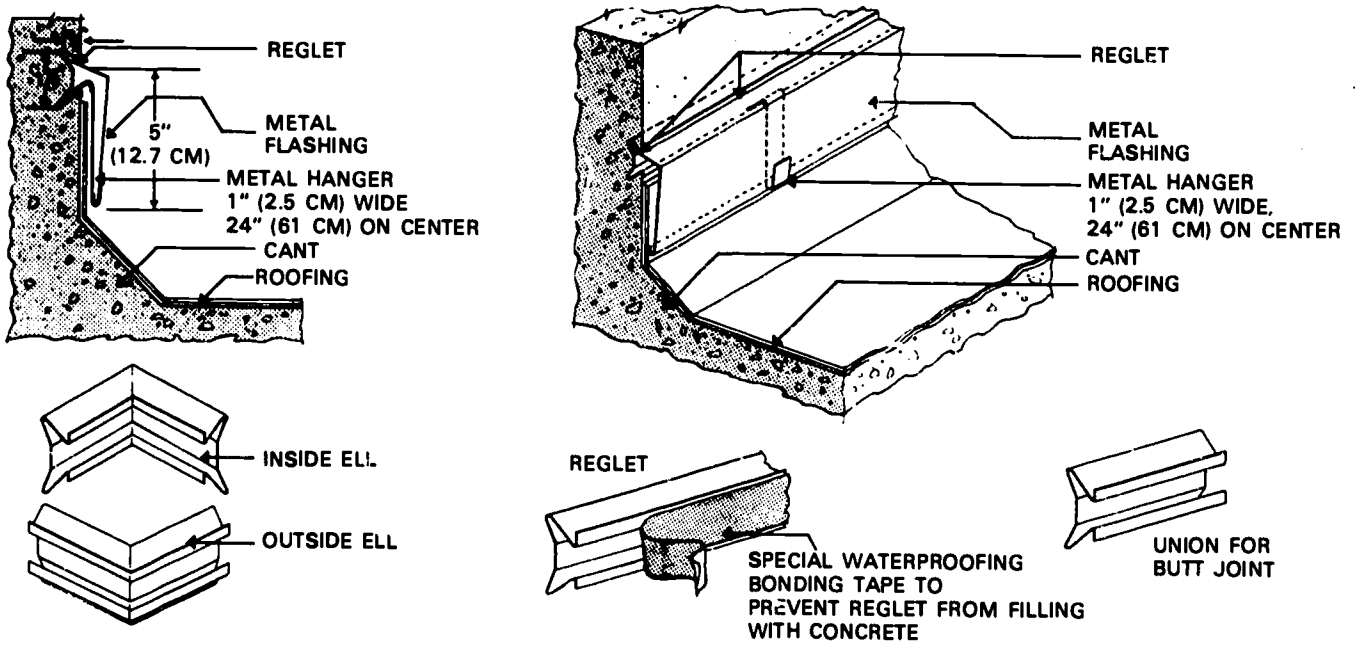


Fig. 8-29. Removable type of wall counterflashing

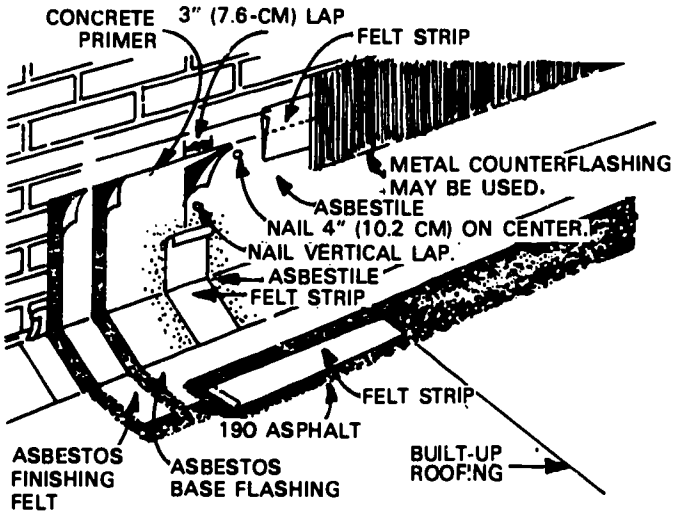


Fig. 8-30. Installation of flashing on a nailable masonry wall

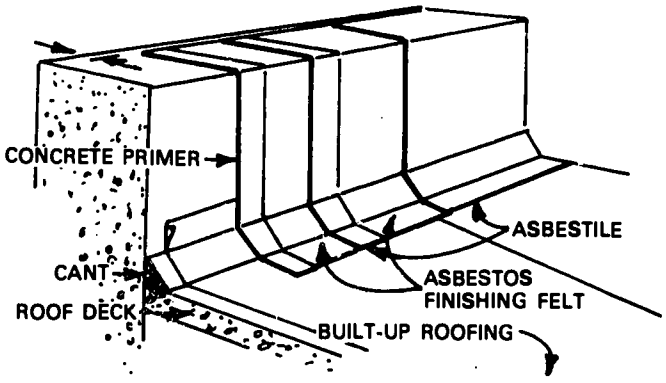


Fig. 8-31. Installation of flashing on a nonnailable masonry wall

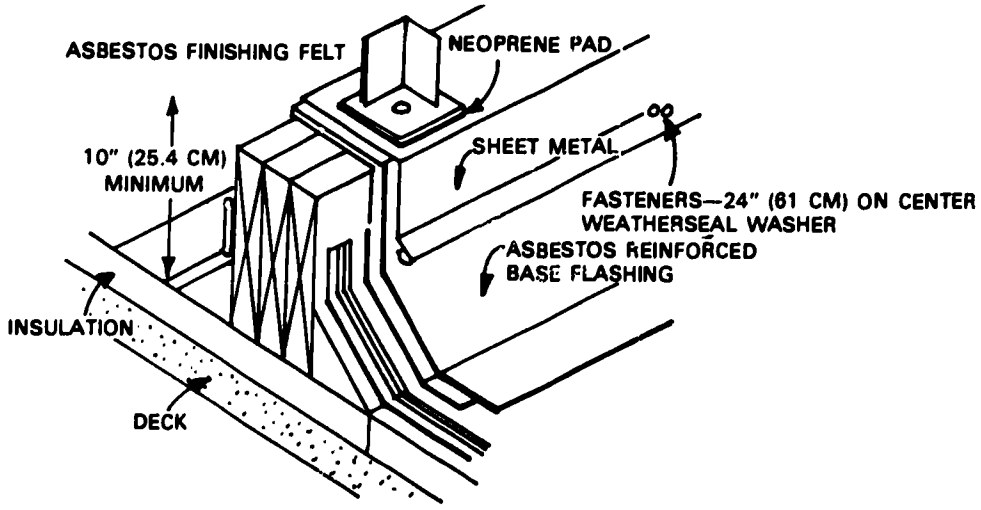


Fig. 8-32. Installation of flashing on an equipment or sign support

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.

Architect. One who plans or designs buildings.
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.
Back-mopping. Mopping the back or underside of roofing.
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.)
Bind. To cause to stick together.
Bitumen. Coal-tar pitch or asphalt.
Bleeding. The draining or loosening of saturants from the roofing material.
Blister. A swelling and separating of the top layer of roofing from the underlayment. A bladderlike air pocket.
Bond. To fasten or stick together.
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.
Buckles. Bends, crumples, or curls in roofing.
Built-up roof. Roof formed by a number of layers of roofing mopped together with hot asphalt or pitch.
Butt. Short length of material; the unused end portion of a roll of roofing.
Butter. To smooth on plastic with a trowel.
Butt joint. Two pieces of roofing material fitted squarely against each other without overlapping.
Cable. A heavy rope or chain.
Cap sheet. A finish roofing material, used as a covering for a roof.
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.
Coal-tar pitch. A thick, dark liquid obtained by distillation of soft coal; used for roofing and waterproofing.
Coating liquid. A liquid, with an asphalt or coal-tar base, used for preserving roofs.
Concealed gutter. An eaves trough installed or lowered into the roof in such a way that it is invisible.
Condensation. The change from vapor to liquid form, as from steam to water.
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.
Creosote. A by-product of coal used for preservation of wood surfaces and in waterproofing materials.
Cupola. A hemispherical roof; a small structure above the roof.
Curb. A protective rim.
Cured. Completely dry; moisture free.
Cutback. Asphalt dissolved into its liquid form.
Dampproofing. The application of coatings of hot or cold bitumens or the use of membranes to keep out dampness.
Debris. Accumulated rubbish, trash, and fragments of roofing.
Deck or substrata. 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.

Draftsperson. One who makes plans and mechanical drawings.

Dragline. A guideline rope.

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.

Eaves. The projecting lower edge of a roof.

Eaves trough. A gutter along the eaves of a roof for carrying off rain water.

Emulsion. An asphalt and water mixture used in dampproofing and roof coating. After the water dries, the asphalt remains.

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.

Fiberboard. Wood pulp that is molded into a sheet and used for insulation.

Fiber. A tough substance that is separated into threads and spun or woven.

Firewall. A wall erected above the roof to block fires between sections of the building.

Fishmouth. An open seam or a ripple on the roof surface.

