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FLAT ROOF MAINTENANCE

Lesson One

Introduction to Flat Roof Systems

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TPC Training Systems

36601

Lesson

1 Introduction to Flat Roof Systems

TOPICS

Introduction to Roofing
Flat Roof Systems
The Structural Deck
Wood Decks
Concrete Decks
Steel Deck
The Vapor Barrier
The Thermal Insulation
Where to Place the Insulation?
The Waterproofing Membrane
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Building Up the Membrane
Aggregate and Flood Coats
Service Walkways

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OBJECTIVES

After studying this Lesson, you should be able to…

- Name and define the four basic components that make up a flat roof system.
- Explain the differences among a prestressed concrete deck, a precast deck, and a reinforced deck.
- Explain the functions of a vapor barrier.
- Tell why thermal insulation is applied above deck in some applications, and below deck in others.
- List three benefits of coating a flat roof with aggregate or crushed slag.

KEY TECHNICAL TERMS

Structural deck 1.07 serves as a base on which to build other roof components
Vapor barrier 1.07 protects roof insulation and members from moisture
Acoustical 1.14 sound absorbing
Camber 1.17 curvature
Bitumen 1.42 natural or heat-processed form of asphalt or coal tar

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Modern commercial and industrial buildings are costly. One of their most costly parts is the roof, which represents 5 to 8% of the total building cost. The elements of nature—sun, wind, rain, and snow—can wear out any roof. But a good preventive maintenance program can make a roof last indefinitely. Preventing roofing problems not only costs less than replacing a worn out roof, but it avoids disturbing the occupants, delaying production, and other inconveniences. Actually, it costs about 40 times as much to replace a roof as it does to maintain it in good condition.

The roofs on most commercial buildings are of the built-up flat type. Flat roofs produce the great majority of the roofing problems that maintenance people must deal with. The problems aren't confined to old roofs. One third of all new roofs have problems within the first year. Almost two thirds of all roofing troubles occur within the first three years of a roof's life. This Unit deals with the causes and solutions of common roofing problems that you should know about. This Lesson describes the materials and built-up construction used in flat roofs.

Introduction to Roofing

1.01 Most buildings consist of floors, walls, and roofs. A few buildings (foundries and tobacco warehouses, for example) have no paved floors—only the dirt of the ground. Some buildings (like railroad car and small shipbuilding facilities) have no walls—they are merely an open shelter or lean-to. But, regardless of their design, all buildings need some type of roof system to protect their occupants and equipment from the elements—sun, wind, rain, and snow.

1.02 Many roof systems are used in construction today. Basically, they are of two types:

- *Flat roof systems* (for factories, warehouses, and commercial buildings). They are designed to waterproof buildings.

- *Sloped roof systems* (for churches, homes, and smaller structures). They are designed to drain water off buildings.

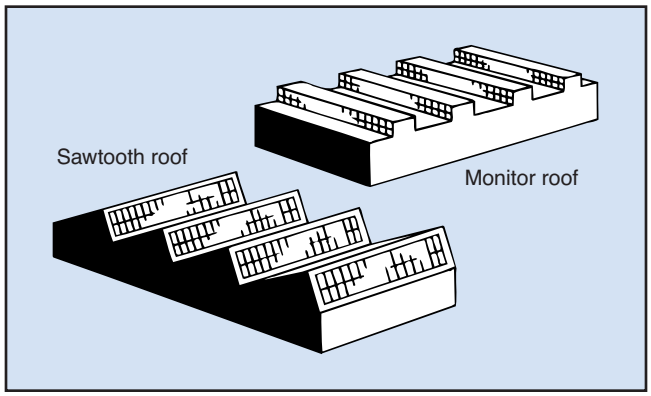
1.03 Flat roof systems may have a slope anywhere from 0 (dead level) to 45°. Sloped roof systems usually are sloped between 30 and 90° (vertical). Remember: the purpose of a roof system is to keep a building's interior and contents dry. The type of roof, of course, should blend well with the rest of the building so it makes a good appearance.

1.04 Often you can tell what activity goes on in a building from the type of roof it has. For example, most older buildings that have monitor or sawtooth roofs (see Fig. 1-1) are factories. The roofs provide large areas of skylight to aid manufacturing and assembly operations. Cantilevered roofs, used to eliminate interior supports, are found on arenas, airplane hangars, parking garages, and other large buildings. The curved roof is usually a few feet higher at the center than it is along the walls.

Flat Roof Systems

1.05 About 90% of today's industrial and commercial roofing is of the flat type, as shown in Fig. 1-2 on the following page. It is the kind usually found on apartment and office buildings, warehouses, and industrial plants. A flat roof is generally the least costly type of roof to construct, especially for large buildings. It also permits the installation of air conditioners, exhaust fans, and related equipment on its flat surface—where they can be mounted and serviced easily. At the same

Fig. 1-1. Typical monitor and sawtooth roofs



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time, it must be able to support intermittent loads, such as people working on the equipment, and the weight of heavy snows in some areas.

