Location of Structure on Site

A number of factors affect the location of a structure on a site, as well as the type of building that may be erected. Once the site is chosen, different methods may be used to create the plan for building the structure. Required documentation to attain final approval of the building includes the plot plan, the Certified Plot Plan, and the Certificate of Occupancy.

Basic Conditions

A number of conditions determine what kind of building may be erected, as well as where on the lot it may be located, including the following:

- Covenants
- Zoning ordinances
- Well location
- Septic system location
- Corner lots
- Nonconforming lots
- Natural grades and contours

Read more on Page 1 to 3

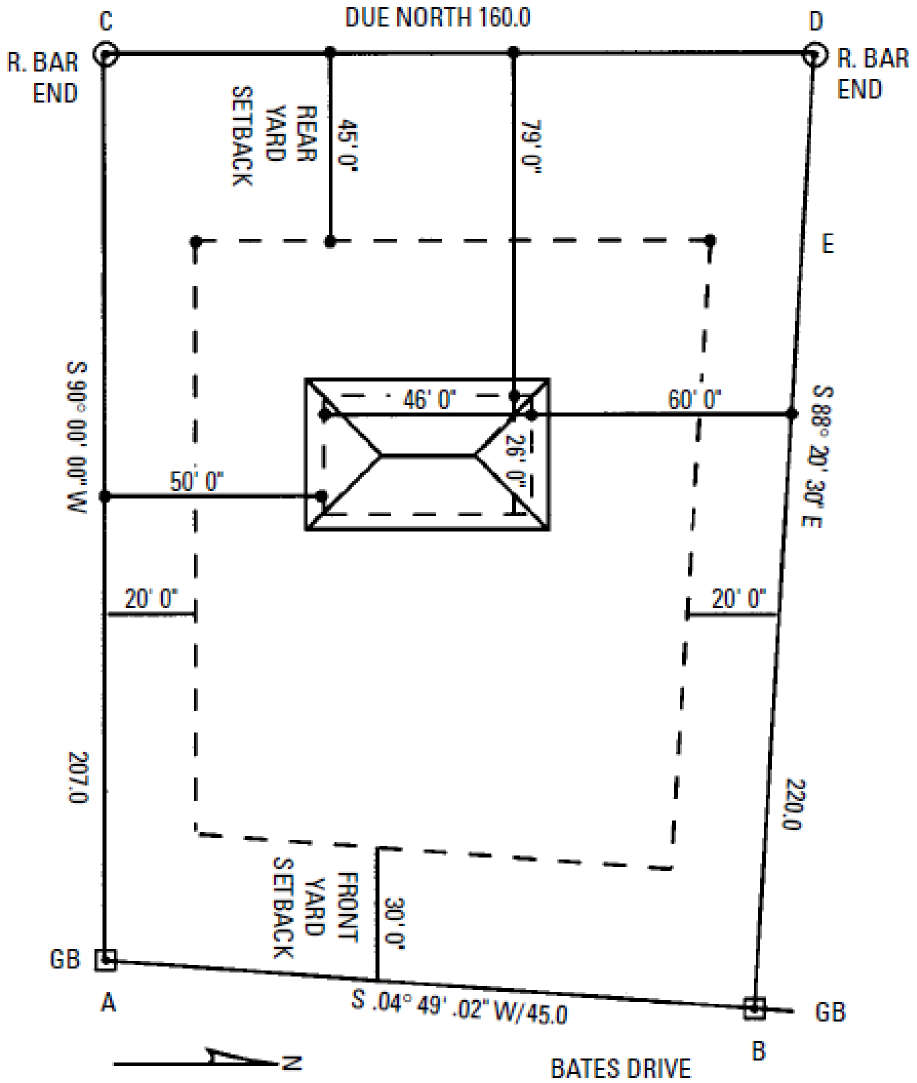


Figure 1-1 Plot plan showing property lines and corner markers, located and identified, house location, and setback lines.

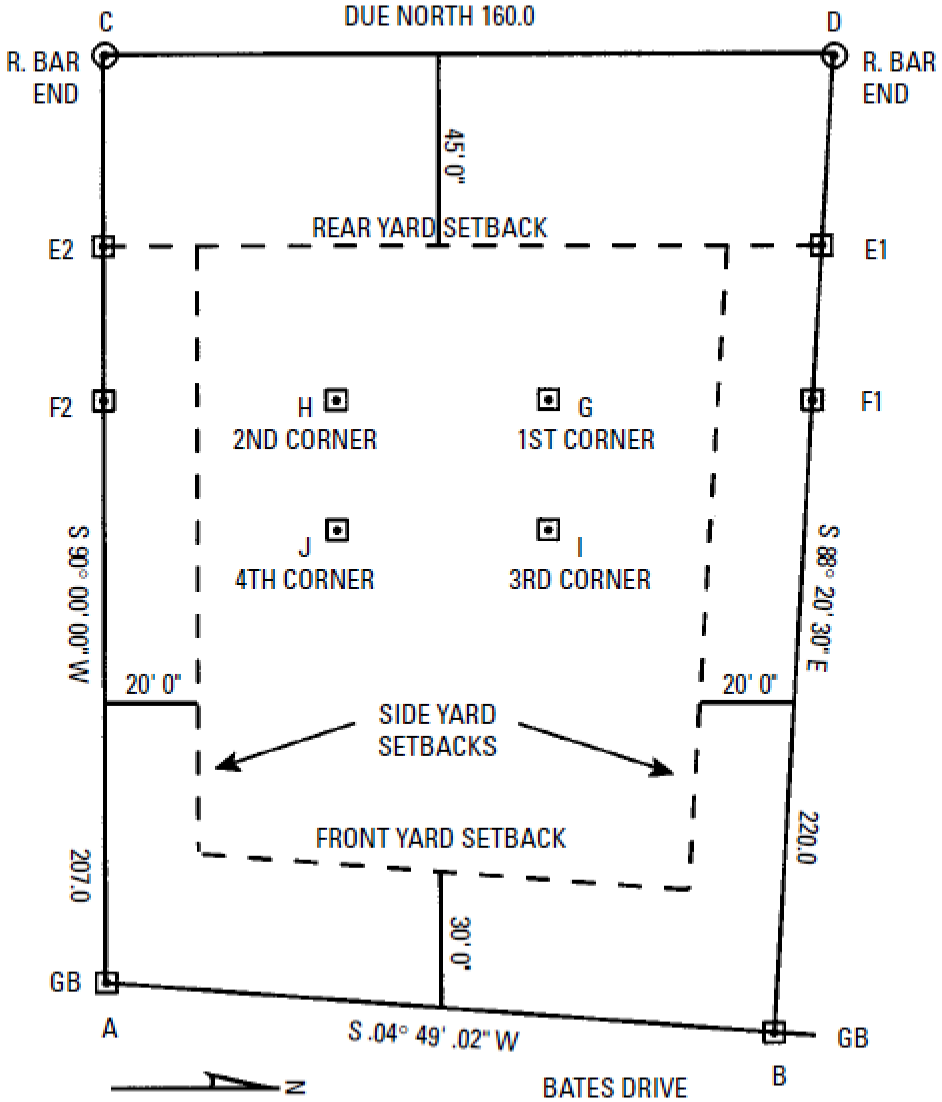


Figure 1-2 Steps 1 to 8. Laying-out with a transit level.

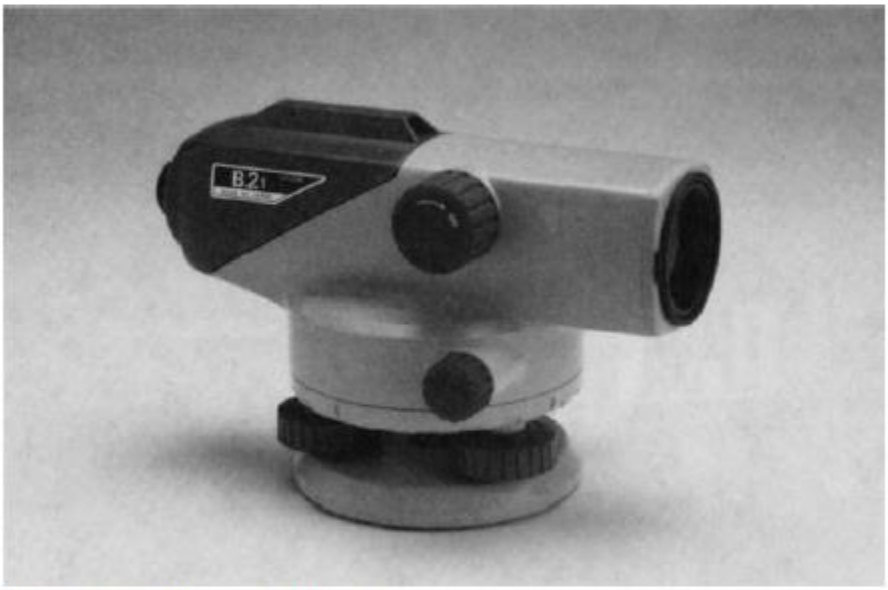


Figure 1-3 Automatic level. *(Courtesy The Lietz Company)*

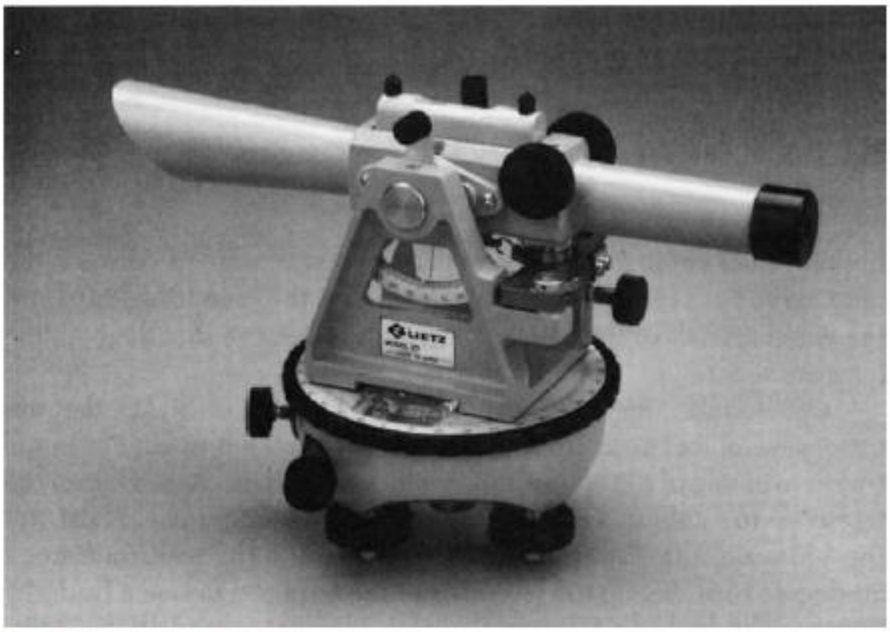


Figure 1-4 Transit level. *(Courtesy The Lietz Company)*

Summary

A number of conditions determine the kind of building that may be erected on a plot of ground. These conditions may determine where on the lot it may be located. There are also covenants that are legally binding regulations. These may, for example, set the minimum size of a house, prohibit utility buildings, or ban rooftop television antennas.

Zoning laws regulate the setback and other factors that play into the equation of house location on a lot. Septic tanks also require special consideration.

A Certificate of Occupancy is an important piece of paper. It is the final piece of paper, the sign-off, that says the construction of the building is complete and it is ready to be occupied. Any town that has adopted the BOCA or UBC building codes requires a CO. In most instances, the bank making the mortgage loan requires a certificate of occupation as well.

Portland Cement

Portland cement is universally considered the most important masonry material used in modern construction. Its numerous advantages make it one of the most economical, versatile, and universally used construction materials available. It is commonly used for buildings, bridges, sewers, culverts, foundations, footings, piers, abutments, retaining walls, and pavements. A concrete structure (either plain or reinforced) is almost unique among the many systems of modern construction. In its plastic state, concrete can be readily handled and placed in forms and cast into any desired shape. Quality concrete work produces structures that are lasting, pleasing in appearance, and require comparatively little maintenance.

Recognition of the limitations of concrete construction in the design phase will eliminate some of the structural weaknesses that detract from the appearance and serviceability of concrete structures. Following are some of the principal limitations and disadvantages:

- Low tensile strength
- Drying shrinkage and moisture movements
- Permeability

Types of Portland Cement

The American Society for Testing and Materials (ASTM) Specification for Portland cement (C150–78) establishes the quality of cement and identifies eight different types:

- *Type I*—This is most commonly used for general construction and is called normal cement.
- *Type IA*—This is normal air-entraining cement.
- *Type II*—This is modified cement for use with concrete in contact with soils or water containing sulfates, which are salts of sulfuric acid. Sulfates attack concrete and can cause the concrete to crack and break up.
- *Type IIA*—This is moderate sulfate-resistant, air-entraining cement.
- *Type III*—This is a high early strength cement that is as strong in 3 days as is Type I or Type II cement in 28 days. Because Type III generates a significant amount of heat (which could damage the concrete), it should not be used in massive structures. It also has poor resistance to sulfates.

- *Type IIIA*—This is high early strength air-entraining cement.
- *Type IV*—This is low heat of hydration cement, developed for use in massive structures such as dams. If the concrete cannot get rid of the heat as it dries out, its temperature can increase by 50°F or 60°F. The temperature increase causes the soft concrete to increase in size. As it hardens and cools off, shrinkage causes cracks to develop. The cracking may be delayed and not show up until much later. These cracks weaken the concrete and allow harmful substances to enter and attack the interior of the concrete.
- *Type V*—This is special high-sulfate-resistant cement for use in structures exposed to fluids containing sulfates (such as seawater or other natural waters).

Normal Concrete

Normal concrete is made with fine aggregates (sand), regular aggregates (crushed stone or gravel), and water. No air-entraining admixtures have been added. Air-entrained concrete, lightweight concrete, heavyweight concrete, polymer concrete, and fiber-reinforced concrete (FRC) are *not* normal concrete.

Read Page 17 to 22

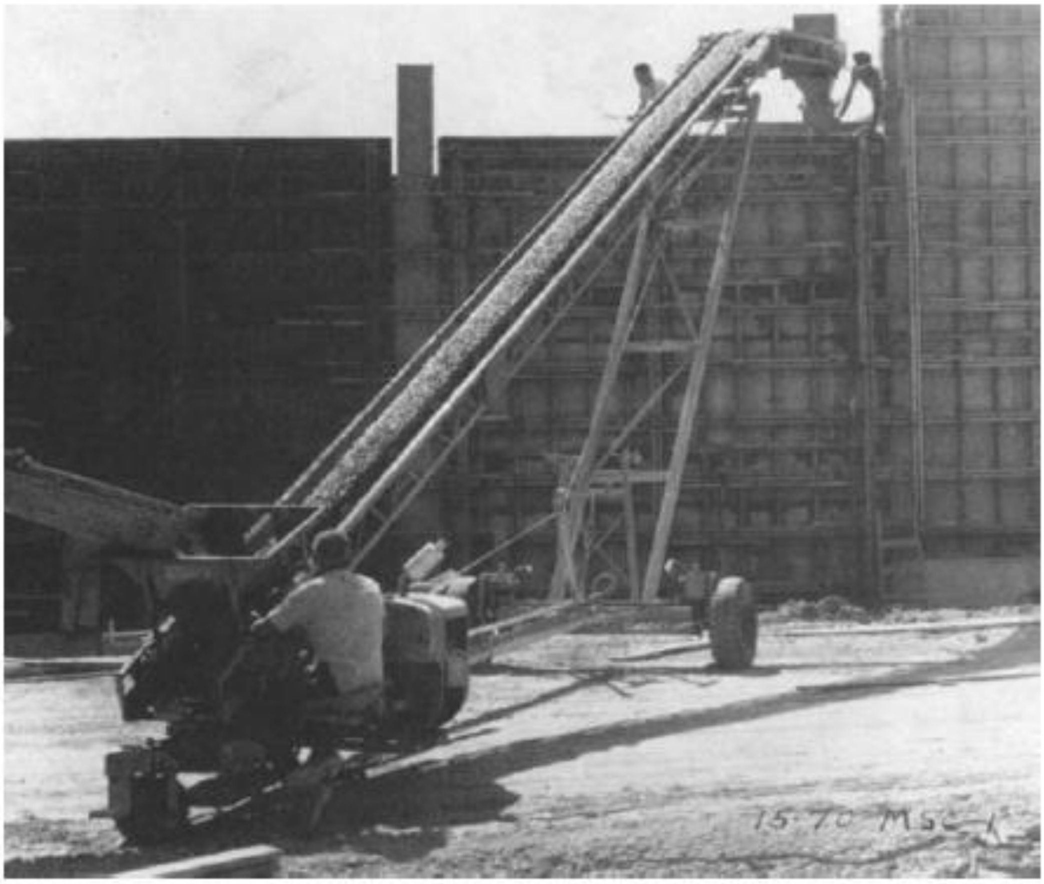


Figure 2-1 Gas-powered portable conveyor. *(Courtesy Morgen Manufacturing Co.)*

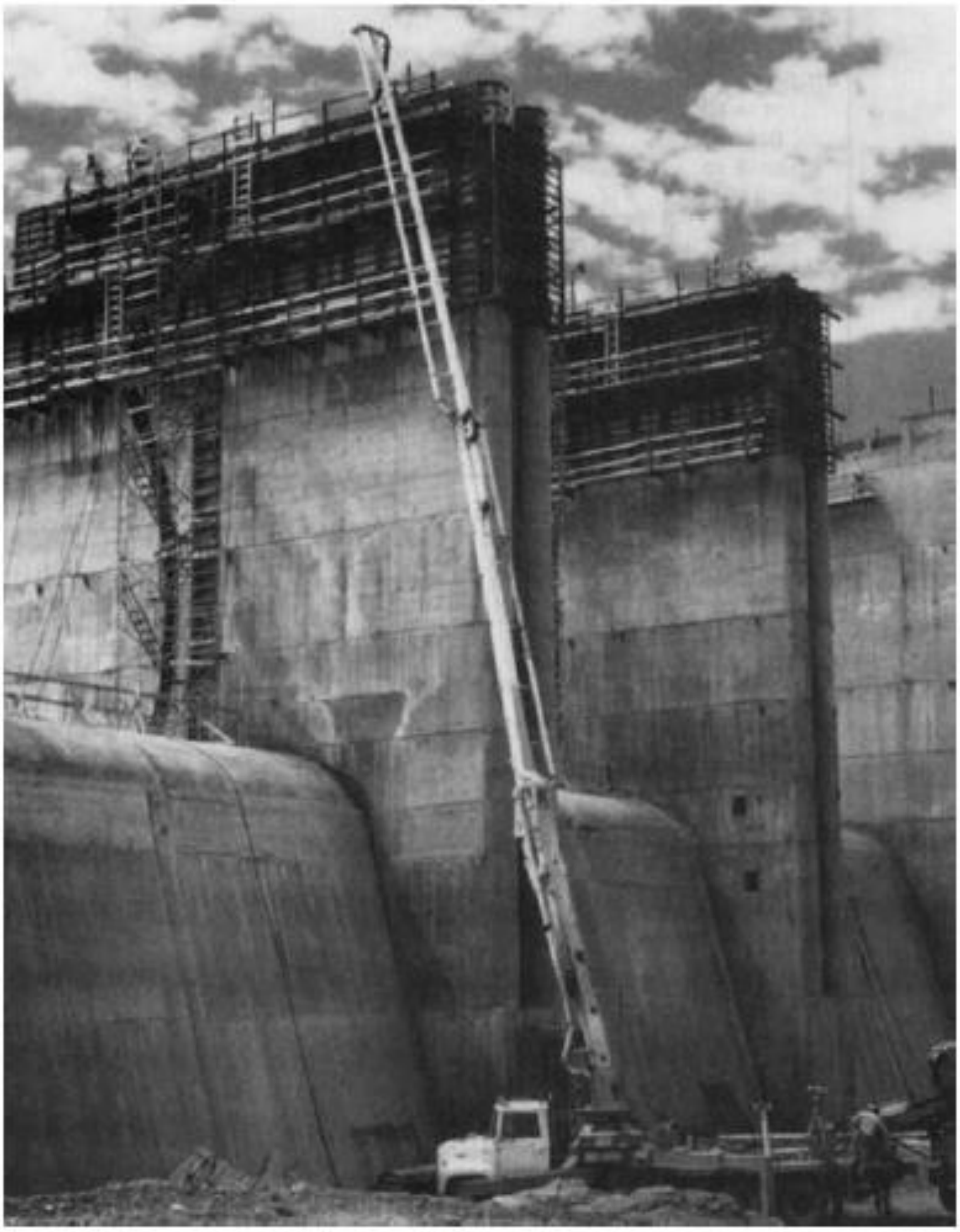


Figure 2-3 Truck-mounted small line concrete pump.
(Courtesy Morgen Manufacturing Co.)

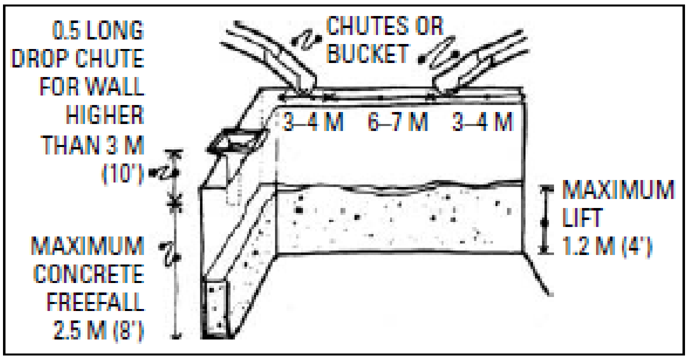


Figure 2-4 Concrete drop chutes.

(Courtesy Canada Mortgage and Housing Corporation)

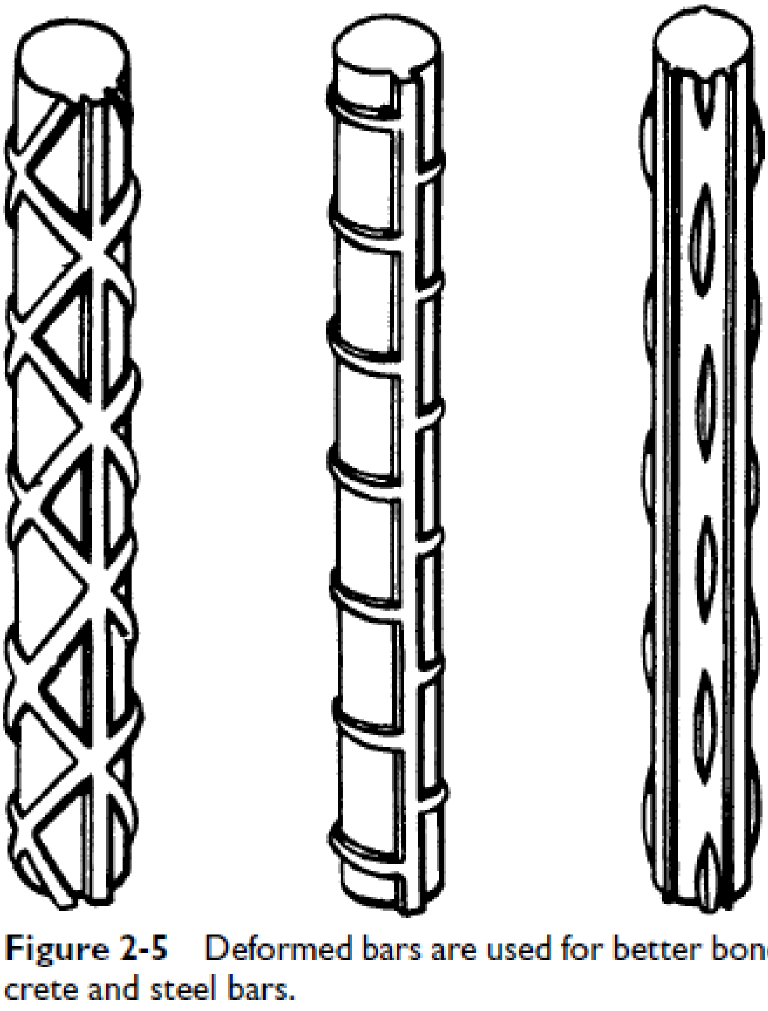


Figure 2-5 Deformed bars are used for better bonding between concrete and steel bars.

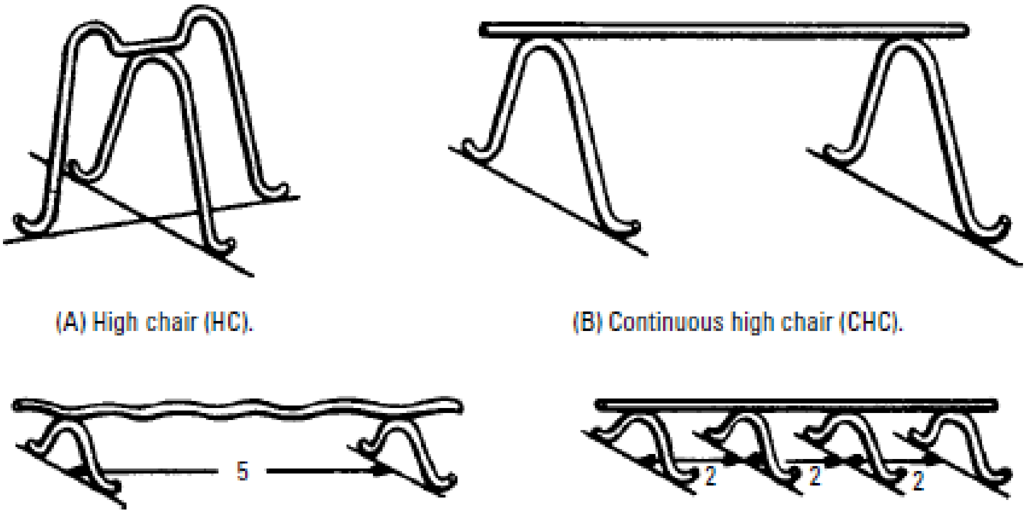
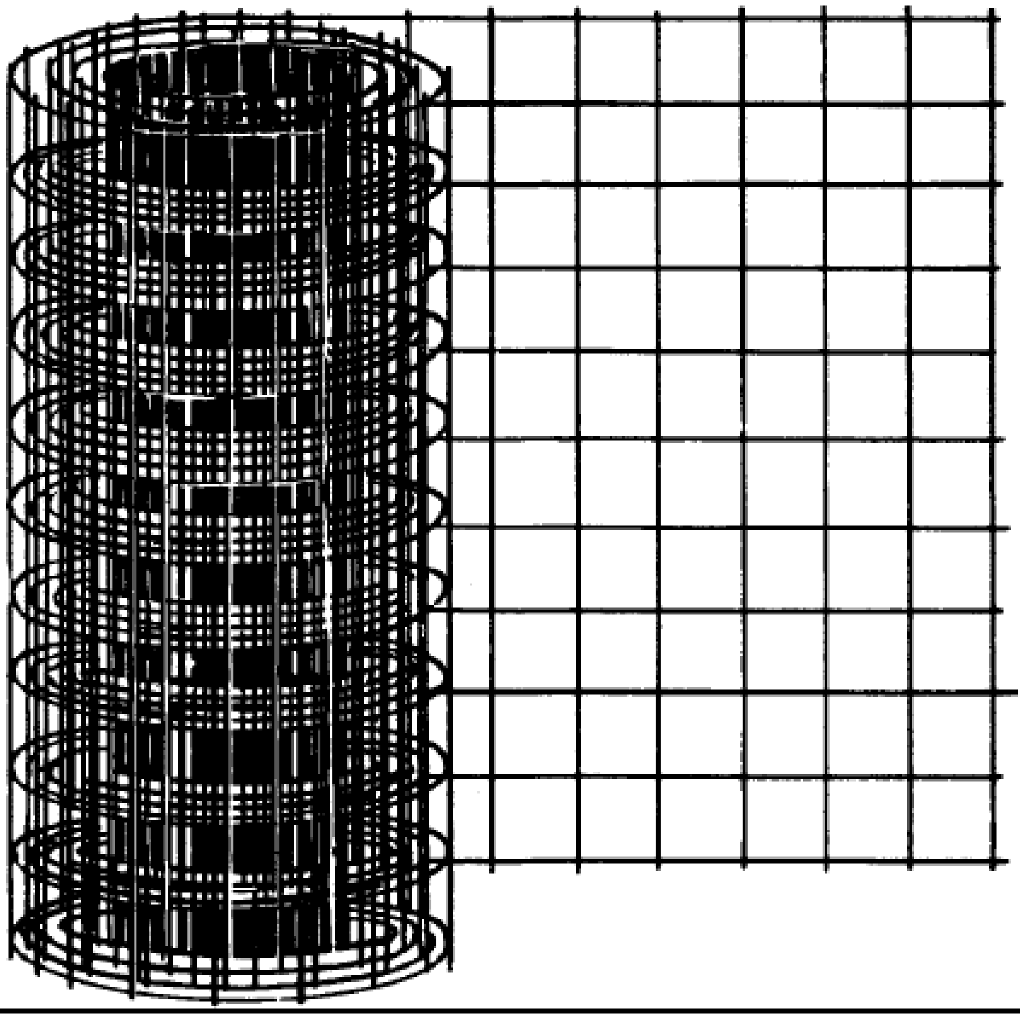


Figure 2-6 Chairs or bolsters used to support bars in concrete beams.



Chairs

Capped metal chairs, concrete brick, or plastic Mesh-ups, manufactured by Lotel, Inc. (Figure 2-8) can be used. As noted previously,

Figure 2-8 Two-inch plastic chair for use with 3- to 5-inch slabs shown with sand disk. *(Courtesy Lotel, Inc.)*

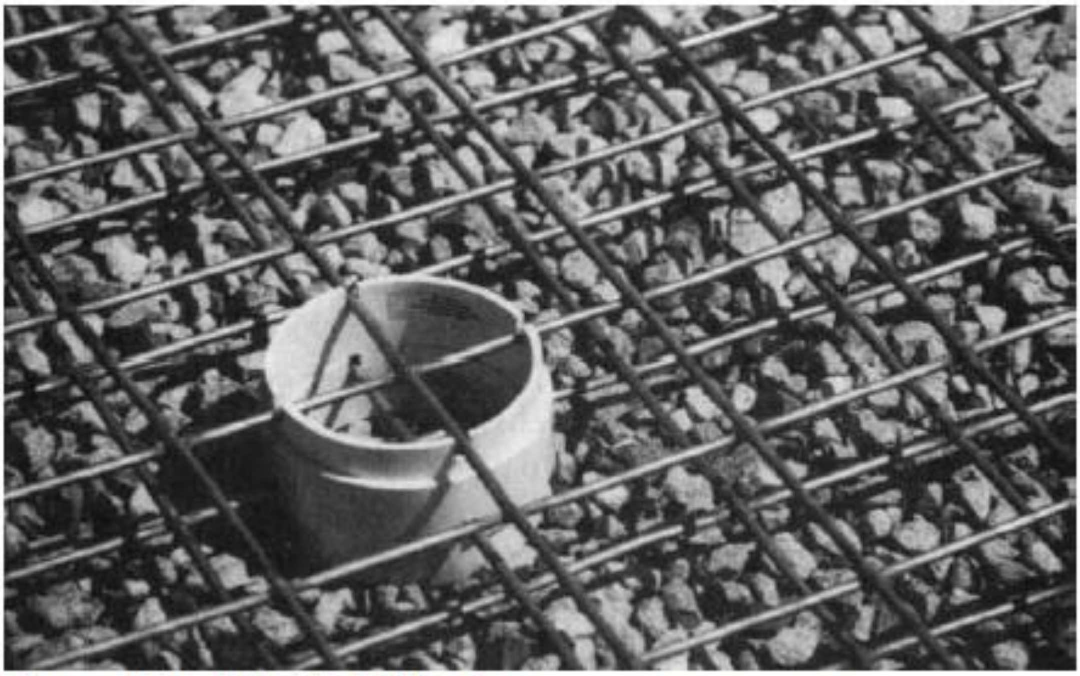


Figure 2-9 RE-RINGS PVC chair. *(Courtesy Structural Components, Inc.)*

Concrete Slump

There are many tests performed to determine if concrete meets job specifications. Most of these tests have been standardized by ASTM. They include tests of strength, slump, air content, unit weight, temperature, and impact rebound. Little, if any, testing is performed in residential construction. If any were done, it would be limited to slump testing.

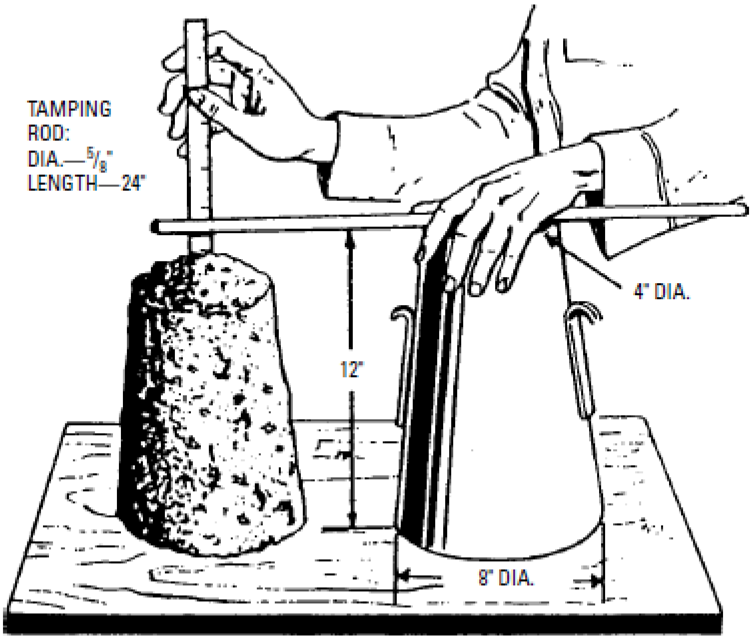


Figure 2-10 Measuring concrete slump.

Summary

The Roman Pantheon was constructed in 27 BC and was the largest concrete structure in the world until the end of the nineteenth century. Portland cement was discovered by Joseph Aspdin, an English builder, in 1824 when he patented an artificial cement. He gave it the name of the island on which he lived.

Foundations

Though the foundation supports a building, the earth is the ultimate support. The foundation is a *system* comprising foundation wall, footing, and soil. The prime purpose of an efficient structural foundation system is to transmit the building loads directly to the soil without *exceeding* the bearing capacity of the soil. A properly designed and *constructed* foundation system transfers the loads uniformly, minimizes settlement, and anchors the structure against racking forces and uplift. Because soil type and bearing capacity are the crucial factors in the foundation system, the foundation must be designed and built as a *system.* Too many residential foundations are designed and built *without* any concern for the soil.

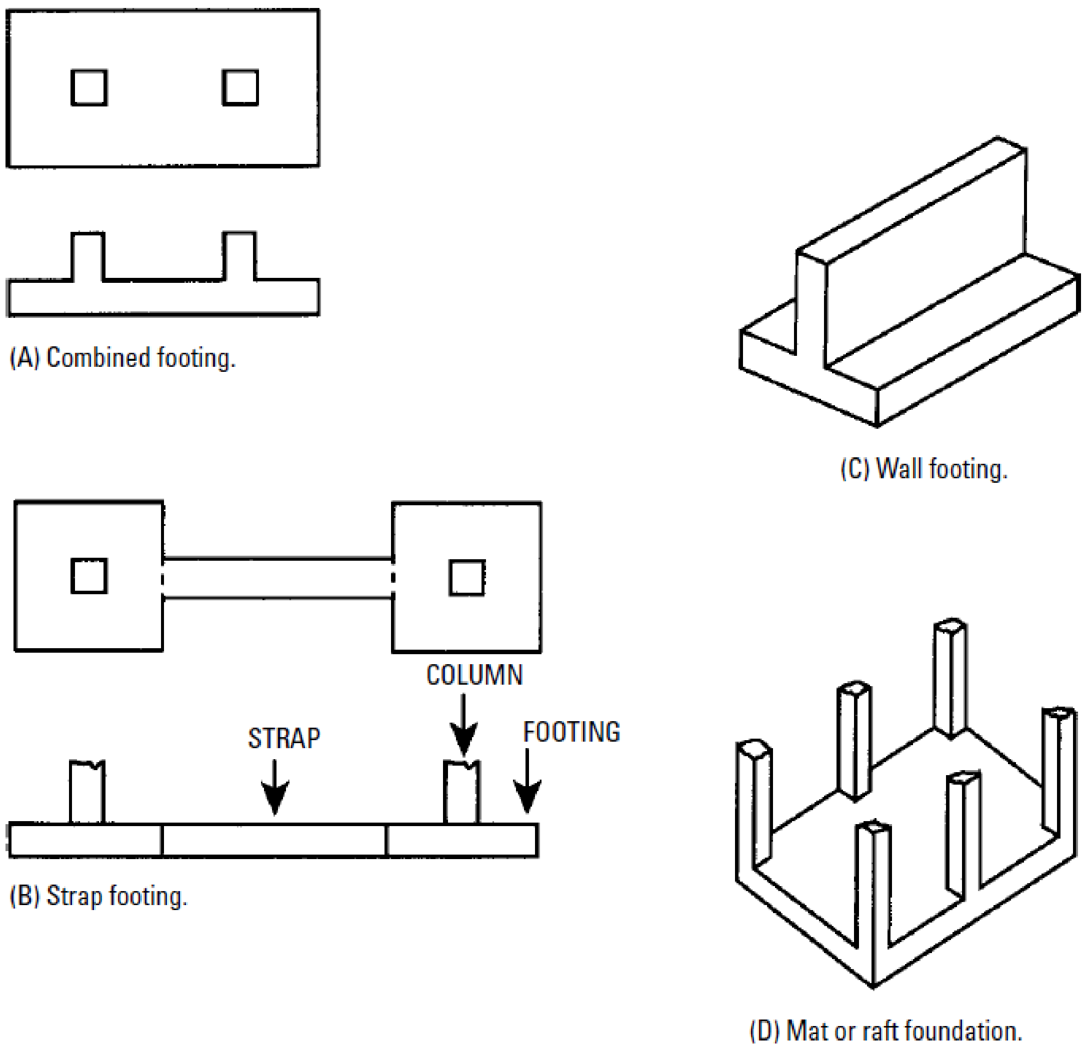
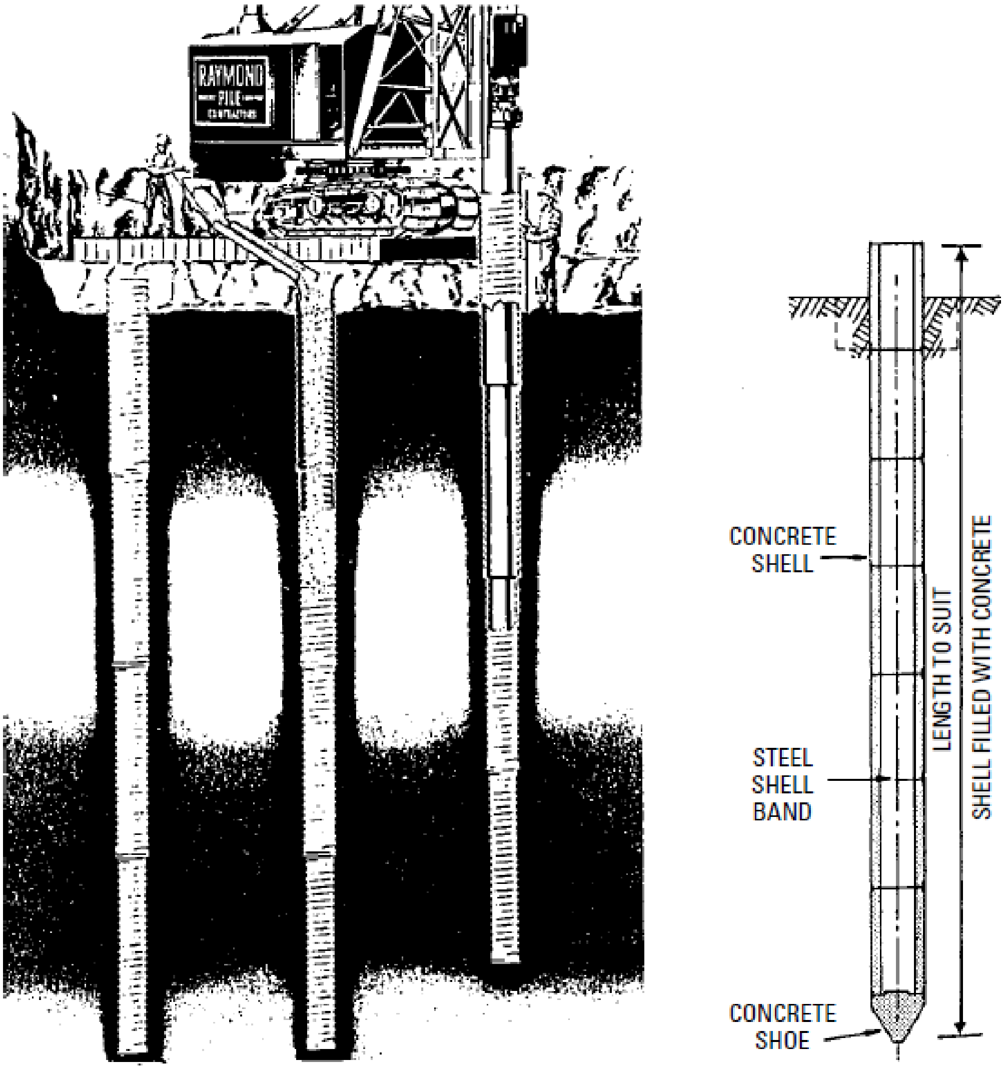


Figure 3-1 Types of shallow foundations.



(A) (B)

Figure 3-2 (A) A step-taper pile. On the right, the pile is being driven with a steel core, and in the center, it is being filled with concrete. At the left is a finished pile. (B) Concrete-shell pile. The steel bands are used to seal the joints between the sections. *(Courtesy Raymond International, Inc.)*

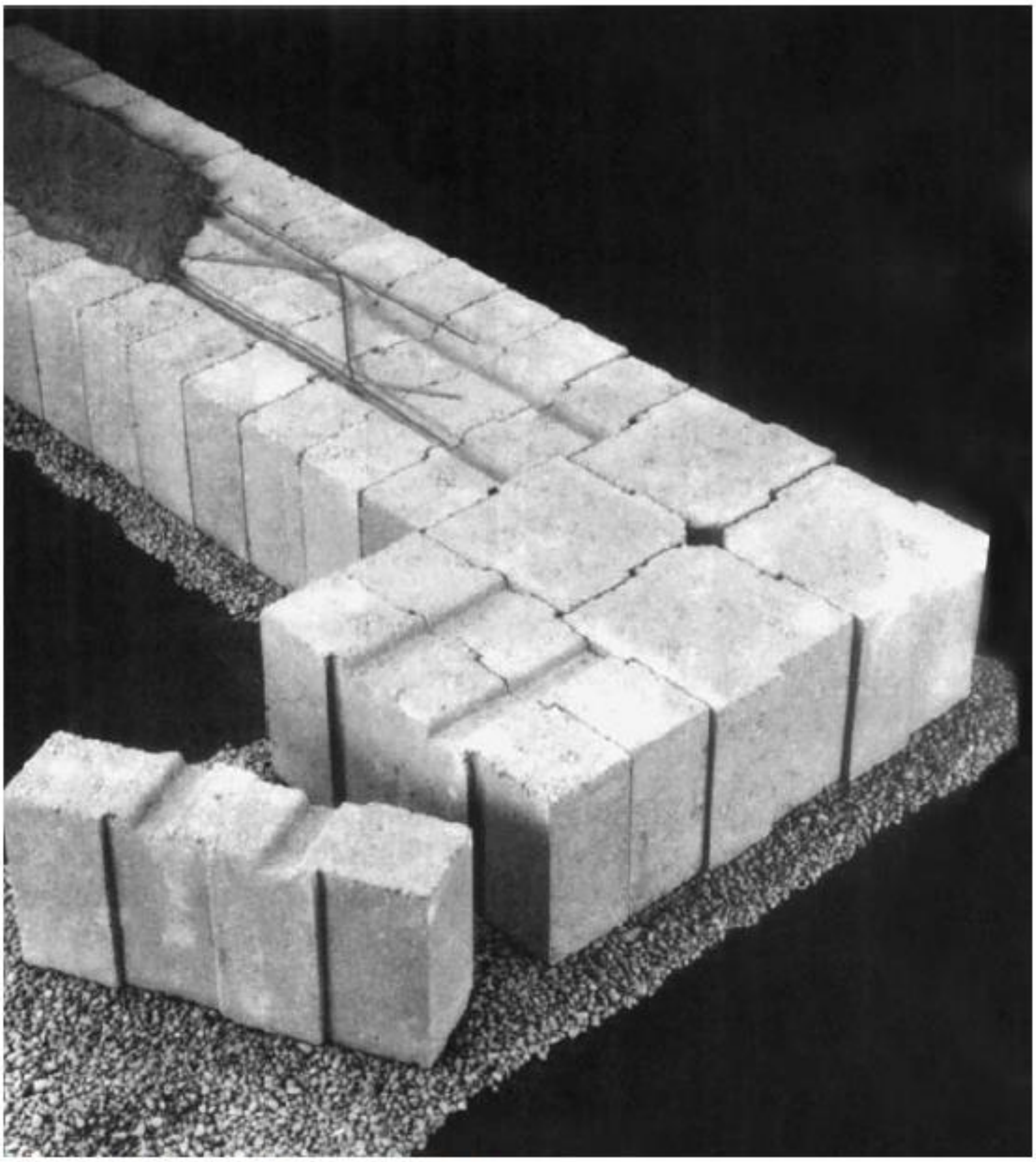


Figure 3-3 IDR Footer—Blocks. *(Courtesy National Concrete Masonry Association)*

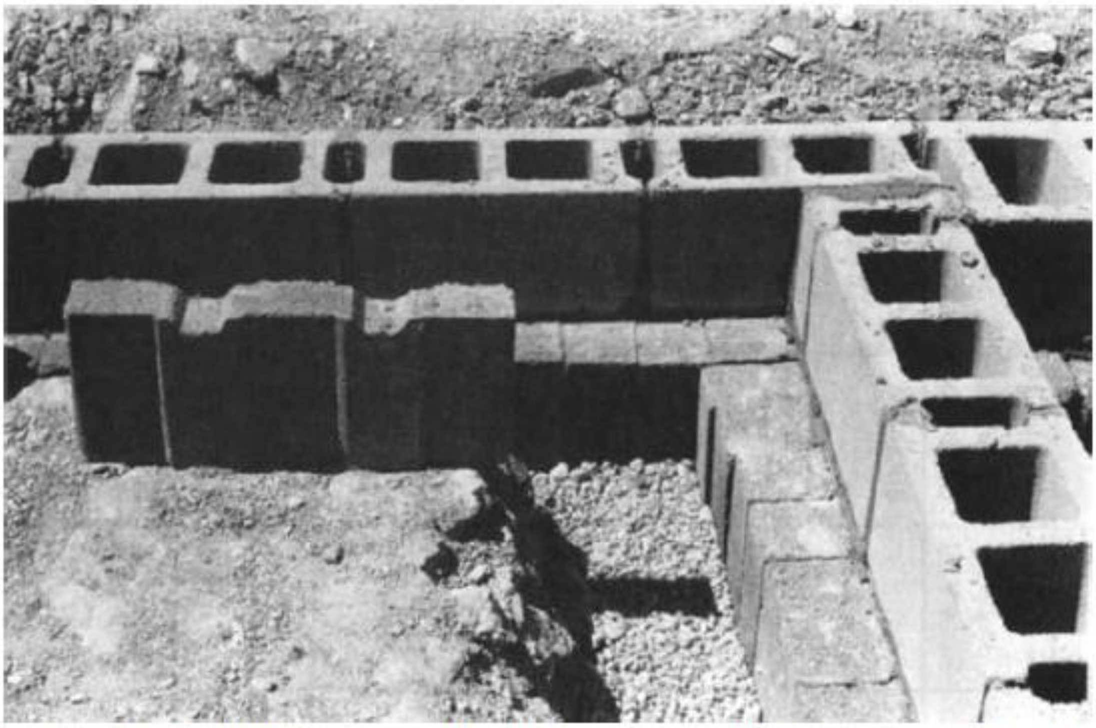


Figure 3-4 IDR Footer—Blocks in place and first course of blocks mortared in place. *(Courtesy National Concrete Masonry Association)*

Rule-of-Thumb

Because residential loads are comparatively light, for average bearing soils, or 2000 pounds per square foot (psf) or greater, the size of the footing may be found from the rule-of-thumb that states:

> *The nonreinforced width of the footing should not exceed twice the width of the foundation wall and should be at least as high as the wall is wide; but in residential construction it should never be less than 6 inches high.*

Table 3-2 Typical Weights of Some Building Materials

Component	*Lb per sq ft*
Roof	
Wood shingles	3.0
Asphalt shingles	3.0
Copper	2.0
Built-up roofing, 3 ply & gravel	5.5
Built-up roofing, 5 ply & gravel	6.5
Slate, $^{1}/_{4}$ inch thick	10.0
Mission tile	13.0
1 inch Wood decking, paper	2.5
2 inch × 4 inch Rafters, 16 inches o.c.	2.0
2 inch × 6 inch Rafters, 16 inches o.c.	2.5
2 inch × 8 inch Rafters, 16 inches o.c.	3.5
$^{1}/_{2}$ inch Plywood	1.5
Walls	
4 inches Stud partition, plastered both sides	22.0
Window glass	5.0
2 inch × 4 inch Studs, 1 inch sheathing	4.5
Brick veneer, 4 inches	42.0
Stone veneer, 4 inches	50.0
Wood siding, 1 inch thickness	3.0
$^{1}/_{2}$ inch Gypsum wallboard	2.5
Floors, Ceilings	
2 inch × 10 inch wood joists, 16 inches o.c.	4.5
2 inch × 12 inch wood joists, 16 inches o.c.	5.0
Oak flooring, $^{25}/_{32}$ inch thick	4.0
Clay tile on 1 inch mortar base	23.0
4 inches Concrete slab	48.0
Gypsum plaster, metal lath	10.0
Foundation Walls	
8 inches Poured concrete, at 150 lb per cu ft	100.0
8 inches Concrete block	55.0

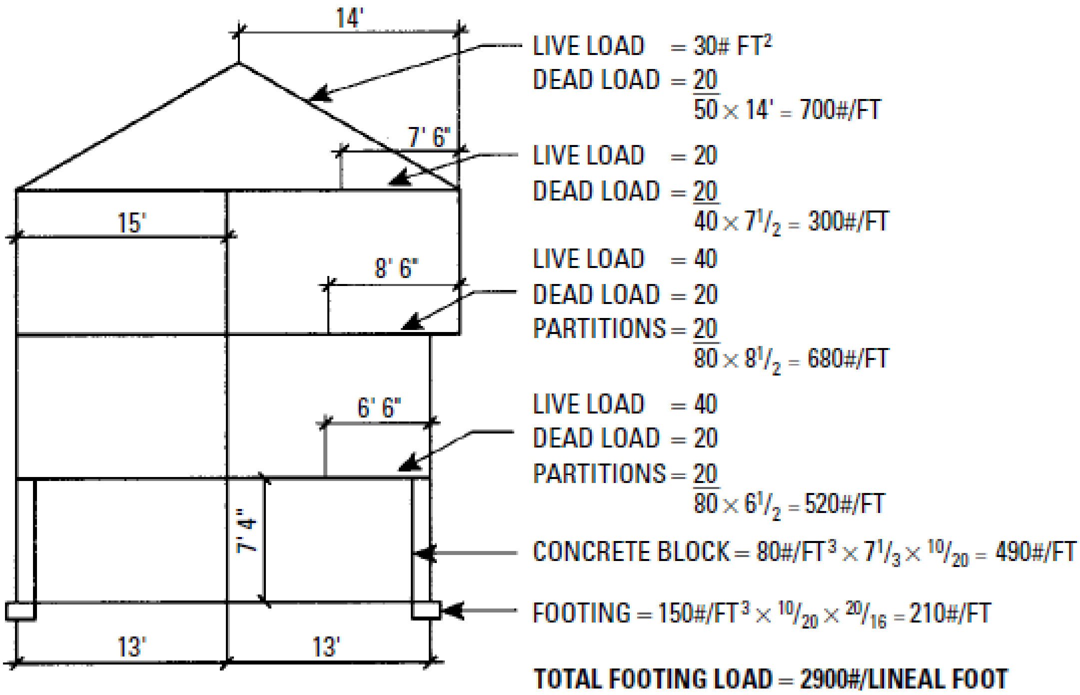


Figure 3-5 Calculations for exterior wall footings.

Example

Using the data given in Figure 3-5, calculate the size of the footing required to support a load of 2900 pounds per foot (lb/ft) bearing on a soil with a design capacity (q_a) of 2,000 pounds per square foot (psf).

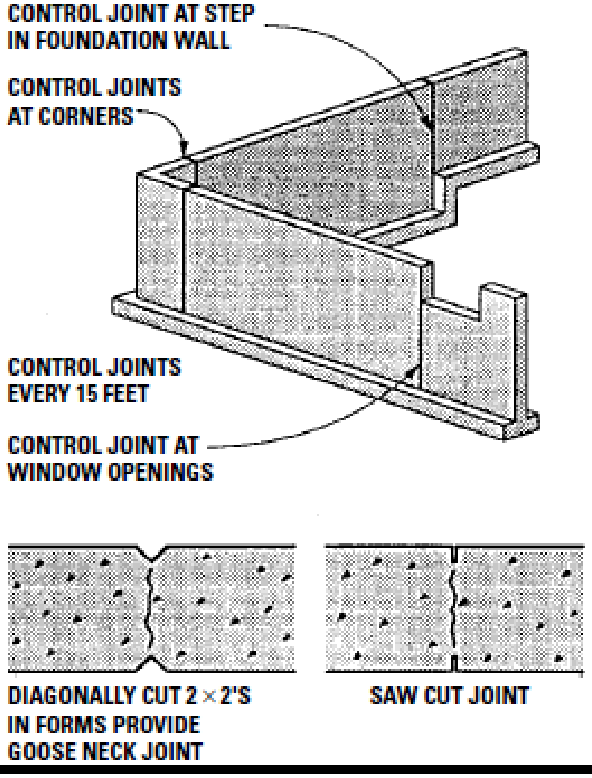
$$\text{Footing area (ft}^2) = \frac{\text{footing load (lb/ft)}}{q_a\,(\text{lb/ft}^2)}$$

$$\text{Area} = \frac{2900\ \text{lb/ft}}{2000\ \text{lb/ft}^2} = 1.45\ \text{ft}^2$$

Stepped Footings

Stepped wall footings (Figure 3-8) are used on sloping sites to maintain the required footing depth below grade. Care must be used to guarantee the following:

- That the vertical step is not higher than three-fourths of the length of the horizontal step
- That concrete is poured monolithically (at the same time)
- That footings and steps are level
- That vertical steps are perpendicular (at 90 degrees) to the horizontal step
- That vertical and horizontal steps are the same width



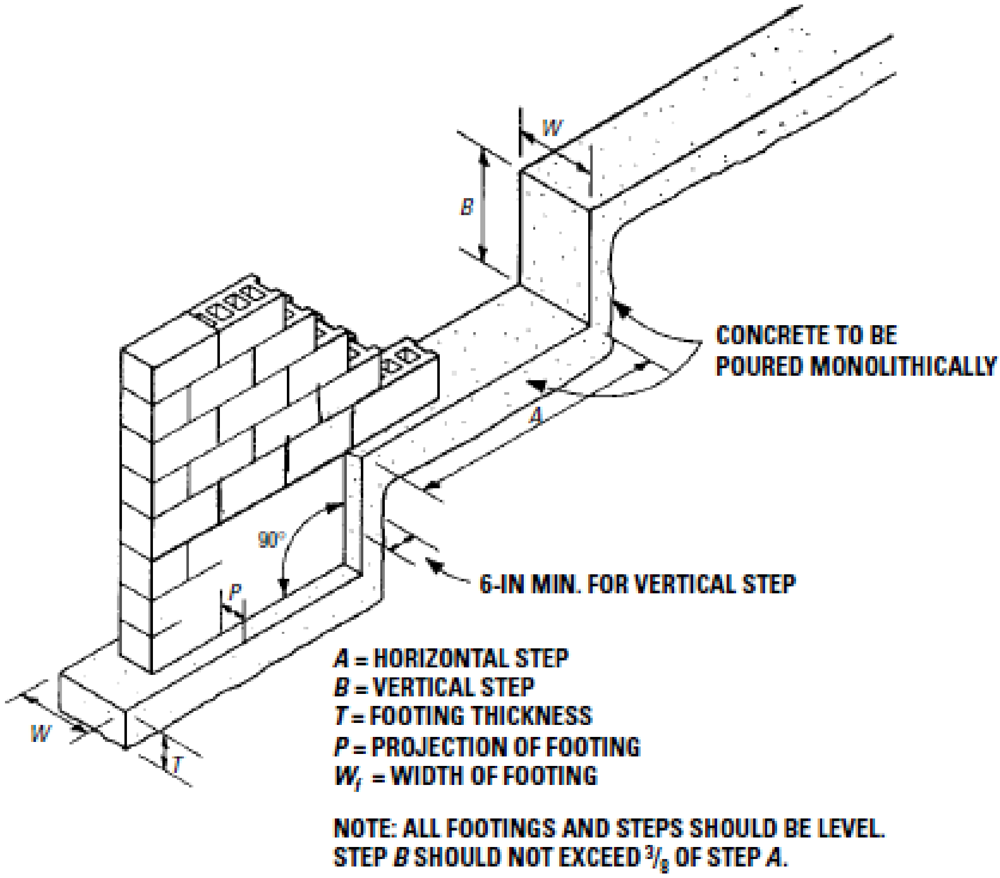


Figure 3-8 Stepped wall footings.

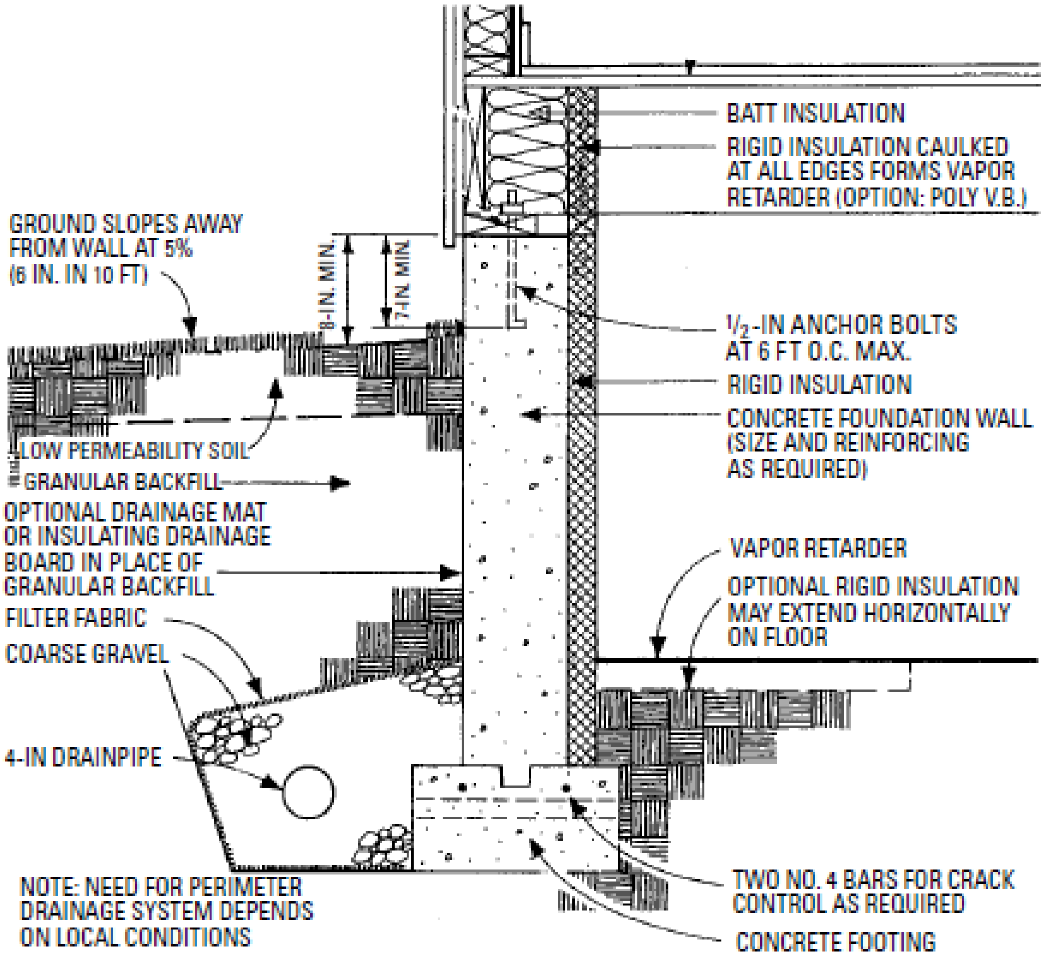


Figure 3-9 Concrete crawl space wall with interior insulation.
(Courtesy ORNL)

lot slabs, and pavements. Slabs-on-grade may be of three types (Figure 3-10):

- Grade beam with soil supported slab
- A notched grade beam supporting the slab
- Monolithically cast slab and grade beam (thickened edge)

Types

The American Concrete Institute (ACI) classifies slabs into the following six types and recognizes five methods of design:

- *Type A slabs*—Contain no reinforcing of any type. They are designed to remain un-cracked from surface loads and are usually constructed with Type I or Type II Portland cement. Joints may be strengthened with dowels or thickened edges. Construction and contraction joint spacing should be minimal to reduce cracking.

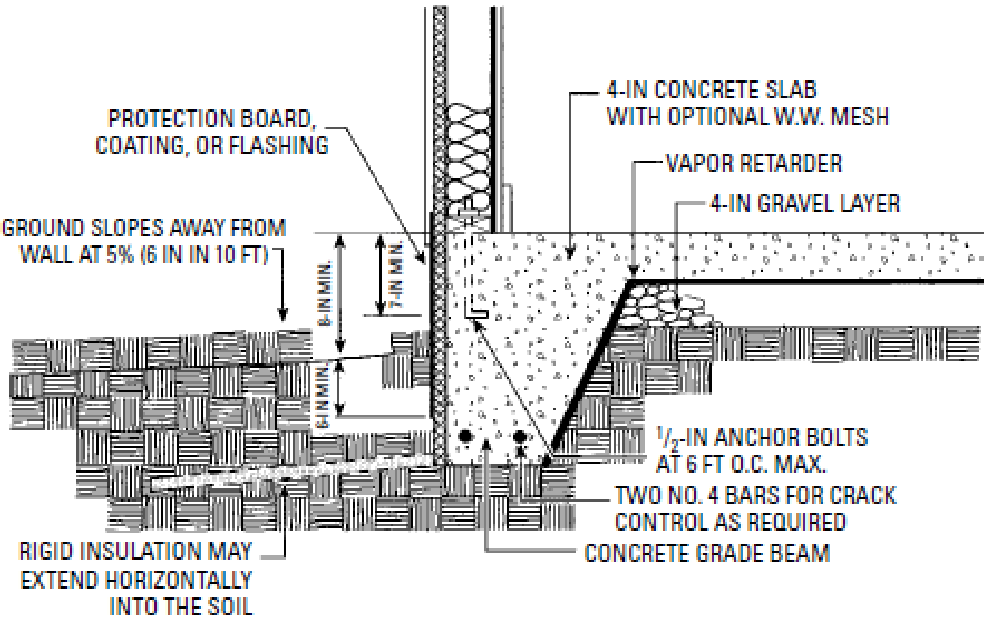


Figure 3-10 Slab-on-grade and integral grade beam with exterior insulation. *(Courtesy ORNL)*

Site Preparation

One of the most important factors in the design, construction, or both of slabs-on-grade and deep foundations is the condition of the site. If an approved septic system design exists, consult it for information on depth of water table, SHWT, presence of debris, stumps, logs, and soil types. Ask the building inspector about previous structures on this lot. Request a copy of soils map, or consult with the zoning administrator as to whether the lot's setbacks are based on soil conditions. If soil information is not available from local officials, call USDA Soil Conservation Service for help. On lots with no known history (or on *virgin lots*), dig test holes 8 to 10 feet deep where the house will sit to locate water table, hidden streams, ledge, debris, or buried foundations that could have a negative effect on the slab. Vegetation, contours, drainage, and their possible negative impact on the slab should be noted. A thorough site investigation is the best insurance against legal action.