Flashing. Sheets of metal or other suitable materials used to make watertight joints in roofs.

Flash point. The temperature at which asphalt or tar, when slowly heated, gives off vapors that will ignite upon the application of a flame.

Flopping. Lifting and dropping a sheet of roofing in a specific place.

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.

Gauntlet. A modern glove with a long wrist extension.

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.

Granite. A rock used for roof gravel.

Graphite. A variety of carbon used in roofing stains and coatings.

Gravel. Crushed stone or rock used for surfacing roofs.

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.

Header. Sheets of roofing laid around openings or parallel with the walls or the edges of the roof.

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.

Holiday. A space or spot on the roof that is missed or unmopped.

Horizontal. In the direction of the horizon or parallel to it.

Impregnate. To cause to be filled or permeated with; to saturate.

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.

Irish flax. An imported brownish roll fiber material used for flashing purposes.

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.

Kerosene. A light, colorless petroleum fuel used in kettle burners and for cleaning uses.

Kettle. A metal vessel for heating asphalt or coal-tar pitch.

Kettleperson. A man or woman who operates a kettle.

LP gas. A liquid petroleum product (butane or propane) used as fuel on certain kettle burners.

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.
Linen. An asphalt-impregnated webbing.
Mastic. A 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.
Monitor. A small tower rising from the roof of a factory or other buildings, with windows or louvers, or both.
Mop yarn. A material of cotton or glass fibers used to make roofing mops.
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. A roof drain.
Overflow. A roof drain in wall, above outlet elevation, for excess water.
Overhang. The length of rafter projecting beyond the wall line.
Parapet. A low wall above roof level.
Pitch. The slope of a roof, indicated by the relation of the rise to the span; also, a coal-tar roofing material.
Pitch pan. A metal pan filled with pitch or mastic set in hot pitch to waterproof under sign supports, angle irons, plumbing pipes, and the like.
Plans. Drawings showing the proportions and relations of parts of a building.
Plaster bond. Dampproofing material sprayed or brushed on masonry and basement walls before plastering.
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.
Ply stick. A stick used in the application of roofing felts to obtain proper lap and exposure.
Portal. An entrance way, especially one that is grand and imposing.
Pot. A roofing kettle.
Precast. Cast beforehand, as precast gypsum roof slabs.
Primer. A thin asphalt base sprayed or brushed on roof before applying asphalt.
Pry 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 as putty.)
Pyramid cleat. A raised metal cleat, sometimes used in surface nailing in windy areas, on oil tanks, and so on.
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 raggle. 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.
Rolling rod. A pipe or rod used to hold a roll of roofing.
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.)