1.06 A flat roof system can be constructed in many ways, depending on the purpose of the building and the climate of the region. It is usually constructed in layers, in a series of clearly defined steps. To protect the building from heat and cold and to save energy, the roof system must be properly insulated. To protect the interior of the building from rain water and melting snow, a flat roof must be waterproof and have an adequate system of drains and gutters. And to protect the insulating and waterproofing qualities of the roof from the elements and from people walking on it, the entire roof should have an adequate protective surfacing.

1.07 Four basic components make up the common flat roof system. They are:

- a *structural deck* that serves as a base on which the other components are built
- a *vapor barrier* that protects the roof insulation and members from moisture generated in the building (not always needed)
- a layer of *thermal insulation* that keeps heat out in summer and cold out in winter
- a *waterproofing membrane*, or upper layer, that is exposed to the elements.

1.08 If any of these components doesn't do its job properly, the roof may fail. Roof failure can injure the building occupants and damage its equipment and contents. Some of the more common reasons for roofing component failure are: improper design, poor application, and improper use of materials.

The Structural Deck

1.09 A flat roof is built up of several layers of material. The first, or primary, layer is the structural deck. The deck rests on the beams or purlins that are secured to the walls of the building. It, in turn, supports all the other layers or components of the roof. To provide ade-

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Fig. 1-2. Common type of built-up flat roof

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quate drainage, no roof should be built perfectly flat. The deck should slope a minimum of 1/4 in. per ft.

1.10 Two general classes of material are used to construct decks—they are called nailable and non-nailable. Nailable materials include: lumber, plywood, structural cement fiber, and precast or poured gypsum. Non-nailable materials include: precast concrete slabs, reinforced concrete, and steel.

Wood Decks

1.11 Wood decks, whether lumber, plywood, or structural cement fiber, are normally supported on wood beams or purlins. The deck thickness depends on the roof loads and the span (distance between beams or purlins). The minimum recommended thickness for decks made of lumber is 1 in. For plywood, it is 1/2 in.

1.12 To provide a smooth surface, all wood should be seasoned and not warped. The entire deck surface must be free of cracks and gaps. Always keep a wood deck perfectly dry during installation. Never install more deck at one time than you can cover with waterproofing the same day.

1.13 *Plywood decks* (see Fig. 1-3) have very high strength for their weight. This is because of the way plywood is made. Logs are peeled into veneers which are glued together under heat and pressure with the grains in alternate layers at right angles to each other. Plywood is easy to bend to fit curved roof trusses. Also, it is an easy material to work with. You don't need any special tools to install a plywood deck.

1.14 *Structural cement fiber* for decks consists of treated wood fibers bonded together with portland cement and molded or compressed into slabs. The slabs have high strength and good insulating qualities. They also have excellent acoustical (sound absorbing) properties which make them useful for auditoriums, etc. Accurately sized excelsior from pine logs is coated with cement and molded, under pressure, into a mat. After it sets, slabs are cut from the mat. The slabs are furnished as tongue-and-groove planks for direct application to the beams or purlins.

Concrete Decks

1.15 Non-nailable reinforced concrete decks are made of high-strength concrete. The concrete may be

Fig. 1-3. A plywood deck before building up

either precast, prestressed, reinforced, insulating, or gypsum based. Like all decks, the concrete surface must be smooth and free from lumps and defects. Also, a concrete deck must be completely dry before you build a roof on it. Otherwise, the trapped moisture will cause the roof to blister.

1.16 Figure 1-4 on the following page shows a *precast concrete deck*. Precast concrete planks are a very common form of deck construction. They are usually 2 ft wide, and they come in various lengths and styles. Tongues and grooves are sometimes cast into the planks to provide a tight roof. As a rule, the supporting members for the planks are structural steel shapes. The planks rest on the beams or purlins, and special metal clips hold them in place. This type of concrete weighs 70 to 110 lb/ft^3.

1.17 *Prestressed concrete* slabs are carefully preloaded when they are made. This ensures that they will be able to resist the roof loads they will support. They are given a built-in camber, or curvature, that acts in the opposite direction of the roof load. In addition to slabs, prestressed concrete is also available in the form of channels and tees. The thickness, dimensions, and strength of this concrete depend on the requirements of each installation. Prestressed concrete usually weighs 110 to 160 lb /ft^3.

1.18 *Reinforced concrete decks* are poured in place, and forms support them while they set. They are reinforced or strengthened with steel bars or mesh buried in the concrete mixture. The mixture consists

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Fig. 1-4. A modern roof of precast concrete

of aggregate (stone or crushed gravel), sand, portland cement, chemical additives, and water. Reinforced concrete weighs 110 to 160 lb/ft^3, depending on the types of aggregate and reinforcement.

1.19 *Insulating concrete* is produced by combining portland cement with an insulating aggregate. The aggregate may be either a sand-like volcanic glass called perlite, or a mica-like substance known as vermiculite. Both of these help to trap air in the concrete, giving it better insulating qualities and making it easier to handle. Insulating concrete is generally mixed right on the job site.