Excavate at or below the frost line, and remove all expansive (clays), compressive, and frost-susceptible soils. Be careful when excavating or backfilling to avoid creating hard and soft spots (Figure 3-11). Use only stable, compactable material for replacement fill. A subbase is not required, but it can even out subgrade

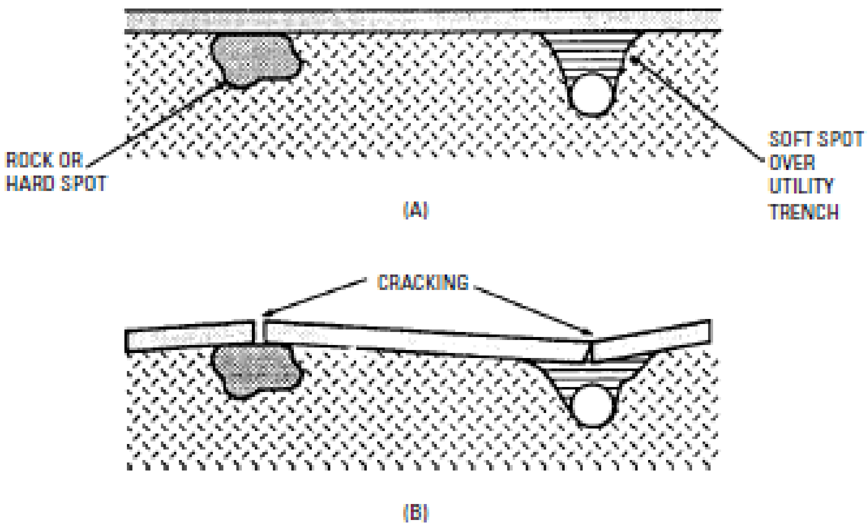


Figure 3-11 Hard and soft spots.

irregularities. Crushed stone ($^3/_4$-inch preferred), gravel free of fines, and coarse sand ($^1/_{16}$-inch grains minimum) are suitable and provide a capillary break. Compact the subbase material to a high density, and do not exceed 5 inches in thickness. Thicker subbases do not significantly increase subgrade support, nor do they allow a reduction in slab thickness.

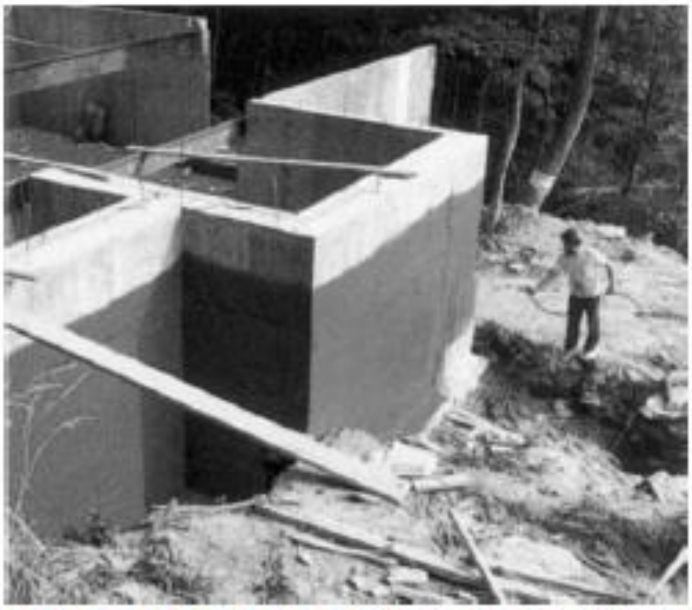


Figure 3-13 The Rub-R-Wall can be applied above or below ground level.

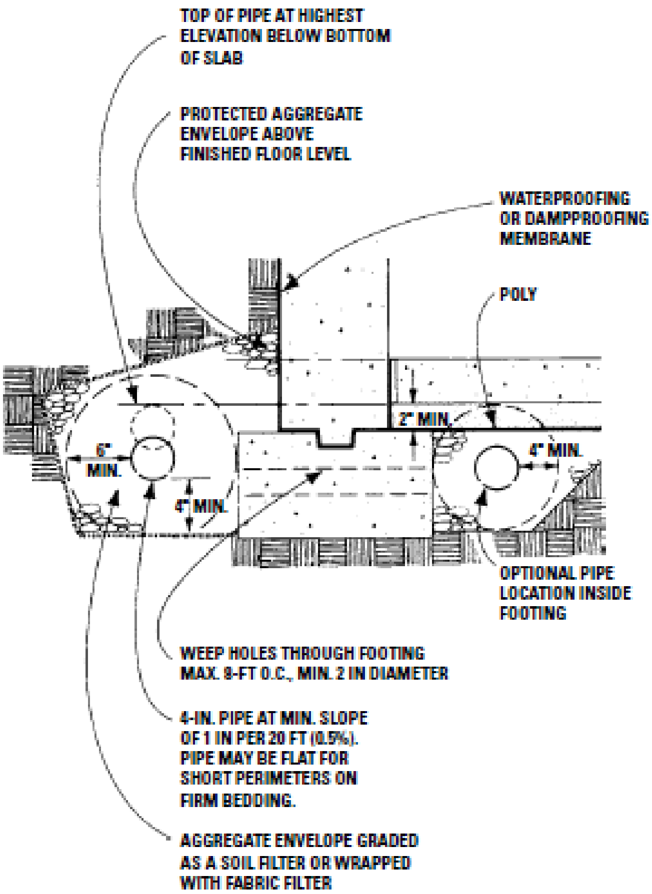


Figure 3-14 Footing with perimeter drainage. *(Courtesy ORNL)*

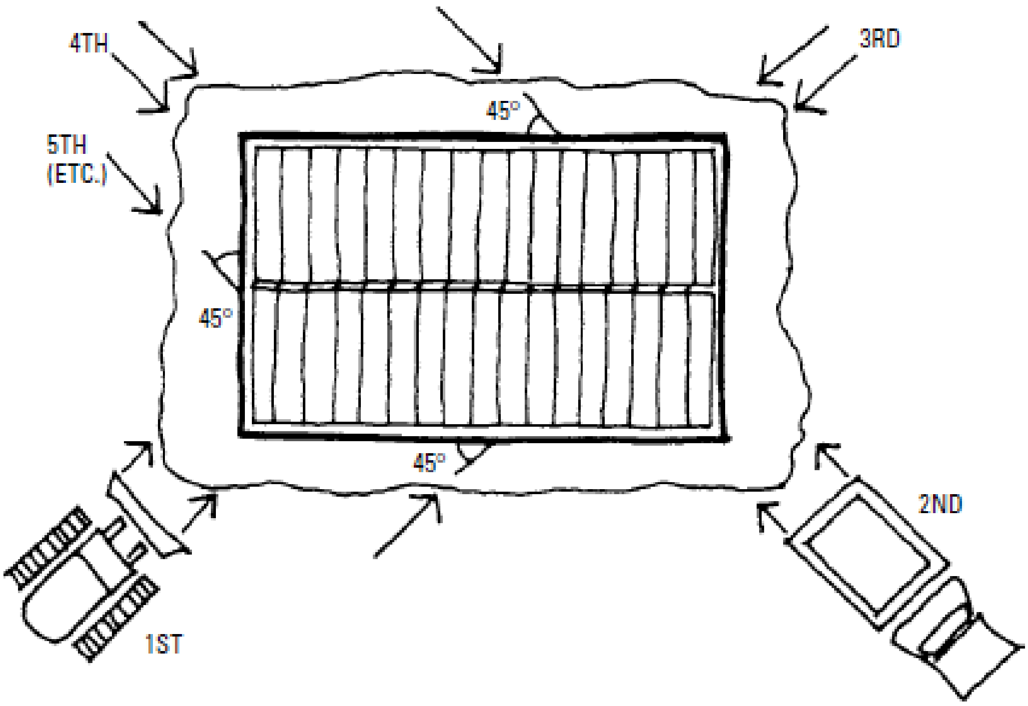


Figure 3-20 Backfilling diagonally. *(Courtesy Canada Mortgage and Housing Corp.)*

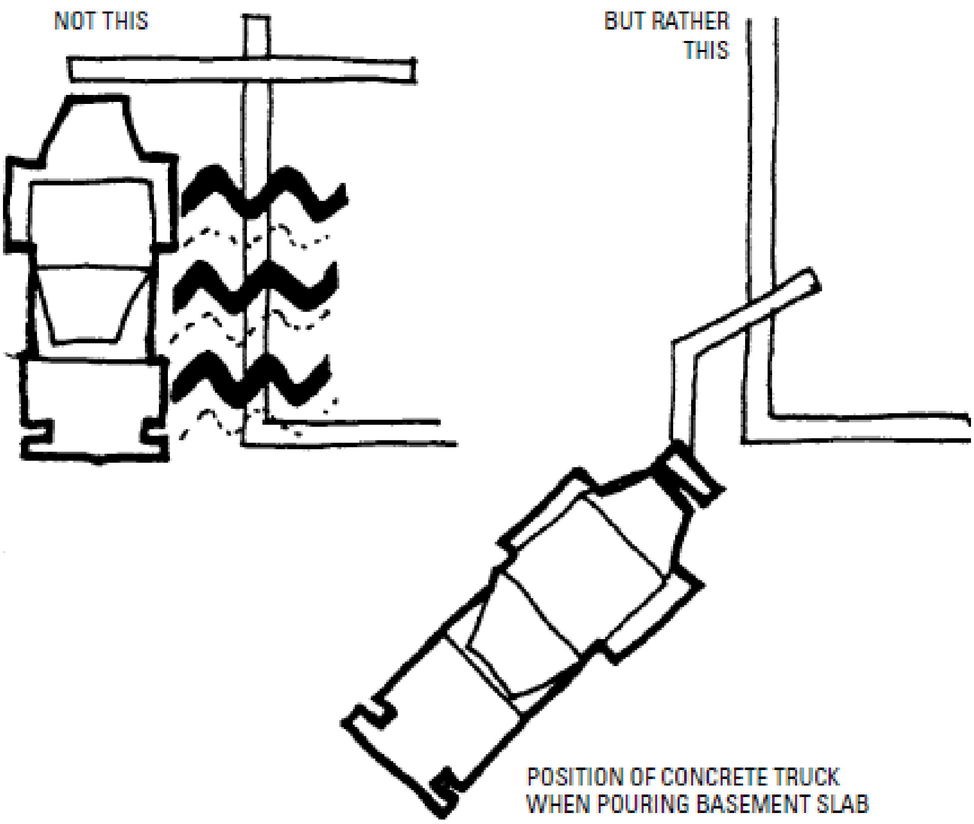
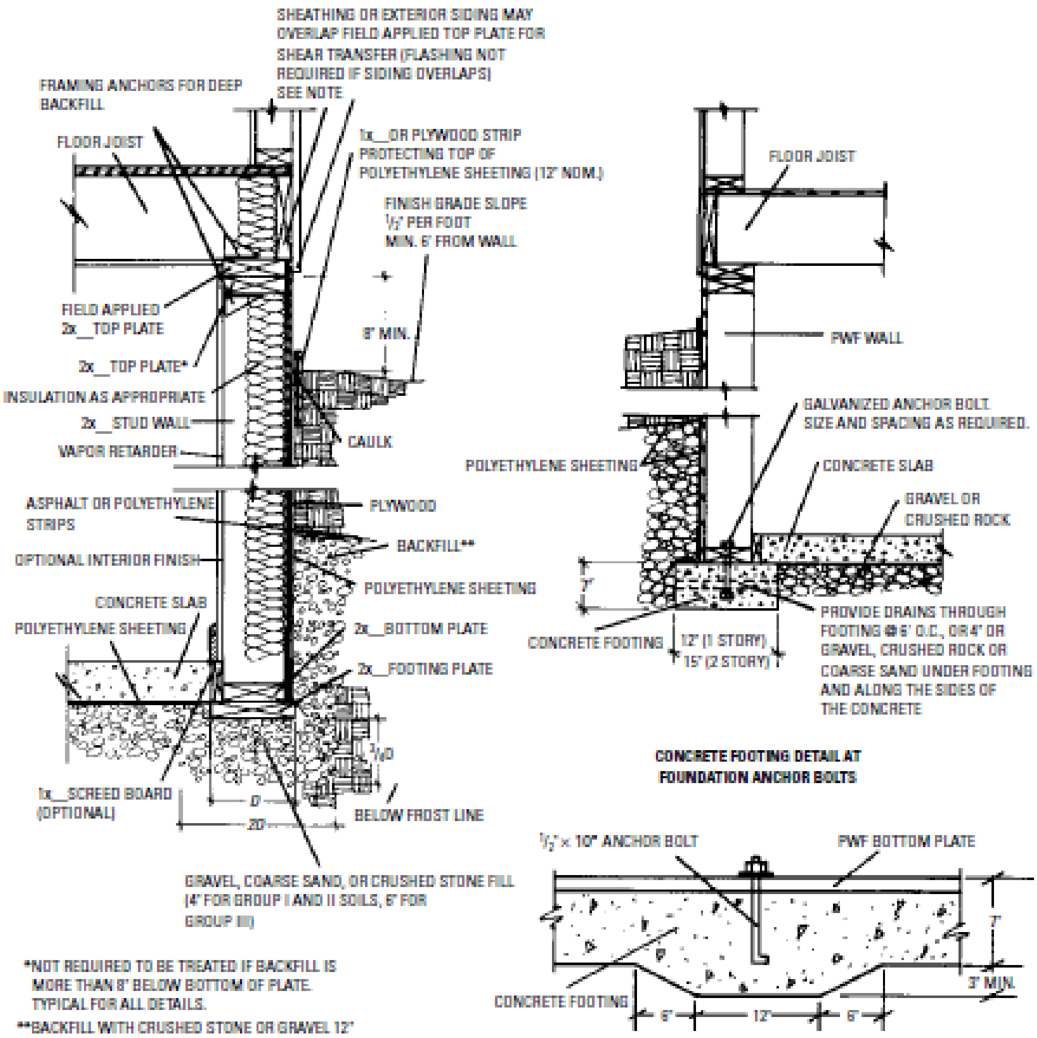


Figure 3-21 Avoid heavy equipment parallel to the foundation.



*NOT REQUIRED TO BE TREATED IF BACKFILL IS MORE THAN 8" BELOW BOTTOM OF PLATE. TYPICAL FOR ALL DETAILS.

**BACKFILL WITH CRUSHED STONE OR GRAVEL 12" FOR GROUP I SOILS, AND HALF THE BACKFILL HEIGHT FOR GROUPS II AND III SOILS.

NOTE:
FOR DAYLIGHT BASEMENT FOUNDATIONS, USE DOUBLE HEADER JOISTS (STAGGER END JOINTS) OR SPLICE HEADER JOIST FOR CONTINUITY ON UPHILL AND DAYLIGHT SIDES OF BUILDING.

Figure 3-22 A basement foundation, on concrete footing.

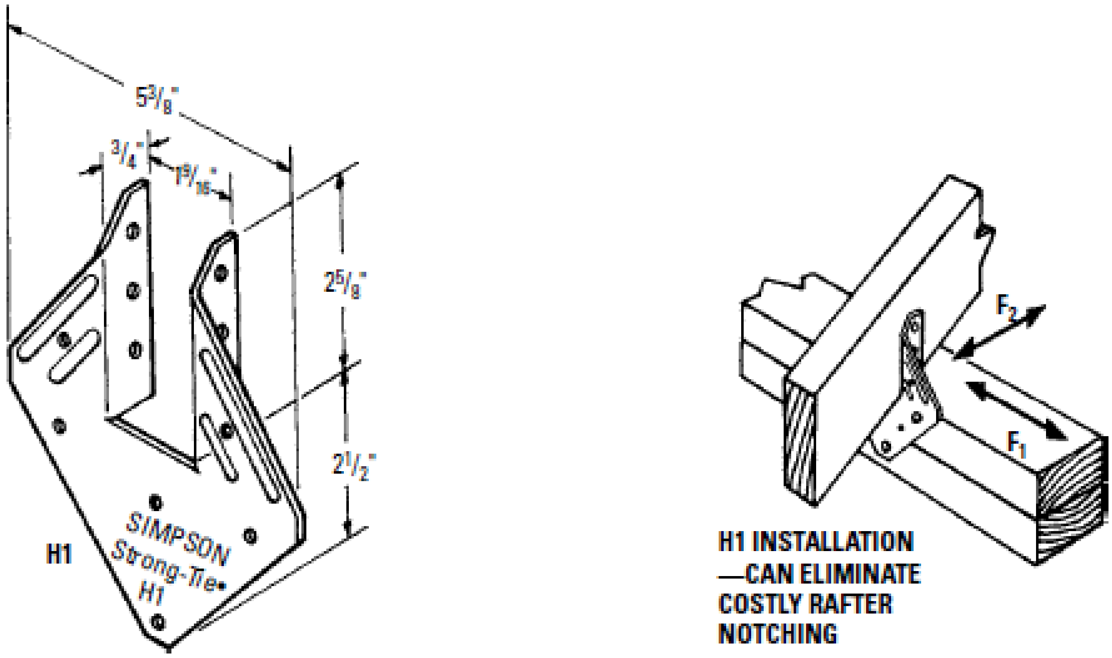


Figure 3-27 Simpson hurricane braces and installation method.
(Courtesy Simpson Strong-Tie Company)

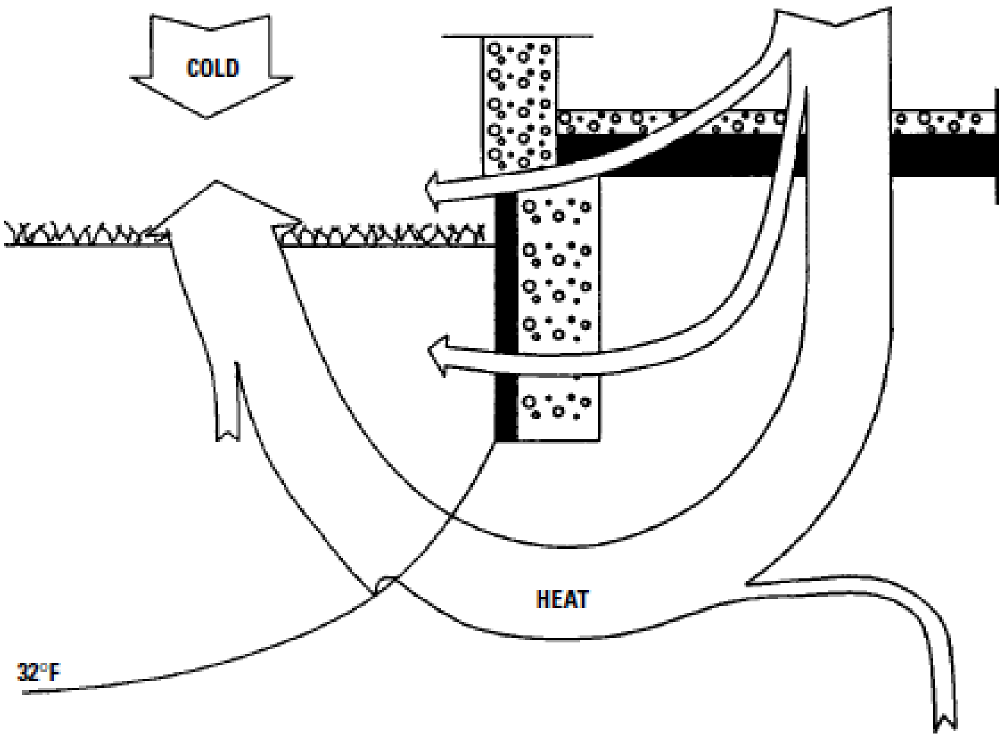


Figure 3-29 Heat-loss path under footings.
(Courtesy NAHB National Research Center)

Shallow Foundation Design Details

There are a number of steps involved in the design/construction of an FPSF:

- Site preparation
- Determining freezing degree index
- Slab insulation
- Foundation wall insulation
- Optional horizontal ground insulation, exterior to the foundation

Site Preparation

Remove all frost-susceptible clays, silts, organic, and compressible soils. A high water table or wet ground could clog the drainage layer with fine soil particles. If these conditions are present, place a synthetic filter fabric down first before laying the drainage layer. Lay down a subbase of 6 inches of clean gravel (free of fines and dust), coarse sand ($^{1}/_{16}$-inch grains minimum), or screened crushed stone $^{3}/_{4}$-inch to $1\,^{1}/_{2}$-inches in size. Ideally, the subbase should be deep enough to keep the subgrade free of frost. The gravel base serves as the footings, a drain screen, and a capillary break and is not frost-susceptible. It must be well compacted.

Ground Insulation

The need for ground insulation depends on the maximum frost index and the depth of the foundation. In soils susceptible to frost heaving, or in colder climates, additional insulation must be placed horizontally at the base of the foundation at the corners, where heat losses are higher. In very cold climates, horizontal ground insulation is placed completely around the perimeter of the foundation. Table 3-4 lists the minimum foundation depth with ground insulation only at the corners and outside unheated rooms. Table 3-5 lists the thickness, width, and length of foundation insulation needed when the foundation is 16 inches below grade.

Summary

The two broad categories of foundations are the shallow and the deep foundations. Shallow foundations consist of four types. Deep foundations may consist of deep holes in the ground with concrete designed to support a building or a foundation made with piles driven into the ground to support the structure.

Footings are strips of concrete or filled concrete blocks placed under the foundation wall. Gravel or crushed stone footings are used with permanent wood foundations.

A foundation should be twice as thick as the wall to be built on it. As far back as 1570 there was a publication dealing with foundation design.

Bearing capabilities of different soils are plotted and placed into charts and tables. Engineers can refer to them for their guidance in planning proper footings and foundations of buildings. The weights of various materials used for building have also been charted and placed in tables for ease in figuring their proper supportable loads.

There is little consistency in the use of rebar in residential foundations: all or none. Yet, few foundations fail because of the lack of rebar. The weather is an important factor to be considered in the design of a foundation. Where the foundation is located geographically is very important in respect to the effects of weather. Frost protection is very important.

Frost lines in the United States are based on the maximum frost depth ever recorded in a particular locality. The BOCA code says that the footings do not have to extend to the frost line when "otherwise protected from frost." The Code does not specify what "otherwise protected" means.

Drainage is another of the important factors needing consideration in the planning of a foundation. Backfilling is an important

Finishing and Curing Concrete

When working with concrete, certain methods and techniques must be employed to ensure the best finished product. This chapter discusses the following:

- Screeding
- Tamping and jitterbugging
- Finishing (including floating, troweling, brooming, grooving, and edging)
- Curing (including curing time and curing methods)

Screeding

To *screed* is to strike-off or level slab concrete after pouring. Generally, all the dry materials used in making quality concrete are heavier than water. Thus, shortly after placement, these materials will have a tendency to settle to the bottom and force any excess water to the surface. This reaction is commonly called bleeding. This bleeding usually occurs with non–air-entrained concrete. It is of utmost importance that the first operations of placing, screeding, and darbying be performed before any bleeding takes place.

Tamping or Jitterbugging

The *hand tamper* or *jitterbug* is used to force the large particles of coarse aggregate *slightly* below the surface to enable the cement mason to pass a darby over the surface without dislodging any large aggregate. After the concrete has been struck-off or rodded (and, in some cases, tamped), it is smoothed with a darby to level any raised spots and fill depressions. Long-handled floats of either wood or metal (called *bull floats*) are sometimes used instead of darbies to smooth and level the surface.

The hand tamper should be used sparingly and, in most cases, not at all. If used, it should be used only on concrete having a low slump (1 inch or less) to compact the concrete into a dense mass. Jitterbugs are sometimes used on industrial floor construction because the concrete for this type of work usually has a very low slump, with the mix being quite stiff and perhaps difficult to work.

Finishing

When the bleed water and water sheen have left the surface of the concrete, finishing may begin. Finishing may take one or more of several forms, depending on the type of surface desired.

Finishing operations must not be overdone, or water under the surface will be brought to the top. When this happens, a thin layer of cement is also brought up and later, after curing, the thin layer becomes a scale that will powder off with usage. Finishing can be done by hand or by rotating power-driven trowels or floats. The size of the job determines the choice, based on economy.

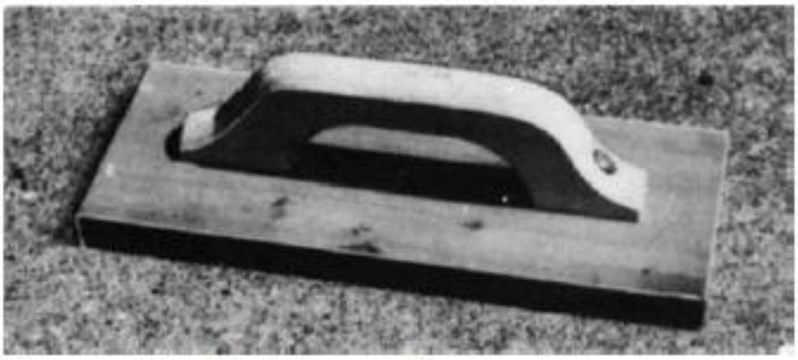


Figure 4-1 Typical wood float.

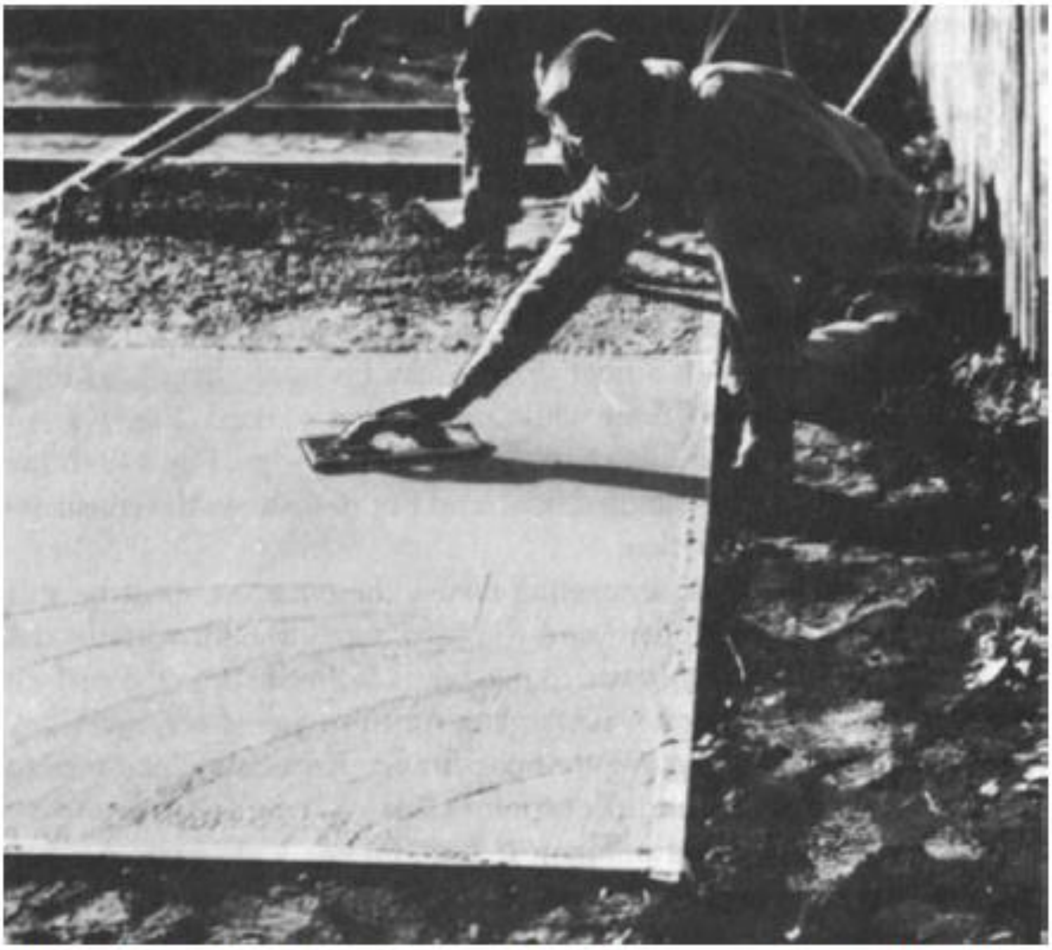


Figure 4-2 Using the hand wood float from the edge of a slab. Often the worker will work out the slab on a kneeling board.

Table 4-1 Curing Methods

Method	*Advantage*	*Disadvantage*
Sprinkling with water or covering with wet burlap	Excellent results if constantly kept wet.	Likelihood of drying between sprinklings. Difficult on vertical walls.
Straw	Insulator in winter.	Can dry out, blow away, or burn.
Curing compounds	Easy to apply. Inexpensive.	Sprayer needed. Inadequate coverage allows drying out. Film can be broken or tracked off before curing is completed. Unless pigmented, can allow concrete to get too hot.
Moist earth	Cheap, but messy.	Stains concrete. Can dry out. Removal problem.
Waterproof paper	Excellent protection, prevents drying.	Heavy cost can be excessive. Must be kept in rolls. Storage and handling problems.
Plastic film	Absolutely watertight, excellent protection. Light and easy to handle.	Should be pigmented for heat protection. Requires reasonable care and tears must be patched. Must be weighed down to prevent blowing away.

the concrete is exposed to the hot sun. Table 4-1 lists various curing methods and their advantages and disadvantages.

Summary

Screeding of concrete is to strike-off or level the slab after pouring. If any operation is performed on the surface while the bleed water is present, serious scaling, dusting, or crazing can result. Tamping, floating, troweling, and brooming are all part of the concrete finishing process.

Read Page 86 to 96

Read Page 101 to 132

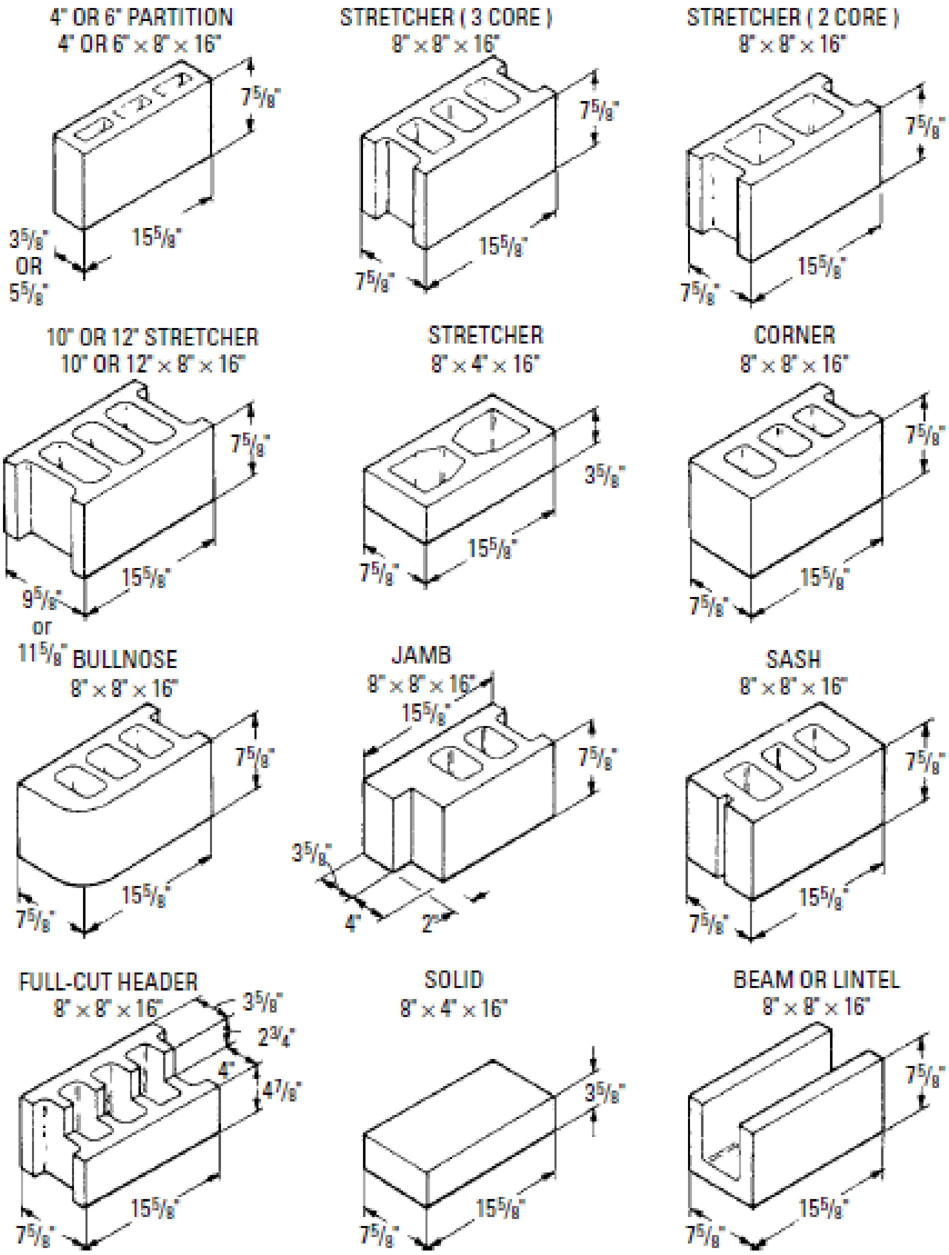


Figure 5-2 Standard sizes and shapes of concrete blocks.

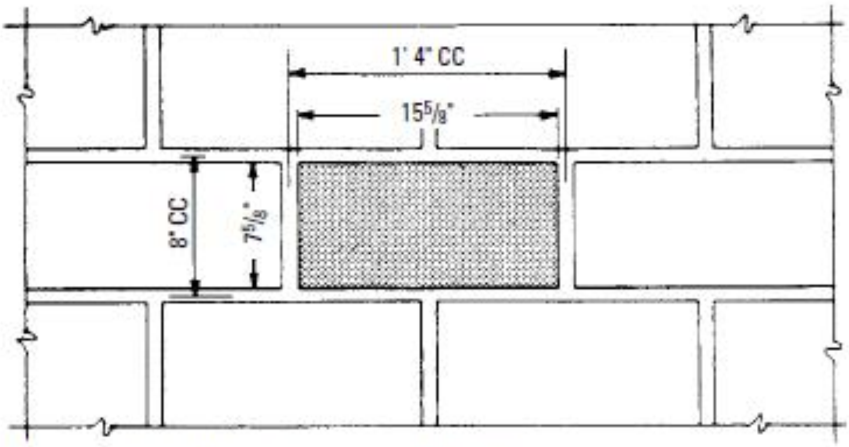


Figure 5-3 Block size to allow for mortar joints.

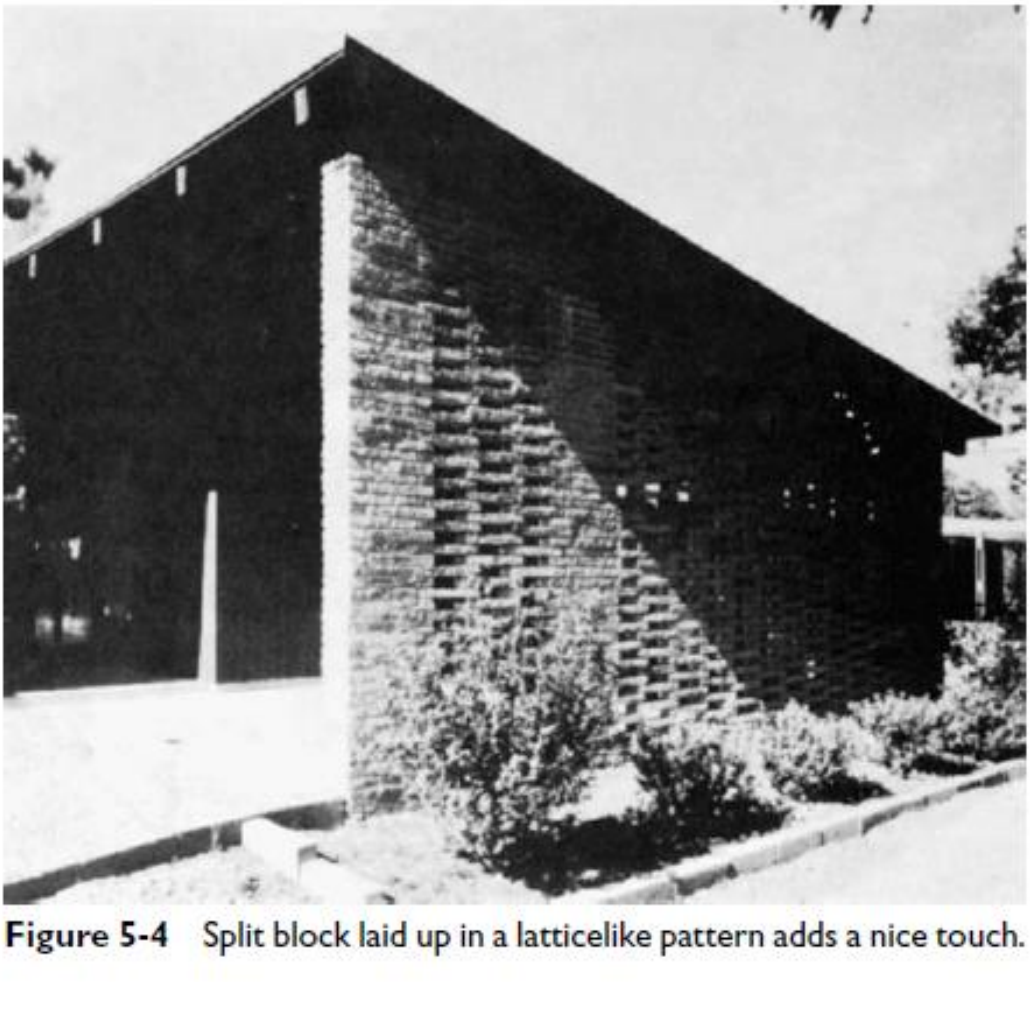


Figure 5-4 Split block laid up in a latticelike pattern adds a nice touch.

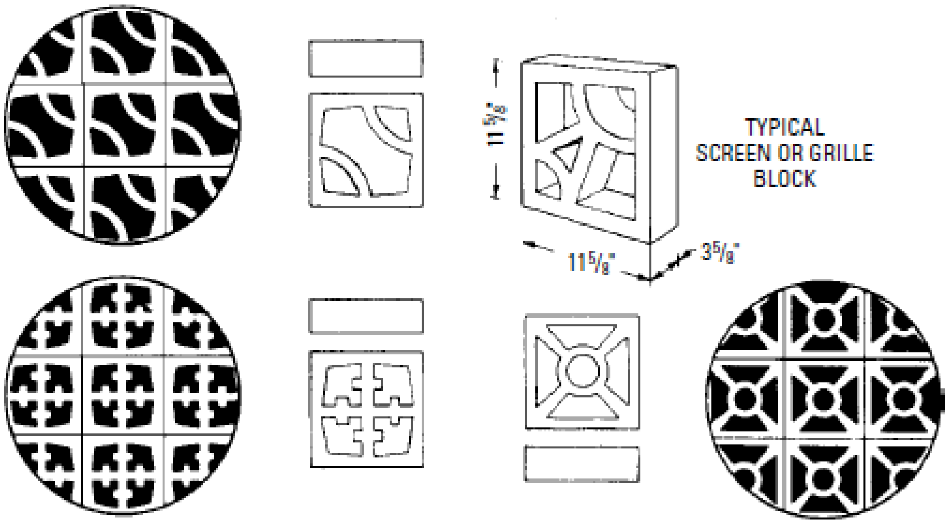


Figure 5-6 Examples of grille blocks. The actual patterns available vary with processors in different areas.

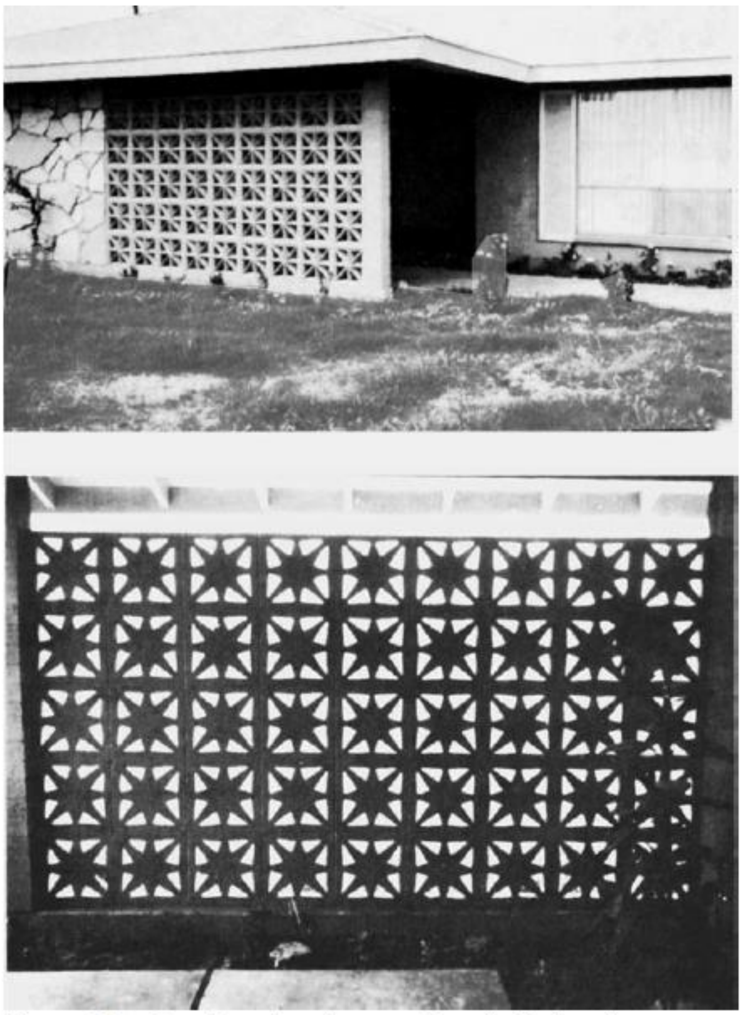


Figure 5-7 Outside and inside views of a grille block wall.

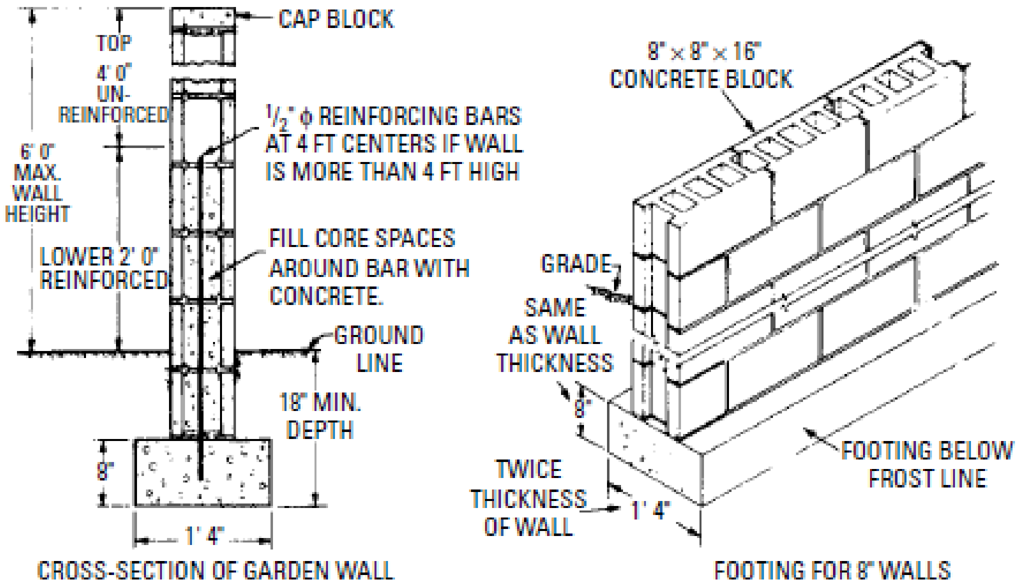


Figure 5-14 This is a cross-section and view of a simple block wall. Vertical reinforcement rods are placed in the hollow cores at various intervals.

Figure 5-15 Vertical reinforcement rods through double-thick column blocks.

Figure 5-16 A newly finished concrete-block wall. Note reinforcement columns at various intervals.

Mortar

Although concrete and mortar contain the same principal ingredients, the purposes they serve and their physical requirements are vastly different. Many architects, contractors, and engineers mistakenly believe that the greater the mortar's compressive strength, the better it will perform.

Concrete is a structural element requiring great compressive strength. Mortar serves to bond two masonry units, so its tensile (stretching) bond and flexural bond strength is more important than compressive strength.

Following are five types of cement:

- *Type M*—This is a high-strength, durable mix recommended for masonry subjected to high compressive loads, severe frost, earth pressure, hurricanes, and earthquakes. Its long-lasting qualities make it an excellent choice for below-grade foundations, retaining walls, manholes, and sewers.
- *Type S*—This is a medium high-strength mortar, used where high flexural bond strength is required, in structures subjected to normal compressive loads.
- *Type N*—This is a general-purpose mortar for use in above-grade masonry. This medium-strength mortar is well suited for masonry veneers and for interior walls and partitions.
- *Type O*—This is a high-lime, low-strength mortar for use in non–load-bearing walls and partitions. It can be used in exterior veneer that will not be subjected to freezing when wet and in load-bearing walls subjected to compressive loads of less than 100 psi. It is a very workable mortar, often used in one- and two-story residential structures.
- *Type K*—This is a very low compressive, low tensile-bond mortar. Its use is limited to non–load-bearing partitions carrying only their own dead weight.

Building with Concrete Blocks

Proper construction of concrete-block walls (whether for yard fencing or building structures) requires proper planning. Standard concrete blocks are made in 4-inch modular sizes. Their size allows for a 3/8-inch-thick mortar joint. By keeping this in mind, the width of a wall and openings for windows and doors may be planned without the need for cutting any of the blocks to fit.

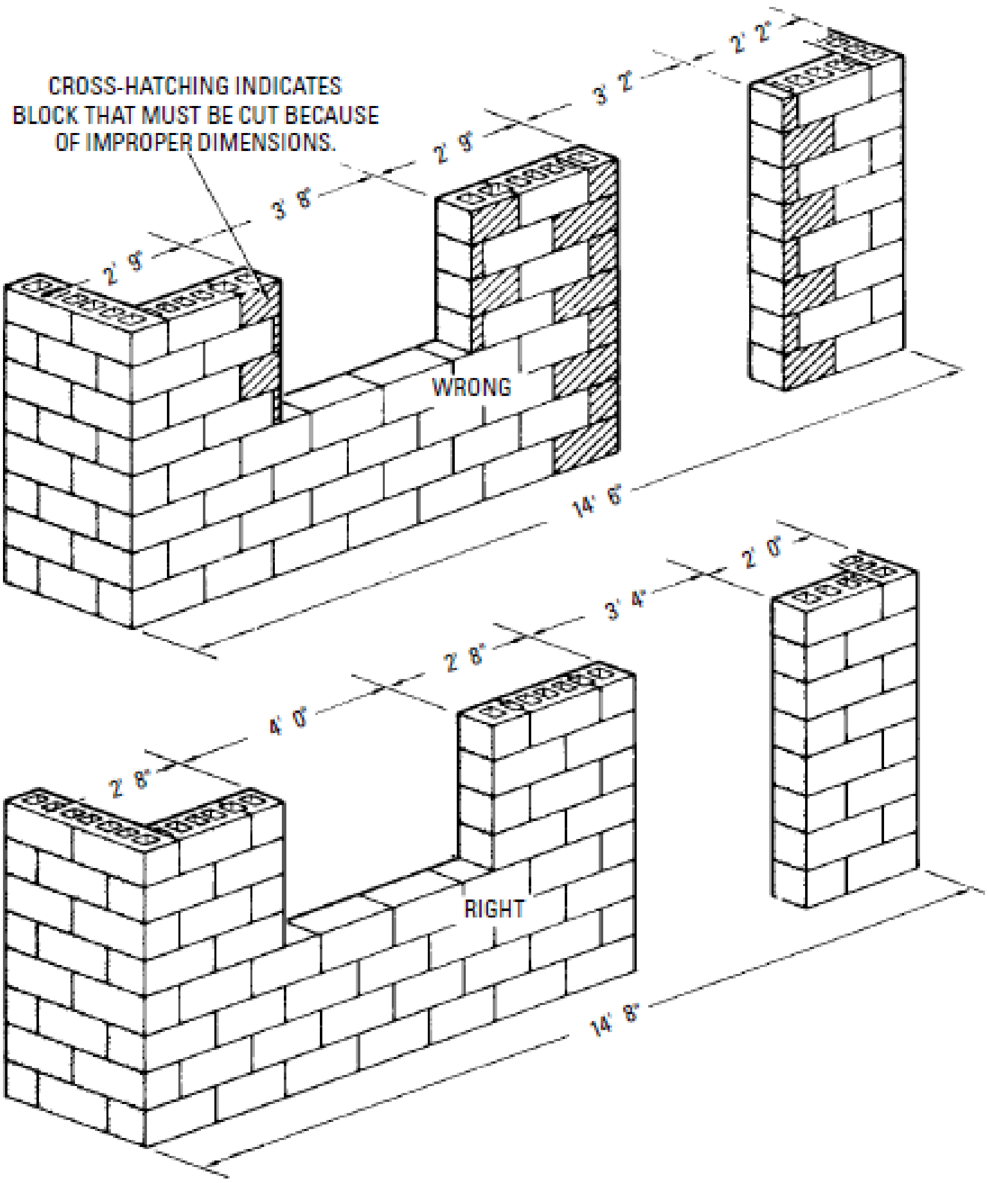


Figure 5-18 The right and wrong way to plan door and window openings in block walls. *(Courtesy Portland Cement Association)*

Laying Block at Corners

In laying up corners with concrete masonry blocks, place a taut line all the way around the foundation with the ends of the string tied together. It is customary to lay up the corner blocks, three or four courses high, and use them as guides in laying the walls.

A full width of mortar is placed on the footing, as shown in Figure 5-19, and the first course is built two or three blocks long each way from the corner. The second course is half a block shorter each way than the first course; the third, half a block shorter than the second, and so on. Thus, the corners are stepped off until only the corner block is laid. Use a line, and level frequently to see that the blocks are laid straight and that the corners are plumb. It is customary that such special units as corner blocks, door and window jamb blocks, fillers, and veneer blocks be provided prior to commencing the laying of the blocks.

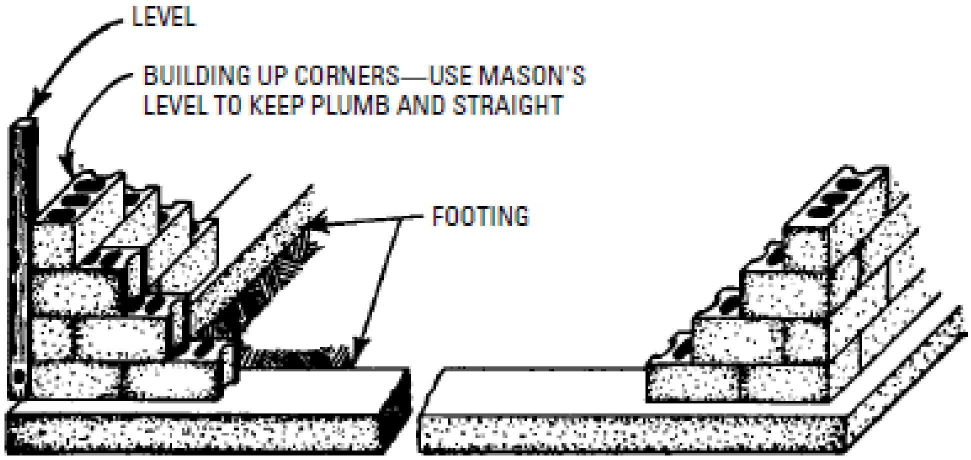


Figure 5-19 Laying up corners when building with concrete masonry block units.

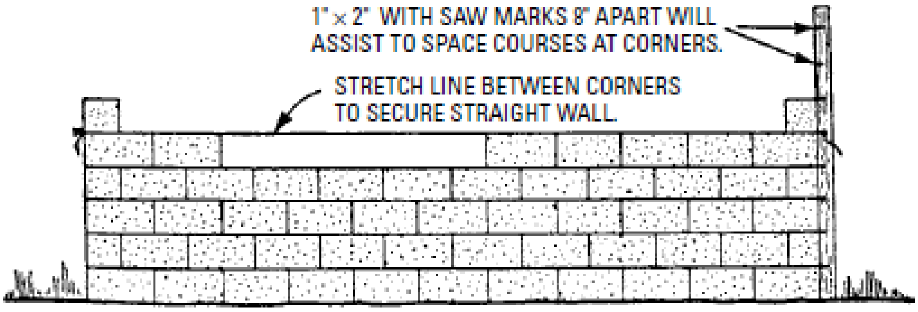


Figure 5-20 Procedure in laying concrete block walls.

nails or wedges driven into the mortar joints so that, when stretched, it just touches the upper outer edges of the block laid in the corners. The blocks in the wall between corners are laid so that they will just touch the cord in the same manner. In this way, straight horizontal joints are secured. Prior to laying up the outside wall, the door and window frames should be on hand to set in place as guides for obtaining the correct opening.

Applying Mortar to Blocks

The usual practice is to place the mortar in two separate strips, both for the horizontal or bed joints, and for the vertical or end joints, as shown in Figure 5-21. The mortar is applied only on the face shells

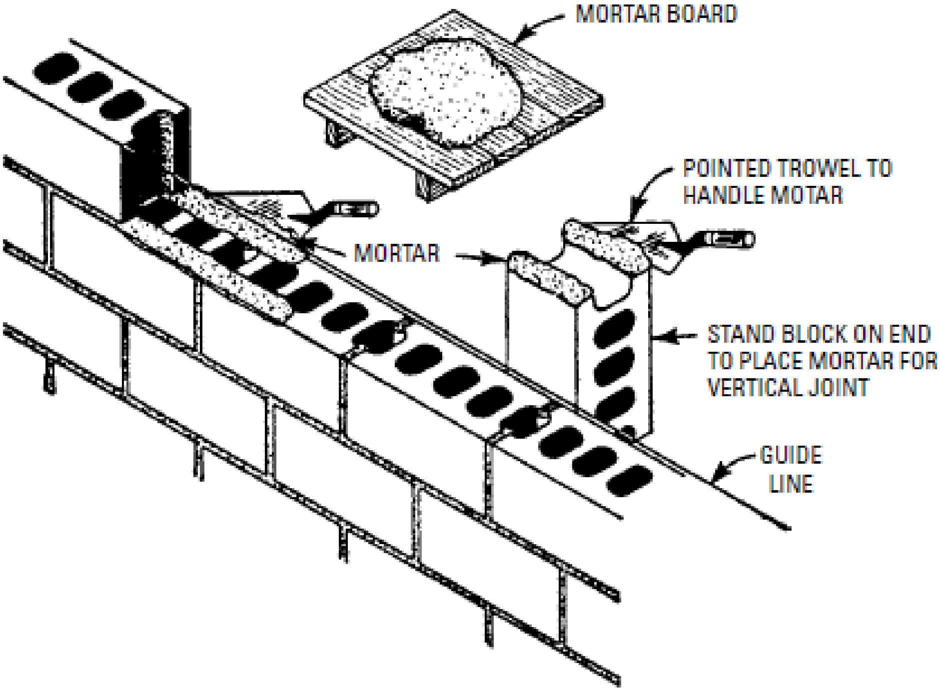


Figure 5-21 Usual practice in applying mortar to concrete blocks.

Placing and Setting Blocks

In placing, the block that has mortar applied to one end is picked up (as shown in Figure 5-22) and placed firmly against the block previously placed. Note that mortar is already in place in the bed or horizontal joints.

Mortar squeezed out of the joints is carefully scraped off with the trowel and applied on the other end of the block or thrown back onto the mortar board for later use. The blocks are laid to touch the line and are tapped with the trowel to get them straight and level,

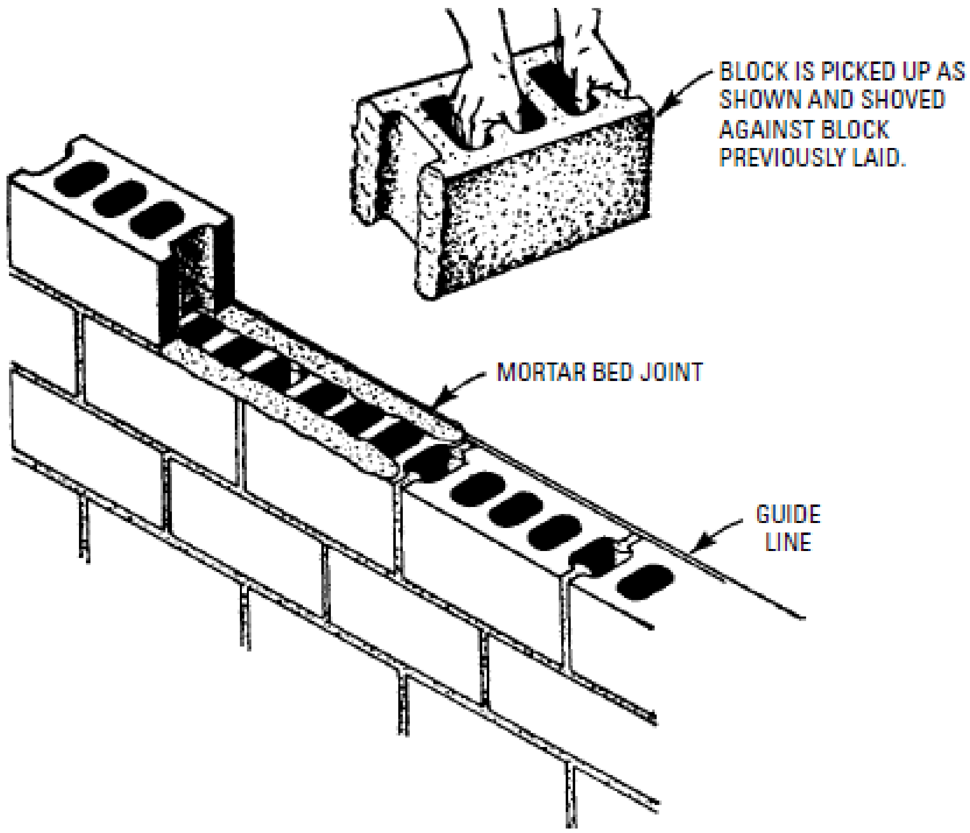


Figure 5-22 Common method used in picking up and setting concrete blocks.

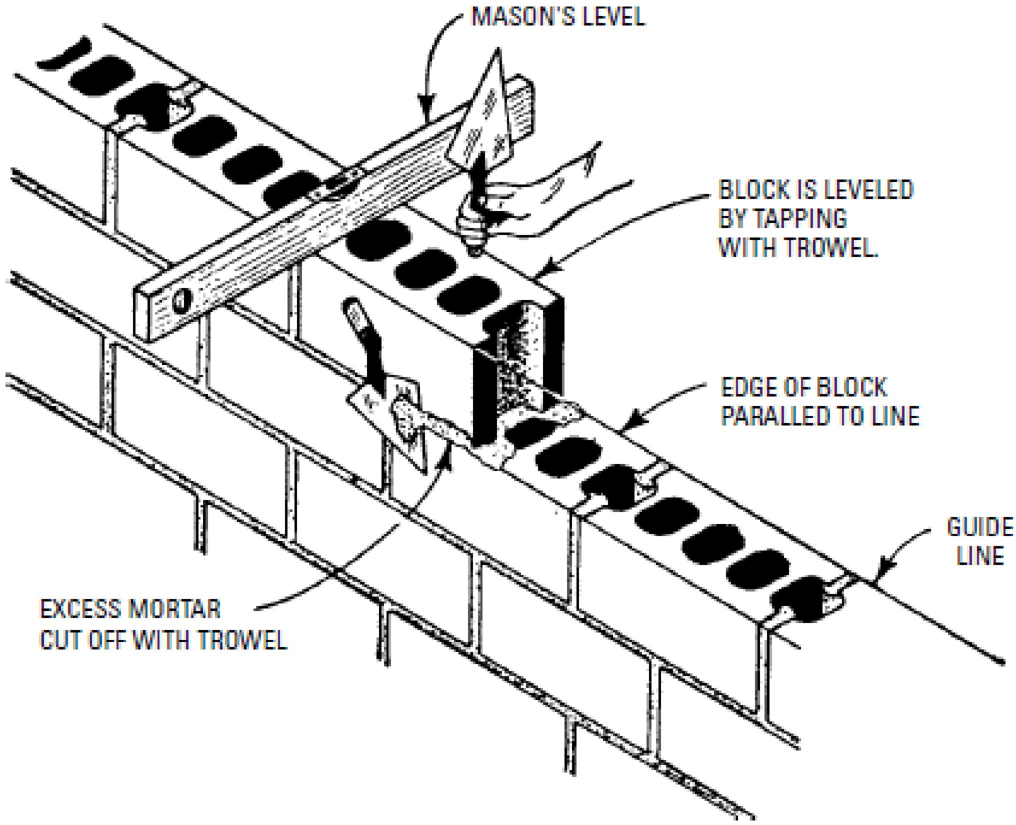


Figure 5-23 A method of laying concrete blocks. Good workmanship requires straight courses with the face of the wall plumb and true.

(A) Several blocks are receiving mortar on the end.

(B) Blocks are tapped into position.

Figure 5-24 Construct of a concrete-block wall.

(*continued*)

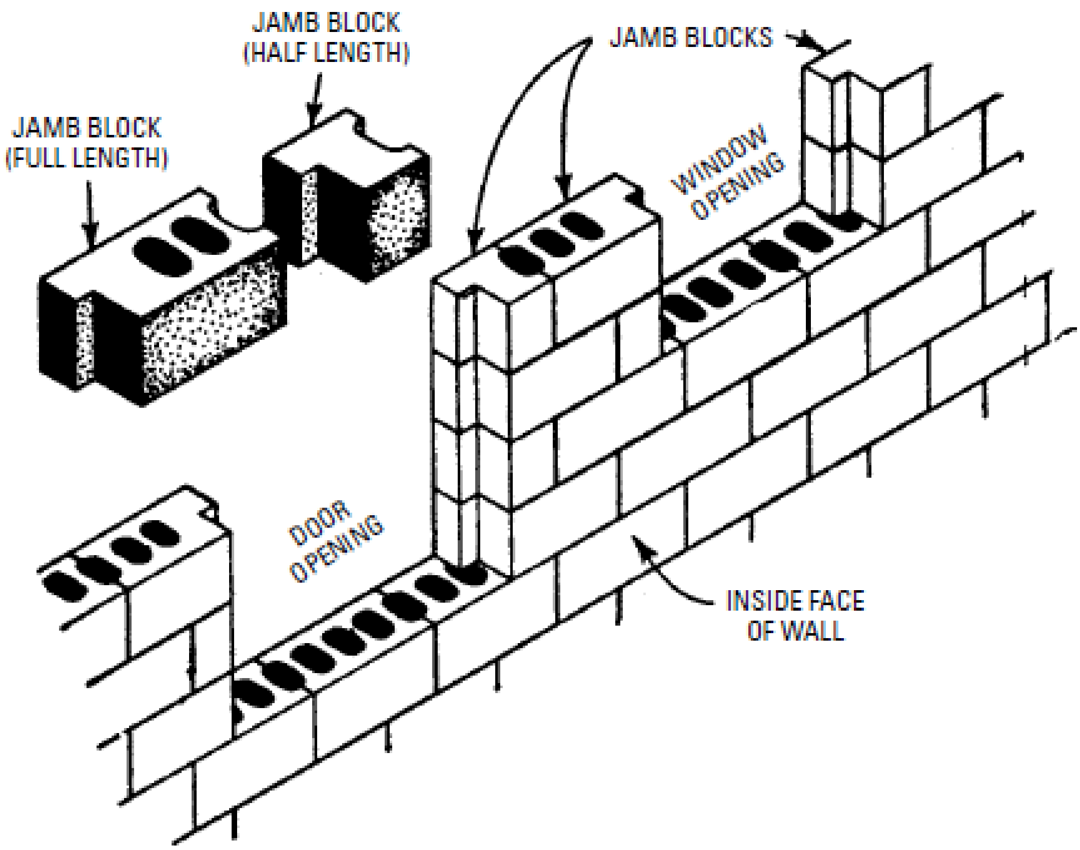


Figure 5-25 A method of laying openings for doors and windows.