Salamander. A white top asbestos roll roofing; usually called white top.

Saturate. To soak thoroughly.

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.

Scar. An indentation mark made on roofing.

Screen. A metal wire screen or basket used on outlets or downspouts.

Scrub. To rub vigorously; to spread the hot material very thin.

Scupper. A hole or gutter bordering a deck; to let water run off.

Seam. A visible line of junction between two parts; a ridge made in joining two sheets of roofing.

Selvage edge. A 2″ or 3″ (5.1-cm or 7.6-cm) sanded edge on roll roofing.

Sheathing. The boards or other material used for covering the frame or roof structure.

Shiplap. A certain form of lapping of sheets of roofing.

Side lap. The lap of roofing material along its side or edge.

Silica. White or colorless, extremely hard, crystalline silicon dioxide.

Skein. A fixed quantity of yarn used in making mops.

Skylight. A window facing skyward, usually located on the roof. An opening in the roof containing a window for light and ventilation.

Solid-mopping. A continuous mopping of a surface, with no area left unmopped.

Slip sheet. A light sheet of paper applied over roof sheathing to prevent the roofing from bonding to sheating. 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.

Spigot. A faucet for drawing asphalt from the kettle.

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.

Split. A long crack or tear in the roofing.

Spot-mopping. A mopping pattern in which hot bitumen is applied in roughly circular areas. A grid of unmopped perpendicular bands is left on the roof.

Spreading rate. The quantity of bitumen, roofing aggregate, and other materials that may be spread over a roof deck in a certain time. Always given in gallons (litres), pounds (kilograms), or other designation "per square."

Sprinkle-mopping. A random mopping pattern in which heated bitumen beads are applied with a brush or mop.

Spud (bar). A sharp, narrow spade for removing gravel and roofing; to dig or remove with a spud (bar), as to remove roof gravel.

Square. A unit of measure of roofing area equal to 100 square feet (9.3 m^2).

Square butts. A type of double-coverage shingles.

Standing sheet. The sheet or sheets of roofing laid at the eave or lower part of the roof and around all openings on the roof.

Staple. A U-shaped piece of metal with pointed ends.

Stapler. A device used for stapling materials together.

Storm collar. A narrow strip of metal formed to fit around vent pipes.

Strip-mopping. A mopping pattern in which hot bitumen is applied in parallel bands.

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.

Talc. A soft magnesium silicate used on roll roofing.

Taper. To make or become smaller toward the end; to lessen gradually; growing smaller by degrees in one direction.

Tar. A by-product of coal; often referred to as coal tar or coal-tar pitch.

Tear off. To remove completely an existing roofing membrane.

Template. A pattern or guide of wood or metal used for shaping or marking work.

Tin caps. A tin flat disk, used to nail through, giving greater holding area to the nail head. Used in windy areas and on soft roofing materials.

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.

Veranda. An open portico or gallery along the side of a building; usually called a porch.

Vergeboard. The outer false rafter on the rake of a gable; sometimes referred to as a bargeboard.

Waterproofing. Making impervious to water by use of membranes; also, the material used in the process.

Washback. A pyramidlike structure on a roof provided to direct water to a drain.

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.

Appendix

Article 30, *Construction Safety Orders*, "Roofing Operations and Equipment"

1723. Application.

(a) The Orders contained in this Article are intended to apply to employees engaged in the removal or application of:

(1) Single-unit (Monolithic) roof coverings include built-up roofing of asphalt or coal-tar pitch or like materials, and flat-seam metal roofings or like materials, and

(2) Multiple-unit roof coverings include asphalt shingles, asbestos-cement shingles, standing-seam metal panels, shingle metal roofing, wood shakes and shingles, clay tile, concrete tile, slate or like materials.

(b) Applicable parts of this Article shall apply wherever kettles, tankers or pots with capacities in excess of 5 gallons are used in providing hot asphalt, pitch or like materials for construction or maintenance operations.

(c) When the work is of short duration and limited exposure, such as minor patching, measuring, roof inspection, etc., and the hazards involved in rigging and installing the safety devices required by this Article equals or exceeds the hazards involved in the actual construction, these provisions may be temporarily suspended provided that adequate risk control is recognized and maintained.

NOTE: See Appendix for additional information on roofing safety.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY:

1. Repealer of Article 30 (Sections 1725–1730) and new Article 30 (Sections 1723–1730) filed 6-6-80; effective thirtieth day thereafter (Register 80, No. 23). For prior history, see Registers.

1724. Roofing—General.

(a) Roof Jack Systems.

(1) Roof jacks shall be constructed to fit the slope of the roof and be designed, fabricated and installed in such a manner that they will sustain all expected loads.

(2) Intervals (spans) between roof jacks shall not exceed 10 feet.

(3) Roof jacks shall be installed in the manner for which they were designed.

(4) When rope supports are used, they shall consist of first-grade Manila rope of at least ¾-inch diameter or other material of equivalent strength.

(5) Wooden supporting members that span between jacks, as illustrated in Appendix Plate C-19, shall be carefully selected for strength and be of at least 2-inch by 6-inch material. Where supporting members other than wood are used they shall be of at least the equivalent strength.

(b) Crawling Boards (Chicken Ladders).

(1) Crawling boards shall be not less than 10 inches wide and 1-inch thick, and shall have cleats of at least 1 by 1½-inch material. The cleats shall be equal in length to the width of the board and spaced at equal intervals not to exceed 24 inches. Nails shall be driven through and clinched on the underside of the board.

(2) Where building design permits, the crawling boards shall extend from the ridge pole to the eaves.

(3) A firmly fastened line of at least ¾-inch diameter Manila rope, or equivalent, shall be laid beside each crawling board for use as a handhold.

(4) Crawling boards shall be secured to the roof by adequate ridge hooks or other effective means.

(c) Catch Platforms.