1.20 *Gypsum* (JIP-sum) *concrete decks* are ideal to use when the structural supporting steel is not designed to carry heavy loads. Gypsum is a rock-like mineral which, when added to concrete, not only makes it lighter but gives it excellent fire resistance. The steel-reinforced gypsum mixture consists of crushed gypsum, wood chips, shavings, and a mineral aggregate. It weighs 30 to 55 lb/ft^3. Formboards must be placed beneath the deck to provide a finished underside, fire resistance, and acoustical control.

Steel Deck

1.21 Steel decking is available in various styles from many manufacturers. It can be used for most types of buildings. The steel is usually corrugated or ribbed and is either painted or galvanized. Standard sheets are 18 gauge to 22 gauge in thickness, 2 ft wide, and 5 to 14 ft in length. The sheets are usually welded to their structural supports from the top. Good control of the welding pattern assures a finished deck of ample load-carrying capacity.

NOTE: All decks—whether wood, concrete, or steel—should be smooth and flat, with no gaps or openings before equipment is installed on the roof. All decks should be rigid enough to support roofers and their equipment without movement that could strain or rupture roof components. Every deck must slope enough (1/4 in. per ft) to drain any water. If it doesn't, lightweight fill or tapered insulation pads must be used to provide the slope.

The Vapor Barrier

1.22 After the deck is completed and ready for building up the roof, the next step is to install the vapor barrier—if it is needed. The purpose of the vapor barrier is to prevent moisture created in the building from getting into the roof system. A barrier is needed especially if the building houses a process that requires or produces high humidity and if the deck material absorbs moisture readily.

1.23 Several types of vapor barrier are available. The one used depends on the degree of fire resistance desired and the type of deck to which it is to be applied. The common barrier materials are: plastic sheet, coated base sheet, Kraft laminate, and saturated felt.

1.24 **Plastic sheet.** A sheet of non-combustible polyvinylchloride (PVC) or chlorinated polyethylene (known as CPE) makes an acceptable fire-resistant barrier. It is usually attached to the deck by adhesives or fasteners through the insulation. Plastic sheets are applied cold, not hot.

1.25 **Coated base sheet**. This is a specially made felt that has been saturated and coated with asphalt. It can be attached to the deck with cold adhesives or hot moppings of bitumen.

1.26 **Kraft laminate.** This consists of two layers of heavy-duty Kraft (paper) sealed together and reinforced with glass fibers. It can be fastened to the deck with cold adhesives or hot bitumen.

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1.27 **Saturated felt.** Two or more layers of 15-lb roofing felt are saturated and laminated together with hot moppings of asphalt or coal-tar bitumen. (The moppings provide the barrier. The felt simply holds the bitumen in place.)

The Thermal Insulation

1.28 The purpose of thermal insulation in a flat roof is to keep heat out of a building in summer and to keep heat in during the winter. With today's demands to conserve energy, insulation should be a part of any new roofing system. Only buildings that are unheated and not air conditioned should now be built without an insulated roof.

1.29 Flat roof insulation is made of fiberboard, cork, perlite, or glass. The usual practice is to mop a coating of asphalt over the roof deck and lay the insulation board in the asphalt. All joints in the boards should be tight. The joints may be taped with a 6 in. strip of felt mopped over them.

1.30 When laying insulation, it is important to keep it dry. It should also be kept dry and protected from the weather while in storage before installation. Wet insulation will cause the roof to blister later on. When laid, the insulation should form a smooth, flat surface like the original deck—ready for the application of the felt waterproofing layers to build up the roof.

1.31 Some manufacturers provide insulating materials for what is called an inverted roof. First the felts and waterproofing membranes are laid in place. Then special insulating boards are laid over the waterproofing and protected by asphalt and gravel. The advantages of this type of construction are:

- the waterproofing membrane is protected from physical damage
- water is kept out of the insulation, so that the waterproofing does not blister.

1.32 To insulate a nailable deck (made of lumber, plywood, or structural cement fiber), the first step is to apply the base felt, overlapped 2 in. at the edges, and nail it down over a layer of sheathing paper. To insulate a non-nailable deck (made of concrete), the first step is to prime the concrete. This is done by coating the entire surface with hot asphalt. While the asphalt is still hot, a smooth layer of base felt is embedded in it. The felt is usually a single thickness 36 in. wide, with a minimum overlap of 2 in., or two layers of 15-lb felt, lapped 18 in.

The Programmed Exercises on the next page will tell you how well you understand the material you have just read. Before starting the exercises, remove the REVEAL KEY from the back of your Book. Read the instructions printed on the Reveal Key. Follow these instructions as you work through the Programmed Exercises.