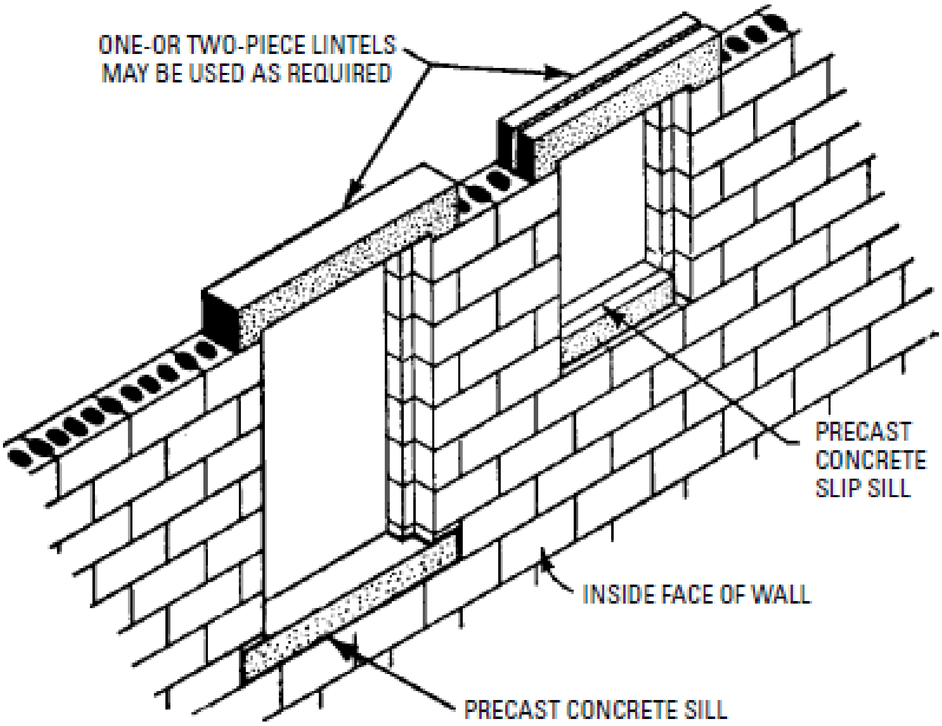


Figure 5-26 A method of inserting precast concrete lintels and sills in concrete-block wall construction.

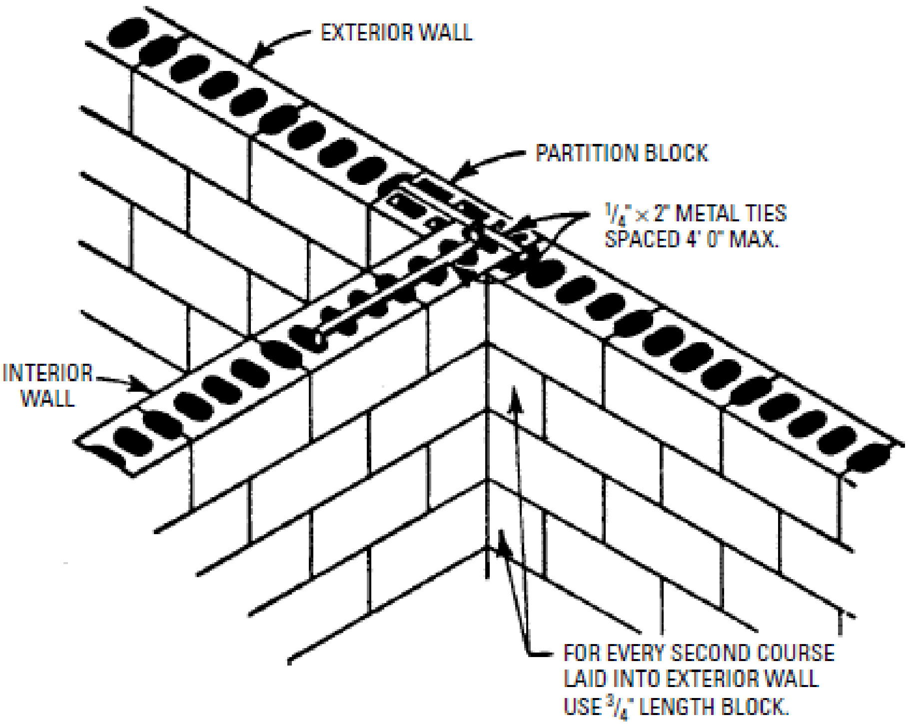


Figure 5-27 Detail of joining an interior and exterior wall in concrete-block construction.

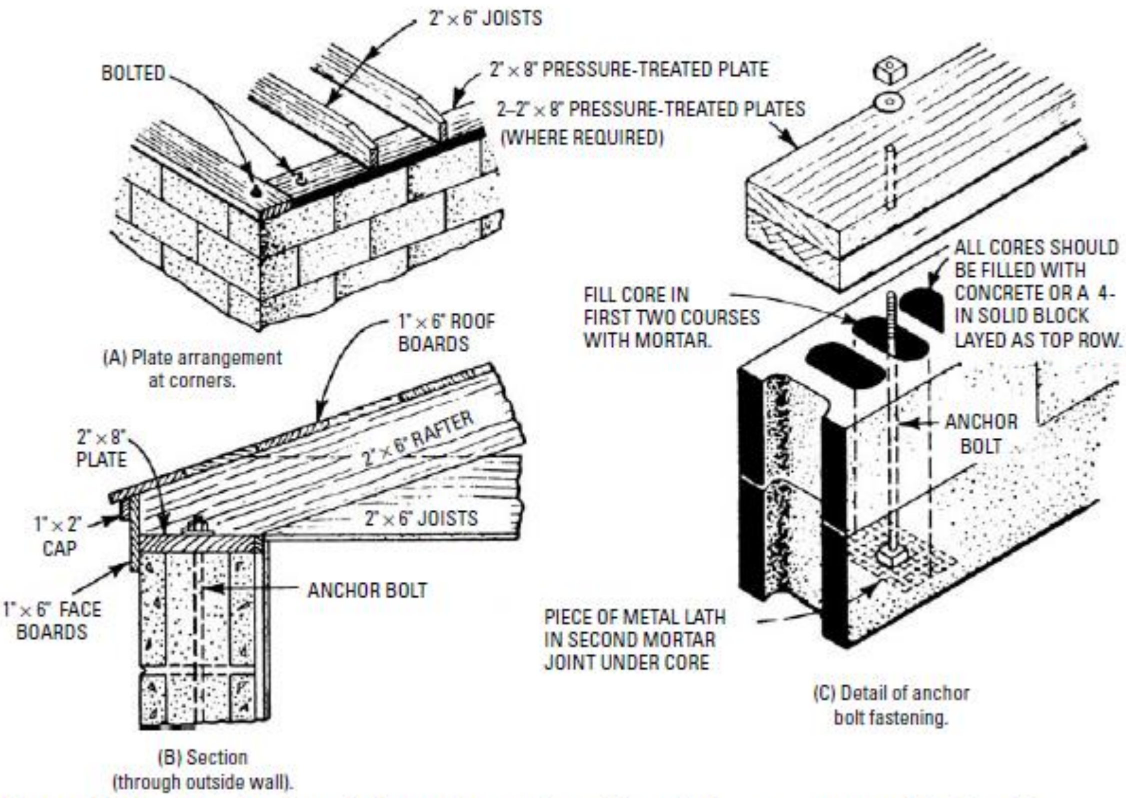


Figure 5-28 Details of methods used to anchor sills and plates to concrete-block walls.

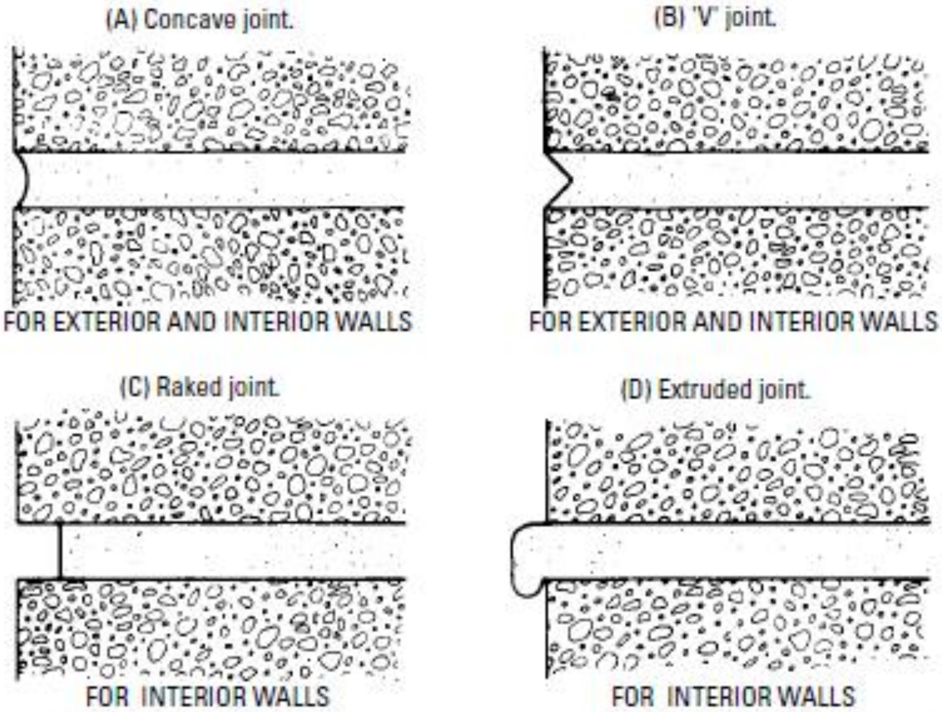


Figure 5-32 Four joint styles popular in block wall construction.

Figure 5-33 Brick wall with extruding joint construction.

Types of Joints

The concave and V-joints are best for most areas. Figure 5-32 shows four popular joints. Although the raked and the extruded styles are recommended for interior walls only, they may be used outdoors in warm climates where rains and freezing weather are at a minimum. In climates where freezes can take place, it is important that no joint permits water to collect.

Figure 5-34 Block with V-joints. Block can be painted—pad painter works well on it.

Tooling the Joints

Tooling of the joints consists of compressing the squeezed-out mortar of the joints back tight into the joints and taking off the excess mortar. The tool should be wider than the joint itself (wider than $^{1}/_{2}$ inch). You can make an excellent tooling device from $^{3}/_{4}$-inch copper tubing bent into an S-shape. By pressing the tool against the mortar, you will make a concave joint—a common joint but one of the best. Tooling not only affects appearance, but it makes the joint watertight, which is the most important function. It helps to compact and fill voids in the mortar. Figure 5-34 shows V-joint tooling of block.

Summary

Concrete blocks are sized in terms of multiples of 4 inches. They come in many shapes and sizes. They are available with a hollow core and solid.

Corner or bull-nose blocks with flat-finished ends are used at corners of walls. Concrete blocks vary in thickness of the face, depending on whether they are to be used for non–load-bearing walls.

There is decorative block, split block, slump block, grille block, screen block, patterned block, and blocks with special finishes.

Standard concrete blocks with hollow cores can make handsome walls, depending on how they are laid and on the sizes chosen. A wall up to 4 feet high needs no reinforcement.

Concrete block or brick wall requires a good foundation to support its weight and prevent any position shift. Although concrete and mortar contain the same principal ingredients, the purposes they serve and their physical requirements are vastly different.

Basement walls must not be less in thickness than the walls immediately above them, and not less than 12 inches for unit masonry walls. Sills and plates are usually attached to concrete block walls by means of anchor bolts. A concrete block wall may be insulated on the exterior, or the interior, or the block cavities may be filled with insulation. Adequate flashing with rust- and corrosion-resisting material is of utmost importance in masonry construction because it prevents water from getting through the wall at vulnerable points. Flashing material usually is 26 gage copper sheet or other approved

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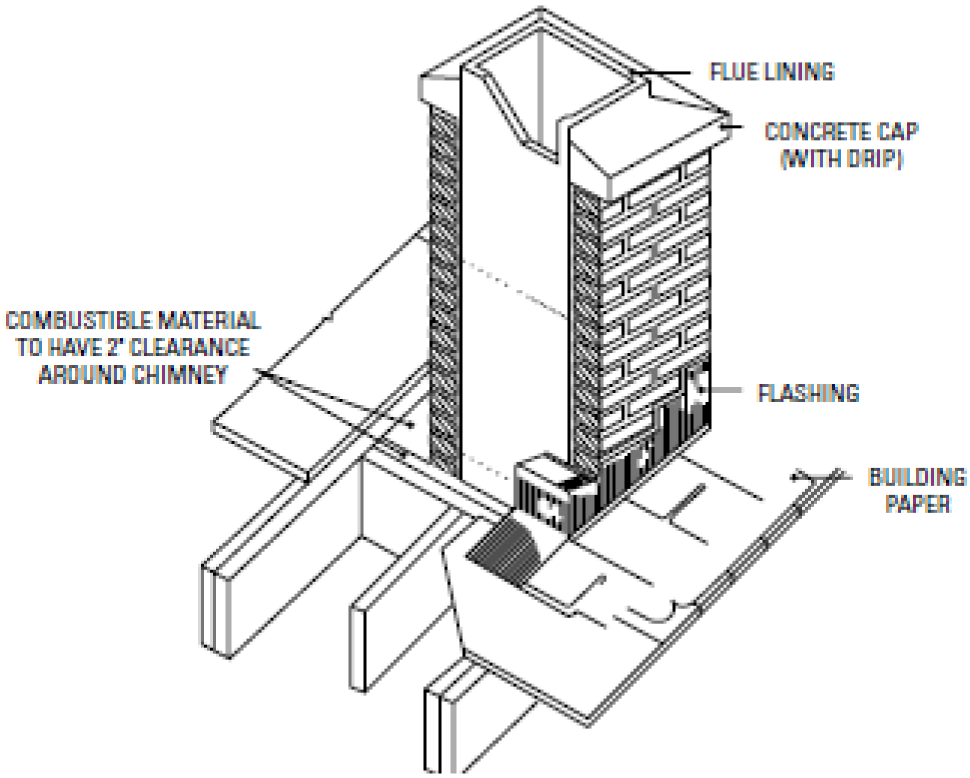
Chimneys and Fireplaces

The term *chimney* generally includes both the chimney proper and (in house construction) the fireplace. No part of a house is more likely to be a source of trouble than a chimney. That is especially true if the chimney is improperly constructed. Accordingly, it should be built so that it will be strong and designed and proportioned so that it gives adequate draft.

For strength, chimneys should be built of solid brickwork and should have no openings except those required for the heating apparatus. If a chimney fire occurs, considerable heat may be engendered in the chimney, and the safety of the house will then depend on the integrity of the flue wall. A little intelligent care in the construction of fireplaces and chimneys will prove to be the best insurance. As a first precaution, all wood framing of floor and roof must be kept at least 2 inches away from the chimney and no woodwork of any kind should be projected into the brickwork surrounding the flues (Figure 6-1).



Read Chapter 7 Page 163 to 185

Chapter 7

Woods Used in Construction

Wood is our most versatile, most useful building material, and a general knowledge of the physical characteristics of various woods used in building operations is important for carpenter and casual user alike.

Botanically, all trees that can be sawed into lumber or timbers belong to the division called *Spermatophytes*. This includes softwoods as well as hardwoods.

With respect to its density, wood may be classified as follows:

- Soft
- Hard

With respect to its leaves, wood may be classified as follows:

- Needle- or scale-leaved, botanically *Gymnosperms*, or conifers, are commonly called softwoods. Most of them, but not all, are evergreens.
- Broad-leaved, botanically *Angiosperms*, are commonly called hardwoods. Most are deciduous, shedding their leaves in the fall. Only one broad-leaved hardwood, the *Chinese Ginkgo*, belongs to the subdivision *Gymnosperms*

With respect to its shade or color, wood may be classified as follows:

- White or very light
- Yellow or yellowish
- Red
- Brown
- Black, or nearly black

In terms of grain, wood may be classified as follows:

- Straight
- Cross
- Fine
- Coarse
- Interlocking

With respect to the nature of the surface when dressed, wood may be classified as follows:

- Plain (for example, white pine)
- Grained (for example, oak)
- Figure or marked (for example, bird's-eye maple)

A section of a timber tree, as shown in Figure 7-1 and Figure 7-2, consists of the following:

- *Outer bark*—Living and growing only at the cambium layer. In most trees, the outside continually sloughs away.
- *Inner bark*—In some trees, notably hickories and basswood, there are long tough fibers, called bast fibers, in the inner bark. In some trees, such as the beech, they are notably absent.
- *Cambium layer*—Sometimes this is only one cell thick. Only these cells are living and growing.

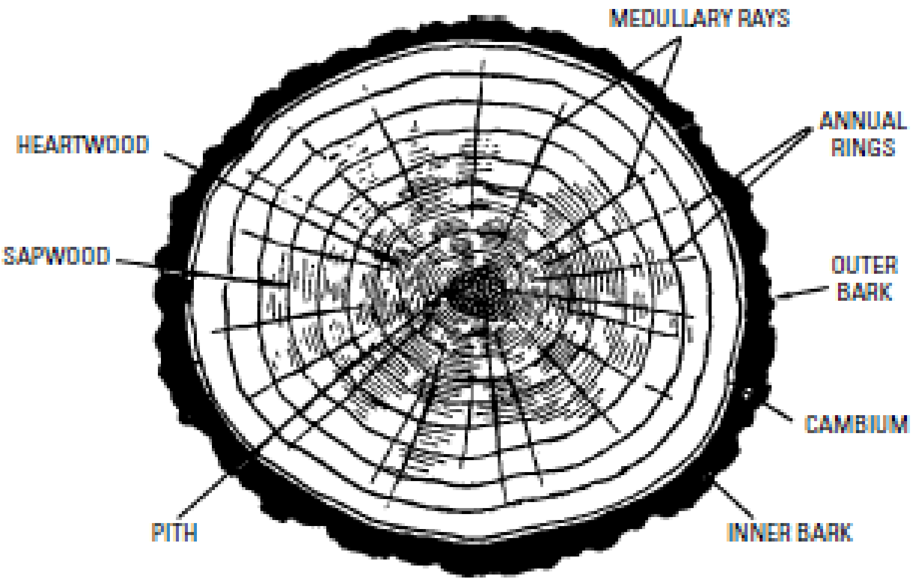


Figure 7-1 This is a cross-section of a 9-year-old oak showing pith, concentric rings comprising the woody part, cambium layer, and the bark. The arrangement of the wood in concentric rings is due to the fact that one layer was formed each year. These rings, or layers, are called annual rings. That portion of each ring formed in spring and early summer is

Cutting at the Mill

When logs are taken to the mill, they may be cut in a variety of ways. One way of cutting is quartersawing. Figure 7-3 shows four variations of this method. Each quarter is laid on the bark and ripped into quarters, as shown in the figure. Quartersawing is rarely done this way, though, because only a few wide boards are yielded. Thus, there is too much waste. More often, when quartersawed stock is required, the log is started as shown in Figure 7-4 and Figure 7-5, sawed until a good figure (pattern) shows, then turned over and sawed. This way, there is little waste, and the boards are wide. In other words, most quartersawed lumber is resawed out of plain sawed stock.

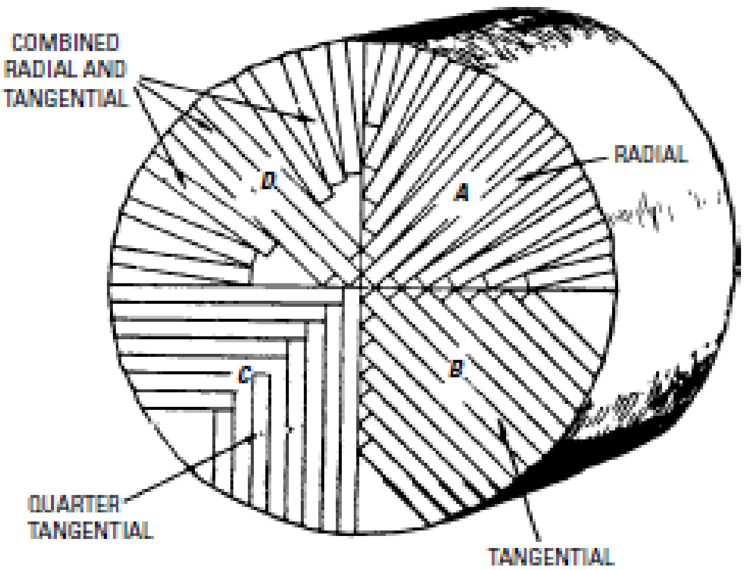


Figure 7-3 Methods of quartersawing.

Defects

The defects found in manufactured lumber (Figure 7-6 and Figure 7–7) are grouped in several classes:

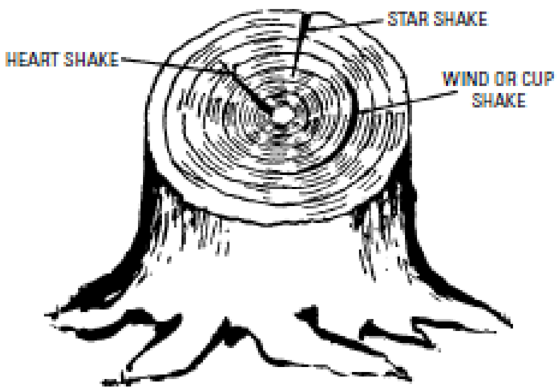


Figure 7-6 Various defects that can be found in lumber.

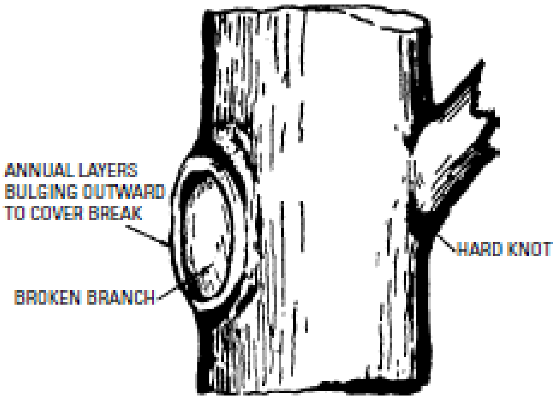


Figure 7-7 Hard knot and broken branch show nature's way of covering the break.

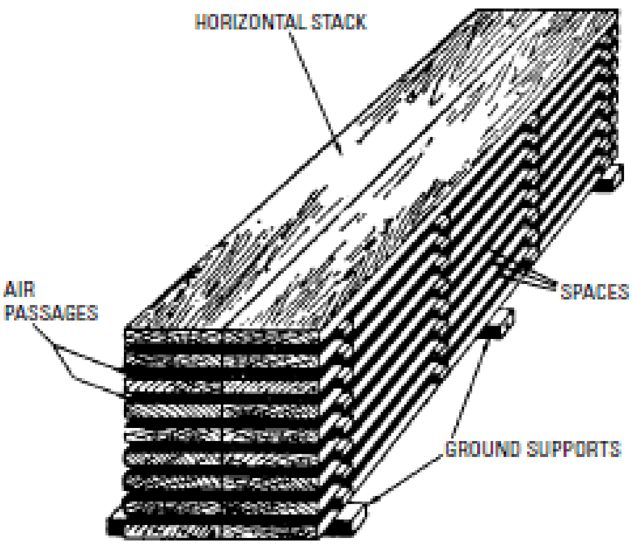


Figure 7-8 Horizontal stack of lumber for air-drying.

Table 7-1 Wood Characteristics

Wood Type	*Description*
Brown Ash	Not a framing timber, but an attractive trim wood. It has brown heart, and a lighter sapwood. The trees often wind shake so badly that the heart is entirely loose. Attractive veneers are sliced from stumps and forks.
Northern White Cedar	Light-brown heart, sapwood is thin and nearly white. Light, weak, soft, and decay-resistant. It holds paint well.
Western Red Cedar	Also called canoe cedar or shingle wood. It is light, soft, straight-grained, and has small shrinkage. It, too, holds paint well. The heart is light brown and is extremely rot-resistant. Sap is quite narrow and nearly white. Used for shingles, siding, and boat building.
Eastern Red Cedar, or Juniper	Pungent aromatic odor said to repel moths. The heartwood is red or brown. It is extremely rot-resistant and has white sapwood. It is used for lining clothes closets, cedar chests, and for fence posts.
Cypress	This is probably our most durable wood for contact with the soil or water. The wood is moderately light, close-grained, and the heartwood is red to nearly yellow, sapwood is nearly white. Cypress does not hold paint well. Otherwise, it is desirable for siding and outside trim. It is attractive for inside trim.
Red Gum	Moderately heavy, interlocking grain. Warps badly in seasoning. Heart is reddish brown, sapwood nearly white. The sapwood may be graded out and sold as white gum, the heartwood as red gum, or together as unselected gum. It cuts into attractive veneers.
Hickory	A combination of hardness, weight, toughness, and strength is found in no other native wood. A specialty wood, almost impossible to nail when dry. It is not rot-resistant.
Eastern Hemlock	Heartwood is pale brown to reddish, sapwood not distinguishable from heart. May be badly wind shaken. Eastern hemlock is brittle, moderately weak, and not at all durable. It is used for cheap, rough framing veneers.
Western Hemlock	Heartwood and sapwood are almost white with purplish tinge. It is moderately strong, not durable, and is mostly used for pulpwood.
Black Locust	Heavy, hard, and strong, the heartwood is exceptionally durable. This is not a framing timber. It is used mostly for posts and poles.

(continued)

Table 7-2 Veneer Grades

Grade	*Description*
N	Smooth surface natural finish veneer. Select; all heartwood or all sapwood. Free of open defects Allows not more than 6 repairs, wood only, per 4 × 8 panel made parallel to grain and well-matched for grain and color.
A	Smooth, paintable. Not more than 18 neatly made repairs boat, sled, or router type, and parallel to grain, permitted. May be used for natural finish in less-demanding applications. Synthetic repairs permitted.
B	Solid surface. Shims, circular repair plugs and tight knots to 1 inch across grain permitted. Some minor splits permitted. Synthetic repairs permitted.
C (plugged)	Improved C veneer with splits limited to $\frac{1}{8}$-inch width and knotholes and borer holes limited to $\frac{1}{4} \times \frac{1}{2}$ inch. Admits some broken grain. Synthetic repairs permitted.
C	Tight knots to $1\frac{1}{2}$ inch. Knotholes to 1 inch across grain, and some to $1\frac{1}{2}$ inch if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed. Stitching permitted.
D	Knots and knotholes to $2\frac{1}{2}$ inch width across grain and $\frac{1}{2}$ inch larger within specified limits. Limited splits are permitted. Stitching permitted. Limited to Exposure 1 or interior panels.

Courtesy American Plywood Association

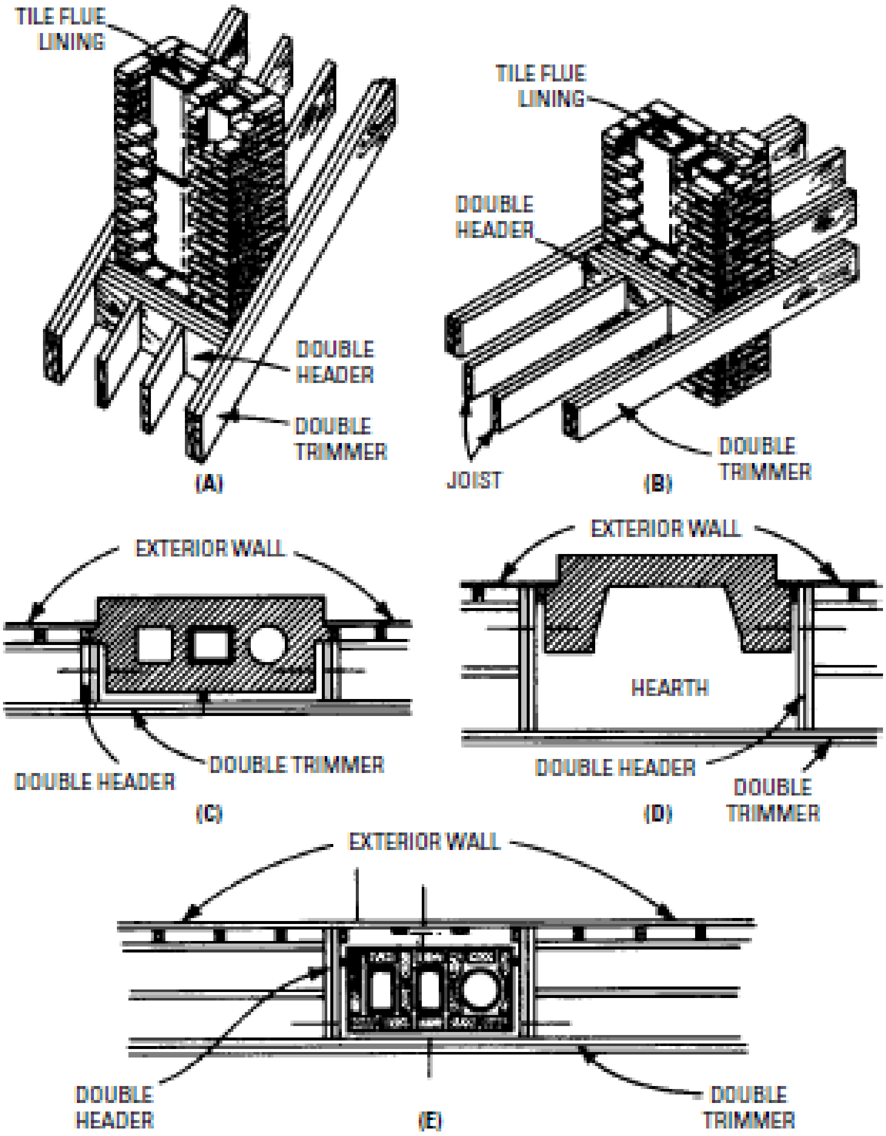


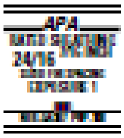
Figure 8-12 Framing around chimneys and fireplaces: (A) roof framing around chimney; (B) floor framing around chimney; (C) framing around chimney above fireplace; (D) floor framing around fireplace; (E) framing around concealed chimney above fireplace.

Chimney and Fireplace Construction

Although carpenters are ordinarily not concerned with the building of the chimney, it is necessary, however, that they be acquainted with the methods of framing around the chimney.

The following minimum requirements are recommended:

- No wooden beams, joists, or rafters shall be placed within 2 inches of the outside face of the chimney. No woodwork shall be placed within 4 inches of the back wall of any fireplace.
- No studs, furring, lathing, or plugging should be placed against any chimney or in the joints thereof. Wooden construction shall be set away from the chimney or the plastering shall be directly on the masonry or on metal lathing or on incombustible furring material.
- The walls of fireplaces shall never be less than 8 inches thick if of brick or 12 inches if built of stone.

APA RATED SHEATHING Typical Trademark			Specially designed for subflooring and wall and roof sheathing. Also good for a broad range of other construction and industrial applications. Can be manufactured as conventional veneered plywood, as a composite, or as a nonveneer panel. EXPOSURE DURABILITY CLASSIFICATIONS: Exterior, Exposure 1, Exposure 2. COMMON THICKNESSES: 5/16, 3/8, 7/16, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4.
APA STRUCTURAL I RATED SHEATHING(3) Typical Trademark			Unsanded grade for use where shear and cross-panel strength properties are of maximum importance, such as panelized roofs and diaphragms. Can be manufactured as conventional veneered plywood, as a composite, or as a nonveneer panel. EXPOSURE DURABILITY CLASSIFICATIONS: Exterior, Exposure 1. COMMON THICKNESSES: 5/16, 3/8, 7/16, 15/32, 1/2, 19/32, 5/8, 23/32, 3/4.
APA RATED STURD-I-FLOOR Typical Trademark			Specially designed as combination subfloor-underlayment. Provides smooth surface for application of carpet and pad and possesses high concentrated and impact load resistance. Can be manufactured as conventional veneered plywood, as a composite, or as a nonveneer panel. Available square edge or tongue-and-groove. EXPOSURE DURABILITY CLASSIFICATIONS: Exterior, Exposure 1, Exposure 2. COMMON THICKNESSES: 19/32, 5/8, 23/32, 3/4, 1-1/8.
APA RATED SIDING Typical Trademark			For exterior siding, fencing, etc. Can be manufactured as conventional veneered plywood, as a composite or as a nonveneer siding. Both panel and lap siding available. Special surface treatment such as V-groove, channel groove, deep groove (such as APA Texture 1-11), brushed, rough sawn and texture-embossed (MDO). Span Rating (stud spacing for siding qualified for APA Sturd-I-Wall applications) and face grade classification (for veneer-faced siding) indicated in trademark. EXPOSURE DURABILITY CLASSIFICATION: Exterior. COMMON THICKNESSES: 11/32, 3/8, 7/16, 15/32, 1/2, 19/32, 5/8.

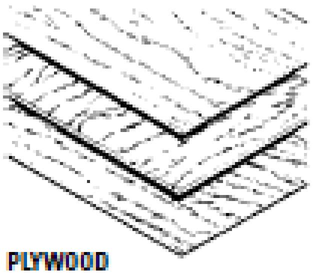
(1) Specific grades, thicknesses and exposure durability classifications may be in limited supply in some areas. Check with your supplier before specifying.

(2) Specify Performance Rated Panels by thickness and Span Rating. Span Ratings are based on panel strength and stiffness. Since these properties are a function of panel composition and configuration as well as thickness, the same Span Rating may appear on panels of different thickness. Conversely, panels of the same thickness may be marked with different Span Ratings.

(3) All plies in Structural I plywood panels are special improved grades and panels marked PS 1 are limited to Group 1 species. Other panels marked Structural I Rated qualify through special performance testing. Structural II plywood panels are also provided for, but rarely manufactured. Application recommendations for Structural II plywood are identical to those for RATED SHEATHING plywood.

Figure 7-12 APA performance-rated panels.

APA PERFORMANCE RATED PANEL COMPOSITIONS



PLYWOOD

Plywood is the original structural wood panel. It is composed of thin sheets of veneer, or plies, arranged in layers to form a panel. Plywood always has an odd number of layers, each one consisting of one or more plies, or veneers.

In plywood manufacture, a log is turned on a lathe and a long knife blade peels the veneer. The veneers are clipped to a suitable width, dried, graded, and repaired if necessary. Next the veneers are laid up in cross-laminated layers. Sometimes a layer will consist of two or more plies with the grain running in the same direction, but there will always be an odd number of layers, with the face layers typically having the grain oriented parallel to the long dimension of the panel.

Adhesive is applied to the veneers which are laid up. Laid-up veneers are then put in a hot press where they are bonded to form panels.

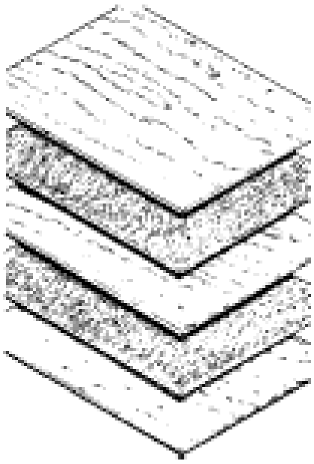
Wood is strongest along its grain, and shrinks and swells most across the grain. By alternating grain direction between adjacent layers, strength and stiffness in both directions are maximized, and shrinking and swelling are minimized in each direction.

ORIENTED STRAND BOARD

Nonveneer panels manufactured with various techniques have been marketed with such names as waferboard, oriented strand board, and structural particleboard. Today, most nonveneer structural wood panels are manufactured with oriented strands or wafers, and are commonly called oriented strand board (OSB).

OSB is composed of compressed strands arranged in layers (usually three to five) oriented at right angles to one another. The orientation of layers achieves the same advantages of cross-laminated veneers in plywood. Since wood is stronger along the grain, the cross-lamination distributes wood's natural strength in both directions of the panel. Whether a reconstituted panel is composed of strands or wafers, nearly all manufacturers orient the material to achieve maximum performance.

Most OSB panels are textured on one side to reduce slickness.



COM-PLY

COM-PLY is an APA product name for composite panels that are manufactured by bonding reconstituted wood cores between wood veneer. By combining reconstituted wood with conventional wood veneer, COM-PLY panels allow for more efficient resource use while retaining the wood grain appearance on the panel face and back.

COM-PLY panels are manufactured in three- or five-layer arrangement. A three-layer panel has a reconstituted wood core and a veneer face and back. The five-layer panel has a wood veneer in the center as well as on the face and back. When manufactured in a one-step pressing operation, voids in the veneers are filled automatically by the particles as the panel is pressed in the bonding process.

Figure 7-15 Performance-rated panel composition.

(Courtesy American Plywood Association)

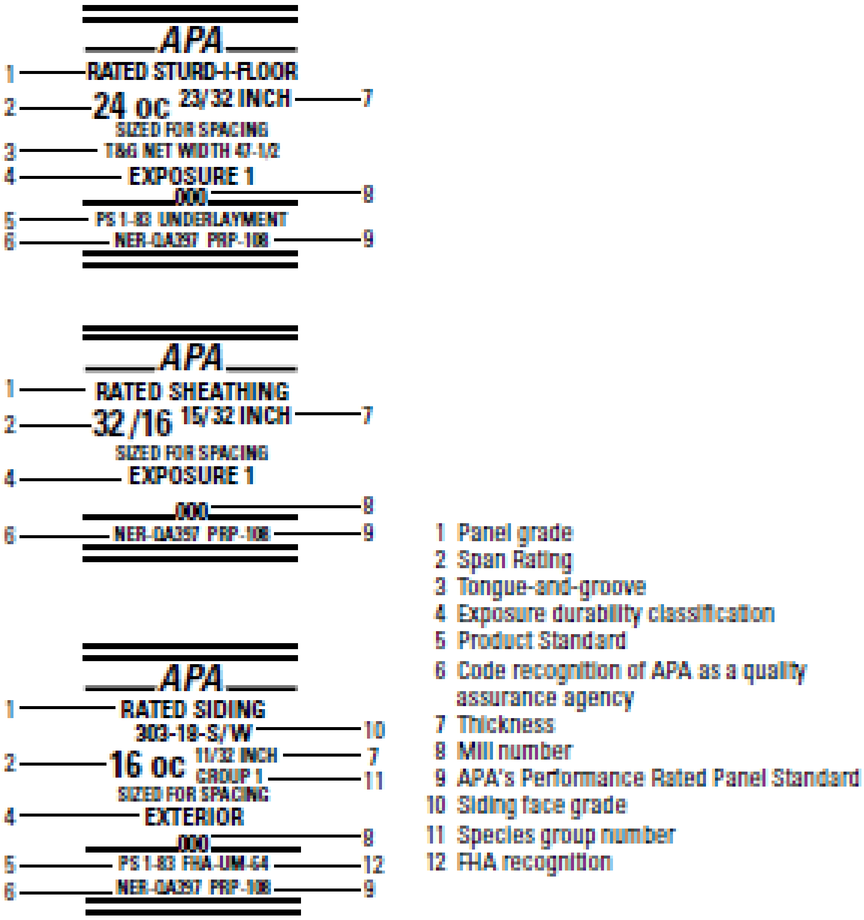


Figure 7-16 How to read an APA label. *(Courtesy American Plywood Association)*

Read Chapter 8 Page 187

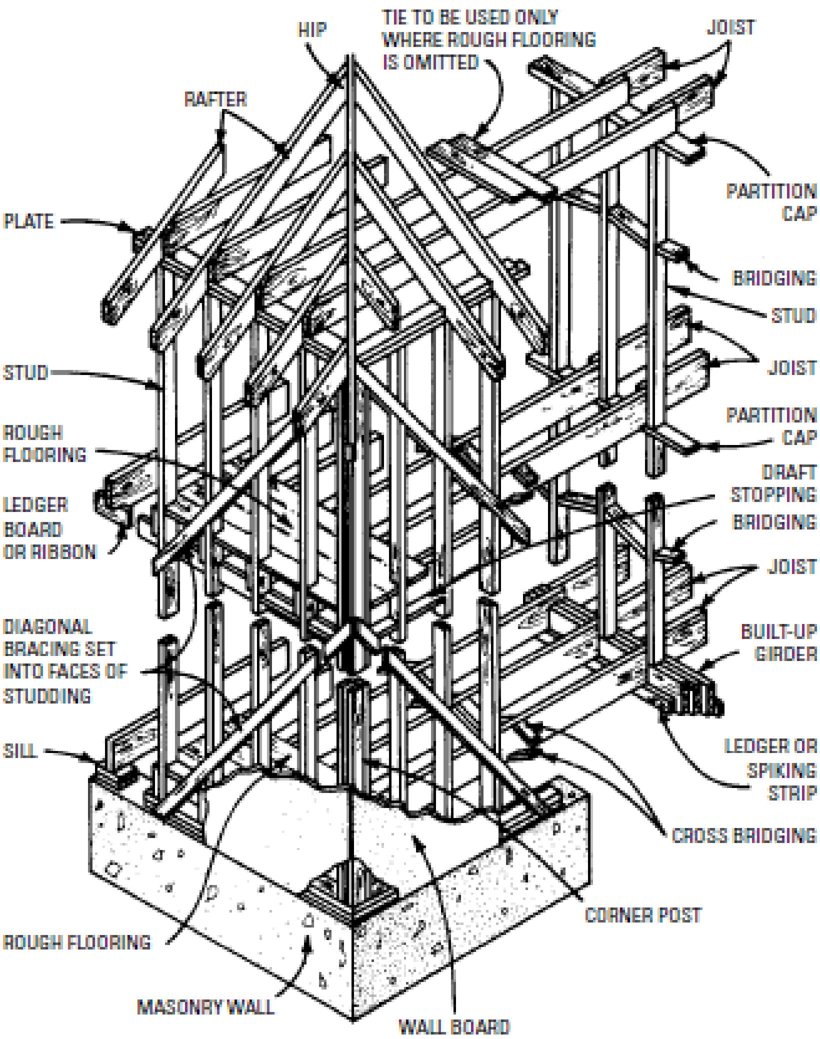


Figure 8-1 Details of balloon-frame construction.

Select Lumber

Select lumber is of good appearance and finished or dressed. It is identified by the following grade names:

- *Grade A*—Grade A is suitable for natural finishes, of high quality, and is practically clear.
- *Grade B*—Grade B is suitable for natural finishes, of high quality, and is generally clear.
- *Grade C*—Grade C is adapted to high-quality paint finish.

Table 8-1 Your Guide to Sizes of Lumber

What You Order	What You Get: Dry or Seasoned*	What You Get: Green or Unseasoned**	What You Used to Get Seasoned or Unseasoned
1 × 4	$\frac{3}{4} \times 3\frac{1}{2}$	$\frac{25}{32} \times 3\frac{9}{16}$	$\frac{25}{32} \times 3\frac{5}{8}$
1 × 6	$\frac{3}{4} \times 5\frac{1}{2}$	$\frac{25}{32} \times 5\frac{5}{8}$	$\frac{25}{32} \times 5\frac{1}{2}$
1 × 8	$\frac{3}{4} \times 7\frac{1}{4}$	$\frac{25}{32} \times 7\frac{1}{2}$	$\frac{25}{32} \times 7\frac{1}{2}$
1 × 10	$\frac{3}{4} \times 9\frac{1}{4}$	$\frac{25}{32} \times 9\frac{1}{2}$	$\frac{25}{32} \times 9\frac{1}{2}$
1 × 12	$\frac{3}{4} \times 11\frac{1}{4}$	$\frac{25}{32} \times 11\frac{1}{2}$	$\frac{25}{32} \times 11\frac{1}{2}$
2 × 4	$1\frac{1}{2} \times 3\frac{1}{2}$	$1\frac{9}{16} \times 3\frac{9}{16}$	$1\frac{5}{8} \times 3\frac{5}{8}$
2 × 6	$1\frac{1}{2} \times 5\frac{1}{2}$	$1\frac{9}{16} \times 5\frac{5}{8}$	$1\frac{5}{8} \times 5\frac{1}{2}$
2 × 8	$1\frac{1}{2} \times 7\frac{1}{4}$	$1\frac{9}{16} \times 7\frac{1}{2}$	$1\frac{5}{8} \times 7\frac{1}{2}$
2 × 10	$1\frac{1}{2} \times 9\frac{1}{4}$	$1\frac{9}{16} \times 9\frac{1}{2}$	$1\frac{5}{8} \times 9\frac{1}{2}$
2 × 12	$1\frac{1}{2} \times 11\frac{1}{4}$	$1\frac{9}{16} \times 11\frac{1}{2}$	$1\frac{5}{8} \times 11\frac{1}{2}$
4 × 4	$3\frac{1}{2} \times 3\frac{1}{2}$	$3\frac{9}{16} \times 3\frac{9}{16}$	$3\frac{5}{8} \times 3\frac{5}{8}$
4 × 6	$3\frac{1}{2} \times 5\frac{1}{2}$	$3\frac{9}{16} \times 5\frac{5}{8}$	$3\frac{5}{8} \times 5\frac{1}{2}$
4 × 8	$3\frac{1}{2} \times 7\frac{1}{4}$	$3\frac{9}{16} \times 7\frac{1}{2}$	$3\frac{5}{8} \times 7\frac{1}{2}$
4 × 10	$3\frac{1}{2} \times 9\frac{1}{4}$	$3\frac{9}{16} \times 9\frac{1}{2}$	$3\frac{5}{8} \times 9\frac{1}{2}$
4 × 12	$3\frac{1}{2} \times 11\frac{1}{4}$	$3\frac{9}{16} \times 11\frac{1}{2}$	$3\frac{5}{8} \times 11\frac{1}{2}$

*19 percent moisture content or under.
**Over 19 percent moisture content.

- *Grade D*—Grade D is suitable for paint finishes and is between the higher finishing grades and the common grades.

Computing Board Feet

The following formula shows the arithmetic method of computing the number of board feet in one or more pieces of lumber:

$$\frac{\text{Pieces} \times \text{Thickness (inches)} \times \text{Width (inches)} \times \text{Length (feet)}}{12}$$

For example, to find the number of board feet in a piece of lumber 2 inches thick, 10 inches wide, and 6 feet long, use the following equation:

$$\frac{1 \times 2 \times 10 \times 6}{12} = 10 \text{ board feet}$$

To find the number of board feet in 10 pieces of lumber 2 inches thick, 10 inches wide, and 6 feet long, use the following equation:

$$\frac{10 \times 2 \times 10 \times 6}{12} = 100 \text{ board feet}$$

Note

> If all three dimensions are expressed in inches, the same formula applies except the divisor is changed to 144.

To find the number of board feet in a piece of lumber 2 inches thick, 10 inches wide, and 18 inches long, use the following equation:

$$\frac{2 \times 10 \times 18}{144} = 2^1/_2 \text{ board feet}$$

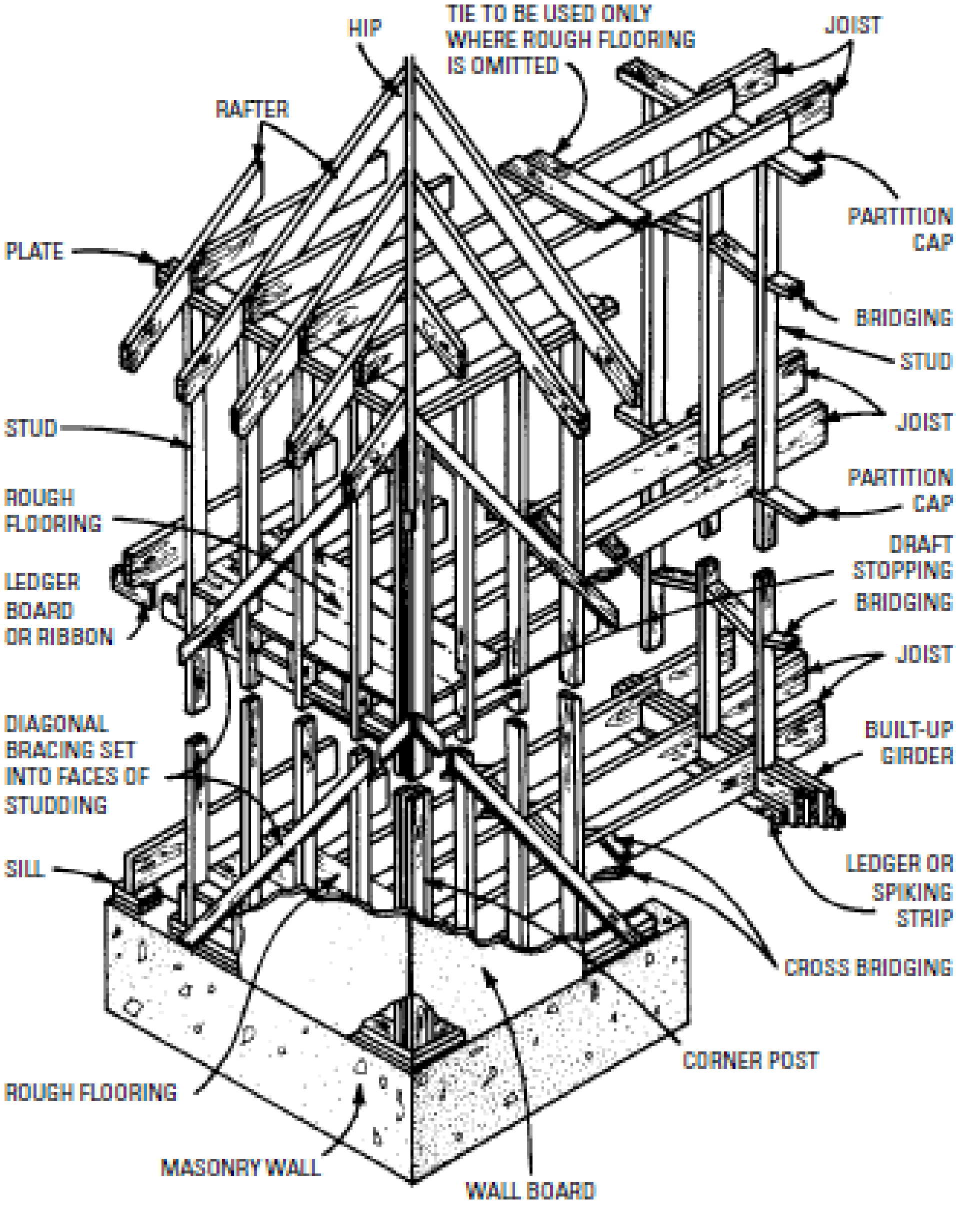


Figure 8-1 Details of balloon-frame construction.

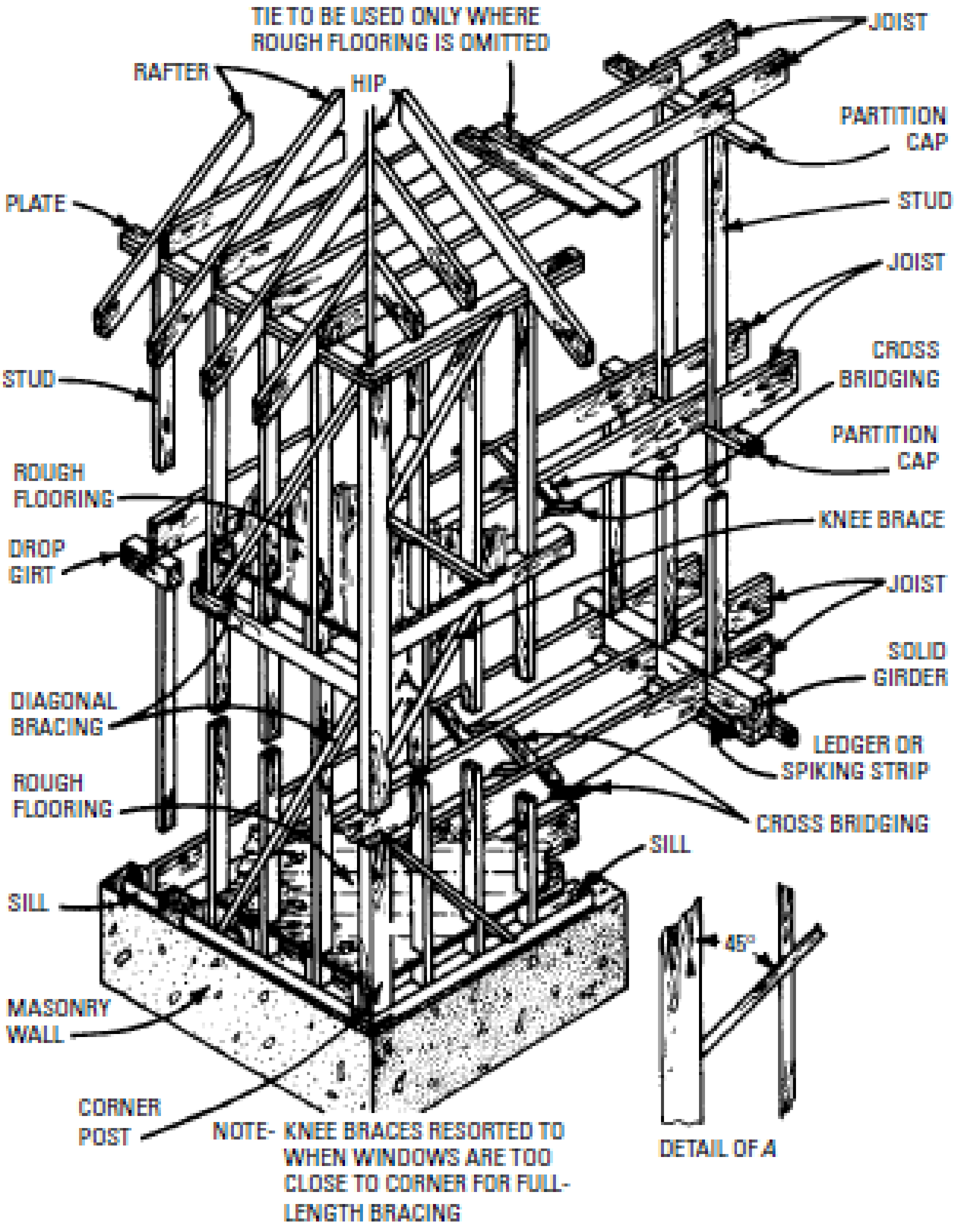


Figure 8-2 Details of plank-and-beam construction.

which extended continuously from a heavy foundation sill to an equally heavy plate at the roof line.

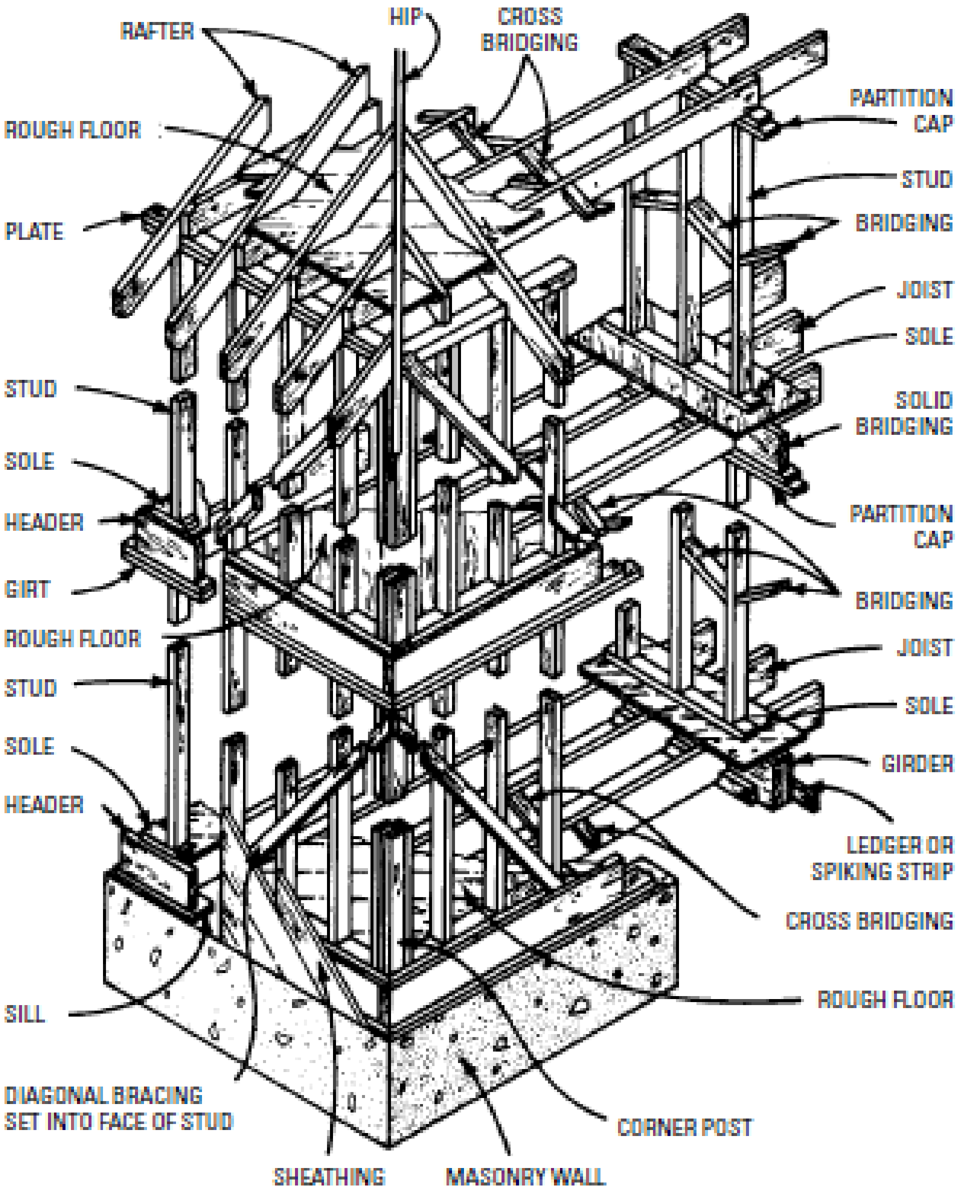
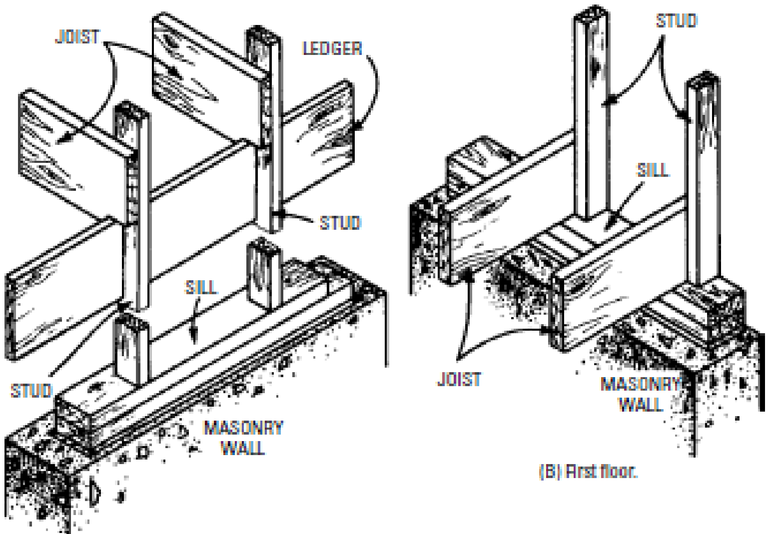


Figure 8-3 Details of western-frame construction.

of framing (in all-lumber construction) lies in the fact that if there is any settlement caused by shrinkage, it will be uniform throughout and will not be noticeable.

Foundation Sills

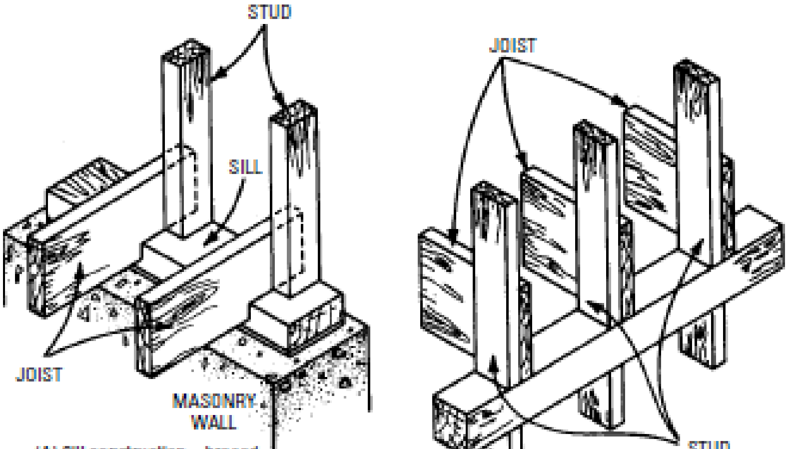
The foundation sill consists of a plank or timber resting on the foundation wall. It forms the support or bearing surface for the outside of



(A) Second floor.

(B) First floor.

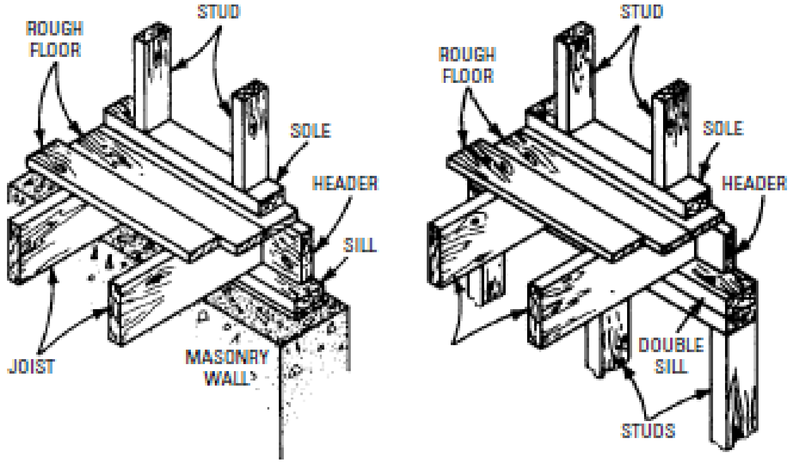
Figure 8-4 Details of balloon framing of sill plates and joists.



(A) Sill construction—braced-frame (first floor).

(B) Detail of girt-braced frame (second floor).

Figure 8-5 Details of plank-and-beam framing of sill plates and joists.



(A) First floor.

(B) Second floor.

Figure 8-6 Details of western framing of sill plates and joists.

Floor Joists

The length of floor joists depends on the following:

- Span
- Size of floor joist
- Live and dead loads
- Spacing between joists
- F_b and the modulus E
- Wood species and wood grade
- Whether the subfloor is glued to the joists

Floor bridging has long been the subject of controversy. More than 20 years ago, the National Association of Home Builders (NAHB) and the Forest Products Laboratory (FPL) (operated by the University of Wisconsin for the United States Department of Agriculture) had shown that bridging, as normally applied, added little to the stiffness of the floor in resisting static (nonmoving) loads. The BOCA code does not require mid-span bridging in Use Groups R-2 and R-3 (multiple-family dwellings, boarding houses, and one- and two-family dwelling units) unless the live load exceeds 40 psf, or the depth of the floor joist exceeds 12 inches nominal. The Canadian Building Code permits a piece of 1 × 3 strapping or furring to be nailed to the bottom of the joist at mid-span for the length of the building, in lieu of bridging. The *CABO One and Two Family Dwelling Code* does not require bridging when floor joists are 12 inches deep or less.