(1) When catch platforms are used, they shall be installed in close proximity below the eaves below roof work areas, extend at least 2 feet horizontally beyond the projection of the eaves, and be provided with standard railings and toeboards (See Article 16).

(2) The platforms shall be fully planked.

(d) Scaffold Platforms.

(1) When built-up scaffold platforms are used to protect workers from falls from the edges of roofs, they shall be installed and maintained in accordance with the provisions of Article 22, Scaffolds.

(2) A fully planked platform, complete with railings and toeboards, shall be provided near the eave level.

(e) Eave Barriers.

(1) When a system of eave barriers is provided to prevent falls from roofs, the barrier shall be 42 to 45 inches high and consist of standard railings and toeboards unless of solid construction (See Article 16).

(2) The barrier system shall be securely anchored at eave level or supported by ropes securely tied to substantial anchorages on the roof.

(3) If the barrier system is to be moved from one work area to another, employees performing the moving operation shall be protected by the use of safety belts and lines.

(f) Safety Belts and Lines.

(1) Where used to prevent workers from falling off roofs, safety belts and lines shall be installed and used in accordance with the provisions of Article 24, Safety Belts and Nets.

(2) Safety lines shall be attached in a secure manner to substantial anchorages on the roof.

(g) High-Lift Material Trucks. Standard railings and toeboards shall be provided on the open sides of the platforms of high lift material trucks when the platform is used as a work surface, other than for loading or unloading purposes, at elevations 7½-feet or more above ground, floor or level underneath.

(h) Ramps and Runways.

(1) Ramps or runways erected exclusively and used for the purpose of loading or unloading roofing materials at elevations above ground, or other level below, not exceeding 20 feet in height shall be at least 40 inches in width. At those elevations exceeding 20 feet in height, standard guardrails shall be installed and maintained on both sides of the ramp or runway.

NOTE: A 10-inch wide horizontal opening is permitted between the railing and the ramp or runway platform.

(2) Runways or ramps shall be secured against displacement and shall be supported to avoid excessive deflection or springing action.

(3) Securely fastened cleats or other adequate provisions to provide traction shall be used on inclined ramps and runways sloped 3 feet in 10 feet or more to improve footing.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

1725. Handling of Buckets, Kettles and Tankers.

(a) Buckets containing hot asphalt or pitch shall not be carried on ladders.

(b) Not more than one bucket of hot asphalt or pitch shall be carried at one time by a worker on a roof having a slope ratio of 5 vertical in 12 horizontal (5:12) or steeper.

(c) Buckets used in carrying service shall not be filled so full that the liquid surface is within 4 inches of the top. No other open container transporting hot asphalt or pitch shall be filled beyond 75 percent of capacity.

(d) An attendant shall be within 10 feet of a kettle or tanker at all times while the burner flame is on, with no ladders or similar obstacles forming a part of the route to be taken to reach the kettle or tanker. However, if the kettle or tanker is controlled by an operating thermostat, the above distance and route limitations do not apply, provided that arrangements are made for needed service.

(e) A clear path, free of debris, shall be maintained between the kettle and the hoist or hand line.

(f) When moving the kettle on any public street or roadway, it shall be drained at least 5 inches below the splash rail.

(g) When in use, the LPG fuel container shall be installed so that the heat from the burner will not increase the temperature of the container more than 10 degrees Fahrenheit after one hour of operation of the burner at full capacity.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

1726. Asphalt and Pitch Kettles.

(a) The covers on kettles shall be constructed to close tightly and the kettles shall have vents providing a total open area of not less than 5 square inches. All kettles used by employees shall be in compliance with the provisions of Section 1726(h) by July 1, 1983.

(b) Kettles shall be equipped with adjustable supports for use in setting kettles so that they are prevented from turning over.

(c) Relief Valve. The fuel tank of every kettle that depends upon the pressure of power-pumped (machine compressed) air for fuel delivery shall be equipped with a spring-loaded relief valve set to pop at a pressure not to exceed the maximum safe working pressure of the vessel, but in no case greater than 60 pounds per square inch.

(d) A Class BC fire extinguisher shall be kept near each kettle in use. Extinguisher capacity shall be at least as follows:

Less than 150 gallons	8:B.C.
150 to 350 gallons	16:B.C.
Larger than 350 gallons	20:B.C.

(e) An extension handle of sufficient length to permit safe closing of a stuck spigot shall be accessible near the kettle at all times.

(f) Kettle and tanker pumps shall be provided with a means of stopping the flow of hot asphalt or pitch manually from the roof top in emergencies when an attendant is not provided within 100 feet horizontally or 20 feet vertically from the kettle or tanker.

(g) Pumper pipelines shall be securely fastened at roof top and shall not be supported by ladders used for access.

(h) New kettles purchased and placed in service after the effective date of these Orders shall have the following safety features:

(1) A fluid level indicator, such as a dipstick, that will indicate the level of liquid asphalt or pitch within the kettle without the necessity of opening the lid for direct observation.

(2) Vents providing a total open area of not less than 100 square inches for up to 200 gallons capacity and not less than 200 square inches for kettles of larger capacities.

NOTE: See Sections on LP-Gas use, Article 32.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

1727. Kettles Mounted and Used on Elevated Truck Beds.

(a) Platforms must be designed and constructed to:

(1) Carry imposed load without excessive tipping or distortion.

(2) Provide a clear work area at least 4 feet wide at the accessible sides and ends of the kettle, including an unobstructed 4-foot passageway between the kettle spigot and the roof.

(3) Provide a noncombustible platform or platform covering.

(b) An access ladder to the platform must be provided. This ladder shall be fixed or be provided with an easily engaged attachment bracket that will prevent ladder slippage. Ladder rails must extend 30 inches above the platform, unless adequate handholds above the platform are provided.

(c) A railing 42 inches to 45 inches high with midrail shall be provided around the edges of the platform.

(d) The platform shall be kept reasonably free from asphalt or pitch drippings.

