

# CHAPTER 1

## LIGHT FLOOR AND WALL FRAMING

In the normal sequence of construction events, the floor and wall activities follow the completed foundation work. In this chapter, we'll examine established methods of frame construction and discuss in general how floor and wall framing members are assembled. An explanation of subflooring installation, exterior sheathing, interior partitions, and rough openings for doors and windows is also given.

### WOOD SILL FRAMING

*LEARNING OBJECTIVE: Upon completing this section, you should be able to describe sill layout and installation.*

Framing of the structure begins after completion of the foundation. The lowest member of the frame structure resting on the foundation is the sill plate, often called the mud sill. This sill provides a roiling base for joists or studs resting directly over the foundation. Work

in this area is critical as it is the real point of departure for actual building activities.

### LAYOUT

The box sill is usually used in platform construction. It consists of a sill plate and header joist anchored to the foundation wall. Floor joists are supported and held in position by the box sill (fig. 1-1). Insulation material and metal termite shields are placed under the sill if desired or when specified. Sills are usually single, but double sills are sometimes used.

Following construction of the foundation wall, the sill is normally the first member laid out. The edge of the sill is setback from the outside face of the foundation a distance equal to the thickness of the exterior sheathing. When laying out sills, remember the comers should be halved together, but are often butted or mitered. If splicing is necessary to obtain required

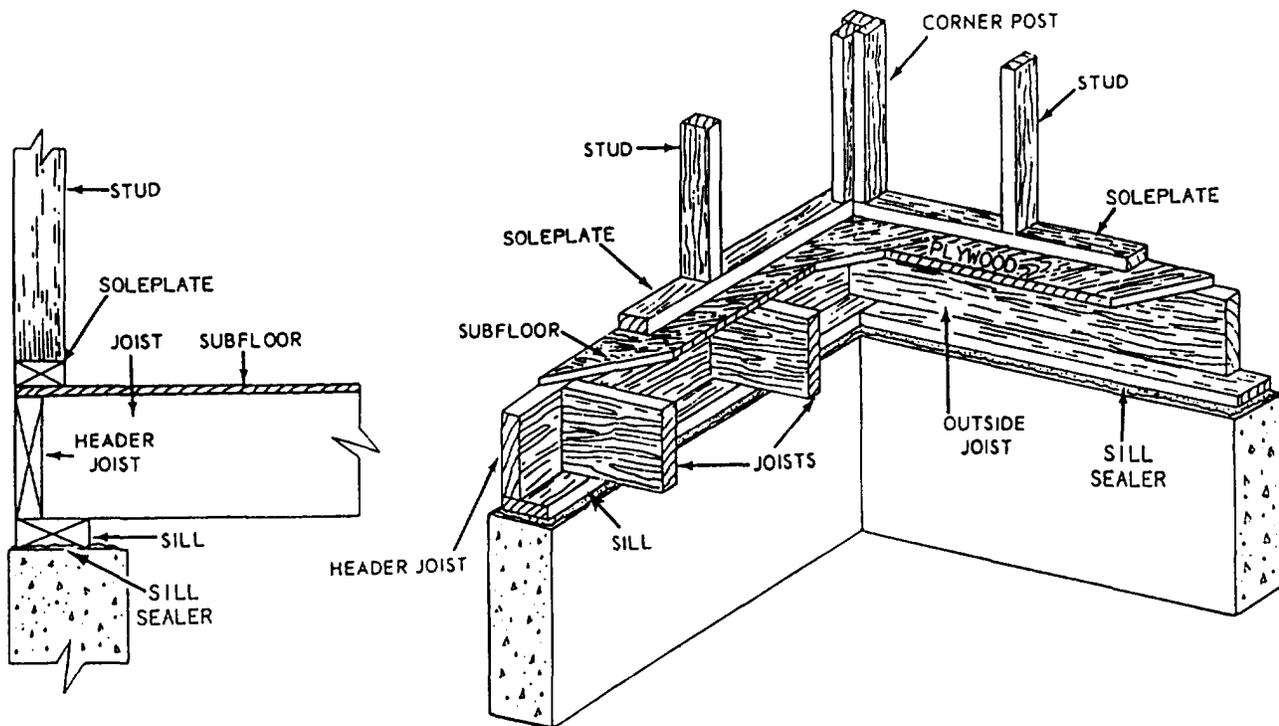


Figure 1-1.—Box-sill assembly.

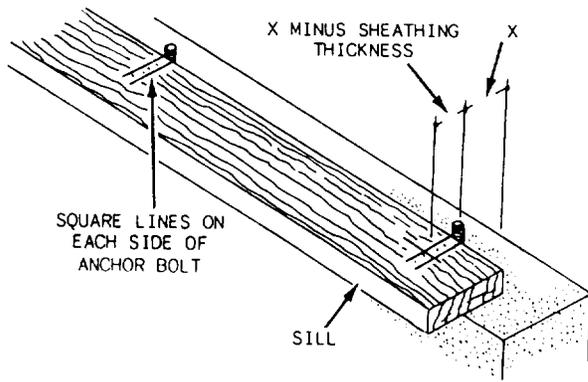


Figure 1-2.—Anchor bolt layout.

length, you should halve the splice joint at least 2 feet and bolt together.

