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Chapter 12

Moisture Protection

Topics

1.0.0 Safety

2.0.0 Roofing Applications

3.0.0 Roofing Terms and Materials

4.0.0 Exterior Wall Coverings

5.0.0 Flashing

6.0.0 Gutters and Downspouts

7.0.0 Exterior Doors

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Overview

Moisture protection for buildings includes many components. The most obvious are the roofing and exterior wall coverings. Openings in the walls are sealed by doors and windows. Flashing helps protect areas where surfaces come together, such as chimneys and roofs. Gutters and downspouts move water from the roof to underground drains. Insulation and ventilation work together to prevent moisture from building up and damaging the building. Your job as a Builder is to incorporate all of these elements to prevent moisture from damaging the building.

Objectives

When you have completed this chapter, you will be able to do the following:

1. Identify safety measures while working on roofing.
2. Identify various types of roof sheathing and describe their installation requirements.
3. Define roofing terms and identify roofing materials.

1.0.0 SAFETY

Before we discuss working on roofing, it is important to review measures to keep your crew safe on the job. This includes fall protection and personal protective equipment (PPE).

1.1.0 Fall Protection

Roofs can be either sloped or flat. There are different considerations for working in these two environments.

1.1.1 Sloped Roofs

There are several components to fall protection systems used on sloped roofs:

- Full body harness
- Self retracting lanyard (SRL)
- Roof brackets/anchors for anchorage points
- Slide guards

The roof brackets/anchors can have single or multiple connections, and must be designed for 5,000 pounds per person.

1.1.2 Flat Roofs

On flat roofs with no ***parapet*** or guardrails, there are several safety considerations. When you are working within 6 feet of the edge, you need to use the following comoponents:

- Full body harness
- Restraining system and/or
- Self retracting lanyard (SRL)

Establish a warning line system six to ten feet away from the leading edge or temporary guardrails for workers without a fall arrest system. Personnel working inside the warning line system do not require fall protection.

1.2.0 Roof Loading

Many factors can affect how you load the materials for installation of a roof. Work directly with your Safety Officer to establish safe work loads. The Safety Plan needs to ensure that the structure will support the load.

2.0.0 ROOFING APPLICATIONS

Previous chapters have dealt with framing wood structures, including ***joists***, studs, ***rafters***, and other structural members. These constitute rough carpentry and are the main supports of a wood frame structure. Subflooring and wall and roof sheathing strengthen and brace the frame.

The remaining work on the structure involves installing the nonstructural members. This work, referred to as finish carpentry, includes installing the roof covering, exterior wall coverings, door and window frames, and the doors and windows themselves. Some nonstructural members are purely ornamental, such as ***casings*** on doors and windows, and the moldings on cornices and inside walls. Installation of purely ornamental members is known as trim carpentry.

Finish carpentry is divided into exterior and interior finish. Exterior finish materials consist of roof sheathing, exterior trim, roof coverings, outside wall covering, and exterior doors and windows. Exterior finish materials are installed after the rough carpentry has been completed. Examples of interior finish materials include all coverings applied to the rough walls, ceilings, and floors. These topics are covered in a later chapter.

2.1.0 Roof Sheathing

Roof sheathing covers the rafters or roof joists. As a structural element of the framing, sheathing provides a nailing base for the finish roof covering and gives rigidity and strength to the roof framing. Lumber and ***plywood*** roof sheathing are the most commonly used materials for pitched roofs. Plank or laminated roof decking is sometimes used in structures with exposed ceilings. Manufactured wood fiber roof decking is also adaptable to exposed ceiling applications.

2.1.1 Lumber

Roof sheathing boards are generally No. 3 common or better. These are typically softwoods, such as Douglas fir, redwood, hemlock, western larch, fir, and spruce. If you are covering the roof with ***asphalt shingles***, you should use only thoroughly seasoned wood for the sheathing. Unseasoned wood will dry and shrink, which may cause the shingles to buckle or lift along the full length of the sheathing board.

Nominal 1 inch boards are used for both flat and pitched roofs. Where flat roofs are to be used for a deck or a balcony, thicker sheathing boards are required. Board roof sheathing, like board wall sheathing and subflooring, can be laid either horizontally or diagonally. Horizontal board sheathing may be closed, laid with no space between the ***courses***, or open, laid with space between the courses. In areas subject to wind driven snow, a solid roof deck is recommended.

2.1.2 Installation

Roof boards used for sheathing under materials requiring solid, continuous support must be laid closed. This includes such applications as asphalt shingles, composition roofing, and sheet metal roofing. Closed roof sheathing can also be used for wood shingles. The boards are nominal 1 inch by 8 inches and may be square edged, dressed and matched, shiplapped, or tongue and groove. *Figure 12-1* shows the installation of both closed and open lumber roof sheathing.

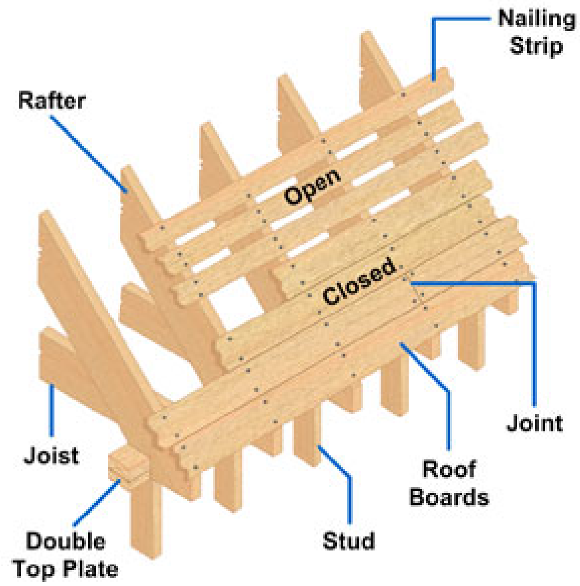


Figure 12-1 – Closed and open roof sheathing.

Open sheathing can be used under wood shingles or ***shakes*** in blizzard-free areas or damp climates. Open sheathing usually consists of 1 by 4 inch strips with on center (OC) spacing equal to the shingle weather ***exposure***, but not over 10 inches. A 10 inch shingle lapped 4 inches by the shingle above it is said to be laid 6 inches to the weather. When applying open sheathing, you should lay the boards without spacing to a point on the roof above the overhang.

2.1.3 Nailing

Nail lumber roof sheathing to each rafter with two 8 penny (8d) nails. Joints must be made on the rafters just as wall sheathing joints must be made over the studs. When tongue and groove boards are used, joints may be made between rafters. In no case should the joints of adjoining boards be made over the same rafter space. Each board should bear on at least two rafters.

2.1.4 Plywood

Plywood offers design flexibility, construction ease, economy, and durability. It can be installed quickly over large areas and provides a smooth, solid base with a minimum number of joints. A plywood deck is equally effective under any type of shingle or ***built up roof***. Waste is minimal, contributing to the low in-place cost.

Plywood is one of the most common roof sheathing materials in use today. It comes in 4 by 8 foot sheets in a variety of thicknesses, grades, and qualities. For sheathing work a lower grade called CDX is usually used. A large area, 32 square feet, can be applied at one time. This, plus its great strength relative to other sheathing materials, makes plywood a highly desirable choice.

The thickness of plywood used for roof sheathing is determined by several factors. The distance between rafters (spacing) is one of the most important. The larger the spacing, the greater the thickness of sheathing that should be used. When 16 inch OC rafter spacing is used, the minimum recommended thickness is 3/8 inch. The type of roofing material to be applied over the sheathing also plays a role. The heavier the roof covering, the thicker the sheathing required. Another factor determining sheathing thickness is the prevailing weather. In areas where there are heavy ice and snow loads, thicker sheathing is required. Finally, you have to consider allowable dead and live roof loads established by calculations and tests.

These are the controlling factors in the choice of roof sheathing materials. Recommended spans and plywood grades are shown in *Table 12-1*.

Table 12-1 – Plywood Roof Sheathing Application Specifications.

Plywood roof sheathing [1, 2, 3] (Plywood continuous over two or more spans; grain of face plies across supports)														
Panel Identification Index	Plywood Thickness (Inch)	Maximum Span (Inches) [4]	Unsupported Edge – Max. Length (inches) [5]	ALLOWABLE ROOF LOADS (per square foot) [6, 7]										
				Spacing of Supports (inches center to center)										
				12	16	20	24	30	32	36	42	48	60	72
12/0	5/16	12	12	100 (130)										
16/0	5/16, 3/8	16	16	130 (170)	55 (75)									
20/0	5/16, 3/8	20	20		85 (110)	45 (55)								
24/0	3/8, 1/2	24	24		150 (160)	75 (100)	45 (60)							
30/12	5/8	30	26			145 (165)	85 (110)	40 (55)						
32/16	1/2, 5/8	32	28				90 (105)	45 (60)	40 (50)					
36/16	3/4	36	30				125 (145)	65 (85)	45 (60)	35 (45)				
42/20	5/8, 3/4, 7/8	42	32					80 (105)	65 (90)	45 (60)	35 (40)			
48/24	3/4, 7/8	48	36						105 (115)	75 (90)	55 (55)	40 (40)		
2-4-1	1 1/8	72	48							175 (175)	105 (105)	80 (80)	50 (50)	30 (35)
1 1/8 G1&2	1 1/8	72	48							145 (145)	85 (85)	65 (65)	40 (40)	30 (30)
1 1/4 G3&4	1 1/4	72	48							160 (165)	95 (95)	75 (75)	45 (45)	25 (35)

Notes:

1. Applies to Standard, Structural I and II and C-C grades only.
2. For applications where the roofing is to be guaranteed by a performance bond, recommendations may differ somewhat from these values. Contact American Plywood Assiciation for bonded roof recommendations.
3. Use 6d common smooth, ring shank, or spiral thread nails for plywood 1/2” thick or less, and 8d common smooth, ring shank, or spiral thread nails for panels over 1/2” but not exceeding 1” thick (if ring shank or spiral thread nails same diameter as common). Use 8d ring shank or spiral thread or 10d common smooth shank nails for 2-4-1, 1 1/8” and 1 1/4” panels. Space nails 6” at panel edges and 12” at intermediate supports except where those spans are 48” or more, nails must be 6” at all supports.
4. These spans must not be exceeded for any load conditions.
5. Provide adequate blocking, tongue and groove edges, or other suitable edge support, such as ply clips, when spans exceed indicated value. Use two ply clips for 48” or greater spans and one for lesser spans.
6. Uniform load deflection limitation: 1/180th of the span under live load plus dead load. 1/240th under live load only. In the table, allowable live load is shown above with allowable total load shown below in parantheses.
7. Allowable roof loads were established by laboratory tests and calculations assuming evenly distributed loads.

2.1.5 Installation

Plywood sheathing is applied after rafters, collar ties, gable studs, and extra bracing, if necessary, are in place. Make sure there are no problems with the roof frame. Check rafters for plumb, make sure there are no badly deformed rafters, and check the tail cuts of all the rafters for alignment. The crowns on all the rafters should be in one direction, up.

Figure 12-2 shows two common methods of starting the application of sheathing at the roof ***eaves***. In *view A*, the sheathing is started flush with the tail cut of the rafters. Notice that when the fascia is placed, the top edge of the fascia is even with the top of the sheathing. In *view B*, the sheathing overlaps the tail end of the rafter by the thickness of the fascia material. You can see that the edge of the sheathing is flush with the fascia.

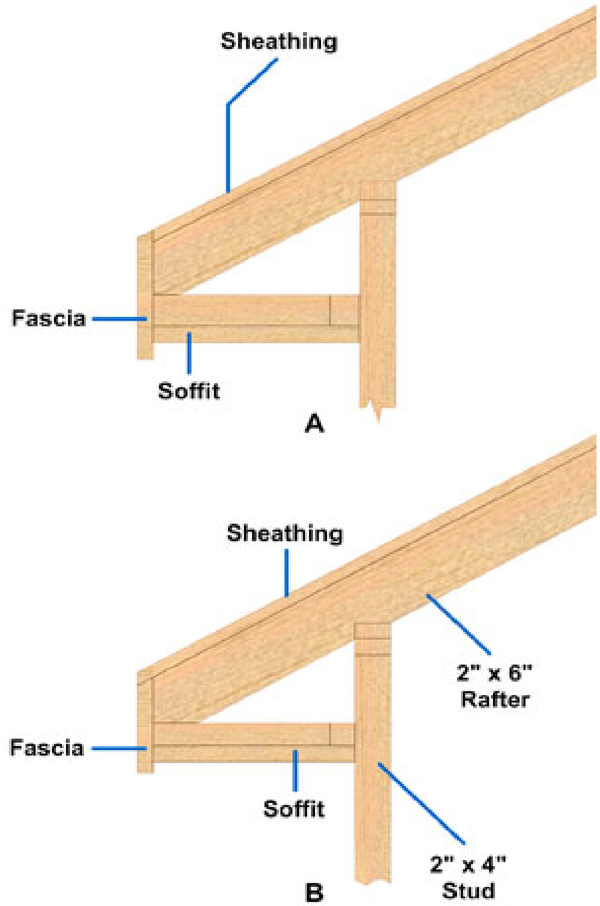


Figure 12-2 – Two methods of starting the first sheet of roof sheathing at the eaves of a roof.
A. Flush with rafter
B. Overlapping rafter

If you choose to use the first method, *view A,* to start the sheathing, measure the two end rafters the width of the plywood panel, 48 inches. From the rafter tail ends, and using the chalk box, strike a line on the top edge of all the rafters. If you use the second method, *view* B, measure the width of the panel minus the actual thickness of the fascia material. Use this chalk line to position the upper edge of the sheathing panels. If the roof rafters are at right angles to the ***ridge*** and plates, this line will place the sheathing panels parallel to the outer ends of the rafters.

WARNING

Be particularly careful when handling sheathing material on a roof during windy conditions. You may be thrown off balance and possibly off the roof entirely. Also, the sheet may be blown off the roof and strike someone.

2.1.6 Placing

Notice in *Figure 12-2* that sheathing is placed before the trim is applied. Always place sheathing from the lower (eaves) edge of the roof up toward the ridge. You can start from the left side and work toward the right, or from the right and work toward the left. Usually, you should start at the same end of the building from which you laid the rafters out.

The first sheet of plywood is a full 4 by 8 foot panel. Place the top edge on the chalk line. If you started the sheathing from the left side of the roof, make sure the right end falls in the middle of a rafter so that the left end of the next sheet has a surface upon which it can bear weight and be nailed.

Place the plywood so that the grain of the top ply is at right angles (perpendicular) to the rafters. Placing the sheathing in this fashion spans a greater number of rafters, spreads the load, and increases the strength of the roof. *Figure 12-3* shows plywood panels laid perpendicular to the rafters with staggered joints.

⚠ CAUTION ⚠

Leave a small space between sheets to allow for expansion.

Butt the sheets that follow against spacers until you reach the opposite end. If there is any panel hanging over the edge, trim it after you fasten the panel in place. Snap a chalk line on the sheathing flush with the end of the house, and then cut the panel with a circular saw. Read the manufacturer's specification stamp and allow proper spacing at the ends and edges of the sheathing. This will compensate for any swelling that might take place with changes in moisture content.

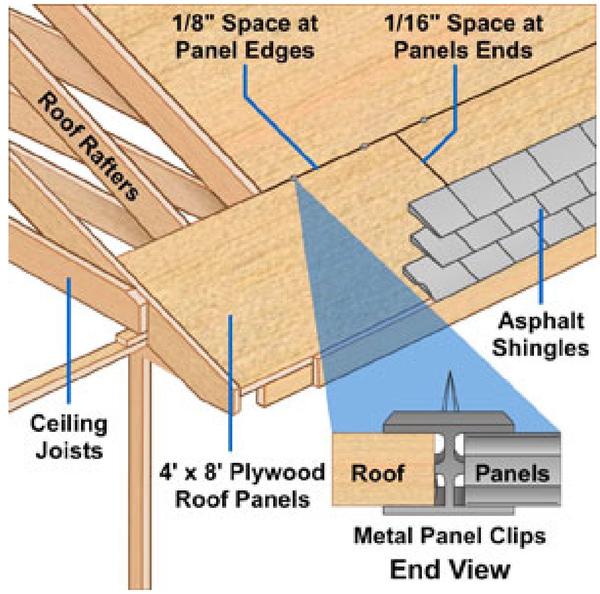


Figure 12-3 – Plywood roofing panel installation.

The cutoff piece of sheathing can be used to start the second course (row of sheathing), provided it spans two or more rafters. If it does not span two rafters, start the second course with a 4 by 4 half sheet of plywood.

It is important to stagger all vertical joints. All horizontal joints need blocking placed underneath, or a metal clip known as a ply clip. Ply clips (H clips or panel clips) are designed to strengthen the edges of sheathing panels between supports or rafters. The use of clips is determined by the rafter spacing and specifications, as shown in *Figure 12-3*.

Carry the pattern to the ridge. Fasten the final course in place, snap a chalk line at the top edge of the rafters, and cut off the extra material. Then sheet the opposite side of the roof using the same pattern.

2.1.7 Nailing

When nailing plywood sheathing, follow the project specifications for nailing procedures. Use 6d common smooth, ring shank, or spiral thread nails for plywood 1/2 inch thick or less. For plywood more than 1/2 inch but not exceeding 1 inch thick, use 8d common smooth, ring shank, or spiral thread nails. When using a nail gun for roof sheathing, follow all applicable safety regulations.

Test your Knowledge (Select the Correct Response)

1. Roof sheathing has what primary purpose?

   A. Appearance
   B. Base for nailing shingles
   C. Insulation
   D. Foundation for joining rafters

2.2.0 Roof Decking

In this section, we will discuss the two most common types of roof decking you will encounter as a Builder, plank and wood fiber.

2.2.1 Plank

Plank roof decking, consisting of 2 inch and thicker tongue and groove planking, is commonly used for flat or low pitched roofs in post and beam construction. Single tongue and groove decking in nominal 2 by 6 and 2 by 8 sizes is available with the V joint pattern only.

Decking comes in nominal widths of 4 to 12 inches and in nominal thicknesses of *2* to 4 inches. Three- and 4 inch roof decking is available in random lengths of 6 to 20 feet or longer (odd and even).

Laminated decking is also available in several different species of softwood lumber: Idaho white pine, inland red cedar, Idaho white fir, ponderosa pine, Douglas fir, larch, and yellow pine. Because of the laminating feature, this material may have a facing of one wood species and back and interior laminations of different woods. It is also available with all laminations of the same species. For all types of decking, make sure the material is the correct thickness for the span by checking the manufacturer's recommendations.

Special load requirements may reduce the allowable spans. Roof decking can serve both as an interior ceiling finish and as a base for roofing. Heat loss is greatly reduced by adding fiberboard or other rigid insulation over the wood decking.

2.2.2 Installation

Install roof decking to a flat roof with the tongue away from you. Install roof decking to a sloping roof with the tongue up. Bevel cut the butt ends of the pieces at approximately a 2° angle, as shown in *Figure 12-4*. This provides a bevel cut from the face to the back to ensure a tight face butt joint when the decking is laid in a random length pattern.

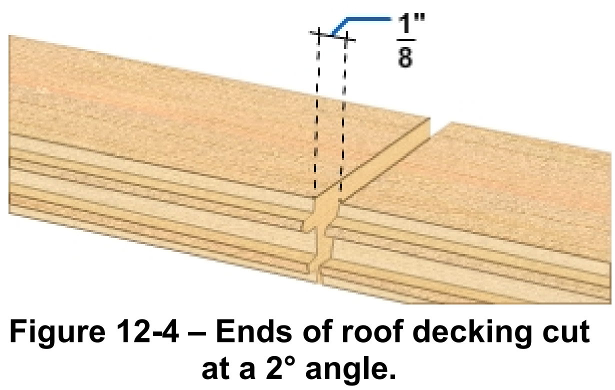
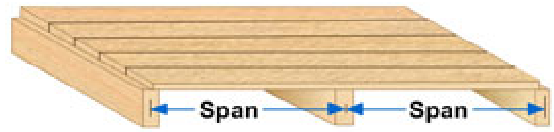


Figure 12-4 – Ends of roof decking cut at a 2° angle.

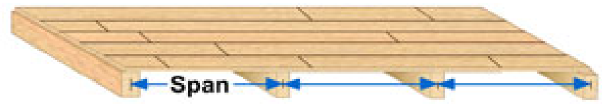
If there are three or more supports for the decking, a controlled random laying pattern, shown in *Figure 12-5*, can be used.

This is an economical pattern because it makes use of random plank lengths, but the following rules must be observed:

- Stagger the end joints in adjacent planks as widely as possible and not less than 2 feet.
- Separate the joints in the same general line by at least two courses.
- Minimize joints in the middle one third of all spans.
- Make each plank bear on at least one support.
- Minimize the joints in the end span.



Double Span



Controlled Random Pattern

Figure 12-5 – Plank decking span arrangements.

The ability of the decking to support specific loads depends on the support spacing, plank thickness, and span arrangement. Although two-span continuous layout offers structural efficiency, use of random length planks is the most economical. Random length double tongue and groove decking is used when there are three or more spans. It is not intended for use over single spans, and it is not recommended for use over double spans, as shown in *Figure 12-5*.

2.2.3 Nailing

Fasten decking with common nails twice as long as the nominal plank thickness. For widths 6 inches or less, toenail once and face nail once at each support. For widths over 6 inches, toenail once and face nail twice. Decking 3 and 4 inches thick must be predrilled and toenailed with 8 inch spikes. Bright common nails may be used, but dipped galvanized common nails have better holding power and reduce the possibility of rust streaks. End joints not over a support should be side nailed within 10 inches of each plank end. Splines are recommended on end joints of 3 and 4 inch material for better alignment, appearance, and strength.

2.2.4 Wood Fiber

All wood fiber roof decking combines strength and insulation advantages that make possible quality construction with economy. This type of decking is weather resistant and protected against termites and rot. It is ideally suited for built up roofing, as well as for asphalt and wood shingles on all types of buildings. Wood fiber decking is available in four thicknesses: 2 3/8 inches, 1 7/8 inches, 1 3/8 inches, and 15/16 inch. The standard panels are 2 inches by 8 feet with tongue and groove edges and square ends. The surfaces are coated on one or both sides at the factory in a variety of colors.

2.2.5 Installation

Lay out wood fiber roof decking with the tongue and groove joint at right angles to the support members. Start the decking at the eave line with the groove edge opposite the applicator. Staple wax paper in position over the rafter before installing the roof deck. The wax paper protects the exposed interior finish of the decking if the beams are to be stained. Caulk the end joints with a nonstaining caulking compound. Butt the adjacent piece up against the caulked joint. Drive the tongue and groove edges of each unit firmly together with a wood block cut to fit the grooved edge of the decking. End joints must be made over a support member.

2.2.6 Nailing

Nail the wood fiber roof panels through the face into the wood, rafters, or trusses, even though they have tongue and groove edges. Face nail 6 inches OC with 6d nails for 15/16 inch, 8d for 1 3/8 inch, 10d for 1 7/8 inch, and 16d for 2 3/8 inch thicknesses.

If you are not going to apply the finish roofing material immediately after the roof is sheeted, cover the deck with building felt paper. The paper will protect the sheathing in case of rain. Wet panels tend to separate.

Roof decking that extends beyond gable end walls for the overhang should span not less than three rafter spaces. This is to ensure anchorage to the railers and to prevent sagging, as shown in *Figure 12-6*. When the projection is greater than 16 to 20 inches, special ladder framing is used to support the sheathing.

Plywood extension beyond the end wall is usually governed by the rafter spacing to minimize waste. Thus, a 16 inch ***rake*** (gable) projection is commonly used when rafters are spaced 16 inches OC. Alternate butt joints of the plywood sheets so they do not occur on the same rafter.

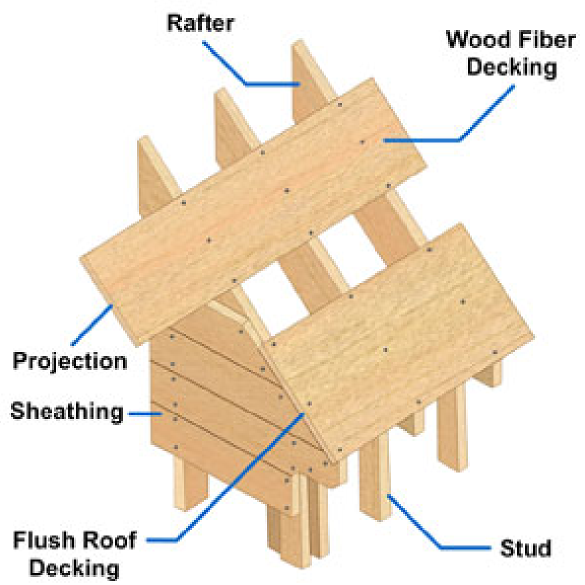


Figure 12-6 – Wood fiber roof decking at gable ends.

2.3.0 Details at Chimney and Valley Openings

Where chimney openings occur in the roof structure, the roof sheathing should have a 3/4 inch clearance on all sides from the finished masonry. *Figure 12-7* shows sheathing details at the ***valley*** and chimney opening. The detail at the top shows the clearances between masonry and wood framing members. Framing members should have a 2 inch clearance for fire protection. The sheathing should be securely nailed to the rafters and to the headers around the opening.

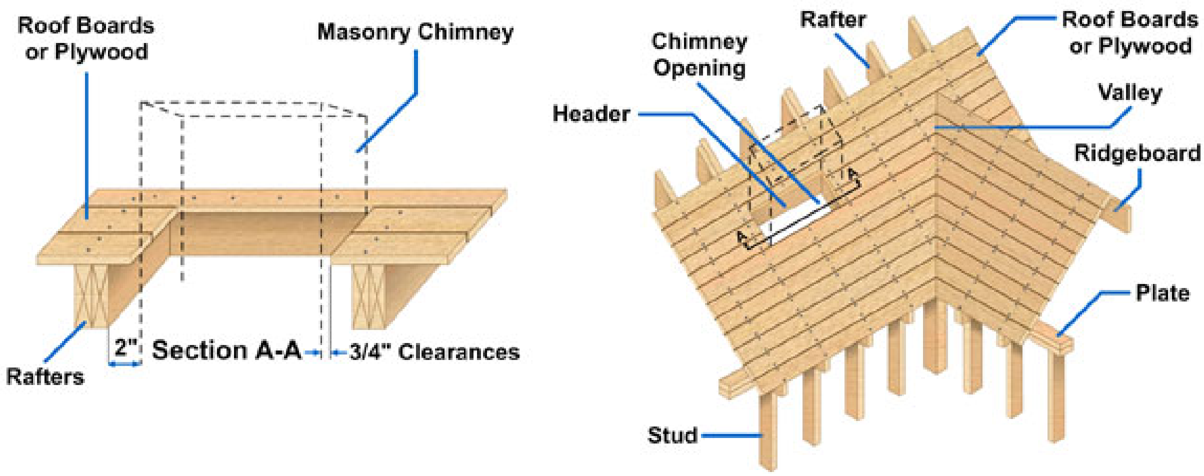


Figure 12-7 – Sheathing details at chimney and valley openings.

Wood or plywood sheathing at the valleys and hips should be installed to provide a tight joint and should be securely nailed to hip and valley rafters. This provides a smooth solid base for metal ***flashing***.

2.4.0 Estimating Sheathing Material

To figure the roof area without actually getting on the roof and measuring, find the dimensions of the roof on the plans. Multiply the length times the width of the roof, including the overhang. Then multiply by the factor shown opposite the ***rise*** of the roof in *Table 12-2*. The result will be the roof area.

Table 12-2 – Determining Roof Area from a Plan.

Rise (Inches)	Factor	Rise	Factor
3”	1.031	8”	1.202
3 1/2”	1.042	8 1/2”	1.225
4”	1.054	9”	1.250
4 1/2”	1.068	9 1/2”	1.275
5”	1.083	10”	1.302
5 1/2”	1.100	10 1/2”	1.329
6”	1.118	11”	1.357
6 1/2”	1.137	11 1/2”	1.385
7”	1.158	12”	1.414
7 1/2”	1.179		

For example, assume a building is 70 feet long and 30 feet wide, including the overhang, and the roof has a rise of 5 1/2 inches.

70 feet x 30 feet = 2,100 square feet

For a rise of 5 1/2 inches, the factor on the chart is

1.100:2,100 square feet x 1.100 = 2,310 square feet

So, the total area to be covered is 2,310 square feet. Use this total area for figuring roofing needs, such as sheathing, felt underlayment, or shingles.

2.4.1 Lumber Sheathing

To decide how much lumber will be needed, first calculate the total area to be covered. Determine the size boards to be used, and then refer to *Figure 12-8*. Multiply the total area to be covered by the factor from the chart. For example, if 1 by 8 inch tongue and groove sheathing boards are to be used, multiply the total roof area by 1.16. To determine the total number of board feet needed, add 5 percent for trim and waste.

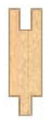
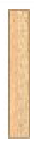
	Normal Size	Width		Area Factor
		Dress	Face	
Shiplap 	1 x 6	5 7/16	4 15/16	1.22
	1 x 8	7 1/8	6 5/8	1.21
	1 x 10	9 1/8	8 5/8	1.16
	1 x 12	11 1/8	10 5/8	1.13
Tongue and Groove 	1 x 4	3 7/16	3 3/16	1.26
	1 x 6	5 7/16	5 3/16	1.16
	1 x 8	7 1/8	6 7/8	1.16
	1 x 10	9 1/8	8 7/8	1.13
	1 x 12	11 1/8	10 7/8	1.10
S4S 	1 x 4	3 1/2	3 1/2	1.14
	1 x 6	5 1/2	5 1/2	1.09
	1 x 8	7 1/4	7 1/4	1.10
	1 x 10	9 1/4	9 1/4	1.08
	1 x 12	11 1/4	11 1/4	1.07

Figure 12-8 – Lumber Sheathing Specifications and Estimating Factor.

2.4.2 Plywood Sheathing

To determine how much plywood will be needed, find the total roof area to be covered and divide by 32, the number of square feet in one 4 by 8 foot sheet of plywood. This gives you the number of sheets required to cover the area. Be sure to add 5 percent for a trim and waste allowance.

2.4.3 Decking or Planking

To estimate plank decking, first determine the area to be covered, and then refer to the chart in *Table 12-3*. In the left column, find the size planking to be applied. For example, if 2 by 6 inch material is selected, the factor is 2.40. Multiply the area to be covered by this factor and add a 5 percent trim and waste allowance.

Table 12-3 – Plank Decking Estimating Factor.

Size	Area Factor
2” x 6”	2.40
2” x 8”	2.29
3” x 6”	3.43
4” x 6”	4.57

2.4.4 Wood Fiber Roof Decking

To estimate the amount of wood fiber decking required, first find the total roof area to be covered. For every 100 square feet of area, you will need 6.25 panels, 2 by 8 feet in size. So, divide the roof area by 100 and multiply by 6.25. Using our previous example with a roof area of 2,310 square feet, you will need 145 panels.

3.0.0 ROOFING TERMS and MATERIALS

The roof covering, or roofing, is a part of the exterior finish. It should provide long-lived waterproof protection for the building and its contents from rain, snow, wind, and to some extent, heat and cold. Before we begin our discussion of roof coverings, let us first look at some of the most common terms used in roof construction.

3.1.0 Terminology

Correct use of roofing terms is not only the mark of a good worker, but also a necessity for good construction. This section covers some of the more common roofing terms you need to know.

3.1.1 Square

Roofing is estimated and sold by the ***square***. A square of roofing is the amount required to cover 100 square feet of the roof surface.

3.1.2 Coverage

Coverage is the amount of weather protection provided by the overlapping of shingles. Depending on the kind of shingle and method of application, shingles may furnish one (single coverage), or two (double coverage), or three (triple coverage) thicknesses of material over the roof surface. Shingles providing single coverage are suitable for reroofing over existing roofs. Shingles providing double and triple coverage are used for new construction. Multiple coverage increases weather resistance and provides a longer service life.

3.1.3 Shingle Surfaces

The various surfaces of a shingle are shown in *view A* of *Figure 12-9*. Shingle width refers to the total measurement across the top of either a strip type or individual type of shingle. The area that one shingle overlaps a shingle in the course (row) below it is referred to as top lap. Side lap is the area that one shingle overlaps a shingle next to it in the same course. The area that one shingle overlaps a shingle two courses below it is known as head lap. Head lap is measured from the bottom edge of an overlapping shingle to the nearest top edge of an overlapped shingle. Exposure is the area that is exposed (not overlapped) in a shingle. For the best protection against leakage, shingles (or shakes) should be applied only on roofs with a unit rise of 4 inches or more. A lesser ***slope*** creates slower water runoff, which increases the possibility of leakage as a result of windblown rain or snow being driven underneath the butt ends of the shingles.

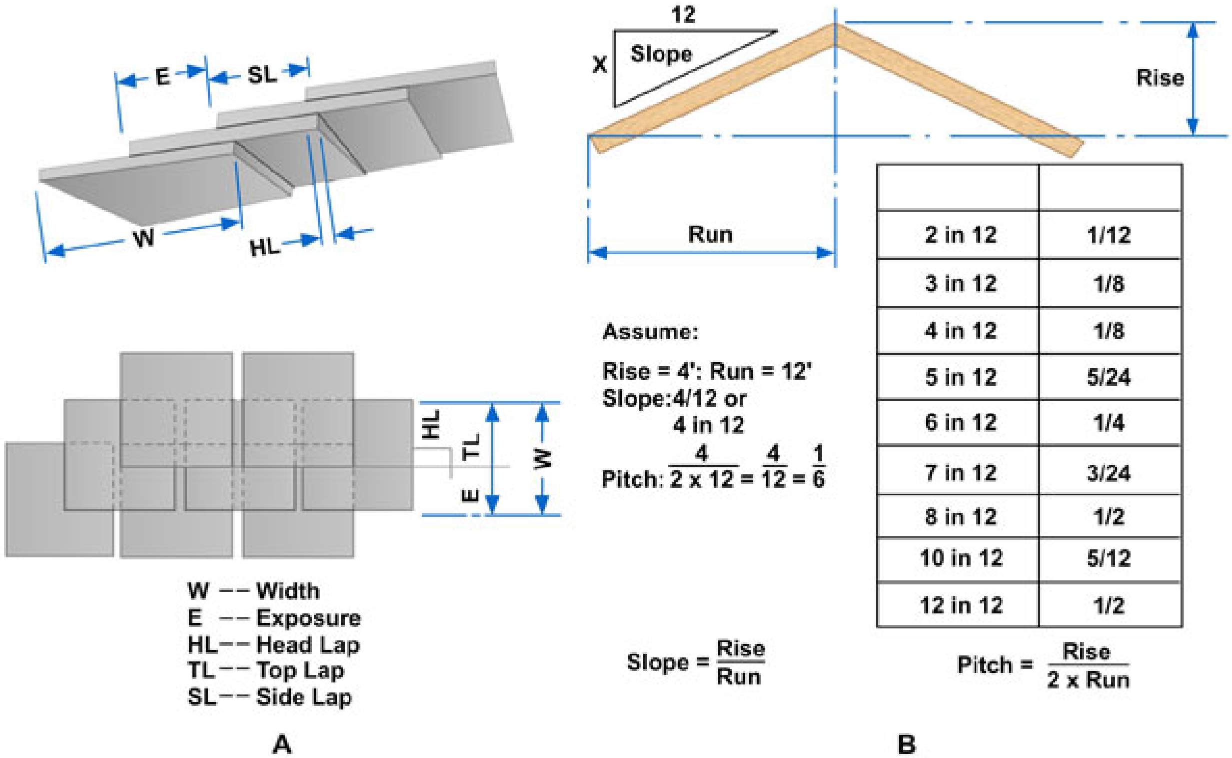


Figure 12-9 – Roofing terminology.
A. Surfaces
B. Slope and pitch

3.1.4 Slope

Slope and pitch are often incorrectly used synonymously when referring to the incline of a sloped roof. *View B of Figure 12-9* shows some common roof slopes with their corresponding roof pitches. Slope refers to the incline of a roof as a ratio of vertical rise to horizontal run. It is expressed sometimes as a fraction but typically as X in 12, for example, a 4 in 12 slope for a roof that rises at the rate of 4 inches for each foot (12 inches) of run. The triangular symbol above the roof in *Figure 12-9, view B*, conveys this information.