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1-1. The two basic types of roof systems in use today are sloped roofs and _____ roofs.	1-1. FLAT Ref: 1.02
1-2. To protect a building from heat and cold, the roof must be properly _____.	1-2. INSULATED Ref: 1.06
1-3. For good drainage, a flat roof should be sloped a minimum of _____ in. per ft.	1-3. 1/4 Ref: 1.09
1-4. To install a plywood deck, you _____ need special tools.	1-4. DO NOT Ref: 1.13
1-5. The added material that gives concrete decks good resistance to fire is _____.	1-5. GYPSUM Ref: 1.20
1-6. In a saturated felt vapor barrier, the barrier is provided by the _____.	1-6. MOPPINGS Ref: 1.27
1-7. You don't need roof insulation if your building isn't air conditioned or _____.	1-7. HEATED Ref: 1.28
1-8. To insulate a nailable deck, a layer of _____ is placed between the deck and base felt.	1-8. SHEATHING PAPER Ref: 1.32

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Where to Place the Insulation?

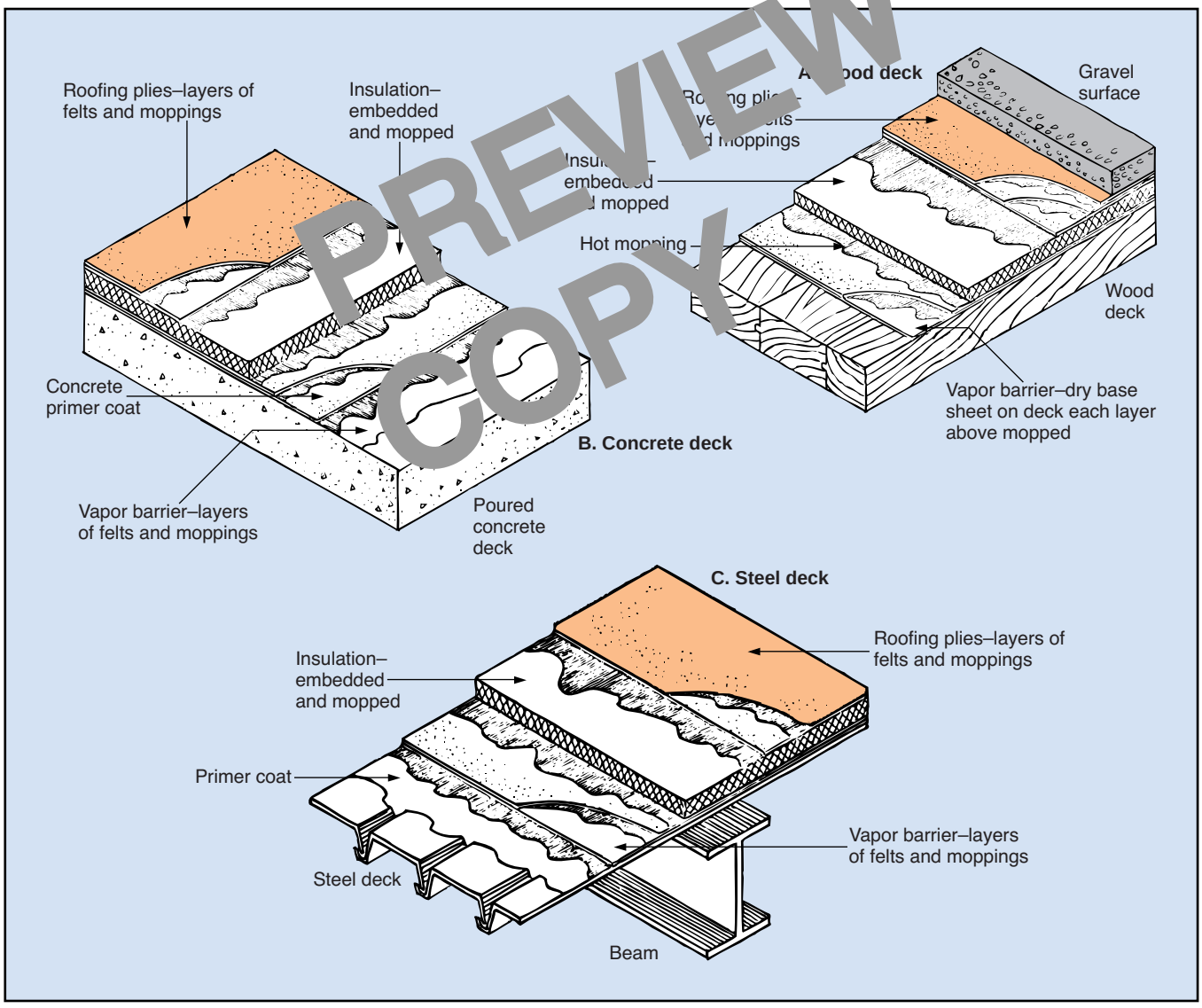
1.33 As described in previous paragraphs, most flat roof systems are built with the insulation *above* the deck—with a vapor barrier between the deck and the insulation. See Fig. 1-5A, B, and C. This system is used for buildings that do not have finished ceilings. The exposed underside of the deck serves as the ceiling. It may be painted for better appearance.