Once the required length has been determined, the next step is to lay out the locations of the anchor bolt holes. Use the following steps:

1. Establish the building line points at each of the corners of the foundation.
2. Pull a chalk line at these established points and snap a line for the location of the sill.
3. Square the ends of the sill stock, (Stock received at jobsites is not necessarily squared at both ends.)
4. Place the sill on edge and mark the locations of the anchor bolts.
5. Extend these marks with a square across the width of the sill. The distance **X** in figure 1-2 shows how far from the edge of the sill to bore

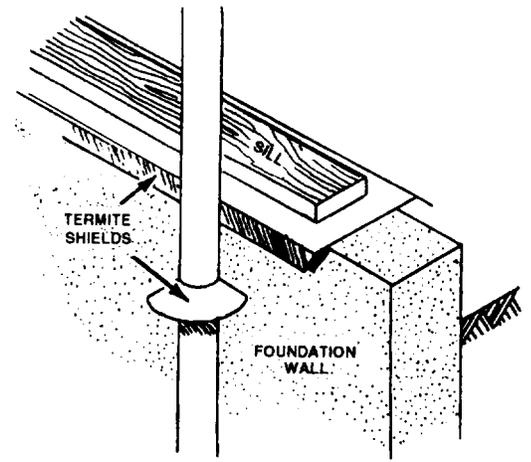


Figure 1-4.—Installing termite shields.

the holes; that is, **X** equals the thickness of the exterior sheathing.

After all the holes are marked, bore the holes. Each should be about 1/4 inch larger than the diameter of the bolts to allow some adjustment for slight inaccuracies in the layout. As each section is bored, position that section over the bolts.

When all sill sections are fitted, remove them from the anchor bolts. Install sill sealer (insulation) as shown in figure 1-3. The insulation compresses, filling the irregularities in the foundation. It also stops drafts and reduces heat loss. Also install a termite shield (fig. 1-4) if specified. A termite shield should be at least 26-gauge aluminum, copper, or galvanized sheet metal. The outer edges should be slightly bent down. Replace the sills and

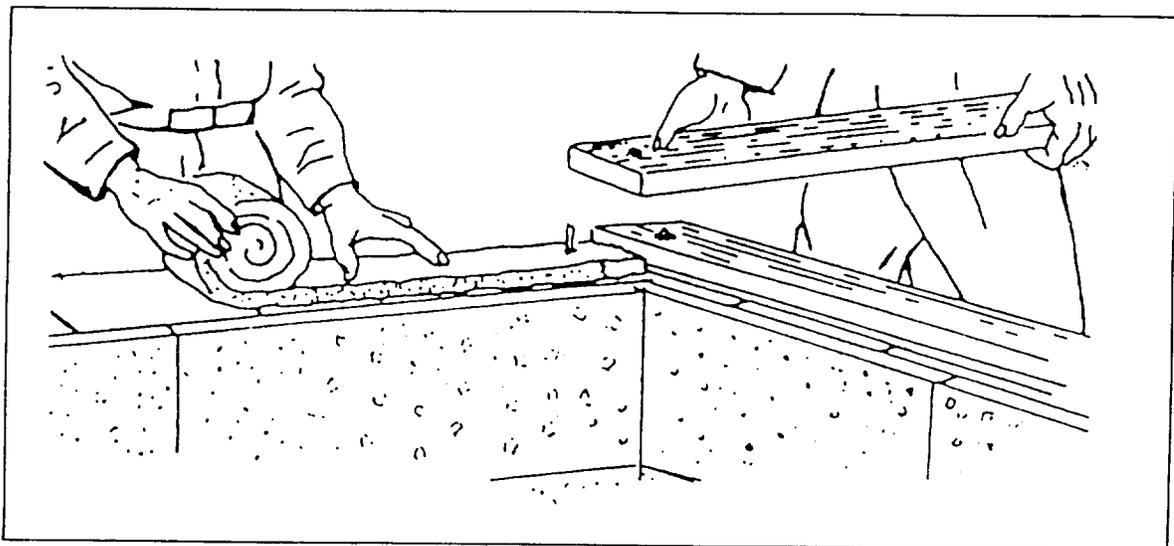


Figure 1-3.—Installing sill sealer.

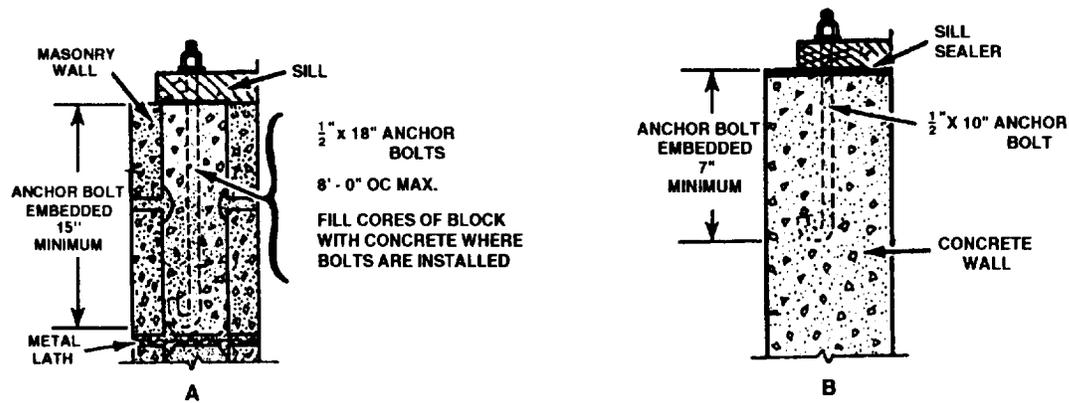


Figure 1-5.—Methods of sill fastening to foundations.