3.1.5 Pitch

Pitch is the incline of a roof as a ratio of the vertical rise to twice the horizontal run. It is expressed as a fraction. For example, if the rise of a roof is 4 feet and the run 12 feet, the roof is designated as having a pitch of 1/6 (4/24 = 1/6).

3.2.0 Materials

In completing roofing projects, you will be working with a number of different materials. In the following section, we will discuss the most common types of underlayments, flashing, roofing cements, and exterior materials you will encounter. We will also talk about built up roofing.

Materials used for pitched roofs include shingles of ***asphalt***, fiberglass, and wood. Shingles add color, texture, and pattern to the roof surface. To shed water, all shingles are applied to roof surfaces in some overlapping fashion. They are suitable for any roof with enough slope to ensure good drainage. Tile and slate are also popular. Sheet materials such as roll roofing, galvanized steel, aluminum, copper, and tin are sometimes used. For flat or low pitched roofs, composition or built up roofing with a gravel topping or ***cap sheet*** are frequent combinations. Built up roofing consists of a number of layers of asphalt ***saturated felt*** mopped down with hot asphalt or tar. Metal roofs are sometimes used on flat decks of dormers, porches, or entryways.

The choice of materials and the method of application are influenced by cost, roof slope, expected service life of the roofing, wind resistance, fire resistance, and local climate. Because of the large amount of exposed surface of pitched roofs, appearance is also important.

3.2.1 Underlayments

There are basically four types of underlayments you will be working with as a Builder: asphalt felt, organic, glass fiber, and tarred.

Once the roof sheathing is in place, it is covered with an asphalt felt underlayment commonly called roofing felt. Roofing felt is saturated with asphalt and serves three basic purposes.

1. It keeps the roof sheathing dry until the shingles can be applied.
2. After the shingles have been laid, it acts as a secondary barrier against wind-driven rain and snow.
3. It also protects the shingles from any resinous materials which could be released from the sheathing.

Roofing felt is designated by the weight per square. As we mentioned earlier, a square is equal to 100 square feet and is the common unit to describe the amount of roofing material. Roofing felt is commonly available in rolls of 15 and 30 pounds per square. The rolls are usually 36 inches wide. A roll of 15 pound felt is 144 feet long, and a roll of 30 pound felt is 72 feet long. After you allow for a 2 inch top lap, a roll of 15 pound felt will cover 4 squares; a roll of 30 pound felt will cover 2 squares.

Underlayment should be a material with low vapor resistance, such as asphalt saturated felt. Do not use materials such as coated felts or laminated waterproof papers, which act as a vapor barrier. These allow moisture or frost to accumulate between the underlayment and the roof sheathing. Underlayment requirements for different kinds of shingles and various roof slopes are shown in *Table 12-4*.

Table 12-4 – Underlayment Recommendations for Shingle Roofs.

Type of Roofing	Sheathing	Type of Underlayment	Normal Slope		Low Slope	
Asbestos-Cement Shingles	Solid	No. 15 asphalt saturated asbestos (inorganic) felt, OR No. 30 asphalt saturated felt	5/12 and up	Single layer over entire roof	3/12 to 5/12	Double layer over entire roof[1]
Asphalt/Fiberglass Shingles	Solid	No. 15 asphalt saturated felt	4/12 and up	Single layer over entire roof	2/12 to 4/12	Double layer over entire roof[2]
Wood Shakes	Spaced	No. 30 asphalt saturated felt (interlayment)	4/12 and up	Underlayment starter course; interlayment over entire roof	Shakes not recommended on slopes less than 4/12 with spaced sheathing	
	Solid[3,5]	No. 30 asphalt saturated felt (interlayment)	5/12 and up	Underlayment starter course; interlayment over entire roof	3/12 to 4/12[4]	Single layer underlayment over entire roof; interlayment over entire roof
Wood Shingles	Spaced	None required	5/12 and up	None required	3/12 to 5/12[4]	None required
	Solid[5]	No. 15 asphalt saturated felt	5/12 and up	None required[6]	3/12 to 5/12[4]	None required[6]

Notes:

1. May be single layer on 4/12 slope in areas where outside design temperature is warmer than 0ºF
2. Square-butt strip shingles only; requires wind resistant shingles or cemented tabs
3. Recommended in areas subject to wind driven snow
4. Requires reduced weather exposure
5. May be desirable to increase insulation and to minimize air infiltration
6. May be desirable for protection of sheathing

Apply the underlayment as soon as the roof sheathing has been completed. For single underlayment, start at the eave line with the 15 pound felt. Roll across the roof with a top lap of at least 2 inches at all horizontal points and a 4 inch side lap at all end joints, as shown in *Figure 12-10, view A*. Lap the underlayment over all hips and ridges 6 inches on each side. A double underlayment can be started with two layers at the eave line, flush with the fascia board or molding. The second and remaining strips have 19 inch head laps with 17 inch exposures, as shown in *Figure 12-10, view B*. Cover the entire roof in this manner. Make sure that all surfaces have double coverage. Use only enough fasteners to hold the underlayment in place until the shingles are applied. Do not apply shingles over wet underlayment.

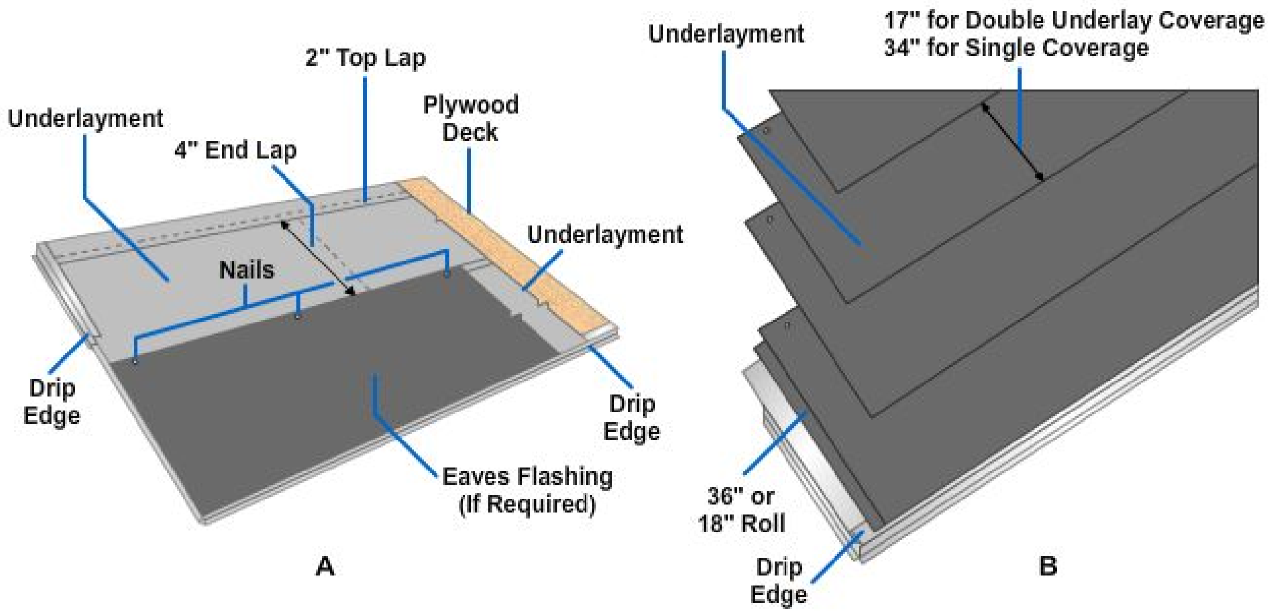


Figure 12-10 – Roofing underlayment.
A. Single coverage
B. Double coverage

In areas where moderate to severe snowfall is common and ice dams occur, melting snow refreezes at the eave line, as shown in *Figure 12-11, view A*. It is good practice to apply one course of 55 pound smooth surface roll roofing as a flashing at the eaves. It should be wide enough to extend from the roof edge to between 12 and 24 inches inside the wall line. Install roll roofing over the underlayment and metal drip edge. This will lessen the chance of melting snow backing up under the shingles and fascia board of closed cornices. Damage to interior ceilings and walls results from this water seepage. Eave flashing provides protection from ice dams. Cornice ventilation by means of ***soffit vents*** and sufficient insulation will minimize the melting, as shown in *Figure 12-11, view B*.

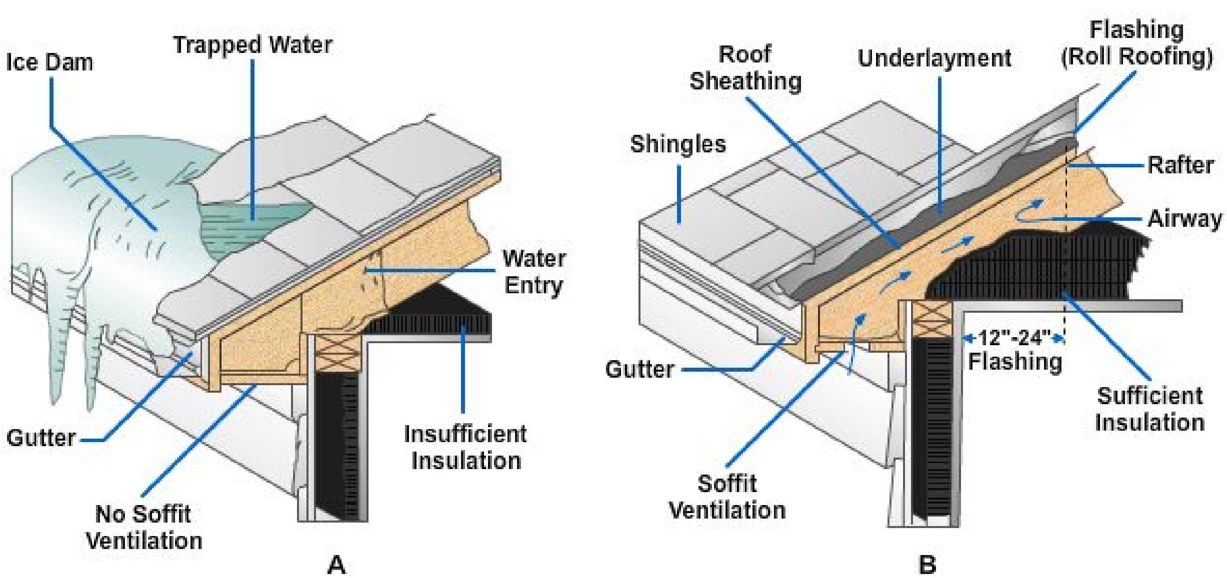


Figure 12-11 – Protection from ice dams.
A. Refreezing snow and ice.
B. Cornice ventilation.

Asphalt Felt – Roofing felts are used as underlayment for shingles, for sheathing paper, and for reinforcements in the construction of built up roofs. They are made from a combination of shredded wood fibers, mineral fibers, or glass fibers saturated with asphalt or ***coal tar pitch***. Sheets are usually 36 inches wide and available in various weights from 10 to 50 pounds. These weights refer to weight per square (100 feet).

Organic Felts – Asphalt saturated felts composed of a combination of felted papers and organic shredded wood fibers are considered felts. They are among the least expensive of roofing felts and are widely used not only as roofing, but also as water and vapor retarders. Fifteen pound felt is used under wood siding and exterior plaster to protect sheathing or wood studs. It is generally used in roofing for layers or plies in gravel-surfaced assemblies and is available perforated. Perforated felts used in built up roofs allow entrapped moisture to escape during application. Thirty pound felt requires fewer layers in a built up roof. It is usually used as underlayment for heavier cap sheets or tile on steeper roofs.

Glass-Fiber Felts – Sheets of glass fiber, when coated with asphalt, retain a high degree of porosity, assuring a maximum escape of entrapped moisture or vapor during application and maximum bond between felts. Melted asphalt is applied so that the finished built up roof becomes a monolithic slab reinforced with properly placed layers of glass fibers. The glass fibers, which are inorganic and do not curl, help create a solid mass of reinforced waterproof roofing material.

Tarred Felts – Coal tar pitch saturated organic felts are available for use with ***bitumens*** of the same composition. Since coal tar and asphalt are not compatible, the components in any construction must be limited to one bitumen or the other unless approved by the felt manufacturer.

3.2.2 Flashing

The roof edges along the eaves and rake should have a metal drip edge, or flashing. Flashing is specially constructed pieces of sheet metal or other materials used to protect the building from water seepage. Flashing must be made watertight and be water shedding. Flashing materials used on roofs may be asphalt saturated felt, metal, or plastic. Felt flashing is generally used at the ridges, hips, and valleys. Metal flashing made of aluminum, galvanized steel, or copper is considered superior to felt. Metal used for flashing must be corrosion resistant. It should be galvanized steel, at least 26-gauge, 0.019 inch thick aluminum, or 16 ounce copper.

Flashing is available in various shapes, as shown in *Figure 12-12*, formed from 26-gauge galvanized steel.

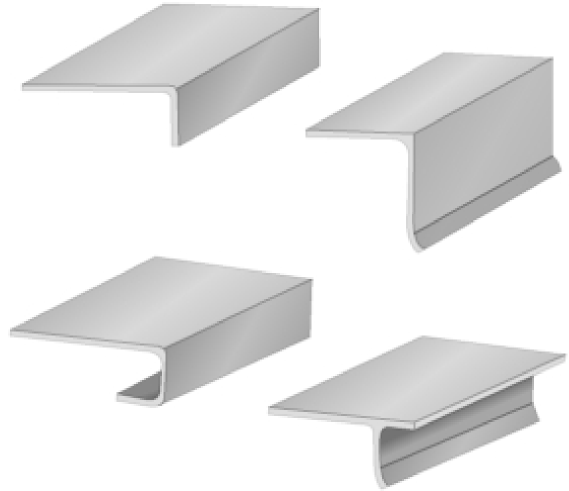


Figure 12-12 – Basic shapes of drip edges.

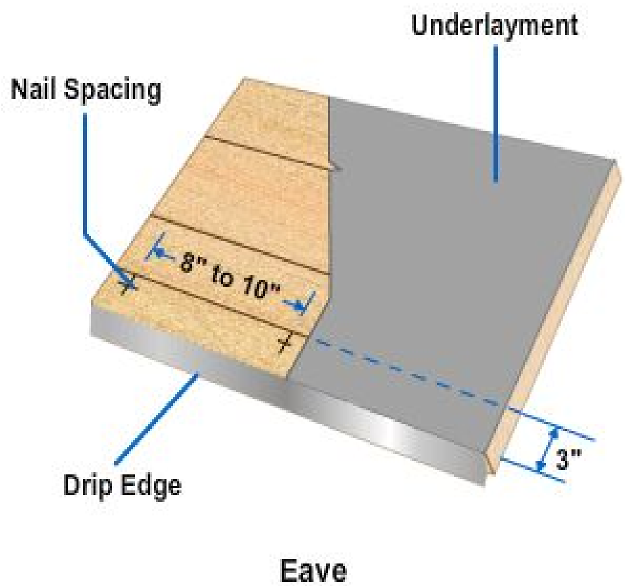


Figure 12-13 – Drip edges at the eave.

It should extend back approximately 3 inches from the roof edge and bend downward over the edge. This causes the water to drip free of underlying cornice construction. At the eaves, the underlayment should be laid over the drip edge as shown in *Figure 12-13*.

At the rake, place the underlayment under the drip edge, as shown in *Figure 12-14*. Galvanized nails, spaced 8 to 10 inches apart, are recommended for fastening the drip edge to the sheathing.

The shape and construction of different types of roofs can create different types of water leakage problems. Water leakage can be prevented by placing flashing materials in and around the vulnerable areas of the roof. These areas include the point of intersection between roof and soil stack or ventilator, the valley of a roof, around chimneys, and at the point where a wall intersects a roof.

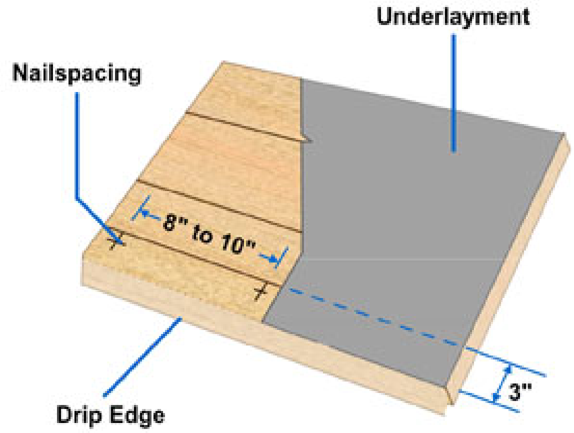


Figure 12-14 – Drip edges at the rake.

As you approach a soil stack, apply the roofing up to the stack and cut it to fit, as shown in *Figure 12-15*. Then install a corrosion resistant metal sleeve, which slips over the stack and has an adjustable flange to fit the slope of the roof. Continue shingling over the flange. Cut the shingles to fit around the stack and press them firmly into the cement.

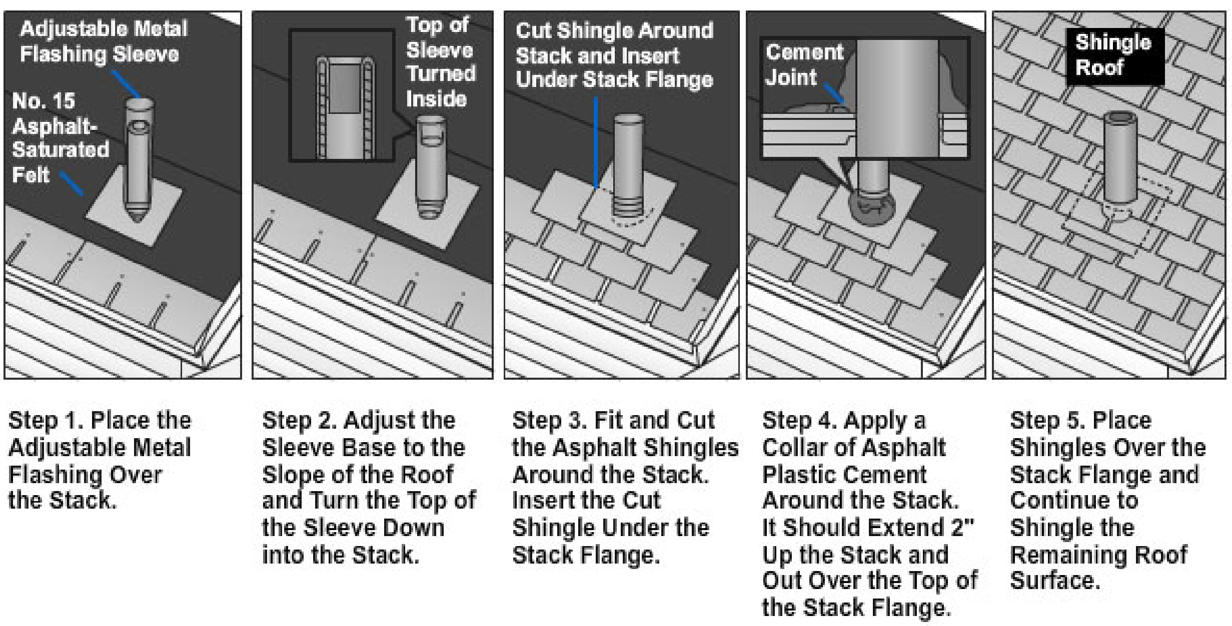


Figure 12-15 – Flashing around a roof projection.

You can use the open or closed method to construct valley flashing. First, apply a valley underlayment strip of 15 pound asphalt saturated felt, 36 inches wide. Center the strip in the valley and secure it with enough nails to hold it in place. Cut the horizontal courses of underlayment to overlap this valley strip a minimum of 6 inches.

Open valleys can be flashed with metal or with 90 pound mineral-surfaced asphalt roll roofing. The color can match or contrast with the roof shingles. Place an 18 inch wide strip of mineral-surfaced roll roofing over the valley underlayment. Center it in the valley with the surfaced side down and the lower edge cut to conform to and be flush with the eave flashing. When it is necessary to splice the material, lay the ends of the upper segments to overlap the lower segments 12 inches and secure them with asphalt plastic cement. This method is shown in *Figure 12-16*. Use only enough nails to hold the strip smoothly in place 1 inch in from each edge.

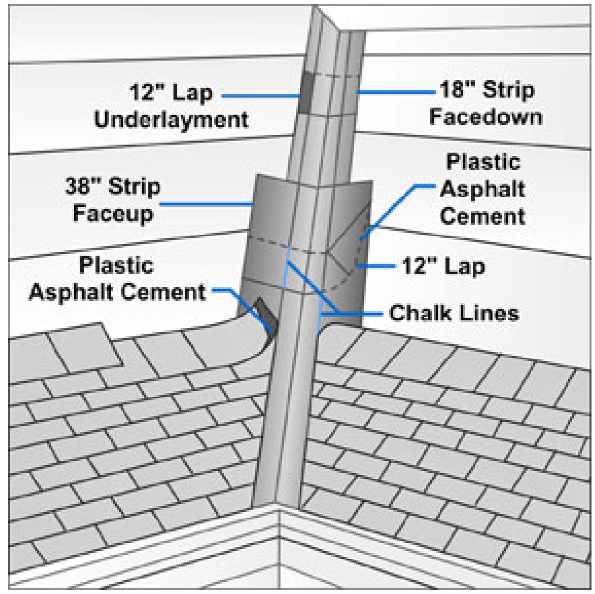


Figure 12-16 – Open valley flashing using roll roofing.

Place another 36 inch wide strip over the first strip. Center it in the valley with the surfaced side up and secure it with nails. Lap it the same way as the underlying 18 inch strip.

Before applying shingles, snap a chalk line on each side of the valley. These lines should start 6 inches apart at the ridge and spread wider apart (at the rate of 1/8 inch per foot) to the eave, as shown in *Figure 12-16*. The chalk lines serve as a guide in trimming the shingle units to fit the valley and ensure a clean, sharp edge. Clip the upper corner of each end shingle to direct water into the valley and prevent water penetration between courses. Cement each shingle to the valley lining with asphalt cement to ensure a tight seal. No exposed nails should appear along the valley flashing.

Closed (woven) valleys can be used only with strip shingles. This method has the advantage of doubling the coverage of the shingles throughout the length of the valley. This increases the weather resistance at this vulnerable point. Place a valley lining made from a 36 inch wide strip of 55 pound or heavier roll roofing over the valley underlayment and center it in the valley, as shown in *Figure 12-17*.

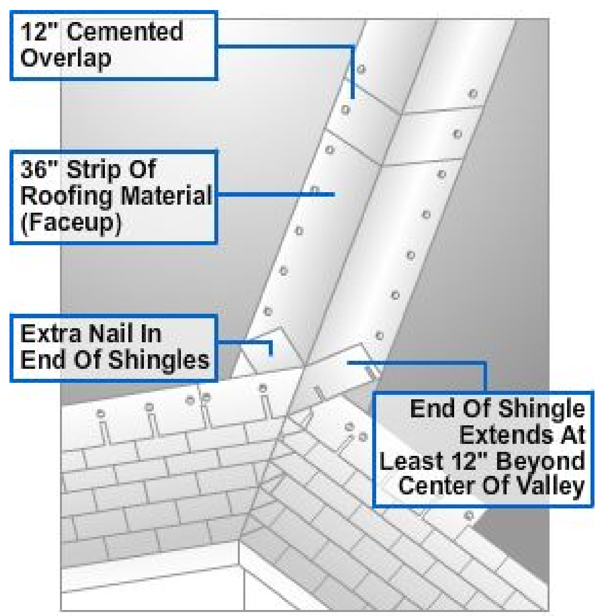


Figure 12-17 – Closed valley flashing.

Lay valley shingles over the lining by either of two methods:

- Apply them on both roof surfaces at the same time, weaving each course, in turn, over the valley.
- Cover each surface to the point approximately 36 inches from the center of the valley and weave the valley shingles in place later.

In either case, lay the first course at the valley along the eaves of one surface over the valley lining and extended along the adjoining roof surface for a distance of at least 12 inches. Then carry the first course of the adjoining roof surface over the valley on top of the previously applied shingle. Succeeding courses are then laid alternately, weaving the valley shingles over each other.

Press the shingles tightly into the valley and nail as usual. Do not locate any nail closer than 6 inches to the valley center line, and use two nails at the end of each terminal strip. As you approach a chimney, apply the shingles over the felt up to the chimney face. If 90 pound roll roofing is used for flashing, cut wood ***cant strips*** and install them above and at the sides of the chimney, as shown in *Figure 12-18*.

Cut the roll roofing flashing to run 10 inches up the chimney. Working from the bottom up, fit metal counterflashing over the base flashing and insert it 1 1/2 inches into the mortar joints. Refill the joints with mortar or roofing cement. Install the counterflashing when the chimney masonry work is done.

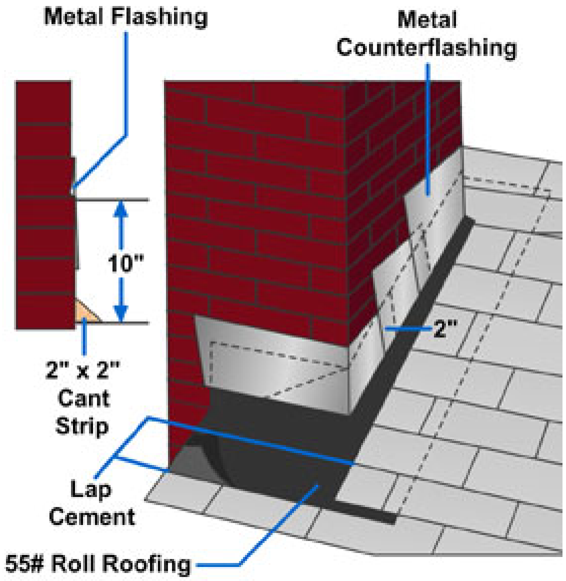


Figure 12-18 – Flashing around a chimney.

Where the roof intersects a vertical wall, install metal flashing shingles. They should be 10 inches long and 2 inches wider than the exposed face of the regular shingles. Bend the 10 inch length so it will extend 5 inches over the roof and 5 inches up the wall, as shown in *Figure 12-19*. Apply metal flashing with each course. This waterproofs the joint between a sloping roof and vertical wall, and is called step flashing.

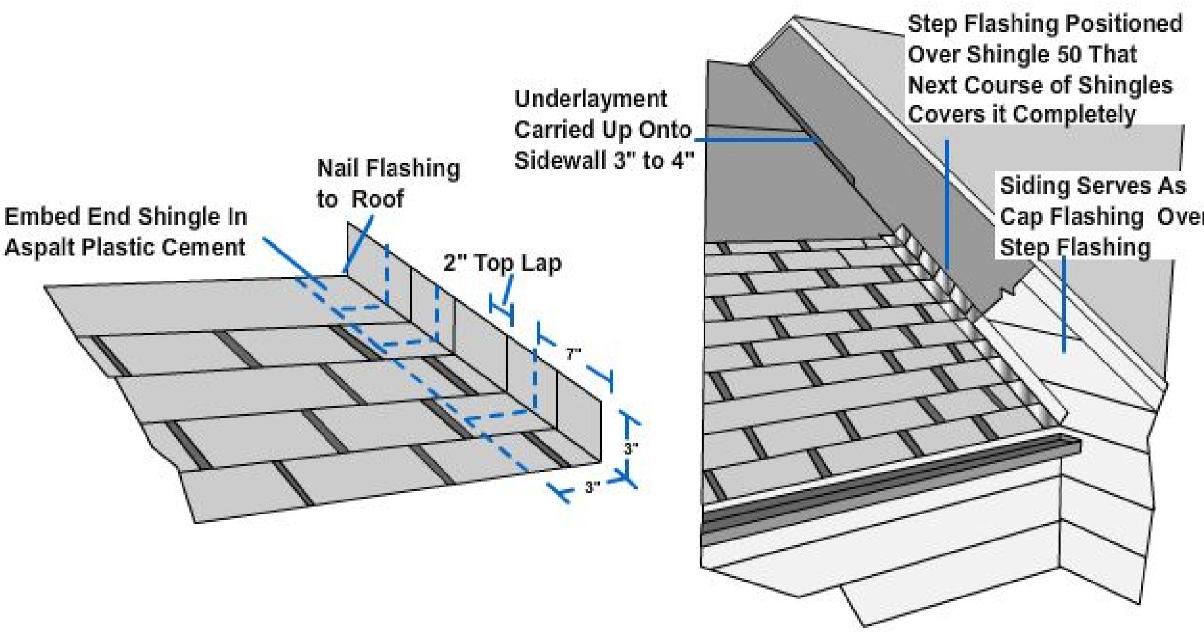


Figure 12-19 – Step flashing.

As each course of shingles is laid, install a metal flashing shingle and nail it at the top edge as shown. Do not nail flashing to the wall; settling of the roof frame could damage the seal. Install wall siding after the roof is completed. It also serves as a cap flashing. Position the siding just above the roof surface. Allow enough clearance to paint the lower edges.

3.2.3 Roof Cements

Roofing cements are used for installing eave flashing, for flashing assemblies, for cementing ***tabs*** of asphalt shingles and laps in sheet material, and for repairing roofs. There are several types of cement, including plastic asphalt cements, lap cements, quick-setting asphalt adhesives, roof coatings, and ***primers***. Follow the recommendation of the shingle roofing manufacturer on the type and quality of materials and methods of application on a shingle roof.

3.2.4 Exterior

Exterior roof treatment consists of applying such products as shingles, roll roofing, tiles, slate, and bituminous coverings. Treatment also includes specific construction considerations for ridges, hips, and valleys.

The two most common shingle types are asphalt and fiberglass, both of which come in various strip shapes.

Asphalt – Asphalt (composition) shingles are available in several patterns. They come in strip form or as individual shingles. The shingles are manufactured on a base of organic felt (cellulose) or an inorganic glass mat. The felt or mat is covered with a mineral-stabilized coating of asphalt on the top and bottom. The top side is coated with mineral granules of specified color. The bottom side is covered with sand, talc, or mica.

Fiberglass – Improved technologies have made the fiberglass mat competitive with organic felt. The weight and thickness of a fiberglass mat is usually less than that of organic felt. A glass fiber mat may be 0.030 inch thick versus 0.055 inch thick for felt. Fiberglass based shingles are popular due to their low cost. The mat does not have to be saturated in asphalt. ASTM standards specify 3 pounds per 100 feet. The combination of glass fiber mats with recently developed resins has significantly lowered the price of composition shingles.

Strip – One of the most common shapes of asphalt or fiberglass shingles is a 12 by 36-inch strip, as shown in *Figure 12-20*, with the exposed surface cut or scored to resemble three 9 by 12 by 2 inch shingles. These are called strip shingles. They are usually laid with 5 inches exposed to the weather. A lap of 2 to 3 inches is usually provided over the upper edge of the shingle in the course directly below. This is called the head lap.

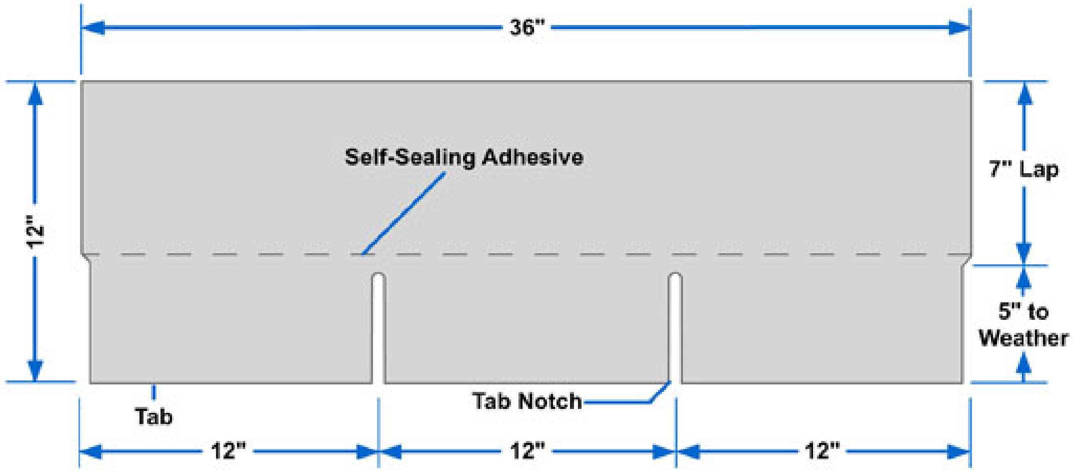


Figure 12-20 – A typical 12 by 36 inch shingle.

The thickness of asphalt shingles may be uniform throughout, or, as with laminated shingles, slotted at the butts to give the illusion of individual units. Strip shingles are produced with either straight tab or random tab design to give the illusion of individual units or to simulate the appearance of wood shakes. Most strip shingles have factory-applied adhesive spaced at intervals along the concealed portion of the strip. These strips of adhesive are activated by the warmth of the sun and hold the shingles firm through wind, rain, and snow.

Strip shingles are usually laid over a single thickness of asphalt saturated felt if the slope of the roof is 4:12 or greater. When special application methods are used, organic or inorganic base saturated or coatedstrip shingles can be applied to decks having a slope of 4:12, but not less than 2:12. *Figure 12-21* shows the application of shingles over a double layer of underlayment. Double underlayment is recommended under square tab strip shingles for slopes less than 4:12.

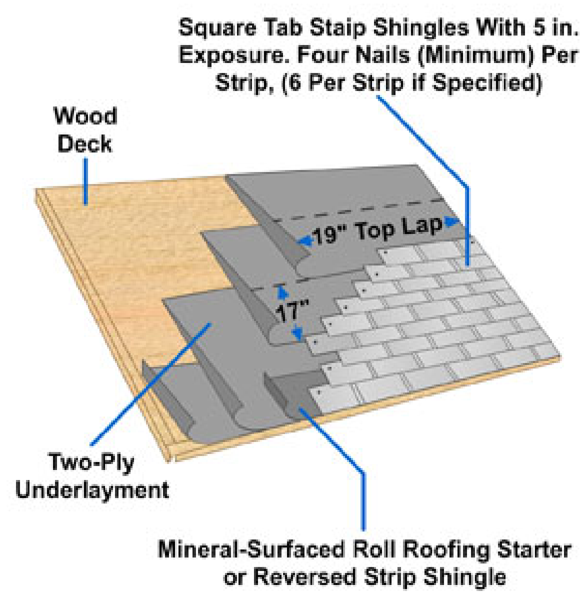


Figure 12-21 – Special shingle application.