Interior Partitions

An interior partition differs from an outside partition in that it seldom rests on a solid wall. Its supports, therefore, require careful consideration, making sure they are large enough to carry the required weight. The various interior partitions may be bearing or nonbearing. They may run at right angles or parallel to the joints upon which they rest.

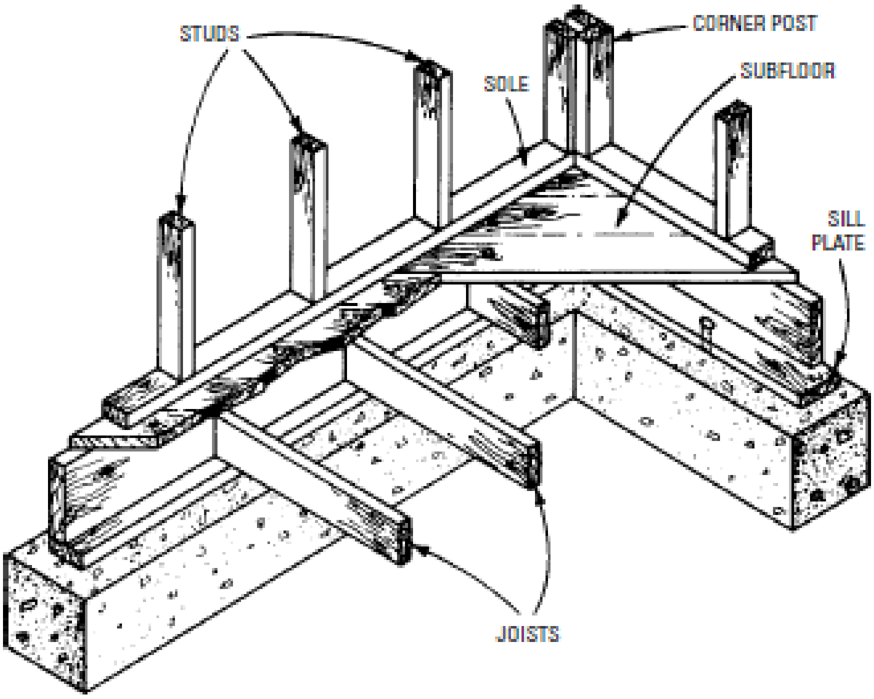


Figure 8-8 A detailed view of a corner stud.

rafters extending without interruption from the eave to the ridge are the most common.

Spacing of Rafters

Spacing of rafters is determined by the stiffness of the sheathing between rafters, by the weight of the roof, and by the rafter span. In most cases, the rafters are spaced 16 or 24 inches on center.

Size of Rafters

The size of the rafters will depend upon the following factors:

- Span
- Weight of the roof material
- Snow and wind loads

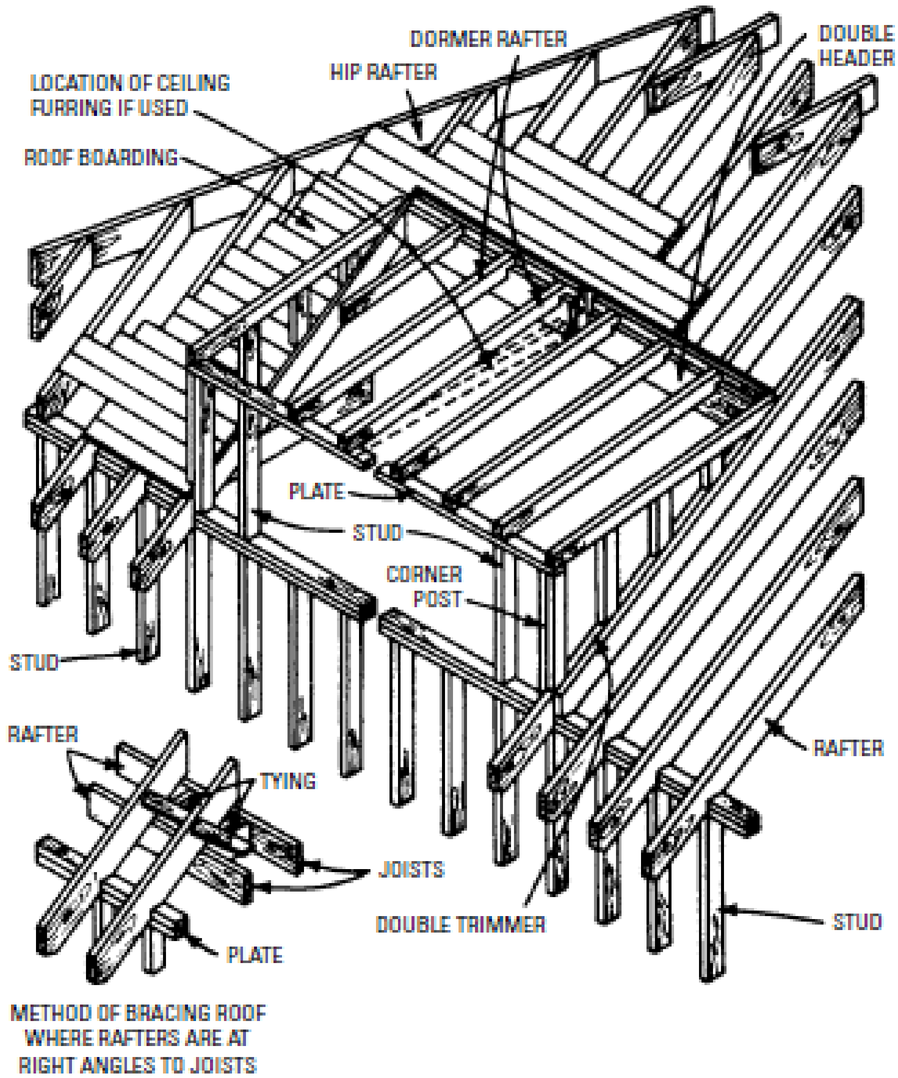


Figure 8-9 A detailed view of a flat-roof dormer.

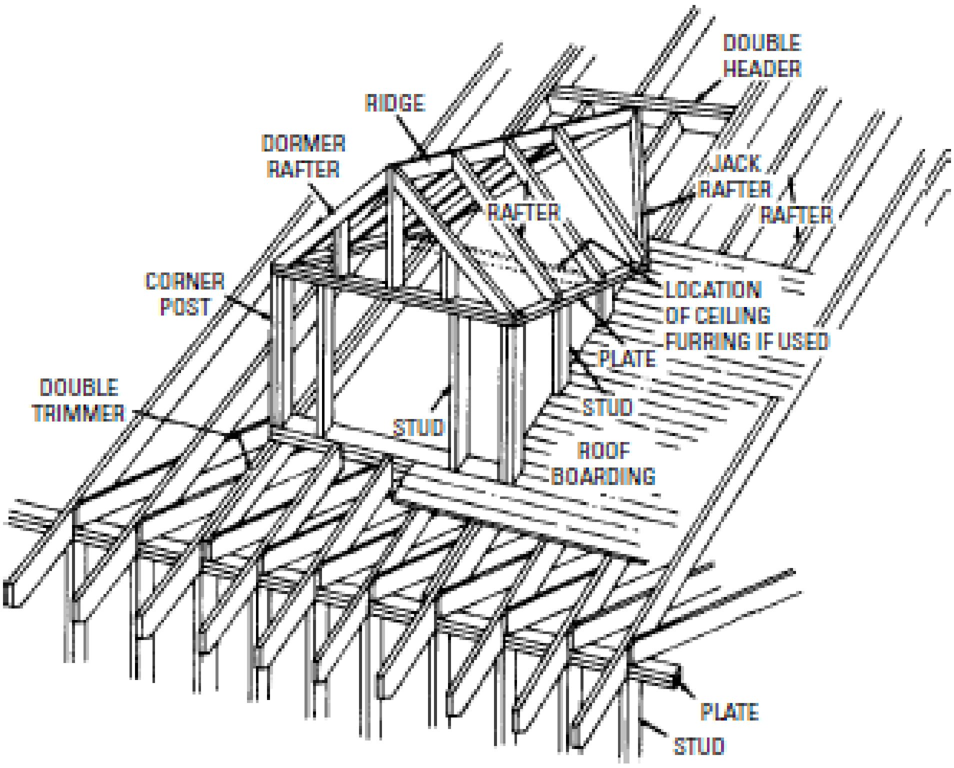


Figure 8-10 A detailed view of gable-roof dormer.

When framing the roof for a dormer window, an opening is provided that the dormer is later built in. As the spans are usually short, light material may be used.

Stairways

The well-built stairway is something more than a convenient means of getting from one floor to another. It must be placed in the right location in the house. The stairs must be designed for traveling up or down with the least amount of discomfort.

The various terms used in the context of building a stairway are as follows (Figure 8-11):

- The *rise* of a stairway is the height from the top of the lower floor to the top of the upper floor
- The *run* of the stairs is the length of the floor space occupied by the construction
- The *pitch* is the angle of inclination at which the stairs run
- The *tread* is that part of the horizontal surface on which the foot is placed

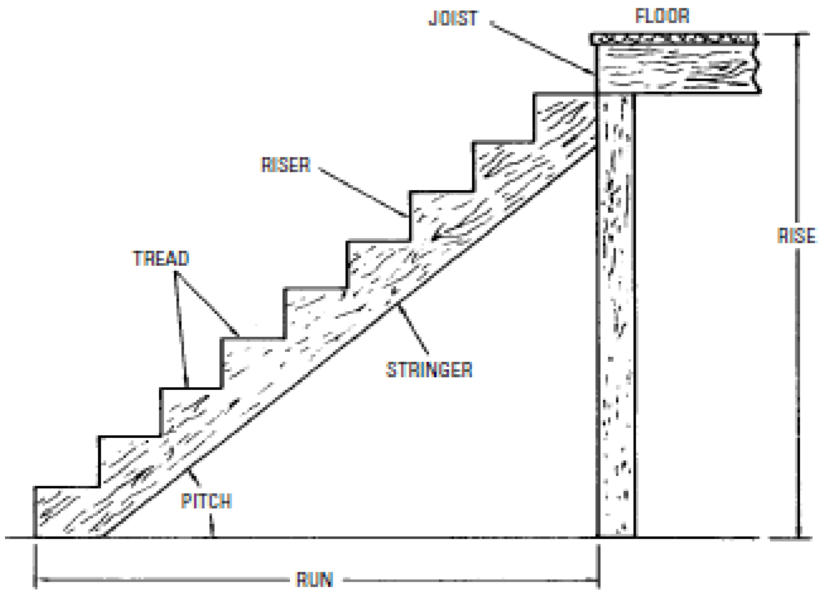


Figure 8-11 Parts of a stairway.

- The *riser* is the vertical board under the front edge of the tread
- The *stringer* is the framework on either side that is cut to support the treads and risers

A commonly followed rule in stair construction is that the *tread* should not measure less than 9 inches deep, and the *riser* should not be more than 8 inches high. The width measurement of the tread and height of the riser combined should not exceed 17 inches. Measurements are for the cuts of the stringers, not the actual width of the boards used for risers and treads. Treads usually have a projection, called a *nosing*, beyond the edge of the riser.

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Girders

By definition, a *girder* is a principal beam extended from wall to wall of a building, affording support for the joists or floor beams where the distance is too great for a single span. Girders may be either solid or built-up.

Construction of Girders

Girders may be of steel, solid wood, or built up from 2-× lumber. A center-bearing wall may be substituted for a girder. Commercially manufactured glue-laminated (glulams) beams may be used, especially if left exposed in finished basements.

The joints on the outside of the girder should fall directly over the post or lally column. However, when the girder is continuous over three or more supports, the joints may be located between $^1/_6$ and $^1/_4$ the span length from the intermediate lally column (Figure 9-1). Nails should penetrate all layers. They should be clinched. Use 20d nails at the ends, driven at an angle, and 20d nails at the top and bottom of the girder, spaced 32 inches on-center (oc) staggered. Place them so that they are not opposite the nails on the other side. The beam/girder should have 4 inches minimum bearing in the beam pocket.

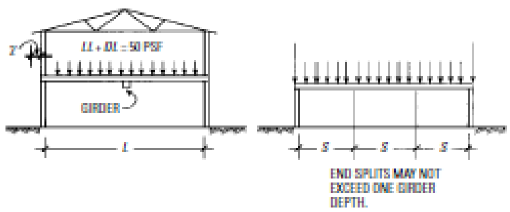


Figure 9-2

Table 9-1 Girder Size and Allowable Spans—One-Story Floor Loads

Nominal Lumber Sizes	Girder Spans = S in Feet; House Widths = L in Feet: 22	24	26	28	30	32
Lumber having an allowable bending stress not less than 1000 psi						
2 – 2 × 6	4 feet- 0 inches	—	—	—	—	—
3 – 2 × 6	5 feet- 3 inches	5 feet- 0 inches	4 feet- 10 inches	4 feet- 8 inches	4 feet- 5 inches	4 feet- 2 inches
2 – 2 × 8	5 feet- 3 inches	4 feet- 10 inches	4 feet- 5 inches	4 feet- 2 inches	—	—
3 – 2 × 8	6 feet- 11 inches	6 feet- 7 inches	6 feet- 4 inches	6 feet- 2 inches	5 feet- 10 inches	5 feet- 5 inches

Load Distribution

In the example we have been using, the girder carries one-half the total floor weight. This is because the girder is supporting the inner ends of the floor joists, and one-half the weight of every joist resting on it. The other half is divided equally between the two foundation walls. We have assumed that the floor joists are butted or over-lapped over the girder. Lapped or butted joists have little resistance to bending when they are loaded and tend to sag between the lally columns.

However, when the floor joists are continuous (one piece), they are better able to resist the bending over the girder. As a result, the

girder now has to support more weight than when the joists are in two pieces. A girder under continuous joists now carries $^5/_8$ instead of $^1/_2$ the load.

Now that you have found the tributary area, you must calculate the total live and dead loads (LL+DD) on the girder. However, you have assumed a total live load and dead load of 50 psf (10 psf + 40 psf) floor load for the 24-foot × 40-foot, single-story ranch. The roof is trussed; therefore, there are no load-bearing partitions.

Example

Using a tributary width of 12 feet, girder length of 40 feet, and LL+DD of 50 psf, find (a) the tributary area, (b) the girder load per lineal foot, (c) the girder load between the lally columns in Figure 9-4, and (d) the total load on the girder.

Tributary area = 12 feet × 40 feet = 480 ft^2

Girder load per lineal foot = 50 psf × 12 feet = 600 pounds

Girder load between lally columns = 600 pounds × 10 feet = 6000 pounds

Total load on girder = 600 pounds × 40 feet = 24,000 pounds

Of course, multiplying the tributary area by the floor load gives you the total load on the girder: 480 ft^2 × 50 psf = 24,000 pounds. Dividing 24,000 pounds by 40 feet = 600 pounds, the load per lineal foot on the girder.

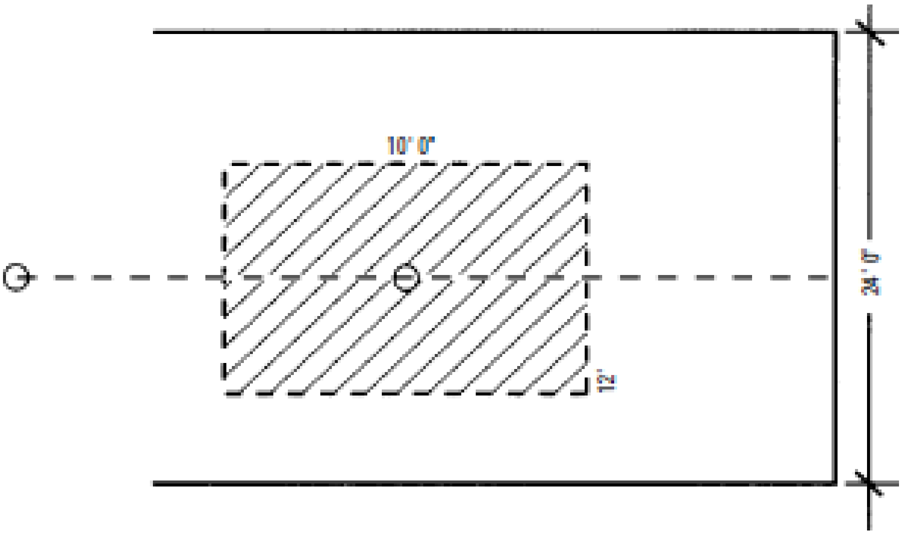


Figure 9-5 Tributary area of column.

To calculate the load on the lally column footing, you need to know the following:

- Ceiling load
- Floor load
- Partition load

$$\text{Footing area (ft}^2) = \frac{\text{footing load (lb/ft)}}{q_a \text{ (lb/ft}^2)}$$

$$\text{Area} = 6000 \text{ pounds}/2000 \text{ psf} = 3 \text{ ft}^2$$

The standard 2-foot × 2-foot × 1-foot (4 ft^2) concrete footing is more than adequate. An 8-foot, 3½-inch lightweight lally column will support 21,000 pounds (kips), and is more than adequate to support 6000 pounds.

Selecting the Girder

There are a number of ways to find the size of the girder necessary to support the floor loads: consult tables such as Table 9-1 and Table 9-2, use the data in *Wood Structural Design Data* (Washington, D.C.: American Wood Council, 1986), or calculate it using structural engineering formulas. These calculations are beyond the scope of this book. However, before you can use these or other tables,you must understand what is meant by F_b and how to use it.

F_b (pronounced eff sub-b) is the allowable bending stress, or extreme fiber stress in bending. It tells how strong the wood fibers are. A beam starts to bend when it is loaded. As the beam bends, the upper wood fibers try to shorten, causing them to be in compression. At the same time, the lower wood fibers try to get longer, putting them in tension. These two opposing forces meet head-on like a pair of scissors, creating a shear force in the beam. Horizontal shear in a beam would be the upper fibers sliding over the lower fibers (Figure 9-6).

Beams do not break easily because wood is very strong in tension parallel to the grain. However, a beam can fail when the lower fibers

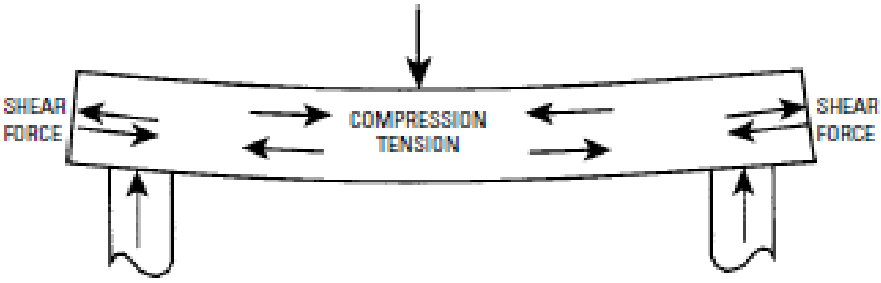


Figure 9-6 Horizontal shear.

Column Spacing

In the one-story ranch, the 40-foot-long girder is supported by lally columns spaced 10 feet oc. As the spacing between columns increases, the girder must be made larger. The girder can be made larger by increasing its width, depth, or both. Doubling the width of a girder doubles its strength. Doubling the depth increases its strength four times. A beam 3 inches wide by 6 inches deep will carry four times as much weight as one 3 inches wide by 3 inches deep. However, as the girder gets deeper, more headroom in the basement is lost. Keep this in mind when a buyer, wanting a more open basement, requests only one lally column.

Our calculations show that the 40-foot beam is carrying 24,000 pounds, or 24 kips. *Kip* is derived from Ki(lo) and P(ound) and means 1000 pounds. Therefore, 24 kips equals 24,000 pounds.

Assume a lally column at the center of the girder and the span now extending 20 feet on each side.

For example, given a 40-foot beam carrying 24 kips, a tributary width of 12 feet, and a lally column 20 feet oc, find the required beam dimensions and the size of the column. Assume an 8-foot-long lally column.

> The beam carries 24,000 pounds/2 = 12,000 pounds for a 20-foot span.

Using an F_b of 1400, *Wood Structural Design Data* lists a 6 × 18 as able to support 13 kips. However, if the height from the bottom of the floor joists to the slab floor is 7 feet-10 inches, the headroom under an 18-inch deep beam is only 6 feet-5 inches. Using a Douglas fir-larch No. 1 with an F_b of 1800 would bring the beam size down to a 10 × 12. This would provide 7 feet of headroom under the beam.

Flitch Beams

Before glue-laminated wood beams and rolled steel beams were readily available, a common method of making wood beams stronger was to make a sandwich of two wood planks separated by a steel plate. This composite material acted as a unit, and allowed the wood to carry considerably more weight without increasing the depth of the wood planks. Known as a *flitch beam* (Figure 9-7), it is rarely seen today, because it is labor and material intensive, particularly in the use of the steel plate, which has to be drilled and then

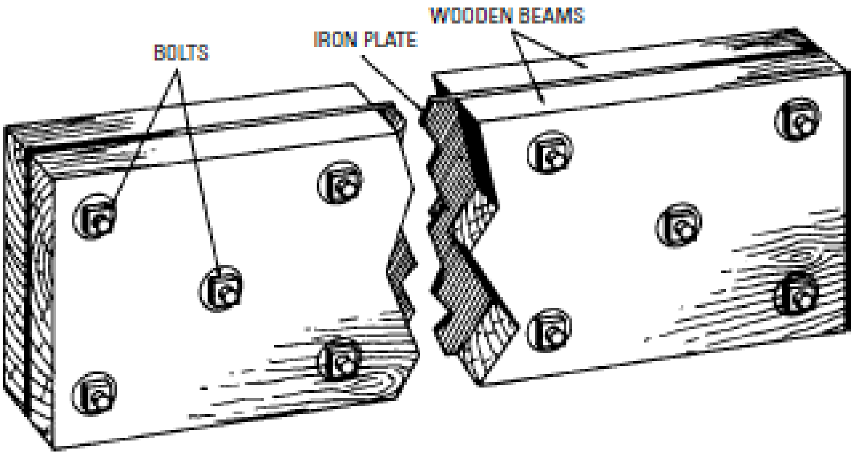


Figure 9-7 A flitch plate girder, or flitch beam.

bolted to the wood planks. Calculating the size of a flitch beam, using structural engineering formulas, to replace the 6 × 18 beam, is too complex for this book. Two 2 × 12 beams, with a ½-inch steel plate in the middle, all bolted together, would carry for a 20-foot span, 10,971 pounds, which is more than 1000 pounds less than required. The two 2 × 12 beams at 20 feet with an F_b of 1400 psi can support only 3090 pounds. With the ½-inch steel plate, it will now support 10,971 pounds.

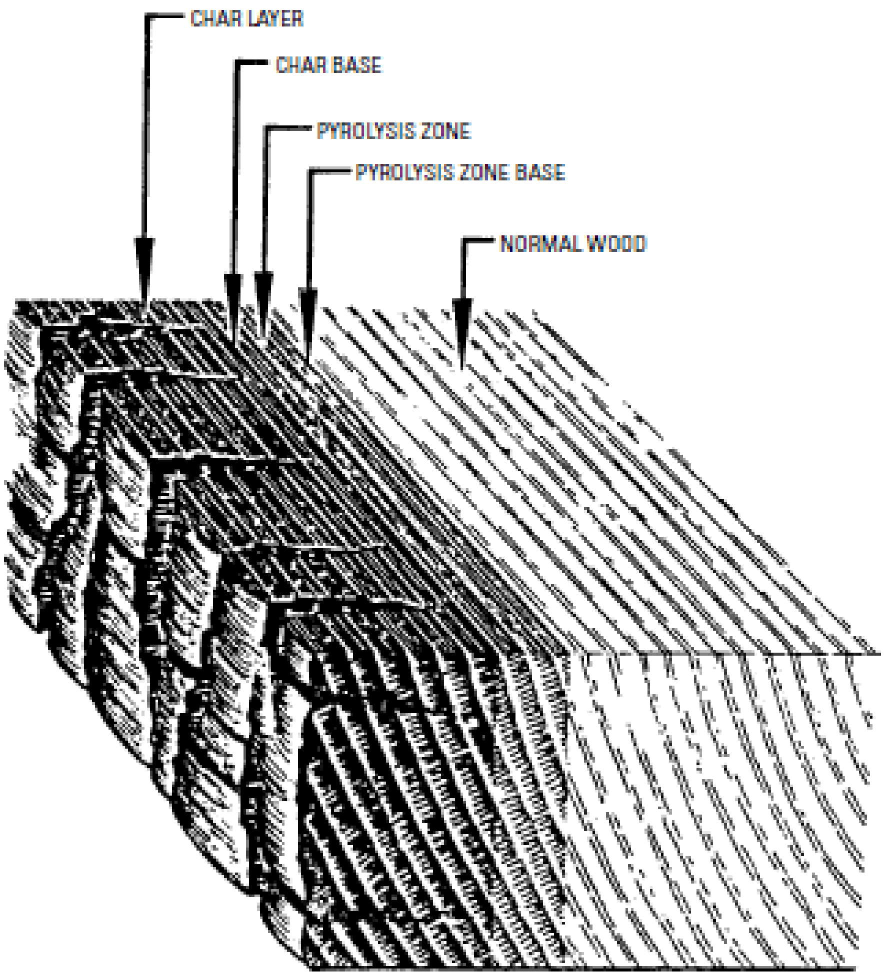


Figure 9-9 Layers of char help to protect heavy timbers. The 2× lumber is too thin and is structurally inadequate once it burns.

Glulam

Glulam (structural glue-laminated timber) was first used in Europe. An auditorium under construction in Switzerland in 1893 employed laminated arches glued with casein glue. Today, about 30 members of the American Institute of Timber Construction produce glulams (Figure 9-10).

Figure 9-10 Glulam beam. *(Courtesy Weyerhaeuser)*

Standard nominal 2-inch lumber is used as the laminations, or lams. The lams are dressed to $1\frac{1}{2}$ inches and bonded together with adhesives. Glulams may be straight or curved, may be laminated horizontally or vertically, and are available in standard or custom sizes. Glulam beams are made with the strongest lams on the top and the bottom of the beam. The beams may be balanced or unbalanced. The unbalanced beam has TOP stamped in the top. Either face may be used as the top in a balanced beam.

Chapter 10

Floor Framing

A 2×10, or any piece of dimensional lumber, can vary in depth from $9\frac{1}{4}$ inches to $9\frac{5}{8}$ inches. If the tops of the floor joists and the floor are to be level over the entire surface of the floor, the joists must be selected from those that are closest to, in this case, $9\frac{1}{4}$ inches. Check, say, every fourth joist while they are still bundled. Mark the actual dimension on the ends of the joist. Or, make a go-no go gage that allows quick selection of joists nearest to the required depth. Selecting the joists can eliminate having to cut end notches. *Do not use wood shims* to level floor joists. Shims (under compression) creep as the weight of the structure eventually crushes them to paper-thin size.

Once the crowns have been identified and marked, set the joists in place, crown up, ready for nailing to the joist header (also called a *rim joist*, *band*, or *box sill*). By butting the ends of the joists over the girder, rather than overlapping, the joists are in line and the $1\frac{1}{2}$-inch offset is eliminated. The ends of each joist are now located exactly on the 16-inch line or the 2-foot module. Although the code official may ask for a 1× lumber tie (Figure 10-1), it is necessary on only one side of the joists. A plywood floor that is continuous over the two joist ends will tie the butted ends together (Figure 10-2), making the metal or lumber tie unnecessary.

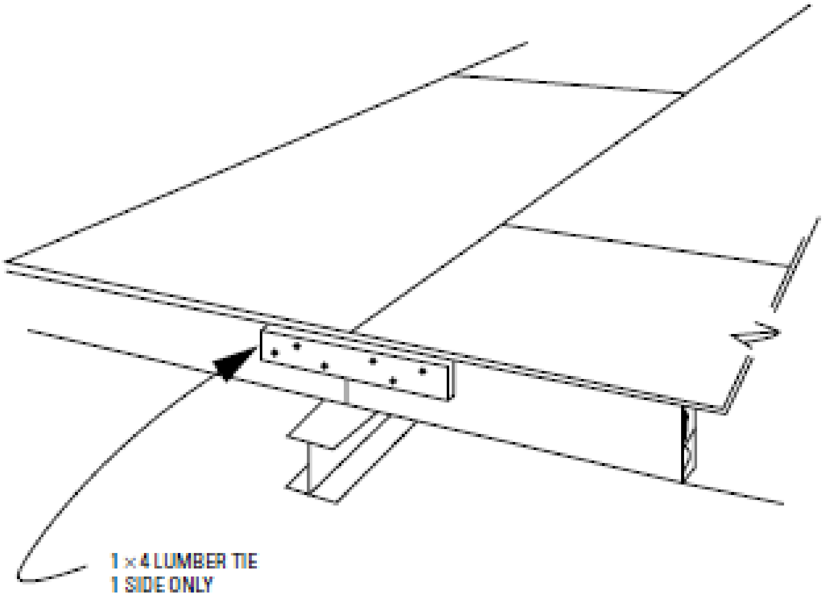


Figure 10-1 A 1× lumber tie on butted joists.

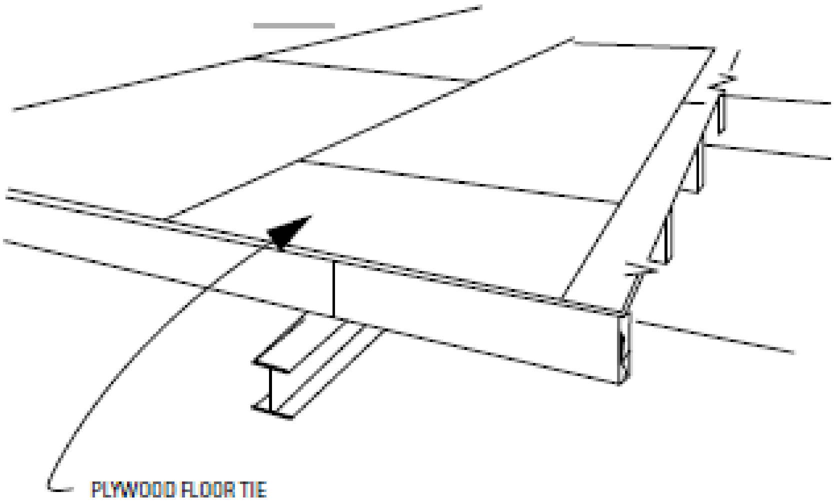


Figure 10-2 Plywood over butted floor joists.

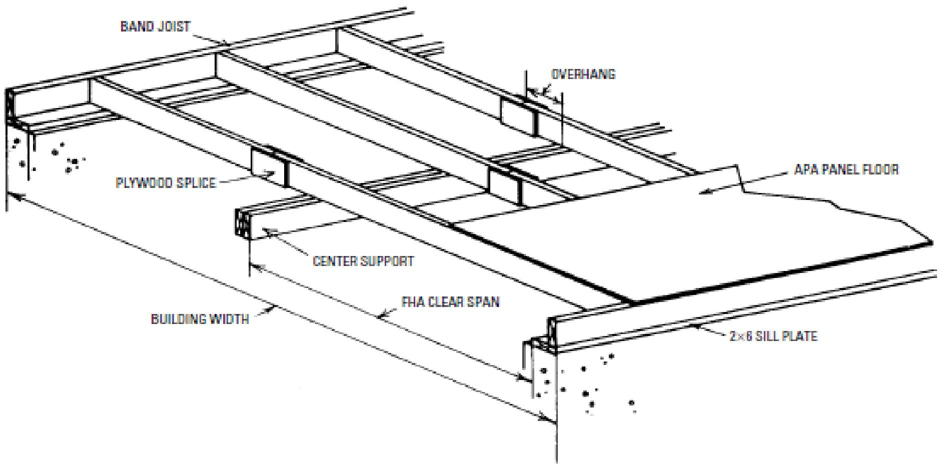
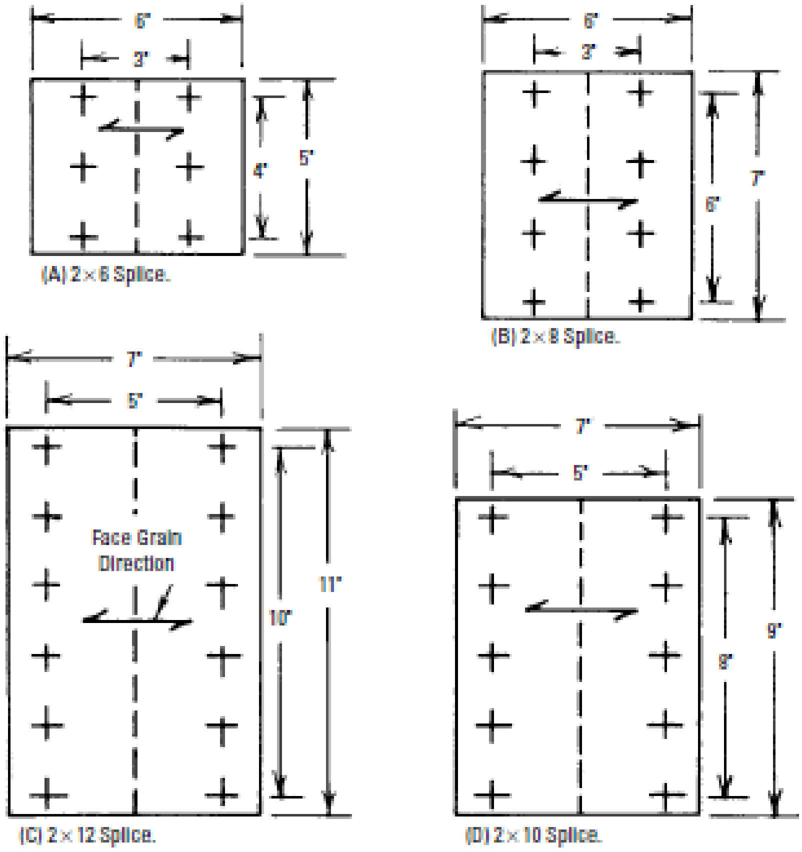


Figure 10-3 Cantilevered joist diagram from APA. *(Courtesy American Plywood Association)*



Note: *The symbol + on the sketches indicates nail locations.*

Figure 10-5 Splice size and nailing schedule. These plywood splice patterns were developed through an APA test program. They require that minimum APA recommendations for subfloor or combination subfloor underlayment be followed. One-half-inch-thick plywood splices are used on both sides of the joist. Fasteners are 10d common nails driven from one side and clinched on the other (double shear). The direction of the splice face grain parallels the joist. No glue is to be used.

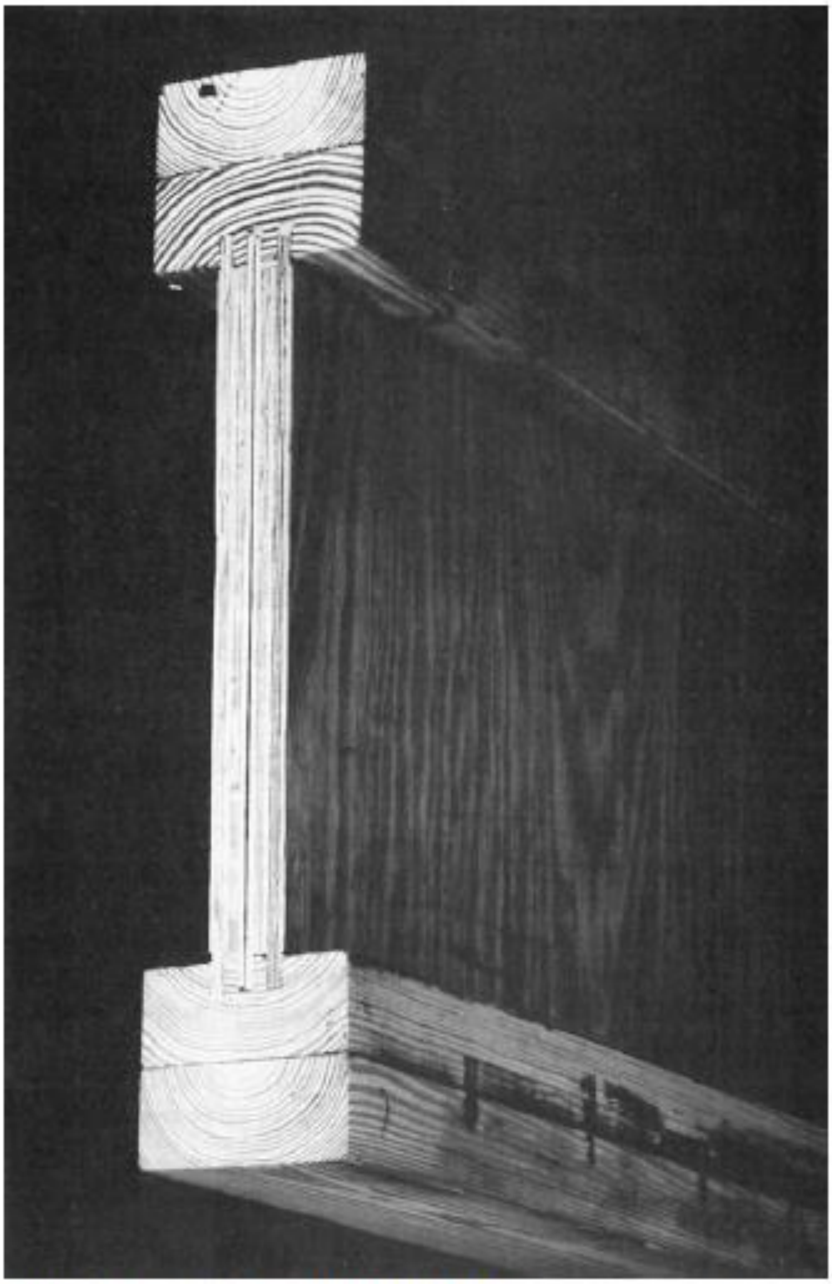


Figure 10-7 Georgia-Pacific Wood I Beam. *(Courtesy Georgia-Pacific)*

Read Page 259 to 269

Chapter 11

Outer Wall Framing

Framing exterior walls with studs 16 inches on center (oc) is the dominant method of framing in the United States. This spacing is believed to have originated in seventeenth century Europe. Wood lath was hand-split from 4-foot-long cordwood. The strength and stiffness of the laths varied considerably. Plastering them on studs 24 inches oc was difficult. Another stud was added, making 4 studs in 4 feet, and thus the 16-inch oc stud spacing.

Although the conventional wood-framed wall is efficient construction, in its present form it does not and cannot achieve its full potential. It is neither as cost-effective nor as energy-efficient as it could be. The manufacturers of insulated structural panels (incorrectly called *stressed skin panels*) see stick building as backward. Lightweight structural polymer concretes, (such as the Swedish 3L and Finnish wood fiber concrete) have insulating value and can be sawn and nailed. They pose challenges to conventional and nonconventional stick building. Newspaper is recycled into cellulose insulation; and now wheat straw, rye, and sugarcane rind are being turned into 5-inch-thick panels called Envirocor panels. With an insulating value of R-1.8 per inch and fire resistance, they perform better in earthquakes and high winds than stick-built houses. The panels are the walls and insulation, with no need for structural framing. Straw panels are not new—it is an old European method. It is still in use there. The USDA had developed straw panels as far back as 1935, but without the structural strength of the Envirocor panels.

The reduction of labor and material costs and ways to build better for less (while achieving energy efficiency at the same time) require not only planning, but also a willingness to consider alternatives to conventional framing. All modern building codes permit the use of alternative methods and materials.

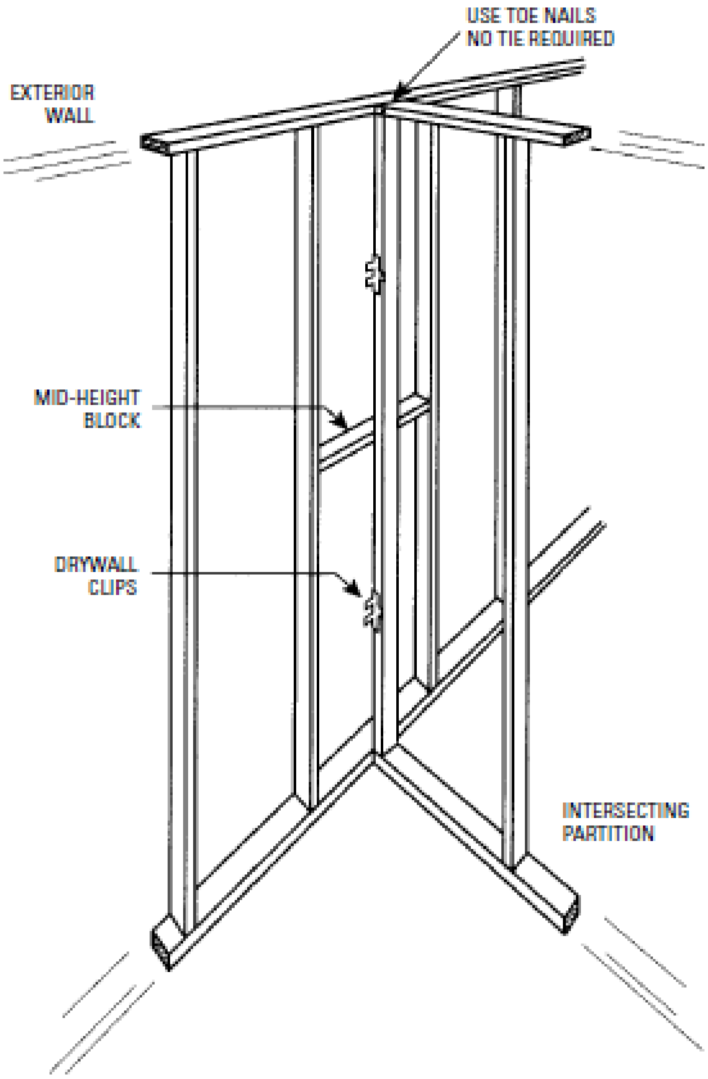


Figure 11-1 A mid-height backer and drywall clips eliminate the three-stud trough.

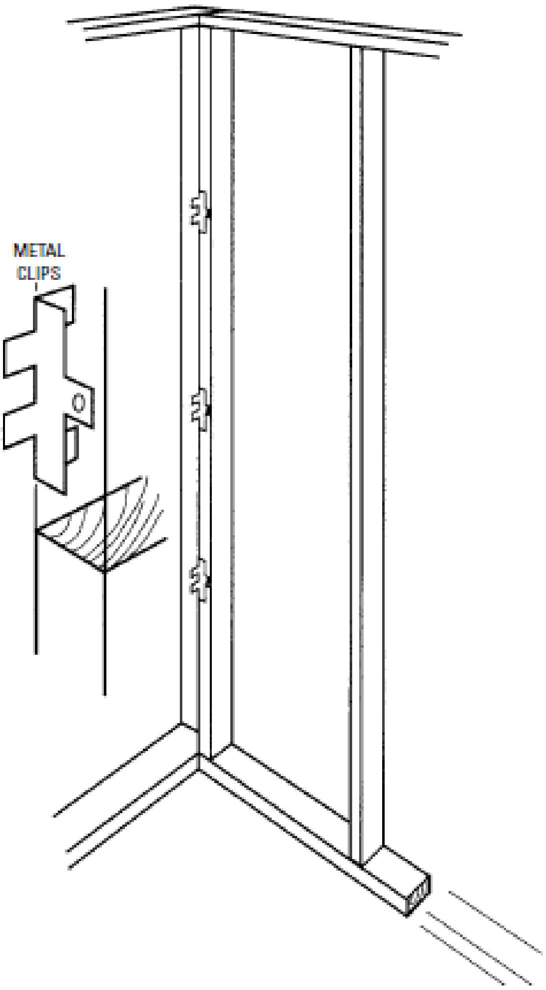


Figure 11-2 Two-stud corner and drywall clips eliminate three- and four-stud corners.

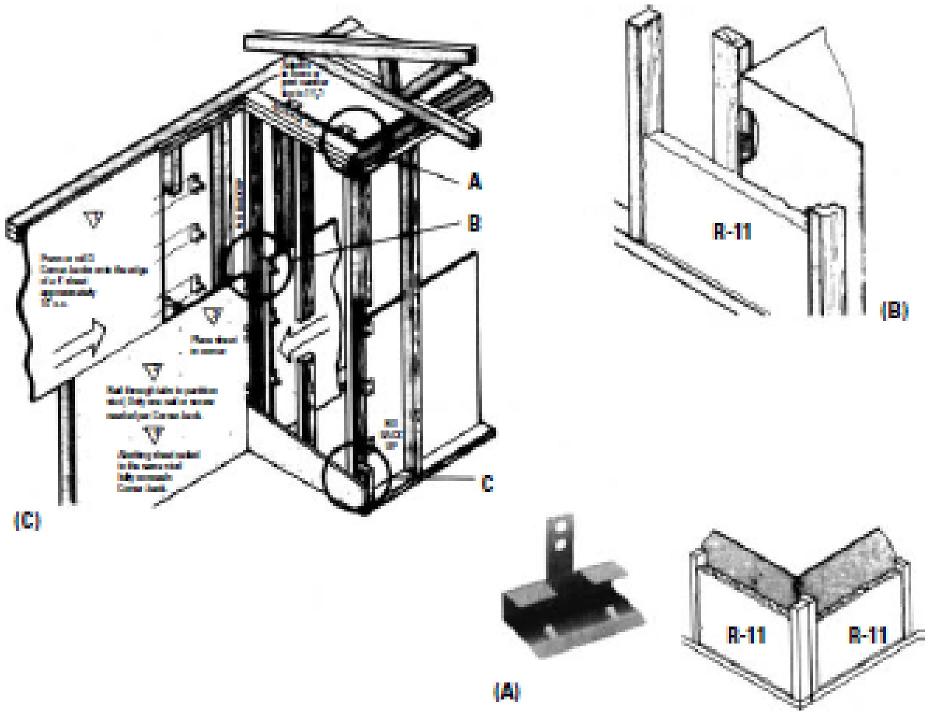


Figure 11-3 (A) The Corner-back eliminates the need for corner backup studs and permits corners to be fully insulated to reduce significant thermal losses. Since the maximum load on the corner stud is one-half or less than the load on a regular stud, two 2 × 4 studs provide structural performance equivalent to three 2 × 4 studs. (B) Corner-back allows the location of partition members without the use of back-up studs. Drywall panels anchor securely to the structural studs. Tee posts are completely eliminated. In addition, cutting insulation is no longer required for a partition abutting exterior walls. The result is straighter corners. (C) The use of Corner-backs in corners and partitions.

Modular Framing

Between 10 and 20 percent of residential framing is wasted. If the depth of the house is not evenly divisible by 4, much of the usable length of floor joists is wasted. Studs, joists, and rafters are produced in 2-foot increments: 8–10–12–14 feet. The joist length is one-half the house depth, minus the thickness of the joist header, plus half of the required $1\frac{1}{2}$-inch overlap. Thus, the required joist length is half the house depth (Figure 11-4).

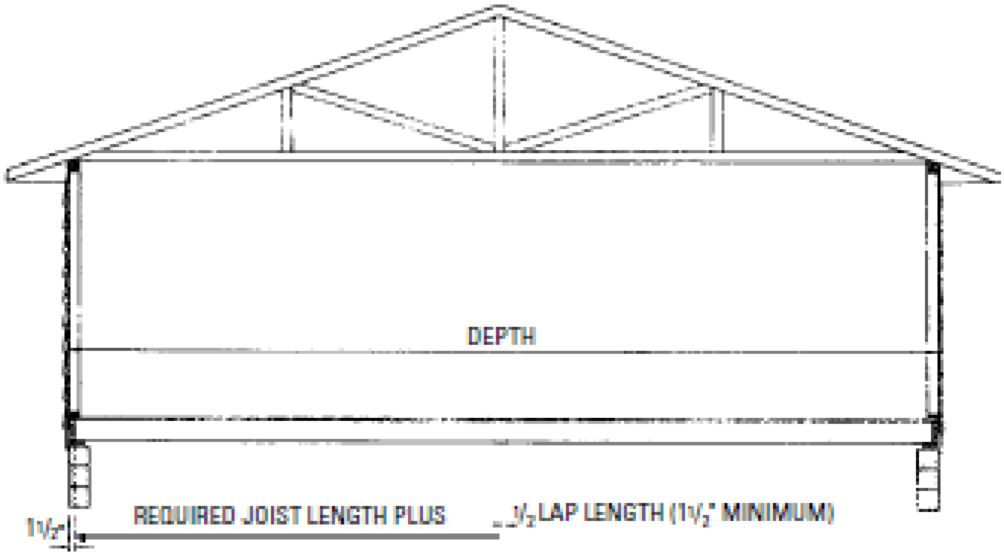


Figure 11-4 Joist length is equal to one-half the house width.
(Courtesy National Forest Products Association)

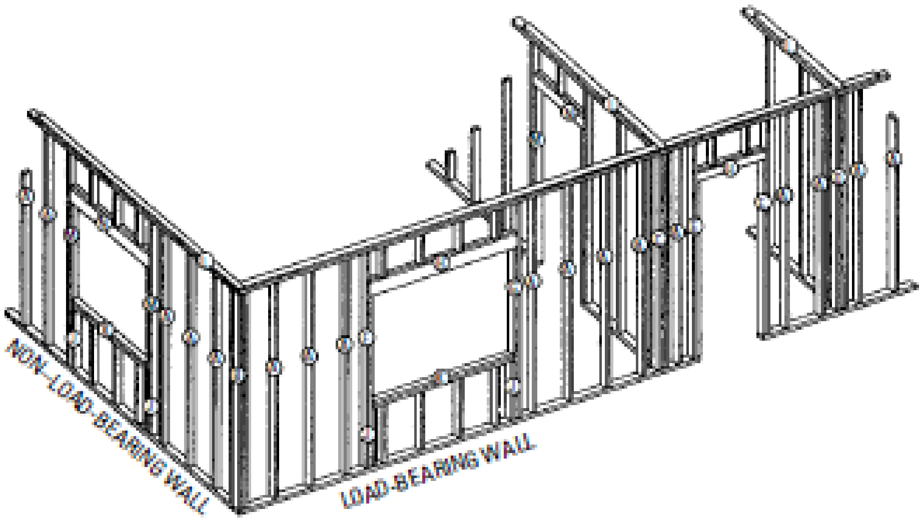


Figure 11-6 Wall framing with cost-saving principles not applied.
(Courtesy National Forest Products Association)

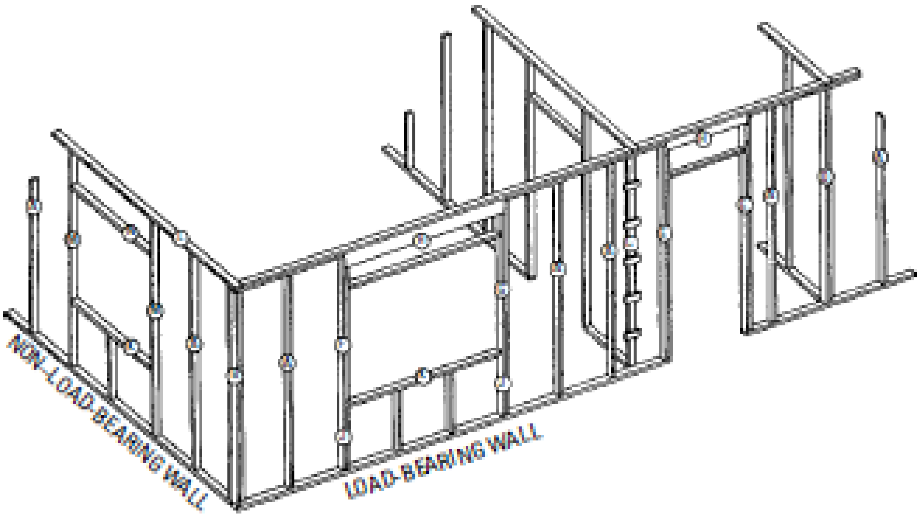


Figure 11-7 Wall framing incorporating cost-saving principles.
(Courtesy National Forest Products Association)

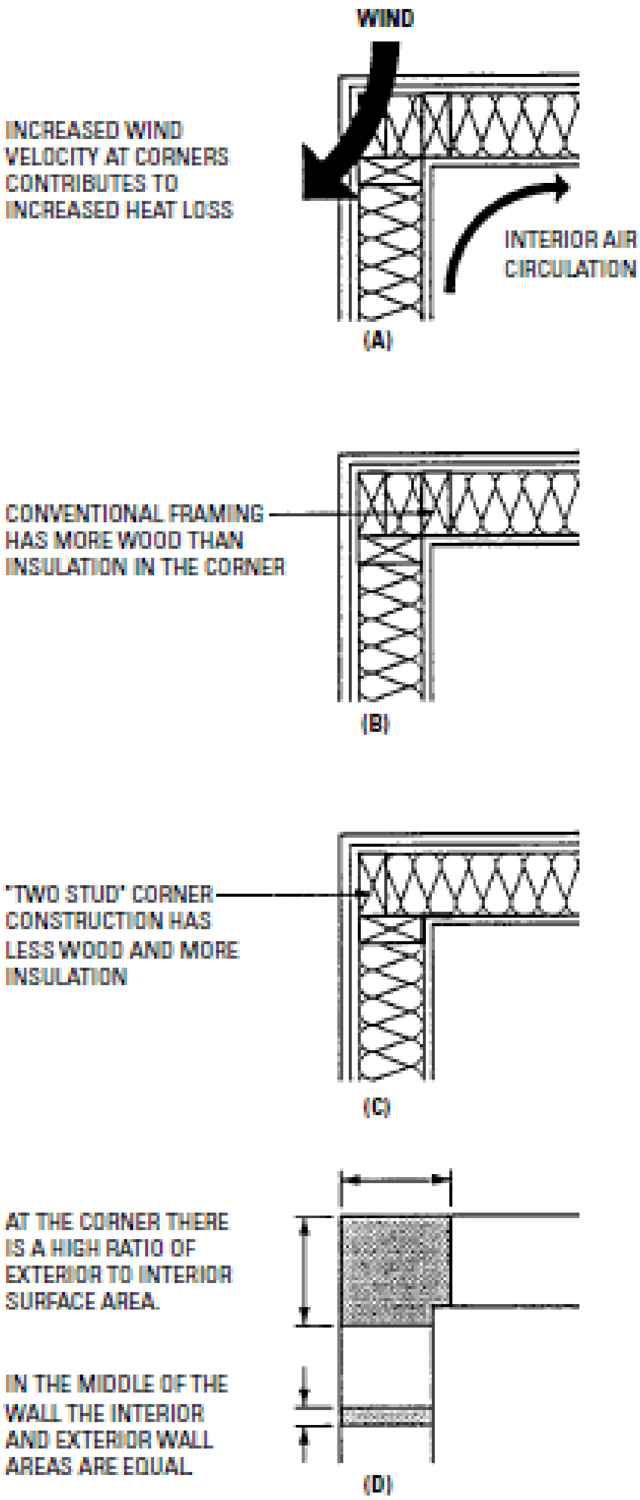


Figure 11-8 Corner problems. *(Courtesy Joseph Lstiburek)*

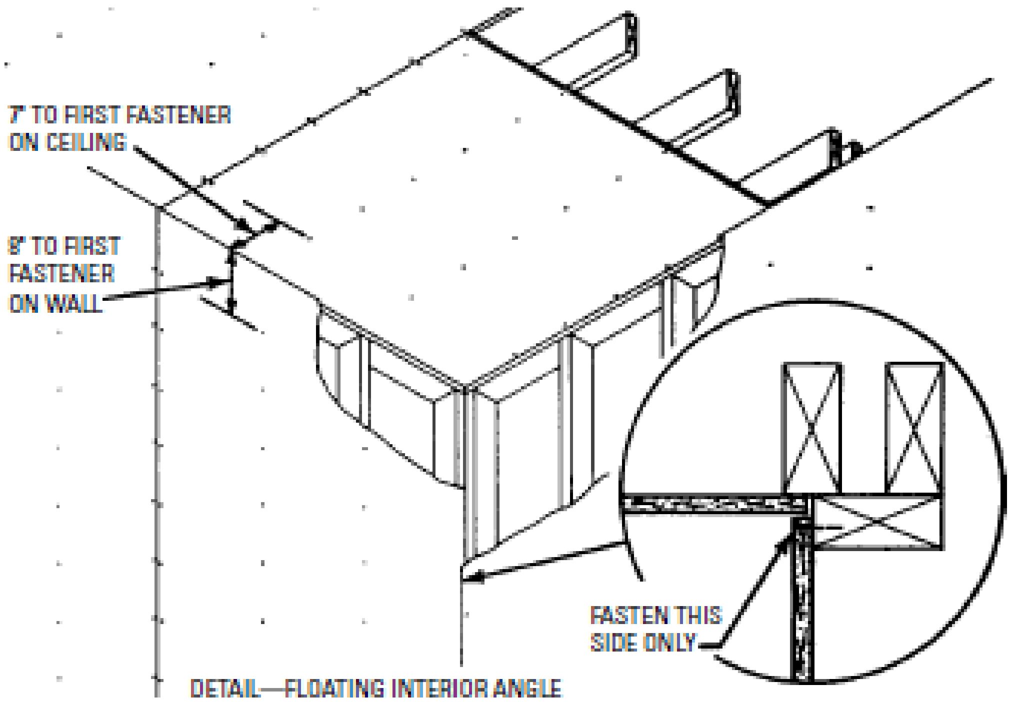


Figure 11-9 Floating corners.

When Prest-on clips are used, they are spaced 16 inches oc on the board. The tab is secured to the stud. The next sheet of gypsum board is placed at right angles to the first sheet of drywall. It covers the tabs. Now both sheets are on the same stud. Accepted (but incorrect) practice nails the four separate ends of the sheetrock to each of the two separate studs, one in each wall. When the wood shrinks, each stud shrinks in a direction opposite the other stud. This movement in two different directions (and not the floating sheetrock) is why the corners break.

Window and Door Framing

Whenever possible, use windows that fit the 2-foot module (that is, windows that fit between the studs spaced 24 inches oc). This eliminates cripples, jacks, header studs, and headers. Double stools (letter *K* in Figure 11-6) are unnecessary (Figure 11-10). Because the header studs transfer the vertical loads downward, there is no load on the stool (letter *K* in Figure 11-7) or on the two cripple studs shown supporting the stool. The ends of the stool are supported by end nailing through the header studs. The stool end cripple supports are unnecessary.

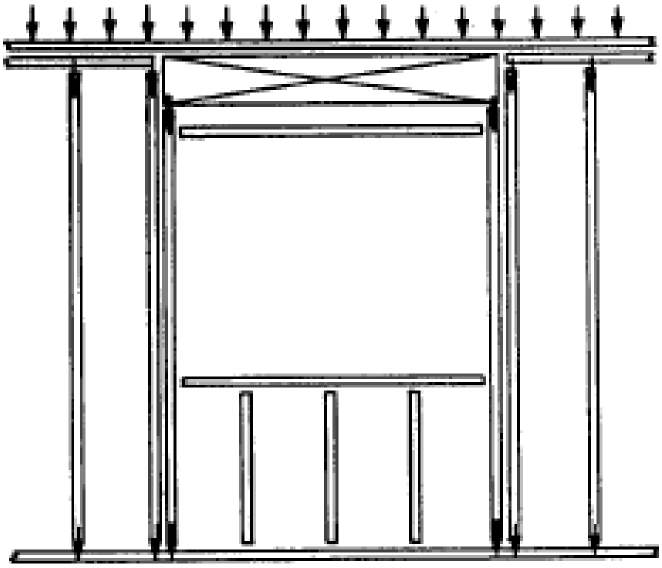
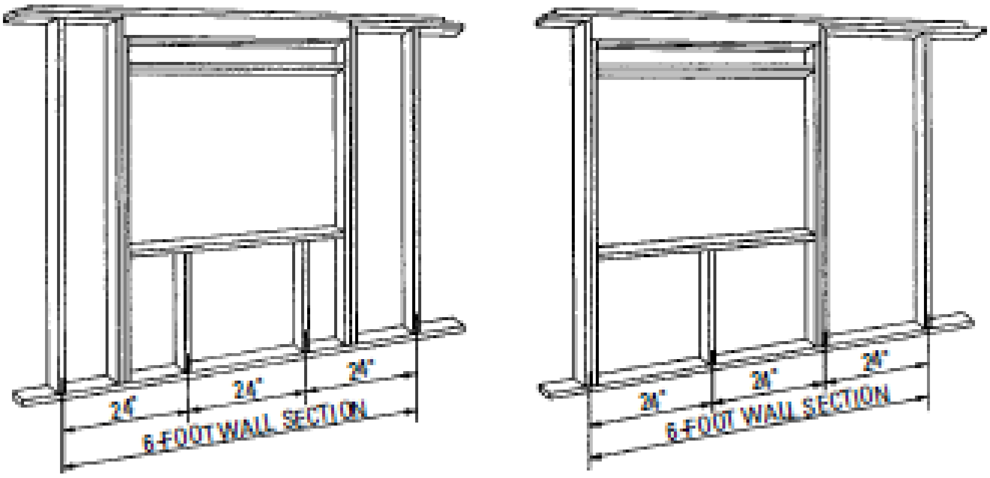


Figure 11-10 Load distribution through header and support studs at opening in load-bearing wall. *(Courtesy National Forest Association)*



(A) Not on module.

(B) On module—uses 20 percent less vertical framing.

Figure 11-11 Windows located on modules can save framing.
(Courtesy National Forest Products Association)

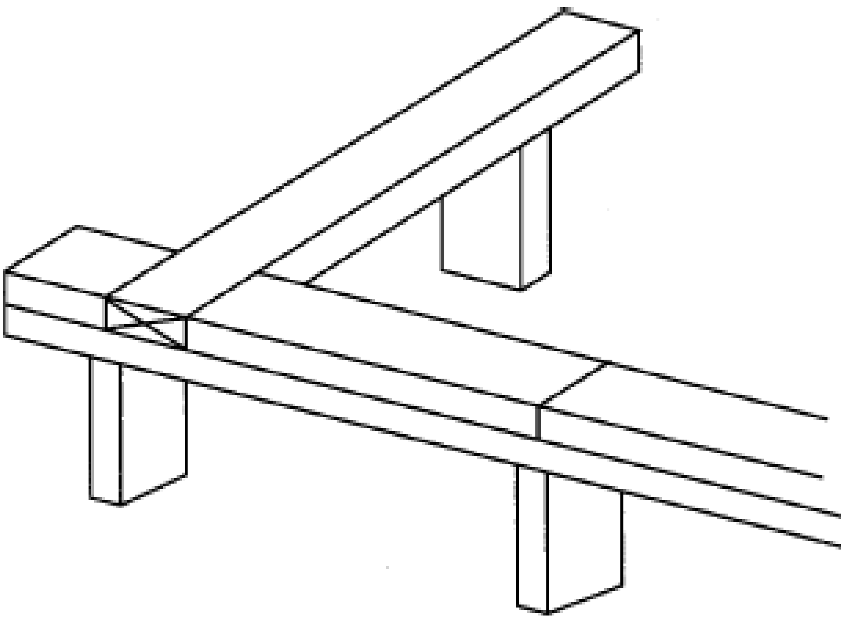


Figure 11-12 Securing the partition to the exterior wall at the double top plates.