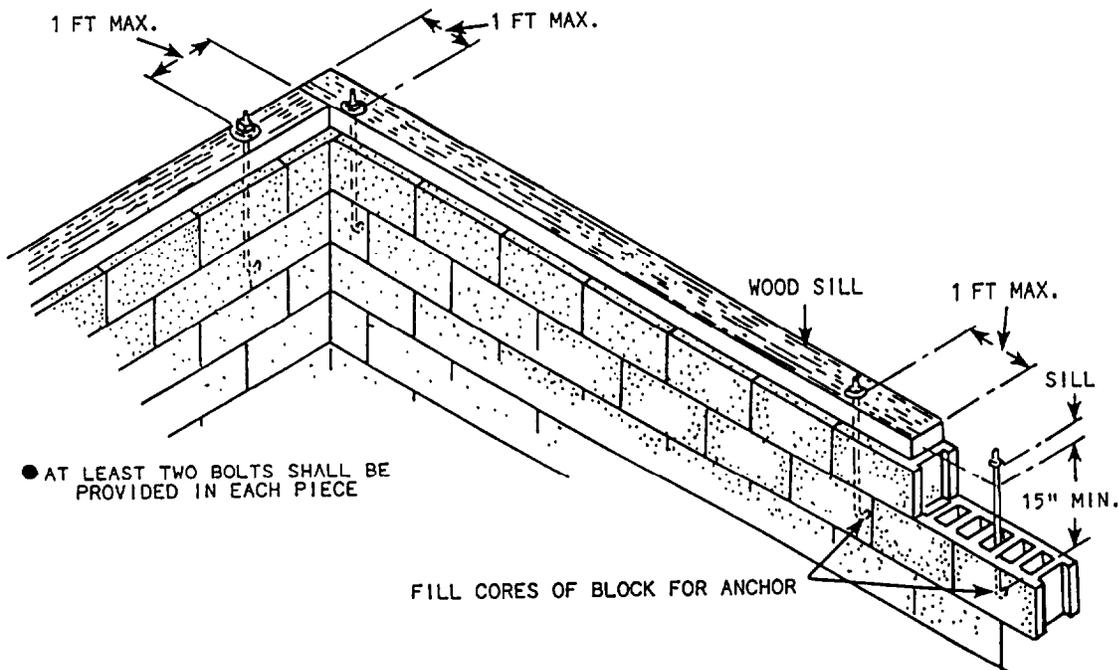


Figure 1-6.—Spacing of anchor bolts.

install the washers and nuts. As the nuts are tightened, make sure the sills are properly aligned. Also, check the distance from the edge of the foundation wall. The sill must be level and straight. Low spots can be shimmed with wooden wedges, but it is better to use grout or mortar.

### FASTENING TO FOUNDATION WALLS

Wood sills are fastened to masonry walls by 1/2-inch anchor bolts. These bolts, also known as j-bolts because of their shape, should be embedded 15 inches or more into the wall in unreinforced concrete (fig. 1-5,

view A) and a minimum of 7 inches into reinforced concrete (view B). The length of the anchor bolt is found in the specifications; the spacing and location of the bolts are shown on the drawings. If this information is not available, anchor bolt spacing should not exceed 6 feet on center (OC). Also, a bolt must be placed within 1 foot of the ends of each piece (as shown in fig. 1-6).

There are alternative ways to fasten sill plates to foundations. Location and building codes will dictate which to use. Always consult the job specifications before proceeding with construction.

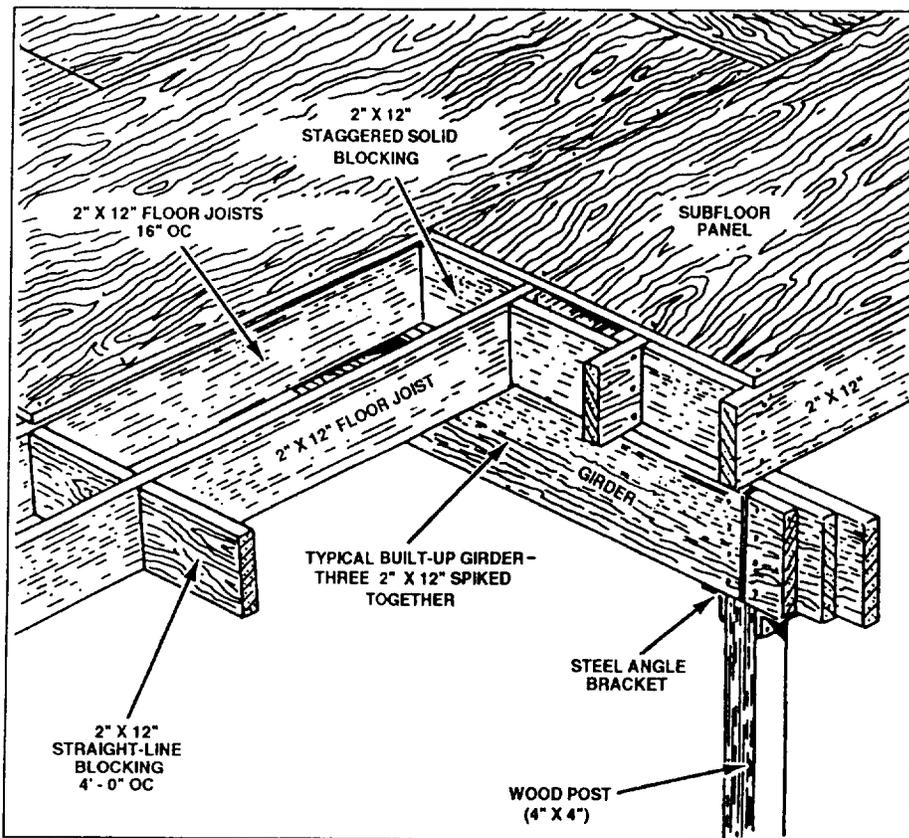


Figure 1-7.—Basic components of floor framing.