When roofing materials are delivered to the building site, handle them with care and protect them from damage. Try to avoid handling asphalt shingles in extreme heat or cold. They are available in bundles that are one third of a square, containing 27 strip shingles per bundle. Store the bundles flat so the strips will not curl after the bundles are open. To get the best performance from any roofing material, always study the manufacturer's directions and install as directed.

On small roofs up to 30 feet long, strip shingles can be laid starting at either end. When the roof surface is over 30 feet long, it is usually best to start at the center and work both ways. Start from a chalk line perpendicular to the eaves and ridge.

Asphalt shingles will vary slightly in length, plus or minus 1/4 inch in a 36 inch strip.

There may also be some variations in width. Thus, chalk lines are required to achieve the proper horizontal and vertical placement of the shingles, as shown in *Figure 12-22*.

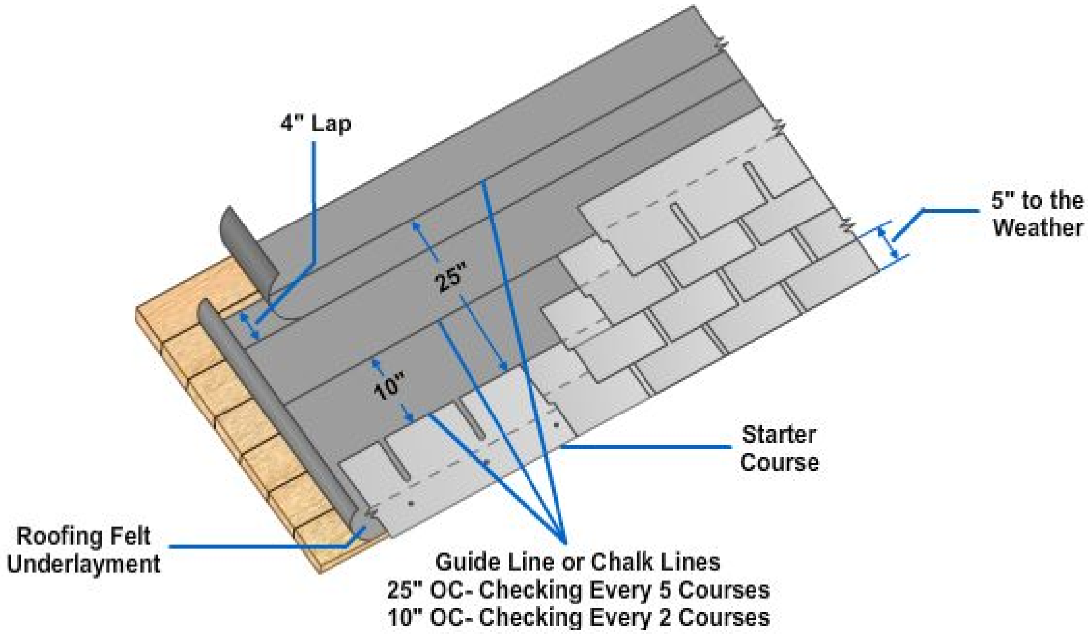


Figure 12-22 – Laying out a shingle roof.

The first chalk line from the eave should allow for the ***starter strip*** and/or the first course of shingles to overhang the drip edge 1/4 to 3/8 inch.

When laying shingles from the center of the roof toward the ends, snap a number of chalk lines between the eaves and ridge. These lines will serve as reference marks for starting each course. Space them according to the shingle type and laying pattern.

Chalk lines parallel to the eaves and ridge will help maintain straight horizontal lines along the butt edge of the shingle. Usually, only about every fifth course needs to be checked if the shingles are skillfully applied. Inexperienced workers may need to set up chalk lines for every second course.

The purpose of a starter strip is to back up the first course of shingles and fill in the space between the tabs. Use a strip of mineral-surfaced roofing 9 inches or wider of a weight and color to match the shingles. Apply the strip so it overhangs the drip edge 1/4 to 3/8 inch above the edge. Space the nails so they will not be exposed at the cutouts between the tabs of the first course of shingles. Sometimes an inverted (tabs to ridge) row of shingles is used instead of the starter strip. When you are laying self sealing strip shingles in windy areas, the starter strip is often formed by cutting off the tabs of the shingles being used. These units are then nailed in place, right side up, and provide adhesive under the tabs of the first course.

Nails used to apply asphalt roofing must have a large head (3/8 to 7/16 inch diameter) and a sharp point.

Figure 12-23 shows standard nail designs for nominal 1 inch sheathing.

Table 12-5 shows recommended nail lengths for nominal 1 inch sheathing. Most manufacturers recommend 12-gauge galvanized steel nails with barbed shanks. Aluminum nails are also used. The length should be sufficient to penetrate the full thickness of the sheathing or 3/4 inch into the wood.

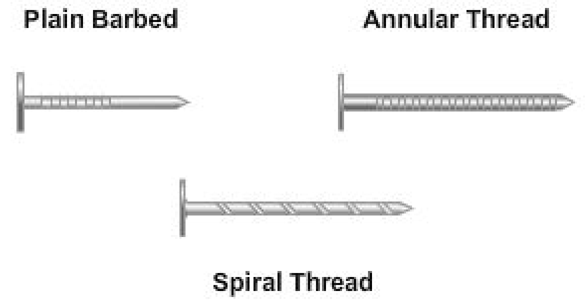


Figure 12-23 – Nails suitable for installing strip shingles.

Table 12-5 – Recommended Nail Lengths for Nominal 1 inch Sheathing.

Application	1" Sheathing	3/8" Plywood
Strip or individual shingle (new construction)	1 1/4"	7/8"
Over asphalt roofing (reroofing)	1 1/2"	1"
Over wood shingles (reroofing)	1 3/4"	–

The number of nails and their correct placement are both vital factors in proper application of roofing material. For three tab square butt shingles, use a minimum of four nails per strip, as shown in *Figure 12-24, view A*. Specifications may require six nails per shingle, as shown in *Figure 12-24, view B*. Align each shingle carefully and start the nailing from the end next to the one previously laid. Proceed across the shingle. This will prevent buckling. Drive nails straight so that the edge of the head will not cut into the shingle. The nail head should be driven flush, not sunk into the surface. If, for some reason, the nail fails to hit solid sheathing, drive another nail in a slightly different location.

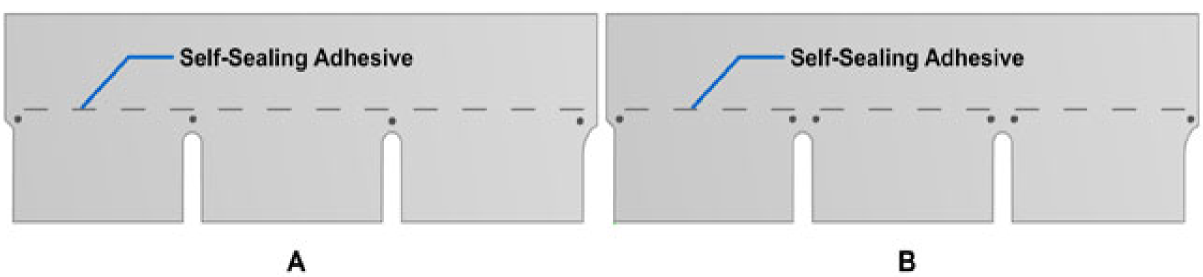


Figure 12-24 – Nail placement for installing strip shingles.

Wood Shingles and Shakes – Wood shingles are available in three standard lengths: 16, 18, and 24 inches. The 16 inch length is the most popular. It has five butt thicknesses per 2 inches of width when it is green (designated a 5/2). These shingles are packed in bundles. Four bundles will cover 100 square feet of wall or roof with 5 inch exposure. The 18 or 24 inch long shingles have thicker butts, five in 2 1/4 inches for the 18 inch shingles and four in 2 inches for 24 inch shingles. The recommended exposures for the standard wood shingle size are shown in *Table 12-6*.

Table 12-6 –Recommended Exposure for Wood Shingles.

Shingle Length	Shingle Thickness (Green)	Maximum Exposure	
		Slope less than 4 in 12	Slope 5 in 12 and over
Inches		Inches	Inches
16	5 butts in 2”	3 3/4	5
18	5 butts in 2 1/4”	4 1/4	5 1/2
24	4 butts in 2”	5 3/4	7 1/2

Figure 12-25 shows the proper method of applying a wood shingle roof. Underlayment or roofing felt is not required for wood shingles except for protection in ice jam areas. Although spaced or solid sheathing is optional, spaced roof sheathing under wood shingles is most common.

Observe the following steps when applying wood shingles:

1. Extend the shingles 1 1/2 inches beyond the eave line and 3/4 inch beyond the rake (gable) edge.

2. Use two rust resistant nails in each shingle. Space them 3/4 inch from the edge and 1 1/2 inches above the butt line of the next course.

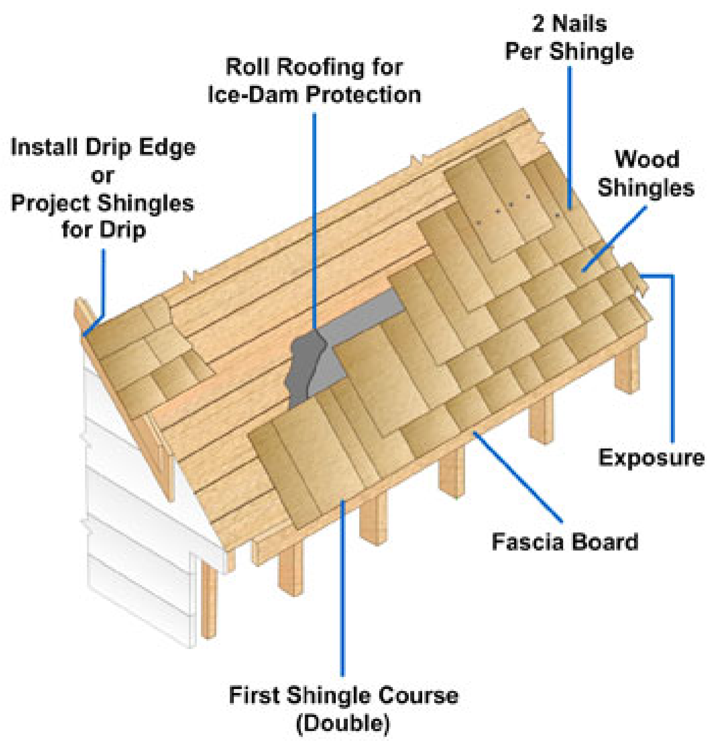


Figure 12-25 – Installation of wood shingles.

3. Double the first course of shingles. In all courses, allow a 1/8 to 1/4 inch space between each shingle for expansion when they are wet. Offset the joints between the shingles at least 1 1/2 inches from the joints in the course below. In addition, space the joints in succeeding courses so that they do not directly line up with joints in the second course below.

4. Where valleys are present, shingle away from them. Select and precut wide valley shingles.

5. Use metal edging along the gable end to aid in guiding the water away from the sidewalls.

6. Use care when nailing wood shingles. Drive the nails just flush with the surface. The wood in shingles is soft and can be easily crushed and damaged under the nail heads.

Wood shakes are usually available in several types, but the split-and-resawed type is the most popular. The sawed face is used as the back face and is laid flat on the roof. The butt thickness of each shake ranges between 3/4 inch and 1 1/2 inches. They are usually packed in bundles of 20 square feet with five bundles to the square.

Wood shakes are applied in much the same way as wood shingles. Because shakes are much thicker (longer shakes have the thicker butts), use long galvanized nails. To create a rustic appearance, lay the butts unevenly. Because shakes are longer than shingles, they have greater exposure. Exposure distance is usually 7 1/2 inches for 18-inch shakes, 10 inches for 24 inch shakes, and 13 inches for 32 inch shakes. Shakes are not smooth on both faces, and because wind driven rain or snow might enter, it is essential to use an underlayment between each course. A layer of felt should be used between each course with the bottom edge positioned above the butt edge of the shakes a distance equal to double the weather exposure. A 36 inch wide strip of the asphalt felt is used at the eave line. Solid sheathing should be used when wood shakes are used for roofs in areas where wind driven snow is common.

Roll Roofing - Roll roofing is made of an organic or inorganic felt saturated with an asphalt coating and has a viscous bituminous coating. Finely ground talc or mica can be applied to both sides of the saturated felt to produce smooth roofing. Mineral granules in a variety of colors are rolled into the upper surface while the final coating is still soft. These mineral granules protect the underlying bitumen from the deteriorating effects of sun rays. The mineral aggregates are nonflammable and increase the fire resistance and improve the appearance of the underlying bitumen. Mineral-surfaced roll roofing comes in weights of 75 to 90 pounds per square. Roll roofing may have one surface completely covered with granules or have a 2 inch plain surface salvage along one side to allow for laps.

Roll roofing can be installed by either exposed or concealed nailing. Exposed nailing is the cheapest but does not last as long. This method uses a 2 inch lap at the side and ends. It is cemented with special cement and nailed with large-headed nails. In concealed nailing installations, the roll roofing is nailed along the top of the strip and cemented with lap cement on the bottom edge. Vertical joints in the roofing are cemented into place after the upper edge is nailed. This method is used when maximum service life is required.

Double coverage roll roofing is produced with slightly more than half its surface covered with granules. This roofing is also known as 19 inch salvage edge. It is applied by nailing and cementing with special adhesives or hot asphalt. Each sheet is lapped 19 inches, blind nailed in the lapped salvage portion, and then cemented to the sheet below. End laps are cemented into place.

Tiles – Roofing tile was originally a thin, solid unit made by shaping moist clay in molds and drying it in the sun or in a kiln. Gradually, the term has come to include a variety of tile-shaped units made of clay, Portland cement, and other materials. Tile designs have come down to us relatively unchanged from the Greeks and Remans. Roofing tiles are durable, attractive, and resistant to fire; however, because of their weight, listed in Table *12-7*, they usually require additional structural framing members and heavier roof decks.

Table 12-7 – Weight of Roofing Materials.

Material	LB Weight/Square (100 square feet)	KG Weight/Square (9.29 m^2)
Tin	100	45
Roll roofing	100	45
Asphalt shingles	130-320	59-145
Copper	150	68
Corrugated iron	200	91
Wood shingles	300	136
Asbestos cement shingles	500	227
Portland cement shingles	500-900	227-408
Built-up roof	600	272
Sheet lead	600-800	272-363
Slate		
1/4"	700	318
3/8"	1,000	454
3/4"	1,500	680
Flat clay tile	1,200	544
Clay shingles	1,100-1,400	499-635
Spanish clay tile	1,900	862
laid in mortar	2,900	1,315

Clay – The clays used in the manufacture of roofing tile are similar to those used for brick. Unglazed tile comes in a variety of shades, from a yellow orange to a deep red, and in blends of grays and greens. Highly glazed tiles are often used on prominent buildings and for landmark purposes.

Clay roofing tiles are produced as either flat or roll tile. Flat tile may be English (interlocking shingle) or French. Roll tiles are produced in Greek or Roman pan and cover, and Mission or Spanish style, as shown in *Figure 12-26*.

Roll Tile – Roll tile is usually installed over two layers of hot mopped 15 pound felt. Double coverage felts, laid shingle fashion, lapped 19 inches, and mopped with hot asphalt, may be required as an underlayment. The individual tiles are nailed to the sheathing through prepunched holes. Special shapes are available for starter courses, rakes, hips, and ridges. Some manufacturers produce tiles in special tile and half units for exposed locations, such as gables and hips.

Mission Tile – Mission tiles are slightly tapered half round units and are set in horizontal courses. The convex and concave sides are alternated to form pans and covers. The bottom edges of the covers can be laid with a random exposure of 6 to 14 inches to weather. Mission tile can be fastened to the prepared roof deck with copper nails, copper wire, or specially designed brass strips. The covers can be set in Portland cement mortar. This gives the roof a rustic appearance, but it adds approximately 10 pounds per square to the weight of the finished roof.

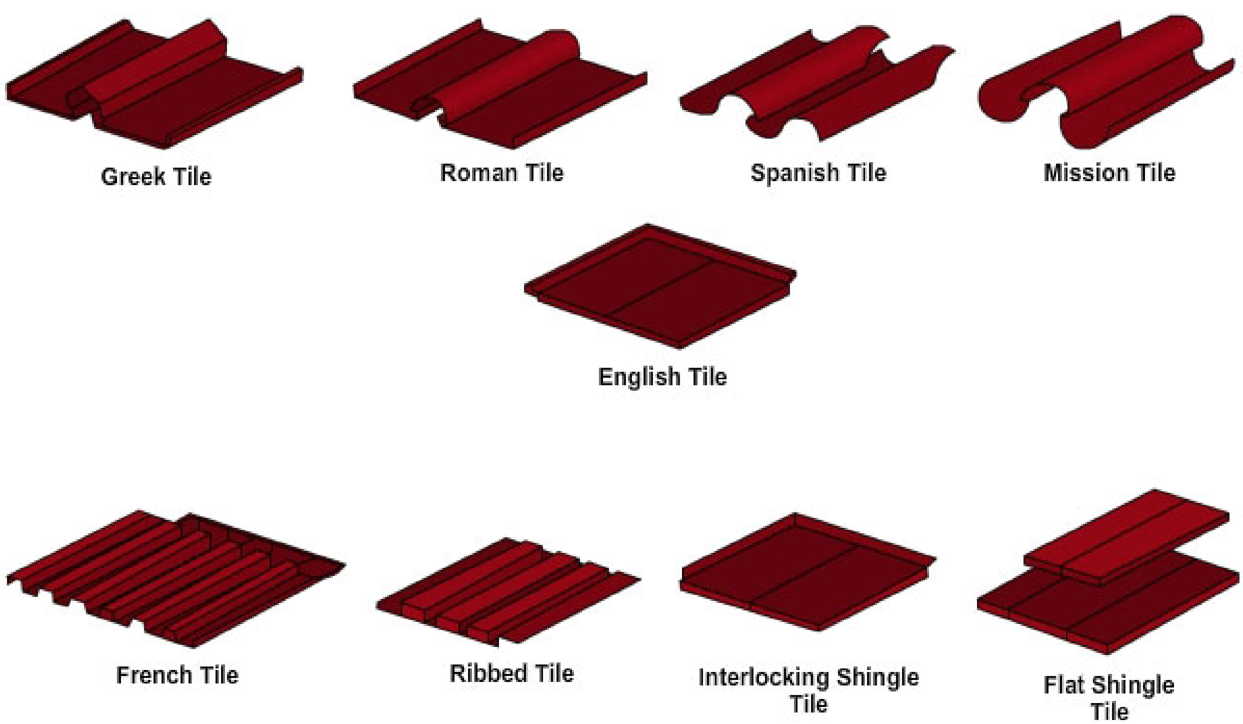


Figure 12-26 – Types of clay roof tiles.

Flat Tile – Flat tile can be obtained as either flat shingle or interlocking. Single tiles are butted at the sides and lapped shingle fashion. They are produced in various widths from 5 to 8 inches with a textured surface to resemble wood shingles, with smooth colored surfaces or with highly glazed surfaces. Interlocking shingle tiles have side and top locks, which permits the use of fewer pieces per square. The back of this type of tile is ribbed. This reduces the weight without sacrificing strength. Interlocking flat tile can be used in combination with lines of Greek pan and cover tile as accents.

Concrete – The acceptance of concrete tile as a roofing material has been slow in the United States. European manufacturers have invested heavily in research and development to produce a uniformly high quality product at a reasonable cost. Concrete tile is now used on more than 80 percent of all new residences in Great Britain. Modern high speed machinery and techniques have revolutionized the industry in the United States, and American-made concrete tiles are now finding a wide market, particularly in the West.

Concrete roof tile, made of Portland cement, sand, and water, is incombustible. It is also a poor conductor of heat. These characteristics make it an ideal roofing material in forested or brushy areas subject to periodic threats of fire. In addition, concrete actually gains strength with age and is unaffected by repeated freezing and thawing cycles.

Color pigments may be mixed with the basic ingredients during manufacture. To provide a glazed surface, cementitious mineral oxide pigments are sprayed on the tile immediately after it is extruded. This glaze becomes an integral part of the tile. The surface of these tiles may be scored to give the appearance of rustic wood shakes.

Most concrete tiles are formed with side laps consisting of a series of interlocking ribs and grooves. These are designed to restrict lateral movement and provide weather checks between the tiles. The underside of the tile usually contains weather checks to halt wind blown water. Head locks, in the form of lugs, overlap wood battens roiled to solid sheathing or strips of spaced sheathing. Nail holes are prepunched. The most common size of concrete tile is 12 3/8 by 17 inches. This provides for maximum coverage with minimum lapping.

Concrete tiles are designed for minimum roof slopes of 2 1/2:12. For slopes up to 3 1/2:12, roof decks are solidly sheeted and covered with roofing felt. For slopes greater than 3 1/2:12, the roof sheathing can be spaced. Roofing felt is placed between each row to carry any drainage to the surface of the next lower course of tile. The lugs at the top of the tiles lock over the sheathing or stripping. Generally, only every fourth tile in every fourth row is nailed to the sheathing, except where roofs are exposed to extreme winds or earthquake conditions. The weight of the tile holds it in place.

Lightweight concrete tile is now being produced using fiberglass reinforcing and a lightweight perlite aggregate. These tiles come in several colors and have the appearance of heavy cedar shakes. The weight of these shingles is similar to that of natural cedar shakes, so roof reinforcing is usually unnecessary.

Slate – Slate roofing is hand split from natural rock. It varies in color from black through blue-gray, gray, purple, red, and green. The individual slates may have one or more darker streaks running across them. These are usually covered during the laying of the slate. Most slate roofing is available in sizes from 10 by 6 to 26 by 14 inches. The standard thickness is 3/16 inch, but thicknesses of 1/4, 3/8, 1/2, and up to 2 inches can be obtained. Slate may be furnished in a uniform size or in random widths. The surface may be left with the rough hand split texture or ground to a smoother texture.

The weight of a slate roof ranges from 700 to 1,500 pounds per square, depending upon thickness. The size of framing members supporting a slate roof must be checked against the weight of the slate and the method of laying. The type of underlayment used for a slate roof varies, depending on local codes. The requirement ranges from one layer of 15 pound asphalt saturated felt to 65 pound rolled asphalt roofing for slate over 3/4 inch thick.

Slate is usually laid like shingles, with each course lapping the second course below at least 3 inches. The slates can be laid in even rows or at random. Each slate is predrilled with two nail holes and is held in place with two large headed slaters' nails. These are made of hard copper wire, cut copper, or cut brass. On hips, ridges, and in other locations where nailing is not possible, the slates are held in place with waterproof elastic slaters' cement colored to match the slate. Exposed nail heads are covered with the same cement.

Bitumens – Hot bituminous compounds (bitumens) are used with several types of roofing systems. Both asphalt and coal tar pitch are bitumens. Although these two materials are similar in appearance, they have different characteristics. Asphalt is usually a product of the distillation of petroleum, whereas coal tar pitch is a byproduct of the coking process in the manufacture of steel.

Some asphalts are naturally occurring or are found in combination with porous rock. Most roofing asphalts are manufactured from petroleum crudes from which the lighter fractions have been removed. Roofing asphalts are available in a number of different grades for different roof slopes, climatic conditions, or installation methods.

Roofing asphalts are graded on the basis of their softening points, which range from a low of 135°F (57.2°C) to a high of 225°F (107.2°C). The softening point is not the point at which the asphalt begins to flow, but is determined by test procedures established by the ASTM. Asphalts begin to flow at somewhat lower temperatures than their softening points, depending on the slope involved and the weight of the asphalt and surfacing material.

Generally, the lower the softening point of an asphalt, the better its self sealing properties and the less tendency it has to crack. Dead flat roofs, where water may stand, or nearly flat roofs require an asphalt that has the greatest waterproofing qualities and the self sealing properties of low softening asphalts. A special asphalt known as dead flat asphalt is used in such cases. As the slope of the roof increases, the need for waterproofing is lessened, and an asphalt that will not flow at expected normal temperatures must be used. For steeper roofing surfaces, asphalt with a softening point of 185°F to 205°F (85°C to 96.1°C) is used. This material is classed as steep asphalt. In hot, dry climates only the high temperature asphalts can be used.

The softening point of coal tar pitch generally ranges from 140°F to 155°F (60.0°C to 68.3°C). The softening point of coal tar pitch limits its usefulness; however, it has been used successfully for years in the eastern and middle western parts of the United States on ***dead level*** or nearly level roofs. In the southwest, where roof surfaces often reach temperatures of 126°F to 147°F (52.2°C to 63.9°C) in the hot desert sun, the low softening point of coal tar pitch makes it unsuitable as a roof surfacing material.

When used within its limitations on flat and low pitched roofs in suitable climates, coal tar pitch provides one of the most durable roofing ***membranes***. Coal tar pitch is also reputed to have cold flow, or self sealing, qualities. This is because the molecular structure of pitch is such that individual molecules have a physical attraction for each other, so self sealing is not dependent on heat. Coal tar pitch roofs are entirely unaffected by water. When covered by mineral aggregate, standing water may actually protect the volatile oils.

Test your Knowledge (Select the Correct Response)

2. What term is used for the area of a shingle that is not overlapped?

   A. Top lap
   B. Exposure
   C. Square
   D. Coverage

3.2.5 Construction Considerations

Laying roofing on a flat surface is a relatively easy procedure. Correctly applying materials to irregular surfaces, such as ridges, hips, and valleys, is somewhat more complex.

Ridge – The most common type of ridge and hip finish for wood and asphalt shingles is the Boston ridge. Asphalt shingle squares (one third of a 12 by 36-inch strip) are used over the ridge and blind nailed, as shown in *Figure 12-27*. Each shingle is lapped 5 to 6 inches to give double coverage. In areas where driving rains occur, use metal flashing under the shingle ridge to help prevent seepage. The use of a ribbon of asphalt roofing cement under each lap will also help.

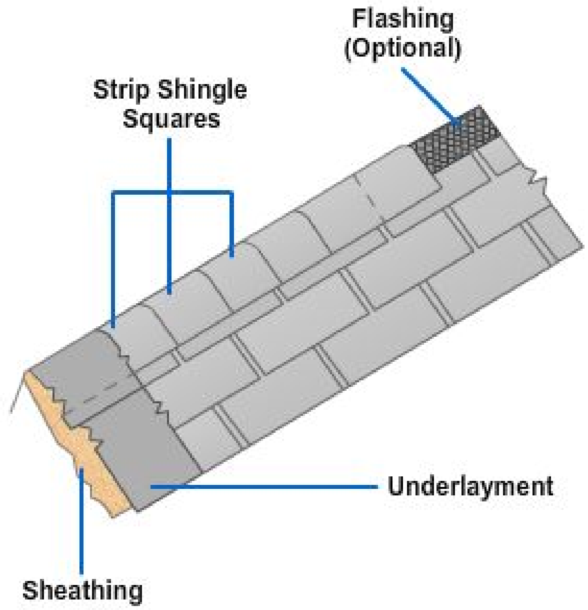


Figure 12-27 – Finish at the ridge - Boston ridge with strip shingles.

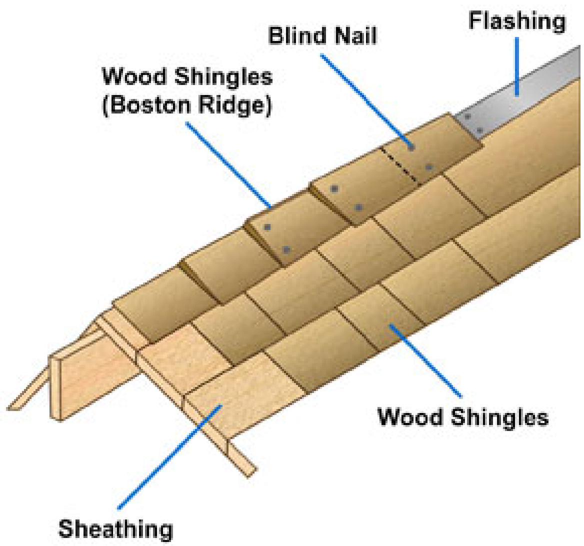


Figure 12-28 – Finish at the ridge - Boston ridge with wood shingles.

A wood shingle roof should be finished with a Boston ridge, shown in *Figure 12-28.* Six inch wide shingles are altemately lapped, fitted, and blindnailed. As shown, the shingles are nailed in place so that the exposed trimmed edges are alternately lapped. Reassembled hip and ridge units for wood shingle roofs are available and save both time and money.

A metal ridge can also be used on asphalt shingle or wood shingle roofs, as shown in *Figure 12-29*. This ridge is formed to the roof slope and should be copper, galvanized iron, or aluminum. Some metal ridges are formed so that they provide an outlet ventilating area. However, the design should be such that it prevents rain or snow from blowing in.

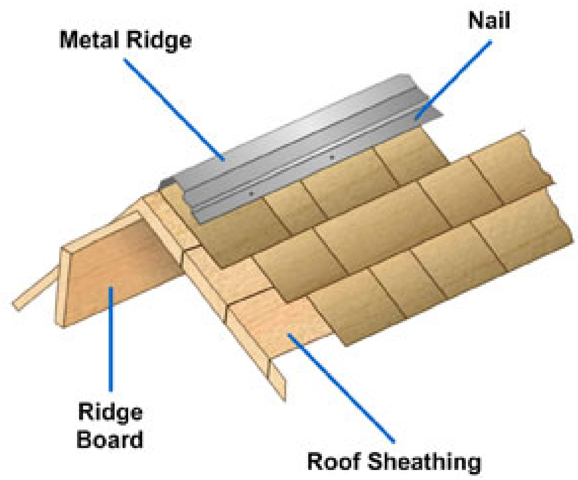


Figure 12-29 – Finish at the ridge – metal ridge.

Hips and Valleys – One side of a hip or valley shingle must be cut at an angle to obtain an edge that will match the line of the hip or valley rafter. One way to cut these shingles is to use a pattern. First, select a 3 foot long 1 by 6. Determine the unit length of a common rafter in the roof if you do not already know it. Set the framing square on the piece to get the unit run of the common rafter on the blade and the unit rise of the common rafter on the tongue, as shown in *Figure 12-30*. Draw a line along the tongue; then saw the pattern along this line. Note: The line cannot be used as a pattern to cut a hip or valley.

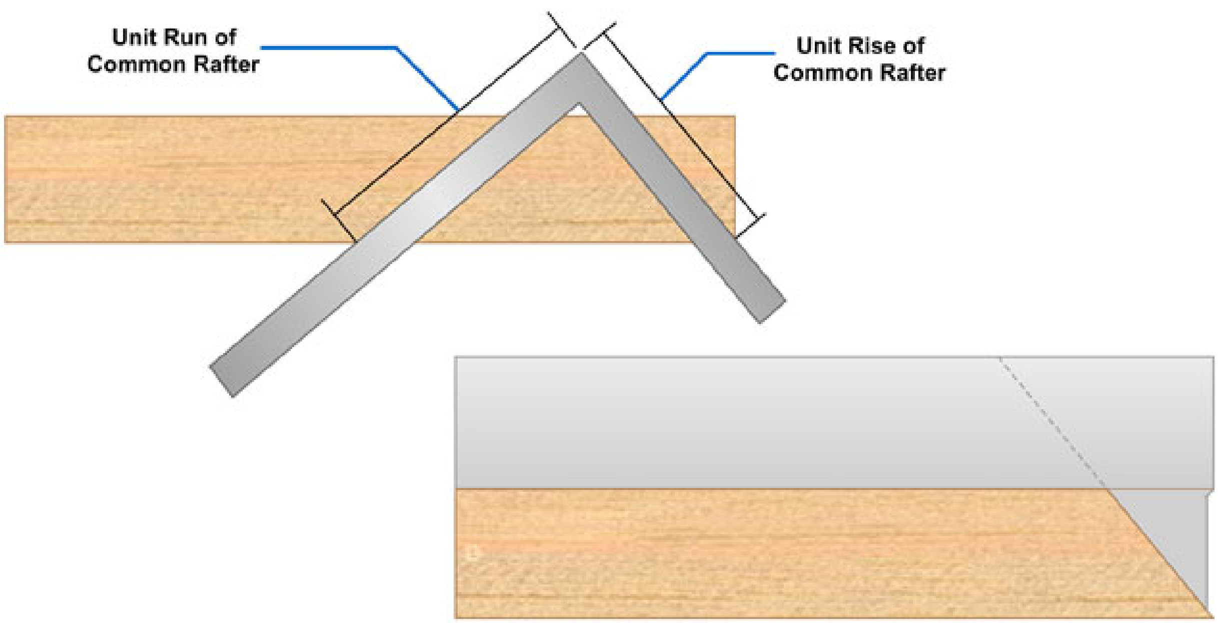


Figure 12-30 - Layout pattern for hip and valley shingles.

3.2.6 Built Up Roofing

A built up roof, as the name indicates, is built up in alternate plies of roofing felt and bitumen. The bitumen forms a seamless, waterproof, flexible membrane that conforms to the surface of the roof deck and protects all angles formed by the roof deck and projecting surfaces. Without the reinforcement of the felts, the bitumens would crack and alligator, and thus lose their volatile oils under solar radiation.

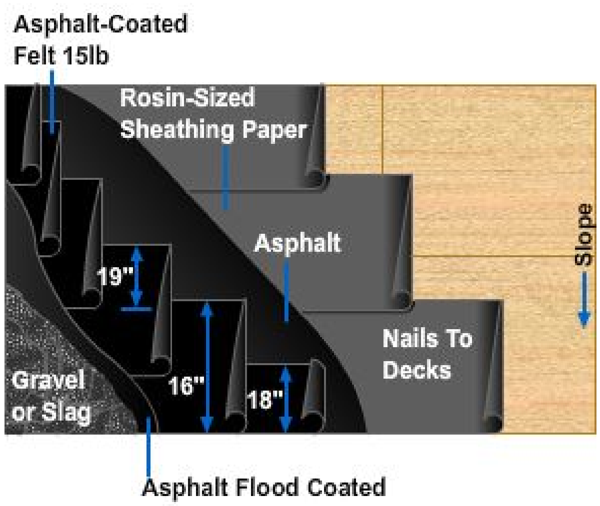


Figure 12-31 – Three ply built up roof over a nailable deck.

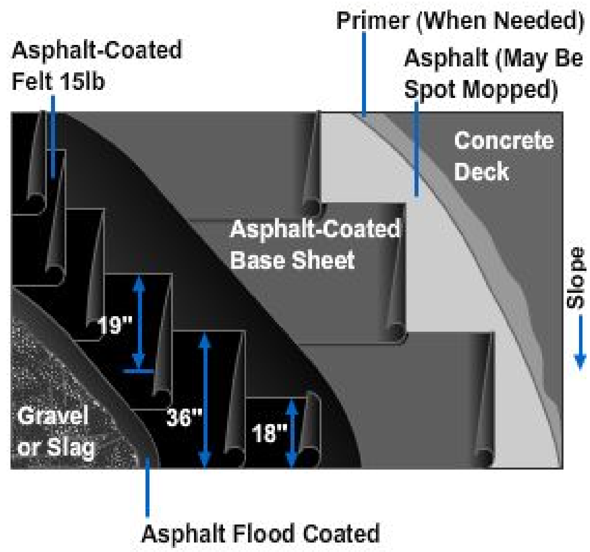


Figure 12-32 – Three ply built up roof over a non-nailable deck.