1.34 Roofs can be (and often are) built with the insulation *below* the deck—with a vapor barrier between the ceiling and the insulation. See Fig. 1-6A, B, and C on the following page. This arrangement is used in buildings that have finished ceilings separate from the deck. Note the built-in air space between the ceiling and deck in each case. If the deck is steel, it is necessary to install a second layer of insulation on top of the deck, beneath the built-up membrane, to make a smooth surface for applying the felts.

The Waterproofing Membrane

1.35 After the vapor barrier and thermal insulation are in place on the structural deck, the built-up membrane is installed to complete the roof. The built-up membrane is the weatherproofing element of the roof. It is constructed of three or more alternating layers of membrane and waterproofing material. The sand-

Fig. 1-5. Flat roofs with insulation above deck



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wiched layers of felt and bitumen form a pliable cover that "gives" with normal expansion and contraction due to heat and cold.

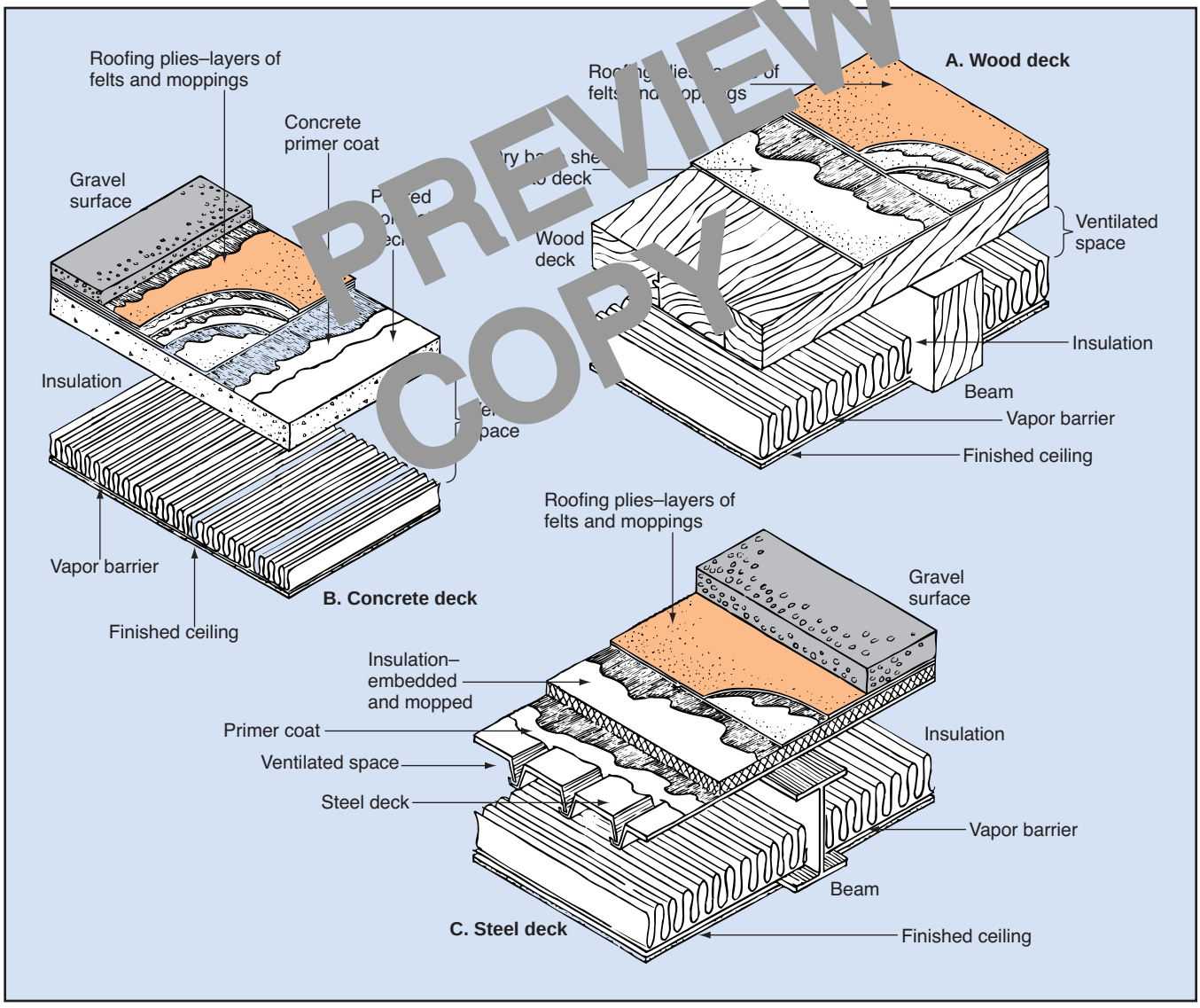
1.36 Built-up roofs are generally referred to by the number of plies they contain. For example, a three-ply roof has three layers of felt, and a five-ply roof has five layers. The number of plies or layers depends on the design of the roof and the purpose of the building. All felts must be laid without any bubbles, buckles, or tears.