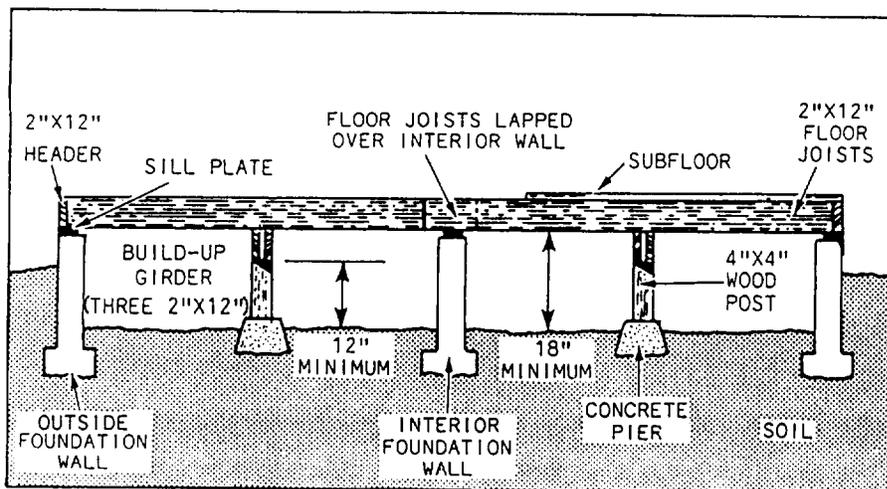


Figure 1-8.—Floor framing on sill plates with intermediate posts and built-up girders.

## FLOOR FRAMING

*LEARNING OBJECTIVE: Upon completing this section, you should be able to identify members used in floor construction, and the construction methods used with subfloor and bridging.*

Floor framing consists specifically of the posts, girders, joists, and subfloor. When these are assembled, as in figure 1-7, they form a level anchored platform for the rest of the construction.

### POSTS

Wood or steel posts and girders support floor joists and the subfloor. Sizes depend on the loads carried. The

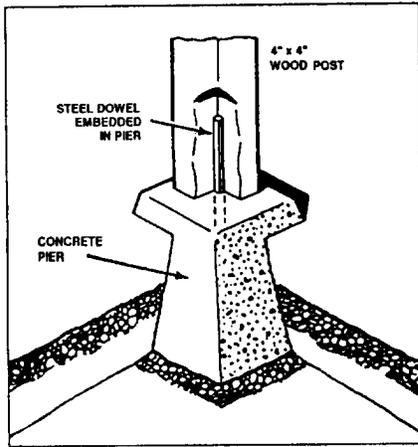


Figure 1-9.—Post fastened using dowel method.

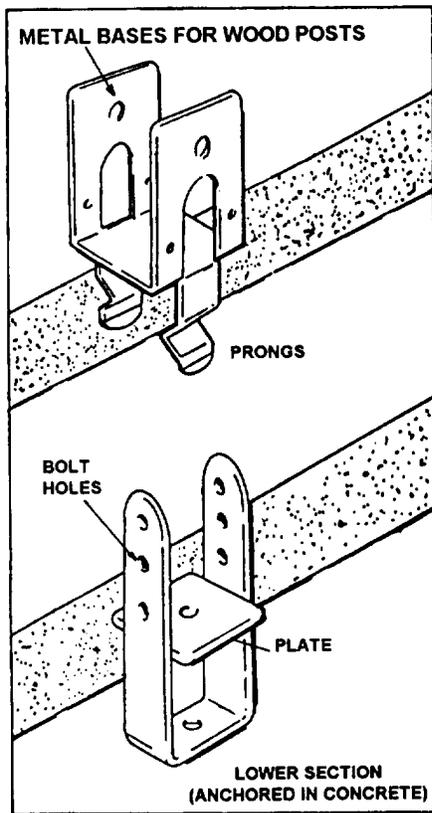


Figure 1-10.—Metal base plates for wood posts.

dimensions and locations are shown on the foundation plan. When required, posts give central support to the long span of girders. Also, girders can be used to support other girders. There should be at least 18 inches clearance between the bottoms of the floor joists and the ground and at least 12 inches between the bottom of the girder and the ground (fig. 1-8).

## Wood

Wood posts are placed directly below wood girders. As a general rule, the width of the wood post should be equal to the width of the girder it supports. For example, a 4-inch-wide girder requires a 4- by 4- or 4- by 6-inch post.

A wood post can be secured to a concrete pillar in several ways. The post can be nailed to a pier block secured to the top of a concrete pier; it can be placed over a previously inserted 1/2-inch steel dowel in the concrete; or, it can be placed into a metal base set into the concrete pier at the time of the pour. When using the dowel method, make sure the dowel extends at least 3 inches into the concrete and the post, as shown in figure 1-9. A metal base embedded in the concrete (fig. 1-10) is the preferred method since nothing else is needed to secure the base.

As with the bottom of the post, the top must also be secured to the girder. This can be done using angle iron brackets or metal plates. Figure 1-11 shows two metal post caps used with posts and girders, either nailed or bolted to the girders.

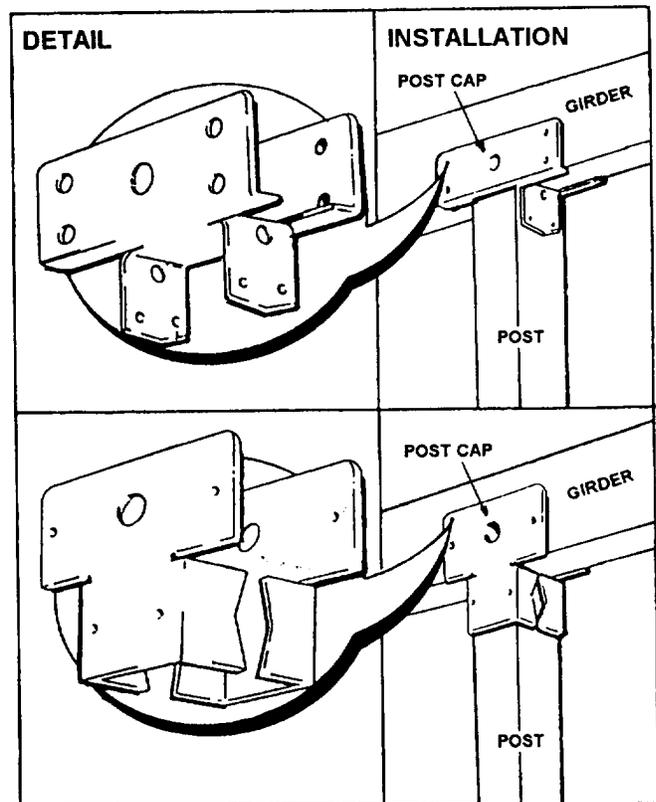


Figure 1-11.—Metal post caps.