Application of Bitumens – The method of applying roofing depends on the type of roof deck. Some roof decks are nailable and others are not. Nailable decks include such materials as wood or fiberboard, poured or precast units of gypsum, and nailable lightweight concrete. Non nailable decks of concrete or steel require different techniques of roofing. *Figure 12-31* shows a three ply built up roof over a nailable deck, with a gravel or ***slag*** surface.

Figure 12-32 shows a three ply built up roof over a non nailable deck with a gravel or slag surface.

Figure 12-33 shows a four ply built up roof over insulation, with a gravel or slag surface.

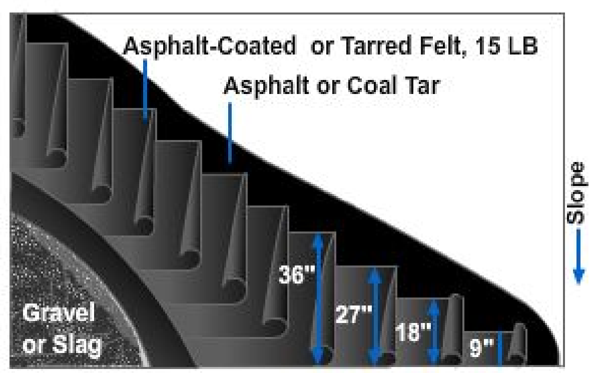


Figure 12-33 – Four ply built up roof over insulation.

The temperatures at which bitumens are applied are very critical. At high temperatures, asphalt is seriously damaged and its life considerably shortened. Heating asphalt to over 500°F (260°C) for a prolonged period may decrease the weather life by as much as 50 percent. Coal tar pitch should not be heated above 400°F (204°C). Asphalt should be applied to the roof at an approximate temperature of 375°F to 425°F (190.6°C to 218.3°C), and coal tar pitch should be applied at 275°F to 375°F (135°C to 190°C).

Bitumens are spread between felts at rates of 25 to 35 pounds per square, depending on the type of ply or roofing felt. An asphalt primer must be used over concrete before the hot asphalt is applied. It usually is unnecessary to apply a primer under coal tar pitch. With wood and other types of nailable decks, the ply is nailed to the deck to seal the joints between the units and prevent dripping of the bitumens through the deck.

Built up roofs are classed by the number of plies of felt that is used in their construction. The roof may be three ply, four ply, or five ply, depending on whether the roofing material can be nailed to the deck, or whether insulation is to be applied underneath it, as well as on the type of surfacing desired, the slope of the deck, the climatic conditions, and the life expectancy of the roofing. The ply and bitumen membrane of a built up roof must form a flexible covering that has sufficient strength to withstand normal structure expansion. Most built up roofs have a surfacing over the last felt ply. This protective surfacing can be applied in several ways.

Surfacing – ***Glaze coat*** and gravel surfaces are the most commonly seen bituminous roofs.

Glaze Coat – A coat of asphalt can be flooded over the top layer of felt. This glaze coat protects the top layer of felt from the rays of the sun. The glaze coat is black, but it may be coated with white or aluminum surfacing to provide a reflective surface.

Gravel – A ***flood coat*** of bitumen (60 pounds of asphalt or 70 pounds of coal tar pitch per square) is applied over the top ply. Then a layer of aggregate, such as rock, gravel, slag, or ceramic granules, is applied while the flood coat is still hot. The gravel weighs approximately 400 pounds per square and the slag 325 pounds per square. Other aggregates would be applied at a rate consistent with their weight and opacity. The surface aggregate protects the bitumen from the sun and provides a fire resistant coating.

3.2.7 Cap Sheets

A cap sheet surface is similar to gravel-surfaced roofings, except that a mineral surface is used in place of the flood coat and job applied gravel. Cap sheet roofing consists of heavy roofing felts (75 to 105 pounds per square) of organic or glass fibers. Mineral-surfaced cap sheets are coated on both sides with asphalt and surfaced on the exposed side with mineral granules, mica, or similar materials. The cap sheets are applied with a 2 inch lap for single ply construction or a 19 inch lap if two ply construction is desired. The mineral surfacing is omitted on the portion that is lapped. The cap sheets are laid in hot asphalt along with the ***base sheet***. Cap sheets are used on slopes between 1/2: 12 and 6:12 where weather is moderate.

3.2.8 Cold Process Roofing

Cold applied ***emulsions***, cutback asphalts, or patented products can be applied over the top ply of a hot mopped roof or as an adhesive between plies. If emulsified asphalt is to be used as art adhesive between plies, special plies such as glass fiber must be used that are sufficiently porous to allow vapors to escape. Decorative and reflective coatings with asphalt emulsion bases have been developed to protect and decorate roofing.

3.2.9 Drainage

When required, positive drainage should be established before the installation of built up roofing. This can be achieved by the use of lightweight concrete or roofing insulation placed as specified with slopes toward roof drains, gutters, or scuppers.

3.2.10 Application Procedures

Built up roofing consists of several layers of tar rag felt, asphalt rag felt, or asphalt asbestos felt set in a hot ***binder*** of melted pitch or asphalt.

Each layer of built up roofing is called a ply. In a five ply roof, the first two layers are laid without a binder; these are called the dry nailers. Before the nailers are nailed in place, a layer of building paper is tacked down to the roof sheathing.

A built up roof, like a shingled roof, is started at the eaves so the strips will overlap in the direction of the watershed. *Figure 12-34* shows how 32 inch building paper is laid over a wood sheathing roof to get five ply coverage at all points in the roof.

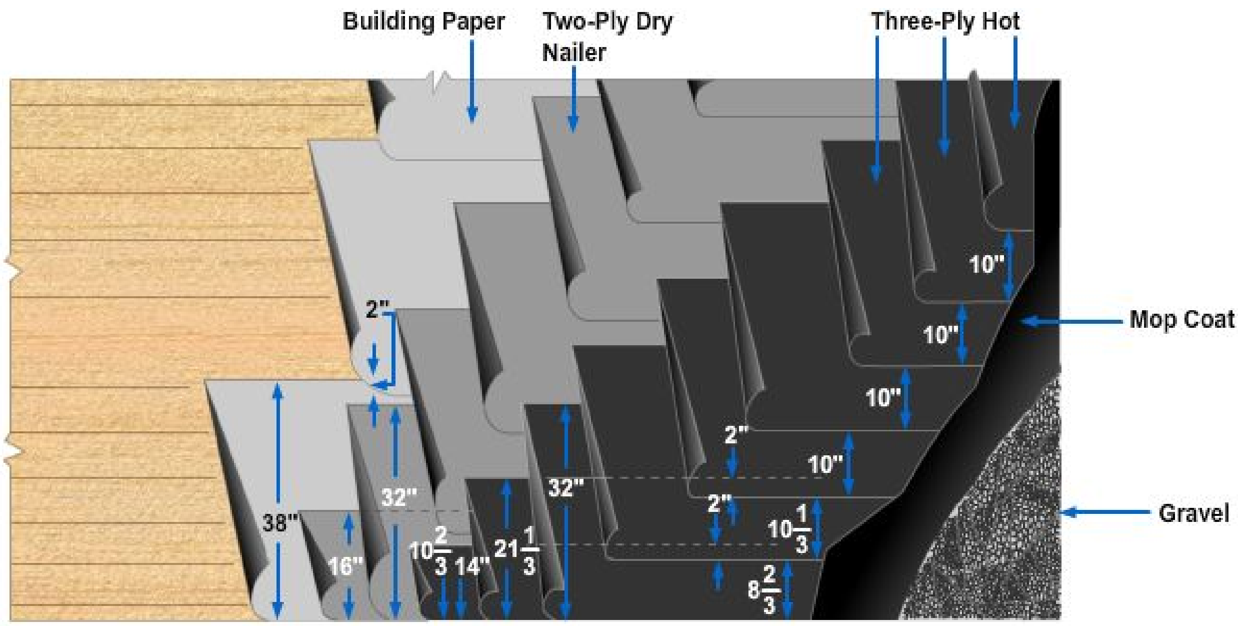


Figure 12-34 – Laying a five ply built up roof.

There are seven basic steps to the process.

1. Lay the building paper with a 2 inch overlap. Spot nail it down just enough to keep it from blowing away.
2. Cut a 16 inch strip of saturated felt and lay it along the eaves. Nail it down with nails placed 1 inch from the back edge and spaced 12 inches OC.
3. Nail a full width (32 inch) strip over the first strip, using the same nailing schedule.
4. Nail the next full width strip with the outer edge 14 inches from the outer edges of the first two strips to obtain a 2 inch overlap over the edge of the first strip laid.

Continue laying full width strips with the same exposure (14 inches) until the opposite edge of the roof is reached. Finish off with a half strip along this edge. This completes the two ply dry nailer.

5. Start the three ply hot with one third of a strip, covered by two thirds of a strip, and then by a full strip, as shown. To obtain a 2 inch overlap of the outer edge of the second full strip over the inner edge of the first strip laid, you must position the outer edge of the second full strip 8 2/3 inches from the outer edges of the first three strips. To maintain the same overlap, lay the outer edge of the third full strip 10 1/3 inches from the outer edge of the second full strip. Subsequent strips can be laid with an exposure of 10 inches. Finish off at the opposite edge of the roof with a full strip, two thirds of a strip, and one third of a strip to maintain three plies throughout.
6. Spread a layer of hot asphalt, the flood coat, over the entire roof.
7. Sprinkle a layer of gravel, crushed stone, or slag over the entire roof.

Melt the binder and maintain it at the proper temperature in a pressure fuel kettle. Make sure the kettle is suitably located. Position it broadside to the wind, if possible. The kettle must be set up and kept level. If it is not level, it will heat unevenly, creating a hazard. The first duty of the kettle operator is to inspect the kettle, especially to ensure that it is perfectly dry. Any accumulation of water inside will turn to steam when the kettle gets hot. This can cause the hot binder to bubble over, which creates a serious fire hazard. Detailed procedures for lighting off, operating, servicing, and maintaining the kettle is given in the manufacturer's manual. Never operate the kettle unattended, while the trailer is in transit, or in a confined area.

The kettle operator must maintain the binder at a steady temperature, as indicated by the temperature gauge on the kettle. Correct temperature is designated in the binder manufacturer's specifications. For asphalt, it is about 400°F. The best way to keep an even temperature is to add material at the same rate as melted material is tapped off. Pieces must not be thrown into the melted mass, but placed on the surface, pushed under slowly, and then released. If the material is not being steadily tapped off, it may eventually overheat, even with the ***burner*** flame at the lowest possible level. In that case, the burner should be withdrawn from the kettle and placed on the ground to be reinserted when the temperature falls. Prolonged overheating causes flashing and impairs the quality of the binder.

Asphalt or pitch must not be allowed to accumulate on the exterior of the kettle because it creates a fire hazard. If the kettle catches fire, close the lid immediately, shut off the pressure and burner valves, and, if possible, remove the burner from the kettle. Never attempt to extinguish a kettle fire with water. Use sand, dirt, or a chemical fire extinguisher.

A hot roofing crew consists of a mopper and as many felt layers, broomers, nailers, and carriers as the size of the roof requires. The mopper is in charge of the roofing crew. It is the mopper's personal responsibility to mop on only binder that is at the proper temperature. Binder that is too hot will burn the felt, and the layer it makes will be too thin. A layer that is too thin will eventually crack and the felt may separate from the binder. Binder that is too cold goes on too thick so more material is used than is required.

The felt layer must get the felt down as soon as possible after the binder has been placed. If the interval between ***mopping*** and felt laying is too long, the binder will cool to the point where it will not bond well with the felt. The felt layer should follow the mopper at an interval of not more than 3 feet. The broomer should follow immediately behind the felt layer, ***brooming*** out all air bubbles and embedding the felt solidly in the binder.

Buckets of hot binder should never be filled more than three-fourths full, and they should never be carried any faster than a walk. Whenever possible, the mopper should work downwind from the felt layer and broomer to reduce the danger of spattering. The mopper must take every precaution against spattering at all times. The mopper should lift the mop out of the bucket, not drag it across the rim. Dragging the mop over the rim may upset the bucket, and the hot binder may quickly spread to the feet, or worse still to the knees, of nearby members of the roofing crew.

4.0.0 EXTERIOR WALL COVERINGS

In this section, we will continue our discussion of exterior finishing. We will examine the exterior finishing of walls, including exterior doors, windows, and glass.

Because siding and other types of exterior wall covering affect the appearance and the maintenance of a structure, the material and pattern should be selected carefully. Wood siding can be obtained in many different patterns and can be finished naturally, stained, or painted. Wood shingles, plywood, wood siding (paneling), fiberboard, and hardboard are some of the types of material used as exterior coverings. Masonry, veneers, metal or plastic siding, and other nonwood materials are additional choices. Many prefinished sidings are available, and the coatings and films applied to several types of base materials may eliminate the need of refinishing for many years.

4.1.0 Wood Siding

One of the materials most used for structure exteriors is wood siding. The essential properties required for siding are good painting characteristics, easy working qualities, and freedom from warp. Such properties are present to a high degree in cedar, eastern white pine, sugar pine, western white pine, cypress, and redwood; to a good degree in western hemlock, spruce, and yellow popular; and to a fair degree in Douglas fir and yellow pine.

4.1.1 Material

The material used for exterior siding that is to be painted should be of a high grade and free from knots, pitch pockets, and uneven edges. Vertical grain and mixed grain (both vertical and flat) are available in some species, such as redwood and western red cedar. The moisture content at the time of application should be the same as what it will attain in service. To minimize seasonal movement due to changes in moisture content, choose vertical grain (edge grain) siding. While this is not as important for a stained finish, the use of edge grain siding for a paint finish will result in longer paint life. A 3-minute dip in a water repellent preservative before siding is installed will result in longer paint life and resist moisture entry and decay. Some manufacturers supply siding with this treatment. Freshly cut ends should be brush treated on the job.

4.1.2 Patterns

Some wood siding patterns are used only horizontally and others only vertically. Some may be used in either manner if adequate nailing areas are provided. A description of each of the general types of horizontal siding follows.

Plain Bevel – Plain bevel siding, shown in *Figure 12-34*, is available in sizes from 1/2 by 4 inches to 1/2 by 8 inches and also in sizes of 3/4 by 8 inches and 3/4 by 10 inches. Anzac siding is 3/4 by 12 inches in size. Usually the finished width of bevel siding is about one half inch less than the size listed. One side of beveled siding has a smooth planed surface, whereas the other has a rough resawn surface. For a stained finish, the rough or sawn side is exposed because wood stain works best and lasts longer on rough wood surfaces.

Dolly Varden – Dolly Varden siding is similar to true bevel siding except that it has shiplap edges. The shiplap edges have a constant exposure distance, as shown in *Figure 12-34.* Because it lies flat against the studs, it is sometimes used for garages and similar buildings without sheathing. Diagonal bracing is needed to stiffen the building and help the structure withstand strong winds and other twist and strain forces.

Drop Siding – Regular drop siding can be obtained in several patterns, two of which are shown in *Figure12-34*. This siding, with matched or shiplap edges, is available in 1 by 6 inch and 1 by 8 inch sizes. It is commonly used for low cost dwellings and for garages, usually without sheathing. Tests have shown that the tongue and groove (matched) patterns have greater resistance to the penetration of wind driven rain than the shiplap patterns, when both are treated with a water repellent preservative.

4.1.3 Fiberboard and Hardboard

Fiberboard and hardboard sidings are also available in various forms. Some have a backing to provide rigidity and strength, whereas others are used directly over sheathing. Plywood horizontal lap siding, with a medium density overlaid surface, is also available as an exterior covering material. It is usually 3/8 inch thick and 12 or 16 inches wide. It is applied in much the same manner as wood siding, except that a shingle wedge is used behind each vertical joint.

A number of siding or paneling patterns can be used horizontally or vertically, as shown in *Figure 12-35*. These are manufactured in nominal 1 inch thicknesses and in widths from 4 to 12 inches. Both ***dressed and matched*** and ***shiplapped*** edges are available. The narrow and medium width patterns are usually more satisfactory under moderate moisture content changes. Wide patterns are more successful if they are vertical grained to keep shrinkage to a minimum. The correct moisture content is necessary in tongue and groove material to prevent shrinkage and tongue exposure.

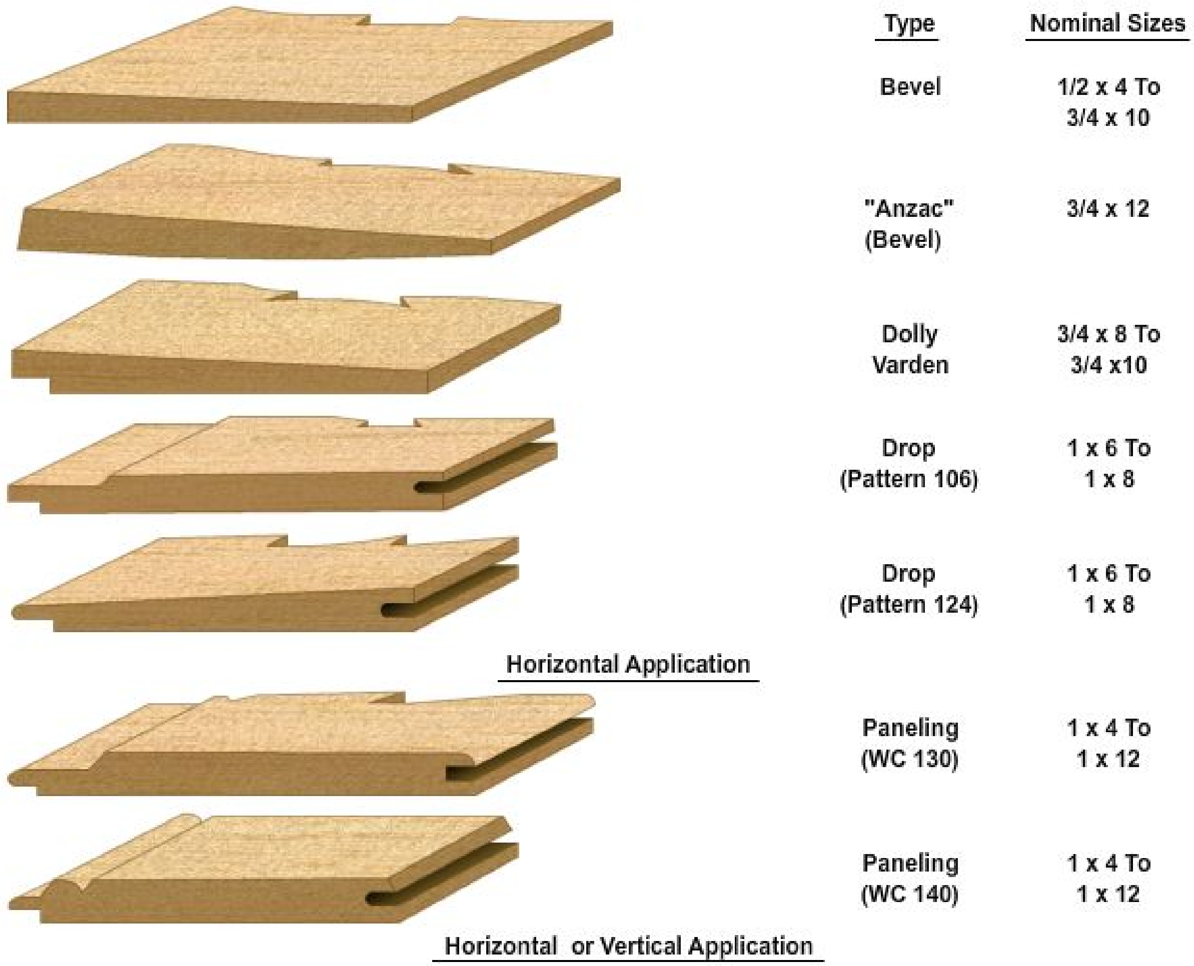


Figure 12-35 – Types of wood siding.

4.1.4 Treatment

Treating the edges of drop, matched, and shiplapped sidings with water repellent preservative helps prevent wind driven rain from penetrating the joints exposed to the weather. In areas under wide overhangs or in porches or other protected sections, the treatment is not as important. Some manufacturers provide siding with this treatment already applied.

4.1.5 Applications

A method of siding application, popular for some architectural styles, uses rough sawn boards and battens applied vertically. These can be arranged in three ways: board and batten, batten and board, and board and board, as shown in *Figure 12-36*.

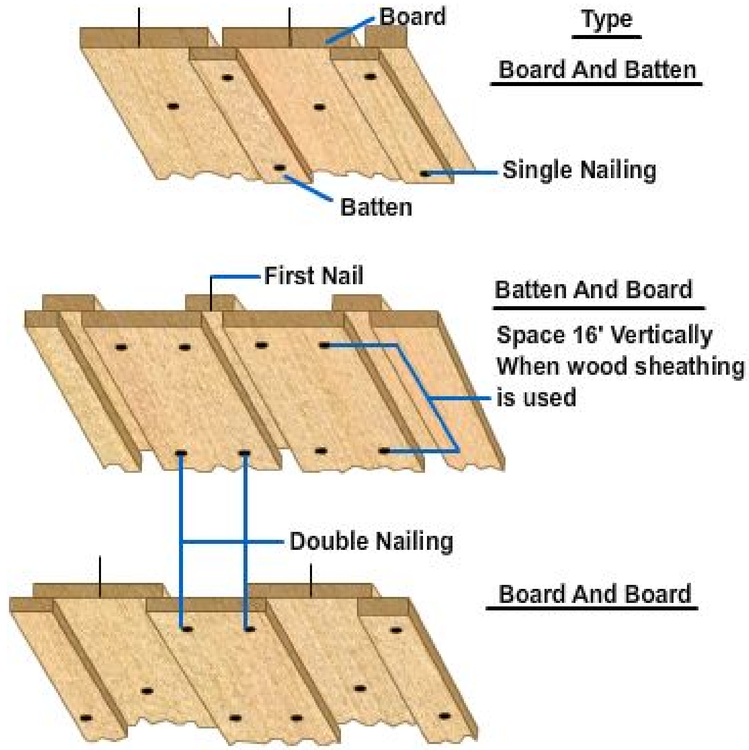


Figure 12-36 – Vertical board siding.

4.1.6 Sheet Materials

A number of sheet materials are available for use as siding. These include plywood in a variety of face treatments and species, and hardboard. Plywood or paper overlaid plywood (panel siding) is sometimes used without sheathing. Paper overlaid plywood has many of the advantages of plywood besides providing a satisfactory base for paint. Medium density overlaid plywood is not common. Stud spacing of 16 inches requires a minimum thickness of panel siding of 3/8 inch. However, 1/2 or 5/8 inch thick sheets perform better because of their greater thickness and strength.

Standard siding sheets are 4 by 8 feet; larger sizes are available. They must be applied vertically with intermediate and perimeter nailing to provide the desired rigidity. Most other methods of applying sheet materials require some type of sheathing beneath. Where horizontal joints are necessary, they should be protected by simple flashing.

An exterior grade plywood should always be used for siding and can be obtained in grooved, brushed, and saw textured surfaces. These surfaces are usually finished with stain. If shiplap or matched edges are not provided, the joints should be waterproofed. Waterproofing often consists of caulking and a batten at each joint, as well as a batten at each stud if closer spacing is desired for appearance. An edge treatment of water repellent preservative will also aid in reducing moisture penetration. When plywood is being installed in sheet form, allow a 1/16 inch edge and end spacing.

Exterior grade particle board might also be considered for panel siding. Normally, a 5/8-inch thickness is required for 16 inch stud spacing and 3/4 inch thickness for 24 inch stud spacing. The finish must be an approved paint, and the stud wall behind must have corner bracing.

Medium density fiberboards might also be used in some areas as exterior coverings over certain types of sheathing. Many of these sheet materials resist the passage of water vapor. When they are used, it is important that a good vapor barrier, well insulated, be used on the warm side of the insulated walls.

4.2.0 Nonwood Siding

Nonwood materials are used in some types of architectural design. Stucco or a cement plaster finish, preferably over a wire mesh base, is common in the Southwest and the West Coast areas. Masonry veneers can be used effectively with wood siding in various finishes to enhance the beauty of both materials.

Some structures require an exterior covering with minimum maintenance. Although nonwood materials are often chosen for this reason, the paint industry is providing comparable long-life coatings for wood base materials. Plastic films on wood siding and plywood are also promising because little or no refinishing is necessary for the life of the building.

4.2.1 Installation

Siding can be installed only after the window and doorframes are installed. In order to present a uniform appearance, the siding must line up properly with the drip caps and the bottom of the window and door sills. At the same time, it must line up at the corners. Siding must be properly lapped to increase wind resistance and watertightness. In addition, it must be installed with the proper nails and in the correct nailing sequence.

4.2.2 Fasteners

One of the most important factors in the successful performance of various siding materials is the type of fasteners used. Nails are the most common, and it is poor economy to use them sparingly. Galvanized, aluminum, and stainless steel corrosive resistant nails may cost more, but their use will ensure spot-free siding under adverse conditions. Ordinary steel wire nails should not be used to attach siding since they tend to rust in a short time and stain the face of the siding. In some cases, the small head rails will show rust spots through the putty and paint. Noncorrosive nails that will not cause rust are readily available.

Two types of nails commonly used with siding are the small head finishing nail and the moderate size flathead siding nail.

Set the small head finishing nail (driven with a nail set) about 1/16 inch below the face of the siding. Fill the hole with putty after applying the prime coat of paint. Nail the more commonly used flathead siding nail flush with the face of the siding and cover the head later with paint.

If the siding is to be natural finished with a water repellent preservative or stain, fasten it with stainless steel or aluminum nails. In some types of prefinished sidings, nails with color-matched heads are supplied.

Nails with modified shanks are available. These include the annular (ring) threaded shank nail and the spiral threaded shank nail. Both have greater withdrawal resistance than the smooth shank nail, and for this reason, a shorter nail is often used.

In siding, drive exposed nails flush with the surface of the wood. Overdriving may not only show the hammer mark, but may also cause objectionable splitting and crushing of the wood. In sidings with prefinished surfaces or overlays, drive the nails so as not to damage the finished surface.

4.2.3 Exposure

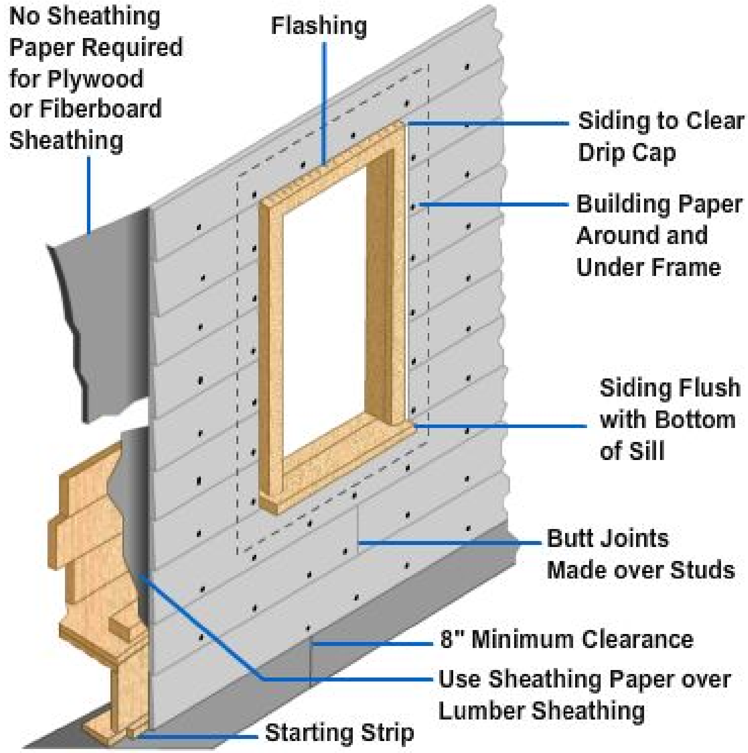


Figure 12-37 – Installation of bevel siding.

The minimum lap for bevel siding is 1 inch. The average exposure distance is usually determined by the distance from the underside of the window sill to the top of the drip cap, as shown in *Figure 12-37*. From the standpoint of weather resistance and appearance, the butt edge of the first course of siding above the window should coincide with the top of the window drip cap. In many one story structures with an overhang, this course of siding is often replaced with a frieze board. It is also desirable that the bottom of a siding course be flush with the underside of the window sill. This may not always be possible because of varying window heights and types that might be used in a structure.

One system used to determine the siding exposure width so that it is approximately equal above and below the window sill is as follows:

1. Divide the overall height of the window frame by the approximate recommended exposure distance for the siding used (4 inches for 6 inch wide siding, 6 inches for 8 inch wide siding, 8 inches for 10 inch wide siding, and 10 inches for 12 inch wide siding). This result will be the number of courses between the top and the bottom of the window. For example, the overall height of our sample window from the top of the drip cap to the bottom of the sill is 61 inches. If 12 inch wide siding is used, the number of courses would be 61/10 = 6.1, or six courses. To obtain the exact exposure distance, divide 61 by 6 and the result would be 10 1/6 inches.
2. Determine the exposure distance from the bottom of the sill to just below the top of the foundation wall. If this distance is 31 inches, use three courses of 10 1/3 inches each. The exposure distance above and below the window would be almost the same as shown in *Figure 12-37*.

When this system is not satisfactory because of big differences in the two areas, it is preferable to use an equal exposure distance for the entire wall height and notch the siding at the window sill. The fit should be tight to prevent moisture from entering.

4.2.4 Installation

Siding should be installed starting with a bottom course. It is normally blocked out with a starting strip the same thickness as the top of the siding board, as shown in *Figure 12-*

37. Each succeeding course should overlap the upper edge of the course below it. Nail siding to each stud or on 16 inch centers. When using plywood, wood sheathing, or spaced wood ***nailing strips*** over nonwood sheathing, you may use 7d or 8d nails for 3/4 inch thick siding. However, with gypsum or fiberboard sheathing, 10d nails are recommended to properly penetrate the stud. For 1/2 inch thick siding, you may use nails 1/4 inch shorter than those used for 3/4 inch siding.

Locate the nails far enough up from the butt to miss the top of the lower siding course, as shown in *Figure 12-38*. The clearance distance is usually 1/8 inch. This allows for slight movement of the siding because of moisture changes without causing splitting. Such an allowance is especially required for the wider 8 to 12 inch siding.

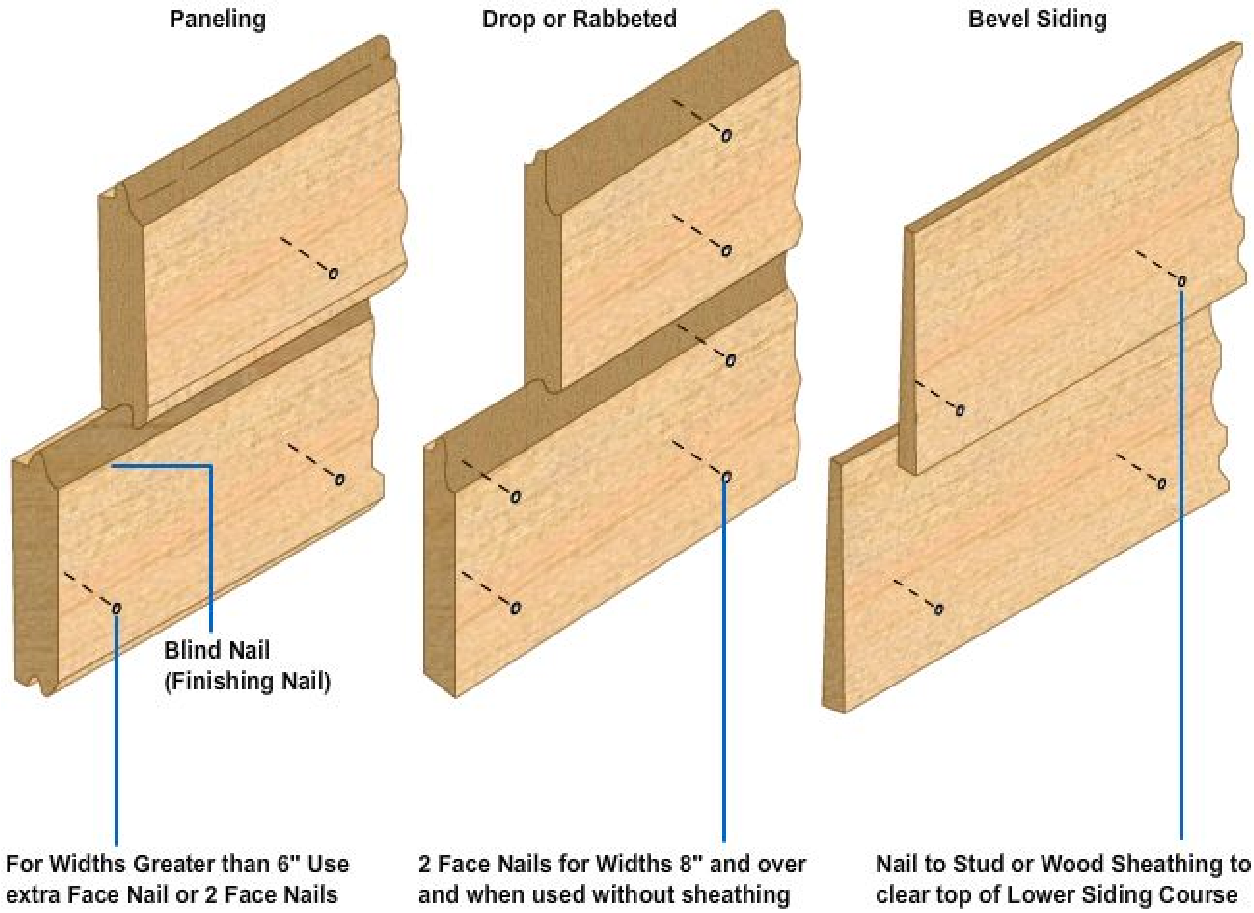


Figure 12-38 – Nailing the siding.

4.2.5 Joints

It is good construction practice to avoid butt joints whenever possible. Use the longer sections of siding under windows and other long stretches, and use the shorter lengths for areas between windows and doors. When a butt joint is necessary, it should be made over a stud and staggered between courses.

Siding should be square cut to provide good joints. Open joints permit moisture to enter and often lead to paint deterioration. It is a good practice to brush or dip the fresh cut ends of the siding in a water repellent preservative before boards are roiled in place. After the siding is in place, it is helpful to use a small finger-actuated oil can to apply the water repellent preservative to the ends and butt joints.

Drop siding is installed in much the same way as lap siding except for spacing and nailing. Drop, Dolly Varden, and similar sidings have a constant exposure distance. The face width is normally 5 1/4 inches for 1 by 6 inch siding and 7 1/4 inches for 1 by 8 inch siding. Normally, one or two nails should be used at each stud, depending on the width, as shown in *Figure 12-38*. The length of the nail depends on the type of sheathing used, but penetration into the stud or through the wood backing should beat least 1 1/2 inches.