(e) Kettle covers shall be closed when the truck is in motion.

(f) Kettles shall be securely attched to the platform so they will not shift or tip.

(g) Kettle burners must be extinguished when the truck is moving.

(h) No riders are to be allowed on the elevated platform while the truck is in motion.

(i) Platforms which can be raised and lowered shall be locked in place when in an elevated position.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code

1728. Handling Coal Tar Pitch.

(a) When coal tar pitch is being handled, suitable skin protection substances shall be readily available at the job site for the use of workers, and workers shall be instructed in its use in accordance with Section 1510.

(b) Suitable respiratory and eye protection shall be readily available to workers handling coal tar pitch in confined spaces where ventilation is inadequate to promptly dissipate the fumes and vapors.

(c) Suitable washing or cleansing facilities shall be available for use on exposed skin surfaces of those handling coal tar pitch.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

1729. Hot Asphalt and Hot Pitch Buckets and Gallows-Type Frames.

(a) Hot Asphalt and Hot Pitch Buckets.

(1) Every hot asphalt and hot pitch bucket shall be made of No. 24 gauge or heavier sheet steel and shall have a metal bail of ¼-inch diameter or larger material. The bail shall be fastened to offset ears, or equivalent, which have been riveted, welded or otherwise securely attached to the bucket.

(2) Mop buckets shall not have a capacity in excess of 9½ gallons.

(3) Mop buckets shall not be used as carrying buckets.

(4) Carrying buckets shall not have a capacity in excess of 6 gallons.

(b) Gallows-Type Frames.

(1) Gallows-type frames shall be made of "selected lumber", or material of equivalent strength, firmly bolted or nailed together and may be job site fabricated or a manufactured assembly. Construction may be as illustrated in Plate C-18, Appendix, or alternate designs may be used provided equivalent or greater strength is afforded.

(2) Gallows-type frames shall be securely tied back to solid construction on the roof at all times while in use or in the case of designs incorporating counterbalancing means, shall be counterbalanced with items or materials which will not be used in performing the work which is being done during the period the hoist is being used.

(3) If a tieback is used, the tieback shall be of Manila rope not less than ¾-inch in diameter, or equivalent, tied securely to the tailpiece, stretched tight and lashed to an object on the roof suitable to provide secure anchorage to hold the frame in place when loaded.

(4) Gallows-type frames are for single line hand use and muscle power only. Any attachment of a power system, winch, hoist, or blocks and falls is prohibited, unless the system complies with Article 15, Section 1613 of these Orders.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

1730. Roof Hazards.

(a) During roofing operations, provisions shall be made to prevent workers from falling off roofs in accordance with Section 1509 of these orders.

(b) Slopes 0:12 to 4:12—Single-Unit (Monolithic) Roof Coverings.

(1) Employees shall be protected from falls from the edges of roofs that are at a height of more than 20 feet from ground or level below to the eave level without a parapet by the use of a combination of warning lines and headers unless conditions prohibit the use of a header, in which case, warning lines alone may be used. Whenever felt laying machines or other equipment that is pulled by an operator who walks backwards is being used, this provision shall apply regardless of the height.

(2) Warning lines consisting of rope, wire or similar material, flagged with bits of highly visible material hanging from the warning lines at approximately 6-foot intervals, shall be installed 42 to 45 inches above the roof surface to warn employees that they are approaching the edge of the roof.

(A) The stanchions (portable or fixed) supporting the warning lines shall be designed and installed to minimize tip over or displacement under normal working conditions.

(B) Warning lines shall have a minimum breaking strength of 100 pounds.

(3) Unless conditions prohibit, headers consisting of sheets of roofing or other roofing materials shall also be laid parallel to the edges of the roof to warn employees that they are approaching the edge of the roof.

(4) The warning lines and headers shall be placed no closer than 5 feet from the roof edge.

(5) When using felt-laying machines or other equipment that is pulled by an operator who walks backwards or motorized equipment on which the operator rides, the headers shall be placed no closer than 10 feet and the warning lines shall be placed no closer than 5 feet from those roof edges that are perpendicular (or nearly so) to the direction in which the operator is moving and when conditions prohibit the use of headers, the warning lines shall be placed no closer than 10 feet from these roof edges that are perpendicular (or nearly so) to the direction in which the operator is moving.

(6) The warning lines and headers shall be erected either around the complete perimeter of the roof or only in areas of the roof where work is being accomplished, so long as the warning lines and headers are moved as the work progresses in such a manner as to provide continuous warning to employees in the work area when they approach the roof edge.

(7) Employees shall be instructed to stay inside the warning lines and headers except when work must be performed at the roof edge.

(8) Application of materials outside the warning lines shall be closely supervised by a qualified person.

(9) On narrow roofs and roofs of unusual shape where warning lines and headers would be impractical, the application of materials shall be closely supervised by a qualified person.

NOTE: The provisions of Subsection (b) do not apply when employees are protected by the use of one, or a combination of, of the following methods:

Safety Belts and Lines [Section 1724(f)].
Catch Platforms [Section 1724(c)].
Scaffold Platforms [Section 1724(d)].
Eave Barriers [Section 1724(e)].
Standard Railings and Toeboards (Article 16).
Parapets at least 24 inches high; except that at those job sites where felt-laying machines or other equipment that is pulled by an operator who walks backwards or motorized equipment on which the operator rides is being used, the provisions of this Subsection shall not apply provided that the parapet is 36 inches or more in height at those roof edges which are perpendicular (or nearly so) to the direction in which the equipment is moving.

(c) Slopes Greater Than 4:12—Single-Unit (Monolithic) Roof Coverings. Employees shall be protected from falls from the edges of roofs that are at a height of more than 20 feet from ground or level below to the eave level without a parapet by one or a combination of the following methods:

Safety Belts and Lines. [Section 1724(f)].
Catch Platforms [Section 1724(c)].
Scaffold Platforms [Section 1724(d)].
Eave Barriers [Section 1724(e)].
Standard Railings and Toeboards (Article 16).
Work platforms such as roof jack systems [Section 1724(a)] or crawling boards [Section 1724(b)] provided that a perimeter barrier at least 30 inches high is erected below the working area.