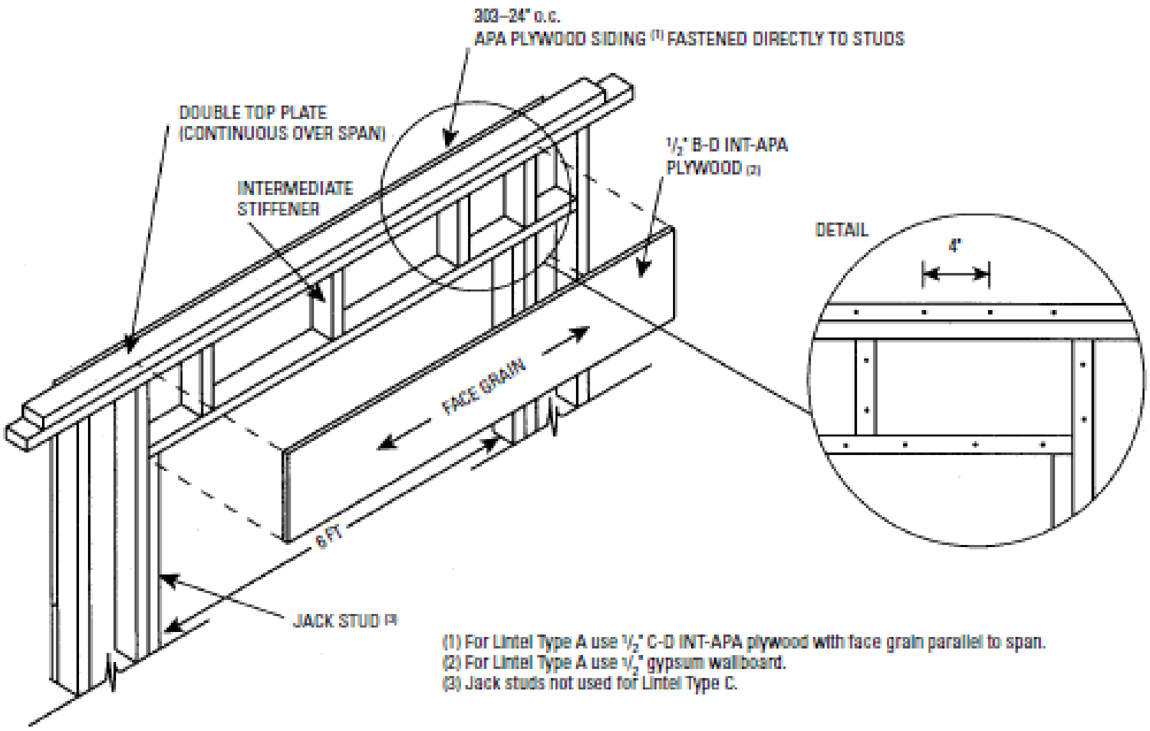


Figure 11-13 Plywood box beams or box beams. *(Courtesy American Plywood Association)*

Read other topics in Chapter 11

Roof Framing

As the covering for any structure, the roof serves the important purpose of protecting the structure against external elements (such as wind, rain, snow, sleet, ice, and even extreme temperature fluctuations). This chapter and Chapter 13 examine the key components of this important component, beginning with an examination of different types of roofs and the underlying framing.

Note

To be accurate and reasonably proficient in the many phases of carpentry (particularly in roof framing and stair building), a good understanding of how to use the steel square is necessary. This tool is invaluable to the carpenter in roof framing. You should purchase a quality square and thoroughly study the instructions for its use. Knowledge of how to use the square is assumed here.

Types of Roofs

There are many forms of roofs and a great variety of shapes. The carpenter and the student (as well as the architect) should be familiar with the names and features of each of the various types. Following are common types of roofs:

- *Shed or lean-to*—This is the simplest form of roof (Figure 12-1), and is usually employed for small sheds and outbuildings. It has a single slope and is not a thing of beauty.

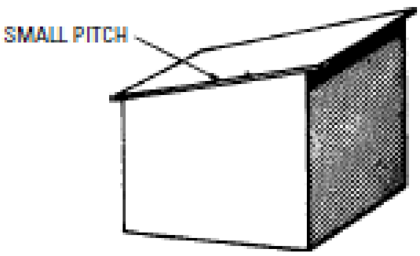


Figure 12-1 Shed or lean-to roof used on small sheds or buildings.

- *Saw-tooth*—This is a development of the shed or lean-to roof, being virtually a series of lean-to roofs covering one building (Figure 12-2). It is used on factories, principally because of the extra light that may be obtained through windows on the vertical sides.

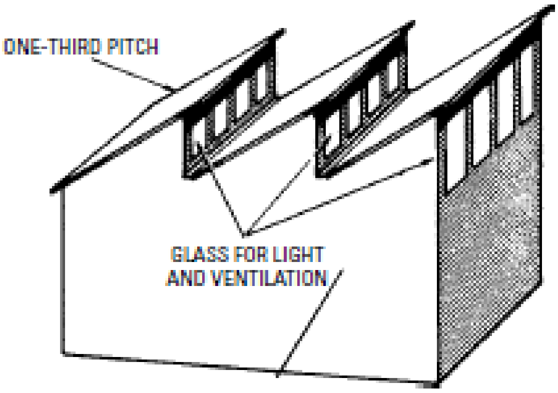


Figure 12-2 A saw-tooth roof used on factories for light and ventilation.

- *Gable or pitch*—This is a very common, simple, and efficient form of a roof, and is used extensively on all kinds of buildings. It is of triangular section, having two slopes meeting at the center or *ridge* and forming a *gable* (Figure 12-3). It is popular because of the ease of construction, economy, and efficiency.

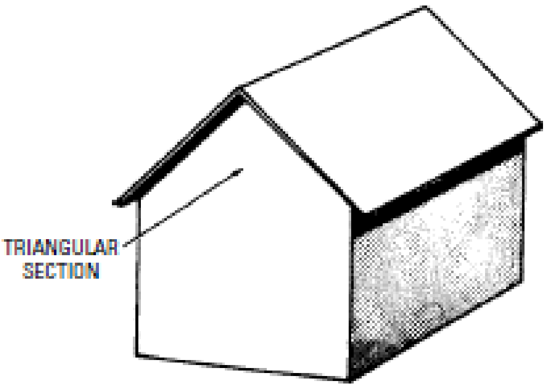


Figure 12-3 Gable or pitch roof that can be used on all buildings.

- *Gambrel*—This is a modification of the gable roof, each side having two slopes (Figure 12-4).
- *Hip*—A hip roof is formed by four straight sides. Each side slopes toward the center of the building and terminates in a ridge instead of a deck (Figure 12-5).
- *Pyramid*—This is a modification of the hip roof in which the four straight sides slope toward the center and terminate in a

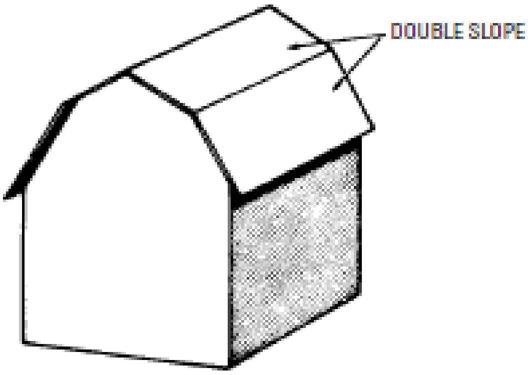


Figure 12-4 Gambrel roof used on barns.

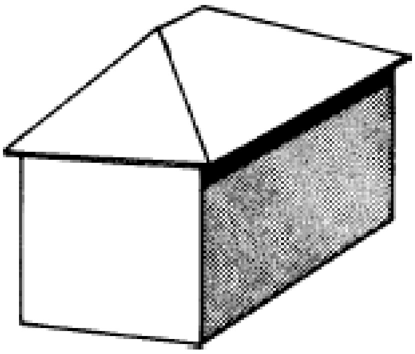


Figure 12-5 Hip roof used on all buildings.

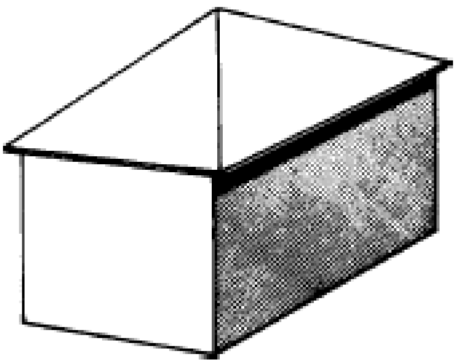


Figure 12-6 Pyramid roof, which is not often used.

point instead of a ridge (Figure 12-6). The pitch of the roof on the sides and ends is different. This construction is not often used.

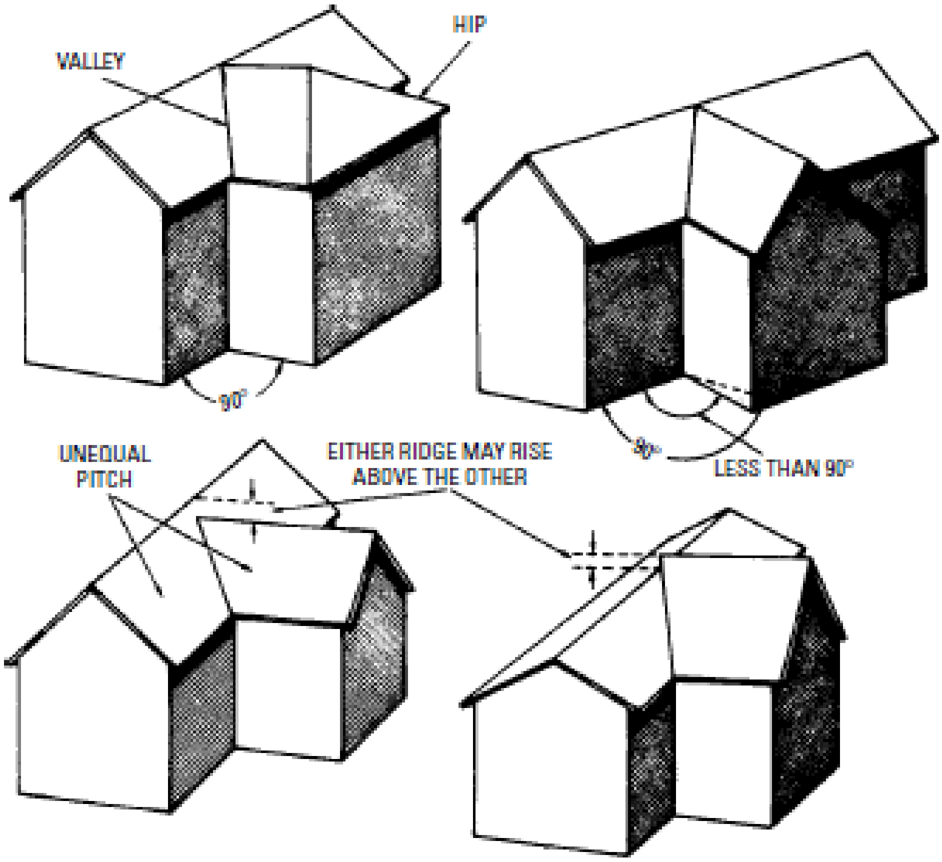


Figure 12-7 Various hip and valley roofs.

- *Double-gable*—This is a modification of a gable or a hip-and-valley roof in which the extension has two gables formed at its end, making an M-shape section (Figure 12-8).
- *Ogee*—This is a pyramidal form of roof having steep sides sloping to the center, each side being ogee-shaped, lying in a compound hollow and round curve (Figure 12-9).
- *Mansard*—The straight sides of this roof slope very steeply from each side of the building toward the center. This roof has a nearly flat deck on top (Figure 12-10). It was introduced by the architect whose name it bears.

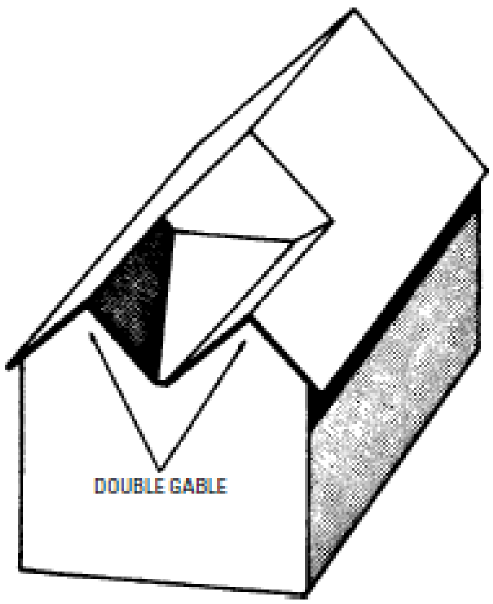


Figure 12-8 Double-gable roof.

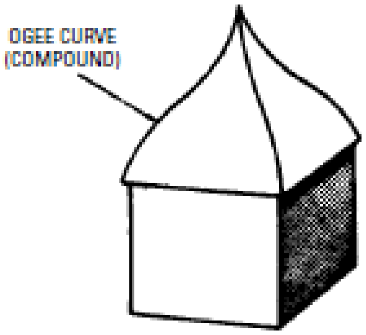


Figure 12-9 Ogee roof.

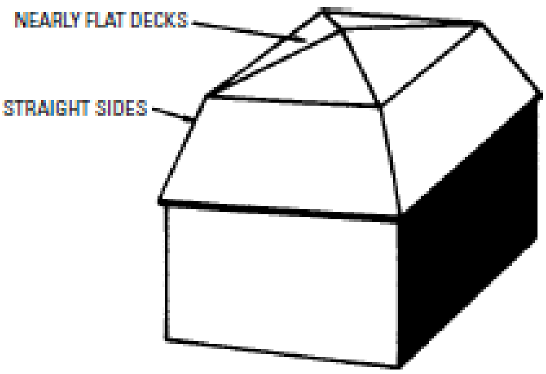


Figure 12-10 Mansard roof.

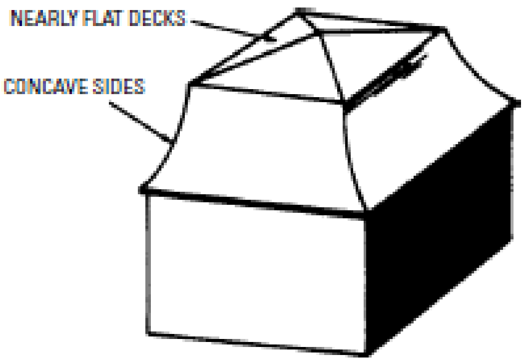


Figure 12-11 French or concave Mansard roof.

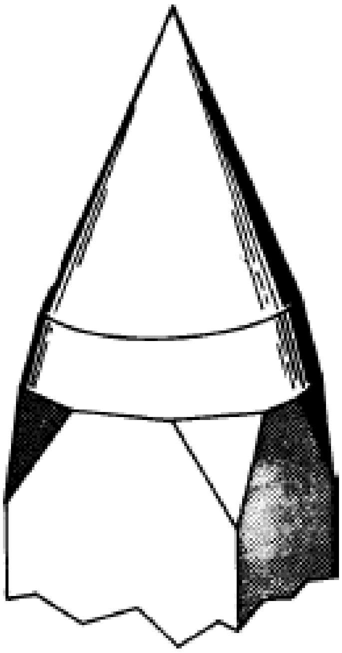


Figure 12-12 Conical or spire roof.

- *Conical or spire*—This is a steep roof of circular section that tapers uniformly from a circular base to a central point. It is frequently used on towers (Figure 12-12).
- *Dome*—This is a hemispherical form of roof (Figure 12-13) that is used chiefly on observatories.

Roof Construction

The frame of most roofs is made up of timbers called *rafters*. These are inclined upward in pairs, their lower ends resting on the top plate, and their upper ends being tied together with a ridge board. On large buildings, such framework is usually reinforced by interior supports to avoid using abnormally large timbers.

The primary object of a roof in any climate is to keep out the elements and the cold. The roof must be sloped to shed water. Where heavy snows cover the roof for long periods, it must be constructed more rigidly to bear the extra weight. Roofs must also be strong enough to withstand high winds.

Rafters

Rafters are the supports for the roof covering and serve in the same capacity as joists for the floor or studs for the walls. According to the expanse of the building, rafters vary in size from ordinary 2 × 4 beams to 2 × 10 beams. For ordinary dwellings, 2 × 6 rafters are used, spaced from 16 to 24 inches oc.

The carpenter should thoroughly know these various types of rafters and be able to distinguish each kind. Following are the various kinds of rafters used in roof construction:

- *Common*—A rafter extending at right angles from plate to ridge (Figure 12-14).

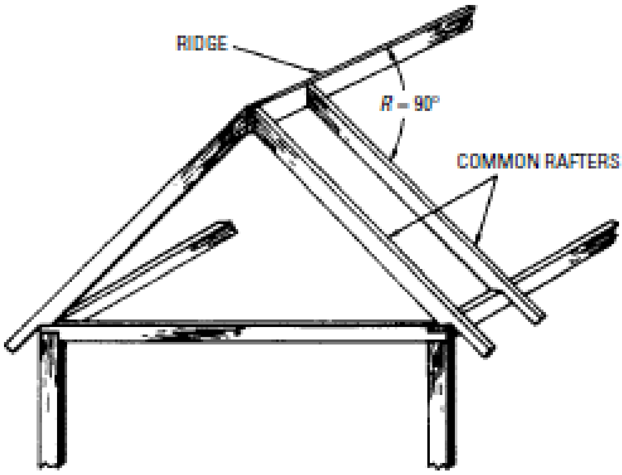
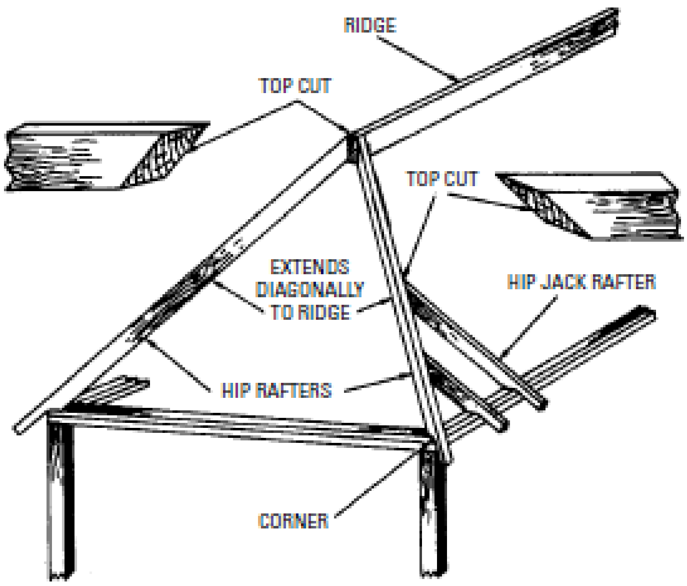


Figure 12-14 Common rafters.



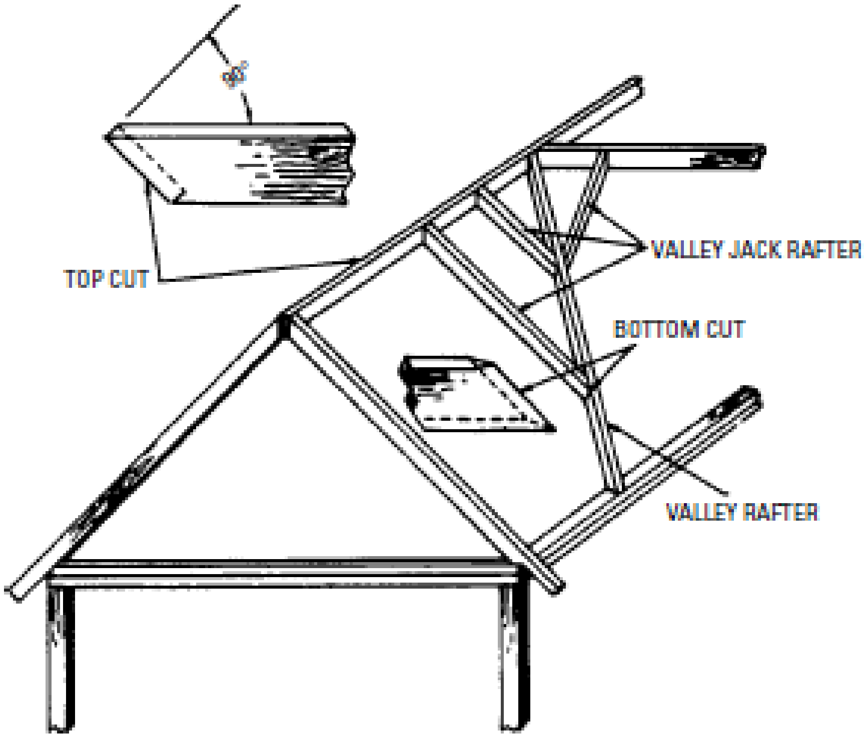


Figure 12-16 Valley and valley jack rafters.

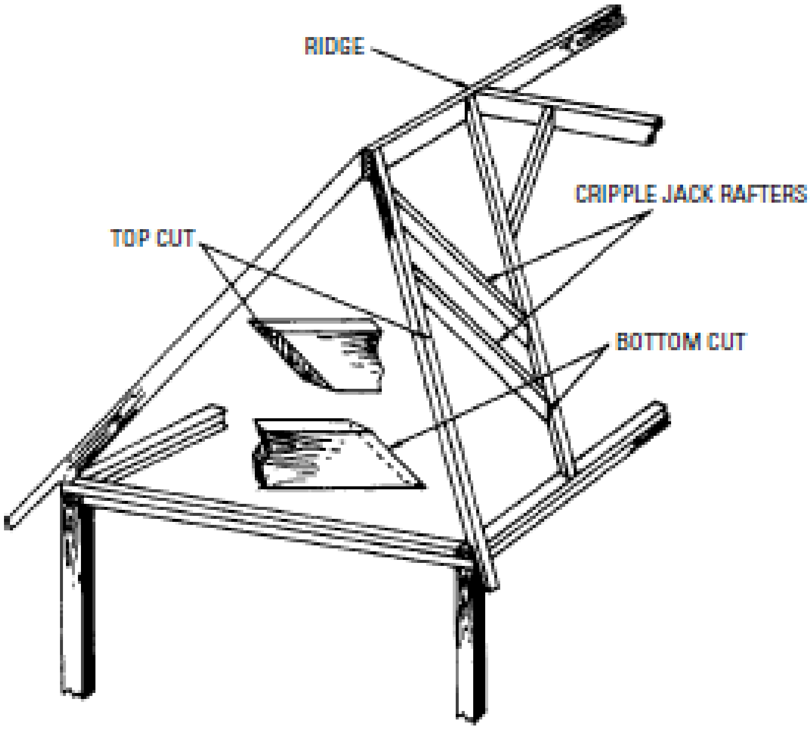


Figure 12-17 Cripple jack rafters.

Length of Rafters

The length of a rafter may be found in several ways:

- By calculation
- With steel framing square (using the multiposition method, by scaling, and by using the framing table)

Example

What is the length of a common rafter having a run of 6 feet and rise of 4 inches per foot?

- *By calculation* (Figure 12-18)— The total rise is calculated as $6 \times 4 = 24$ inches, or 2 feet. The edge of the rafter forms the hypotenuse of a right triangle whose other two sides are the run and rise. Therefore the length of the rafter (in feet) can be calculated as follows:

$$\sqrt{\text{run}^2 + \text{rise}^2} = \sqrt{6^2 + 2^2} = \sqrt{40} = 6.33$$

Practical carpenters would not consider it economical to find rafter lengths in this way, because it takes too much time and there is the chance for error. It is to avoid both objections that the *framing square* has been developed.

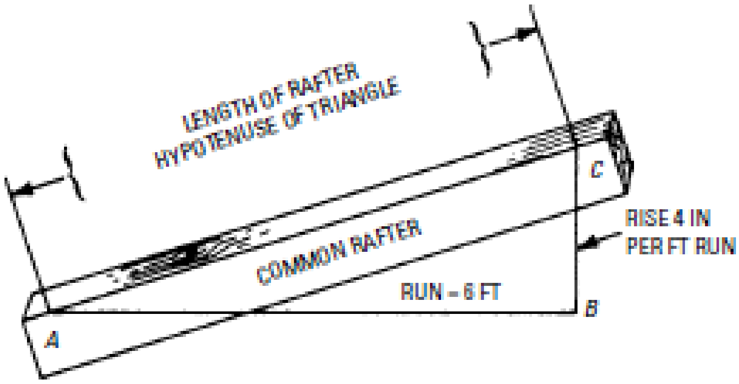


Figure 12-18 Method of finding the length of a rafter by calculation.

- *With steel framing square*— The steel framing square consider-

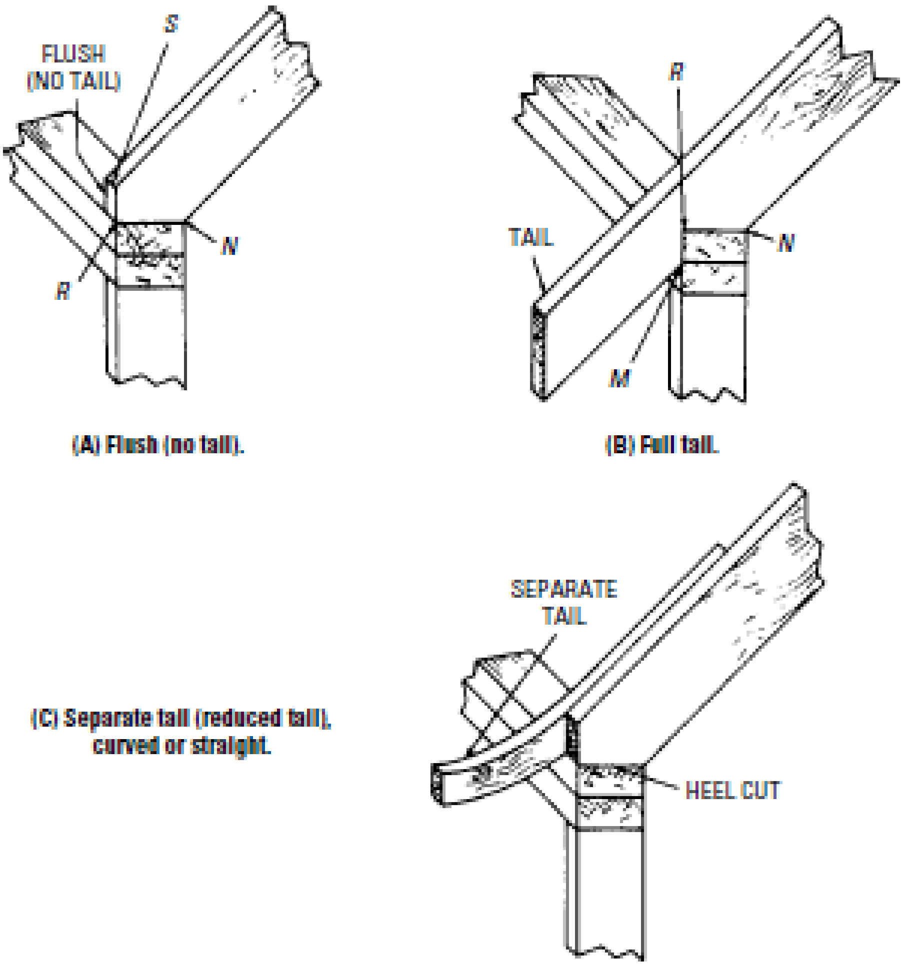


Figure 12-25 Various common rafter tails.

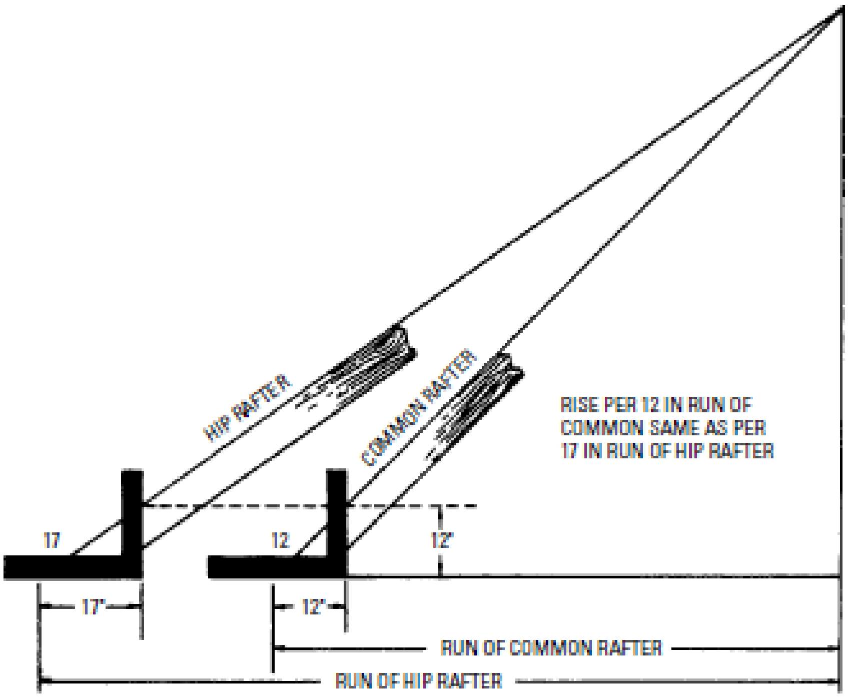


Figure 12-28 Hip and common rafters shown in the same plane, illustrating the use of 12 for the common rafter and 17 for the hip rafter.

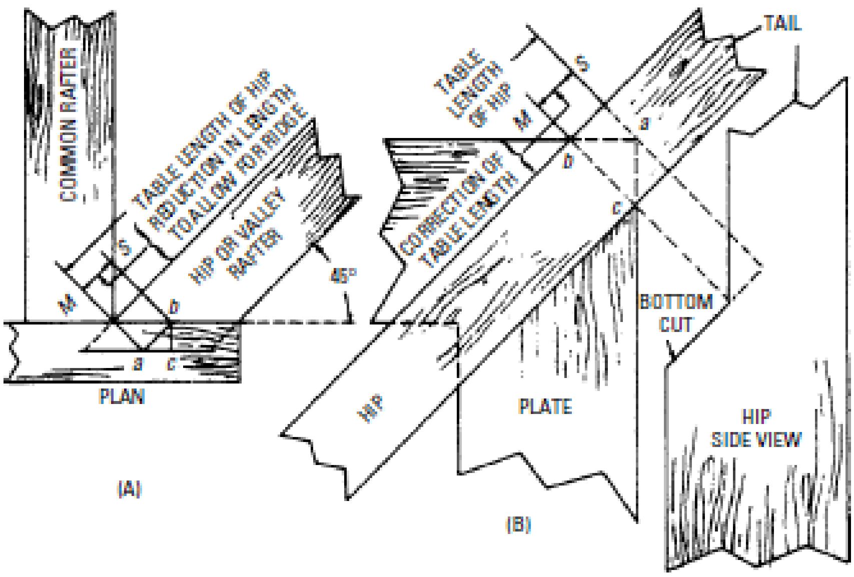


Figure 12-29 Correction in table length of hip to allow for half-thickness of ridge board.

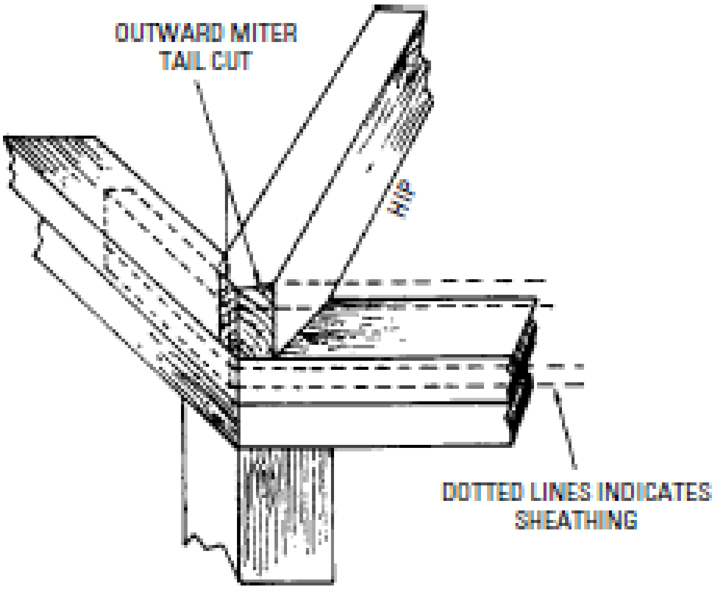


Figure 12-31 Flush hip rafter miter cut.

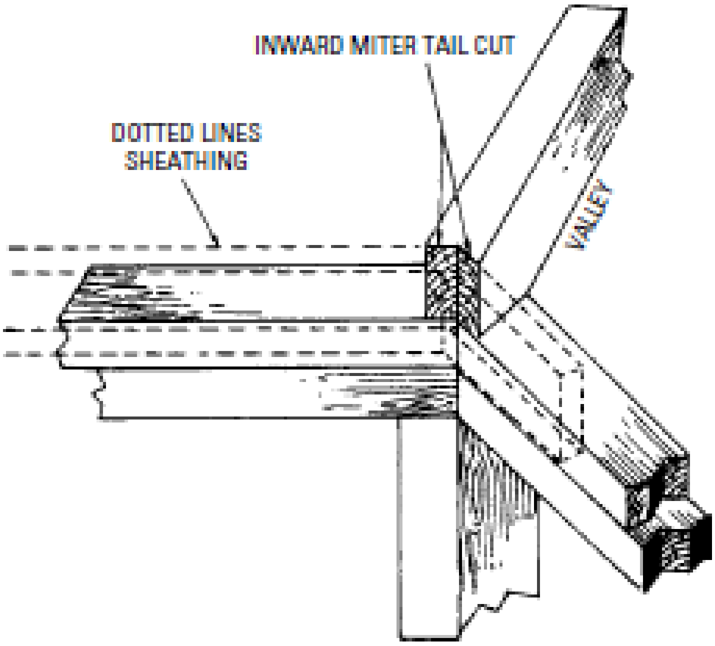


Figure 12-32 Flush valley miter cut.

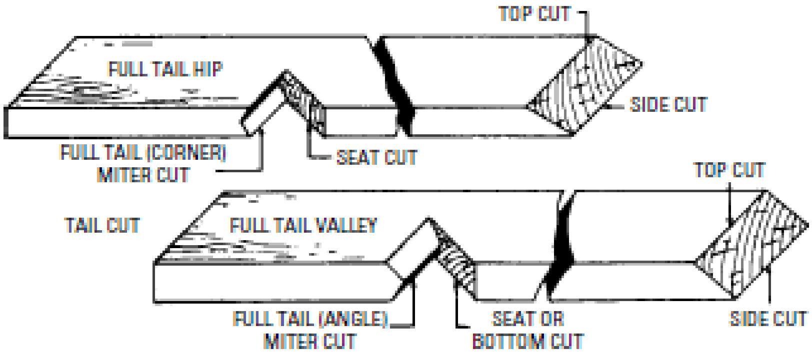


Figure 12-33 Flush tail hip and valley rafters showing all cuts.

Side Cuts of Hip and Valley Rafters

These rafters have a side or cheek cut at the ridge end. In the absence of a framing square, a simple method of laying out the side cut for a 45-degree hip or valley rafter is as follows.

Measure back on the edge of the rafter from point *A* of the top cut, as shown at left in Figure 12-34. Distance *AC* is equal to the thickness of the rafter. Square across from *C* to *B* on the opposite edge, and scribe line *AB*, which gives the side cut. At right in Figure 12-34, *FA* is the top cut, and *AB* is the side cut. The plumb and side cuts should be made at the same time by sawing along lines *FA* and *AB* to save extra labor.

This rule for laying out hip side cuts does not hold for any angle other than 45 degrees.

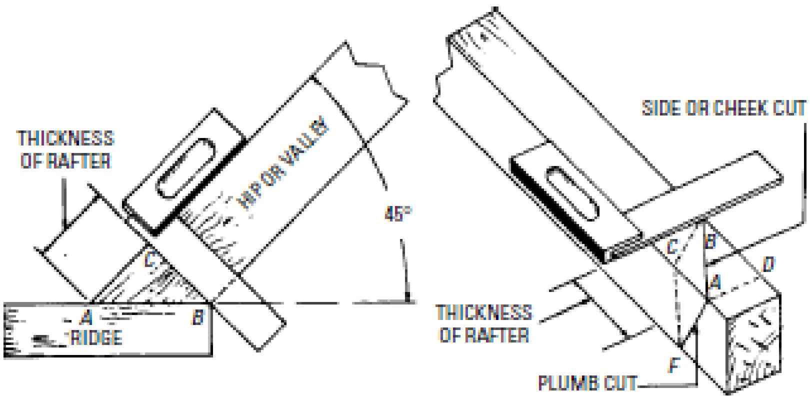


Figure 12-34 A method of obtaining a side cut of 45-degree hip or valley rafter without the aid of a framing square.

Backing of Hip Rafters

By definition, the term *backing* is the bevel upon the top side of a hip rafter that allows the roofing boards to fit the top of the rafter without leaving a triangular hole between it and the back of the roof covering. The height of the hip rafter, measured on the outside surface vertically upward from the outside corner of the plate, will be the *same as that of the common rafter measured from the same line*, whether the hip is backed or not. This is not true for an unbacked valley rafter when the measurement is made at the center of the timber.

Figure 12-35 shows the graphical method of finding the backing of hip rafters. Let *AB* be the span of the building and *OD* and *OC* the plan of two unequal hips. Lay off the given rise as shown. Then *DE* and *CF* are the lengths of the two unequal hips. Take any point, such as *G* on *DE*, and erect a perpendicular cutting *DF* at *H*. Resolve *GH* to *J* (that is, make *HJ* = *GH*), and draw *NO* perpendicular to *OD* and through *H*. Join *J* to *N* and *O*, giving a bevel angle *NJO*, which is the backing for rafter *DE*. Similarly, the bevel angle *NJO* is found for the backing of rafter *CF*.

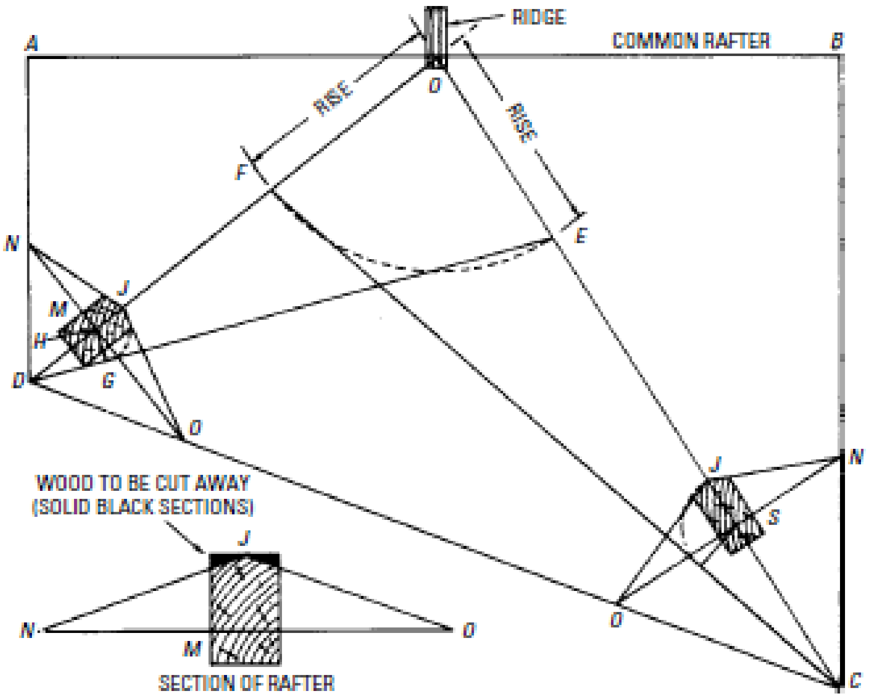


Figure 12-35 Graphical method of finding length of rafters and backing

Jack Rafters

As outlined in the classification, there are several kinds of jack rafters as distinguished by their relation with other rafters of the roof. These various jack rafters are known as the following:

- Hip jacks
- Valley jacks
- Cripple jacks

The distinction between these three kinds of jack rafters (Figure 12-36) is as follows. Rafters that are framed between a hip rafter and the plate are *hip jacks;* those framed between the ridge and a valley rafter are *valley jacks;* and those framed between hip and valley rafters are *cripple jacks.*

The term cripple is applied because the ends or *feet* of the rafters are cut off—the rafter does not extend the full length from ridge to plate. From this point of view, a valley jack is sometimes erroneously

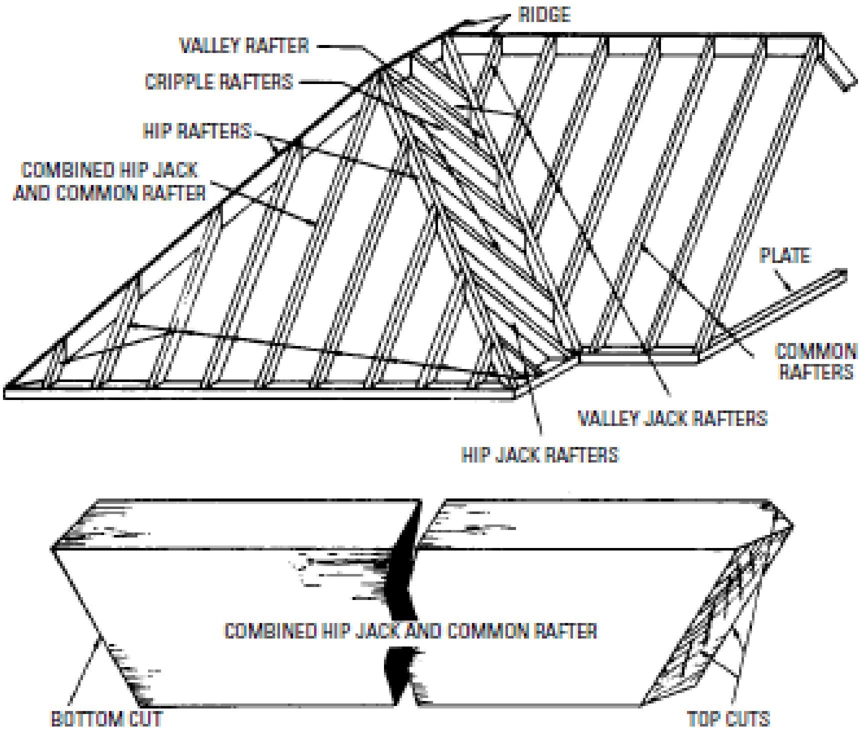


Figure 12-36 A perspective view of hip and valley roof showing the various jack rafters, and enlarged detail of combined hip jack and common rafters showing cuts.

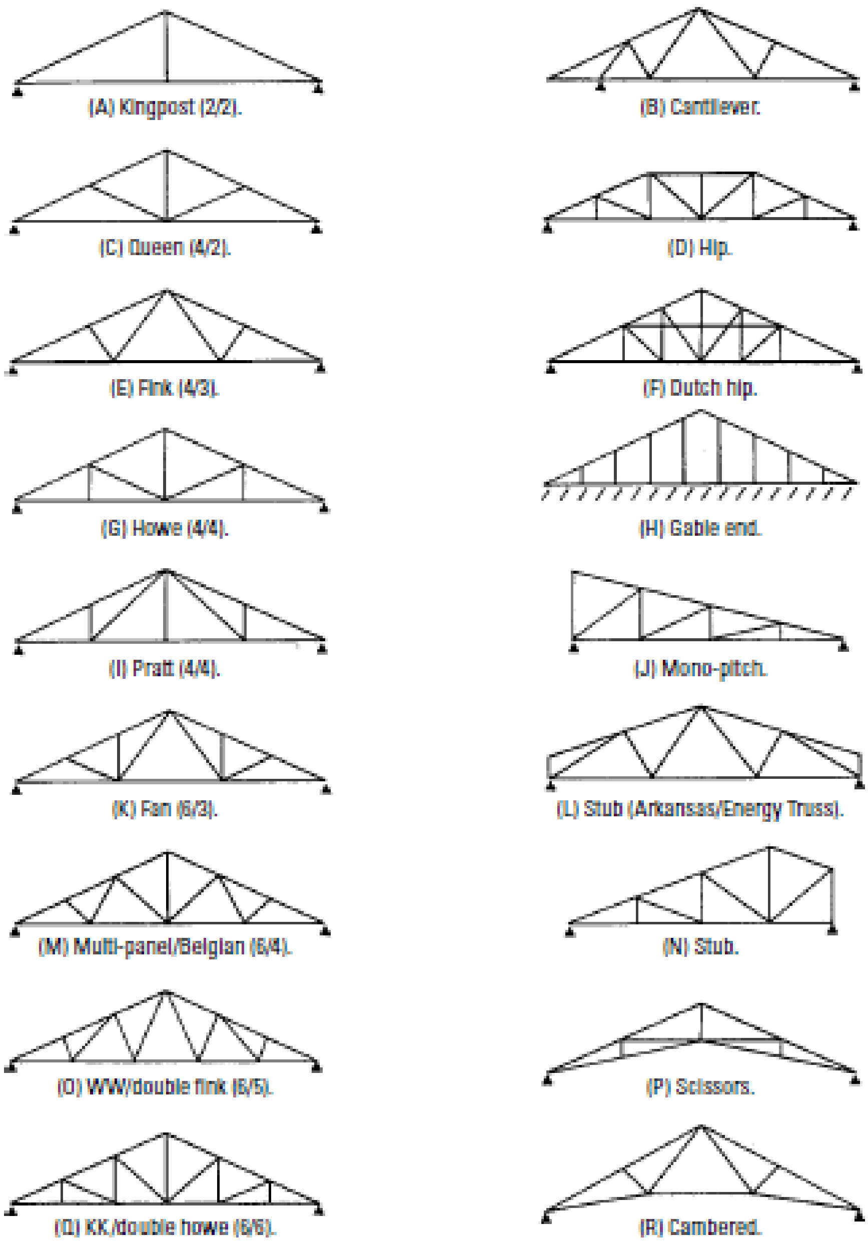


Figure 12-48 Additional truss configurations.

Read other topics in Chapter 12

Roofing

A roof includes the roof cover (the upper layer, which protects against rain, snow, and wind) or roofing, the sheathing to which it is fastened, and the framing (rafters) that support the other components.

Because of its exposure, roofing usually has a limited life. It is made to be readily replaceable. Roofing may be made of many widely diversified materials, among which are the following:

- *Wood*—These are usually in the form of shingles (uniform, machine-cut) or shakes that are hand-cut. They are seen in many areas of the country (Figure 13-1).
- *Metal or aluminum*—Simulates other kinds of roofing.
- *Slate*—This may be the natural product or rigid manufactured slabs, often cement asbestos, though these are on the decline since the controversy over asbestos.
- *Tile* (Figure 13-2)—This is a burned clay or shale product, available in several standard types.
- *Built-up covers of asphalt or tar-impregnated felts, with a mopping of hot tar or asphalt*—These are placed between the plies and a mopping of tar or asphalt overall. Tar-felt roofs usually have the top covered with embedded gravel or crushed slag.
- *Roll roofing*—which, as the name implies, is marketed in rolls containing approximately 108 ft^2. Each roll is usually 36 inches wide and may be plain or have a coating of colored mineral granules. The base is a heavy asphalt-impregnated felt.
- *Asphalt shingles* (Figure 13-3)—These are usually in the form of strips with two, three, or four tabs per unit. These shingles are asphalt with the surface exposed to the weather heavily coated with mineral granules. Because of their fire resistance, cost, and durability, asphalt shingles are the most popular roofing material for homes. Asphalt shingles are available in a wide range of colors, including black and white.
- *Glass fiber shingles*—These are made partly of a glass fiber mat (which is waterproof) and partly of asphalt. Like asphalt shingles, glass fiber shingles come with self-sealing tabs and carry a Class-A fire-resistance warranty. For the do-it-yourselfer, they may be of special interest because they are lightweight, about 220 pounds per square (100 ft^2 of roofing).

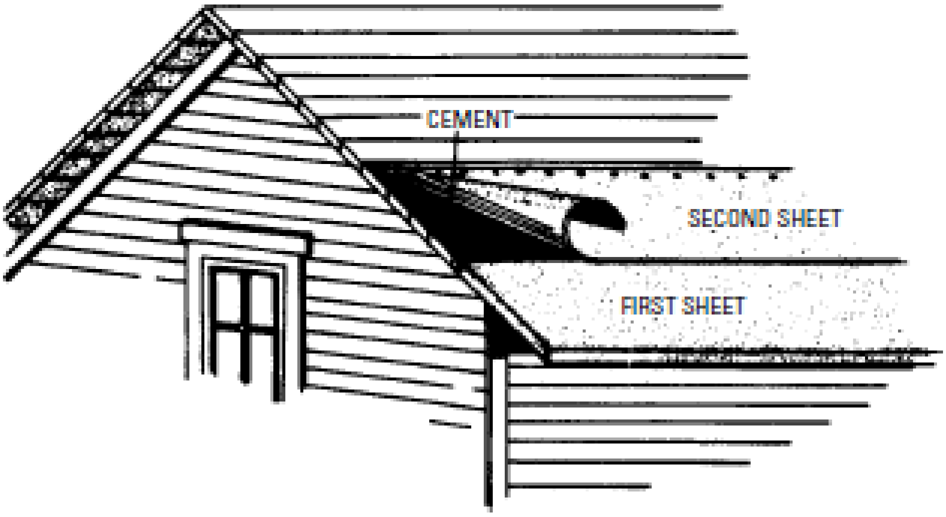


Figure 13-4 Method of cementing and lapping the first and second strips of roll roofing.

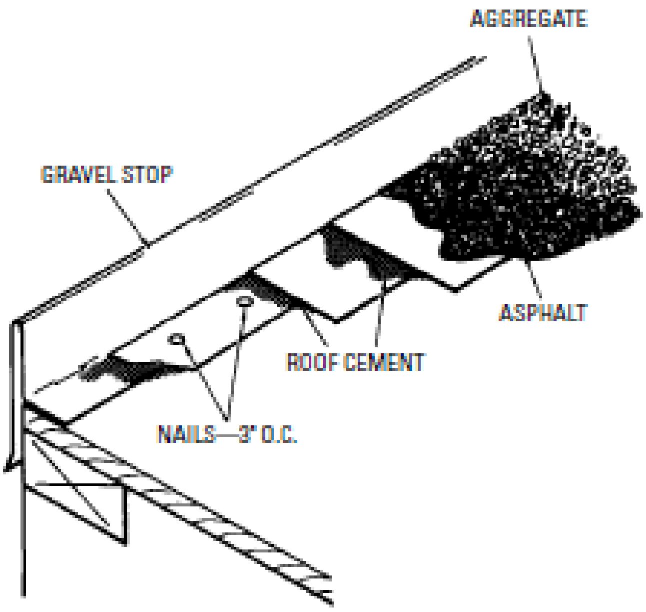


Figure 13-6 The gravel stop.

Wood Shingles

The better grades of shingles are made of cypress, cedar, and redwood, and are available in lengths of 16 and 18 inches and thickness at the butt of $^5/_{16}$ and $^7/_{16}$ inches, respectively. They are packaged in bundles of approximately 200 shingles in random widths from 3 to 12 inches.

An important requirement in applying wood shingles is that each shingle should lap over the two courses below it, so that there will always be at least three layers of shingles at every point on the roof. This requires that the amount of shingle exposed to the weather (the spacing of the courses) should be less than a third of the length of the shingle. Thus, in Figure 13-7, $5^1/_2$ inches is the maximum amount that 18-inch shingles can be laid to the weather and have an adequate amount of lap. This is further shown in Figure 13-8.

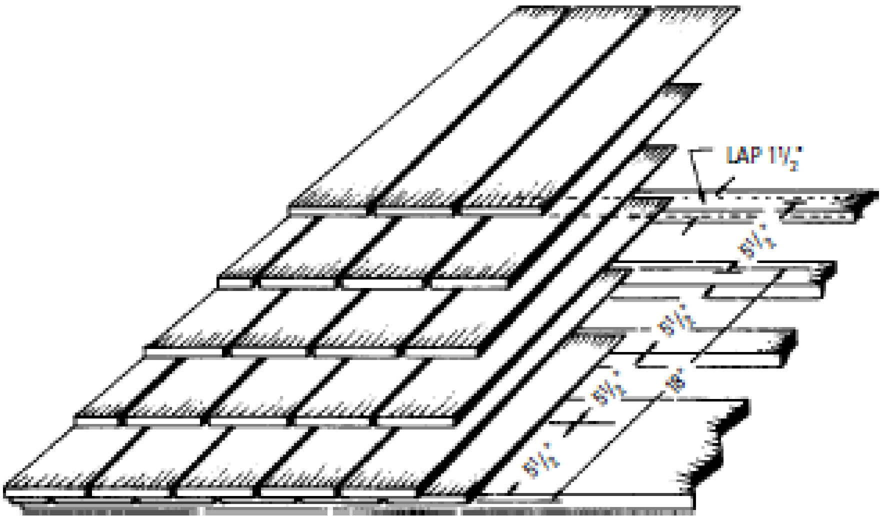


Figure 13-7 Section of a shingle roof showing the amount of shingle that may be exposed to the weather as governed by the lap.

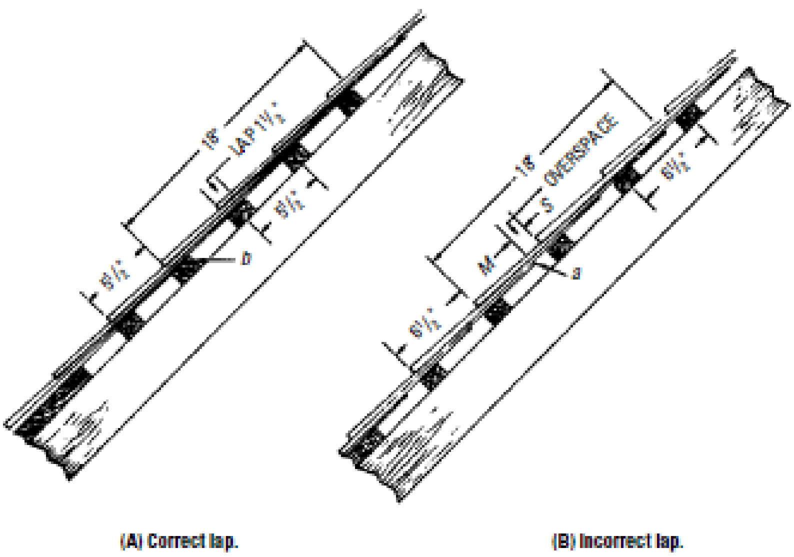


Figure 13-8 The amount of lap is an important factor in applying wood shingles.

There are various methods of laying shingles, the most common are known as the following:

- Straightedge
- Chalk line
- Gage-and-hatchet

The *straightedge method* is one of the oldest. A straightedge having a width equal to the spacing to the weather or the distance between courses is used. This eliminates measuring, it being necessary only to keep the lower edge flush with the lower edge of the course of shingles just laid. The upper edge of the straightedge is then in line for the next course. This is considered the slowest of the three methods.

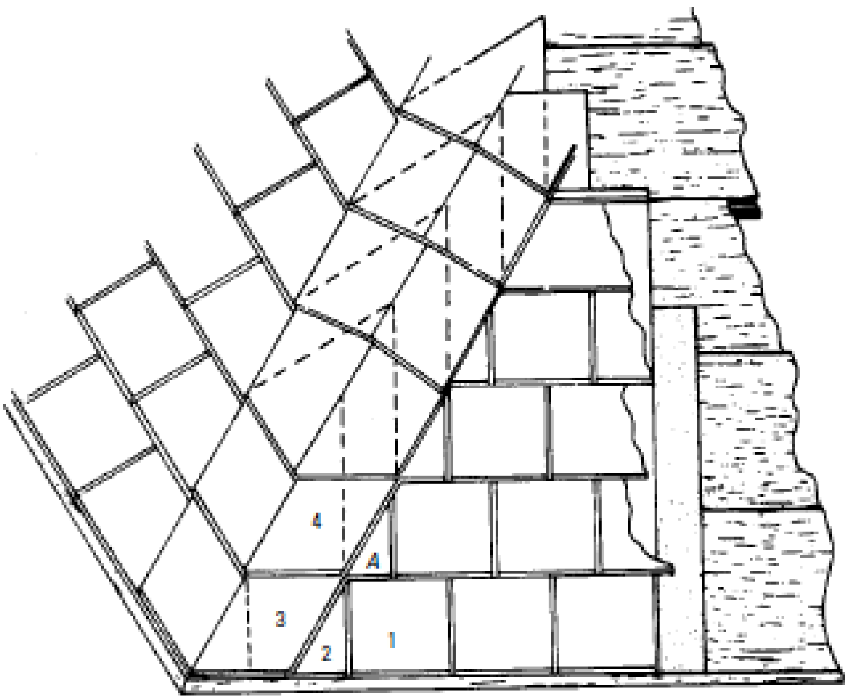


Figure 13-11 Hip roof shingling.

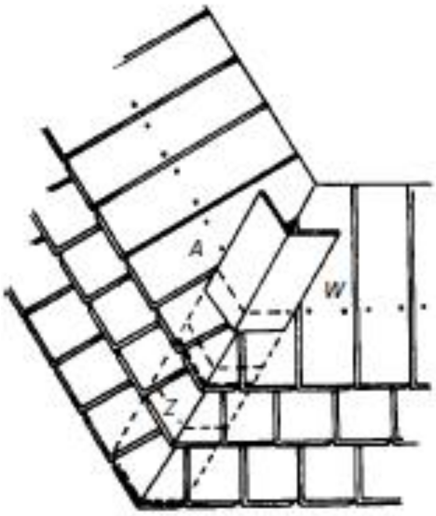


Figure 13-12 Method of installing metal shingles under wood shingles.

Figure 13-13 Wood fiber roofing from Masonite is a relatively new product. It is available in fire-rated versions and is bigger than standard shingles.

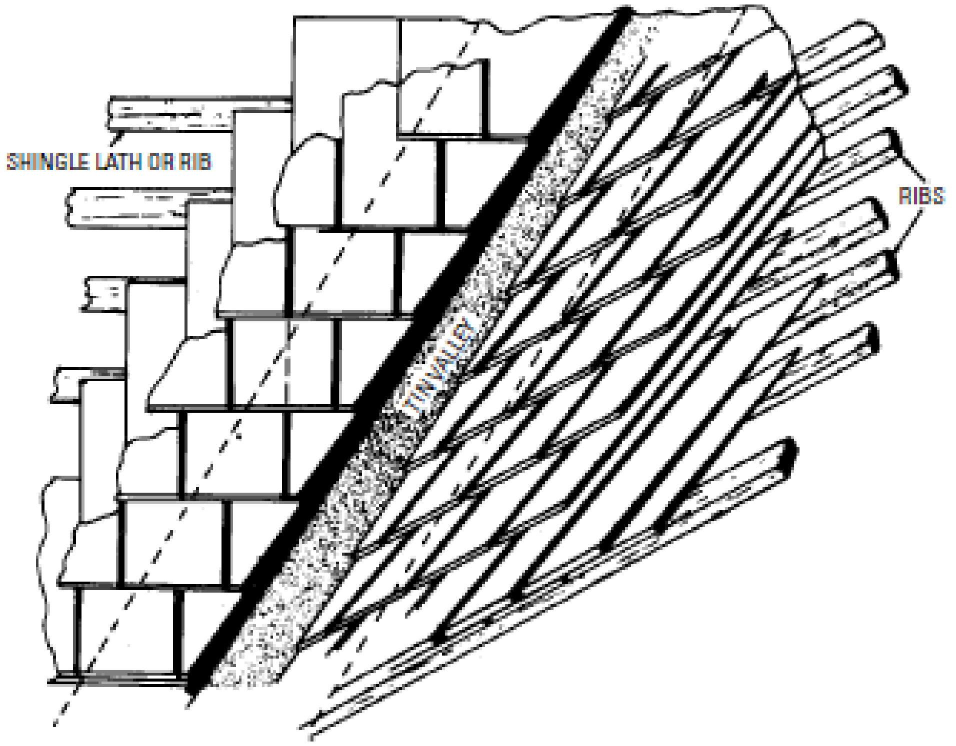


Figure 13-14 Method of shingling a valley.

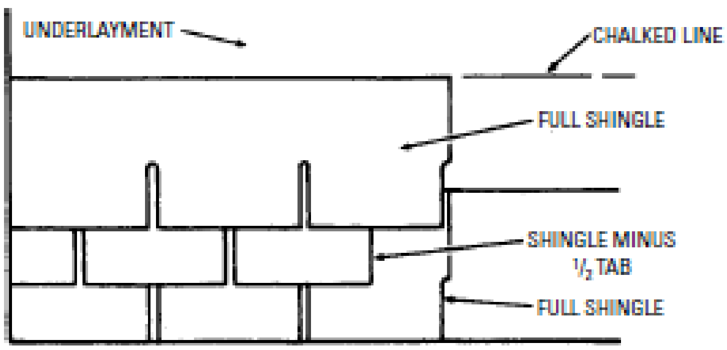


Figure 13-16 Application of the starter shingles.

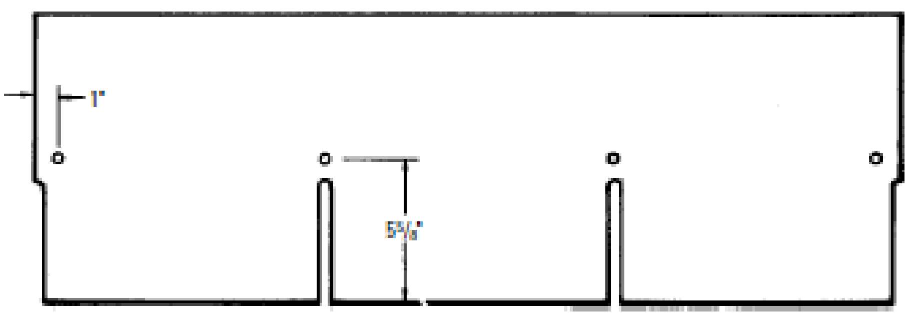


Figure 13-17 The proper placement of nails.

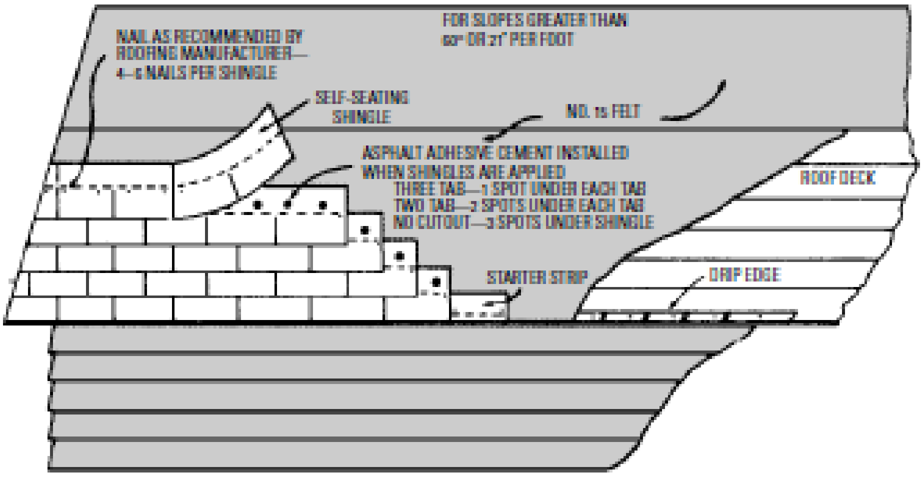


Figure 13-19 If the roof slope exceeds 60 degrees, you have to take special steps in application.

Slate

Slate is an ideal roofing material and is used on permanent buildings with pitched roofs. The process of manufacture is to split the quarried slate blocks horizontally to a suitable thickness, and to cut vertically to the approximate sizes required. The slates are then passed through planers. After the operation, the slates are ready to

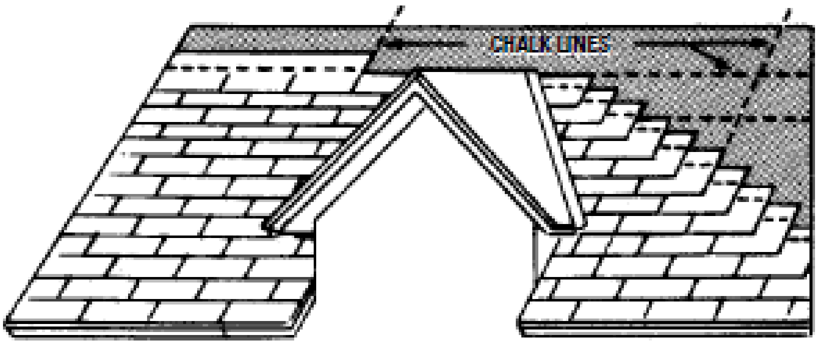


Figure 13-20 For neatness, shingle courses should meet in a line above dormer.

in Figure 13-22.