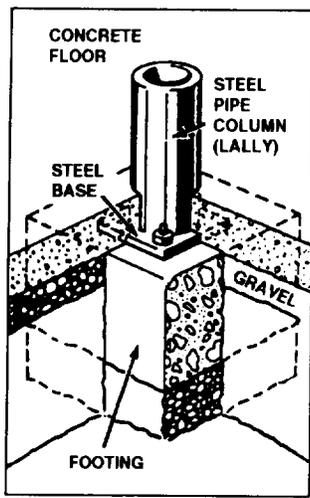


Figure 1-12.—Bolting of steel column.

### Steel

Steel pipe columns are often used in wood-frame construction, with both wood and steel girders. When using wood girders, secure the post to the girder with lag bolts. For steel girders, machine bolts are required.

The base of the steel post is bolted to the top of the pier, as shown in figure 1-12. The post can also be bolted to anchor bolts inserted in the slab prior to pouring.

### GIRDERS

Girders are classified as bearing and nonbearing according to the amount and type of load supported. Bearing girders must support a wall framed directly above, as well as the live load and dead load of the floor. Nonbearing girders support just the dead and live loads of the floor system directly above. The dead load is the weight of the material used for the floor unit itself. The live load is the weight created by people, furniture, appliances, and so forth.

### Wood

Wood girders may be a single piece of timber, or they may be laminated (that is, built up) of more than one plank. The built-up girder in figure 1-13, for example, consists of three 2- by 12-inch planks. The

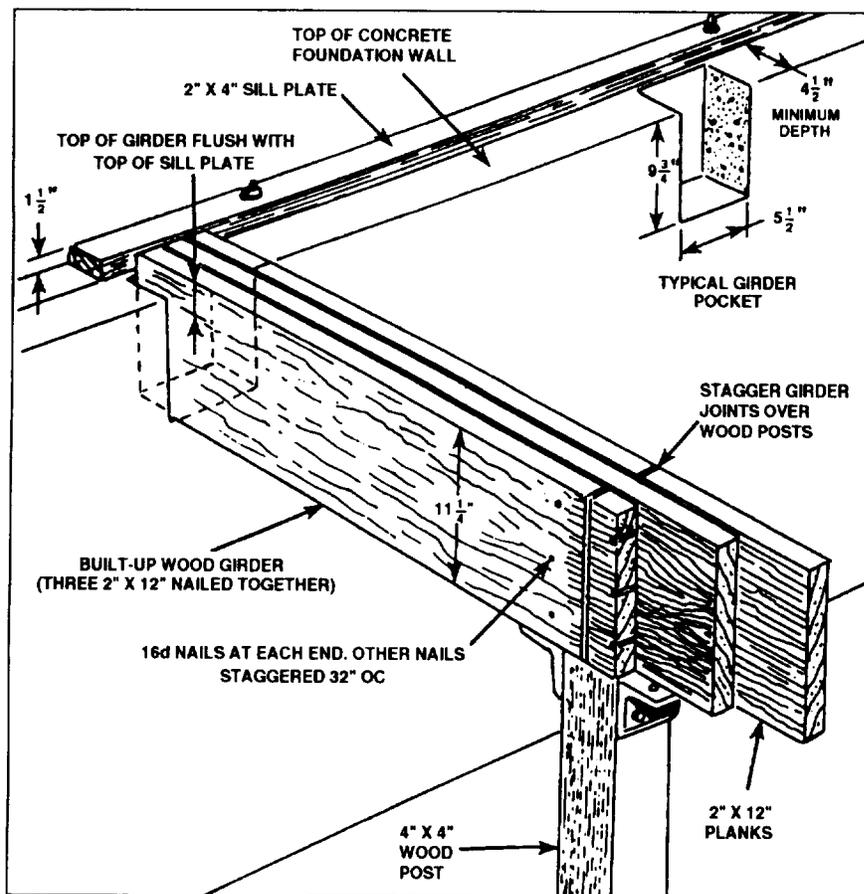


Figure 1-13.—Built-up girder.