NOTE: The provisions of this Subsection (c) do not apply under the following conditions:

1) When employees are protected from falls from the edges of roofs by a parapet at least 24 inches high, or

2) At those job sites where motorized equipment on which the operator rides which has been designed for use on roofs of slopes greater than 4:12 is being used if the parapet is 36 inches or more in height at those roof edges which are perpendicular (or nearly so) to the direction in which the equipment is moving.

(d) Equipment Hazards on Sloped Roofs—Single-Unit (monolithic) Roof Coverings. Equipment that is pulled by an operator who walks backwards shall not be used on a roof having a slope greater than 4:12.

(e) Slopes 0:0 Through 5:12—Multiple-Unit Roof Coverings. Employees shall be protected from falls from the edges of roofs that are at a height of more than 20 feet above ground or level below to the eave level without a parapet by the use of a roof jack system as provided in Section 1724(a) or other method affording equivalent protection, such as crawling boards as provided in Section 1724(b).

(f) Slopes Greater Than 5:12—Multiple-Unit Roof Coverings. Employees shall be protected from falls from the edges of roofs that are at a height of more than 20 feet above ground or level below to the eave level without a parapet by one or a combination of the following methods:

Safety Belts and Lines. [Section 1724(f)].
Catch Platforms [Section 1724(c)].
Scaffold Platforms [Section 1724(d)].
Eave Barriers [Section 1724(e)].
Roof Jack Systems [Section 1724(a)].

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

Roofing

Built-up 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.

Built-up Roofing

TOPIC 1—SAFETY

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

1. One of the most common types of accidents in the roofing industry involves: 1._____

   1. Collision with a vehicle
   2. Burns
   3. Clothing caught in equipment
   4. Shocks

2. The recommended procedure for putting out a flash fire in a kettle is to: 2._____

   1. Spray it with cold water.
   2. Let it die out by itself.
   3. Throw potassium chloride on it.
   4. Smother it by keeping the kettle lid closed.

3. The costliest type of accident in the roofing industry involves: 3._____

   1. Burns
   2. Falls
   3. Shocks
   4. Slips

4. Smoke of what color from a kettle indicates that the kettle is probably overheated? 4._____

   1. White
   2. Yellow
   3. Black
   4. Purple

5. When hotstuff is pumped to the roof through flex-hose or flex-pipe, the hose or pipe should be: 5._____

   1. Held with one hand only by the roofer at the roof
   2. Placed so that the end extends over the top of the wall and into the roof area
   3. Placed first in a bucket of hotstuff to ensure that no condensation is present
   4. None of the above

6. Containers of LP gas should always be stored and transported: 6._____

   1. Lying flat
   2. Leaning at a 75° angle
   3. Standing up
   4. None of the above

7. It is recommended that burned areas of the body be immersed in cold water or have ice applied to them for at least how long after the victim is burned? 7._____

   1. 15 minutes
   2. 30 minutes
   3. 45 minutes
   4. One hour

8. Which of the following is (are) considered bad practice? 8._____

   1. Carrying hotstuff up or down ladders
   2. Leaving nails protruding from scrap lumber
   3. Pumping hotstuff through a flex-hose that is not equipped with a handle at the end
   4. All of the above

9. An employee who violates a safety standard, regulation, rule, or order is subject to: 9._____

   1. A fine
   2. A citation
   3. Criminal prosecution
   4. None of the above

10. Which of the following is a sign of sunstroke? 10._____

   1. Skin that is damp and cold
   2. Skin that is hot and dry
   3. Increased pulse rate
   4. Bleeding from the nose

BUILT-UP ROOFING

TOPIC 2—ROOF PREPARATION AND HANDLING AND LOADING OF BUILT-UP 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. Which of the following can affect the number of plies to be used on a built-up roof? 1. ____

   1. The type of roof deck
   2. Climatic conditions
   3. The pitch of the roof
   4. All of the above

2. Which types of asphalt have low melting points? 2. ____

   1. Steep grade and special steep grade
   2. Dead level and flat grade
   3. Flat grade and special steep grade
   4. Dead level and steep grade

3. On a flat roof the overflow should generally be placed about how many inches higher than the lowest part of the roof? 3. ____

   1. 1 (2.5 centimetres)
   2. 1½ (3.8 centimetres)
   3. 2 (5.1 centimetres)
   4. 4 (10.2 centimetres)

4. Solvents, emulsions, and coatings should be stored in a place that is: 4. ____

   1. Warm and dry
   2. Dry and cool
   3. Warm and damp
   4. Damp and cool

5. Roll materials should be stored where the temperature is at least: 5. ____

   1. 40° F. (4.4° C)
   2. 45° F. (7.2° C)
   3. 50° F. (10° C)
   4. None of the above

6. Rafters are usually placed how far apart? 6. ____

   1. 16 to 24 inches (40.6 to 61 centimetres)
   2. 16 or 18 inches (40.6 or 45.7 centimetres)
   3. 12 to 24 inches (30.5 to 61 centimetres)
   4. 16 or 24 inches (40.6 or 61 centimetres)

7. When materials are loaded on a roof deck, the materials loaded first should be placed: 7. ____

   1. At the left rake
   2. At the highest point
   3. At the lowest point
   4. Along the eaves

8. On steep roofs where rolls of material cannot be loaded in an upright position, the rolls should be: 8. _____

   1. Laid flat, with two rolls serving as the base for one roll laid on top of them
   2. Stacked above chimneys and other projections that can act as supports to prevent their rolling down the deck
   3. Laid flat, in a single layer and running in the same direction as the rafters
   4. Stored inside the building and brought to the roof only as needed