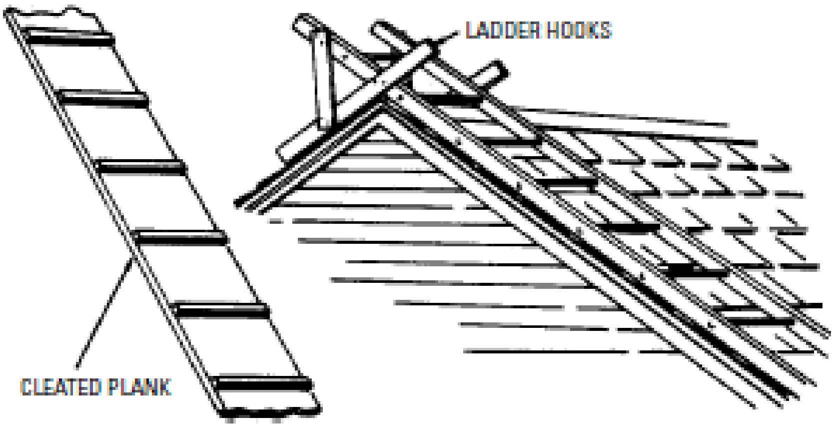


Figure 13-21 Two types of supports used in repairs of roof.

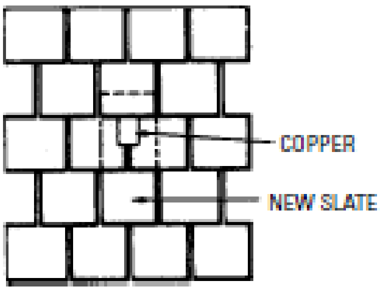


Figure 13-22 Method of inserting new pieces of slate shingles.

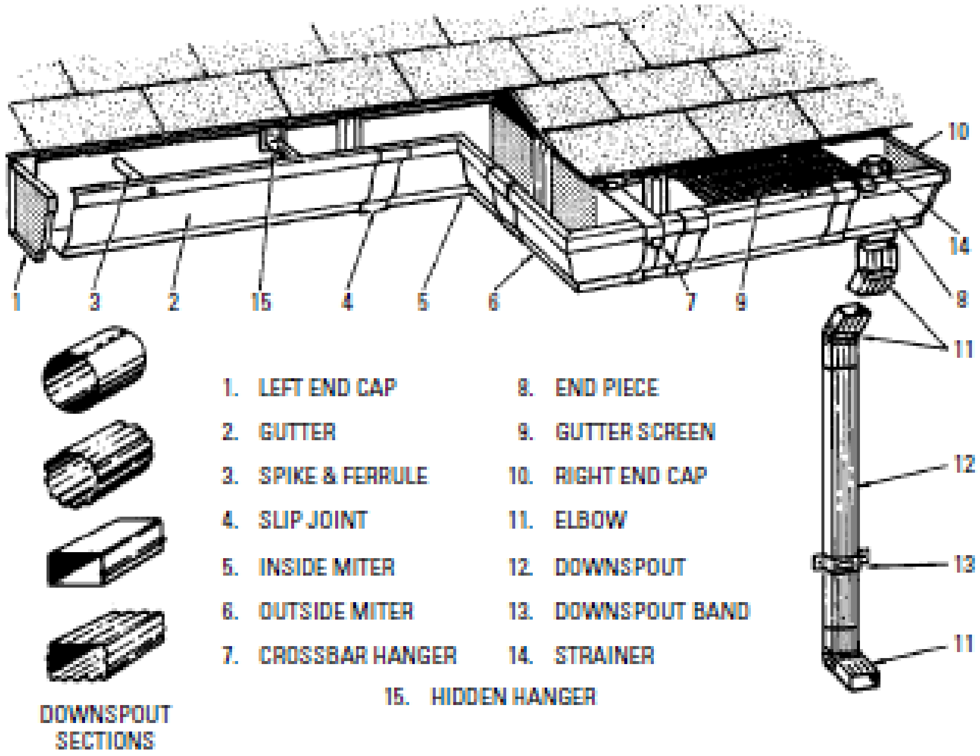


Figure 13-23 Various downspouts and fittings. *(Courtesy Billy Penn Gutters)*

Selecting Roofing Materials

Roofing materials are commonly sold by dealers or manufacturers based on quantities to cover 100 ft^2. This quantity is commonly termed one square by roofers and in trade literature. When ordering roofing material, make allowance for waste such as in hips, valleys, and starter courses. This applies in general to all types of roofing.

Chapter 14

Cornice Construction

The *cornice* is the projection of the roof at the eaves that forms a connection between the roof and the sidewalls. The general types of cornice construction are the box, the closed, the wide box, and the open.

Box Cornices

The typical *box cornice* shown in Figure 14-1 utilizes the rafter projection for nailing surfaces for the facia and soffit boards. The *soffit* provides a desirable area for inlet ventilators. A frieze board is often used at the wall to receive the siding. In climates where snow and ice dams may occur on overhanging eaves, the soffit of the cornice may be sloped outward and left open $^1/_4$ inch at the facia board for drainage.

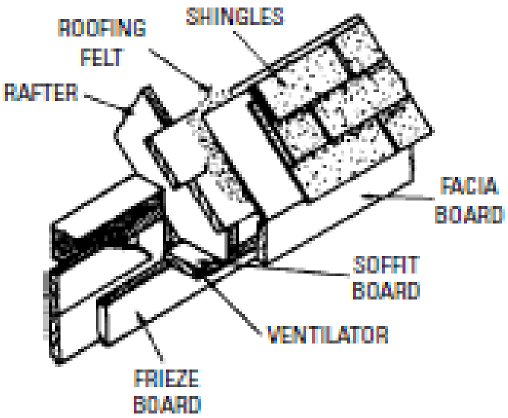


Figure 14-1 Box cornice construction.

Closed Cornices

The *closed cornice* shown in Figure 14-2 has no rafter projection. The overhang consists only of a frieze board and a shingle or crown molding. This type is not as desirable as a cornice with a projection, because it gives less protection to the sidewalls.

Wide Box Cornices

The *wide box cornice* in Figure 14-3 requires forming members called *lookouts*, which serve as nailing surfaces and supports for the soffit board. The lookouts are nailed at the rafter ends and are toenailed to the wall sheathing and directly to the stud. The soffit can be of various materials (such as beaded ceiling boards, plywood, or aluminum), either ventilated or plain. A bed molding may be used

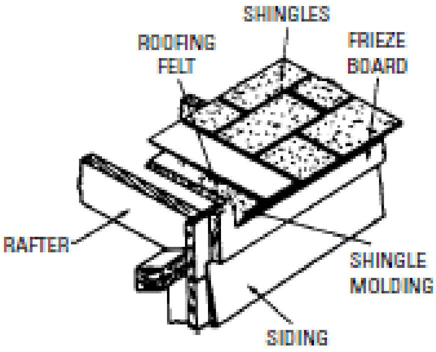


Figure 14-2 Closed cornice construction.

at the juncture of the soffit and frieze. This type of cornice is often used in hip roof houses, and the facia board usually carries around the entire perimeter of the house.

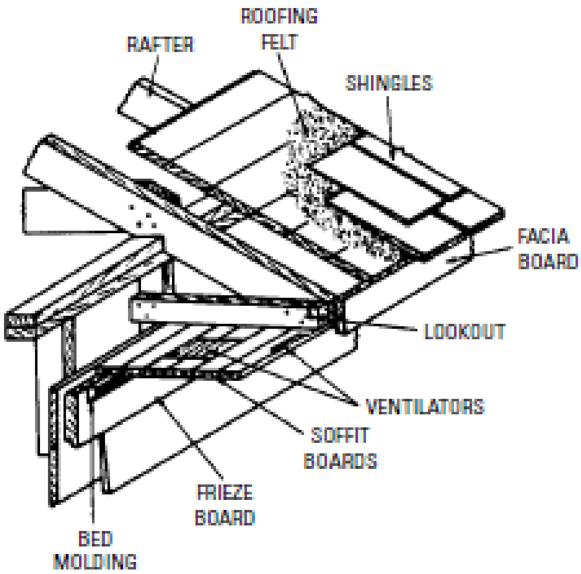


Figure 14-3 Wide cornice construction.

Open Cornices

The *open cornice* shown in Figure 14-4 may consist of a facia board nailed to the rafter ends. The frieze is either notched or cut out to fit between the rafters and is then nailed to the wall. The open cornice is often used for a garage. When it is used on a house, the roof boards

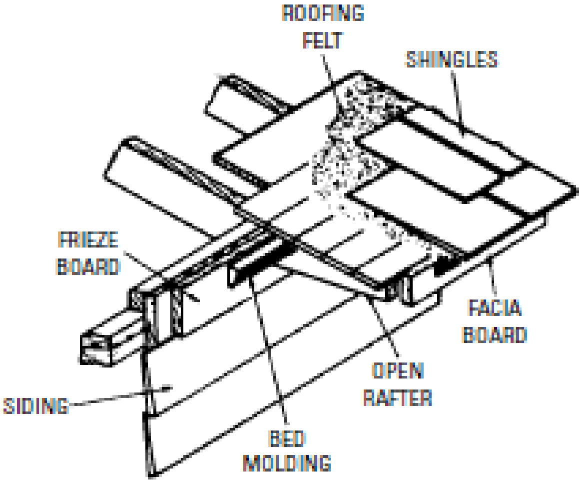


Figure 14-4 Open cornice construction.

Cornice Returns

The cornice return is the end finish of the cornice on a gable roof. The design of the cornice return depends to a large degree on the rake or gable projection and on the type of cornice used. In a close rake (a gable end with very little projection), it is necessary to use a frieze or rake board as a finish for siding ends, as shown in Figure 14-5. This board is usually $1^1/_8$-inch thick and follows the roof slope to meet the return of the cornice facia. Crown molding or other type of finish is used at the edge of the shingles.

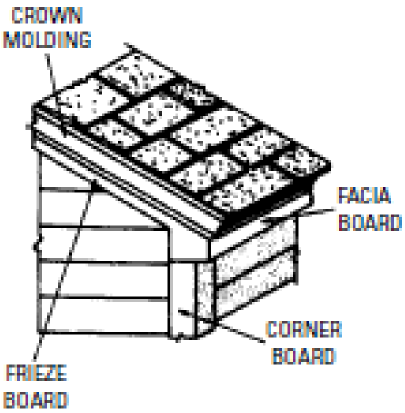


Figure 14-5 The closed cornice return.

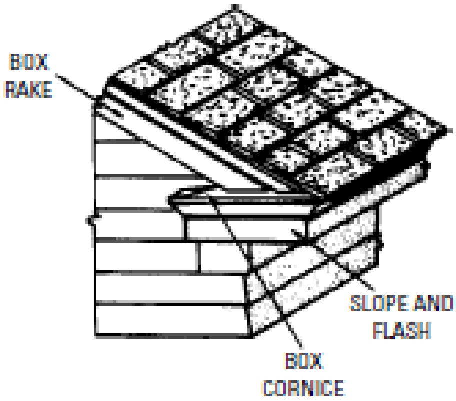


Figure 14-6 The box cornice return.

When the gable end and the cornice have some projection as shown in Figure 14-6, a box return may be used. Trim on the rake projection is finished at the cornice return. A wide cornice with a small gable projection may be finished as shown in Figure 14-7. Many variations of this trim detail are possible. For example, the frieze board at the gable end might be carried to the rake line and mitered with a facia board of the cornice. This siding is then carried across the cornice end to form a return.

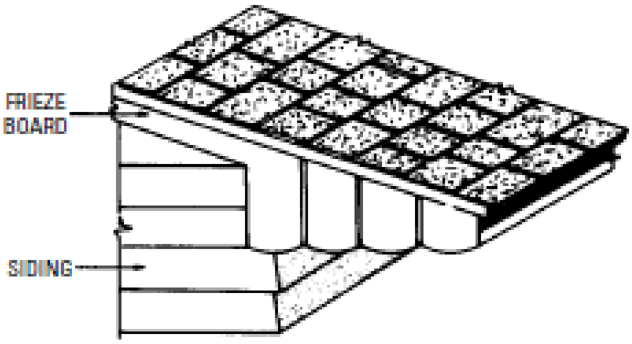


Figure 14-7 The wide cornice return.

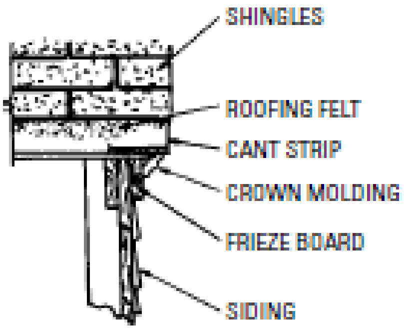


Figure 14-8 The closed end finish.

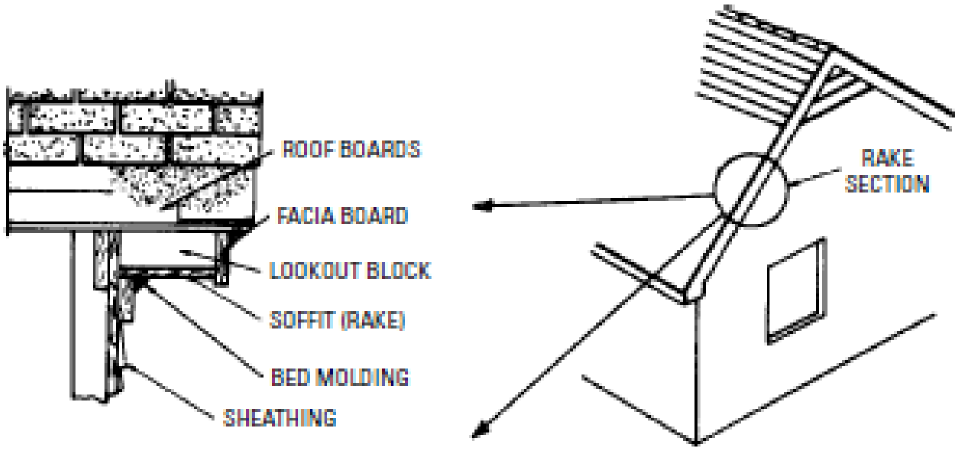


Figure 14-9 The box end finish.

Read Chapter 14 Cornice Construction

Chapter 15

Sheathing and Siding

Sheathing is nailed directly to the framework of the building. Its purpose is to strengthen the building, to provide a base wall to which the finish siding can be nailed, to act as insulation, and, in some cases, to be a base for further insulation. Some of the common types of sheathing include *fiberboard*, *wood*, and *plywood*.

Fiberboard Sheathing

Fiberboard usually comes in 2-feet × 8-feet or 4-feet × 8-feet sheets that are tongue-and-grooved, and generally coated or impregnated with an asphalt material to increase water resistance. Thickness is normally $^1/_2$ and $^{25}/_{32}$ inch. Fiberboard sheathing may be used where the stud spacing does not exceed 16 inches, and it should be nailed with 2-inch galvanized roofing nails or other type of noncorrosive nails. If the fiberboard is used as sheathing, most builders will use plywood at all corners (the thickness of the sheathing) to strengthen the walls, as shown in Figure 15-1.

Solid Wood Sheathing

Wood wall sheathing can be obtained in almost all widths, lengths, and grades. Generally, widths are from 6 to 12 inches, with lengths selected for economical use. All solid wood wall sheathing used is $^{25}/_{32}$ to 1 inch in thickness. This material may be nailed on horizontally or diagonally, as shown in Figure 15-2. Wood sheathing is laid on tight, with all joints made over the studs. If the sheathing is to be put on horizontally, it should be started at the foundation and worked toward the top. If the sheathing is installed diagonally, it should be started at the corners of the building and worked toward the center or middle.

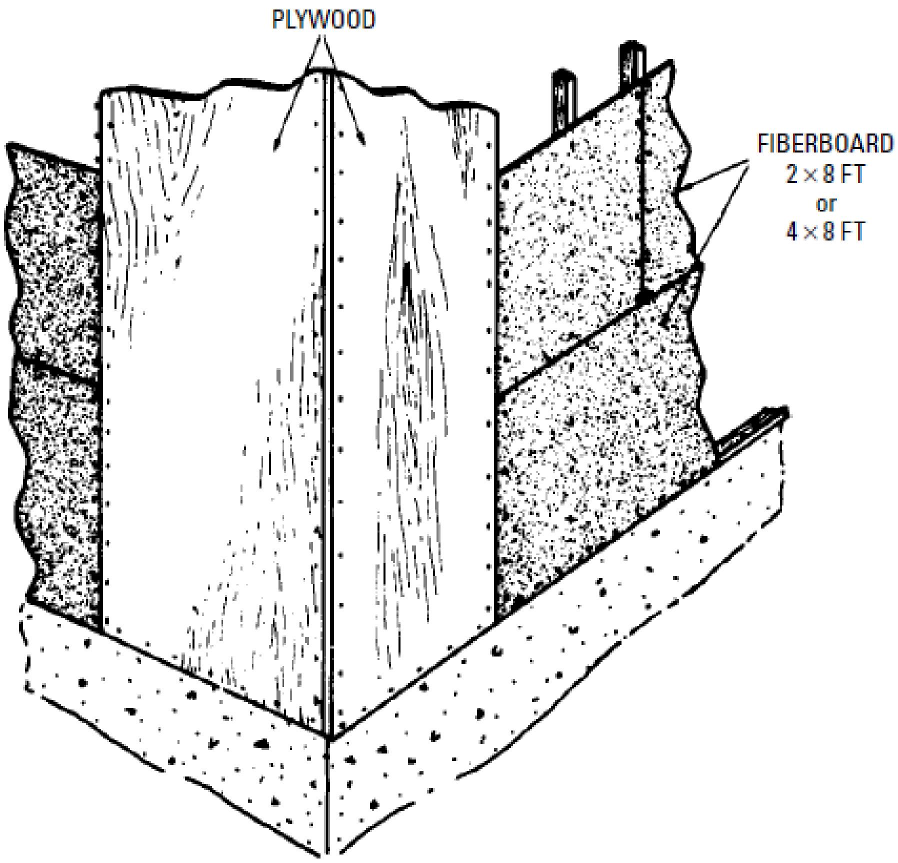
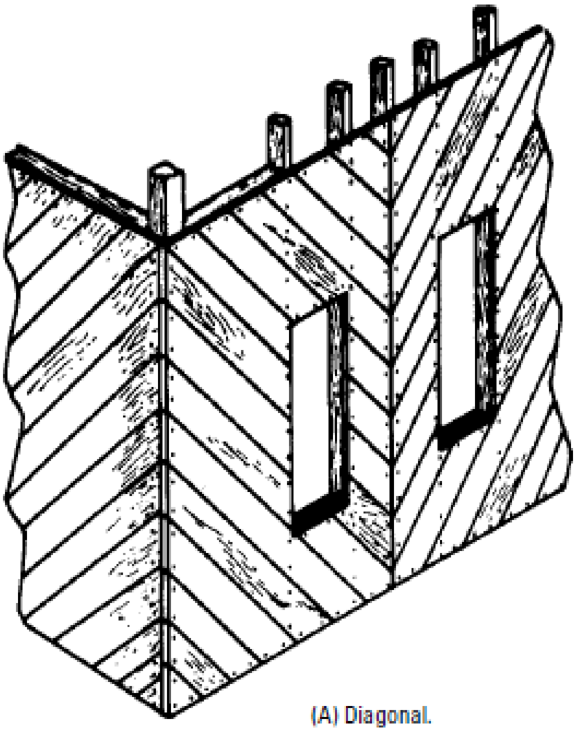
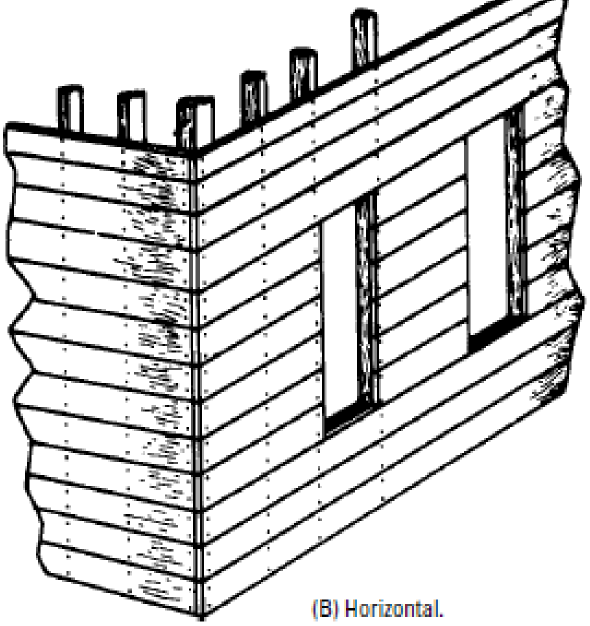


Figure 15-1 Method of using plywood on all corners as bracing when using fiberboard as exterior sheathing.



(A) Diagonal.



(B) Horizontal.

Figure 15-2 Two methods of nailing on wood sheathing.

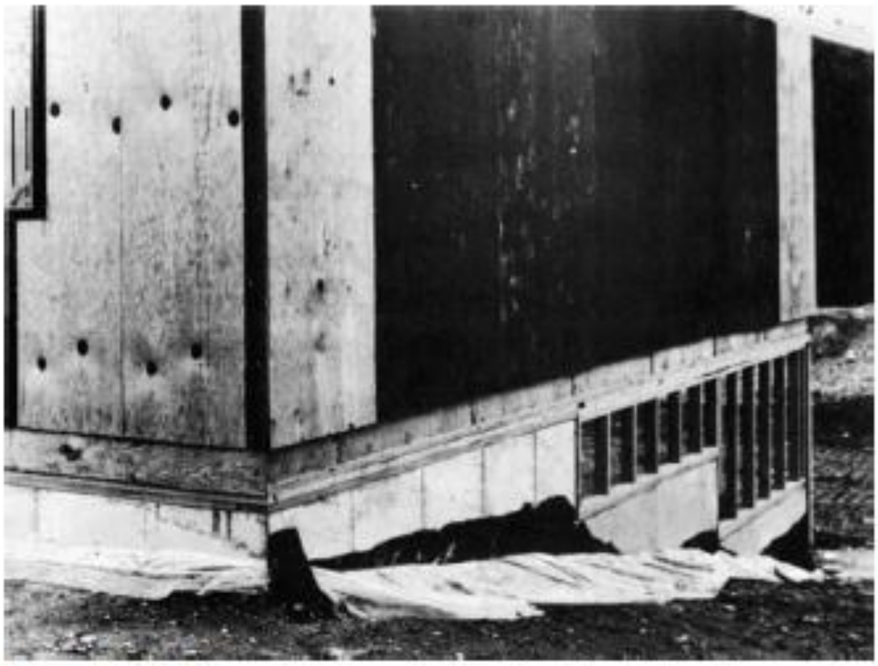


Figure 15-4 Plywood is a popular sheathing. Here it is used at corners with fiberboard.

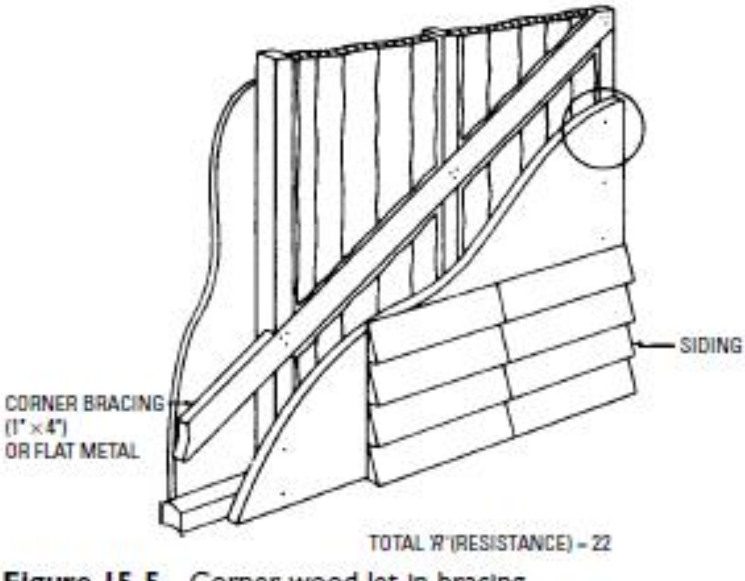
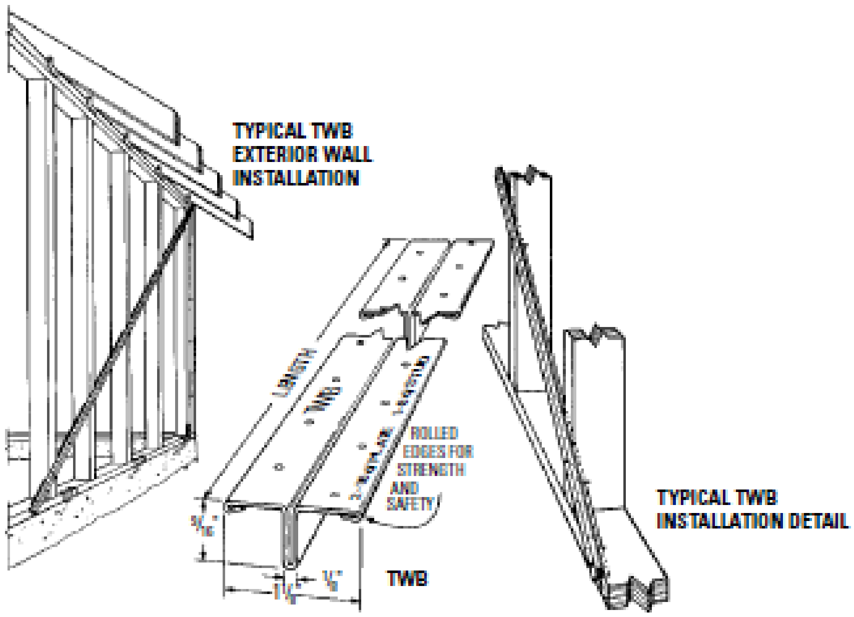


Figure 15-5 Corner wood let-in bracing.



MODEL NO.	LENGTH	ANGLE AND WALL SIZE	FASTENERS	
			PLATES	STUDS
TWB10	9' 3"	8' @ 60°	2-16d	1-8d
TWB12	11' 4"	8' @ 45°	2-16d	1-8d
TWB14	14' 2"	10' @ 45°	2-16d	1-8d

Figure 15-6 Simpson Strong-Tie TWB T-type wall brace.
(Courtesy Simpson Strong-Tie Company, Inc.)

Read Chapter 15 Sheathing

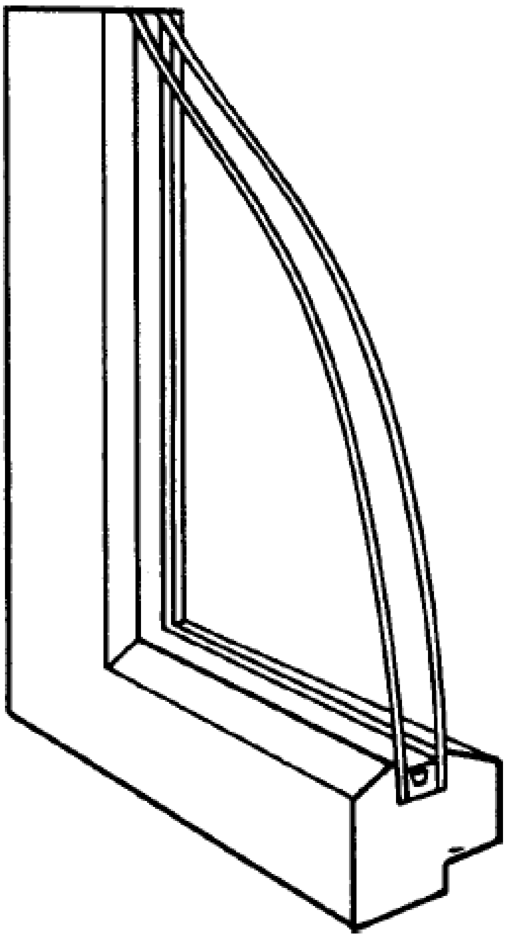


Figure 16-1 A double-insulated window. The dead air space between the sandwich of glass helps save on fuel.

Heat Transfer

Heat is energy, not a substance. It can flow or be transferred from one place to another. Convection, conduction, and radiation are the three ways heat can be transferred.

- *Convection*—A forced hot-air system is an example of convection. The hot air is bodily moved from the furnace to the various rooms of a house. Convective loops are caused by temperature differences. A sea breeze is an example of a convective loop. As the land is warmed by the sun, the warm air, which is not as heavy as the cold air, rises and leaves an empty space, a vacuum. The colder air on the water moves in to fill up the empty space. As long as the warm air rises, there will be a continuous flow or convective loop.

- *Conduction*—This is the transfer of heat through solid objects. Anyone who has grabbed the handle of a hot metal pan knows what conduction is. It is the transfer of heat between bodies in direct contact.
- *Radiation*—The sun radiates its heat energy through the vacuum of space. The wood stove radiates its heat energy throughout a room. Heat is a form of electromagnetic energy (like radio waves) that travels through space and fluids until it is absorbed by a solid or reflected by a radiant barrier such as silver or aluminum foil.

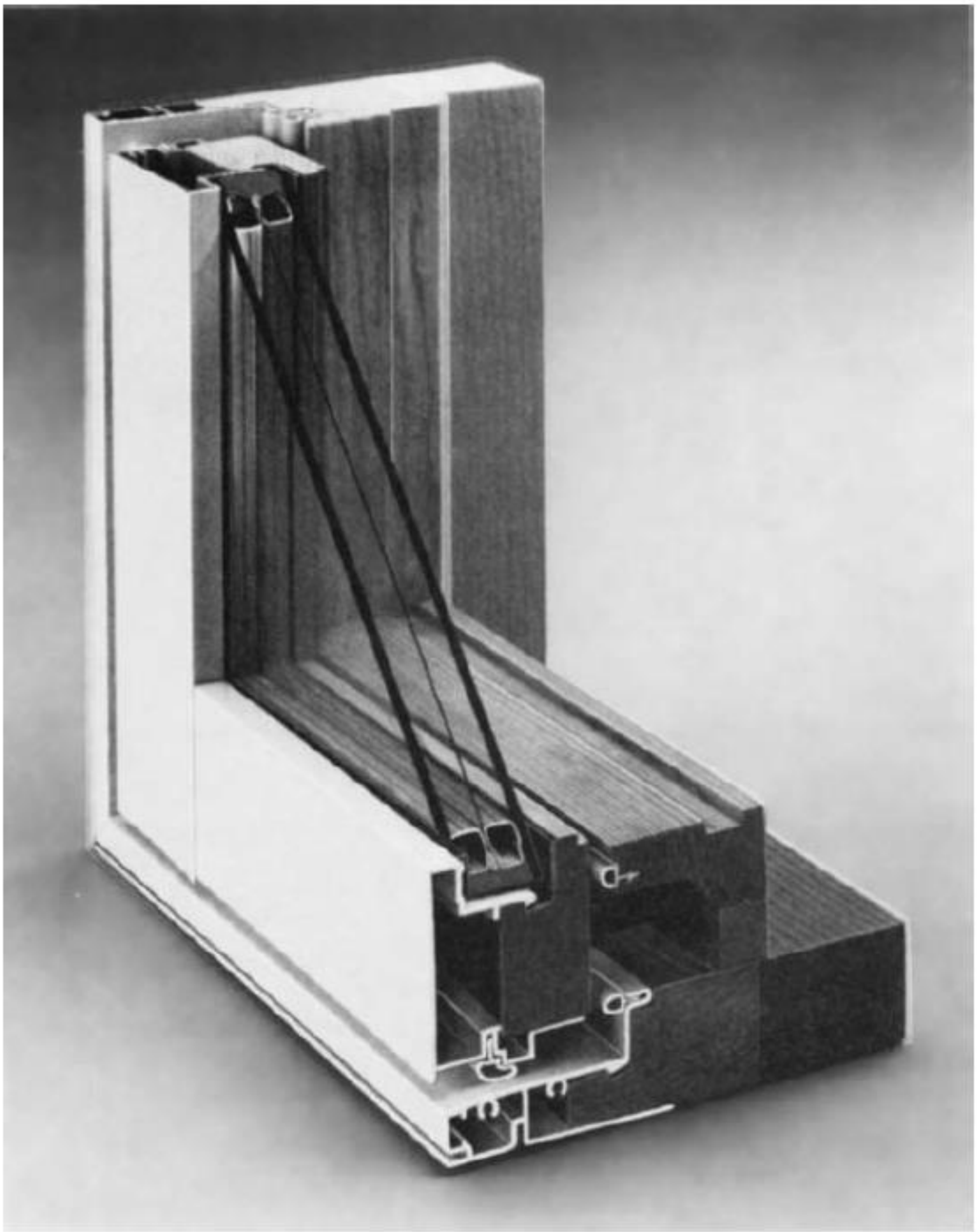
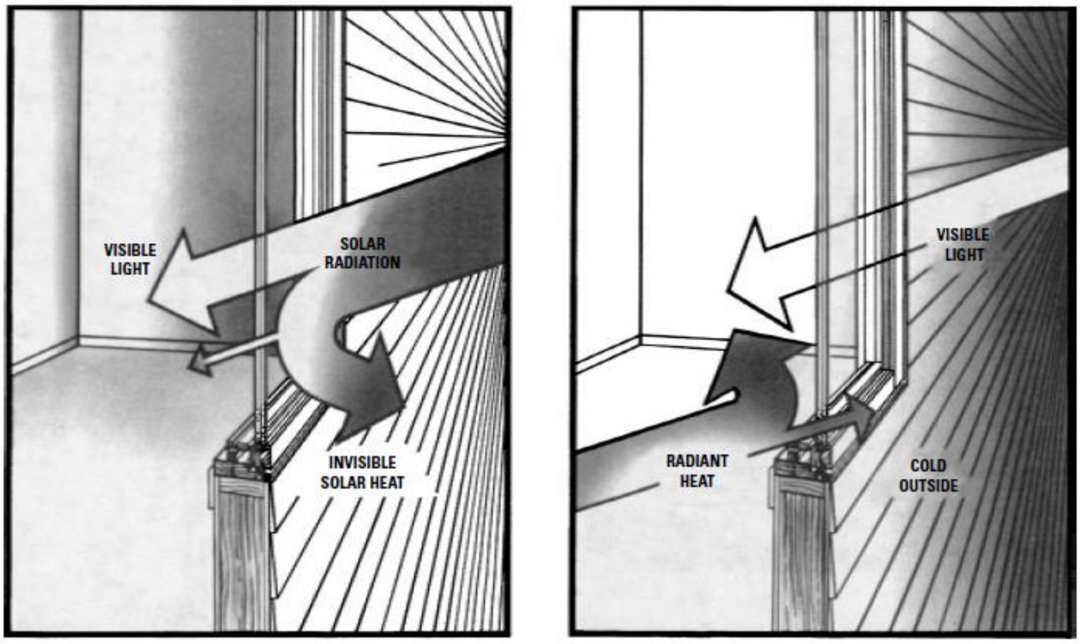


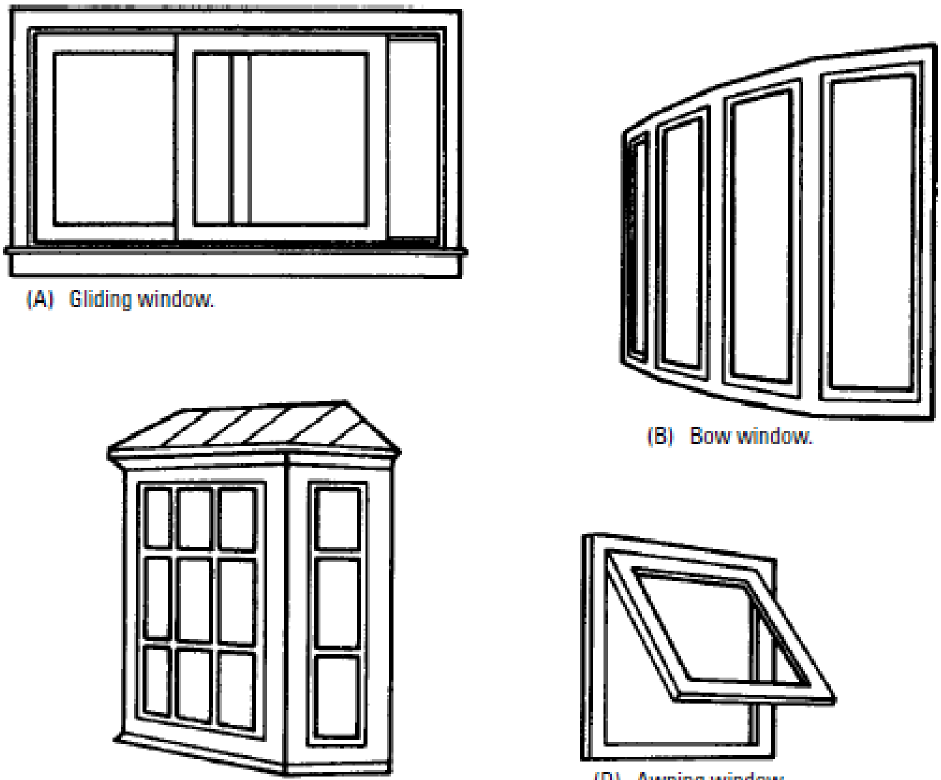
Figure 16-2 Heat Mirror film suspended between two panes of glass.



(A) Hot climate.

(B) Cold climate.

Figure 16-3 Two Heat Mirror options. *(Courtesy of Hurd Millwork Company, Inc.)*



(A) Gliding window.

(B) Bow window.

(C) Bay window.

(D) Awning window.

Figure 16-5 Various kinds of windows.

Window Framing

The frame into which the window sash fits is set into a rough opening in the wall framing and is intended to hold the sash in place (Figure 16-6).

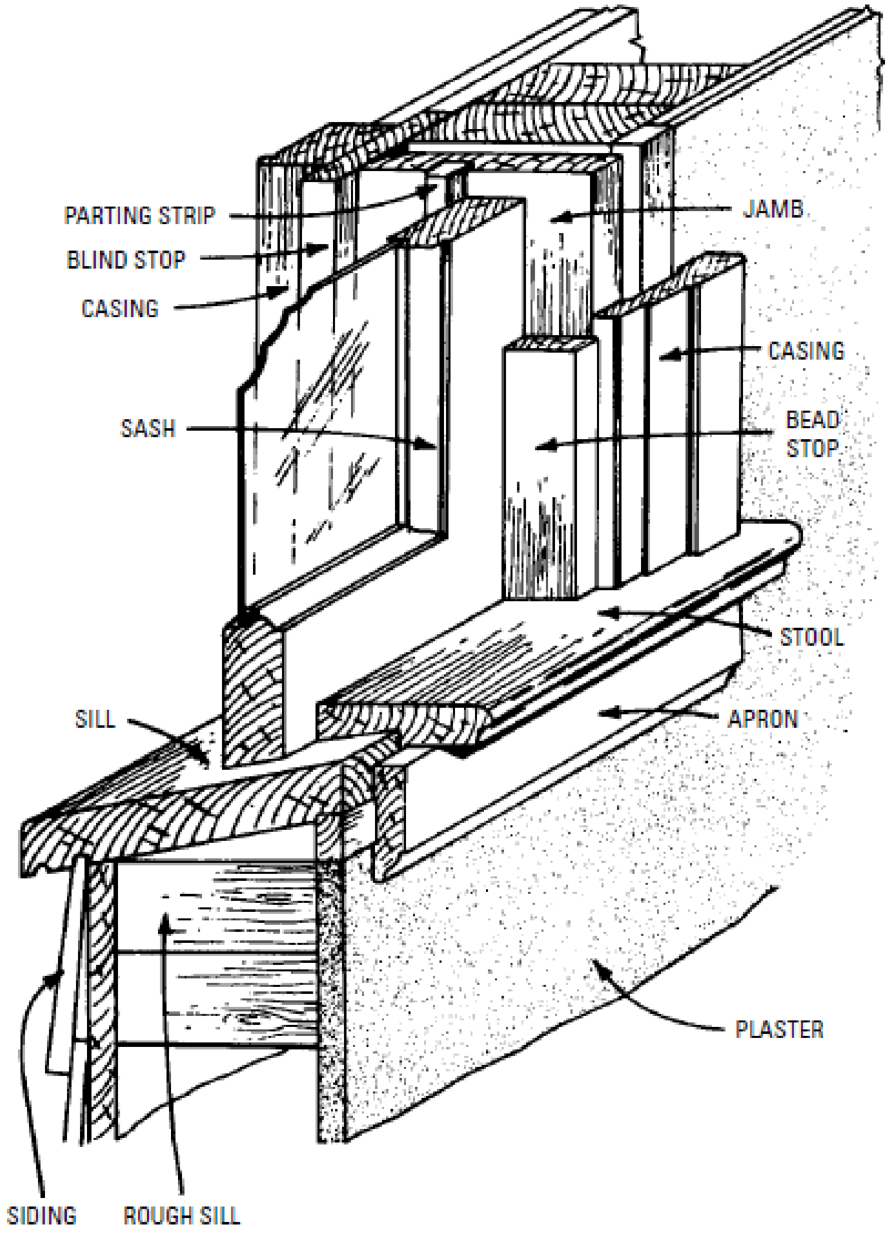


Figure 16-6 Side view of window frame.

Double-Hung Windows

The *double-hung window* is the most common kind of window. It is made up of two parts—an upper and lower sash. They slide vertically past each other. Figure 16-7 shows an illustration of this type of window, made of wood. It has some advantages and some disadvantages. Screens can be installed on the outside of the window without interfering with its operation. For full ventilation of a room, only one-half the area of the window can be utilized, and any current of air passing across its face is (to some extent) lost in the room. Double-hung windows are sometimes more involved in their frame

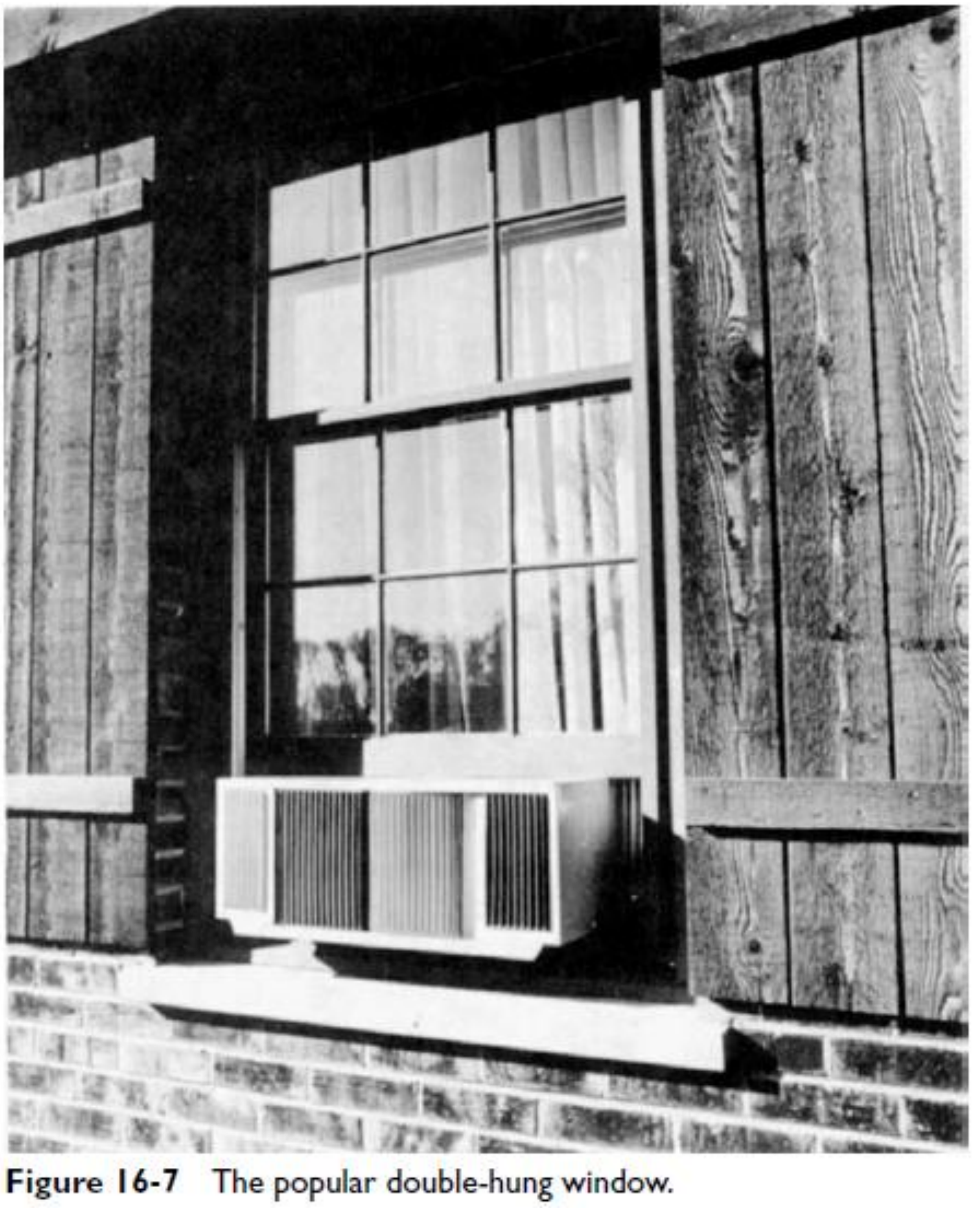


Figure 16-7 The popular double-hung window.

Hinged or Casement Windows

There are two types of *casement windows*—the out-swinging and the in-swinging window. These windows may be hinged at the side, top, or bottom. The casement window that opens out requires the screen to be located on the inside. This type of window, when closed, is most efficient as far as waterproofing. The in-swinging, like double-hung windows, are clear of screens, but they are extremely difficult to make watertight. Casement windows have the advantage of their entire area being opened to air currents, thus catching a parallel breeze and slanting it into a room.

Casement windows are considerably less complicated in their construction than double-hung units. Sill construction is very much like that for a double-hung window, however, but with the stool much wider and forming a stop for the bottom rail. When there are two casement windows in a row in one frame, they are separated by a vertical double jamb called a *mullion*, or the stiles may come together in pairs like a French door. The edges of the stiles may be a reverse rabbet, a beveled reverse rabbet with battens, or beveled astragals. The battens and astragals ensure better weather tightness. Figure 16-8 shows a typical casement window with a mullion.

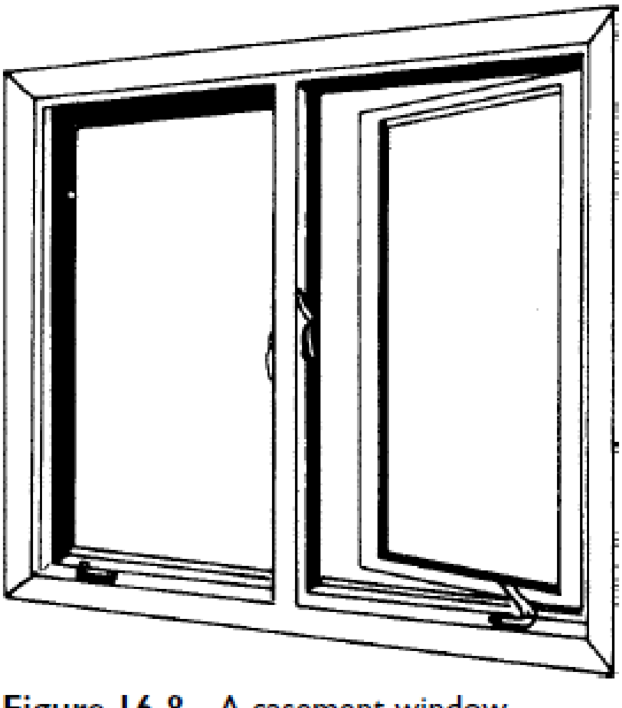


Figure 16-8 A casement window.

Types of Insulation

Following are seven generic types of insulation:

- Mineral fiber (glass, rock, and slag)
- Cellulose
- Cellular plastics
- Vermiculite

- Perlite
- Reflective insulations
- Insulating concrete

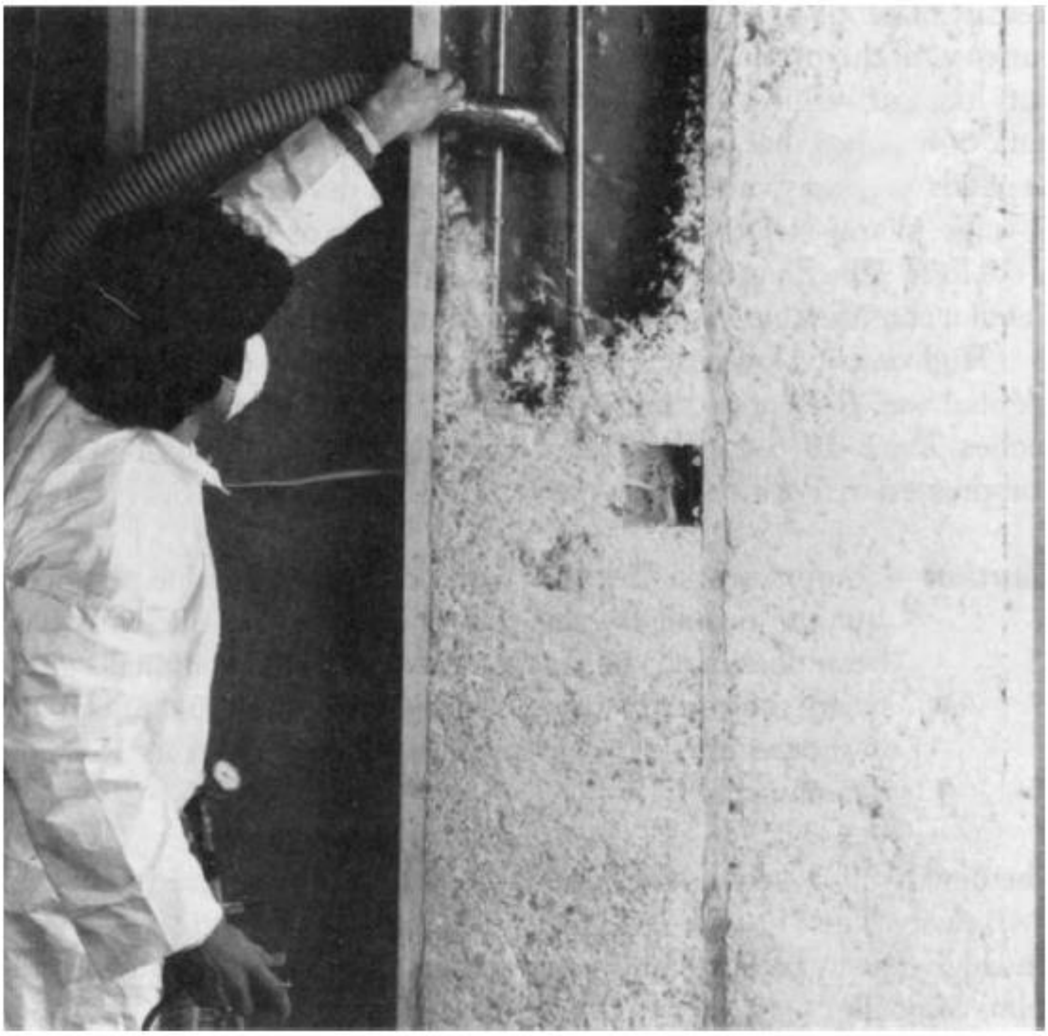


Figure 17-1 BIB Insulation being installed behind the nylon netting.
(Courtesy Ark-Seal International)

R-Value at 75° Mean Temp.	Minimum Thickness	Max. Net Coverage		Max. Gross Coverage 2 × 6 Framing on 16" center		Min. Weight per Sq Ft
To obtain insulation Resistance (*R*) of:	Installed insulation should not be less than (inches)	Min. sq ft coverage per bag	Bags per 1000 sq ft	Maximum sq ft coverage per bag	Bags per 1000 sq ft	Weight per sq ft of installed insulation should be no less than (lbs.)
Attic:						
R-40	10.8	17.22	58.08	18.08	55.31	1.80
R-38	10.3	18.13	55.17	19.08	52.40	1.71
R-32	8.6	21.52	46.46	22.89	43.69	1.44
R-30	8.1	22.96	43.56	24.52	40.79	1.35
R-24	6.5	28.70	34.85	31.18	32.08	1.08
R-19	5.1	36.25	27.59	40.00	25.00	.86
R-13	3.5	52.98	18.87	58.46	17.11	.59
R-11	3.0	62.61	15.97	69.09	14.47	.50
Sidewalls:				2 × 4 Studs on 16" Center		
R-13	3.5			33.90	29.59	1.02

Figure 17-3 Typical coverage label on a bag of cellulose insulation.

Read Chapter 17 Insulations

R Value 75° Mean Temp.	Initially Installed Thickness (Approx.)	Open Attic Minimum Thickness (Inches)	Maximum Coverage per Bag (Square Feet)			Minimum Bags per Thousand Sq Ft			Minimum Weight (lbs/sq ft) At 1.7 PCF Settled Density
			NET	2 × 6 Framing on 16" Centers	2 × 4 Framing on 24" Centers	NET	2 × 6 Framing on 16" Centers	2 × 4 Framing on 24" Centers	
R-11	4"	3.0	70.3	77.4	74.9	14.2	12.9	13.4	.427
R-13	4.75"	3.6	59.5	65.5	63.4	16.8	15.3	15.8	.505
R-19	6.75"	5.2	40.7	44.8	42.5	24.6	22.3	23.5	.737
R-22	8"	6.0	35.1	38.4	36.5	28.5	26.0	27.4	.854
R-24	8.75"	6.6	32.2	34.9	33.3	31.1	28.6	30.0	.932
R-30	10.75"	8.2	25.8	27.5	26.5	38.8	36.4	37.8	1.164
R-32	11.5"	8.8	24.2	25.7	24.8	41.4	39.0	40.4	1.242
R-38	13.5"	10.4	20.3	21.4	20.8	49.2	46.7	48.1	1.475
R-40	14.25"	11.0	19.3	20.3	19.7	51.8	49.3	50.7	1.553
R-44	15.75"	12.1	17.6	18.4	17.9	56.9	54.5	55.9	1.708
R-50	18"	13.7	15.5	16.1	15.7	64.7	62.3	63.7	1.941

Figure 17-4 New labels now being used show the initially installed thickness and the minimum settled thickness.

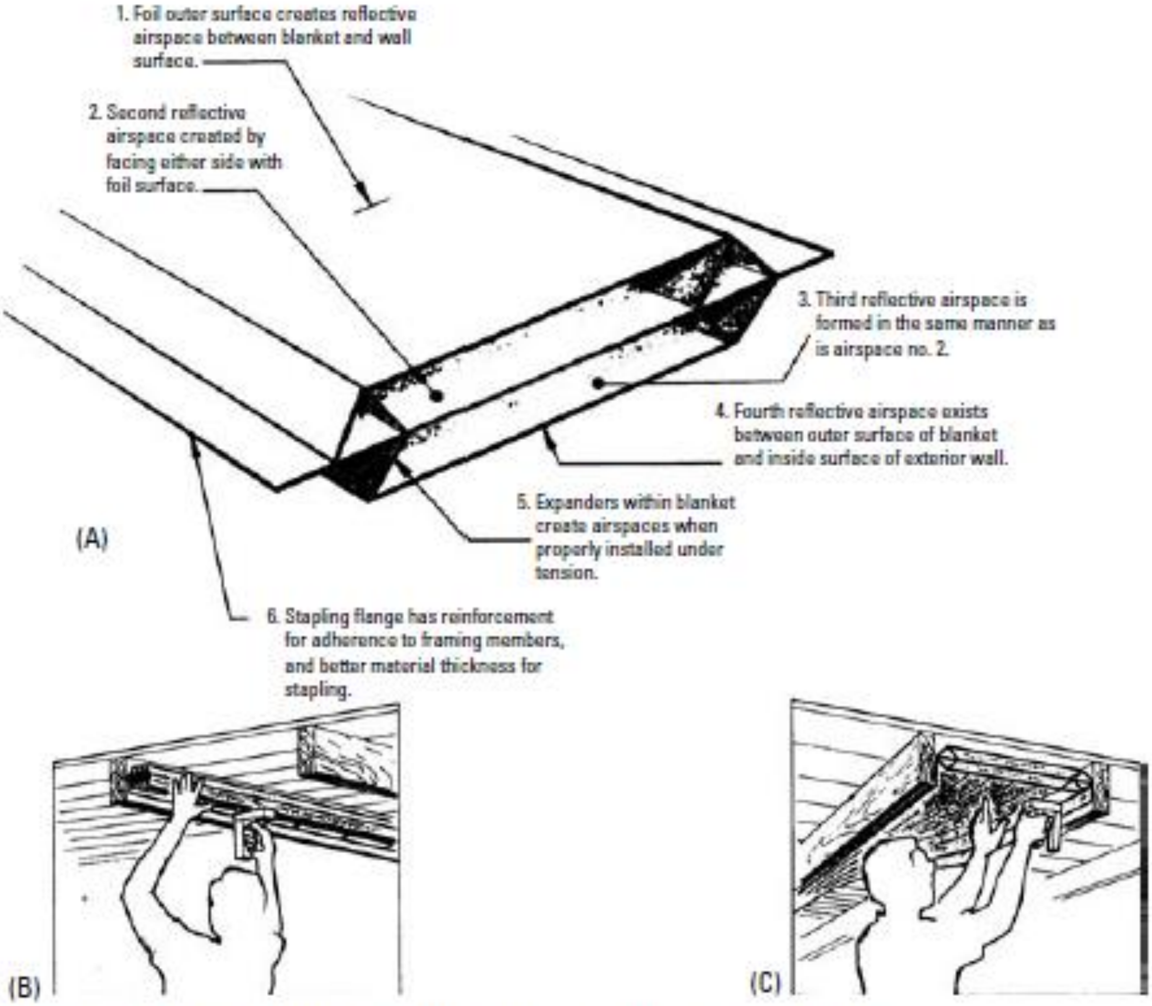


Figure 17-11 Reflective insulation and its installation.

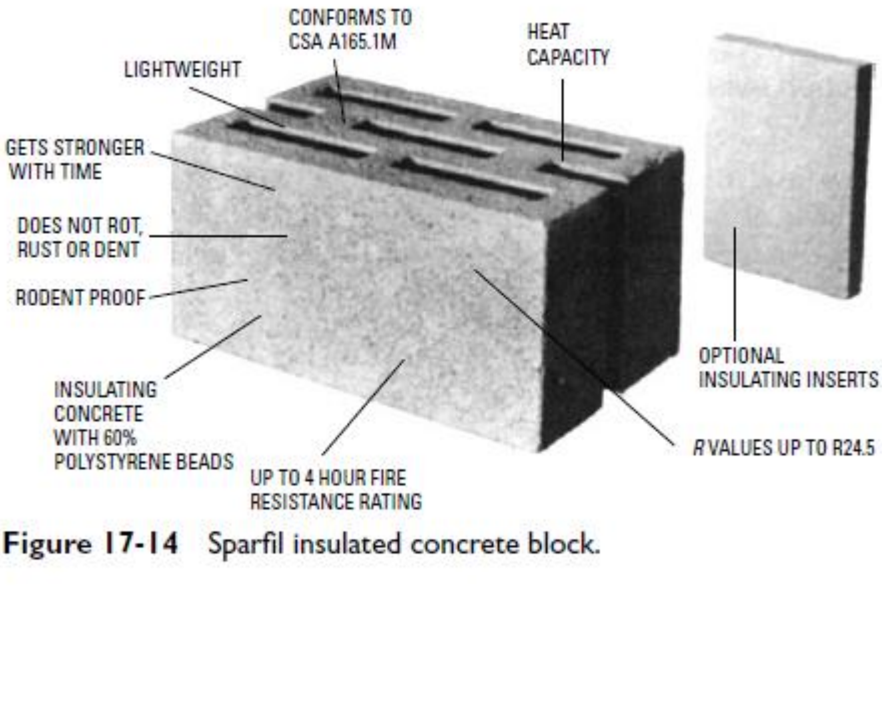


Figure 17-14 Sparfil insulated concrete block.