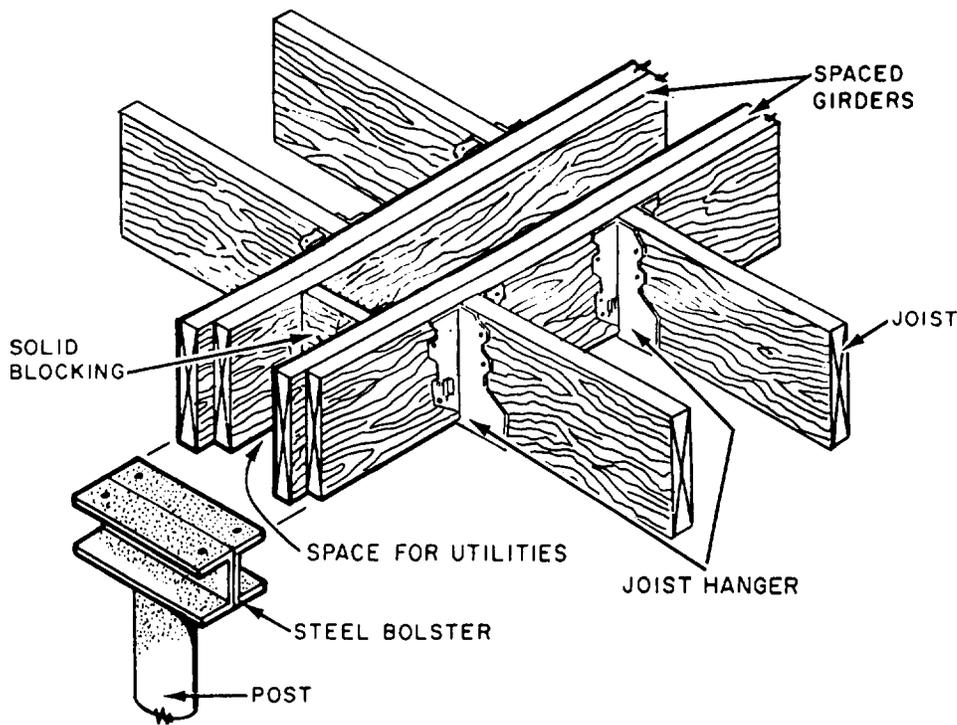


Figure 1-14.—Spaced wood girders.

joints between the planks are staggered. In framing, a built-up girder is placed so that the joints on the outside of the girder fall directly over a post. Three 16-penny (16d) nails are driven at the ends of the planks, and other nails are staggered 32 inches OC. As shown in figure 1-13, the top of the girder is flush with the top sill plate.

When space is required for heat ducts in a partition supported on a girder, a spaced wood girder, such as that shown in figure 1-14, is sometimes necessary. Solid blocking is used at intervals between the two members. A single-post support for a spaced girder usually requires a bolster, preferably metal, with a sufficient span to support the two members.

The ends of a girder often rest in pockets prepared in a concrete wall (fig. 1-13). Here, the girder ends must bear at least 4 inches on the wall, and the pocket should be large enough to provide a 1/2-inch air space around the sides and end of the girder. To protect against termites, treat the ends of the girder with a preservative. As a further precaution, line the pockets with metal.

## Steel

S-beams (standard) or W-beams (wide flange), both shown in figure 1-15, are most often used as girders in wood-framed construction. Whether the beam is wood

or steel, make sure it aligns from end to end and side to side. Also make sure the length of the bearing post under the girder is correct to ensure the girder is properly supported.

## PLACING POSTS AND GIRDERS

Posts must be cut to length and set up before the girders can be installed. The upper surface of the girder may be in line with the foundation plate sill, or the girder ends may rest on top of the walls. Long girders must be

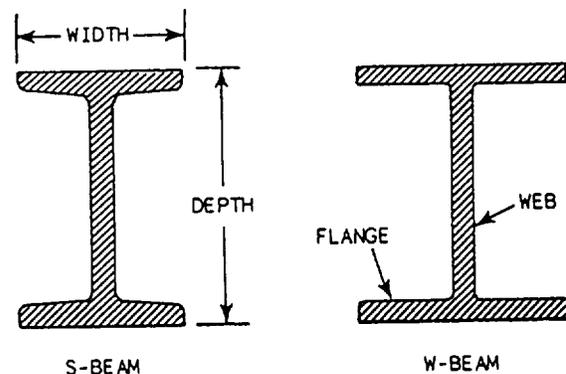


Figure 1-15—Types of steel beams.

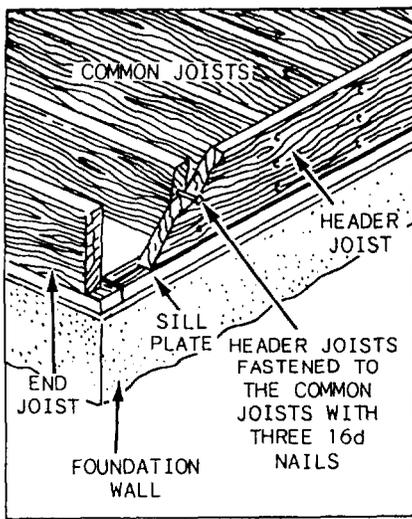


Figure 1-16.—Header joist.

placed in sections. Solid girders must be measured and cut so that the ends fall over the center of a post. Built-up girders should be placed so their outside joints fall over the posts (fig. 1-13).

## FLOOR JOISTS

In platform framing, one end of the floor joist rests directly on the sill plate of the exterior foundation wall or on the top plate of a framed outside wall. The bearing should be at least 1 1/2 inches. The opposite end of the joist laps over or butts into an interior girder or wall. The size of joist material (2 by 6, 2 by 10, 2 by 12, and so forth) must be chosen with consideration for the span and the amount of load to be carried. The foundation plan usually specifies the joist size, the spacing between joists, and what direction the joists should travel.

The usual spacing of floor joists is 16 inches OC. Floor joists are supported and held in position over exterior walls by header joists or by solid blocking between the joists. The header-joist system is used most often.

### Header

Header joists run along the outside walls. Three 16d nails are driven through the header joists into the ends of the common joists, as shown in figure 1-16. The header and joists are toenailed to the sill with 16d nails. The header joists prevent the common joists from

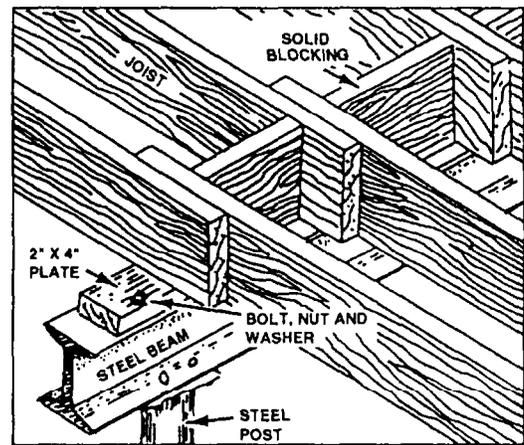


Figure 1-17.—Lapped joists.

rolling or tipping. They also help support the wall above and fill in the spaces between the common joists.