1.37 The felts for membranes, which are usually available in sheets 3 ft wide, can be divided into four basic groups:

- saturated felts
- saturated and coated felts
- prepared roofings
- plastic materials.

1.38 **Saturated felts.** Felt saturated with asphalt or coal-tar bitumen is either organic or inorganic. Organic felts are made from a mixture of paper, wood chips, and rags. The felt texture must be open enough to absorb twice its weight in asphalt. It must also be strong enough to be laid by machine without tearing. The main ingredients of inorganic felts are

Fig. 1-6. Flat roofs with insulation below deck



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asbestos or glass fibers. Inorganic felt weighs 20 to 25 lb/ft^2.

1.39 **Saturated and coated felts.** These felts are either organic or inorganic. At the factory, they are coated on both sides to keep rolled felts from sticking to themselves. They weigh from 30 to 55 lb/ft^2.

1.40 **Prepared roofings.** Prepared roofings consist of saturated and coated felts (described above) with added surfacing materials for decoration. The most common additives are talc, mica, sand, and ceramic granules. They are usually packaged in rolls of "one square" (100 ft^2).

1.41 **Plastic materials.** This group includes modern synthetic materials, such as vinyl, rubber, and polyethylene. Although they are sometimes used in membranes, their main use is in roof components like flashings and expansion joints. Rolls of these materials may contain one to five squares.

Waterproofing Materials

1.42 Two types of waterproofing material can be used in built-up flat roof systems. They are asphalt base bitumen and coal-tar bitumen. *Bitumen* (BIT-yu-men) is either a natural or a heat-processed form of asphalt or coal tar. It contains mostly hydrogen and carbon (as hydrocarbons) with small amounts of common elements like oxygen and sulfur. Both asphalt and coal tar serve as a bed for the membrane felts and aggregate surface of the roof. Both are applied in the hot liquid state—after which they cool and harden.

1.43 **Asphalt-base bitumen.** Two groups make up asphalt-base bitumens. *Low-slope asphalt* has a softening point of 135 to 175°F (57 to 79°C). *Steep-grade asphalt* softens at 180 to 200°F (82 to 93°C), depending on the source of the crude oil from which it is made. For roofing jobs, it is applied at temperatures of 350 to 375°F (177 to 191°C).

1.44 Asphalt bitumen is a brownish-black combustible mixture. The oldest of natural adhesives, it has two outstanding properties. It is both sticky and water resistant. If it is heated above 450°F (232°C), it loses some of its essential oils, and its service life is shortened.

Table 1-1. Guidelines for installing a conventional flat roof

1. Roof must have enough slope to drain properly.
2. All roof openings must be reinforced with steel.
3. Deck must be free of holes, smooth, and well secured to supporting structure.
4. Deck must be thoroughly dry before roofing proceeds.
5. Insulation must be thoroughly attached to roof deck.
6. All felts installed during a working day must be complete layers or systems.
7. All felts must be separated by proper chemical coatings.
8. All felts must be thoroughly mopped and "broomed in."
9. All materials must be kept dry during installation.
10. All aggregates must be kept clean and dry until applied.
11. All asphalt and coal-tar bitumens must be applied at the proper temperatures.
12. All defects like splits and blistering must be promptly removed and repaired.

1.45 Asphalt is present in most petroleum crude oils. Since it has the highest molecular weight of all the oil's components, it readily settles to the bottom of the barrel. The lighter components of the oil are removed by a simple distilling process, leaving a heavy residue behind.

1.46 The residue is further processed to remove the heavy fuels (such as Bunker C and No. 6 oils) used to fuel large utility and power plants. What is left is almost pure asphalt. This is treated by an oxygen process that removes hydrogen (as water), raises its softening point, and makes it heavier. The final product flows at 400°F (205°C), hardens at 170°F (77°C), and resists cracking at -30 to +30°F (-34 to -1°C).

1.47 Asphalt is not affected by changes in temperature as much as coal tar is. Asphalt is also less brittle at low temperatures than roofing-grade coal tar and less fluid at high temperatures than coal tar.

1.48 **Coal-tar bitumen.** Coal-tar bitumen is a black liquid produced by distilling bituminous (soft) coal. Because of its ability to seal itself, coal tar is especially suitable for flat roofs on which water stands or collects. The tar must be applied hot—mopped on when used on felt, and poured on when used as a surface coating. Either coal tar or asphalt can be used for sealing roofs with slopes

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up to 1/2 in. per ft. For slopes more than 1/2 in., steep-grade asphalt is more efficient than coal tar.

Building Up the Membrane

1.49 As the waterproofing membrane is built up, each layer of felt must be saturated with bitumen (either asphalt base or coal tar) depending on the roof specifications. The bitumen is the waterproofing agent, and it is therefore a very important part of the membrane. Table 1-1 on the previous page presents some good guidelines for building up a common flat roof.