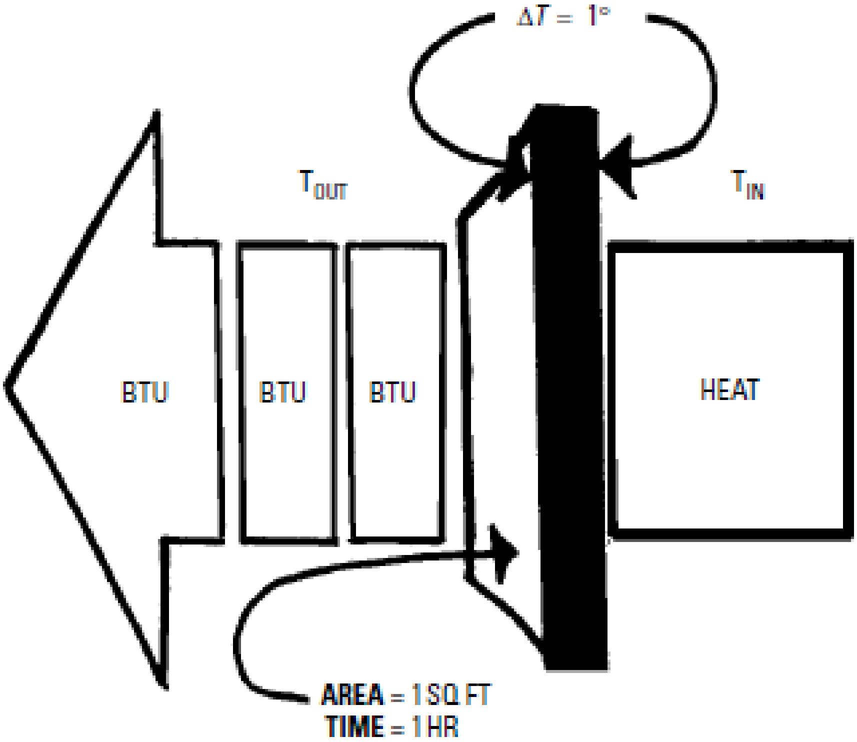


Figure 17-17 Heat flow through a material.

$$\text{Resistance}\ (R) = \frac{1}{\text{Conductivity}\ (U)}$$

$$\text{Conductivity}\ (U) = \frac{1}{\text{Resistance}\ (R)}$$

The U-factor is the thermal transmittance, a measure of how readily heat moves through a material. In looking at Figure 17-17, we can see that heat flow is a function of the area, the ΔT, and the U-factor. We can now write an equation to express this:

$$A = UA(T_i - T_o)$$

$$QA = UA\Delta T$$

Where, the following is true:

Q is the rate of heat loss in Btu/hr

U is the thermal transmittance in Btu/ft^2/h/°F

A is the surface area (ft^2)

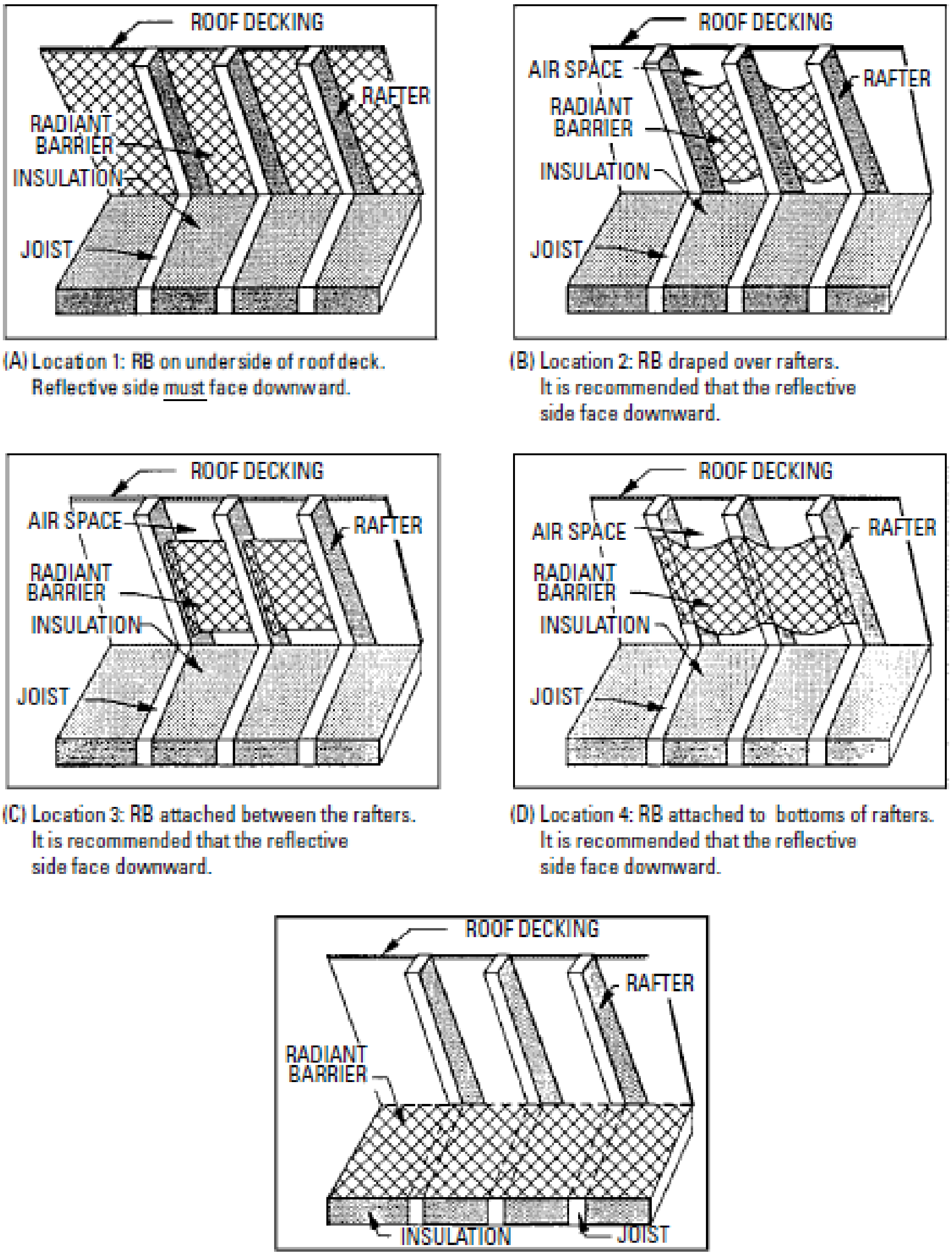
T_i and T_o are the inside and outside temperatures (°F)

If we want to calculate the heat loss through a wall using the formula $Q = UA\Delta T$, we will need the total U of the wall elements and the wall area. The total U-factor of the wall elements can be found if we know their R-values because $U = 1/R$. However, if the R-values are unknown, they can be found in the *ASHRAE Handbook of Fundamentals*. If the local library does not have a copy, try the larger HVAC contractors.

As an example, assume a wall section as shown in Table 17-2.

Table 17-2 Sample Wall Section

Item	*R-Value*
Outside air film	0.17
1/2 inch × 8 inches bevel siding	0.81
1/2 inch plywood	0.62
3 1/2 inches fiberglass	11.00
1/2-inch gypsum board	0.45
Inside air film	0.68
Total R-value	**13.73**



(A) Location 1: RB on underside of roof deck. Reflective side must face downward.

(B) Location 2: RB draped over rafters. It is recommended that the reflective side face downward.

(C) Location 3: RB attached between the rafters. It is recommended that the reflective side face downward.

(D) Location 4: RB attached to bottoms of rafters. It is recommended that the reflective side face downward.

(E) Location 5: RB on attic floor over conventional insulation. Reflective side must face upward.

Figure 17-18 Five possible locations for an attic radiant barrier (RB).

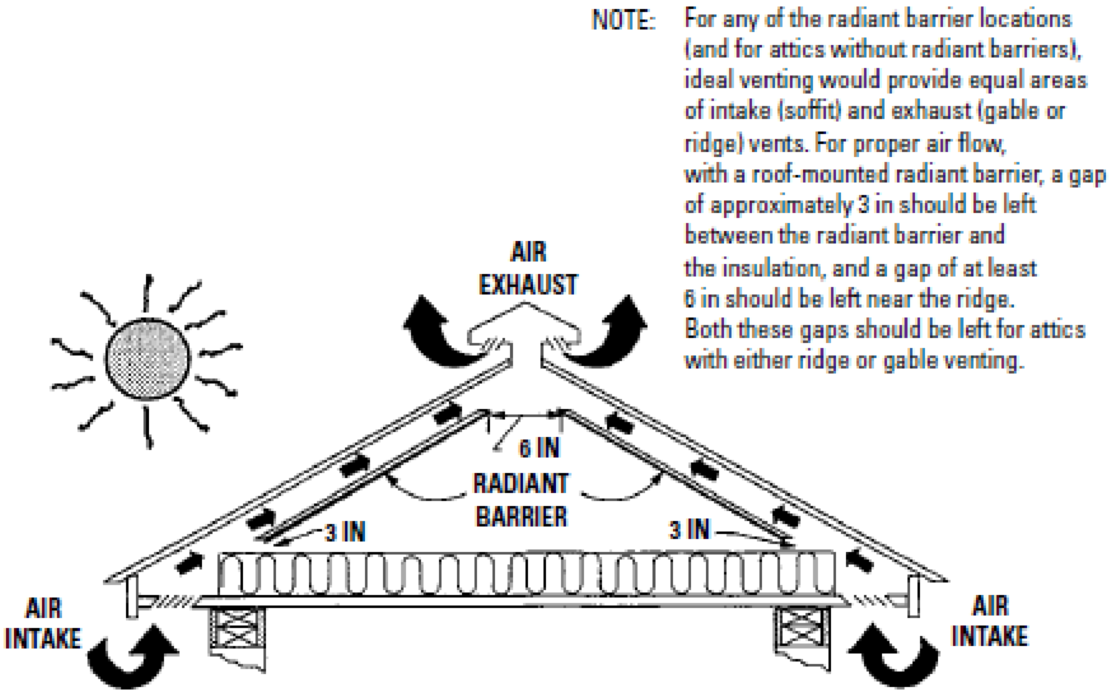


Figure 17-19 Cross-section of attic showing attic ventilation paths.

Chapter 18

Interior Walls and Ceilings

Interior walls of all modern houses use plasterboard, wallboard, or sheetrock. All three words mean the same thing. There are no more plastered walls, unless they are used in commercial buildings. However, in most instances, they, too, have a backing of wallboard of some kind to hold the plaster.

This chapter deals primarily with the various types of finished walls used in residential structures. The plasterboard or wallboard is easily applied and the joints finished by the do-it-yourselfer. Finished wallboard is also available with various coatings or coverings and strips of finished plastic molding to supply the finished touch. Standardized size also makes the wallboard or drywall much easier to handle.

Plasterboard

Plasterboard (sometimes referred to as *drywall* or *wallboard*) is available in solid sheet material. Standard width is usually 4 feet, with a few types in 2-foot widths. Lengths are from 6 to 16 feet and are available with thickness from 1/4 to 3/4 inch. Edges are tapered to permit smooth edge finishing, although some boards can be purchased with square edges.

The most common length is 8 feet to permit wasteless mountings to the wall studs. This particular size will fit standard 8-foot ceiling heights when vertically mounted. However, recommended mounting for easier handling is horizontal. Two lengths (one above the other) fit the 8-foot ceiling heights when mounted horizontally. In addition to regular wallboard, many other types are available for special purposes.

Regular wallboard comes in thickness of 1/4, 3/8, 1/2, and 5/8 inch. The 1/4-inch board is used in two- or three-layer wallboard construction and generally has square edges. The most commonly used thickness is 3/8 inch, which can be obtained in lengths up to 16 feet. All have a smooth cream-colored paper covering that takes any kind of decoration.

Insulating Wallboards

Insulating (foil-backed) wallboards have aluminum foil that is laminated to the back surface. The aluminum foil creates a vapor barrier and provides reflected insulation value. It can be used in a single-layer construction or as a base layer in two-layer construction. Thicknesses are 3/8, 1/2, and 5/8 inch, with lengths from 6 to

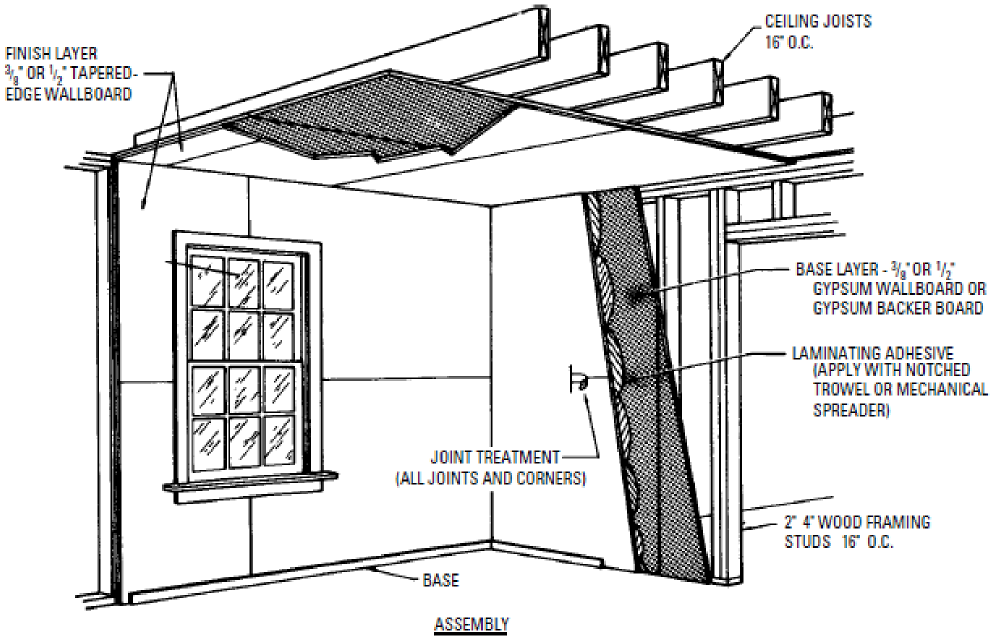


Figure 18-7 A cross-section view of double-layer wall construction, details for handling corners, and special wall construction for sound deadening. *(Courtesy National Gypsum Co.)*

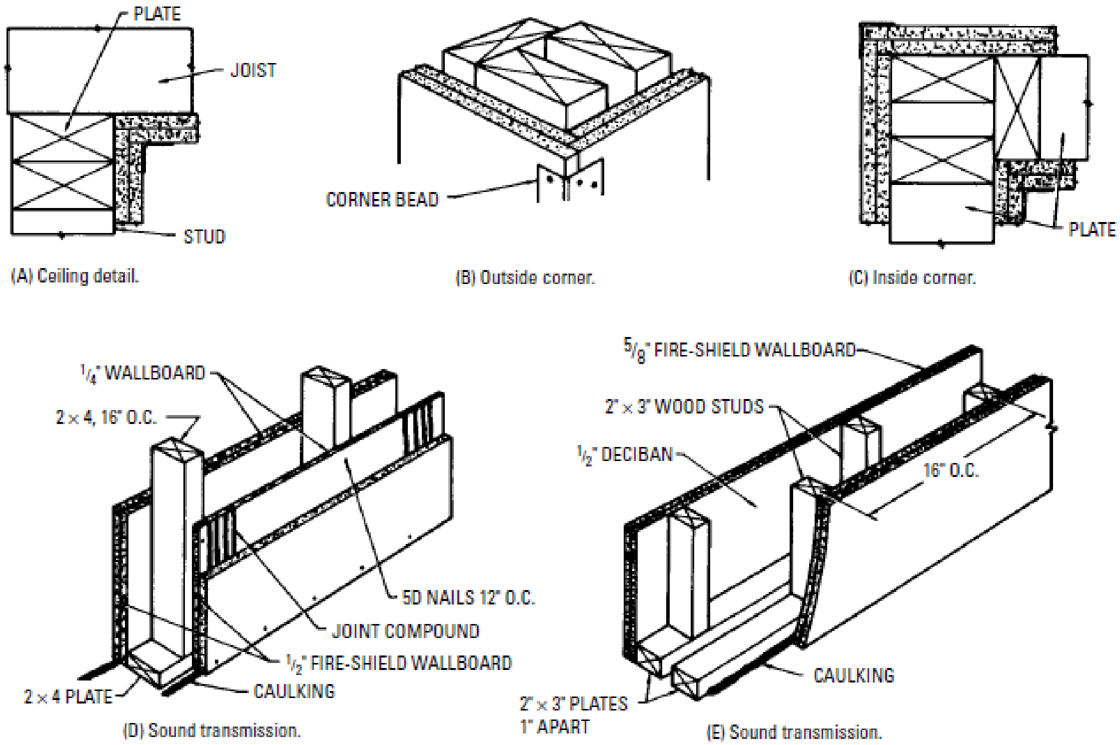


Figure 18-7 *(continued.)*

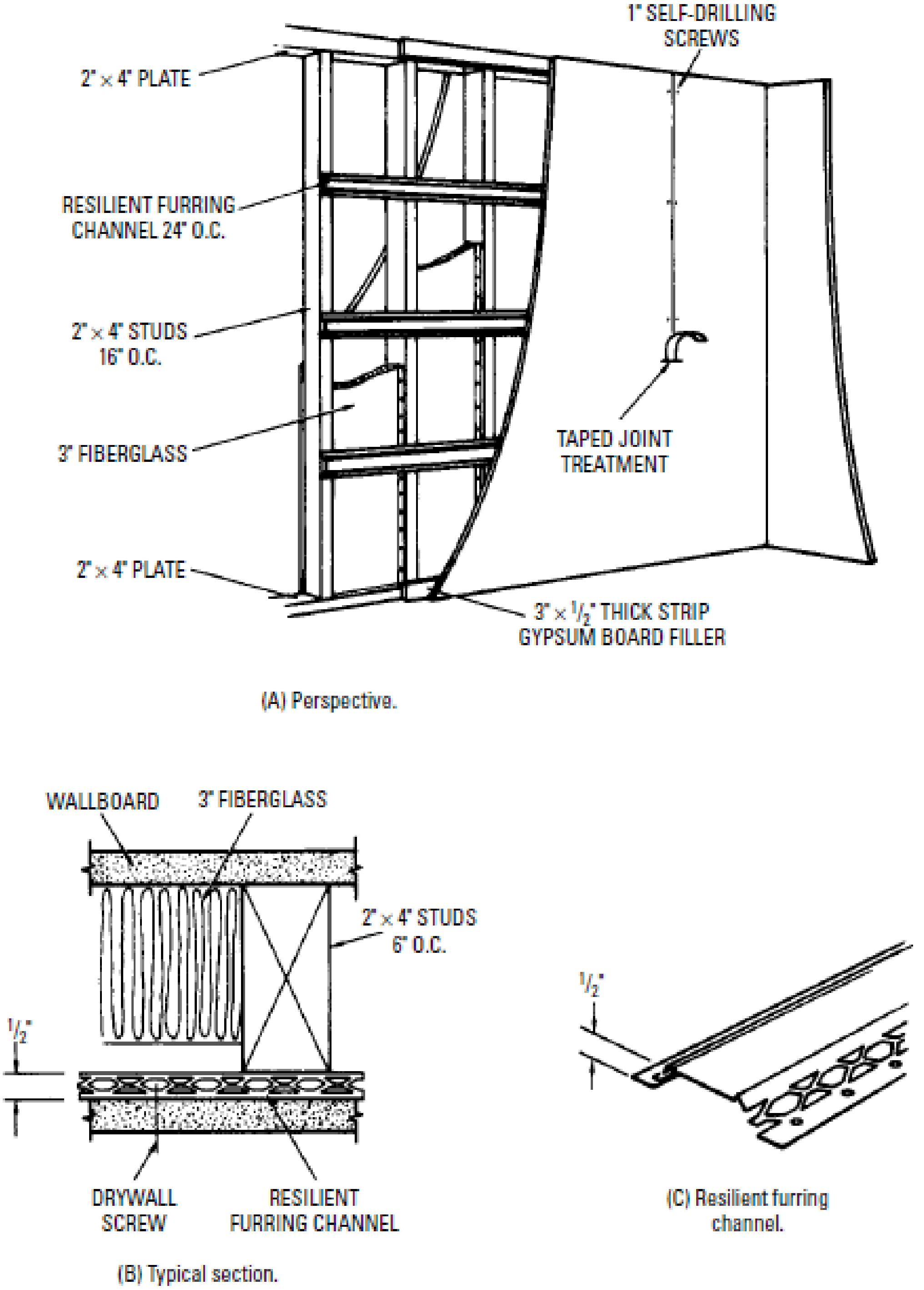


Figure 18-8 Resilient furring strips, with expanded edges, may be installed to isolate the plasterboard from the stud. *(Courtesy National Gypsum Co.)*

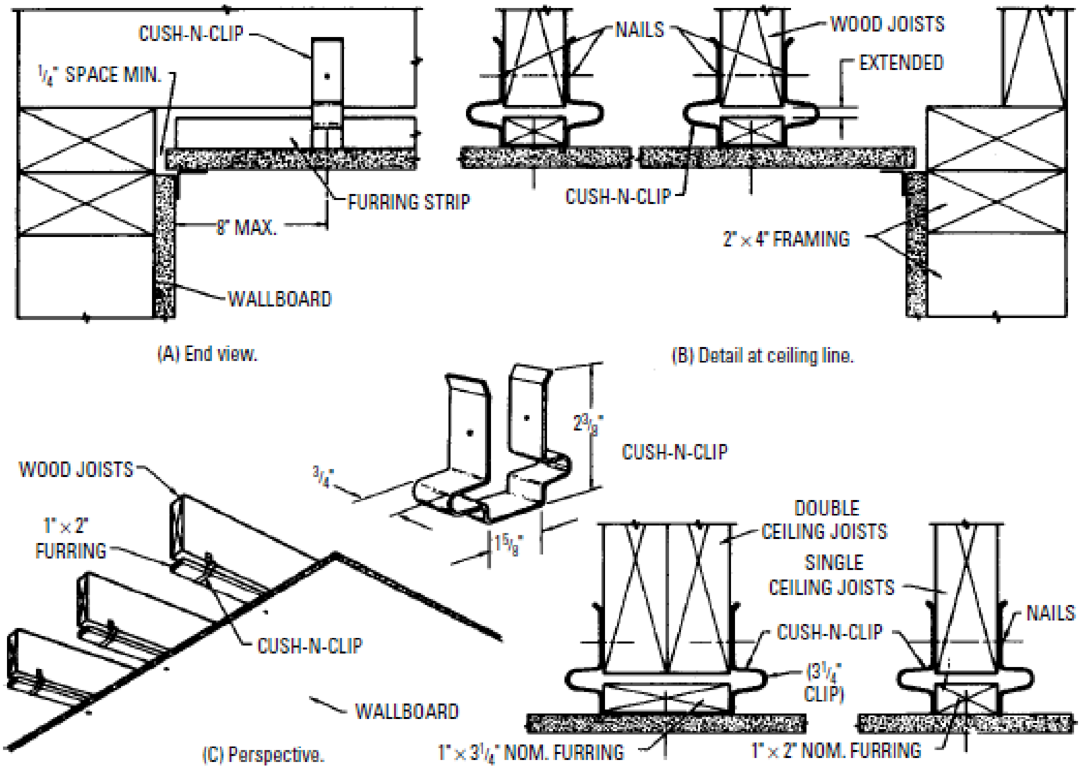


Figure 18-9 Details for installing spring clips to ceiling joist. Clips suspend plasterboard from the stud. *(Courtesy National Gypsum Co.)*

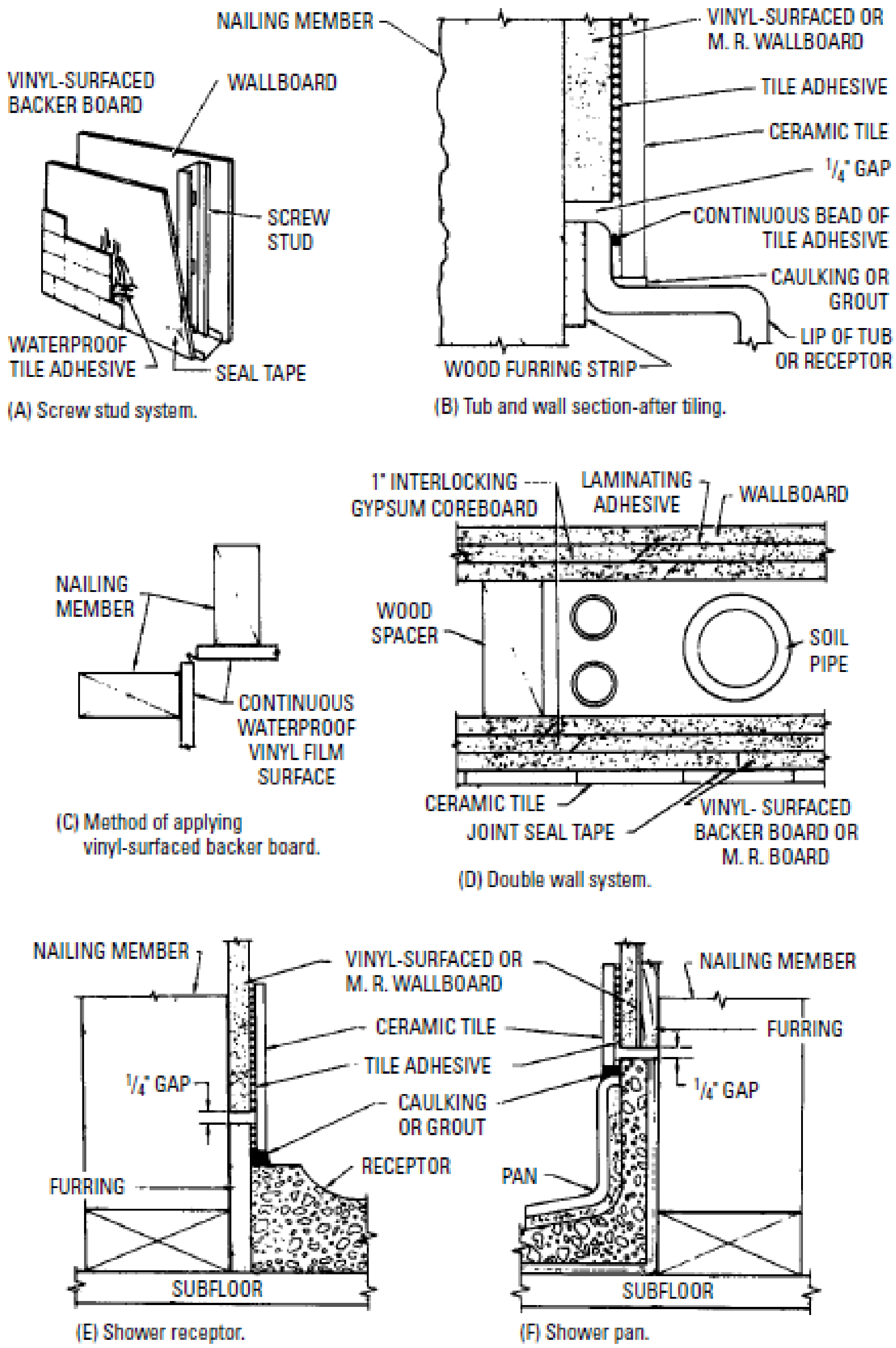
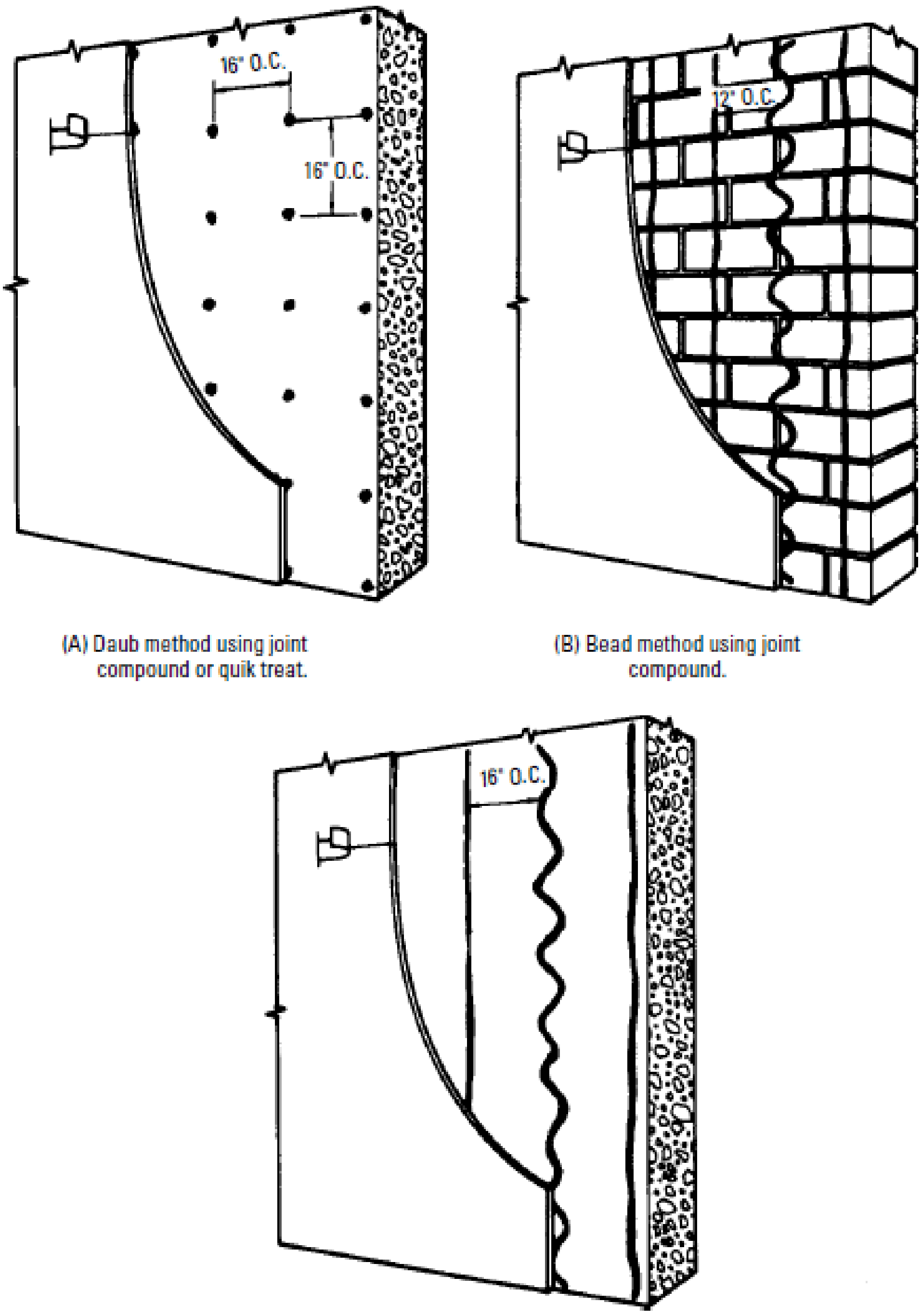


Figure 18-10 Details for installing vinyl-locked and moisture-resistant wallboard for bath and shower use.



(A) Daub method using joint compound or quik treat.

(B) Bead method using joint compound.

(C) Bead method using MC adhesive or black adhesive.

Figure 18-11 Method of applying adhesive directly to masonry walls.

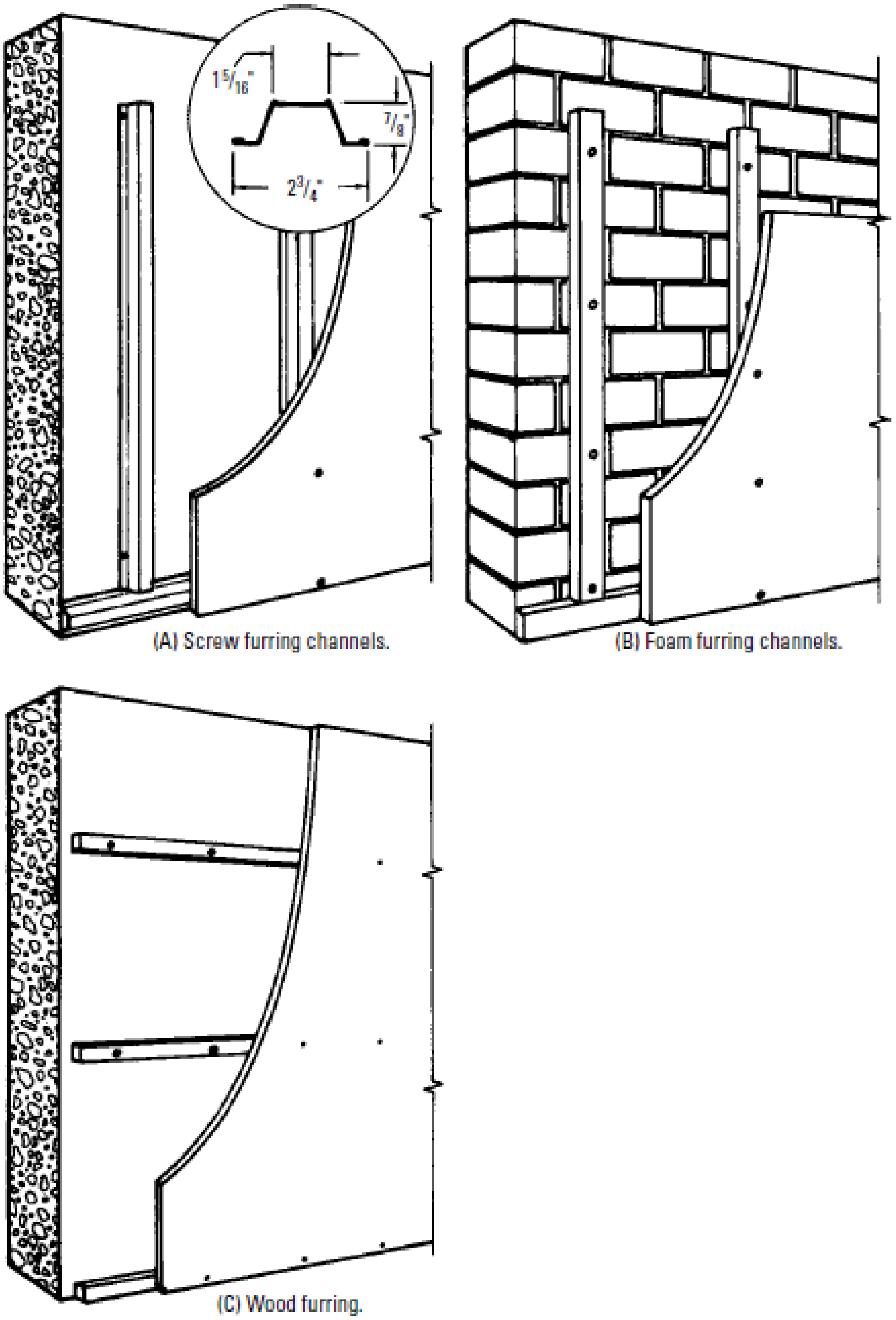
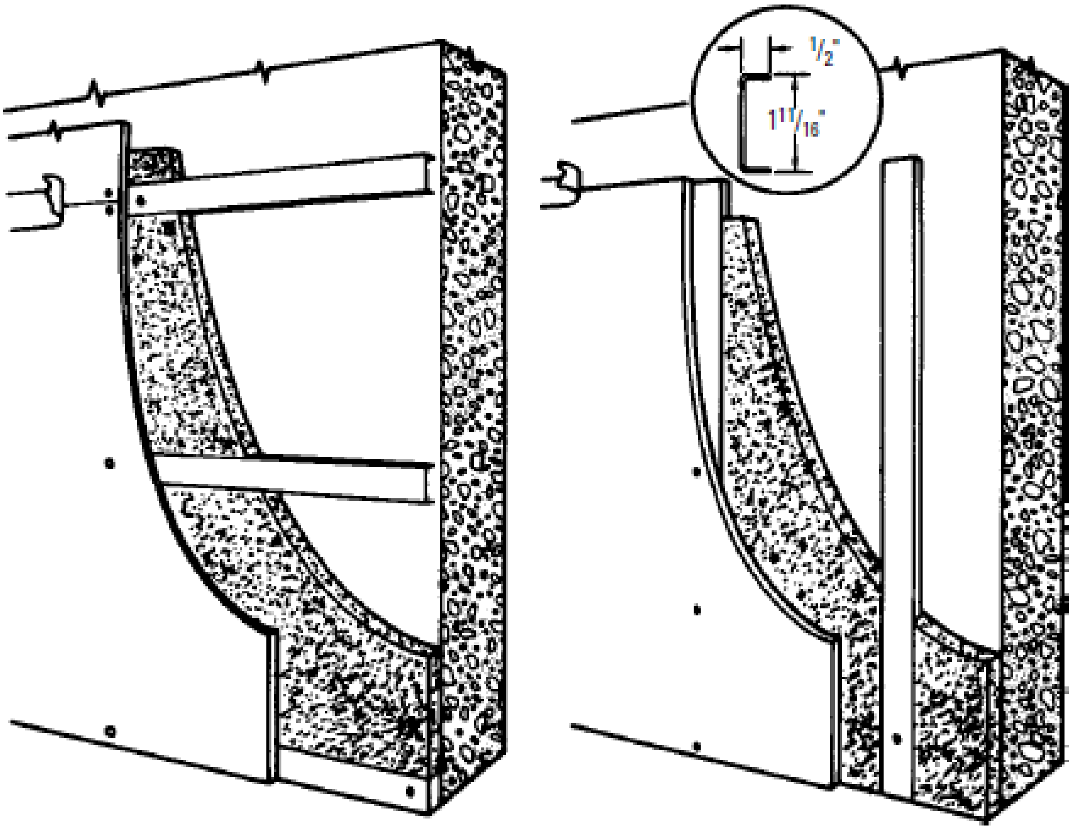


Figure 18-12 Three types of furring strips used between masonry walls and plasterboard.

(Courtesy National Gypsum Co.)



(A) Foam furring channels horizontally.

(B) Foam furring channels vertically.

Figure 18-13 U-shaped furring channels installed horizontally or vertically over foam insulating material.

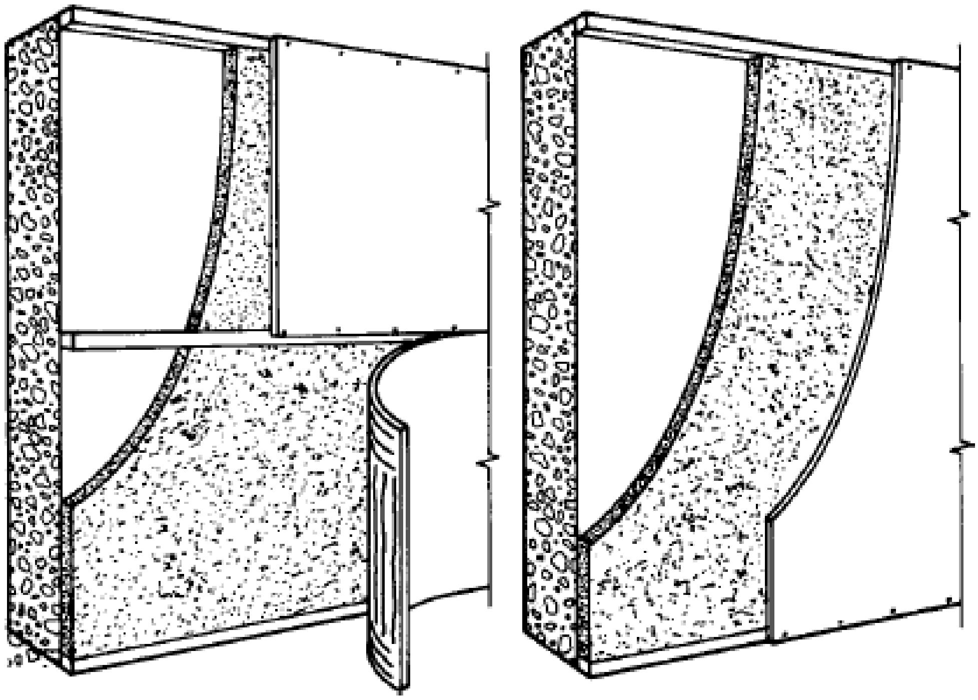
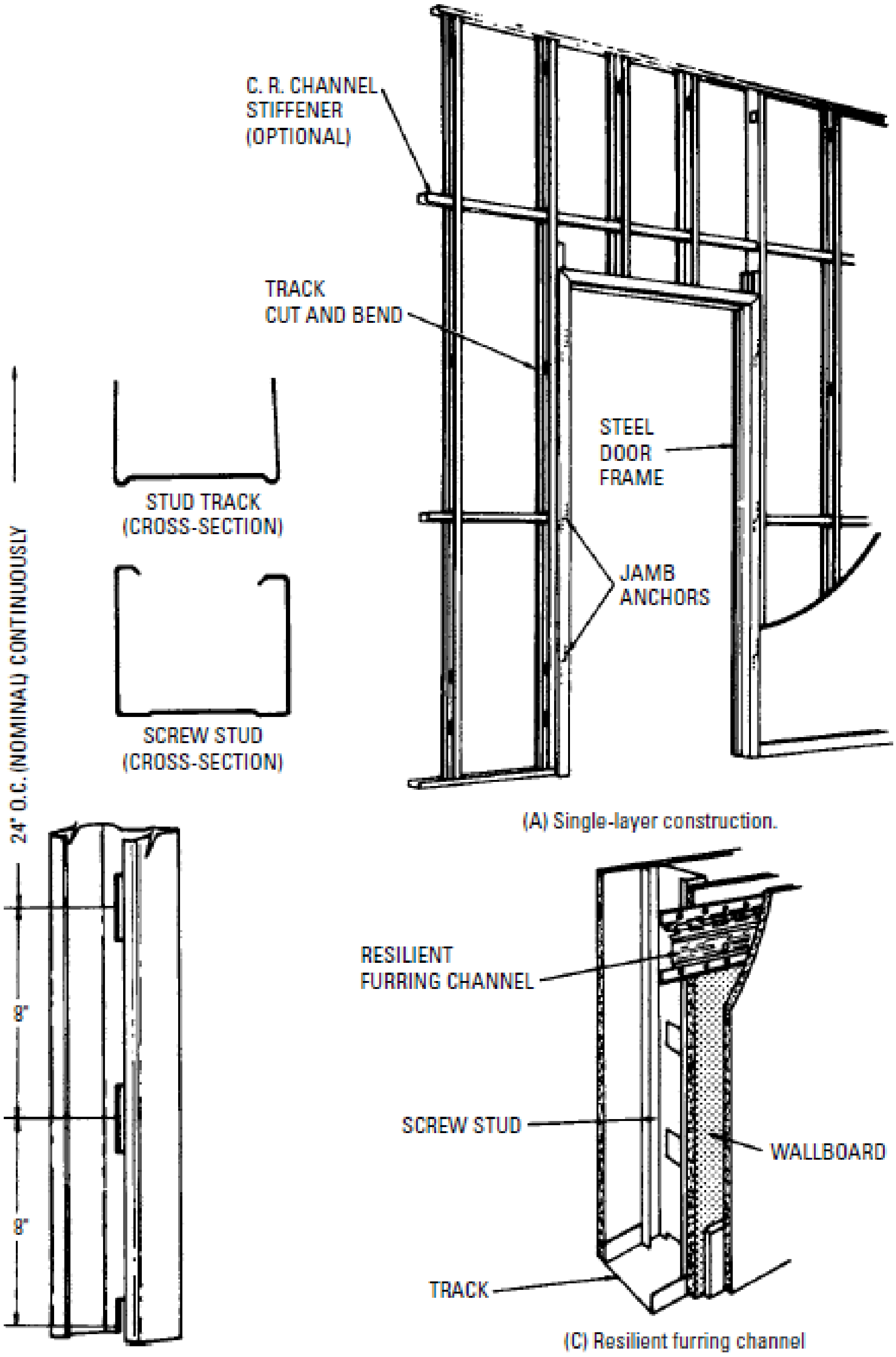


Figure 18-15 Plasterboard may be installed against foam insulation with adhesive.

(Courtesy National Gypsum Co.)



(A) Single-layer construction.

(B) Screw stud.

(C) Resilient furring channel with gypsum wallboard.

Figure 18-16 Details of metal wall construction using metal studs and tracks.

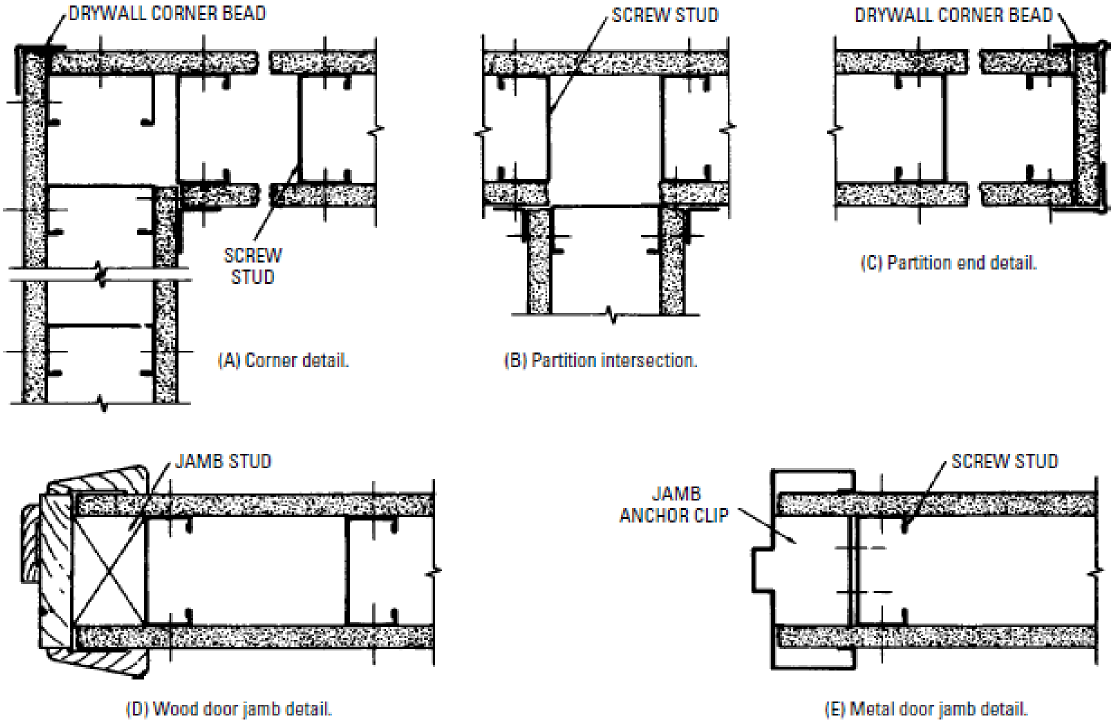
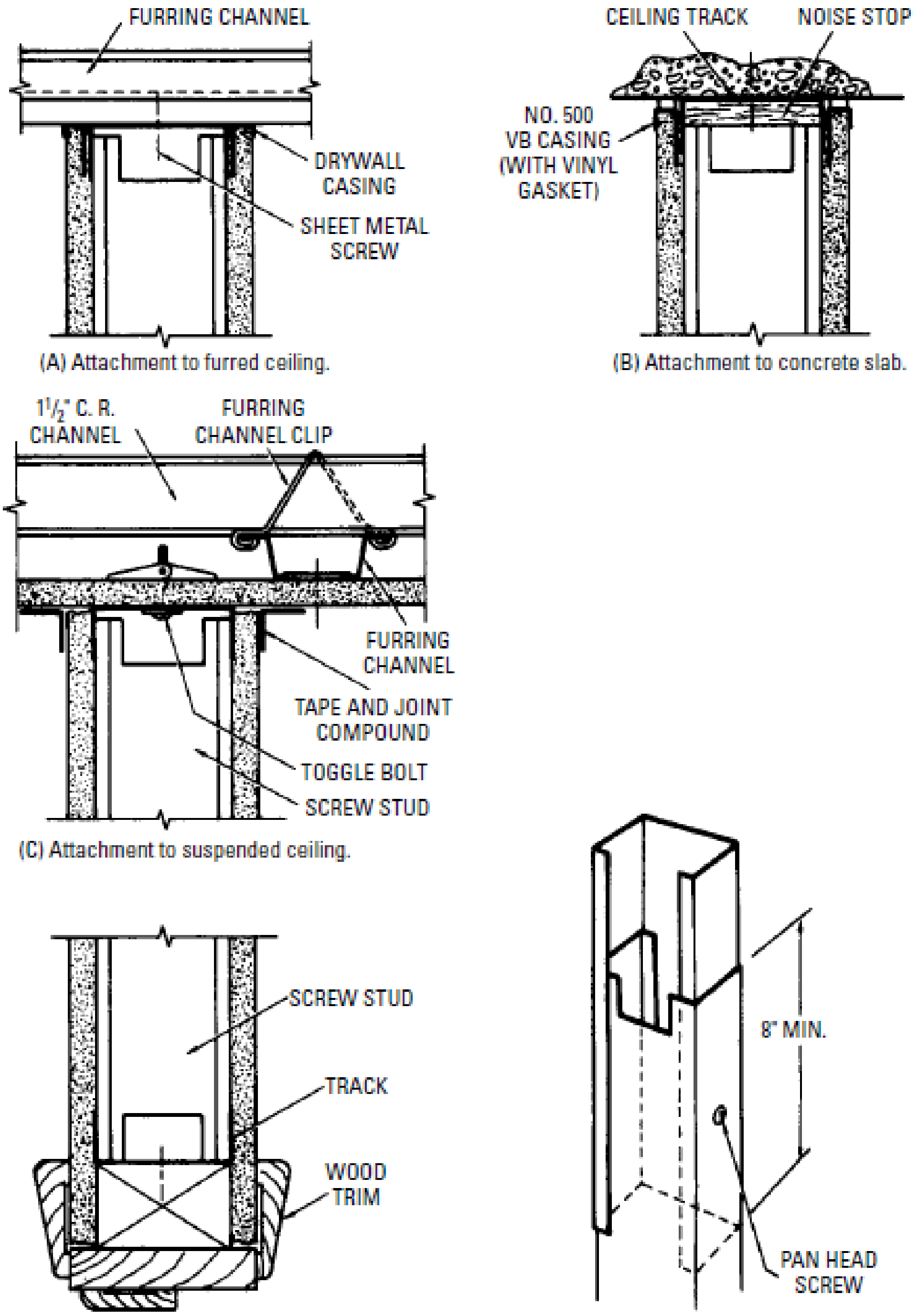


Figure 18-17 Details for intersections and jambs using metal wall construction.

(Courtesy National Gypsum Co.)



(A) Attachment to furred ceiling.

(B) Attachment to concrete slab.

(C) Attachment to suspended ceiling.

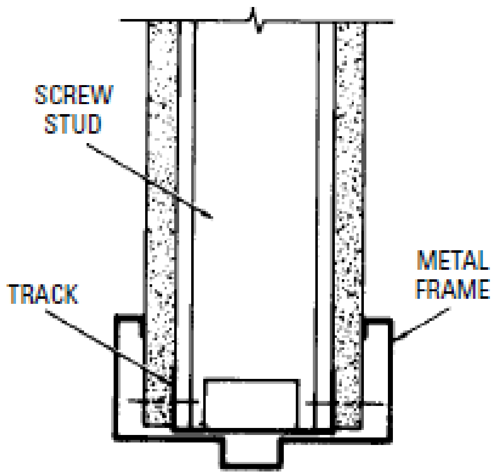
(D) Door head detail-wood.

(E) Stud splice.

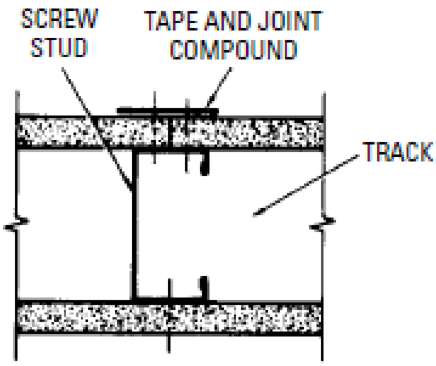
Figure 18-18 How to handle ceiling and base finishing.

(Courtesy National Gypsum Co.)

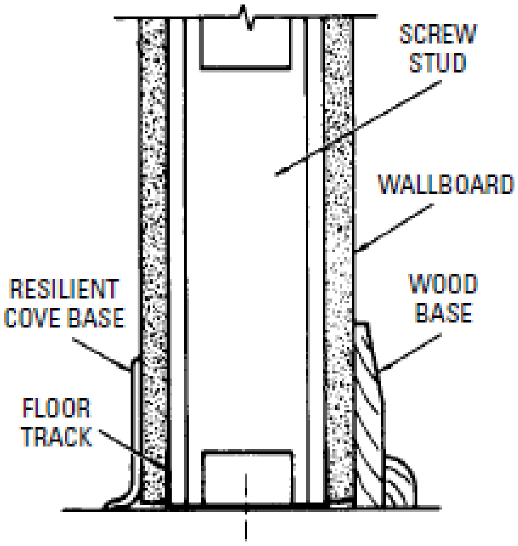
(*continued*)



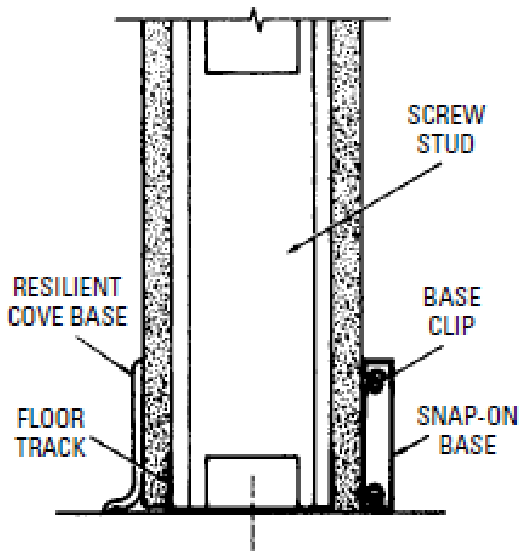
(A) Door head detail—metal.



(B) Butt joint detail.



(C) Base detail.



(D) Base detail.

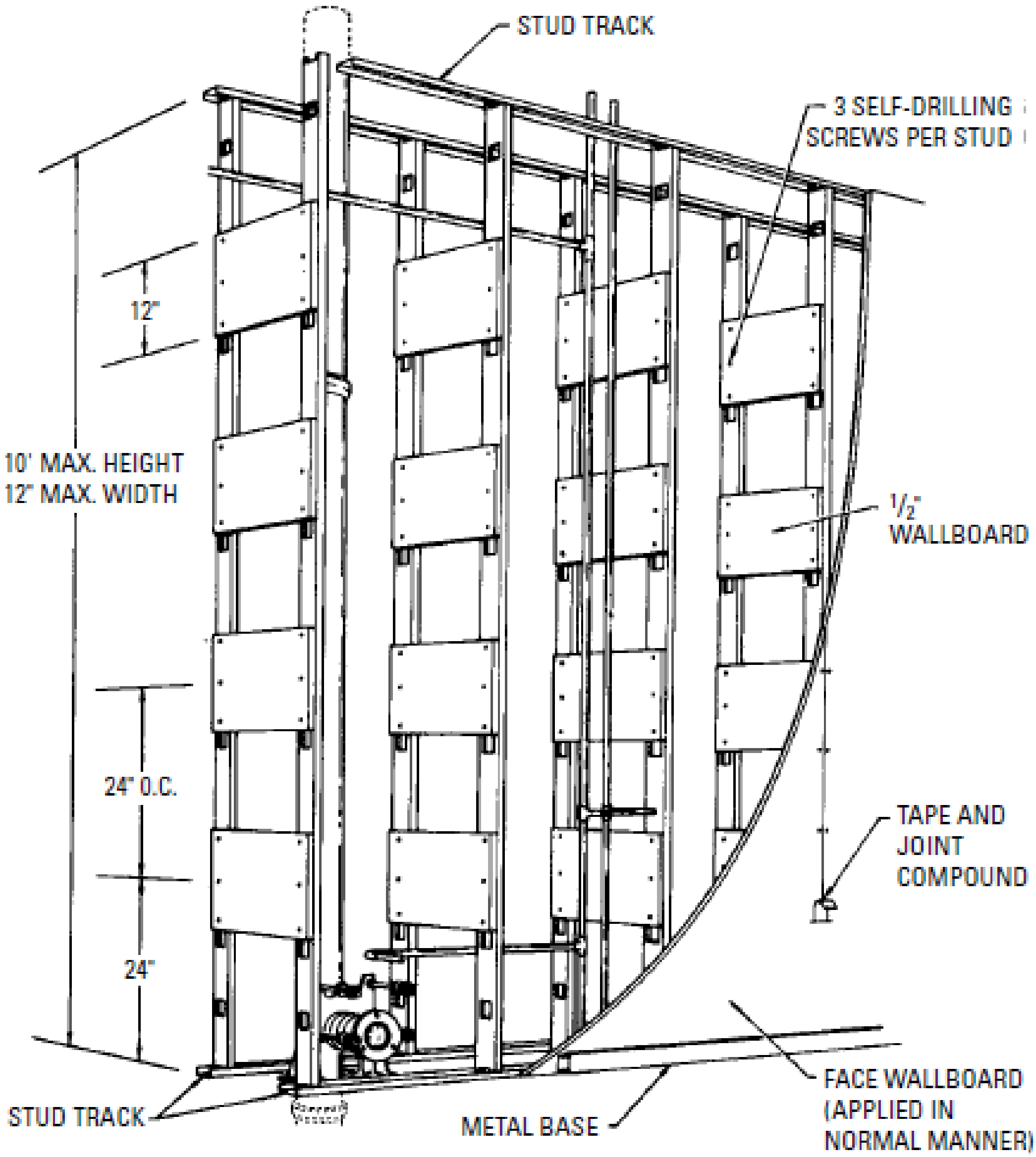
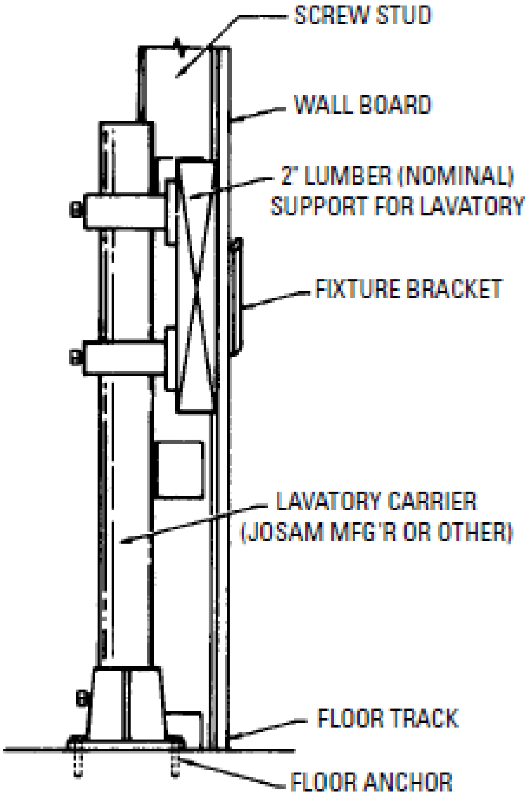
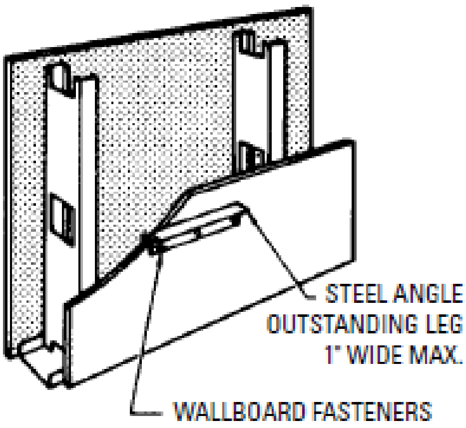


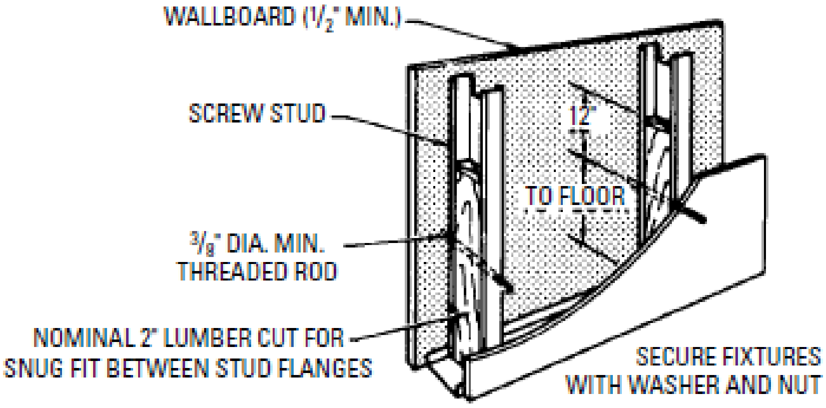
Figure 18-19 Deep-wall construction where space is needed for reasons such as plumbing and heating pipes.



(A) Lavatory support.

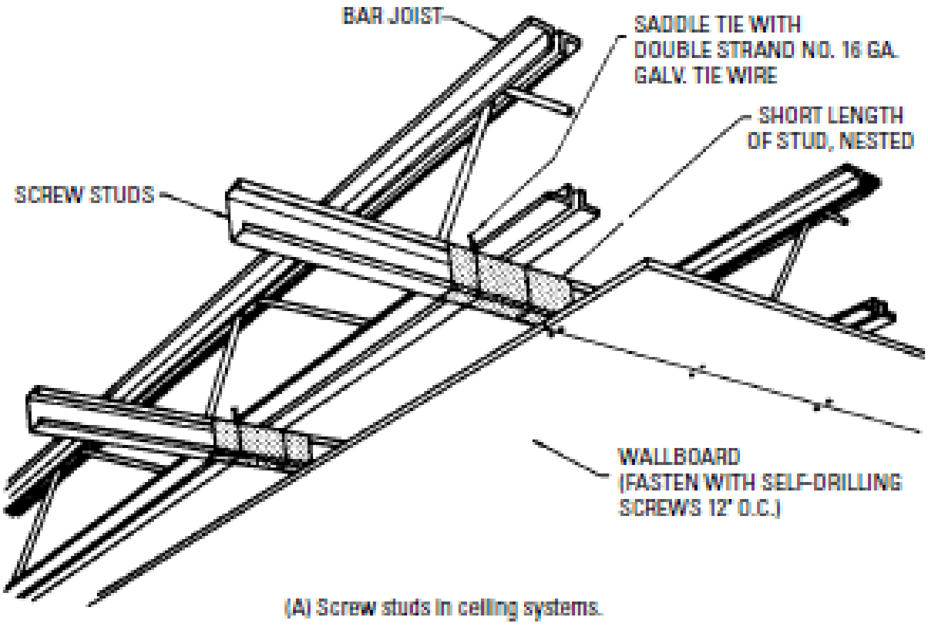


(B) Flush-to-wall attachments.

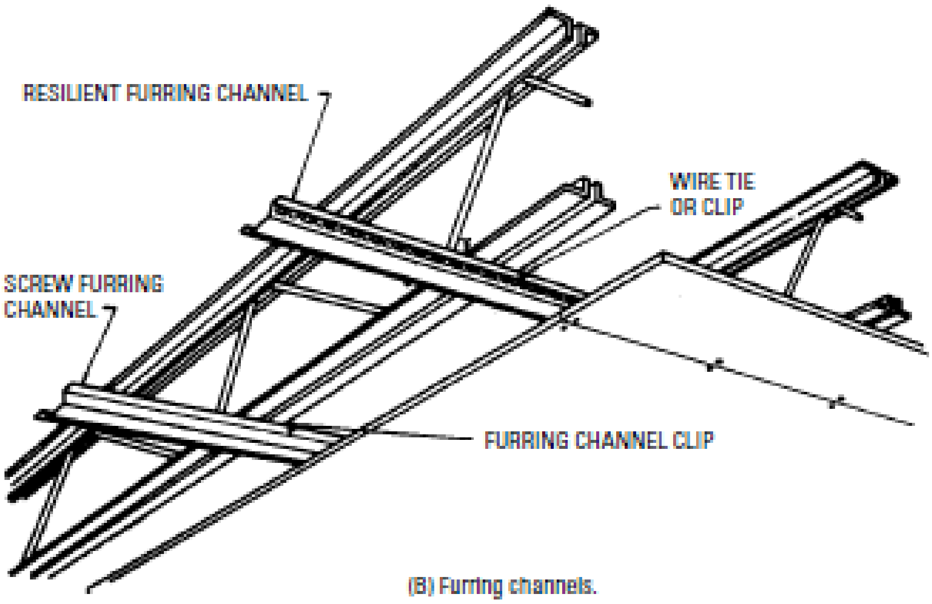


(C) For wall-hung furniture
(both sides of partition).
ALLOWABLE 60 FT LBS PER FASTENER—(2' 0" O.C. STUD SPACING)

Figure 18-19 (*continued*)



(A) Screw studs in ceiling systems.



(B) Furring channels.