9. Special precautions must be taken to guard against asphalt leaks when which type of asphalt is used? 9. _____

   1. Dead level
   2. Special steep grade
   3. Steep grade
   4. Flat grade

10. Which of the following should be consulted or examined during the deck inspection prior to the loading of materials on the deck? 10. _____

   1. The architect
   2. The blueprints for the roof
   3. CAL/OSHA regulations
   4. The kettle operator

BUILT-UP ROOFING

TOPIC 3—MOPPING OPERATIONS

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

1. On roofs with steep slopes, felt is normally: 1._____

   1. Strapped
   2. Shiplapped
   3. Laid with a Mini-mopper
   4. None of the above

2. Felt rolls have a tendency to pull downward from their own weight on a roof with a pitch greater than: 2._____

   1. 1/12
   2. 3/12
   3. 3½/12
   4. 5/12

3. Which of the following is a recommended practice in preparing to use a combination felt layer? 3._____

   1. Opening every third valve
   2. Opening every other valve
   3. Testing the machine in an area other than the immediate work area
   4. Heating the asphalt to a temperature of 295° F. (146.1° C)

4. Air pockets that form in felt when it is laid on hot asphalt should be removed with: 4._____

   1. The wheel of the felt-laying machine
   2. The end of the felt roll
   3. A broom
   4. A hammer

5. Which of the following is best suited for work on a large work area? 5._____

   1. Mini-mopper
   2. Roller-type felt layer
   3. Combination felt layer
   4. All of the above

6. A combination felt layer can be used for: 6._____

   1. Glazing seams
   2. Mopping for installation of insulation
   3. Applying flood coating in graveling operations
   4. All of the above

7. Which of the following is sometimes used as a mop cart? 7._____

   1. Combination felt layer
   2. Mini-mopper
   3. Roller-type felt layer
   4. None of the above

8. Roller-type felt layers are designed for use on: 8 _____

1. Dead-level roofs
2. Large work areas
3. Graveling operations
4. Steep roofs

9. Sheets of felt that are to be applied with hot asphalt should be no longer than how many feet? 9. _____

1. 18 (5.5 metres)
2. 19 (5.8 metres)
3. 20 (6.1 metres)
4. 21 (6.4 metres)

10. Which of the following is recommended for use in lubricating a mop handle? 10. _____

1. Butane
2. Linseed oil
3. Kerosene
4. Wax

BUILT-UP ROOFING

TOPIC 4—APPLICATION OF BUILT-UP ROOF ASSEMBLIES

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

1. If built-up roofing were applied to all of the following types of roofs, which would require the greatest number of plies? 1._____

   1. Barrel
   2. Flat
   3. Gable
   4. Hip

2. When felts are mopped together, they should be: 2._____

   1. Sprinkle-mopped
   2. Spot-mopped
   3. Solid-mopped
   4. None of the above

3. Felt plies or layers should be mopped together: 3._____

   1. At a rate of 18 pounds (8.2 kilograms) of bitumen per square
   2. At a rate of 20 pounds (9.1 kilograms) of bitumen per square
   3. At a rate of 25 pounds (11.4 kilograms) of bitumen per square
   4. In accordance with the specifications

4. Which of the following calculations would be used to determine the felt exposure on a four-ply roof assembly? 4._____

   1. 36" ÷ 4 (91.4 cm ÷ 4)
   2. 34" x 4 (86.4 cm x 4)
   3. 36" x 0.04 (91.4 cm x 0.04)
   4. 34" ÷ 4 (86.4 cm ÷ 4)

5. One of the greatest causes of deterioration in built-up roofs is: 5._____

   1. Ultra-violet rays from the sun
   2. Rain
   3. Wind
   4. Air pollution

6. The flood coat for a gravel roof should be approximately how many pounds of asphalt per square? 6._____

   1. 35 (15.9 kilograms)
   2. 60 (27.2 kilograms)
   3. 90 (40.8 kilograms)
   4. 120 (54.4 kilograms)

7. On a cap sheet roof, the end laps of the cap sheets should be staggered by at least: 7._____

   1. 2 inches (5.1 centimetres)
   2. 1 foot (30.5 centimetres)
   3. 18 inches (45.7 centimetres)
   4. 2 feet (61 centimetres)

8. Glazing is done to: 8._____

   1. Provide a better seal on the roof deck.
   2. Prevent the seams of exposed felt from curling.
   3. Provide a more pleasing appearance on the finished roof.
   4. Help prevent "holidays" on a gravel roof.

9. The advantages of topcoating include which of the following? 9._____

   1. It absorbs heat from the sun and helps warm the building.
   2. It helps to increase the rate at which snow on the roof will melt.
   3. It helps to reduce the cost of the roof because less gravel is required.
   4. All of the above.

10. Hot asphalt can be prevented from dripping through the roof deck and onto workers or finished products below by using: 10._____

   1. A mineral surface cap sheet
   2. A "one and two" assembly
   3. A rosin sheet
   4. A header sheet

BUILT-UP ROOFING

TOPIC 5—INSULATION AND ITS APPLICATION

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

1. Roofing insulation is used to do *all but* which of the following? 1._____

   1. Retard fire.
   2. Prevent moisture leaks.
   3. Minimize heat loss or gain.
   4. Absorb sound.

2. Which of the following is used to prevent moisture in the building or roof deck from entering and damaging insulation? 2._____

   1. Water stops
   2. Breathers
   3. Vapor barriers
   4. All of the above

3. On large concrete roof decks, how many pressure release vents are generally recommended for every ten squares of roofing? 3._____

   1. One
   2. Two
   3. Three
   4. Four

4. Water stops help to: 4._____

   1. Confine to a small area water that has leaked through punctured felt.
   2. Release pressure from accumulated moisture.
   3. Reduce the costs of insulation since less insulation is required when they are used.
   4. Decrease the possibility of oxidation on a ribbed steel deck.