4.2.6 Application

There are two ways to apply nonwood siding: horizontally and vertically. Note that these are manufactured items. Make sure you follow the recommended installation procedures.

Horizontally – Use a corrosion resistant finishing nail to blind nail horizontally applied matched paneling in narrow widths at the tongue,as shown in *Figure 12-38*. For widths greater than 6 inches, use an additional nail, as shown.

Other materials, such as plywood, hardboard, or medium density fiberboard, are used horizontally in widths up to 12 inches. Apply them in the same manner as lap or drop siding, depending on the pattern. Apply repackaged siding according to the manufacturer’s directions.

Vertically – Nail vertically applied siding and sidings with interlapping joints in the same manner as those applied horizontally. Nail them to blocking used between studs or to wood or plywood sheathing. Space blocking from 16 to 24 inches OC. With plywood or nominal 1 inch board sheathing, space nails on 16 inch centers only.

When using the various combinations of boards and battens, you should also nail them to blocking spaced from 16 to 24 inches OC between studs, or closer for wood sheathing. Fasten the first boards or battens with nails at each blocking to provide at least 1 1/2 inches of penetration. For wide underboards, you may use two nails spaced about 2 inches apart rather than the single row along the center, as shown in *Figure 12-38*. Nails of the top board or batten should always miss the underboards and should not be nailed through them, as shown in *Figure 12-38*. In such applications, space double nails closely to prevent splitting if the board shrinks. It is also a good practice to use sheathing paper, such as 15 pound asphalt felt, under vertical siding.

Exterior grade plywood, paper overlaid plywood, and similar sheet materials used for siding are usually applied vertically. Drive the nails over the studs; the total effective penetration into the wood should be at least 1 1/2 inches. For example, 3/8 inch plywood siding over 3/4 inch wood sheathing would require a 7d nail which is 2 1/4 inches long. This would result in a 1 1/8 inch penetration into the stud, but a total effective penetration of 1 7/8 inches into the wood sheathing.

Caulk the joints of all types of sheet material with ***mastic*** unless the joints are of the interlapping or matched type of battens. It is good practice to place a strip of 15 pound asphalt felt under joints.

Test your Knowledge (Select the Correct Response)

3. Which of the following properties is/are essential for wood siding?

   A. Weathers easily
   B. Paints easily only
   C. Works easily only
   D. Paints and works easily

4.3.0 Corner Coverings

The outside corners of a wood framed structure can be finished in several ways. Siding boards can be miter joined at the corners. Shingles can be edge lapped alternately. The ends of siding boards can be butted at the corners and then covered with a metal cap.

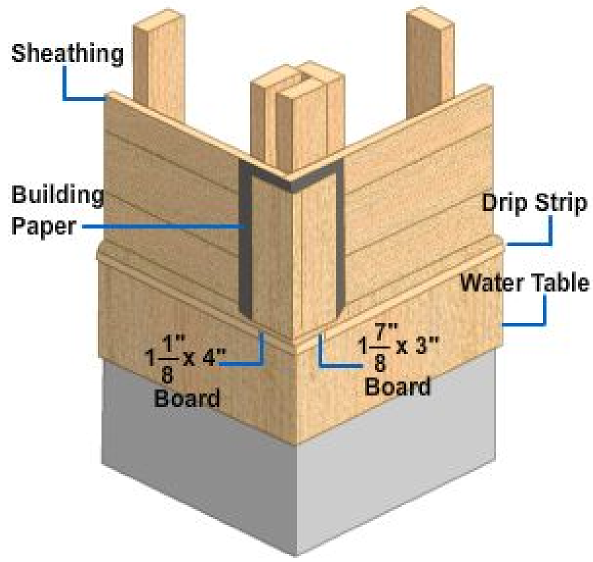


Figure 12-39 – Corner board.

4.3.1 Corner Boards

A type of corner finish that can be used with almost any kind of outside wall covering is called a corner board. This corner board can be applied to the corner with the siding or shingles end or edge butted against the board.

A corner board usually consists of two pieces of stock: one piece 3 inches wide and the other 4 inches wide if an edge butt joint between the corner boards is used. The boards are cut to a length that will extend from the top of the water table to the bottom of the frieze. They are edge butted and nailed together before they are nailed to the corner. This procedure, shown in *Figure 12-39,* ensures a good tight joint. Tack a strip of building paper over the corner before nailing the corner board in position. Always allow an overlap of paper to cover the subsequent crack formed where the ends of the siding butts against the corner board.

4.3.2 Interior Corners

Interior corners, shown in *Figure 12-40*, are butted against a square corner board of nominal 1 1/4 or 1 3/8 inch size, depending on the thickness of the siding.

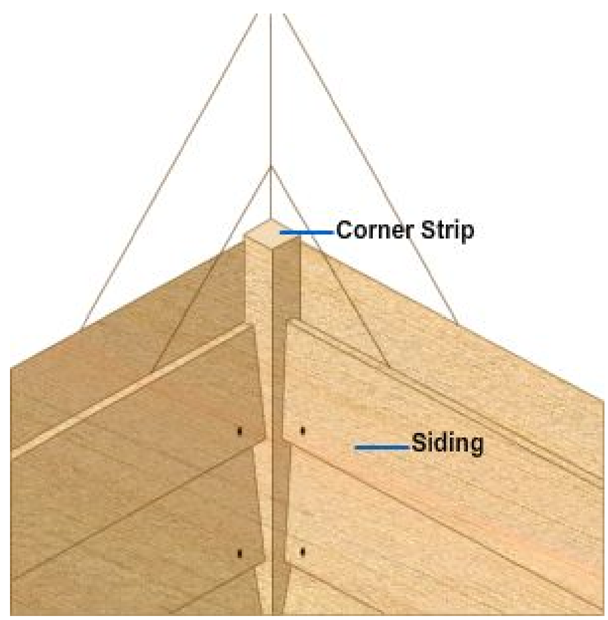


Figure 12-40 – Siding details - interior corners.

4.3.3 Mitered Corners

Mitering the corners of bevel and similar sidings, as shown in *Figure 12-41*, is often not satisfactory unless it is carefully done to prevent openings. A good joint must fit tightly the full depth of the miter. You should also treat the ends with a water repellent preservative before nailing.

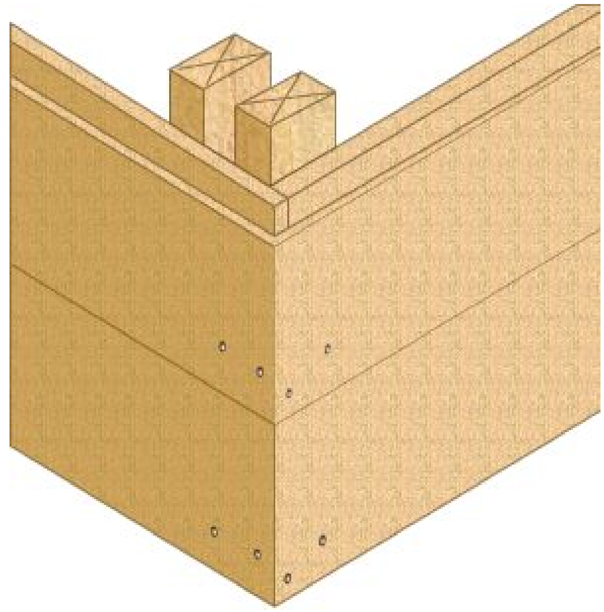


Figure 12-41 – Siding details – mitered corners.

4.3.4 Metal Corners

Metal corners, shown in *Figure 12-42*, are perhaps more commonly used than the mitered corner and give a mitered effect. They are easily placed over each corner as the siding is installed. The metal corners should fit tightly and should be nailed on each side to the sheathing or corner stud beneath. When made of galvanized iron, they should be cleaned with a mild acid wash and primed with a metal primer before the structure is painted to prevent early peeling of the paint. Weathering of the metal will also prepare it for the prime paint coat.

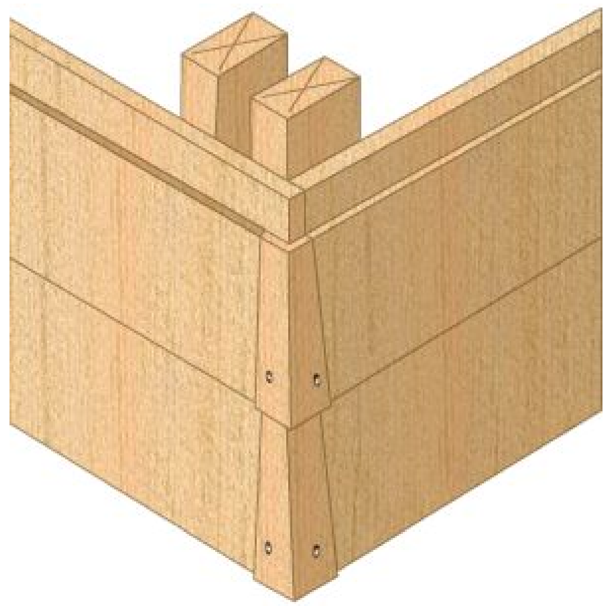


Figure 12-42 – Siding details - metal corners.

Corner boards of various types and sizes, shown in *Figure 12-39*, may be used for horizontal sidings of all types. They also provide a satisfactory termination for plywood and similar sheet materials. Terminate vertical matched paneling or boards and battens by lapping one side and nailing it to the lapped member, as well as to the nailing members beneath.

Corner boards are usually 1 1/8 or 1 3/8 inches wide. To give a distinctive appearance, they should be quite narrow. Plain outside casing, commonly used for window and doorframes, can be adapted for corner boards.

4.3.5 Shingles and Shakes

Prefinished shingle or shake exteriors are sometimes used with color-matched metal corners. They can also be lapped over the adjacent corner shingle, alternating each course. This kind of corner treatment, called lacing, usually requires that flashing be used beneath.

When siding returns against a roof surface, such as at the bottom of a dormer wall, there should be a 2 inch clearance, as shown in *Figure 12-43*. Siding that is cut for a tight fit against the shingles retains moisture after rains, which usually results in peeling paint. Shingle flashing extending well up on the dormer wall will provide the necessary resistance to entry of wind driven rain. Here again, a water repellent preservative should be used on the ends of the siding at the roof line.

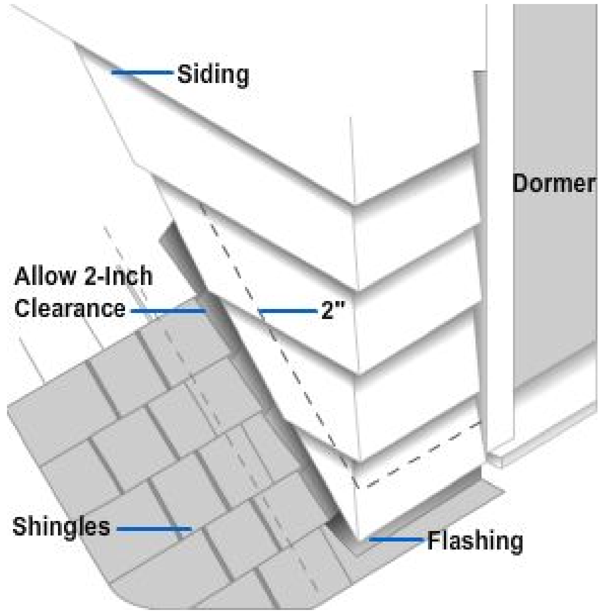


Figure 12-43 – Siding details - siding return against roof.

4.4.0 Gable Ends

At times, the materials used in the gable ends and in the walls below differ in form and application. The details of construction used at the juncture of the two materials should ensure good drainage. For example, when vertical boards and battens are used at the gable end and horizontal siding below, use a drip cap or similar molding, as shown in *Figure 12-44*. Use flashing over and above the drip cap so that moisture cannot enter this transition area.

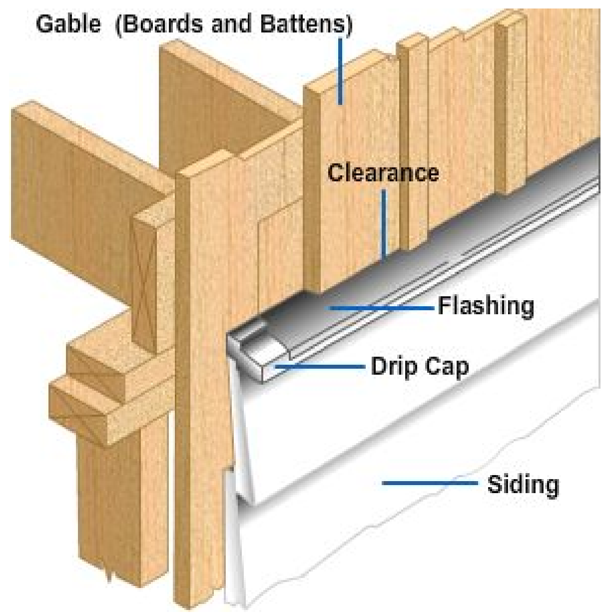


Figure 12-44 – Gable end finish (material transition).

4.5.0 Patterns

Apply wood shingles and shakes in a single or double course pattern over either wood or plywood sheathing. When sheathing with 3/8 inch plywood, use threaded nails. For nonwood sheathing, use 1 by 3 inch or 1 by 4 inch wood nailing strips as a base.

In the single course method, simply lay one course over the other as you apply lap siding. The shingles can be second grade because only one half or less of the butt portion is exposed, as shown in *Figure 12-45*. Do not soak shingles before application but lay them out with about a 1/8 to 1/4 inch space between adjacent shingles to allow for expansion during rainy weather. When a siding effect is desired, lay shingles so that they are in contact, but only lightly. Pre-stained or treated shingles provide the best results.

In a double course system, apply the undercourse over the wall, and nail the top course directly over a 1/4 to 1/2 inch projection of the butt, as shown in *Figure 12-46*. Nail the first course only enough to hold it in place while you apply the outer course. The first shingles can be a lower quality. Because much of the shingle length is exposed, the top course should be first grade shingles.

Apply shingles and shakes with rust resistant nails long enough to penetrate into the wood backing strips or sheathing. In a single course, a 3d or 4d zinc coated shingle nail is commonly used. In a double course, where nails are exposed, a 5d zinc coated nail with a small flat head is used for the top course, and a 3d or 4d size for the undercourse. Use building paper over lumber sheathing.

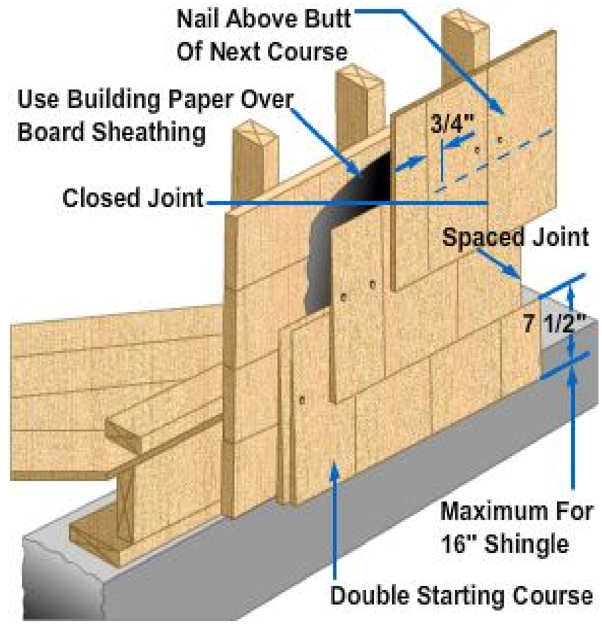


Figure 12-45 – Single coursing of sidewalls (wood shingles and shakes).

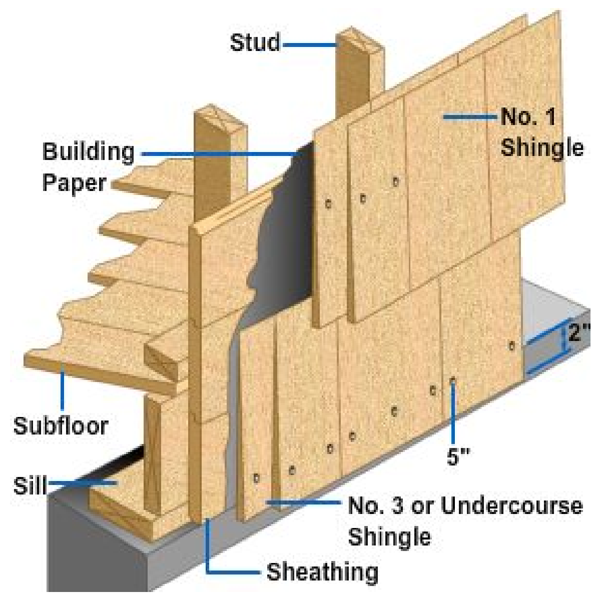


Figure 12-46 – Double coursing of sidewalls (wood shingles and shakes).

5.0.0 FLASHING

Flashing should be installed at the junction of material changes, chimneys, and roof and wall intersections. It should also be used over exposed doors and windows, over roof ridges and valleys, along the edge of a pitched roof, and any other place where rain and melted snow may penetrate.

To prevent corrosion or deterioration where unlike metals come together, use fasteners made of the same kind of metal as the flashing. For aluminum flashing, use only aluminum or stainless steel nails, screws, hangers, and clips. For copper flashing, use copper nails and fittings. Galvanized sheet metal or ***terneplate*** should be fastened with galvanized or stainless steel fasteners. One wall area that requires flashing is the intersection of two types of siding materials. A stucco finish gable end and a wood siding lower wall should be flashed as shown in *Figure 12-47*. A wood molding, such as a drip cap, separates the two materials and is covered by the flashing, which extends at least 4 inches above the intersection. When sheathing paper is used, it should lap the flashing as shown in *Figure 12-47*.

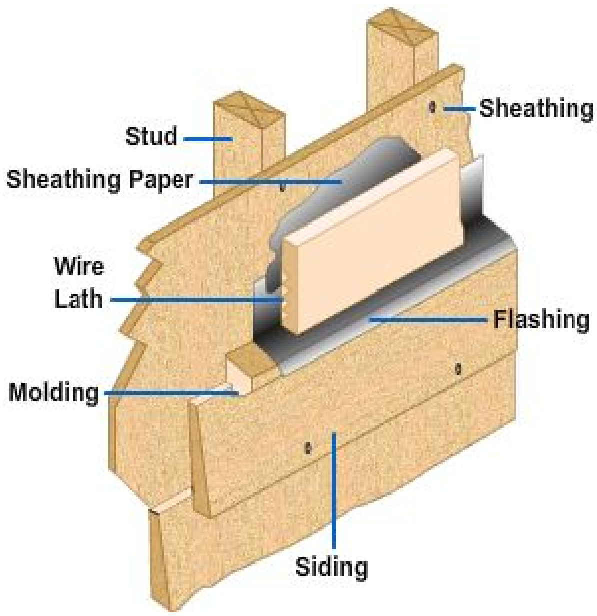


Figure 12-47 – Flashing of material changes - stucco above, siding below.

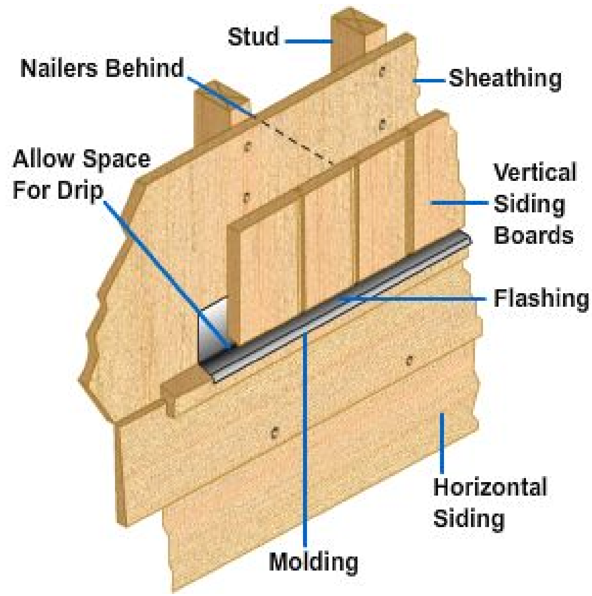


Figure 12-48 – Flashing of material changes - vertical siding above, horizontal below.

When a wood siding pattern change occurs on the same wall, the intersection should also be flashed. A vertical board sided upper wall with horizontal siding below usually requires some type of flashing, as shown in *Figure 12-48*. A small space above the molding provides a drip for rain. This will prevent paint peeling, which could occur if the boards were in tight contact with the molding. A drip cap, shown in *Figure 12-44*, is sometimes used as a terminating molding.

5.1.0 Door and Window Flashing

The same type of flashing shown in *Figure 12-47* should be used over door and window openings exposed to driving rain. However, window and door heads protected by wide overhangs in a single story structure with a hip roof do not ordinarily require the flashing. When building paper is used on the sidewalls, it should lap the top edge of the flashing. To protect the walls behind the window sill in a brick veneer exterior, extend the flashing under the masonry sill up the underside of the wood sill.

Flashing is also required at the junctions of an exterior wall and a flat or low pitched built up roof, as shown in *Figure 12-49*. Where a metal roof is used, turn the metal up on the wall and covered it with the siding. Allow a clearance at the bottom of the siding to protect against melted snow and rain.

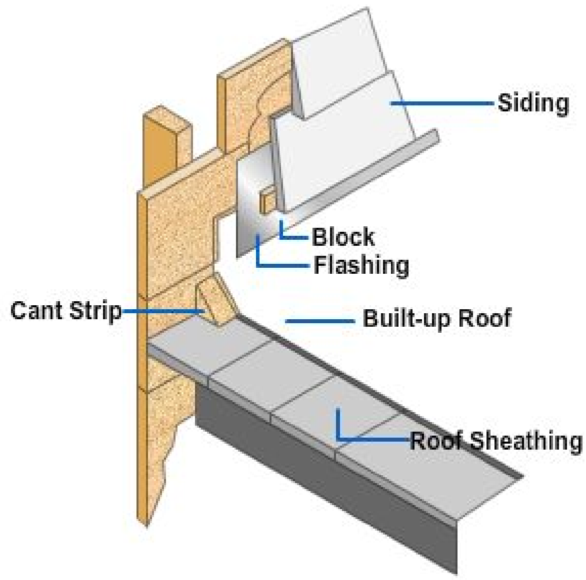


Figure 12-49 – Flashing at the intersection of an exterior wall and a flat or low pitched roof.

6.0.0 GUTTERS and DOWNSPOUTS

Several types of gutters are available to carry the rainwater to the downspouts and away from the foundation. On flat roofs, water is often drained from one or more locations and carried through an inside wall to an underground drain. All downspouts connected to an underground drain should be fitted with basket strainers at the junctions of the gutter, as shown in *Figure 12-50*.

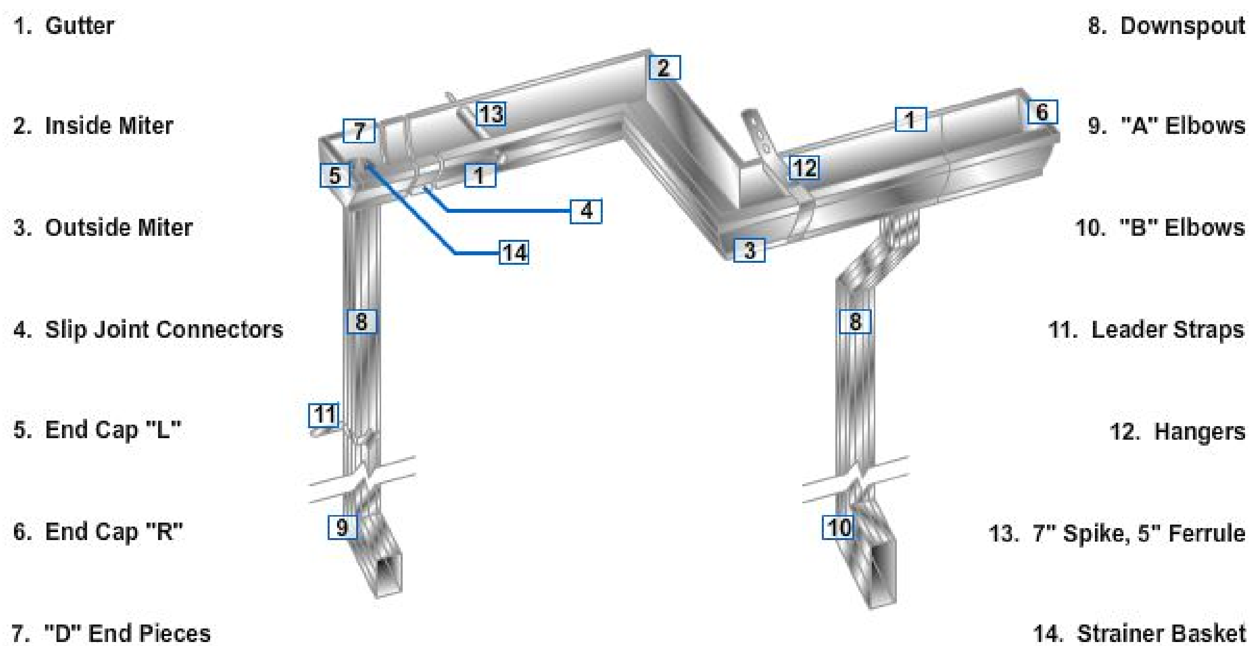


Figure 12-50 – Parts of a metal gutter system.

Perhaps the most commonly used gutter is the type hung from the edge of the roof or fastened to the edge of the cornice fascia. Metal gutters may be the half round shown in *Figure 12-51, view A*, or K style, *view B* and may be made of galvanized metal, copper, or aluminum. Some have a factory applied enamel finish.

Downspouts are round or rectangular, as shown in *Figure 12-51, views C* and *D*. The round type is used for the half round gutters. They are usually corrugated to provide extra stiffness and strength. Corrugated patterns are less likely to burst when plugged with ice.

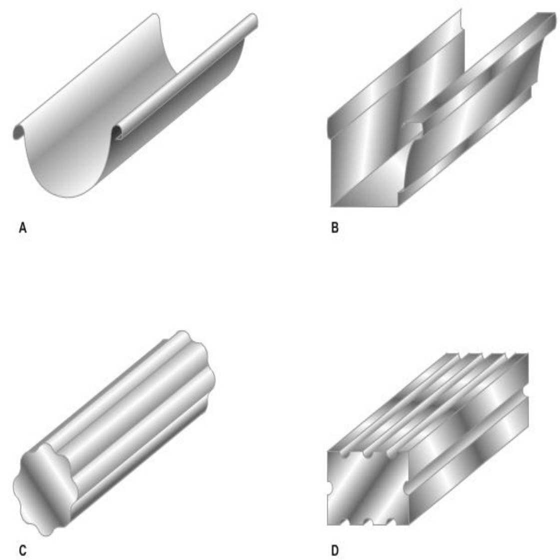


Figure 12-51 – Gutters and downspouts.
A. Half round gutter
B. K style gutter
C. Round downspout
D. Rectangular downspout

On long runs of gutters, such as required around a hip roof structure, at least four downspouts are desirable. Gutters should be installed with a pitch of 1 inch per 16 feet toward the downspouts. Formed or half round gutters are suspended with flat metal hangers, as shown in *Figure 12-52, views A* and *B.* Spike and ferrule hangers are also used with formed gutters, as shown in *view C*. Gutter hangers should be spaced 3 feet OC.

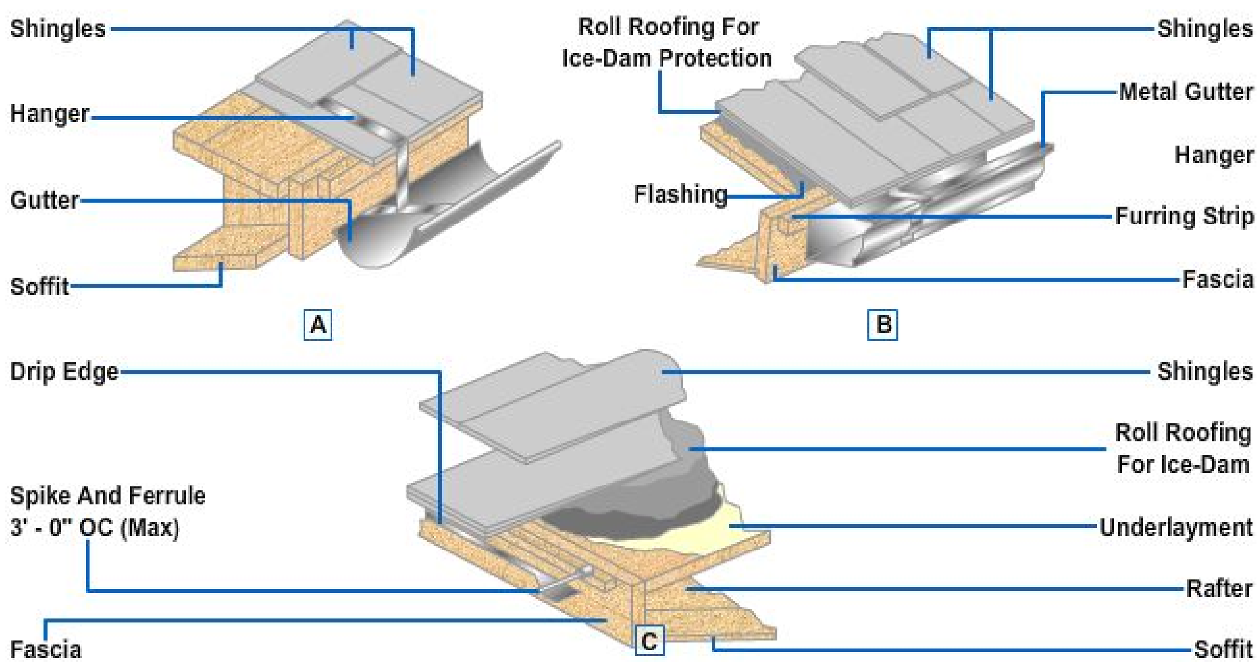


Figure 12-52 – Gutter hangers.
A. Flat metal hanger with half round gutter
B. Flat metal hanger with K style metal gutter
C. Spike and ferrule with formed gutter

Gutter splices, corner joints, and downspout connections should be watertight. Fasten downspouts to the wall with leaderstraps, as shown in *Figure 12-53*, or hooks. Install one strap at the top, one at the bottom, and one at each intermediate joint. Use an elbow at the bottom to guide the water to a splash block, shown in *Figure 12-53, view A*, which carries the water away from the foundation. The minimum length of a splash block should be 3 feet. In some areas, the downspout drains directly into a tile line, which carries the water to a storm sewer, as shown in *view B*.

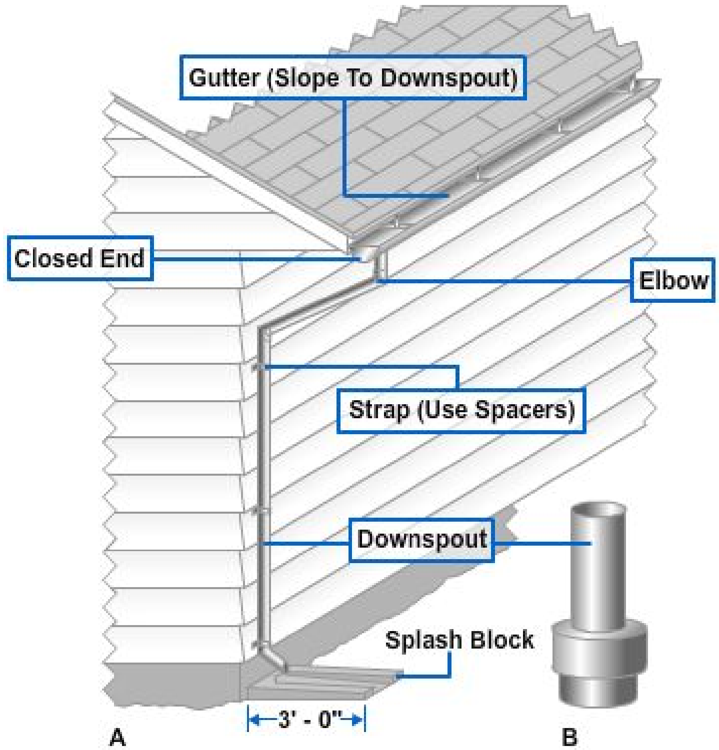


Figure 12-53 – Downspout installation.
A. Downspout with splash block
B. Drain to storm sewer

7.0.0 EXTERIOR DOORS

Many types of exterior doors are available to provide access, protection, safety, and privacy. Wood, metal, plastic, glass, or a combination of these materials is used in the manufacture of doors. The selection of door type and material depends on the degree of protection or privacy desired, architectural compatibility, psychological effect, fire resistance, and cost.

7.1.0 Door Types

Better quality exterior doors are of solid core construction. The core is usually fiberglass, or the door is metal faced with an insulated foam core. Solid core doors are used as exterior doors because of the heavy service and the additional fireproofing. Hollow core doors are normally used for interior applications. Wood doors are classified by design and method of construction as panel or flush doors.

7.1.1 Panel Doors

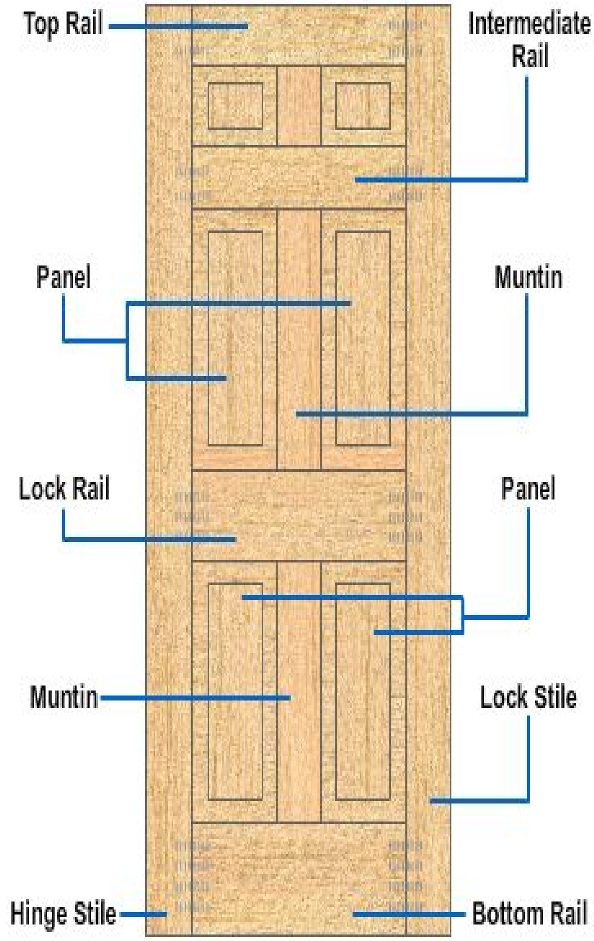


Figure 12-54 – Parts of a six-panel door.