Figure 18-22 Complete details showing two methods of mounting wallboard to suspended ceiling structures. *(Courtesy National Gypsum Co.)*

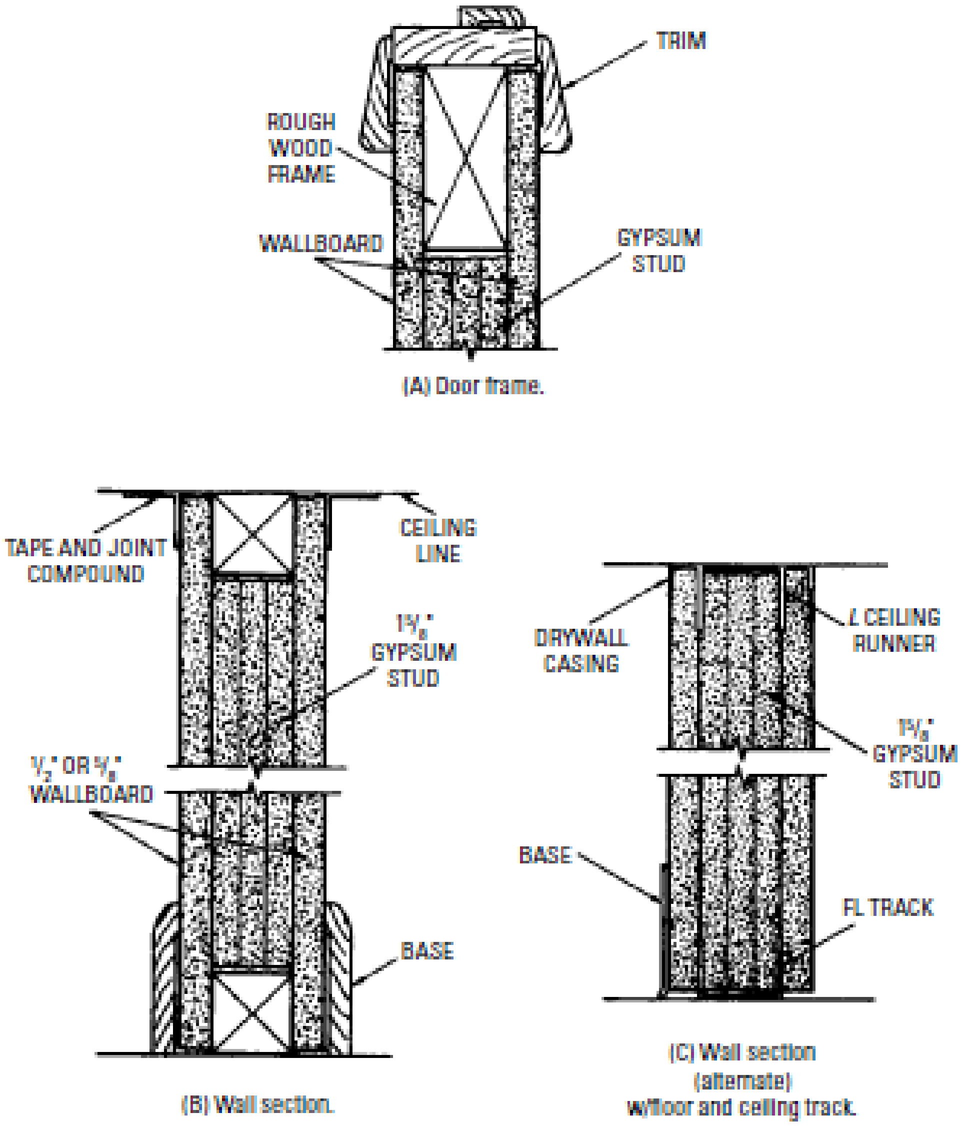


Figure 18-23 Cross-sectional view of a semisolid all-plasterboard wall. *(Courtesy National Gypsum Co.)*

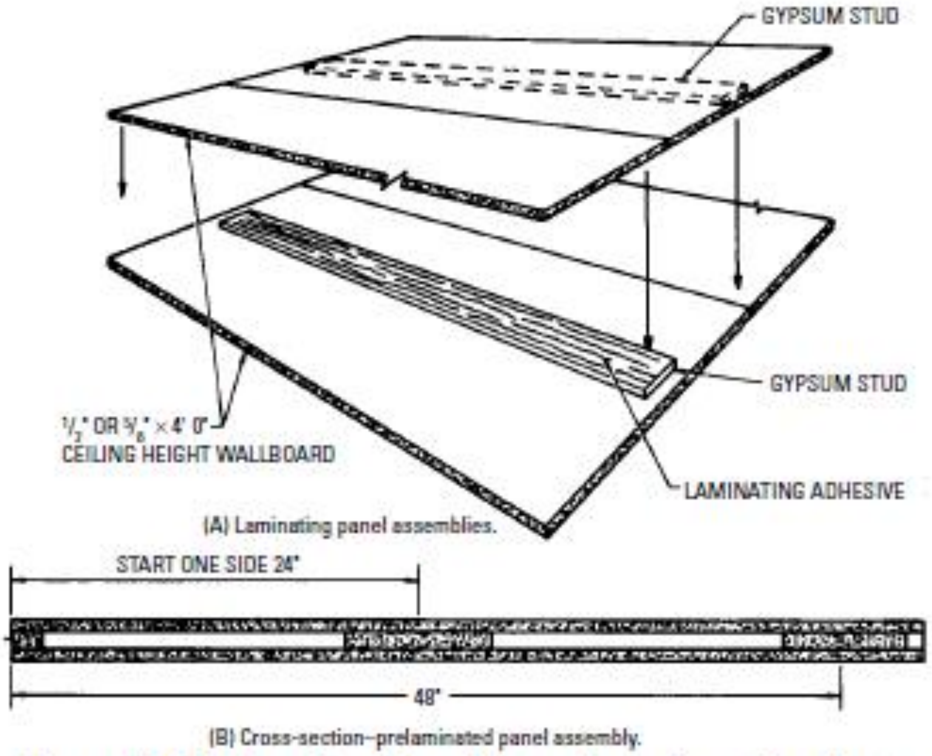


Figure 18-24 Plasterboards are laminated together with wide pieces of plasterboard acting as wall studs. *(Courtesy National Gypsum Co.)*

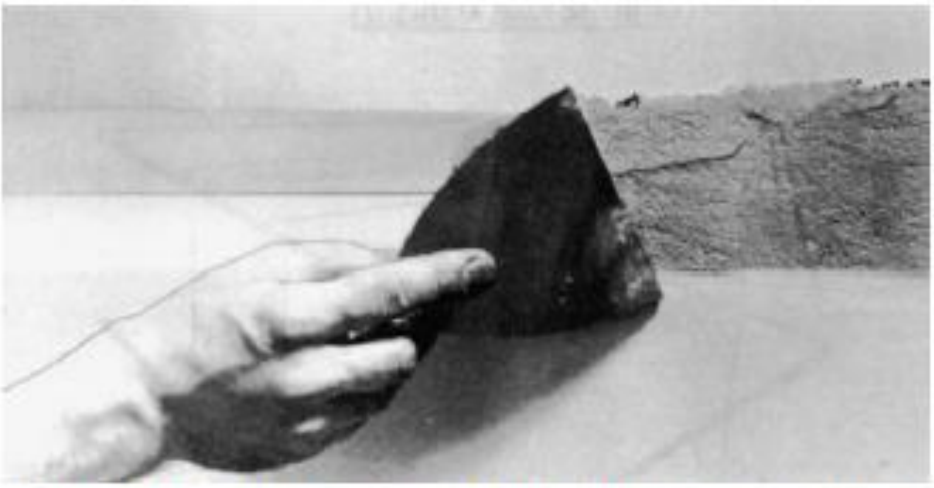


Figure 18-25 The first step in finishing joints between plasterboard. *(Courtesy National Gypsum Co.)*

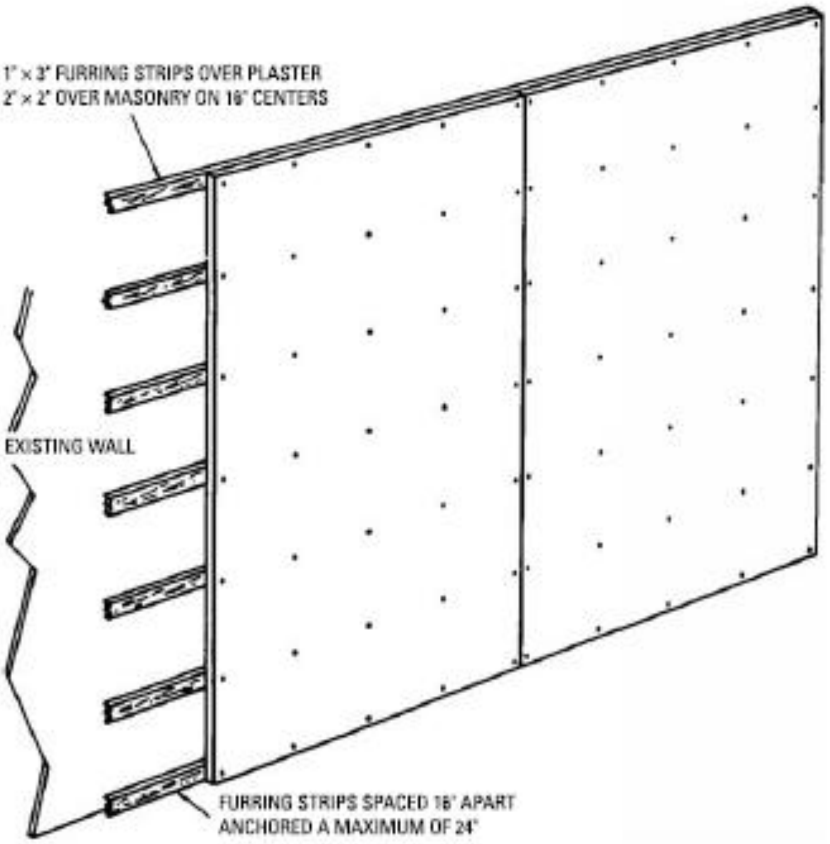


Figure 18-42 Wood furring strips installed over solid masonry or old existing walls. *(Courtesy National Gypsum Co.)*

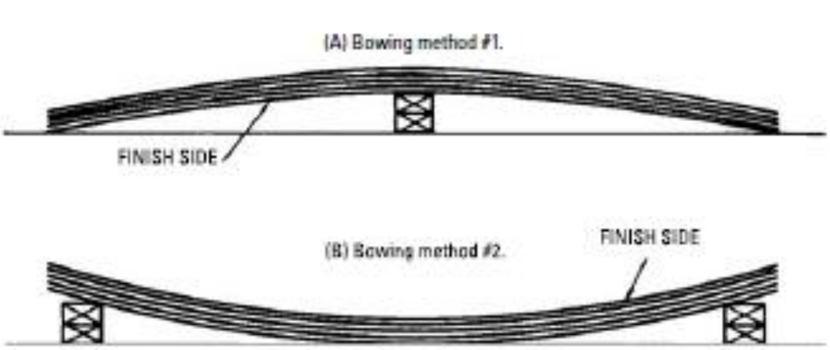


Figure 18-43 Bowing wallboard for the adhesive method of installation. *(Courtesy National Gypsum Co.)*

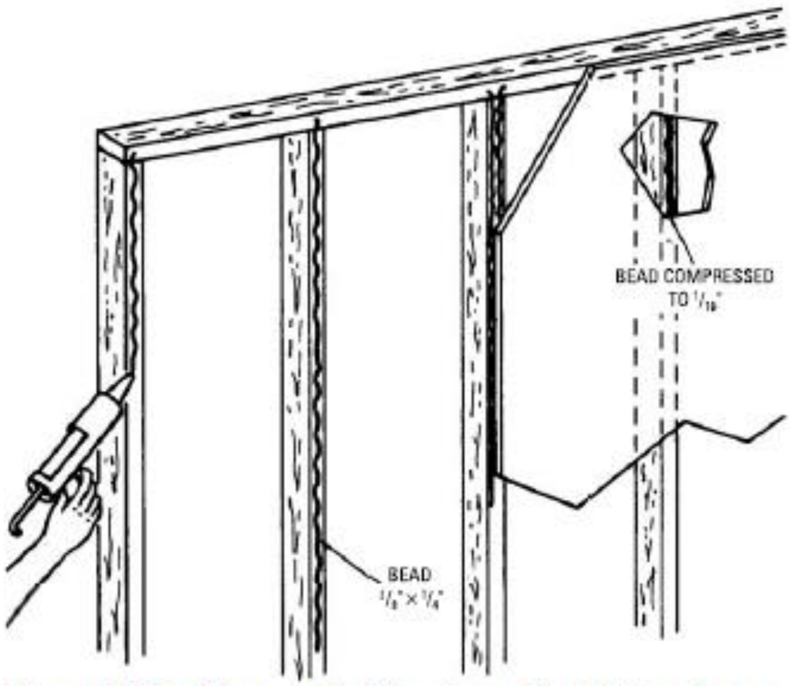


Figure 18-44 Adhesive applied directly to wall studs. The adhesive is applied in a wavy line the full length of the stud. *(Courtesy National Gypsum Co.)*

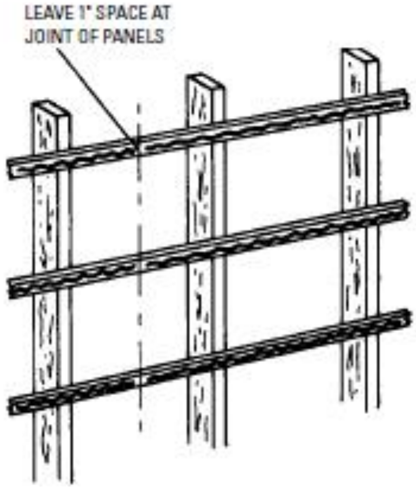


Figure 18-45 Adhesive applied directly to wood furring strips. *(Courtesy National Gypsum Co.)*

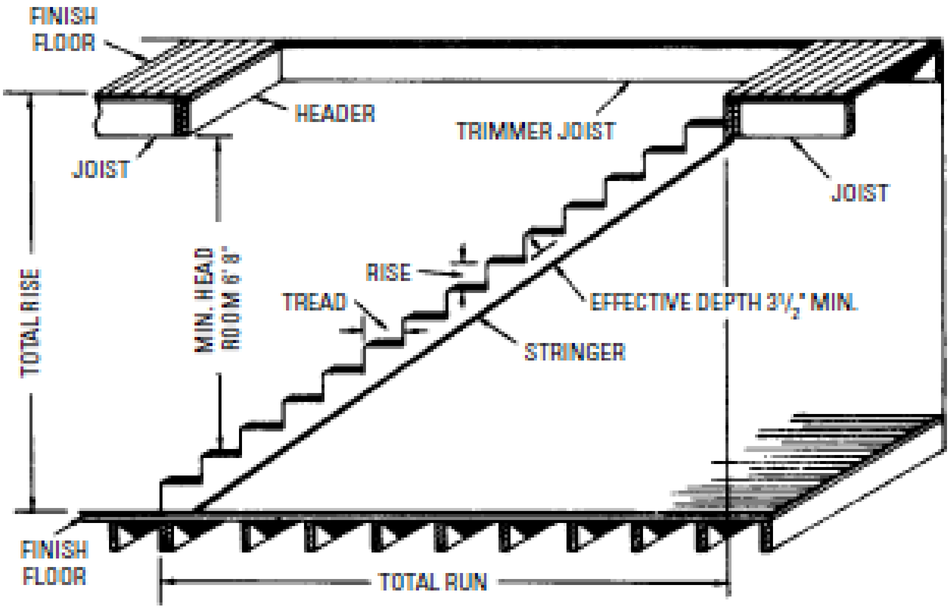


Figure 19-1 Stairway design.

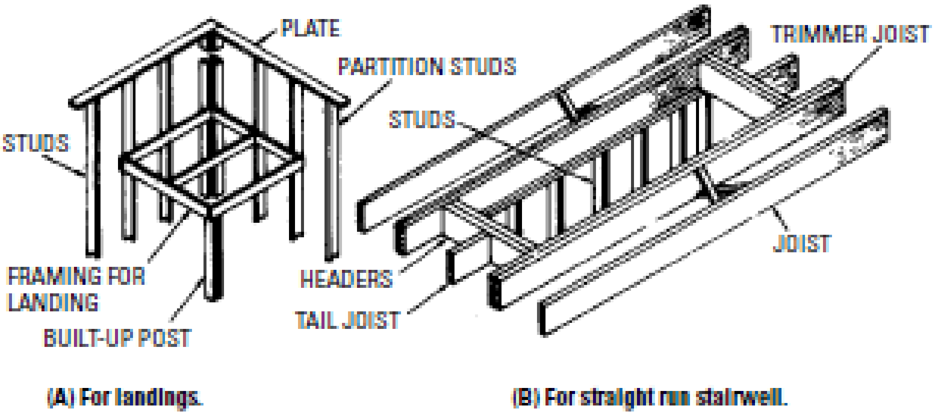


Figure 19-2 Framing of stairways.

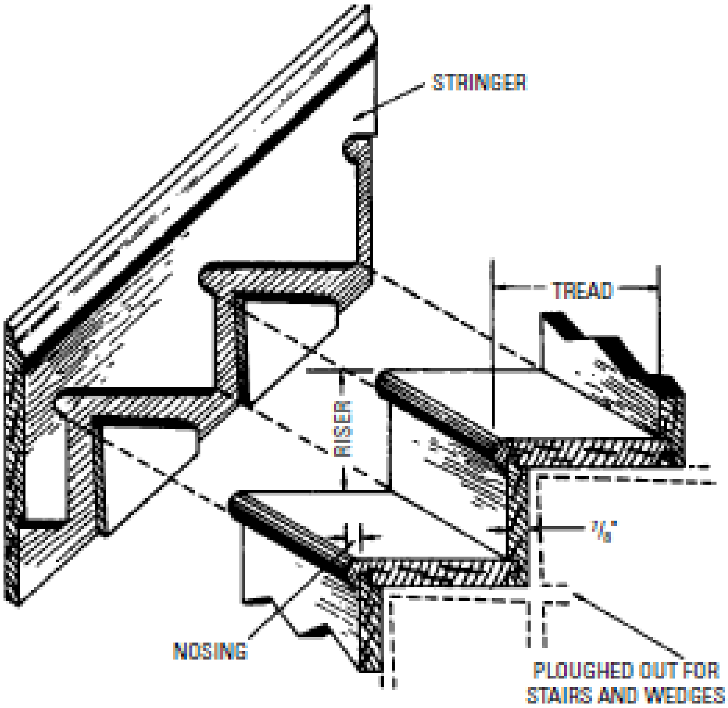


Figure 19-3 The housing in the stringer board for the tread and riser.

and risers are to be nailed to the carriages.

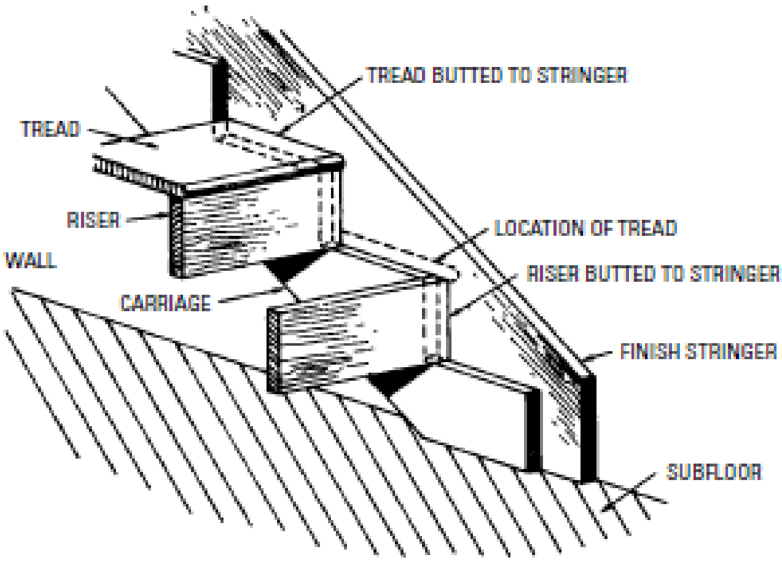
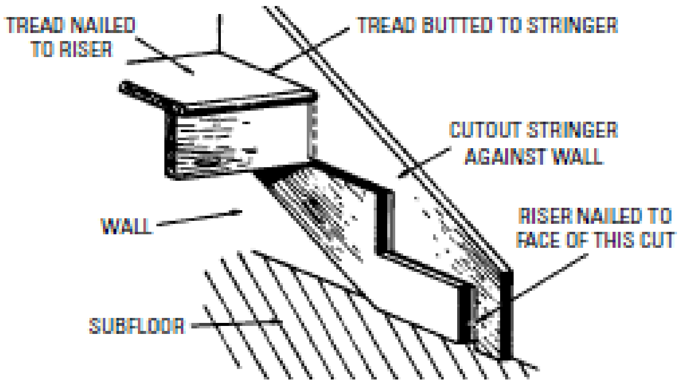


Figure 19-4 Finished wall stringer and carriage.

Another method of fitting the treads and risers to the wall stringers is shown in Figure 19-5A. The stringers are laid out with the same rise and run as the stair carriages, but they are cut out in reverse. The risers are butted and nailed to the riser cuts of the wall stringers, and the assembled stringers and risers are laid over the carriage. Sometimes the treads are allowed to run underneath the



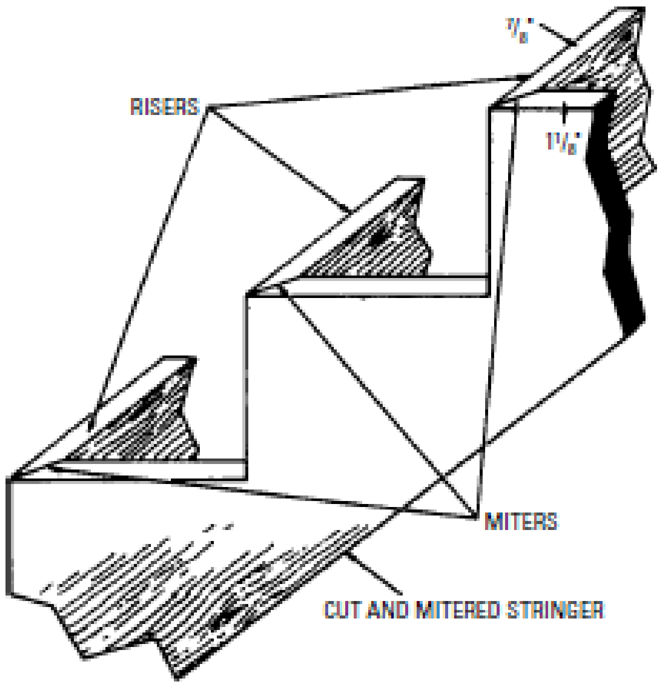


Figure 19-6 Cut and mitered stringer.

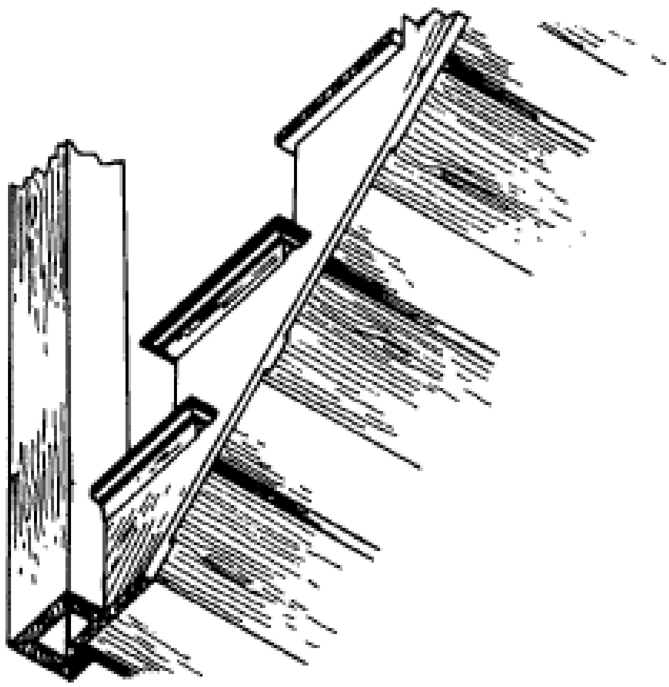


Figure 19-7 Use of molding on the edge of treads.

Basement Stairs

Basement stairs may be built either with or without riser boards. Cutout stringers are probably the most widely used support for the treads, but the tread may be fastened to the stringers by cleats, as shown in Figure 19-8. Figure 19-9 shows two methods of terminating basement stairs at the floor line.

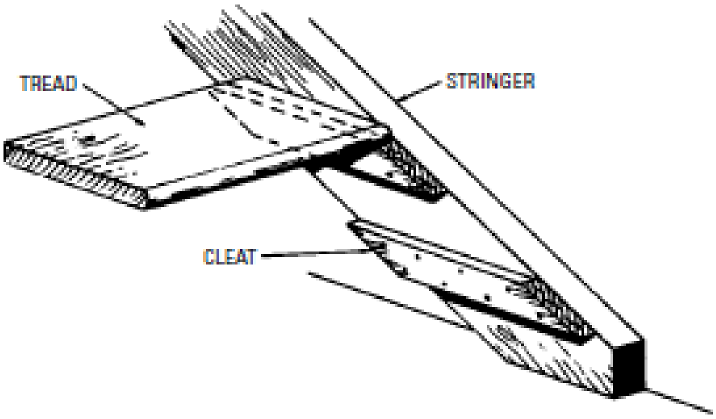


Figure 19-8 Cleat stringer used in basement stairs.

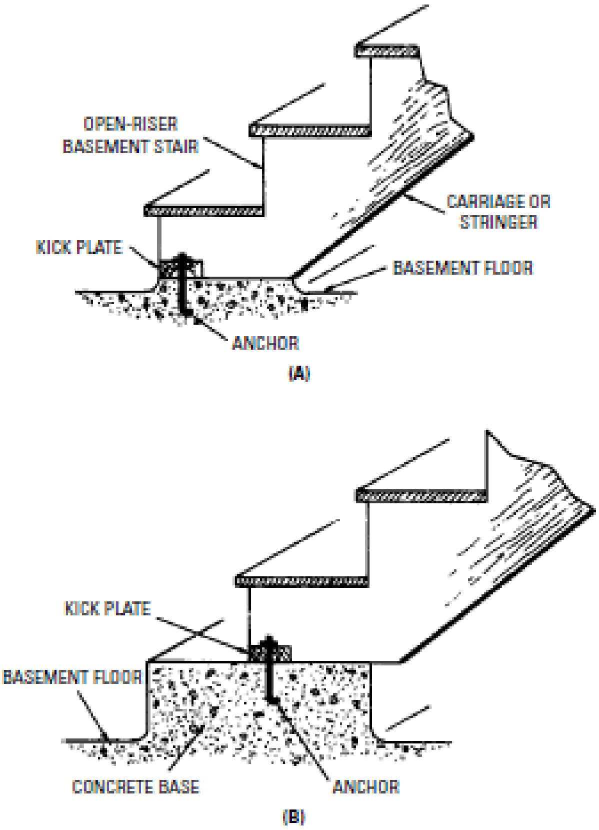


Figure 19-9 Basement stair termination at floor line.

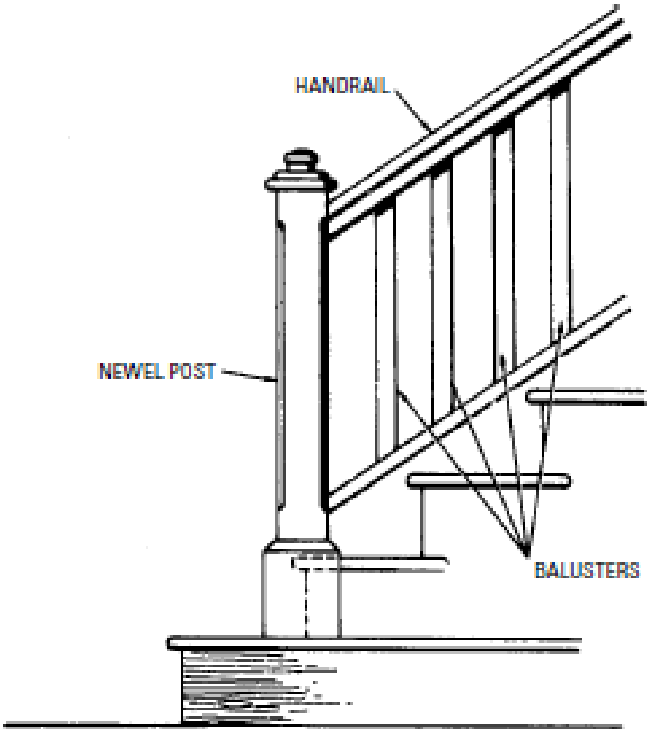


Figure 19-10 Newel post, balusters, and handrail.

Glossary of Stair Terms

The terms generally used in stair design may be defined as follows.

- *Balusters*—The vertical members supporting the handrail on open stairs (Figure 19-12).
- *Carriage*—The rough timber supporting the treads and risers of wooden stairs sometimes referred to as the *string* or *stringer*, as shown in Figure 19-13.
- *Circular stairs*—A staircase with steps planned in a circle, all the steps being winders (Figure 19-14).
- *Flight of stairs*—The series of steps leading from one landing to another.
- *Front string*—The front string is that side of the stairs over which the handrail is placed.
- *Fillet*—A band nailed to the face of a front string below the curve and extending the width of a tread.
- *Flyers*—Steps in a flight of stairs parallel to each other.

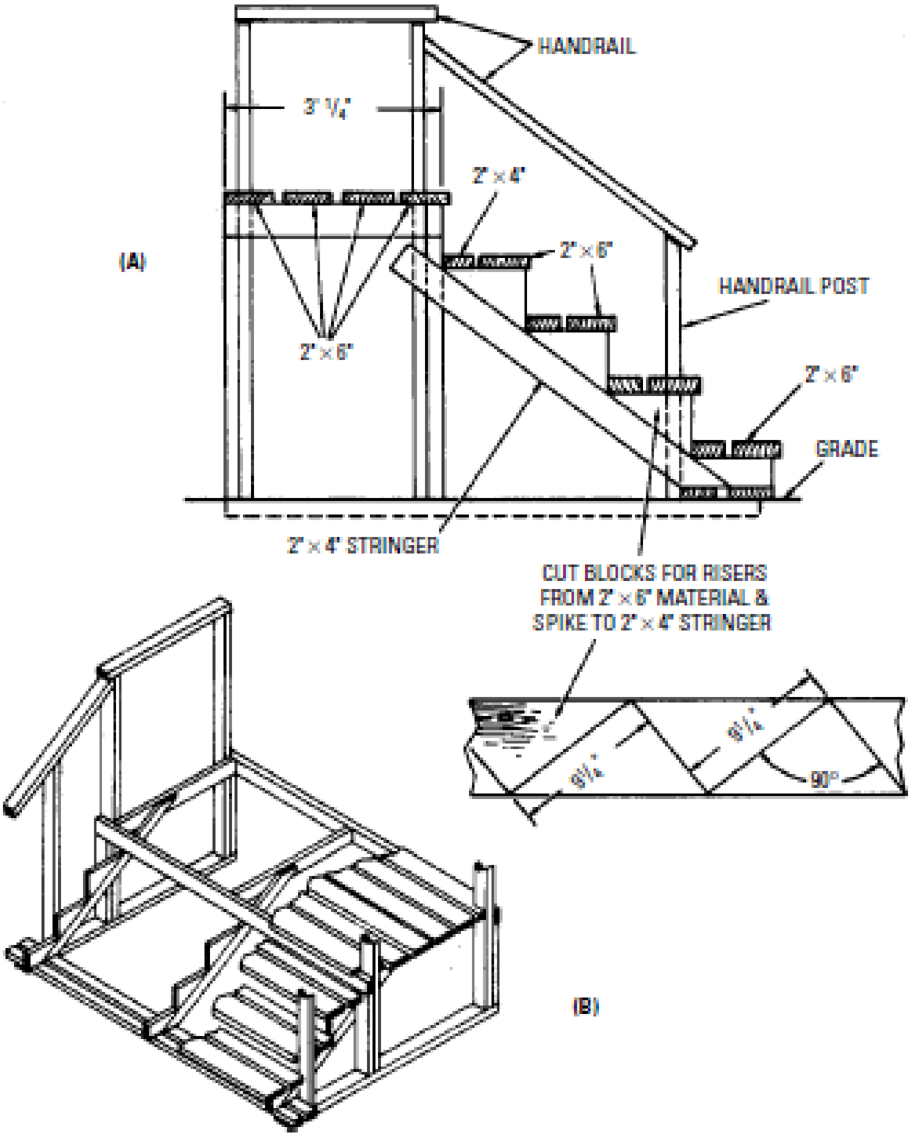


Figure 19-11 Outside step construction.

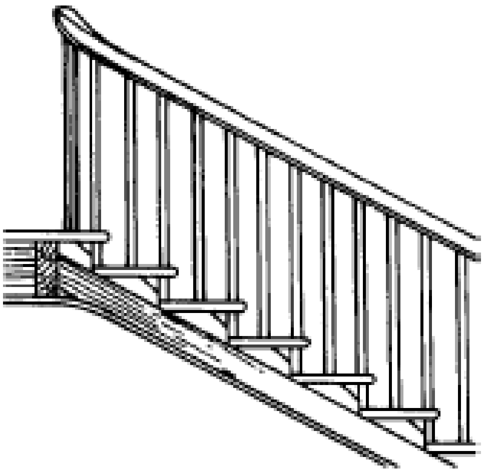


Figure 19-12 The baluster, which supports the handrail.

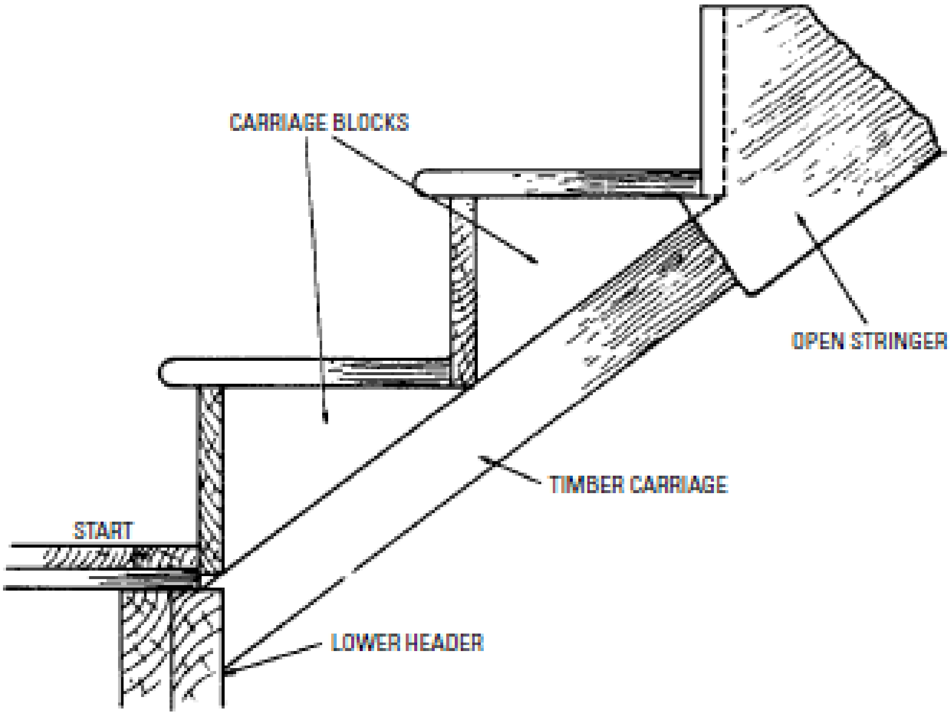


Figure 19-13 Carriage blocks connected to a stair stringer.

- *Housing*—The housing has notches in the stringboard of a stair for the reception of steps.
- *Landing*—The floor at the top or bottom of each story where the flight ends or begins.
- *Newel*—The main post of the railing at the start of the stairs and the stiffening posts at the angles and platform.

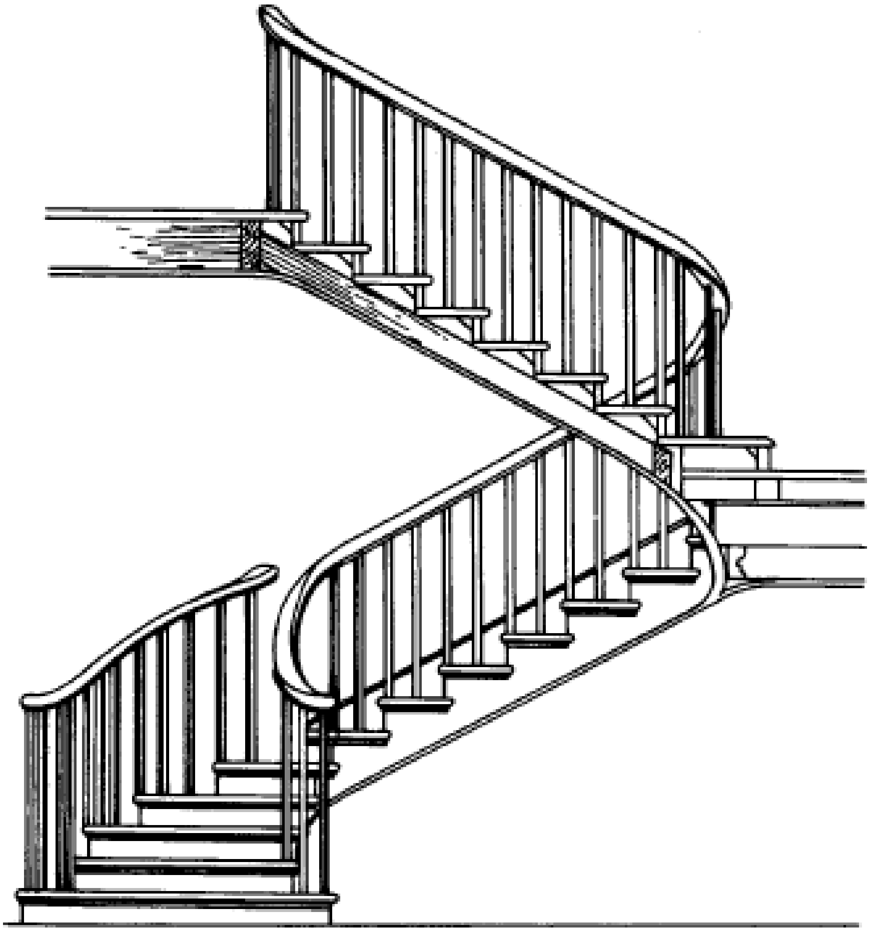


Figure 19-14 A typical circular staircase.

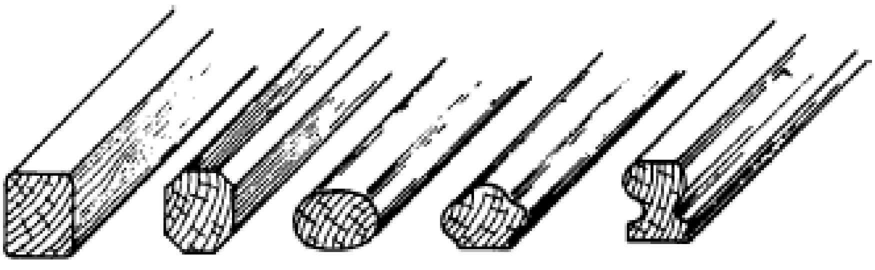


Figure 19-15 Various forms of handrails.

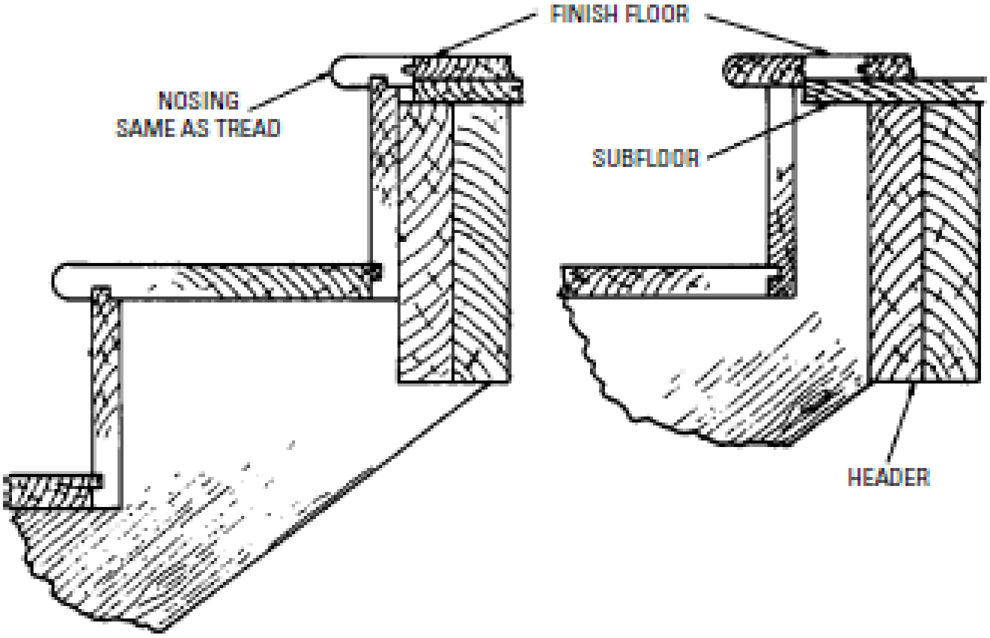


Figure 19-16 The nosing installed on the tread.

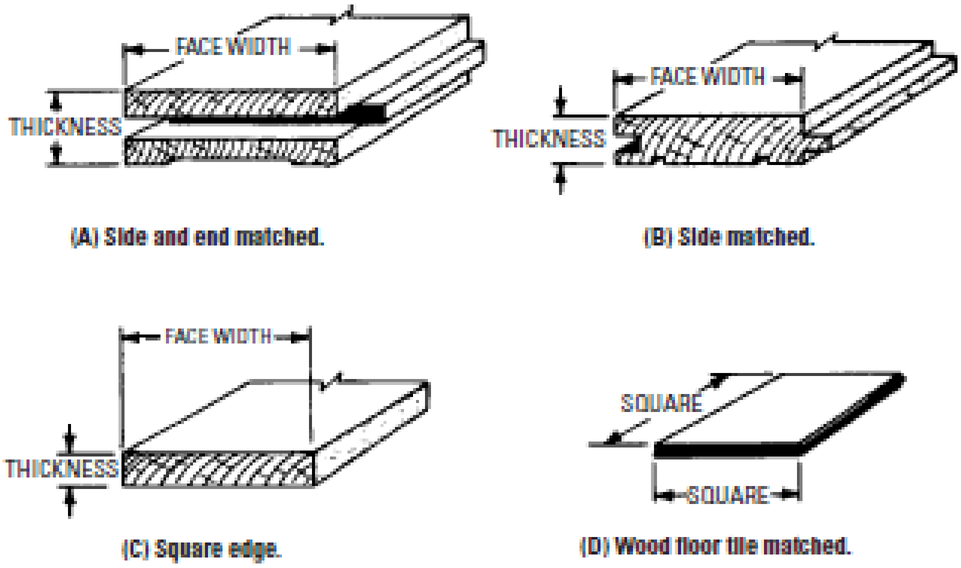


Figure 20-1 Types of finished hardwood flooring.

The flooring is generally hollow backed. The top face is slightly wider than the bottom, so that the strips are driven tightly together at the topside, but the bottom edges are slightly open. The tongue should fit snugly in the groove to eliminate squeaks in the floor.

Another pattern of flooring used to a limited degree is $^{3}/_{8}$ inch thick with a face width of $1^{1}/_{2}$ and 2 inches, with square edges and a flat back. Figure 20-1D shows a type of wood floor tile commonly known as parquetry.

Installation of Wood Strip Flooring

Flooring should be laid after plastering and other interior wall and ceiling finish is completed, after windows and exterior doors are in place, and after most of the interior trim is installed. When wood floors are used, the subfloor should be clean and level, and should be covered with a deadening felt or heavy building paper, as shown in Figure 20-2. This felt or building paper will stop a certain amount of dust, and will somewhat deaden the sound. Where a crawl space is used, it will increase the warmth of the floor by preventing air infiltration. The location of the joists should be chalk-lined on the paper as a guide for nailing (Table 20-1).

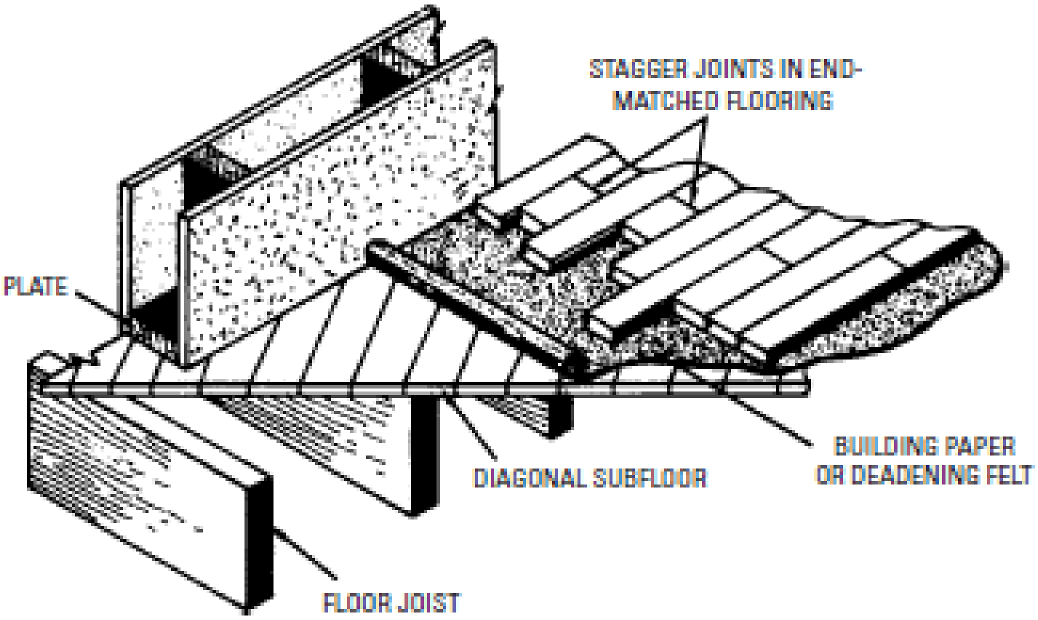


Figure 20-2 Application of strip flooring showing the use of deadening felt or heavy building paper.

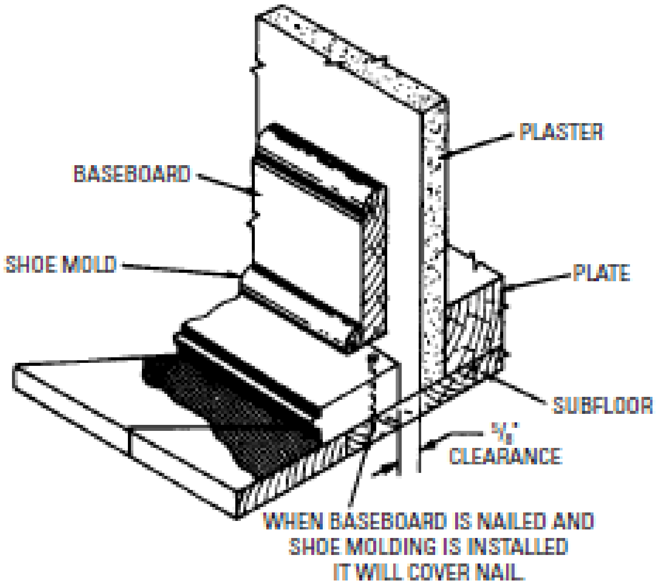


Figure 20-3 Method of laying the first strips of wood flooring.

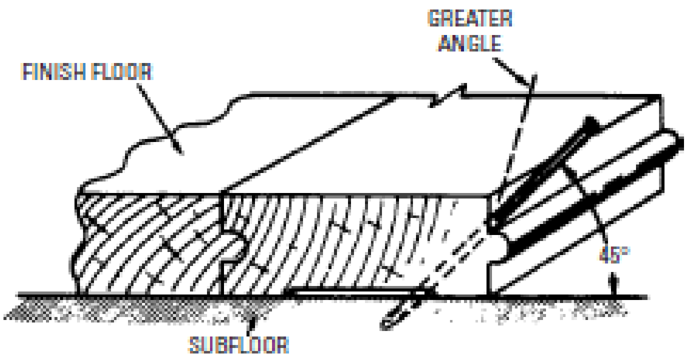


Figure 20-4 Nailing methods for setting nails in flooring.

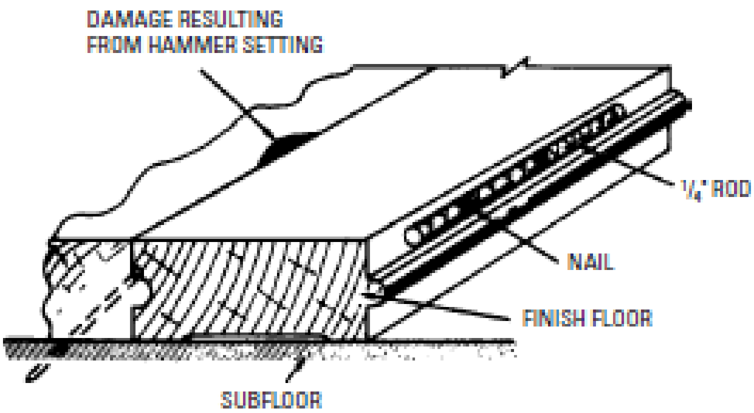


Figure 20-5 Suggested method for setting nails in flooring.

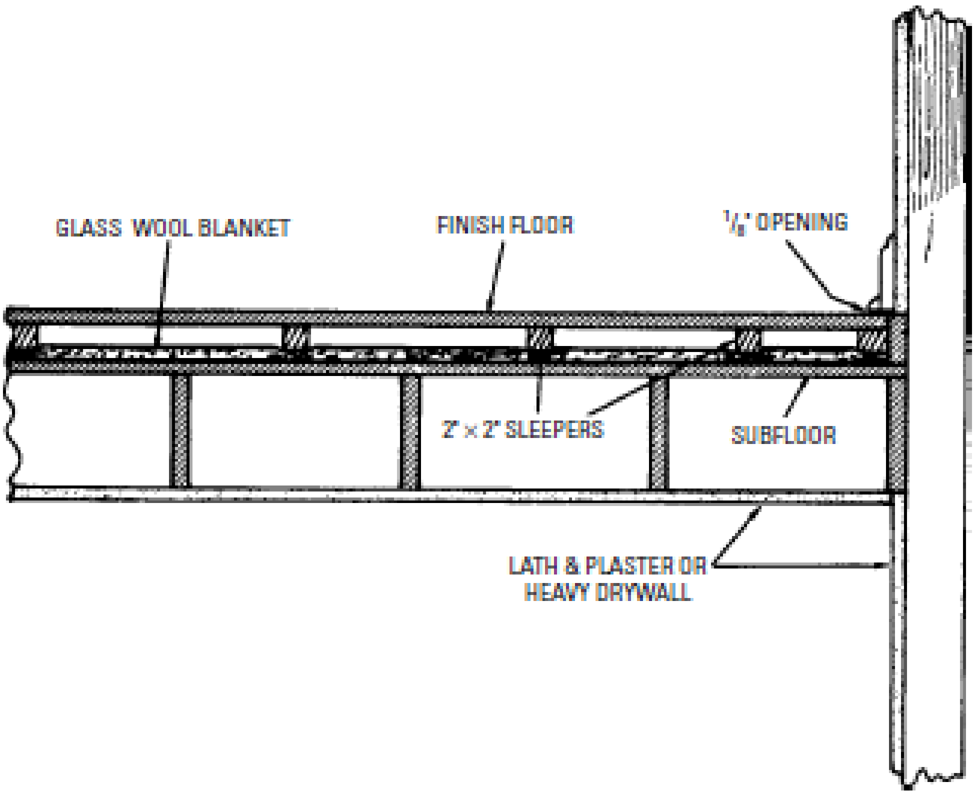


Figure 20-6 A sound-resistant floor.

Chapter 21

Doors

Doors can be obtained from the mills in stock sizes much more cheaply than they can be made by hand. Stock sizes of doors cover a wide range, but those most commonly used are 2 feet-4 inches × 6 feet-8 inches, 2 feet-8 inches × 6 feet-8 inches, 3 feet-0 inches × 6 feet-8 inches, and 3 feet-0 inches × 7 feet-0 inches. These sizes are either $1\frac{3}{8}$-inch (interior) or $1\frac{3}{4}$-inch (exterior) thick.

Types of Doors

The various types of doors include the following:

- Paneled doors
- Flush doors
- Solid-core doors
- Hollow-core doors
- Louver doors

Paneled Doors

Paneled (or *sash*) doors are made in a variety of panel arrangements (horizontal, vertical, or combinations of both). A sash door has for its component parts top rail, bottom rail, and two stiles, which form the sides of the door. Doors of the horizontal type have intermediate rails forming the panels. Panels of the vertical type have horizontal rails and vertical stiles forming the panels.

The rails and stiles of a door are generally mortised-and-tenoned, the mortise being cut in the side stiles as shown in Figure 21-1. Top and bottom rails on paneled doors differ in width, the bottom rail being considerably wider. Intermediate rails are usually the same width as the top rail. Paneling material is usually plywood that is set in grooves or dadoes in the stiles and rails, with the molding attached on most doors as a finish.

Flush Doors

Flush doors are usually perfectly flat on both sides. Solid planks are rarely used for flush doors. Flush doors are made up with solid or hollow cores, with two or more plies of veneer glued to the cores.

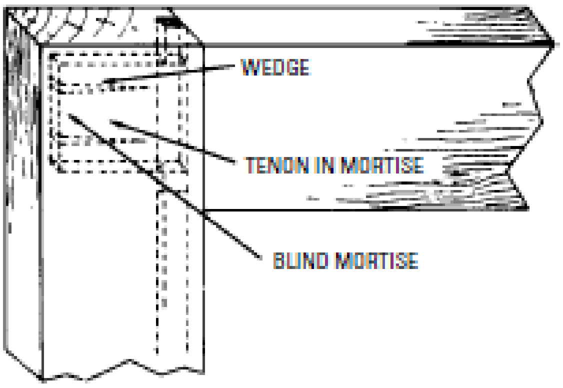


Figure 21-1 Door construction showing mortise joints.

thick) is applied at right angles to the direction of the core, and the other section ($^1/_8$ inch or less) is glued with the grain vertical. A $^3/_4$-inch strip (the thickness of the door) is glued to the edges of the door on all four sides. Figure 21-2 shows this type of door construction.

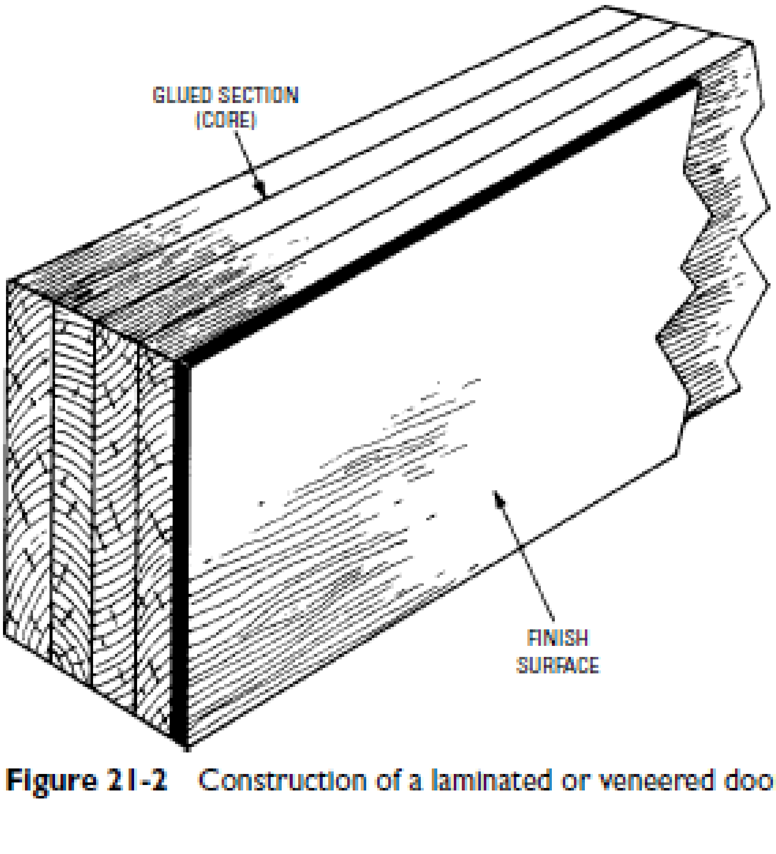


Figure 21-2 Construction of a laminated or veneered door.

Hollow-Core Doors

Hollow-core doors have wooden grids or other honeycomb material for the base, with solid wood edging strips on all four sides. The face of this type door is usually three-ply veneer instead of two single plies. The hollow-core door has a solid block on both sides for installing doorknobs and to permit the mortising of locks. The honeycomb-core door is for interior use only.

Louver Doors

This type of door has stationary or adjustable louvers. They may be used as an interior door, room divider, or a closet door. The *louver door* comes in many styles, such as shown in Figure 21-3. An exterior louver door may be used (which is called a *jalousie* door). This door has the adjustable louvers usually made of wood or glass. Although there is little protection against winter winds, a solid storm window is made to fit over the louvers to give added protection.

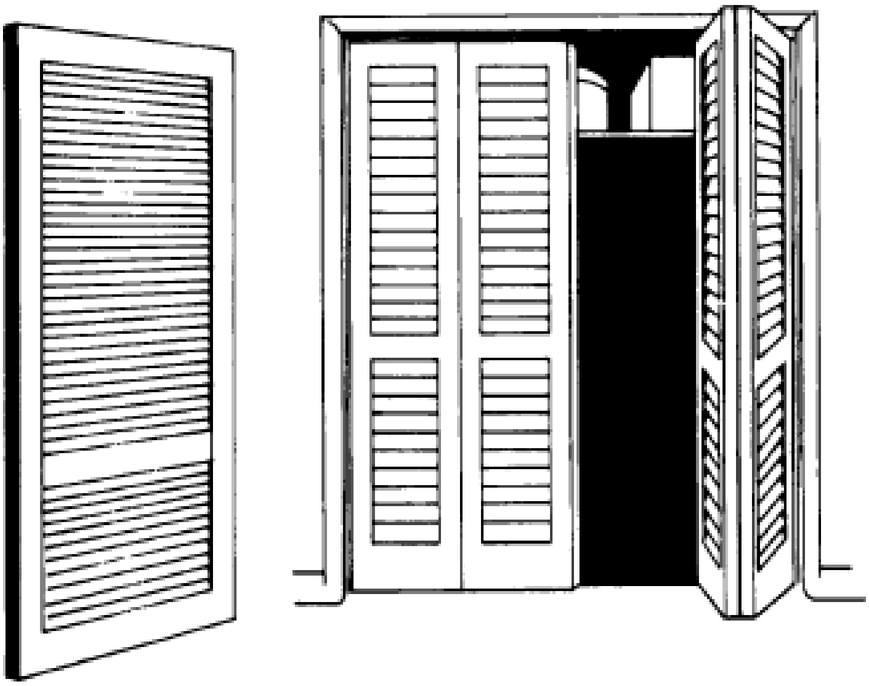


Figure 21-3 Various styles of louver doors.

* Door frames
* Door jambs
* Door trim

Door Frames

Before a door can be installed, a frame must be built for it. There are numerous ways to do this. A frame for an exterior door consists of the following essential parts (Figure 21-4):

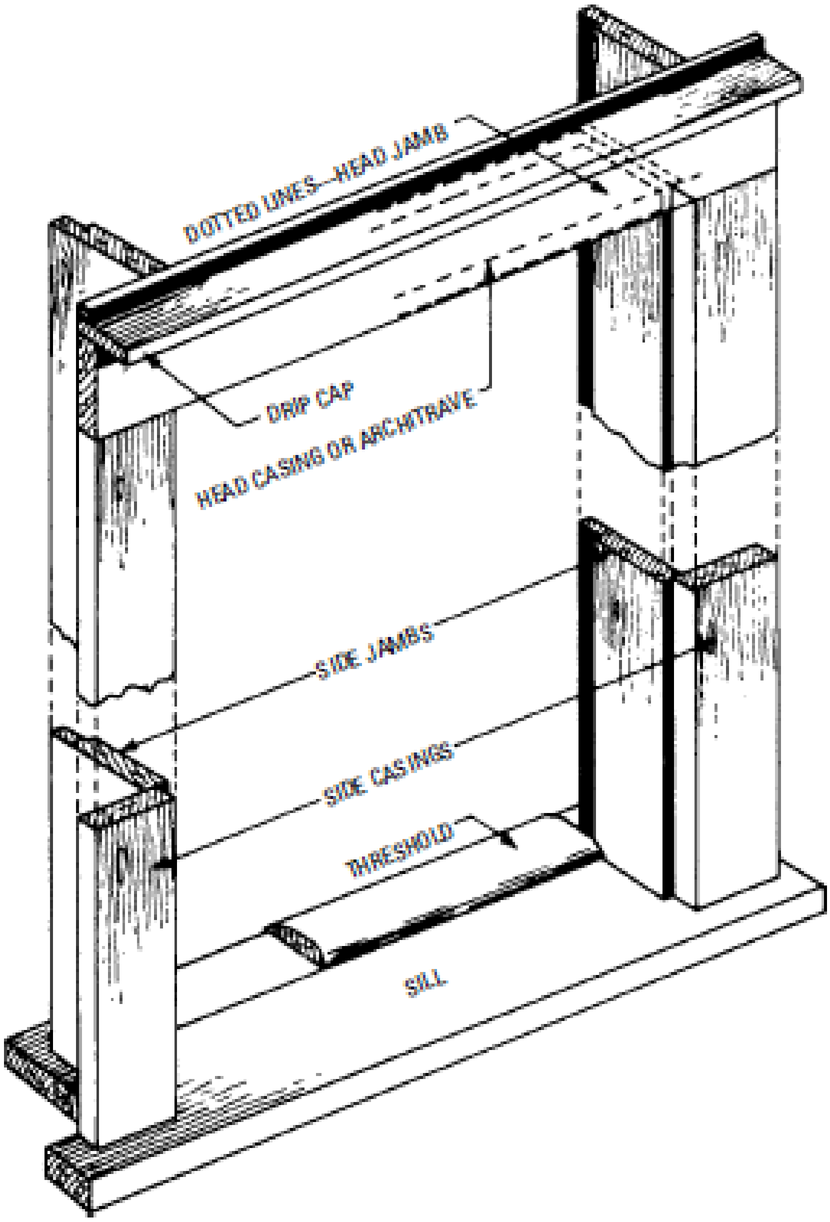


Figure 21-4 View of door frame showing the general construction.

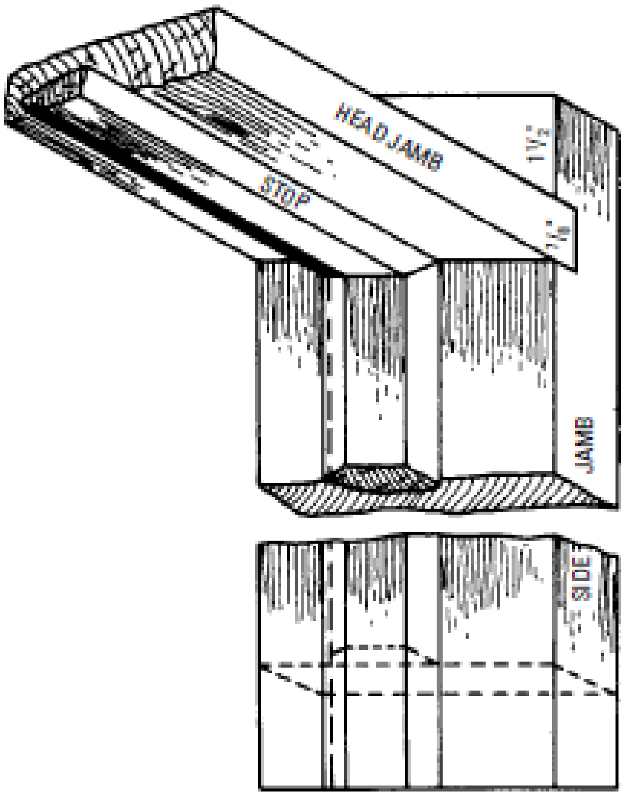


Figure 21-5 Details showing upper head jambs dadoed into side jambs.

Door Trim

Door trim material is nailed onto the jambs to provide a finish between the jambs and the plastered wall. This is called *casing*. Sizes vary from $^1/_2$ to $^3/_4$ inch in thickness, and from $2^1/_2$ to 6 inches in width. Most casing material has a concave back to fit over uneven wall material. In miter work, care must be taken to make all joints clean, square, neat, and well fitted. If the trim is to be mitered at the top corners, a miter box, miter square, hammer, nail set, and block plane will be needed. Door openings are cased up in the following manner:

1. Leave a $^1/_4$-inch margin between the edge of the jamb and the casing on all sides.
2. Cut one of the side casings square and even with the bottom of the jamb.
3. Cut the top or mitered end next, allowing $^1/_4$ inch extra length for the margin at the top.
4. Nail the casing onto the jamb and set it even with the $^1/_4$-inch margin line, starting at the top and working toward the bottom.
5. The nails along the outer edge will need to be long enough to penetrate the casing, plaster, and wall stud.
6. Set all nail heads about $^1/_8$ inch below the surface of the wood.
7. Apply the casing for the other side of the door opening in the same manner, followed by the head (or top) casing.

Read the other Topics of Chapter 21 Doors

Read Chapter 22 Ceramic Tiles

Read Chapter 23 Attic Ventilation

Read Chapter 24 Radon