### Lapped

Joists are often lapped over a girder running down the center of a building. The lapped ends of the joists may also be supported by an interior foundation or framed wall. It is standard procedure to lap joists the full width of the girder or wall. The minimum lap should be 4 inches. Figure 1-17 shows lapped joists resting on a steel girder. A 2- by 4-inch plate has been bolted to the top of a steel beam. The joists are toenailed into the plate. Solid blocking may be installed between the lapped ends after all the joists have been nailed down. Another system is to put in the blocks at the time the joists are placed.

### Double

Joists should be doubled under partitions running in the same direction as the joists. Some walls have water pipes, vent stacks, or heating ducts coming up from the basement or the floor below. Place bridging between double joists to allow space for these purposes (fig. 1-18).

### Cantilevered

Cantilevered joists are used when a floor or balcony of a building projects past the wall below, as shown in figure 1-19. A header piece is nailed to the ends of the

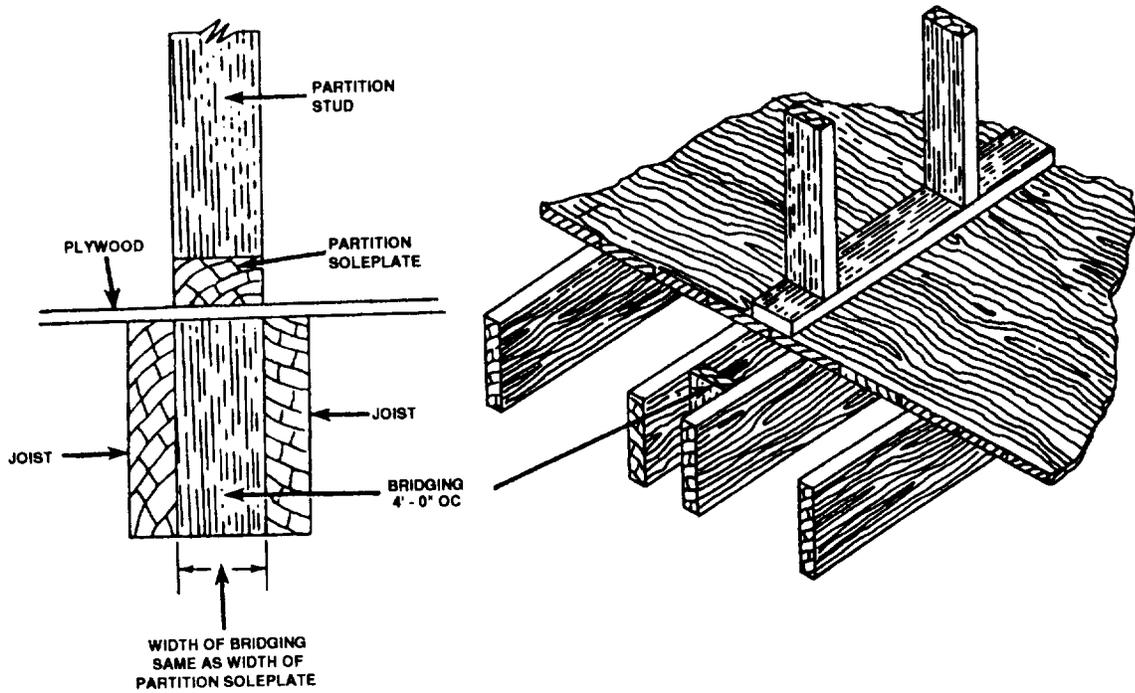


Figure 1-18.—Double joists.

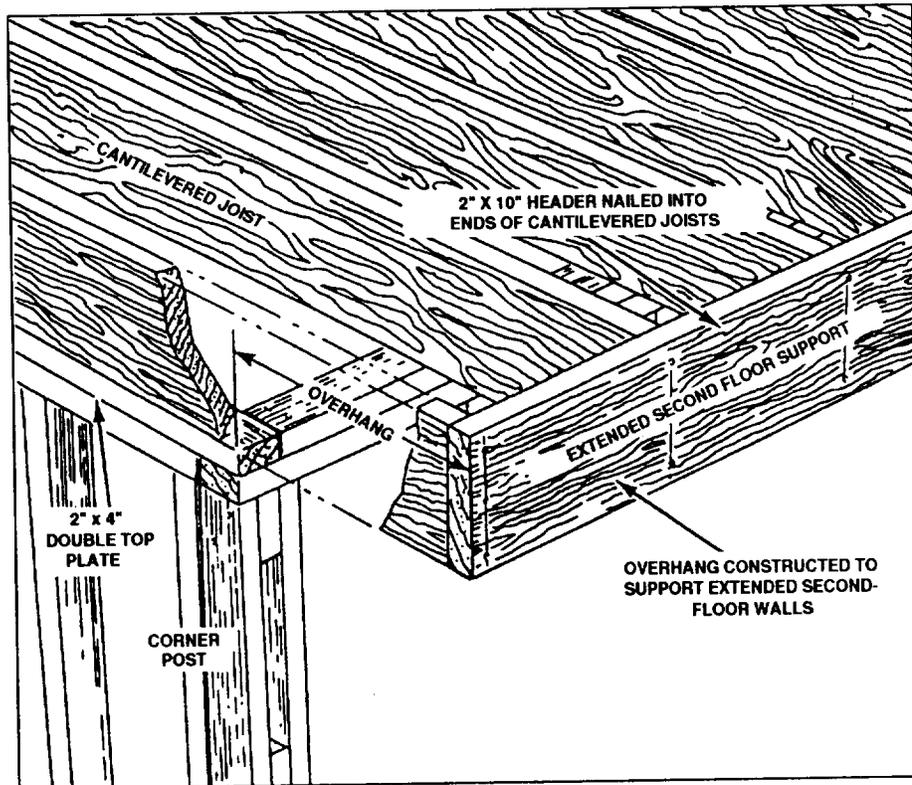


Figure 1-19.—Cantilevered joists.