A panel door, or stile and rail door, consists of vertical members called stiles and horizontal members called rails. The stiles and rails enclose panels of solid wood, plywood, louvers, or glass, as shown in *Figure 12-54*. The stiles extend the full height at each side of the door. The vertical member at the hinged side of the door is called the hinge, or hanging, stile, and the one to which the latch, lock, or push is attached is called the closing, or lock, stile. Three rails run across the full width of the door between the stiles: the top rail, the intermediate or lock rail, and the bottom rail. Additional vertical or horizontal members, called ***muntins***, may divide the door into any number of panels. The rails, stiles, and muntins maybe assembled with either glued dowels or mortise and tenon joints.

7.1.2 Sash Doors

Panel doors in which one or more panels are glass are classed as sash or glazed doors. Fully glazed panel doors with only a top and bottom rail without horizontal or vertical muntins are referred to as casement or French doors. Storm doors are lightly constructed glazed doors. They are used in conjunction with exterior doors to improve weather resistance. Combination doors consist of interchangeable or hinged glass and screen panels.

7.1.3 Flush Doors

Flush doors are usually made up of thin sheets of veneer over a core of wood, particle board, or fiberboard. The veneer faces act as stressed skin panels and tend to stabilize the door against warping. The face veneer may be of ungraded hardwood suitable for a plain finish or selected hardwood suitable for a natural finish. The appearance of flush doors may be enhanced by the application of plant-on decorative panels. Both hollow core and solid core doors usually have solid internal rails and stiles so that hinges and other hardware may be set in solid wood.

Two types of solid wood cores widely used in flush door construction are shown in *Figure 12-55*. The first type, called a continuous block, strip or wood stave core, consists of low density wood blocks or strips that are glued together in adjacent vertical rows, with the end joints staggered. This is the most economical type of solid core. It is subject to excessive expansion and contraction unless it is sealed with an impervious skin, such as a plastic laminate.

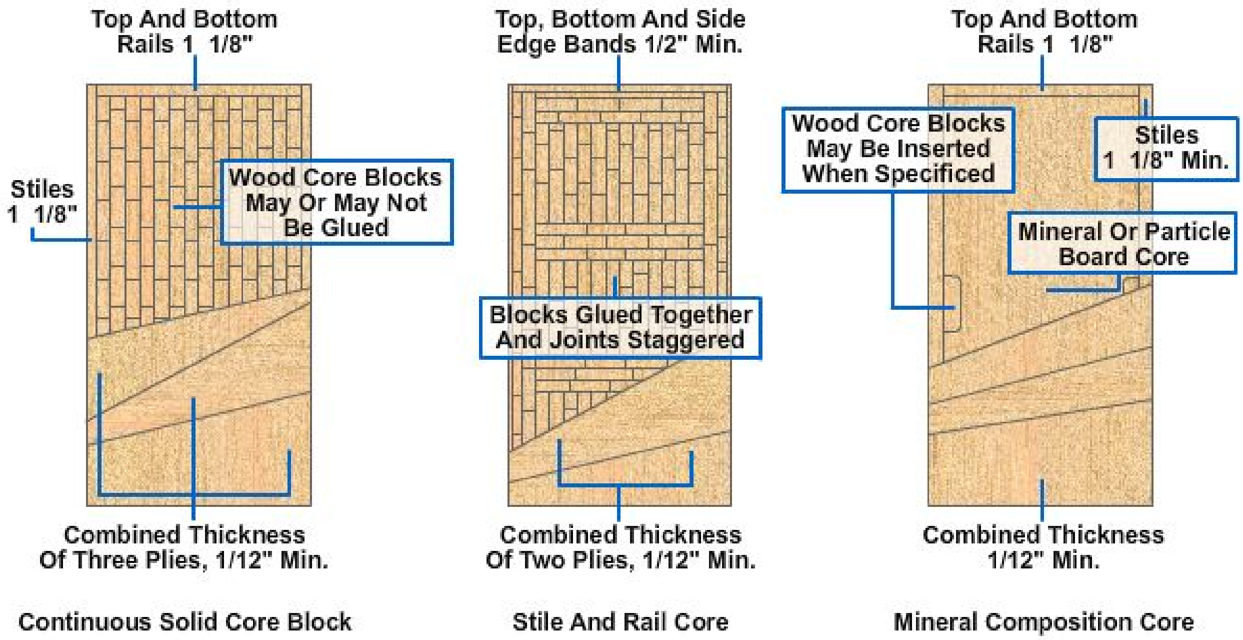


Figure 12-55 – Three types of solid core doors.

The second type is the stile and rail core, in which blocks are glued up as panels inside the stiles and rails. This type of core is highly resistant to warpage and is more dimensionally stable than the continuous block core.

In addition to the solid lumber cores, there are two types of composition solid cores. Mineral cores, shown in *Figure 12-55*, consist of inert mineral fibers bonded into rigid panels. The panels are framed within the wood rails and stiles, resulting in a core that is light in weight and little affected by moisture. Because of its low density, this type of door should not be used where sound control is important.

The other type, which is not shown, has particleboard, flakeboard, or waferboard cores, consisting of wood chips or vegetable fibers mixed with resins or other binders, formed under heat and pressure into solid panels. This type of core requires a solid perimeter frame. Since particleboard has no grain direction, it provides exceptional dimensional stability and freedom from warpage. Because of its low screw holding ability, it is usually desirable to install wood blocks in the core at locations where hardware will be attached.

7.2.0 Doorjambs

The doorjamb is the part of the frame that fits inside the masonry opening or rough frame opening. Jambs may be wood or metal. The jamb has three parts: the two side jambs and the head jamb across the top. Exterior doorjambs have a stop as part of the jamb. The stop is the portion of the jamb that the face of the door closes against. The jamb is 1 1/4 inches thick with a 1/2 inch rabbet serving as a stop.

7.2.1 Wood

Wood jambs are manufactured in two standard widths, 5 1/4 inches for lath and plaster and 4 1/2 inches for drywall. Jambs may be easily cut to fit walls of any thickness. If the jamb is not wide enough, strips of wood are nailed on the edges to form an extension. Jambs may also be custom made to accommodate various wall thicknesses.

7.2.2 Metal

Standard metal jambs are available for lath and plaster, concrete block, and brick veneer in 4 3/4, 5 3/4, 6 3/4, and 8 3/4 inch widths. For drywall construction, the common widths available are 5 1/2 and 5 5/8 inches.

The sill is the bottom member in the doorframe. It is usually made of oak for wear resistance. When softer wood is used for the sill, a metal nosing and wear strips are generally included.

The brick mold or outside casings are designed and installed to serve as stops for the screen or combination door. The stops are provided for by the edge of the jamb and the exterior casing thickness, as shown in *Figure 12-56*.

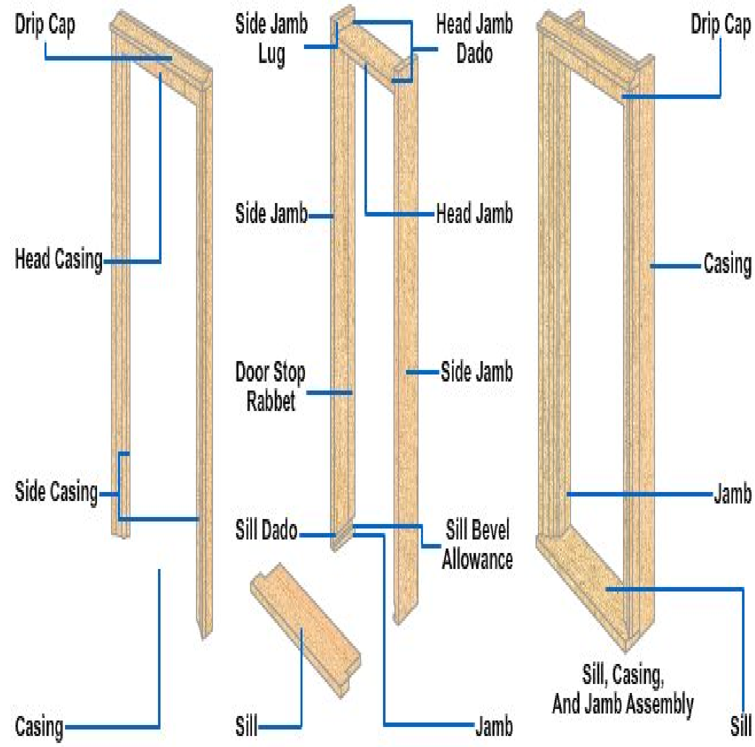


Figure 12-56 – Parts of an exterior doorframe.

Doorframes can be purchased knocked down (K. D.) or preassembled with just the exterior casing or brick mold applied. In some cases, they come preassembled with the door hung in the opening. When the doorframe is assembled on the job, nail the side jambs to the head jamb and sill with 10d casing nails. Then nail the casings to the front edges of the jambs with 10d casing nails spaced 16 inches OC.

Exterior doors are 1 3/4 inches thick and not less than 6 feet 8 inches high. The main entrance door is 3 feet wide, and the side or rear service door is 2 feet 8 inches wide. A hardwood or metal threshold, shown in *Figure 12-57*, covers the joint between the sill and the finished floor.

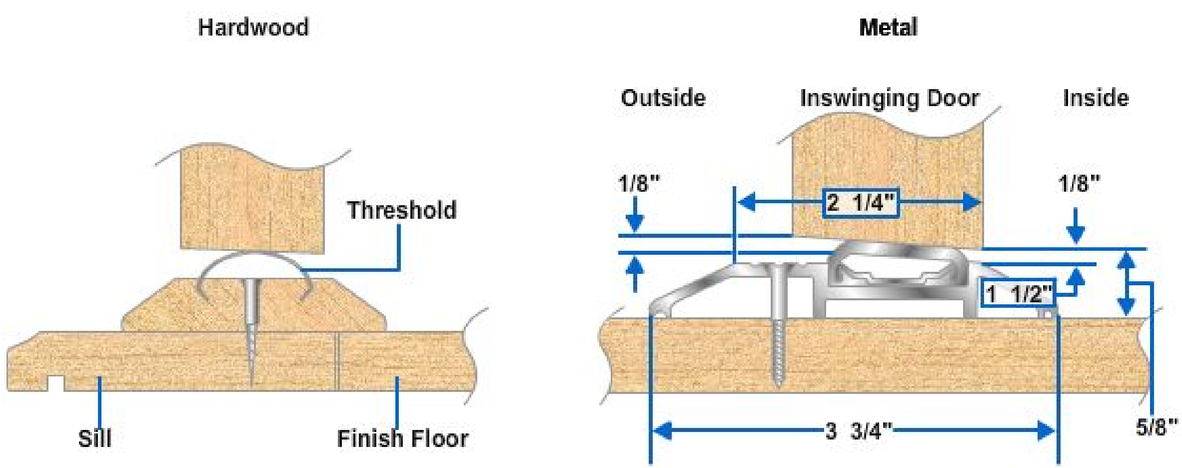


Figure 12-57 – Thresholds.

The bottom of an exterior door may be equipped with a length of hooked metal that engages with a specially shaped threshold to provide a weatherproof seal. Wood and metal thresholds are available with flexible synthetic rubber tubes that press tightly against the bottom of the door to seal out water and cold or hot air. These applications are shown in *Figure 12-58*. Manufacturers furnish detailed instructions for installation.

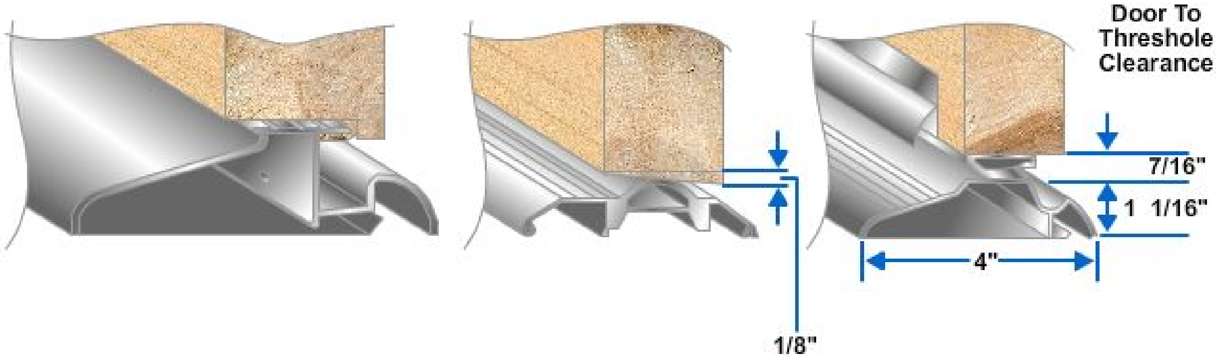


Figure 12-58 – Thresholds providing weatherproof seals.

7.3.0 Door Swings

Of the various types of doors, the swinging door shown in *Figure 12-59* is the most common. The doors are classed as either right hand or left hand, depending on which side is hinged. Stand outside the door. If the hinges are on your left hand side, it is a left hand door. If the hinges are on your right, it is a right hand door. For a door to swing freely in an opening, the vertical edge opposite the hinges must be beveled slightly. On a left hand door that swings away from the viewer, a left hand regular bevel is used; if the door opens toward the viewer, it has a left hand reverse bevel. Similarly, if the hinges are on the right and the door swings toward the viewer, it has a right hand reverse bevel.

A door that swings both ways through an opening is called a double-acting door. Two doors that are hinged on opposite sides of a doorway and open from the center are referred to as double doors; such doors are frequently double-acting. One leaf of a double door may be equipped with an ***astragal***, an extended lip that fits over the crack between the two

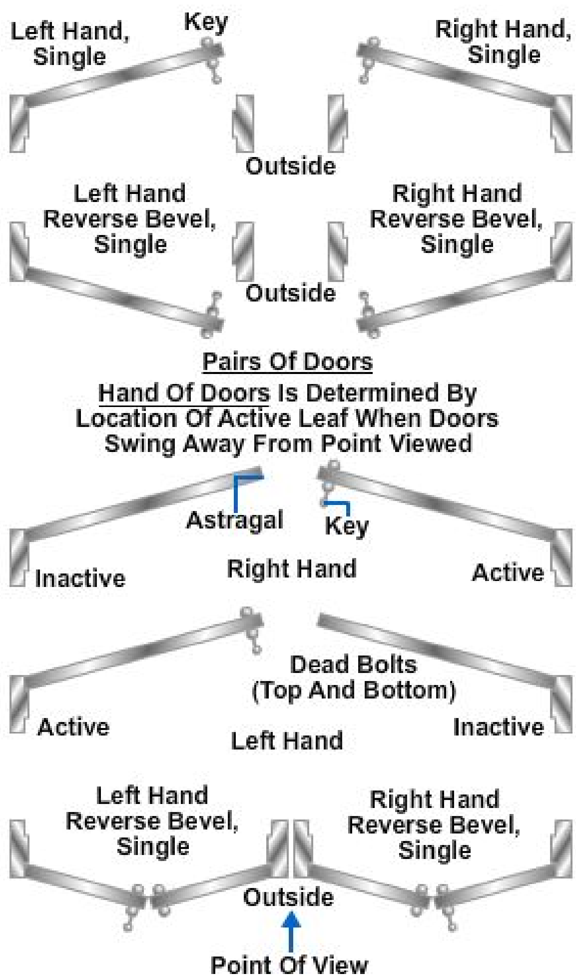


Figure 12-59 – Determining door swings.

doors. A Dutch door is one that is cut and hinged so that top and bottom portions open and close independently.

7.4.0 Installing the Exterior Doorframe

Before installing the exterior doorframe, prepare the rough opening to receive the frame. The opening should be approximately 3 inches wider and 2 inches higher than the size of the door. The sill should rest firmly on the floor framing, which normally must be notched to accommodate the sill. The subfloor, floor joists, and stringer or header joist must be cut to a depth that places the top of the sill flush with the finished floor surface.

Line the rough opening with a strip of 15-pound asphalt felt paper, 10 or 12 inches wide. In some structures, you may need to install flashing over the bottom of the opening. Then set the assembled frame into the opening. Set the sill of the assembled doorframe on the trimmed-out area in the floor framing, tip the frame into place, center it horizontally, and then secure it with temporary braces.

Using blocking and wedges, level the sill and bring it to the correct height, even with the finished floor. Be sure the sill is level and well supported. For masonry wall and slab floors, the sill is usually placed on a bed of mortar.

With the sill level, drive a 16d casing nail through the side casing into the wall frame at the bottom of each side. Insert blocking or wedges between the trimmer studs and the top of the jambs. Adjust the wedges until the frame is plumb. Use a level and straightedge for this procedure, as shown in *Figure 12-60*.

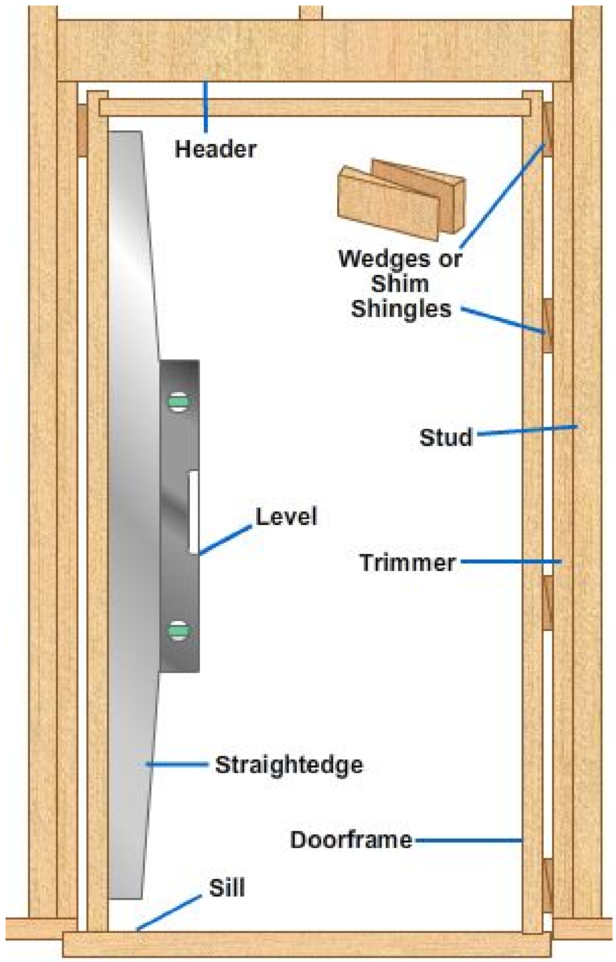


Figure 12-60 – Plumbing an exterior doorjamb.

CAUTION

When setting doorframes, never drive any of the nails completely into the wood until all nails are in place and you have made a final check to make sure that no adjustments are necessary.

Place additional wedges between the jambs and stud frame in the approximate location of the lock strike plate and hinges. Adjust the wedges until the side jambs are well supported and straight. Then secure the wedges by driving a 16d casing nail through the jamb, wedge, and into the trimmer stud. Finally, nail the casing in place with 16d casing nails. These nails should be placed 3/4 inch from the outer edges of the casing and spaced 16 inches OC.

After the installation is complete, lightly tack a piece of 1/4 or 3/8 inch plywood over the sill to protect it during further construction work. At this time, many Builders prefer to hang a temporary door so the interior of the structure can be secured and provide a place to store tools and materials.

Hanging the door and installing door hardware are a part of the interior finishing operation and are described in the Finish Carpentry chapter.

7.5.0 Prehung Exterior Door Units

A variety of prehung exterior door units are available. They include single doors, double doors, and doors with sidelights. Millwork plants provide detailed instructions for installing their products.

First, check the rough opening. Make sure the size is correct and that it is plumb, square, and level. Apply a double bead of caulking compound to the bottom of the opening, and set the unit in place. Do not remove the spacer shims, located between the frame and door, until the frame is firmly attached to the rough opening.

Insert shims between the side jambs and trimmer studs. They should be located at the top, bottom, and midpoint of the door. Drive 16d finishing nails through the jambs, shims, and into the structural frame members. Manufacturers usually recommend that at least two of the screws in the top hinge be replaced with 2 1/4 inch screws. Finally, adjust the threshold so that it makes smooth contact with the bottom edge of the door. After you install a prehung exterior door unit, remove the door from the hinges and carefully store it. A temporary door can be used until final completion of the project.

Test your Knowledge (Select the Correct Response)

4. A main entrance door is normally what size?

   A. 1 1/2 inches thick, 2 feet 8 inches wide, 6 feet 8 inches high
   B. 1 1/2 inches thick, 3 feet 0 inches wide, 7 feet 0 inches high
   C. 1 3/4 inches thick, 2 feet 8 inches wide, 7 feet 0 inches high
   D. 1 3/4 inches thick, 3 feet 0 inches wide, 6 feet 8 inches high

8.0.0 WINDOWS

The primary purpose of windows is to allow the entry of light and air, but they may also be an important part of the architectural design of a building. Windows and their frames are millwork units that are usually fully assembled at the factory, and ready for use in buildings. These units often have the ***sash*** fitted and weather stripped, frame assembled, and exterior casing in place. Standard combination storms and screens or separate units can also be included. Wood components are treated with a water repellent preservative at the factory to provide protection before and after they are placed in the walls.

Insulated glass, used both for stationary and moveable sash, consists of two or more sheets of spaced glass with hermetically sealed edges. It resists heat loss more than a single thickness of glass and is often used without a storm sash.

Window frames and sashes should be made from a clear grade of decay resistant heartwood stock, or from wood that has been given a preservative treatment. Examples include pine, cedar, cypress, redwood, and spruce.

Frames and sashes are also available in metal. Heat loss through metal frames and sash is much greater than through similar wood units. Glass blocks are sometimes used for admitting light in places where transparency or ventilation is not required.

Windows are available in many types, each with its own advantage. The principal types are double hung, casement, stationary, awning, and horizontal sliding. In this chapter, we will cover only the first three.

8.1.0 Double Hung Windows

The double hung window, shown in *Figure 12-61*, is perhaps the most familiar type of window. It consists of upper and lower sashes that slide vertically in separate grooves in the side jambs or in full width metal weather stripping. This type of window provides a maximum face opening for ventilation of one half the total window area. Each sash is provided with springs, balances, or compression weather stripping to hold it in place in any location. Compression weather stripping, for example, prevents air infiltration, provides tension, and acts as a counterbalance. Several types allow the sash to be removed for easy painting or repair.

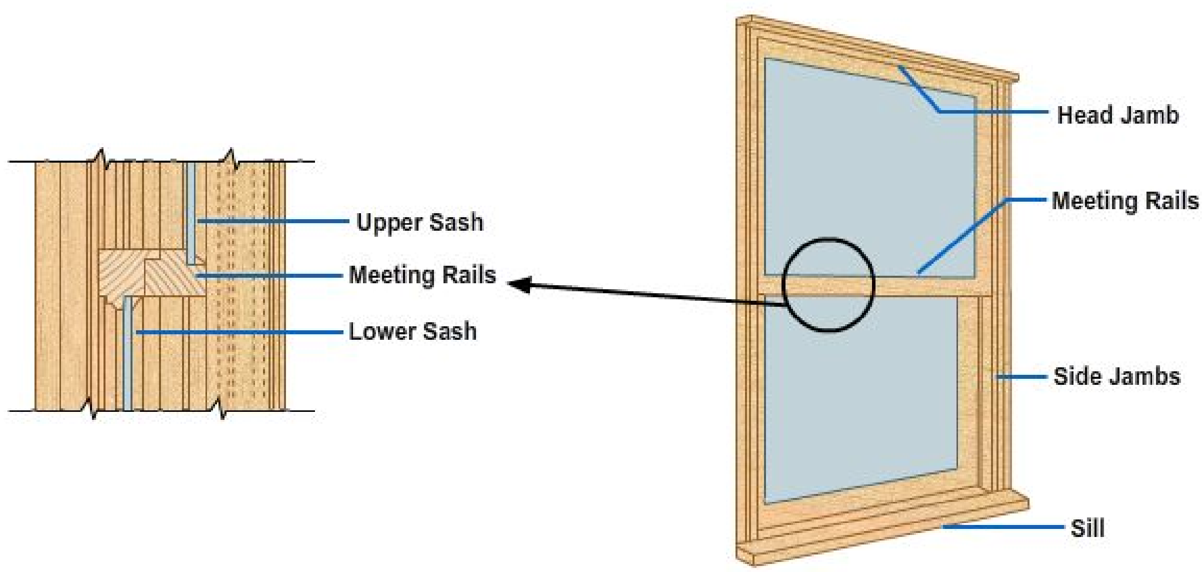


Figure 12-61 – Typical double hung window.

The jambs and the sides and top of the frames are made of nominal 1 inch lumber; the width provides for use with drywall or plastered interior finish. Sills are made from nominal 2 inch lumber and are sloped at about 3 inches in 12 inches for good drainage. Wooden sash is normally 1 3/8 inches thick. *Figure 12-62* shows an assembled window ***stool*** and ***apron***.

The sash may be divided into a number of lights (glass panes or panels) by small wood members called muntins. Some manufacturers provide preassembled dividers which snap in place over a single light, dividing it into six or eight lights. This simplifies painting and other maintenance.

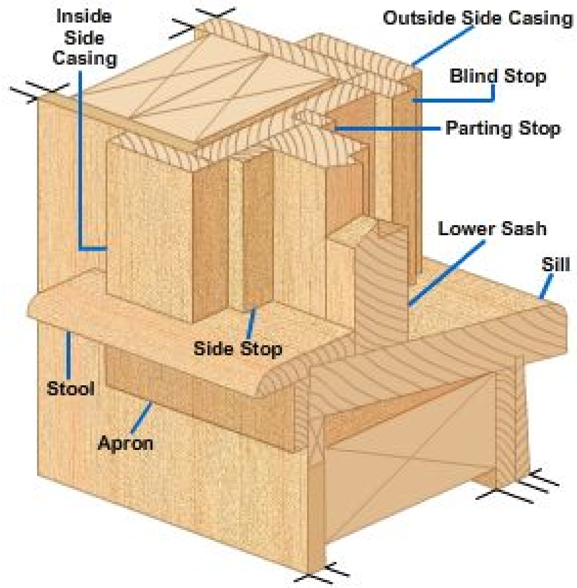


Figure 12-62 – Window stool with apron.

Place assembled frames in the rough opening over strips of building paper put around the perimeter to minimize air infiltration. Plumb the frame and nail it to side studs and header through the casings or the blind stops at the sides. Where nails are exposed, such as on the casing, use the corrosion resistant type.

Hardware for double hung windows includes the sash lifts that are fastened to the bottom rail. These are sometimes eliminated by providing a finger groove in the rail. Other hardware consists of sash locks or fasteners located at the meeting rail. They lock the window and draw the sash together to provide a wind tight fit.

Double hung windows can be arranged in a number of ways: as a single unit, doubled (or ***mullion***), or in groups or three or more. One or two double hung windows on each side of a large stationary insulated window are often used to create a window wall. Such large openings must be framed with headers large enough to carry roof loads.

8.2.0 Casement Windows

Casement windows consist of a side hinged sash, usually designed to swing outward, as shown in *Figure 12-63*. This type can be made more weathertight than the in swinging style. Screens are located inside these out swinging windows, and winter protection is obtained with a storm sash or by using insulated glass in the sash. One advantage of the casement window over the double hung type is that the entire window area can be opened for ventilation.

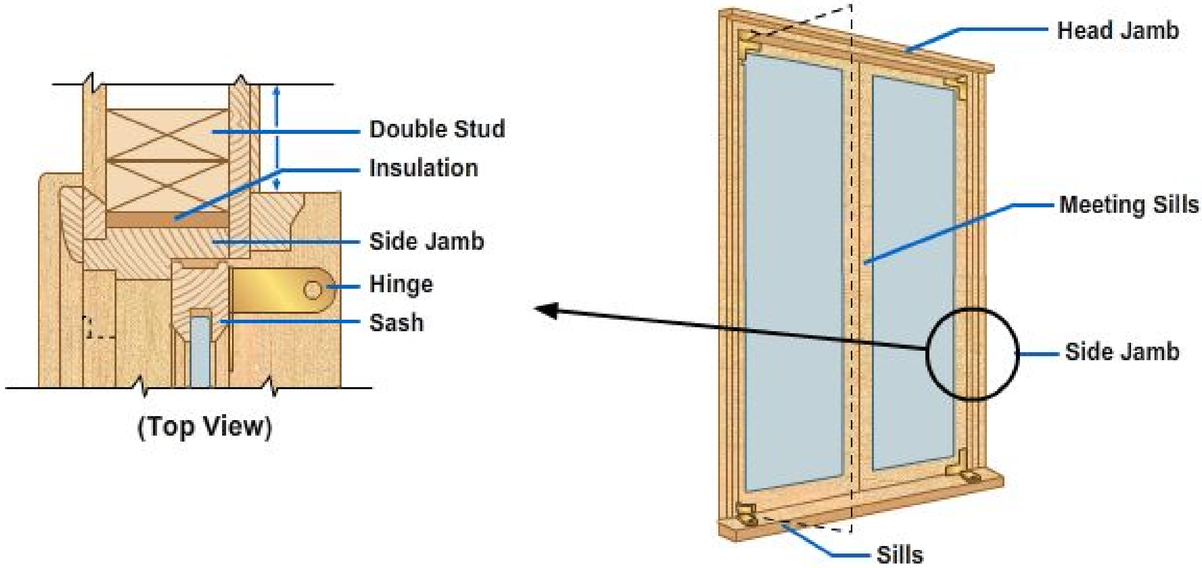


Figure 12-63 – Out-swinging casement sash.

Weather stripping is also provided for this type of window, and units are usually received from the factory entirely assembled with hardware in place. Closing hardware consists of a rotary operator and sash lock. As in the double hung units, casement sash can be used in a number of ways, as a pair or in combinations of two or more pairs. Style variations are achieved by divided lights. Snap in muntins provide a small, multiple pane appearance for traditional styling.

Metal sash can be used, but it has low insulating value, so should be installed carefully to prevent condensation and frosting on the interior surfaces during cold weather. A full storm window unit may be necessary to eliminate this problem in cold climates.

8.3.0 STATIONARY WINDOWS

Stationary windows, used alone or in combination with double hung or casement windows as shown in *Figure 12-64*, usually consist of a wood sash with a large single pane of insulated glass. They are designed to provide light as well as be attractive, and are fastened permanently into the frame. Because of their size, sometimes 6 to 8 feet wide, stationary windows require a 1 3/4 inch thick sash to provide strength. This thickness is required because of the thickness of the insulated glass.

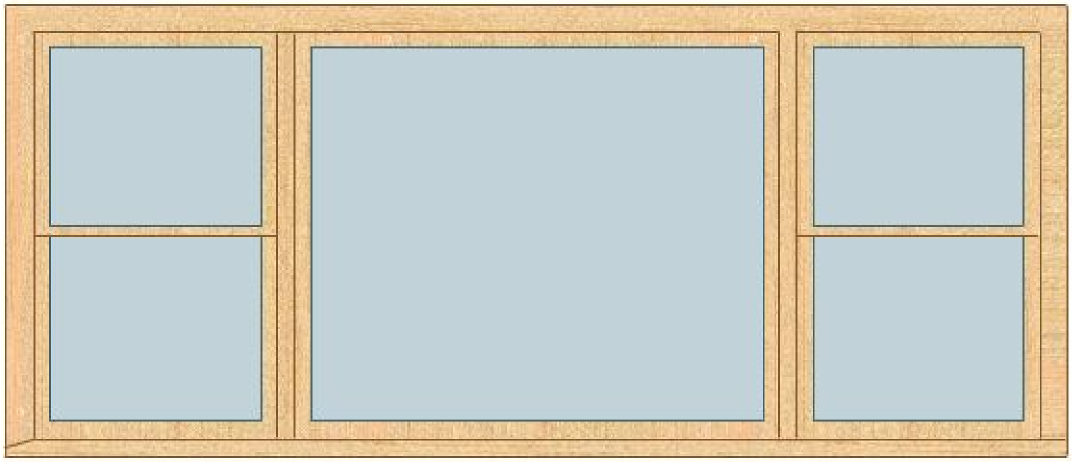


Figure 12-64 – Typical use of stationary window in combination with other types.

Other types of stationary windows may be used without a sash. The glass is set directly into rabbeted frame members and held in place with stops. As with all window sash units, back puttying and face puttying of the glass, with or without a stop, will assure moisture resistant windows, as shown in *Figure 12-65*.

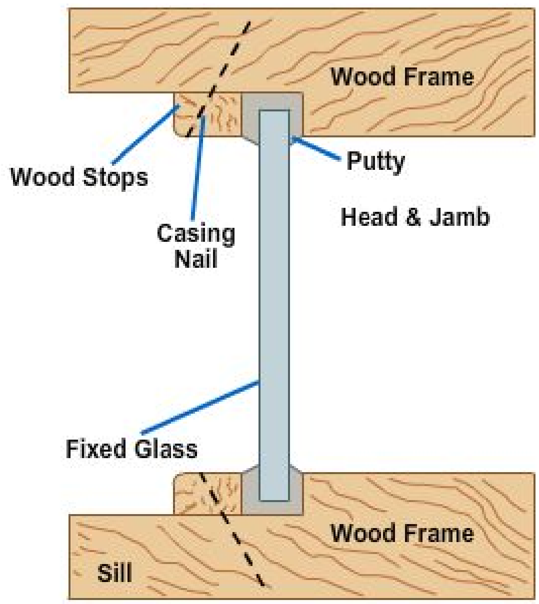


Figure 12-65 – Fixed glass in wood stops.

9.0.0 GLASS

It is surprising how many types of glass and glasslike materials are used in construction. Each has its own characteristics, advantages, and best uses. In this section, we will cover the various types of glass and materials, and the methods used in assembling glass features, known as glazing.

9.1.0 Types

The Glass and Glazing section of construction specifications contains a wide range of materials. These may include sheet glass, plate glass, heat and glare reducing glass, insulating glass, tempered glass, laminated glass, and various transparent or translucent plastics. Also included may be ceramic coated, corrugated, figured, and silvered and other decorative glass. Additional materials may include glazier's points, setting pads, glazing compounds, and other installation materials.

9.1.1 Sheet/Window

Sheet or window glass is manufactured by the flat or vertically drawn process. Because of the manufacturing process, a wave or draw distortion runs in one direction through the sheet. The degree of distortion controls the usefulness of this type of glass. For best appearance, window glass should be drawn horizontally or parallel with the ground. To ensure this, the width dimension is given first when you are ordering.

9.1.2 Plate

Plate glass is similar to window and heavy sheet glass. The surface, rather than the composition or thickness, is the distinguishing feature. Plate glass is manufactured in a continuous ribbon and then cut into large sheets. Both sides of the sheet are ground and polished to a perfectly flat plane. Polished plate glass is furnished in thicknesses or from 1/8 inch to 1 1/4 inches. Thicknesses 5/16 inch and over are termed heavy polished plate. Regular polished plate is available in three qualities: silvering, mirror glazing, and glazing. The glazing quality is generally used where ordinary glazing is required. Heavy polished plate is generally available in commercial quality only.

9.1.3 Heat Absorbing

Heat absorbing glass contains controlled quantities of a ferrous iron admixture that absorbs much of the energy of the sun. Heat absorbing glass is available in plate, heavy plate, sheet, patterned, tempered, wired, and laminated types. Heat absorbing glass dissipates much of the heat it absorbs, but some of the heat is retained. Thus, heat absorbing glass may become much hotter than ordinary plate glass.