1.50 Each layer of felt reinforces the membrane, adding strength and a degree of rigidity. The layers form a knitted mass that resists cracking in cold weather and keeps the bitumen from flowing in hot weather. The felts also help the roof builder apply the bitumen uniformly.

Aggregate and Flood Coats

1.51 The last sheet of felt to be laid (called the top or cap sheet) normally receives an embedded coating of aggregate. The aggregate is generally gravel, crushed slag, or marble chips. Each 100 ft^2 of roof requires about 400 lb of aggregate. A light-colored aggregate prolongs roof life by reflecting heat. This also reduces the air conditioning load.

1.52 Actually, an aggregate performs a great many functions in the life of a roof:

- It protects the roof from the sun, wind, and rain.
- It protects the bitumen from sunlight, heat, rain, and foot traffic.
- It increases the roof's resistance to wind and fire.
- It shields the roof against the impact of hailstones.
- It resists corrosion by acid mists in industrial areas.

1.53 A final heavy flood coat of bitumen is sometimes laid on the built-up membrane. The finely divided aggregate forms hundreds of tiny dams that slow the flow of the hot bitumen, allowing it to set to a

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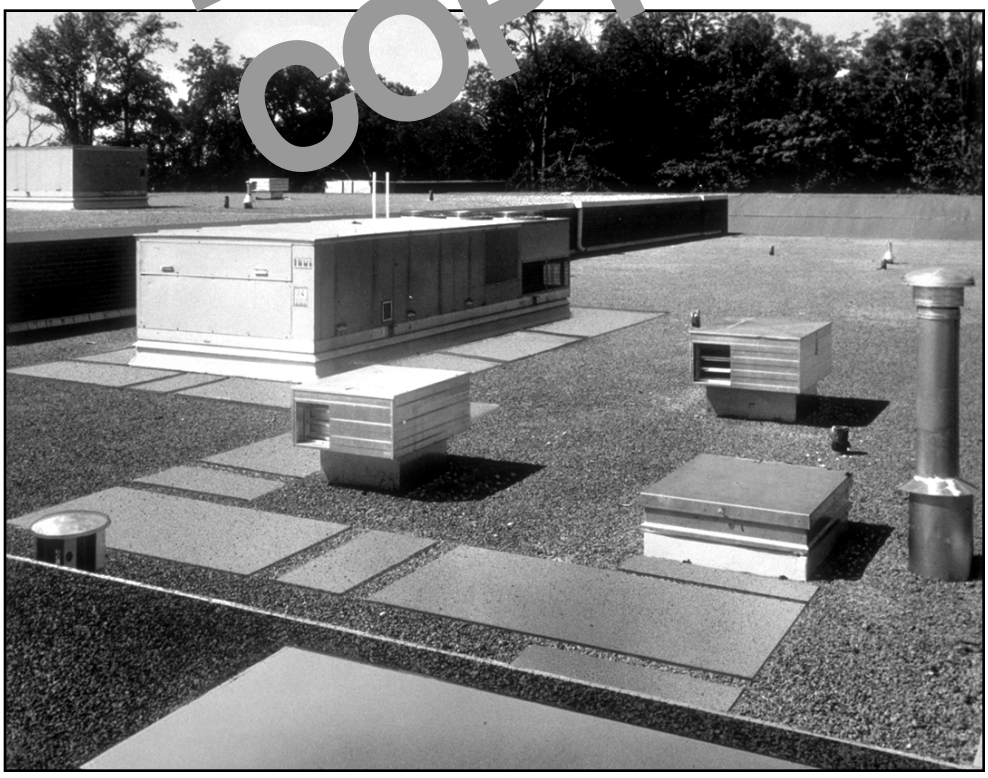
Fig. 1-7. Service walkway made of heavy felt pads



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much greater depth than mopped bitumen does. Steeply sloped roofs, however, have no aggregate covering—just a smooth surfaced felt coating.

REMEMBER: The uniform mopping of bitumen between the built-up layers of felt is the backbone of a good roofing membrane. You can repair the final poured top coat if it is defective. But it is very difficult to repair the buried felts.

Service Walkways

1.54 A simple—but often overlooked—aid to lengthening roof life is a system of footpaths or walkways for those who service roof-mounted equipment. A typical installation is shown in Fig. 1-7. The walkways extend from the access stairs or penthouse to the various appliances via the shortest possible routes. Limiting foot traffic to these walkways greatly reduces roof damage.

1.55 The walkway surface consists of asphalt saturated felt pads, 1/2 to 1 in. thick, surfaced with embedded aggregate to assure good footing and prevent slipping.