5. Which of the following can be used to fasten insulation to steel decks? 5._____

   1. Asphalt
   2. Steel fasteners
   3. Cold adhesive
   4. All of the above

6. What type of deck causes the roofer the greatest number of problems in installing insulation? 6._____

   1. Gypsum and lightweight-concrete decks
   2. Steel decks
   3. Wooden decks
   4. Urethane decks

7. Installed insulation should be covered with roofing and sealed: 7._____

   1. At the convenience of the roofer
   2. By the end of the workday
   3. Within 24 hours after installation
   4. Within 30 days after application

8. Urethane insulation is: 8._____

   1. Susceptible tc rot
   2. Very flammable
   3. Available in board form only
   4. None of the above

9. Stored insulation must be protected from: 9._____

   1. The ultraviolet rays of the sun
   2. Rodents
   3. Moisture
   4. Children

10. When a base sheet is laid under insulation, it should extend how many inches past the end of the insulation? 10._____

    1. 3 (7.6 centimetres)
    2. 4 (10.2 centimetres)
    3. 6 (15.2 centimetres)
    4. 8 (20.3 centimetres)

BUILT-UP ROOFING

TOPIC 6—CUTTING AND FOLDING OF CORNERS

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

1. Felts laid at corners are generally turned how many inches up the wall? 1._____

   1. 3 (7.6 centimetres)
   2. 6 (15.2 centimetres)
   3. 9 (22.9 centimetres)
   4. 12 (30.5 centimetres)

2. Watertightness at corners depends on: 2._____

   1. Accuracy of layout and cutting
   2. Snugness of fit
   3. Proper sealing with flashing compound
   4. All of the above

3. An important aspect of folding and cutting corners is to make sure that: 3._____

   1. Edges will not buck water.
   2. No mastic is used near the corner.
   3. Only nails are used to secure felts to walls.
   4. None of the above.

4. The term "fly" means: 4._____

   1. A felt
   2. A tab
   3. A bead of mastic
   4. The amount of turnup when felt is folded up the wall

5. Cut corners may be used on: 5._____

   1. Inside corners
   2. Outside corners
   3. Angles
   4. All of the above

BUILT-UP ROOFING

TOPIC 7—SUMPS AND DRAINS

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 relation to drains, insulation should be installed: 1._____

   1. Underneath
   2. Above
   3. Even with
   4. Tapered away from

2. A flat roof should: 2._____

   1. Drain only toward outlets.
   2. Drain in all directions.
   3. Drain toward north and south magnetic poles.
   4. Drain to one corner only.

3. Overflow scuppers are placed: 3._____

   1. Always near outlets
   2. 2 to 4 inches (5.1 to 10.2 centimetres) above outlets
   3. 2 to 4 inches (5.1 to 10.2 centimetres) above the lowest part of the roof
   4. Wherever it is convenient

4. A cast-iron-type drain consists of all of the following except: 4._____

   1. Base
   2. Screen basket
   3. Ring
   4. Strainer

5. Insulation should be tapered back how many inches from drains? 5._____

   1. 10 (25.4 centimetres)
   2. 12 (30.5 centimetres)
   3. 18 (45.7 centimetres)
   4. 24 (61 centimetres)

6. Which of the following is *not* a type of wall drain? 6._____

   1. Center wall
   2. Right hand
   3. Left hand
   4. Vertical side

7. Sump drains are usually installed on decks made of: 7._____

   1. Steel
   2. Gypsum
   3. Concrete
   4. Wood

8. In the application of a ring drain, all felt layers should be applied: 8._____

   1. Before the drain is set in place
   2. After the drain is set in place
   3. At right angles to the drain
   4. At least 1 inch (2.5 centimetres) from the drain

9. What is the first step in installing a wall drain? 9._____

1. Coat the opening with a layer of plastic cement.
2. Place the outlet box, and secure it with nails.
3. Coat the opening with a mopping of hot asphalt.
4. Apply a layer of felt around the opening.

10. Ring drains should be placed at least how far from curbs and walls? 10 _____

1. 1 foot (0.3 metre)
2. 2 feet (0.6 metre)
3. 3 feet (0.9 metre)
4. 6 feet (1.8 metres)

BUILT-UP ROOFING

TOPIC 8—FLASHING

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

1. Flashings are used to: 1._____

   1. Reinforce felts.
   2. Seal junctions of horizontal and vertical surfaces.
   3. Keep asphalt from flashing.
   4. Provide drainage.

2. As temperatures vary, flexible flashings tend to: 2._____

   1. Rust.
   2. Expand and contract.
   3. Become impregnated with resin.
   4. Do all of the above.

3. Which of the following is used to prevent the intrusion of water at the top of a parapet? 3._____

   1. Gravel guard
   2. Kick strip
   3. Pipe jack
   4. Coping

4. Base flashings are used to: 4._____

   1. Support cap flashings.
   2. Seal the deck to a vertical surface.
   3. Protect the felts.
   4. Reinforce cant strips.

5. Saddles and crickets may be made of: 5._____

   1. Blacktop
   2. Sheet metal
   3. Insulation board
   4. All of the above

6. Which of the following is (are) used to conduct water away from chimneys and skylights? 6._____

   1. Gravel guard
   2. Cricket
   3. Strip flashing
   4. Pitch pan

7. Fiberglass and polyester resin flashing has a limited application because of its inability to withstand: 7._____

   1. Heavy winds
   2. Heat
   3. Cold
   4. Shock and fracture

8. Generally, metal flashings are applied by the: 8._____

   1. Roofer
   2. Carpenter
   3. Sheet metal worker
   4. None of the above

9. Which of the following is (are) satisfactory for use as flashings? 9._____

   1. Clay and glazed tile
   2. Cap sheets and felt
   3. Lead
   4. All of the above

10. Gravel guards should be installed: 10._____

   1. From left to right
   2. From right to left
   3. With the large ends butted against each other
   4. With uneven bottom laps