Because of its higher rate of expansion, heat absorbing glass requires careful cutting, handling, and glazing. Sudden heating or cooling may induce edge stresses, which can result in failure if edges are improperly cut or damaged. Large lights made of heat absorbing glass that are partially shaded or heavily draped are subject to higher working stresses and require special design consideration.

9.1.4 Glare Reducing

Glare reducing glass is available in two types. The first type is transparent with a neutral gray or other color tint which lowers light transmission but preserves true color vision. The second type is translucent, usually white, which gives wide light diffusion and reduces glare. Both types absorb some of the sun’s radiant energy and therefore have heat absorbing qualities. The physical characteristics of glare reducing glass are quite similar to those of plate glass. Although glare reducing glass absorbs heat, it does not require the special precautions that heat absorbing glass does.

9.1.5 Insulating

Insulating glass units consist of two or more sheets of glass separated by either 3/16, 7/32, or 1/4 inch air space. These units are factory sealed. The captive air is dehydrated at atmospheric pressure. The edge seal can be made either by fusing the edges together or by using metal spacing strips. A mastic seal and metal edge support the glass.

Insulating glass requires special installation precautions. Openings into which insulating glass is installed must be plumb and square. Glazing must be free of paint and paper because they can cause a heat trap that may result in breakage. There must be no direct contact between insulating glass and the frame into which it is installed. The glazing compound must be a nonhardening type that does not contain any materials that will attack the metal-to-glass seal of the insulating glass. Never use putty. Resilient setting blocks and spacers should be provided for uniform clearances on all units set with face stops. Use metal glazing strips for 1/2 inch thick sash without face stops. Use a full bed of glazing compound in the edge clearance on the bottom of the sash and enough at the sides and top to make a weathertight seal. It is essential that the metal channel at the perimeter of each unit be covered by at least 1/8 inch of compound. This ensures a lasting seal.

9.1.6 Tempered

Tempered glass is plate or patterned glass that has been reheated to just below its melting point and then cooled very quickly by subjecting both sides to jets of air. This leaves the outside surfaces, which cool faster, in a state of compression. The inner portions of the glass are in tension. As a result, fully tempered glass has three to five times the strength against impact forces and temperature changes than untempered glass has. Tempered glass chipped or punctured on any edge or surface will shatter and disintegrate into small blunt pieces. Because of this, it cannot be cut or drilled.

9.1.7 Heat Strengthened

Heat strengthened glass is plate glass or patterned glass with a ceramic glaze fused to one side. Preheating the glass to apply the ceramic glaze strengthens the glass considerably, giving it characteristics similar to tempered glass. Heat strengthened glass is about twice as strong as plate glass. Like tempered glass, it cannot be cut or drilled.

Heat strengthened glass is available in thicknesses of 1/4 and 5/16 inch and in limited standard sizes. It is opaque and is most often used for spandrel glazing in curtain wall systems. Framing members must be sturdy and rigid enough to support the perimeter of the heat strengthened glass panels. Each panel should rest on resilient setting blocks. When used in operating doors and windows, it must not be handled or opened until the glazing compound has set.

9.1.8 Wired

Wired glass is produced by feeding wire mesh into the center of molten glass as it is passed through a pair of rollers. A hexagonal, diamond-shaped, square, or rectangular pattern weld or twisted wire mesh may be used. To be given a fire rating, the mesh must be at least 25 gauge, with openings no larger than 1 1/8 inches. Also, the glass must be no less than 1/4 inch thick. Wired glass may be etched or sandblasted on one or both sides to soften the light or provide privacy. It may be obtained with a pattern on one or both sides.

9.1.9 Patterned

Patterned glass has the same composition as window and plate glass. It is semi-transparent with distinctive geometric or linear designs on one or both sides. The pattern can be impressed during the rolling process, or sandblasted or etched later. Some patterns are also available as wired glass. Patterned glass allows entry of light while maintaining privacy. It is also used for decorative screens and windows. Patterned glass must be installed with the smooth side to the face of the putty.

9.1.10 Laminated

Laminated glass is composed of two or more layers of either sheet or polished plate glass with one or more layers of transparent or pigmented plastic sandwiched between the layers. A vinyl plastic, such as plasticized polyvinyl resin butyl 0.015 to 0.025 inch thick, is generally used. Only the highest quality sheet or polished plate glass is used in making laminated glass. When this type of glass breaks, the plastic holds the pieces of glass and prevents the sharp fragments from shattering. When four or more layers of glass are laminated with three or more layers of plastic, the product is known as bullet-resisting glass. Safety glass has only two layers of glass and one of plastic.

9.1.11 Safety

Safety glass is available with clear or pigmented plastic, and either clear or heat absorbing and glare reducing glass. Safety glass is used where strong impact may be encountered and the hazard of flying glass must be avoided. Exterior doors with a pane area greater than 6 square feet and shower tubs and enclosures are typical applications. Glazing compounds must be compatible with the layers of laminated plastic. Some compounds cause deterioration of the plastic in safety glass.

9.1.12 Mirrors

Mirrors are made with polished plate, window, sheet, and picture glass. The reflecting surface is a thin coat of metal, generally silver, gold, copper, bronze, or chromium, applied to one side of the glass. For special mirrors, lead, aluminum, platinum, rhodium, or other metals may be used. The metal film can be semi-transparent or opaque and can be left unprotected or protected with a coat of shellac, varnish, paint, or metal (usually copper). Mirrors used in building construction are usually either polished plate glass or tempered plate glass.

Proper installation requires that the weight of the mirror be supported at the bottom. Mastic installation is not recommended because it may cause silver spoilage.

9.1.13 Plexiglas®

Sheets made of thermoplastic acrylic resin (Plexiglas® and Luciteo, both trade names) are available in flat and corrugated sheets. This material is readily formed into curved shapes and, therefore, is often used in place of glass. Compared with glass, its surface is more readily scratched; hence, it should be installed in out-of-reach locations. This acrylic plastic is obtainable in transparent, translucent, or opaque sheets and in a wide variety of colors.

9.2.0 GLAZING MATERIALS

In this section, we will discuss the various types of sealers you'll need to install, hold fast, and seal a window in its setting.

9.2.1 Wood Sash Putty

Wood sash putty is a cement composed of fine powdered chalk (whiting) or lead oxide (white lead) mixed with boiled or raw linseed oil. Putty may contain other drying oils such as soybean or perilla. As the oil oxidizes, the putty hardens. Litharge (an oxide of lead) or special driers may be added if rapid hardening is required. Putty is used in glazing to set sheets of glass into frames. Special putty mixtures are available for interior and exterior glazing of aluminum and steel window sash.

A good grade of wood sash putty resists sticking to the putty knife or glazier's hands, yet it should not be too dry to apply to the sash. In wood sash, apply a suitable primer, such as priming paints or boiled linseed oil.

Putty should not be painted until it has thoroughly set. Painting forms an airtight film, which slows the drying. This may cause the surface of the paint to crack. All putty should be painted for proper protection.

9.2.2 Metal Sash Putty

Metal sash putty differs from wood putty in that it is formulated to adhere to nonporous surfaces. It is used for glazing aluminum and steel sash either inside or outside. It should be applied as recommended by the manufacturer. Metal sash putty should be painted within 2 weeks after application, but should be thoroughly set and hard before painting begins.

There are two grades of metal sash putty: one for interior and one for exterior glazing. Both wood sash putty and metal sash putty are known as oleoresinous caulking compounds. The advantage of these materials is their low cost; their disadvantages include high shrinkage, little adhesion, and an exposed life expectancy of less than 5 years.

9.2.3 Elastic Compounds

Elastic glazing compounds are specially formulated from selected processed oils and pigments, which remain plastic and resilient over a longer period than the common hard putties. Butyl and acrylic compounds are the most common elastics. Butyl compounds tend to stain masonry and have a high shrinkage factor. Acrylic based materials require heating to 110°F before application. Some shrinkage occurs during curing. At high temperatures, these materials sag considerably in vertical joints. At low temperatures, acrylic based materials become hard and brittle. They are available in a wide range of colors and have good adhesion qualities.

9.2.4 Polybutane Tape

Polybutane tape is a non-drying mastic which is available in extruded ribbon shapes. It has good adhesion qualities, but should not be used as a substitute or replacement for spacers. It can be used as a continuous bed material in conjunction with a polysulfide sealer compound. This tape must be pressure applied for proper adhesion.

9.2.5 Polysulfide Compounds

Polysulfide base products are two-part synthetic rubber compounds based on a polysulfide polymer. The consistency of these compounds after mixing is similar to that of a caulking compound. The activator must be thoroughly mixed with the base compound at the job. The mixed compound is applied with either a caulking gun or spatula. The sealing surfaces must be extremely clean. Surrounding areas of glass should be protected before glazing. Excess and spilled material must be removed and the surfaces cleaned promptly. Once polysulfide elastomer glazing compound has cured, it is very difficult to remove. Any excess material left on the surfaces after glazing should be cleaned during the working time of the material (2 to 3 hours). Toluene and xylene are good solvents for this purpose.

9.2.6 Rubber Materials

Rubber compression materials are molded in various shapes. They are used as continuous gaskets and as intermittent spacer shims. A weathertight joint requires that the gasket be compressed at least 15 percent. Preformed materials reduce costs because careful cleaning of the glass is not necessary, and there is no waste of material.

9.3.0 Measuring and Cutting Glass

Always measure the length and width of the opening in which the glass is to fit at more than one place. Windows are often not absolutely square. If there is a difference between two measurements, use the smaller and then deduct 1/8 inch from the width and length to allow for expansion and contraction. Otherwise, the glass may crack with changes of temperature. This is especially true with steel casement windows.

Cutting glass is a matter of confidence and experience. You can gain both by practicing on scrap glass before trying to cut window glass to size. Equipment required for glass cutting consists of a glass cutter, a flat, solid table, a tape measure, and a wood or metal T-square or straightedge. Lightly oil the cutting wheel with a thin machine oil or lubricating fluid, as shown in *Figure 12-66, view A*. Hold the cutter by resting your index finger on the flat part of the handle, as shown in *view B*.

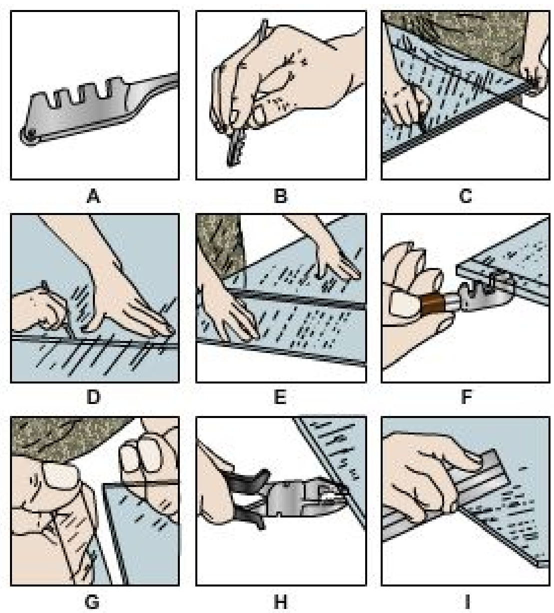


Figure 12-66 – Glass cutting.

To cut a piece of glass, lay a straightedge along the proposed cut, as shown in *view C*. Hold it down firmly with one hand and with the glass cutter in the other, make one continuous smooth stroke along along the surface of the glass with the side of the cutter pressed against the straightedge, as shown in *view D*. The objective is to score the glass, not cut through it. You should be able to hear the cutter bite into the glass as it moves along. Make sure the cut is continuous and that you have not skipped any section. Going over a cut is a poor practice as the glass is sure to break away at that point. Snap the glass immediately after cutting by placing a pencil or long dowel under the score line and pressing with your hands on each side of the cut, as shown in *view E*. Frosted or patterned glass should be cut on the smooth side. Wire-reinforced glass can be cut the same as ordinary glass, except that you will have to separate the wires by flexing the two pieces up and down until the wire breaks or by cutting the wires with side- cutting pliers.

To cut a narrow strip from a large piece of glass, score a line and then tap gently underneath the score line with the cutter to open up an inch or so of the score line, as shown in *view F*. Next, grasp the glass on each side of the line and gently snap off the waste piece, as shown in *view G*. Press downward away from the score mark. If the strip does not break off cleanly, nibble it off with the pliers, as shown in *view H*, or the notches in the cutter. Slivers less than 1/2 inch wide are cut off by scoring the line and then nibbling off the waste. Do not nibble without first scoring a line. You can smooth off the edges of glass intended for shelving or tabletops with an oilstone dipped in water, as shown in *view I*. Rub the stone back and forth from end to end with the stone at a 45° angle to the glass. Rub the stone side to side only, not up and down. No attempt should be made to change the size of heat strengthened, tempered, or doubled glazed units, since any such effort will result in permanent damage.

All heat absorbing glass must be clean cut. Nibbling to remove flares or to reduce oversized dimensions of heat absorbing glass is not permitted.

9.4.0 Sheet Glass Sizes and Grades

Sheet glass is produced in a number of thicknesses, but only 3/32 and 1/8 inch sheets are commonly used as a window glass. These thicknesses are designated, respectively, as single strength (SS) and double strength (DS). Thick sheet glass, manufactured by the same method as window glass, is used in openings that exceed window glass size recommendations. *Table 12-8* lists the thicknesses, weights, and recommended maximum sizes.

Table 12-8 – Weight and Maximum Sizes of Sheet Glass.

Thickness (inch)	Thickness (millimeters)	Weight (ounces/ square foot)	Weight (kilograms/ square meter)	Maximum Size (inches)	Maximum Size (millimeters)
Window Glass					
SS 3/32	**2.4**	**19**	**5.8**	**40 x 50**	**1,020 x 1,270**
DS 1/8	**3.2**	**26**	**7.9**	**60 x 80**	**1,520 x 2,030**
Thick Sheet Glass					
3/16	**4.8**	**40**	**7.2**	**120 x 84**	**3,050 x 2,130**
7/32	**5.6**	**45**	**9.7**	**120 x 84**	**3,050 x 2,130**
1/4	**6.3**	**52**	**15.9**	**120 x 84**	**3,050 x 2,130**
3/8	**9.5**	**77**	**23.5**	**160 x 84**	**4,060 x 2,130**
7/16*	**11.1**	**86**	**26.2**	**60 x 84**	**1,520 x 2,130**
*** Used for glass shelving and table tops**					

Sheet glass comes in six grades as shown in *Table 12-9.*

Table12-9 – Grades of Sheet Glass.

Grade	Use
AA	For uses where superior quality is required
A	For selected glazing
B	For general glazing
Silvering Quality A	For silvering mirror applications; seldom used for glazing
Silvering Quality B	For mirror applications; seldom used for glazing
Greenhouse Quality	For greenhouse glazing or similar applications where appearance is not critical

The maximum size glass that may be used in a particular location is governed to a great extent by wind load. Wind velocities, and consequently wind pressures, increase with height above the ground. Various building codes or project specifications determine the maximum allowable glass area for wind load.

9.5.0 Sash Preparation

Attacth the sash so that it will withstand the design load and comply with the specifications. Adjust, plumb, and square the sash to within 1/8 inch of nominal dimensions on shop drawings. Remove all rivets, screws, bolts, nail heads, welding fillets, and other projections from specified clearances. Seal all sash corners and fabrication intersections to make the sash watertight. Put a coat of primer paint on all sealing surfaces of wood sash and carbon steel sash. Use appropriate solvents to remove grease, lacquers, and other organic protecting finishes from sealing surfaces of aluminum sash.

9.5.1 Wood

On old wood sashes, you must clean all putty runs of broken glass fragments and glazier’s points, triangular pieces of zinc or galvanized steel driven into the rabbet. Remove loose paint and putty by scraping. Wipe the surface clean with a cloth saturated in mineral spirits or turpentine; prime the putty runs and allow them to dry.

On new wood sashes, remove the dust, prime the putty runs, and allow them to dry. All new wood sashes should be pressure treated for decay protection.

9.5.2 Metal

On old metal sashes, you must remove loose paint or putty by scraping. Use steel wool or sandpaper to remove rust. Clean the surfaces thoroughly with a cloth saturated in mineral spirits or turpentine. Prime bare metal and allow it to dry thoroughly.

On new metal sashes, you should wipe the sash thoroughly with a cloth saturated in mineral spirits or turpentine to remove dust, dirt, oil, or grease. Remove any rust with steel wool or sandpaper. If the sash is not already factory primed, prime it with rust-inhibitive paint and allow it to dry thoroughly.

9.6.0 Glazing

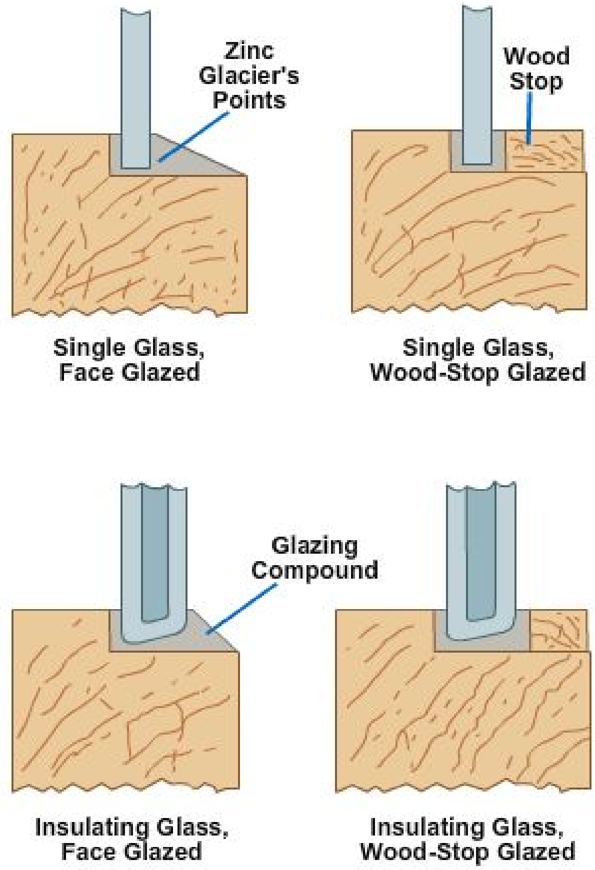


Figure 12-67 – Types of wood sash glazing.

Glazing refers to the installation of glass in prepared openings of windows, doors, partitions, and curtain walls. Glass may be held in place with glazier's points, spring clips, or flexible glazing beads. Glass is kept from contact with the frame with various types of shims. Putty, sealants, or various types of caulking compounds are applied to make a weathertight joint between the glass and the frame.

9.6.1 Wood Sash

Most wood sash is face glazed. The glass is installed in rabbets, consisting of L-shaped recesses cut into the sash or frame to receive and support panes of glass. The glass is held tightly against the frame by glazier's points. The rabbet is then filled with putty. The putty is pressed firmly against the glass and beveled back against the wood frame with a putty knife. A priming paint is essential in glazing wood sash. The priming seals the pores of the wood, preventing the loss of oil from the putty. Wood frames are usually glazed from the outside, as shown in *Figure 12-67*.

As we noted earlier, wood sash putty is generally made with linseed oil and a pigment. Some putties contain soybean oil as a drying agent. Do not paint putty until it is thoroughly set. Apply a bead of putty or glazing compound between the glass and the frame as a bedding. You should usually apply the bedding to the frame before the glass is set. Then use back puttying to force putty into spaces that may have been left between the frame and the glass.

9.6.2 Metal Windows and Doors

Glass set in metal frames must be prevented from making contact with metal. This may be accomplished by first applying a setting bed of metal sash putty or glazing compound. Metal sash putty differs from wood sash putty in that it is formulated to adhere to a nonporous surface.

Figure 12-68 shows examples of the types of metal sash putty. Elastic glazing compounds may be used in place of putty. These compounds are produced from processed oils and pigments, and will remain plastic and resilient over a longer period than will putty. A skin quickly forms over the outside of the compound after it is placed, while the interior remains soft. This type of glazing compound is used in windows or doors subject to twisting or vibration. It may be painted as soon as the surface has formed.

For large panes of glass, setting blocks may be placed between the glass edges and the frame to maintain proper spacing of the glass in the openings. The blocks may be of wood, lead, neoprene, or some flexible material. For large openings, set flexible shims between the face of the glass and the glazing channel to allow for movement. Plastics and heat absorbing or reflective glass require more clearance to allow for greater expansion. The shims may be in the form of a continuous tape of a butyl rubber based compound, which has been extruded into soft, tacky, ready to use tape that adheres to any clean, dry surface. Apply the tape to the frame and the glass holding ***stop*** before placing the glass in a frame. Under compression, the tape also serves as a sealant.

Glass may be held in place in the frame by spring clips inserted in holes in the metal frame or by continuous angles or stops attached to the frame with screws or Snap-on spring clips. The frames of metal windows are shaped either for outside or inside glazing.

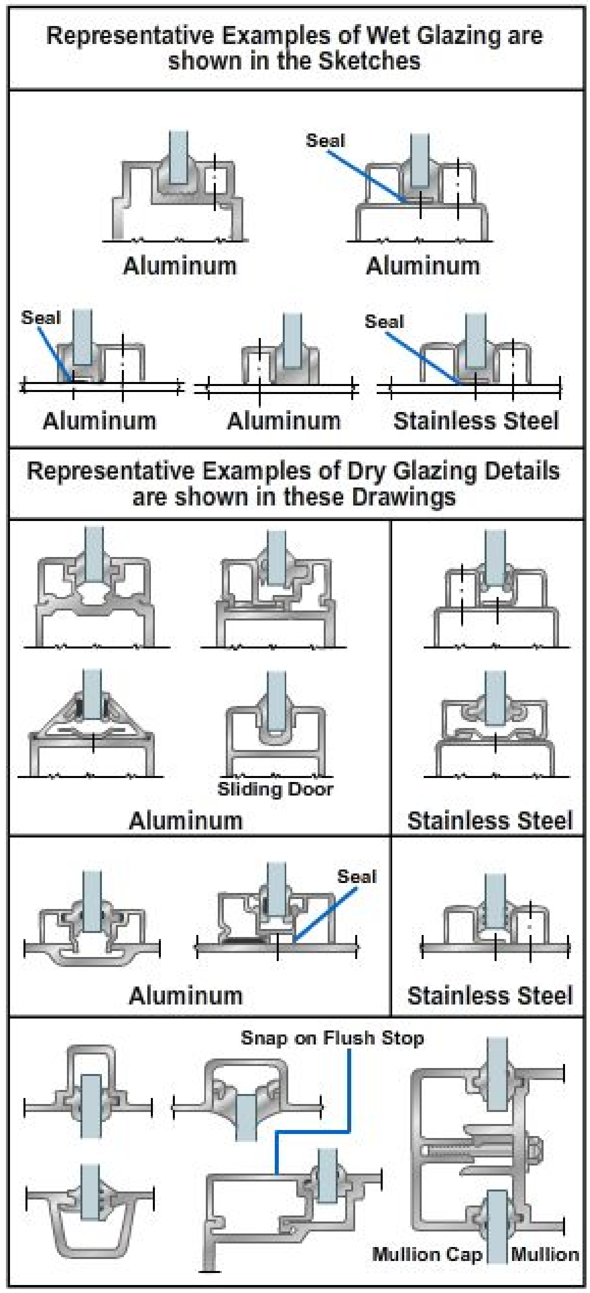


Figure 12-68 – Types of metal sash glazing.

Test your Knowledge (Select the Correct Response)

5. **(True or False)** Heat loss through metal window frames is less than through wood window frames.

   A. True
   B. False

9.7.0 Setting Glass in Wood and Metal Sashes

Do not ***glaze*** or reglaze exterior sash when the temperature is 40°F or lower unless absolutely necessary. Thoroughly clean sash and door members of dust with a brush or cloth dampened with turpentine or mineral spirits. Lay a continuous 1/6 inch thick bed of putty or compound in the putty run, as shown in *Figure 12-69*. The glazed face of the sash can be recognized as the size on which the glass was cut. If the glass has a bowed surface, set it with the concave side in. Set wire glass with the twist vertical. Press the glass firmly into place so that the bed putty will fill all irregularities.

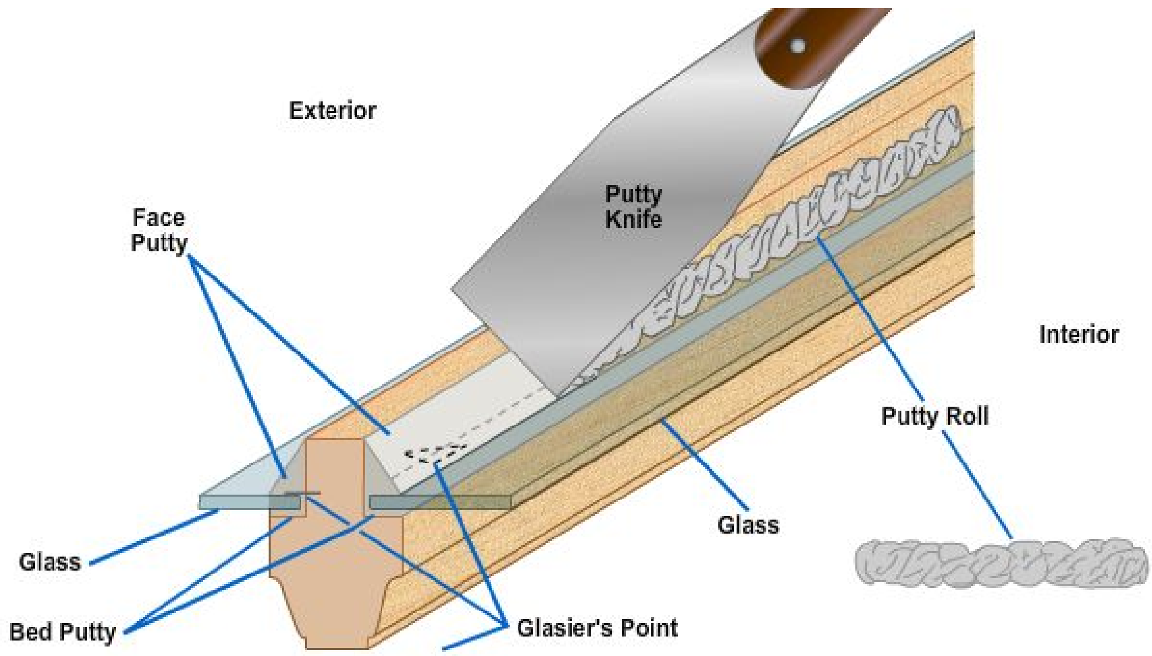


Figure 12-69 – Setting glass with glazier's points and putty.

When glazing wood sash, insert two glazier's points per side for small lights and about 8 inches apart on all sides for large lights. When glazing metal sash, use wire clips or metal glazing beads.

After the glass has been bedded, lay a continuous bead of putty against the perimeter of the glass face putty run. Press the putty with a putty knife or glazing tool with sufficient pressure to ensure its complete adhesion to the glass and sash. Finish with full, smooth, accurately formed bevels with clean cut miters. Trim up the bed putty on the revers side of the glass. When glazing or reglazing interior sash and transoms and interior doors, use wood or metal glazing beads bedded in putty. In setting wired glass for security purposes, set wood or metal glazing beads, and secure with screws on the side facing the area to be protected.

Paint wood sash putty as soon as it has surface hardened. Do not wait longer than 2 months after glazing. When painting the glazing compound, overlap the glass 1/16 inch as a seal against moisture.

For metal sashes, use type 1 metal sash elastic compound. Paint metal sash putty immediately after a firm skin has formed on the surface.

Depending on weather conditions, the time for skinning over may be 2 to 10 days. Type II metal sash putty can usually be painted within 2 weeks after placing. This putty should not be painted before it has hardened because early painting may retard the set.

Clean the glass on both sides after painting. A cloth moistened with mineral spirits will remove putty stains. When scrapers are used, exercise care to avoid breaking the paint seal at the putty edge.

After installing large glass units in buildings under construction, it is good practice to place a large X on the glass. Use masking tape or washable paint. This will alert workers so they will not walk into the glass or damage it with tools and materials.

10.0.0 INSULATION

The inflow of heat through outside walls and roofs in hot weather or its outflow during cold weather is a major source of occupant discomfort. Providing heating or cooling to maintain temperatures at acceptable limits for occupancy is expensive. During hot or cold weather, insulation with high resistance to heat flow helps save energy. Also, you can use smaller capacity units to achieve the same heating or cooling result, resulting in additional savings.

Most materials used in construction have some insulating value. Even air spaces between studs resist the passage of heat. However, when these stud spaces are filled or partially filled with material having a high insulating value, the stud space has many times the insulating ability of the air alone.

10.1.0 Types

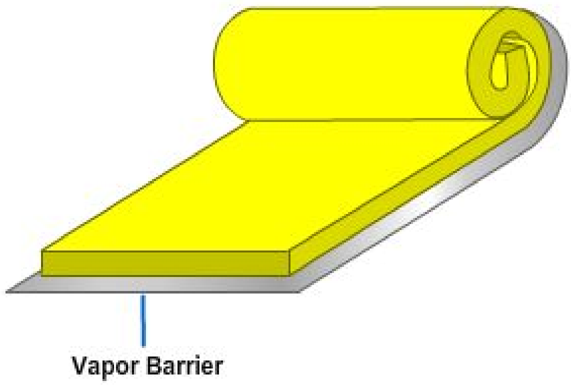
Commercial insulation is manufactured in a variety of forms and types, each with advantages for specific uses. Materials commonly used for insulation can be grouped in the following general classes:

- flexible insulation (blanket and batt)
- loose fill insulation
- reflective insulation
- rigid insulation (structural and nonstructural)
- miscellaneous types

The insulating value of a wall varies with different types of construction, kinds of materials used in construction, and types and thicknesses of insulation. As we just mentioned, air spaces add to the total resistance of a wall section to heat transmission, but an air space is not as effective as the same space filled with an insulating material.

10.1.1 Flexible

Flexible insulation is manufactured in two types, blanket and batt. Blanket insulation, shown in *Figure 12-70*, is furnished in rolls or packages in widths to fit between studs and joists spaced 16 and 24 inches OC. It comes in thicknesses of 3/4 inch to 12 inches. The body of the blanket is made of felted mats of mineral or vegetable fibers such as rock or glass wool, wood fiber, and cotton. Organic insulations are treated to make them resistant to fire, decay, insects, and vermin. Most blanket insulation is covered with paper or other sheet material with tabs on the sides for fastening to studs or joists. One covering sheet serves as a vapor barrier to resist movement of water vapor and should always face the warm side of the wall. Aluminum foil, asphalt, or plastic laminated paper is commonly used as barrier materials.



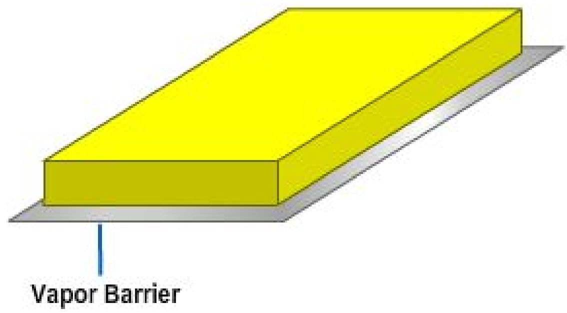


Figure 12-70 – Blanket insulation. **Figure 12-71 – Batt insulation.**

Batt insulation, shown in *Figure 12-71*, is also made of fibrous material preformed to thicknesses of 3 1/2 to 12 inches for 16 and 24 inch joist spacing. It is supplied with or without a vapor barrier. One friction type of fibrous glass batt is supplied without a covering and is designed to remain in place without the normal fastening methods.

10.1.2 Loose Fill

Loose fill insulation, shown in *Figure 12-72*, is usually composed of materials used in bulk form, supplied in bags or bales, and placed by pouring, blowing, or packing by hand. These materials include rock or glass wool, wood fibers, shredded redwood bark cork wood pulp products, vermiculite, sawdust, and shavings. Fill insulation is suited for use between first floor ceiling joists in unheated attics. It is also used in sidewalls of existing houses that were not insulated during construction. Where no vapor barrier was installed during construction, suitable paint coatings, as described in the Finishes chapter, should be used for vapor barriers when blown insulation is added to an existing house.

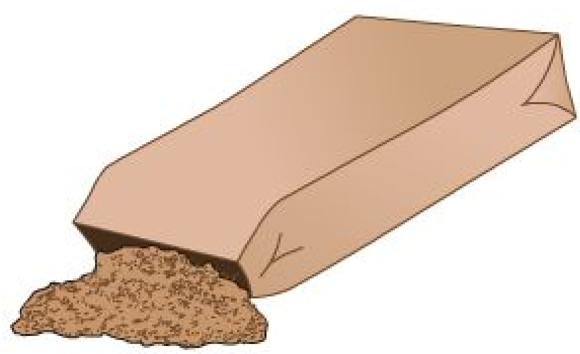


Figure 12-72 - Loose fill insulation.

10.1.3 Reflective

Most materials have the property of reflecting radiant heat, and some materials have this property to a very high degree. Materials high in reflective properties include aluminum foil, copper, and paper products coated with a reflective oxide. Such materials can be used in enclosed stud spaces, attics, and similar locations to retard heat transfer by radiation. Reflective insulation is effective only where the reflective surface faces an air space at least 3/4 inch deep. Where this surface contacts another material, the reflective properties are lost and the material has little or no insulating value. Proper installation is the key to obtaining the best results from the reflective insulation.

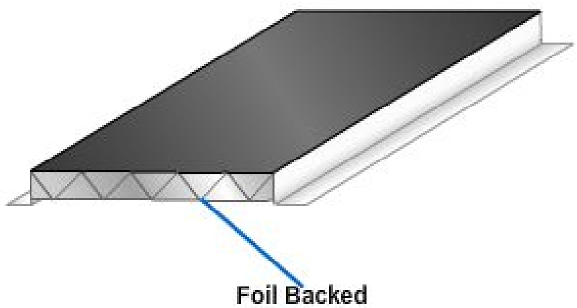


Figure 12-73 – Insulation with reflective backing.

Reflective insulation is equally effective whether the reflective surface faces the warm or cold side. Reflective insulation used in conjunction with foil backed gypsum drywall makes an excellent vapor barrier. The type of reflective insulation, shown in *Figure 12-73*, includes a reflective surface. When properly installed, it provides airspace between other surfaces.

10.1.4 Rigid

Rigid insulation, shown in *Figure 12-74*, is usually a fiberboard material manufactured in sheet form. It is made from processed wood, sugar cane, or other vegetable products.

Structural insulating boards, in densities ranging from 15 to 31 pounds per cubic foot, are fabricated as building boards, roof decking, sheathing, and wallboard. Although these boards have moderately good insulating properties, their primary purpose is structural.

Figure 12-74 – Rigid insulation.

Roof insulation is nonstructural and serves mainly to provide thermal resistance to heat flow in roofs. It is called slab or block insulation and is manufactured in rigid units 1/2 inch to 3 inches thick and usually 2 by 4 foot sizes.

In building construction, perhaps the most common forms of rigid insulation are sheathing and decorative covering in sheet or in tile squares. Sheathing board is made in thicknesses of 1/2 and 25/32 inch. It is coated or impregnated with an asphalt compound to provide water resistance. Sheets are made in 2 by 8 foot sizes for horizontal application and 4 by 8 foot or longer sizes for vertical application.