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1-9. With the insulation below the deck, the deck and ceiling must be separated by a(an)_____.	1-9. AIR SPACE Ref: 1.34
1-10. The main ingredients of inorganic felts are glass or _____ fibers.	1-10. ASBESTOS Ref: 1.38
1-11. Sometimes talc, mica, or sand is added to saturated and coated roofing felts for _____.	1-11. DECORATION Ref: 1.40
1-12. Bitumens embed the _____ felts and the aggregate surface of the roof.	1-12. MEMBRANE Ref: 1.42
1-13. At high temperatures, which is more fluid and mixes better—asphalt or coal tar?	1-13. COAL TAR Ref: 1.47
1-14. The more layers of felt a membrane has, the greater its _____ and rigidity.	1-14. STRENGTH Ref: 1.50
1-15. A light-colored aggregate prolongs roof life by reflecting _____.	1-15. HEAT Ref: 1.51
1-16. You can reduce roof damage from foot traffic by installing special _____ made of asphalt-saturated felt.	1-16. WALKWAYS Ref: 1.54,1.55, Fig. 1-7

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Answer the following questions by marking an "X" in the box next to the best answer.

1-1. What is the least costly and most widely used type of roof?

- ☐ a. Cantilever
- ☐ b. Monitor
- ☐ c. Flat
- ☐ d. Saw-tooth

1-2. Which roofing layer serves as the base on which the others are built?

- ☐ a. Vapor barrier
- ☐ b. Thermal insulation
- ☐ c. Waterproofing membrane
- ☐ d. Structural deck

1-3. Which of the following statements about plywood for roof decks is true?

- ☐ a. It doesn't require special tools
- ☐ b. It fits curved roofs readily
- ☐ c. It is easy to work with
- ☐ d. All of the above

1-4. Lightweight concrete can be made fire-resistant by adding what to it?

- ☐ a. Aggregate
- ☐ b. Perlite
- ☐ c. Gypsum
- ☐ d. Vermiculite

1-5. Which of the following materials for vapor barriers may be applied hot or cold?

- ☐ a. Final floodcoat
- ☐ b. Kraft laminate
- ☐ c. Saturated felt
- ☐ d. Plastic sheet

1-6. To insulate a concrete deck, you must first

- ☐ a. lay sheathing paper over it
- ☐ b. prime the concrete with asphalt
- ☐ c. cement a layer of felt on it
- ☐ d. cover it with plywood

1-7. If the insulation is above the deck, a vapor barrier must be between the

- ☐ a. deck and the insulation
- ☐ b. air space and the membrane
- ☐ c. membrane and the insulation
- ☐ d. deck and the air space

1-8. The weatherproofing element of a built-up roof is the

- ☐ a. vapor barrier
- ☐ b. insulation
- ☐ c. aggregate
- ☐ d. membrane

1-9. When comparing asphalt and coal tar, which of the following is true?

- ☐ a. Coal tar is less brittle at low temperature
- ☐ b. Asphalt is less affected by temperature
- ☐ c. Coal tar is less fluid at high temperature
- ☐ d. All of the above

1-10. What material is used for a service walkway on a roof?

- ☐ a. Felt pads
- ☐ b. Gypsum boards
- ☐ c. Plywood sheets
- ☐ d. Lightweight concrete

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SUMMARY

The two basic types of roof systems used in construction today are flat roof systems and sloped roof systems. Most industrial and commercial buildings have a flat roof system. Not only are they less expensive than sloped roofs, but they allow for the installation of air conditioners and other equipment on their surface. The four basic components that make up a flat roof system are the structural deck, vapor barrier, thermal insulation, and waterproofing membrane.

The structural deck, which rests on the beams secured to the walls of the building, is typically made of wood, concrete, or steel. The next layer in building up a roof is the vapor barrier, if one is needed. Its purpose is to keep moisture from the building out of the roofing material. A vapor barrier may be made of plastic, coated felt, or Kraft laminate. The purpose of thermal insulation is to keep heat out of a building in the summer and to keep heat in the building during the winter. It is usually placed above the deck with a vapor barrier between the deck and insulation. Sometimes, however, the insulation is below the deck with a vapor barrier between the ceiling and the insulation.

After the vapor barrier and insulation are in place, the built-up (weatherproofing) membrane finishes the roof. The felts for membranes are usually divided into four basic groups: saturated felts, saturated and coated felts, prepared roofings, and plastic materials. The waterproofing material is either asphalt-base bitumen or coal-tar bitumen. The last sheet of felt laid typically receives an embedded coating of aggregate to protect the roof.

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Answers to Self-Check Quiz

1-1. c. Flat. Ref: 1.05, Fig. 1-2

1-2. d. Structural deck. Ref: 1.09

1-3. d. All of the above. Ref: 1.13

1-4. c. Gypsum. Ref: 1.20

1-5. b. Kraft laminate. Ref: 1.26

1-6. b. Prime the concrete with asphalt. Ref: 1.32

1-7. a. Deck and the insulation. Ref: 1.33, Fig. 1-5

1-8. d. Membrane. Ref: 1.35

1-9. b. Asphalt is less affected by temperature. Ref: 1.47

1-10. a. Felt pads. Ref: 1.55

Contributions from the following sources are appreciated:

Figure 1-3. American Plywood Association
Figure 1-4. Portland Cement Association
Figure 1-5. Plant Engineering Directory and Catalog
Figure 1-6. Plant Engineering Directory and Catalog
Figure 1-7. The Celotex Corporation

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