10.1.5 Miscellaneous

Some insulations are not easily classified, such as insulation blankets made up of multiple layers of corrugated paper. Other types, such as lightweight vermiculite and perlite aggregates, are sometimes used in plaster as a means of reducing heat transmission. Other materials in this category are foamed in place insulations, including sprayed and plastic foam types. Sprayed insulation is usually inorganic fibrous material blown against a clean surface that has been primed with an adhesive coating. It is often left exposed for acoustical as well as insulating properties.

Expanded polystyrene and urethane plastic forms can be molded or foamed in place. Urethane insulation can also be applied by spraying. Polystyrene and urethane in board form can be obtained in thicknesses from 1/2 to 2 inches.

10.2.0 LOCATION of INSULATION

In most climates, all walls, ceilings, roofs, and floors that separate heated spaces from unheated spaces should be insulated. This reduces heat loss from the structure during cold weather and minimizes air conditioning during hot weather. The insulation should be placed on all outside walls and in the ceiling. In structures that have unheated crawl spaces, insulation should be placed between the floor joists or around the wall perimeter.

If a blanket or batt insulation is used, it should be well supported between joists by slats and a galvanized wire mesh, or by a rigid board. The vapor barrier should be installed toward the subflooring. Press fit or friction insulations fit tightly between joists and require only a small amount of support to hold them in place.

Reflective insulation is often used for crawl spaces, but only dead air space should be assumed in calculating heat loss when the crawl space is ventilated. A ground cover of roll roofing or plastic film, such as polyethylene, should be placed on the soil of crawl spaces to decrease the moisture content of the space as well as of the wood members.

Insulation should be placed along all walls, floors, and ceilings that are adjacent to unheated areas. These include stairways, dwarf (knee) walls, and dormers of 1 1/2 story structures. Provisions should be made for ventilating the unheated areas.

Where attic space is unheated and a stairway is included, insulation should be used around the stairway as well as in the first floor ceiling. The door leading to the attic should be weather stripped to prevent heat loss. Walls adjoining an unheated garage or porch should also be insulated. In structures with flat or low pitched roofs, insulation should be used in the ceiling area with sufficient space allowed above for cleared unobstructed ventilation between the joists. Insulation should be used along the perimeter of houses built on slabs. A vapor barrier should be included under the slab.

In the summer, outside surfaces exposed to the direct rays of the sun may attain temperatures of 50°F or more above shade temperatures and tend to transfer this heat into the house. Insulation in the walls and in the attic areas retards the flow of heat and improves summer comfort conditions.

Where air conditioning is used, insulation should be placed in all exposed ceilings and walls in the same manner as insulating against cold weather heat loss. Shading of glass against direct rays of the sun and the use of insulated glass helps reduce the air conditioning load.

Ventilation of attic and roof spaces is an important adjunct to insulation. Without ventilation, an attic space may become very hot and hold the heat for many hours. Ventilation methods suggested for protection against cold weather condensation apply equally well to protection against excessive hot weather roof temperatures.

The use of storm windows or insulated glass greatly reduces heat loss. Almost twice as much heat loss occurs through a single glass as through a window glazed with insulated glass or protected by a storm sash. Double glass normally prevents surface condensation and frost forming on inner glass surfaces in winter. When excessive condensation persists, paint failures and decay of the sash rail can occur.

⚠ CAUTION ⚠

Prior to the actual installation of the insulation, consult the manufacturer's specifications and guidelines for personal protection items required. Installing insulation is not particularly hazardous; however, there are some health safeguards to be observed when working with fiberglass.

10.3.0 INSTALLATION

Blanket insulation and batt insulation with a vapor barrier should be placed between framing members so that the tabs of the barrier lap the edge of the studs as well as the top and bottom plates. This method is not popular with contractors because it is more difficult to apply the drywall or rock lath (plaster base). However, it assures a minimum of vapor loss compared to the loss when the tabs are stapled to the sides of the studs. To protect the top and soleplates, as well as the headers over openings, use narrow strips of vapor barrier material along the top and bottom of the wall, as shown in *Figure 12-75*. Ordinarily, these areas are not well covered by the vapor barrier on the blanket or batt. A hand stapler is commonly used to fasten the insulation and the vapor barriers in place.

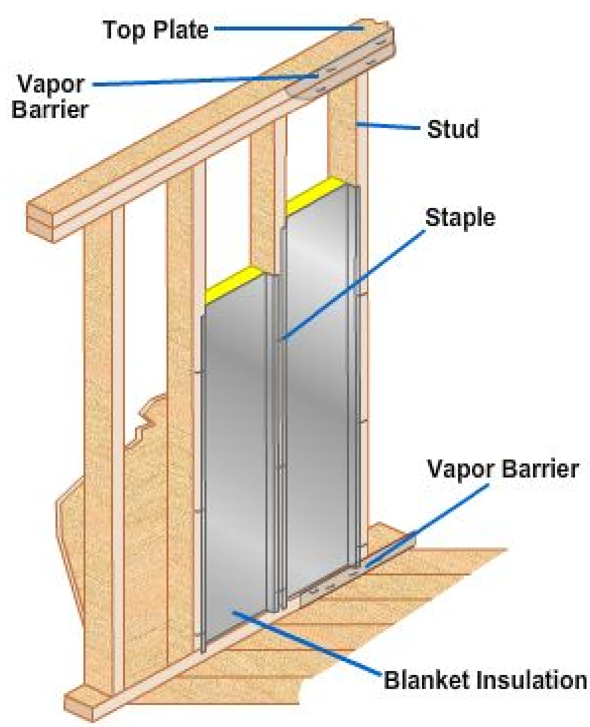


Figure 12-75 –Application of insulation with a vapor barrier.

For insulation without a vapor barrier (batt), a plastic film vapor barrier, such as 4 roil polyethylene, is commonly used to envelop the entire exposed wall and ceilings, as shown in *Figure 12-76, views A* and *B*. It covers the openings, window and door headers, and edge studs. This system is one of the best for resistance to vapor movement. It does not have the installation inconveniences encountered when tabs of the insulation are stapled over the edges of the studs. After the drywall is installed or plastering is completed, the film is trimmed around the window and door openings.

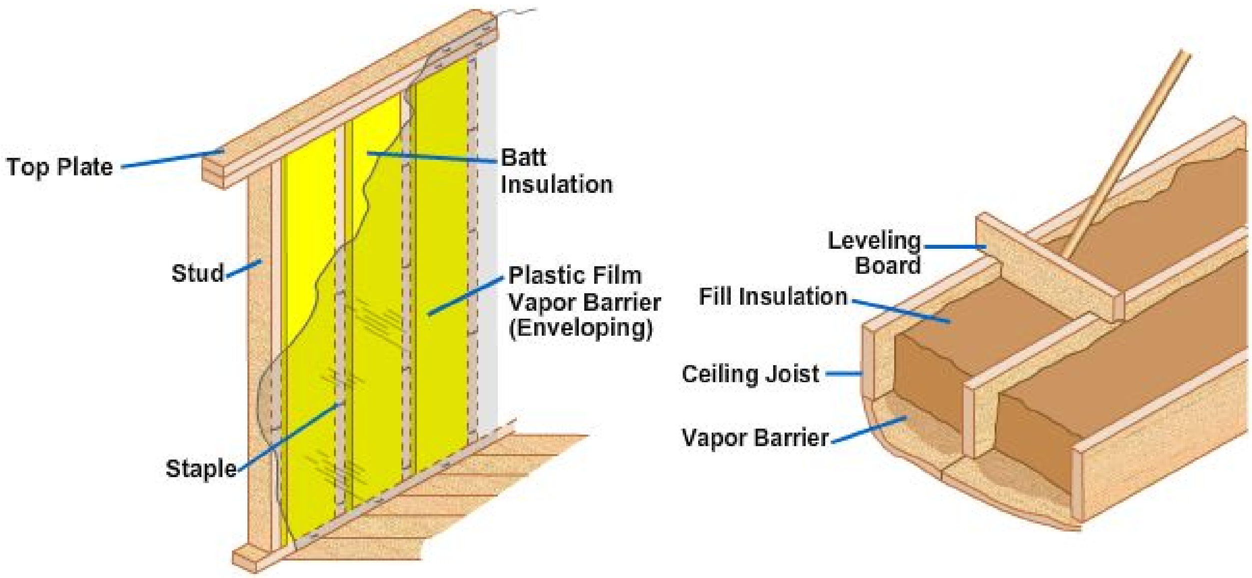


Figure 12-76 – Application of insulation without a vapor barrier.

Reflective insulation, in a single sheet form with two reflective surfaces, should be placed to divide the space formed by the framing members into two approximately equal spaces. Some reflective insulations include air spaces and are furnished with nailing tabs. This type is fastened to the studs to provide at least a 3/4 inch space on each side of the reflective surfaces.

Fill insulation is commonly used in ceiling areas and is poured or blown into place, as shown in *Figure 12-77*. A vapor barrier should be used on the warm side (the bottom, in case of ceiling joists) before insulation is placed. A leveling board as shown gives a constant insulation thickness. Thick batt insulation might also be combined to obtain the desired thickness with the vapor barrier against the back face of the ceiling finish. Ceiling insulation 6 or more inches thick greatly reduces heat loss in the winter and also provides summertime protection.

Areas around doorframes and window frames between the jambs and rough framing members also require insulation. Carefully fill the areas with insulation. Try not to compress the material, which may cause it to lose some of its insulating qualities. Because these areas are filled with small sections of insulation, a vapor barrier must be used around the openings as well as over the header above the openings, as shown in *Figure 12-77*.

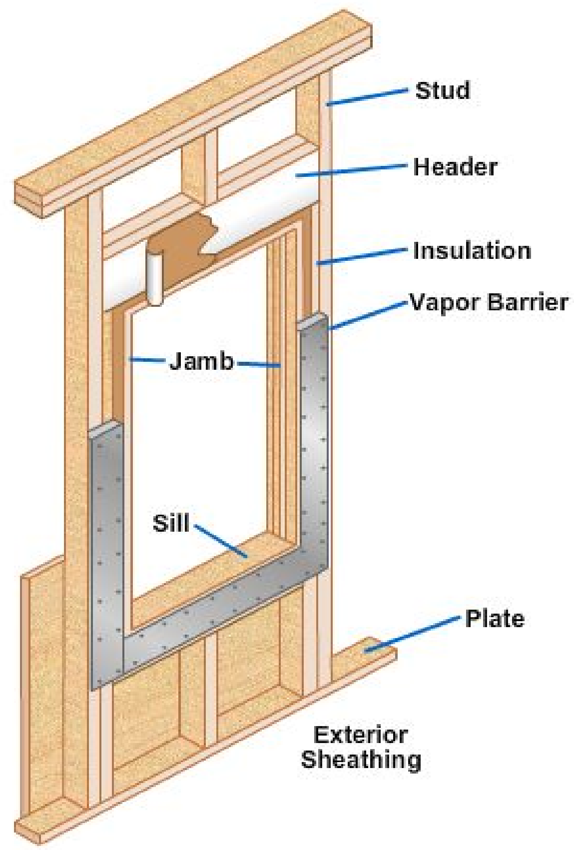


Figure 12-77 – Precautions in insulating around a window.

Enveloping the entire wall eliminates the need for this type of vapor barrier installation.

In 1 1/2 and 2 story structures and in basements, the area at the joist header at the outside walls should be insulated and protected with a vapor barrier, as shown in *Figure 12-78*. Insulation should be placed behind electrical outlet boxes and other utility connections in exposed walls to minimize condensation on cold surfaces.

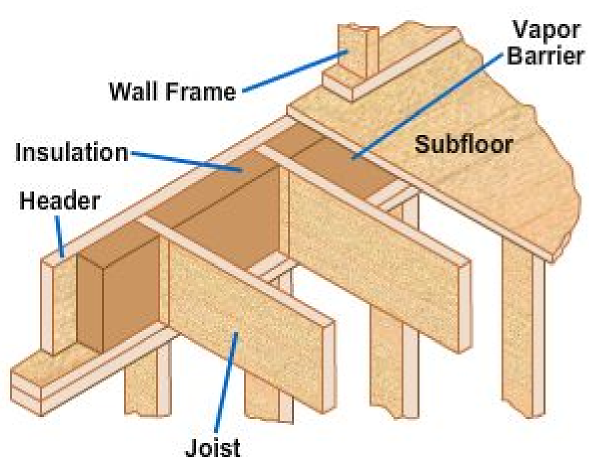


Figure 12-78 – Precautions in insulating at a joist header.

10.4.0 VAPOR BARRIER

Most building materials are permeable to water vapor. This presents problems because considerable water vapor can be generated inside structures. In cold climates during cold weather, this vapor may pass through wall and ceiling materials and condense in the wall or attic space. In severe cases, it may damage the exterior paint and interior finish, or even result in structural member decay. For protection, a material highly resistive to vapor transmission, called a vapor barrier, should be used on the warm side of a wall and below the insulation in an attic space.

10.4.1 Types

Effective vapor barrier materials include asphalt-laminated papers, aluminum foil, and plastic films. Most blanket and batt insulations include a vapor barrier on one side, and some of them with paper backed aluminum foil. Foil backed gypsum lath or gypsum boards are also available and serve as excellent vapor barriers.

Some types of flexible blanket and batt insulations have barrier material on one side. Such flexible insulations should be attached with the tabs at their sides fastened on the inside (narrow) edges of the studs, and the blanket should be cut long enough so that the cover sheet can lap over the face of the soleplate at the bottom and over the plate at the top of the stud space. However, such a method of attachment is not the common practice of most installers.

When a positive seal is desired, wall height rolls of plastic film vapor barriers should be applied over studs, plates, and window and doorheaders. This system, called enveloping, is used over insulation having no vapor barrier or to ensure excellent protection when used over any type of insulation. The barrier should be fitted tightly around outlet boxes and sealed if necessary. A ribbon of sealing compound around an outlet or switch box minimizes vapor loss at this area. Cold air returns, located in outside walls, should be made of metal to prevent vapor loss and subsequent paint problems.

10.4.2 Paint Coatings

Paint coatings cannot substitute for the membrane types of vapor barriers, but they do provide some protection for structures where other types of vapor barriers were not installed during construction. Of the various types of paint, one coat of aluminum primer followed by two decorative coats of flat wall oil base paint is quite effective. For rough plaster for buildings in very cold climates, two coats of aluminum primer may be necessary. A pigmented primer and sealer, followed by decorative finish coats or two coats of rubber base paint, are also effective in retarding vapor transmission.

11.0.0 VENTILATION

Condensation of moisture vapor may occur in attic spaces and under flat roofs during cold weather. Even where vapor barriers are used, some vapor will probably work into these spaces around pipes and other inadequately protected areas and through the vapor barrier itself. Although the amount might be unimportant if equally distributed, it may be sufficiently concentrated in some cold spots to cause damage. While wood shingle and wood shake roofs do not resist vapor movement, such roofings as asphalt shingles and builtup roofs are highly resistant. The most practical method of removing the moisture is by adequate ventilation of roof spaces.

A warm attic that is inadequately ventilated and insulated may cause formation of ice dams at the cornice as shown in *Figure 12-79*. During cold weather after a heavy snowfall, heat causes the snow next to the roof to melt. Water running down the roof freezes on the colder surface of the cornice, often forming an ice dam at the gutter that may cause water to back up at the eaves and into the wall and ceiling. Similar dams often form in roof valleys.

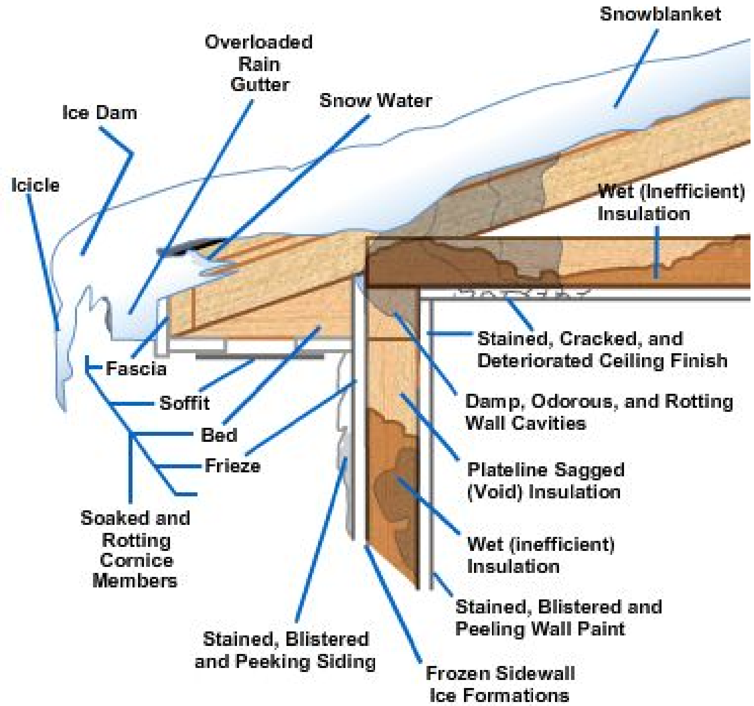


Figure 12-79 – Ice dam and damage.

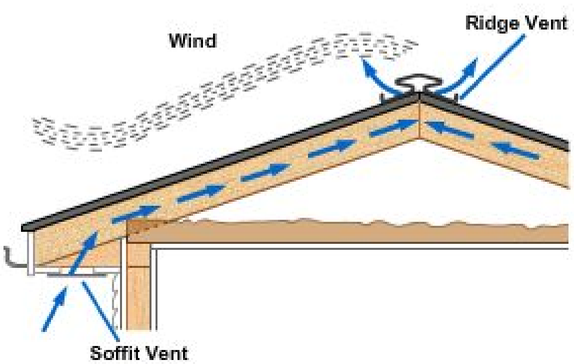


Figure 12-80 – Adequate ventilation to prevent ice dams.

Ventilation provides part of the solution to these problems. With a well insulated ceiling and adequate ventilation, as shown in *Figure 12-80*, attic temperatures are low and melting of snow over the attic space greatly reduced.

In hot weather, ventilation of attic and roof spaces offers an effective means of removing hot air and lowering the temperature in these spaces. Insulation between ceiling joists below the attic or roof space to further retard heat flow into the rooms below improves comfort conditions. It is common practice to install louvered openings in the end walls of gable roofs for ventilation.

Air movement through such openings depends primarily on wind direction and velocity. No appreciable movement can be expected when there is no wind. Positive air movement can be obtained by providing additional openings (vents) in the soffit areas of the roof overhang, as shown in *Figure 12-81, view A*, or ridge *view B*.

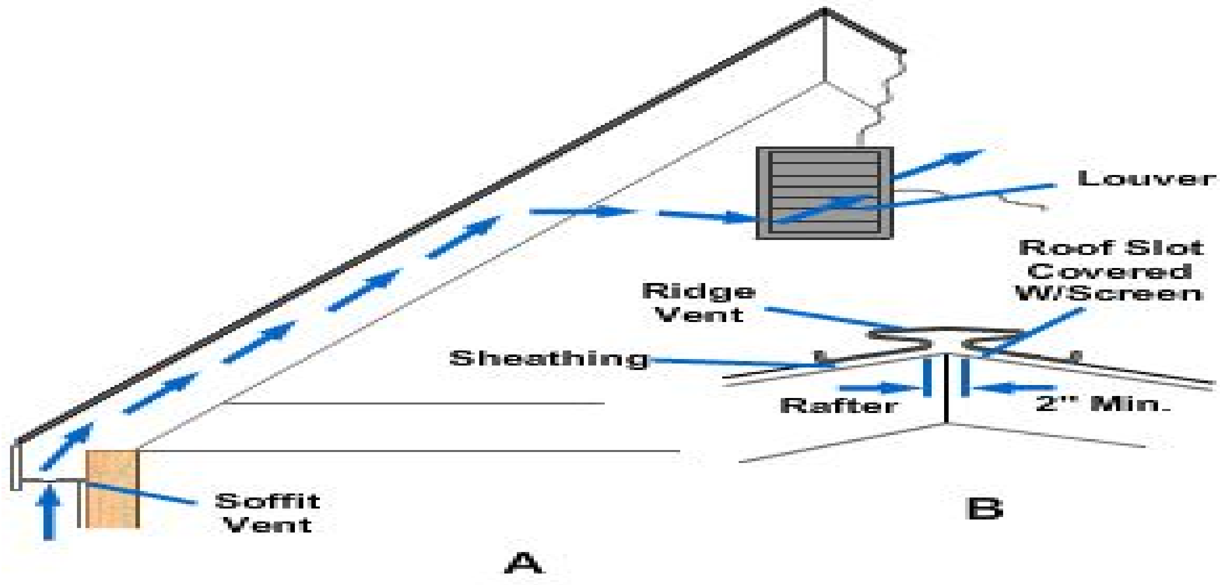


Figure 12-81 – Vents in soffit areas.

Hip roof structures are best ventilated by soffit vents and by outlet ventilators along the ridge. The differences in temperature between the attic and the outside create an air movement independent of the wind, and also a more positive movement when there is wind. Turbine type ventilators are also used to vent attic spaces, as shown in *Figure 12-82*.

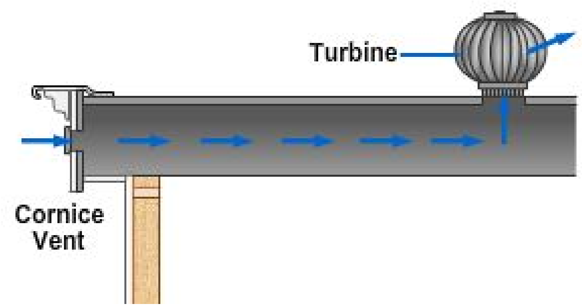


Figure 12-82 – Turbine type ventilator.

Where there is a crawl space under the house or porch, ventilation is necessary to remove the moisture vapor rising from the soil. Such vapor may otherwise condense on the wood below the floor and cause decay. As mentioned earlier, a permanent vapor barrier on the soil of the crawl space greatly reduces the amount of ventilation required.

Tight construction (including storm windows and storm doors) and the use of humidifiers have created potential moisture problems that must be resolved by adequate ventilation and the proper use of vapor barriers. Blocking of soffit vents with insulation, for example, must be avoided because this can prevent proper ventilation of attic spaces. Inadequate ventilation often leads to moisture problems, resulting in unnecessary maintenance costs.

Various styles of gable end ventilators are available. Many are made with metal louvers and frames; others may be made of wood to more closely fit the structural design. However, the most important factors are to have properly sized ventilators and to locate ventilators as close to the ridge as possible without affecting appearance.

Ridge vents require no special framing, only the disruption of the top course of roofing and the removal of strips of sheathing. Snap chalk lines running parallel to the ridge, down at least 2 inches from the peak. Use a linoleum cutter or a utility knife with a very stiff blade to cut through the roofing along the lines. Remove the roofing material and any roofing nails that remain. Set your power saw to cut through just the sheathing (not into the rafters) along the same lines. A carbide tipped blade is best for this operation. Remove the sheathing. Nail the ridge vent over the slot you have created, using gasketed roofing nails. Remember to use compatible materials. For example, aluminum nails should be used with aluminum vent material. Because the ridge vent also covers the top of the roofing, be sure the nails are long enough to penetrate into the rafters. Caulk the underside of the vent before nailing.

The openings for louvers and in-the-wall fans, shown in *Figure 12-83*, are quite similar. In fact, fans are usually covered with louvers. Louver slats should have a downward pitch of 45° to minimize water blowing in. As with soffit vents, a backing of corrosion resistant screen is needed to keep insects out. Ventilation fans may be manually or thermostatically controlled.

When installing a louver in an existing gable end wall, disturb the siding, sheathing, or framing members as little as possible. Locate the opening by drilling small holes through the wall at each corner. Snap chalk lines to establish the cuts made with a reciprocating saw. Cut back the siding to the width of the trim housing the louver (or the louver with fan), but cut back the sheathing only to the dimensions of the fan housing. Box in the rough opening itself with 2 by 4s and nail or screw the sheathing to them. Flash and caulk a gable end louver as you would a door or a window.

Small, well distributed vents or continuous slots in the soffit provide good inlet ventilation. These small louvered and screened vents, shown in *Figure 12-84*, are easily obtained and simple to install. Only small sections need to be cut out of the soffit to install these vents, which can be sawed out before the soffit is installed. It is better to use several small, well distributed vents than a few large ones. Any blocking that might be required between rafters at the wall line should be installed to provide an airway into the attic area.

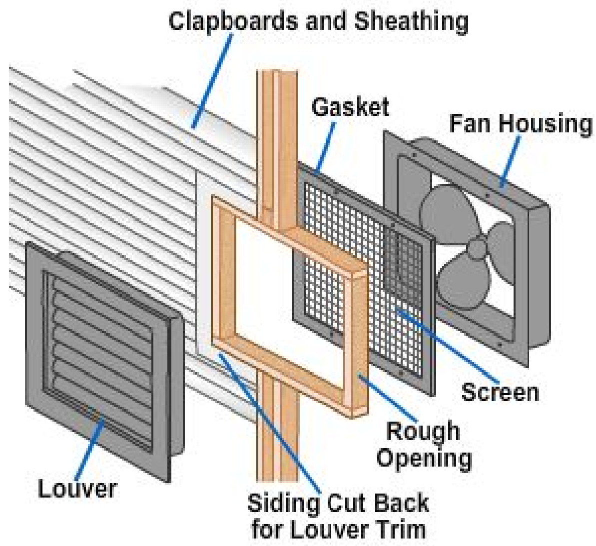


Figure 12-83 – Openings for louvers and in-the-wall fans.

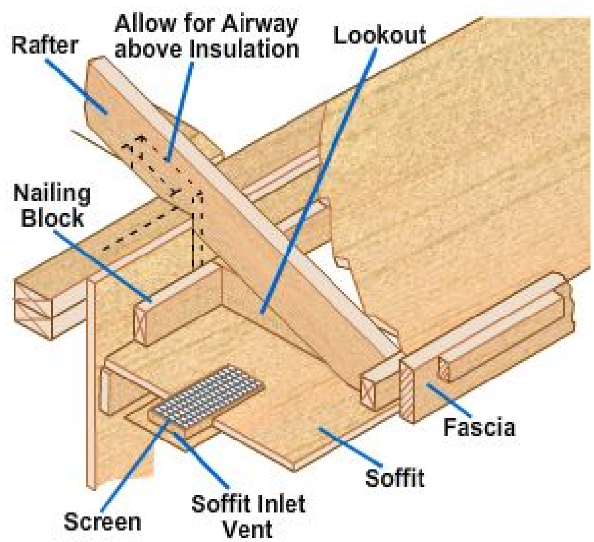


Figure 12-84 – Louvered and screened vent.

A continuous screened slot vent, which is often desirable, should be located near the outer edge of the soffit near the fascia, as shown in *Figure 12-85*. This location minimizes the chance of snow entering. This type of vent is also used on the overhang of flat roofs.

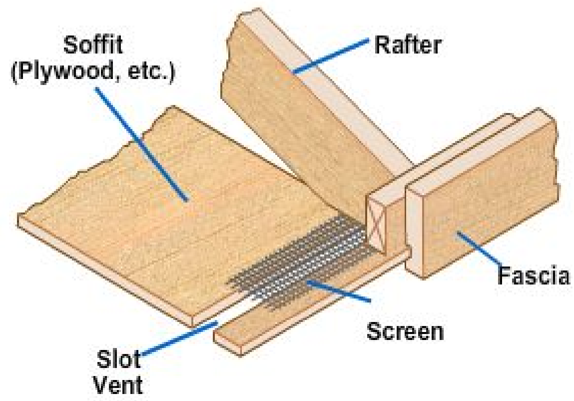


Figure 12-85 – Continuous screened slot vent.

Summary

This chapter covered the many aspects of moisture protection. You learned about roofing finishes, from sheathing to underlayment to final finishes such as shingles and built-up roofing. You learned about exterior wall finishes, including different types of siding. You learned about the importance of flashing to protect the transition from one surface to another. You learned how gutters and downspouts move water away from the surfaces of the building. You found out how to install doors and windows, including glazing windows. You discovered the importance of insulation and ventilation in keeping a building free of moisture.

Trade Terms Introduced in this Chapter

Apron	On a window, a piece of finish trim placed under the stool.
Asphalt	A dark brown to black, solid or semi-solid, hydrocarbon produced from the residuum left after the distillation of petroleum. It comes in a wide range of viscosities and softening points, from about 135°F (dead – level asphalt) to 225°F.
Asphalt shingles	A type of composition shingle made of felt and saturated with asphalt or tar pitch.
Astragal	A closure between the two leaves of a double-swing or double-slide door to close the joint. This can also be a piece of molding.
Base sheet	The first layer of roofing applied on the deck. Also a dry or slip-sheet.
Binder	Hot melted pitch (or asphalt) applied between the layers of a built up roof to bind the layers of felt together.
Bitumens	The generic term for a semi-solid mixture of complex hydrocarbons derived from petroleum or coal. In the roofing industry there are two basic bitumens, asphalt and coal tar pitch.
Brooming	The act of sweeping in roofing felts with a broom.
Built up roof	A roof formed by a number of layers of roofing mopped together with hot asphalt or pitch, and surfaced with mineral aggregate or asphaltic materials (BUR).
Burner	An apparatus that emits flames used to heat a kettle.
Cant strip	Triangular-shaped material used under flashing to modify the angle at the point where the roof meets any vertical element of the structure.
Cap sheet	The top sheet of the BUR forming the finished surface of the roof.
Casings	The trim around doors and windows.
Coal tar pitch	Dark brown to black solid hydrocarbon obtained from the residuum of the distillation of coke-oven tar (soft coal). It is used as the waterproofing agent of dead level or low slope built up roofs. It comes in a narrow range of softening points, from 129 to 144°F.

Course	A continuous row or layer of shingles or other roofing materials.
Dead level	Absolutely horizontal or zero slope
Dressed and matched	Boards or planks machined with a tongue on one edge and a groove on the other edge.
Eaves	The part of a roof projecting over the sidewall.
Emulsions	An asphalt and water mixture used in damp proofing and roof coating. After drying, the asphalt remains.
Exposure	The portion of roofing exposed to the weather. The correct felt exposure in a shingled, multi ply roof is computed by dividing the felt width minus 2 inches by the number of plies (For example, for two plies of 36 inch-wide felt, the exposure is 36 – 2 divided by 2 = 17 inches.)
Flashing	Sheets of metal or other suitable material used to make watertight joints on roofs. Base flashing forms the upturned edges of the watertight membrane. Cap or counter-flashing shields the exposed edges and joints of the base flashing.
Flood coat	The top layer of bitumen in an aggregate surfaced built up roofing membrane. Correctly applied, it is poured, not mopped, to a weight of 60 pounds square for asphalt and 75 pounds per square for coal-tar pitch.
Glaze	The process of installing glass panes in window frames and doorframes and applying putty to hold the glass in position.
Glaze coat	The top layer of asphalt in a smooth-surfaced built up roof assembly. A thin protective coating of bitumen applied to the top of a built up membrane, when the top pouring and aggregate surfacing are delayed (phased application).
Joists	A member that makes up the body of the floor and ceiling frames.
Mastic	(1) A thick, bituminous adhesive used for applying floor and wall tiles. (2) A waterproof caulking compound used in roofing that retains some elasticity after setting.
Membranes	A flexible or semi-flexible roof covering, the weather resistant component of the roofing system.
Mopping	An application of bitumen with a mop or mechanical applicator to the substrate or to the felts of a built up roofing membrane.
Mullion	The division between multiple windows or screens.
Muntins	The small members dividing glass panes in a window frame; vertical separators between panels in a panel door.

Nailing strips	A strip of wood set in concrete along the eaves or gable of a roof.
Parapet	The part of a wall above the roof line; a low wall above the roof level.
Plywood	A flat panel made up of a number of thin sheets (veneers) of wood. The grain direction of each ply, or layer, is at right angles to the one adjacent to it. The veneer sheets are united under pressure by a bonding agent.
Primers	A thin asphalt base sprayed or brushed on a roof before applying asphalt.
Rafters	A sloping roof member supporting the roof covering and extending from the ridge or the hip of the roof to the eaves.
Rake	The angle of slope of a roof rafter.
Ridge	The long joining members placed at the angle where two slopes of a roof meet at the peak.
Rise	In a roof, the vertical distance between the plate and the ridge.
Sash	The movable part of a window.
Saturated felt	A felt that has been impregnated with bitumen of low softening point, from 100 to 160°F.
Shakes	A rough, unshaven shingle.
Shiplapped	Lumber worked with a rabbeted joint on each edge to ensure snug fits.
Slag	A refuse product of the smelting of ores that is used on roofs for gravel.
Slope	The tangent of the angle between the roof surface and the horizontal in inches per foot. A. Dead level – to 1/4 inch per foot per foot B. Flat – over 1/4 inch up to 11/2 inch per foot C. Steep slope – over 11/2 inches per foot
Soffit	The underside of a subordinate member of a building.
Square	A unit of measure of roofing area equal to 100 square feet.
Starter strip	A strip of roofing used at the eaves of a roof under the first row of shingles.
Stool	On a window, a narrow interior shelf that runs across the lower part of the window opening and butts against the sill.

Stop	Molding nailed into a window frame to hold the bottom sash of a double hung window in place.
Tabs	The lower or butt end of a shingle
Terneplate	A steel plate coated with an alloy of lead and a small amount of tin.
Valley	The gutter or angle formed by the meeting of two roof slopes.
Vents	An opening for the circulation of air, etc., an outlet, as a vent pipe.

Additional Resources and References

This chapter is intended to present thorough resources for task training. The following reference works are suggested for further study. This is optional material for continued education rather than for task training.

Basic Roof Framing, Benjamin Barnow, Tab Books, Inc., Blue Ridge Summit, Pa., 1986.

Carpentry, Leonard Keel, American Technical Publishers, Alsip, Ill., 1985.

Design of Wood Frame Structures for Permanence, National Forest Products Association, Washington, D.C., 1988.

Facilities Planning Guide, NAVFAC P-437, Naval Facilities Engineering Command, Alexandria, Va., 1982.

Fall-Protection Guide for Ashore Facilities, Department of the Navy, 2003.

Manual of Built up Roof Systems, C. W. Griffin, McGraw-Hill Book Co., New York, 1982.

Modern Carpentry, Willis H. Wagner, Goodheart-Wilcox Co., South Holland, Ill., 1983.

Operations Officer's Handbook, COMCBPAC/COMCBLANTINST 5200.2A, Commander, Naval Construction Battalions, U.S. Pacific Fleet, Pearl Harbor, Hawaii, and Commander, Naval Construction Battalions, U.S. Atlantic Fleet, Norfolk, Va., 1988.

Seabee Crewleader's Handbook 3rd edition, CECOS, June 2003.

Seabee Planner's and Estimator's Handbook, NAVFAC P-405, Chapter 5, Naval Facilities Engineering Command, Alexandria, Va., 1983.

Wood Frame House Construction, L.O. Anderson, Forest Products Laboratory, U.S. Forest Service, U.S. Department of Agriculture, Washington, D.C., 1975.

http://www.safetycenter.navy.mil/bestpractices/ashore/fall_protection.htm