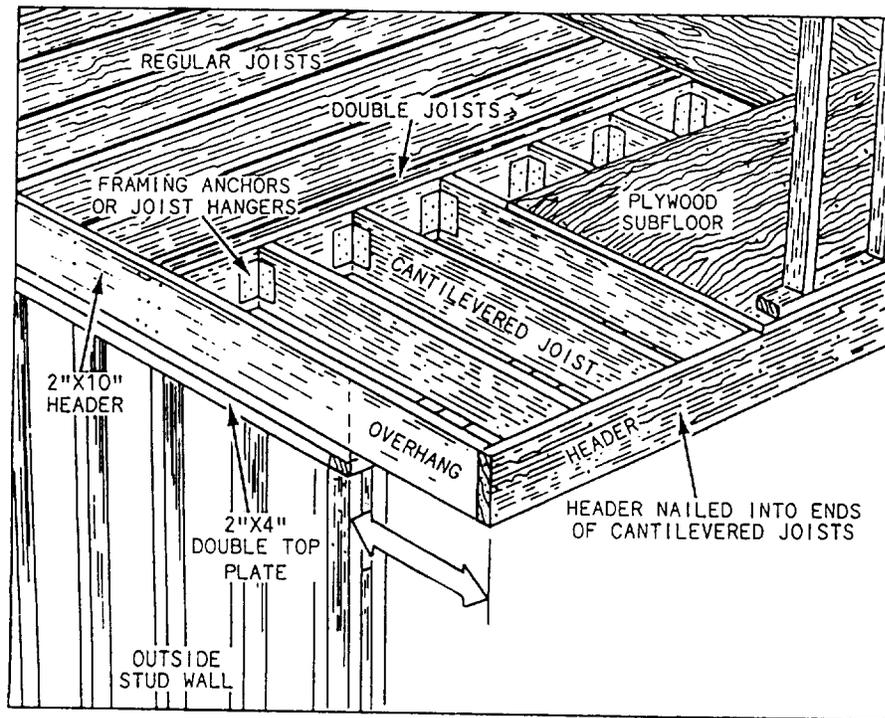


Figure 1-20.—Framing for cantilevered joists.

joists. When regular floor joists run parallel to the intended overhang, the inside ends of the cantilevered joists are fastened to a pair of double joists (fig. 1-20). Nailing should be through the first regular joist into the ends of the cantilevered joists. Framing anchors are strongly recommended and often required by the specifications. A header piece is also nailed to the outside ends of the cantilevered joists.

### Butted over a Girder

Joist ends can also be butted (rather than lapped) over a girder. The joists should then be cleated together with a metal plate or wooden cleat, as shown in

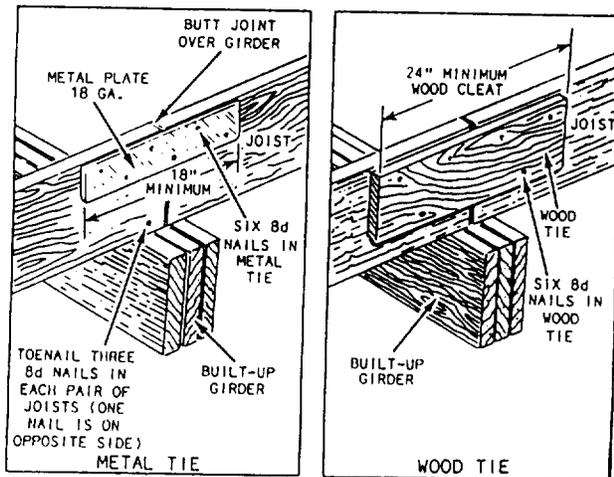


Figure 1-21.—Butting joists over a girder.

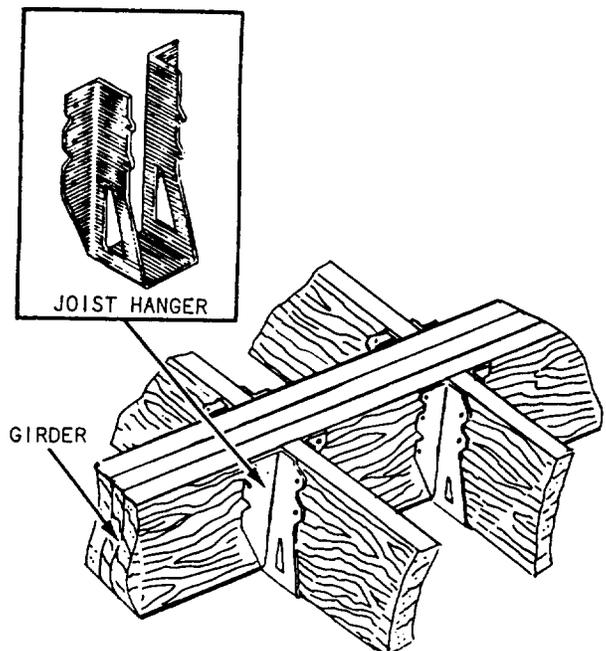


Figure 1-22.—Butting Joists against a girder.

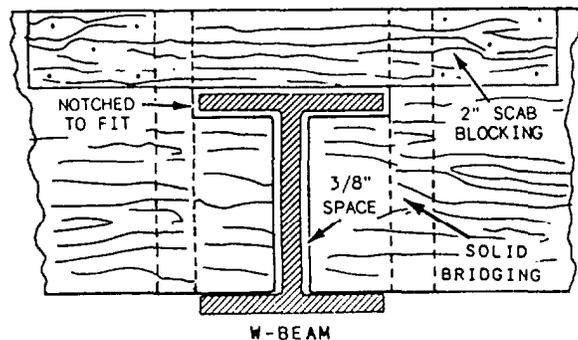
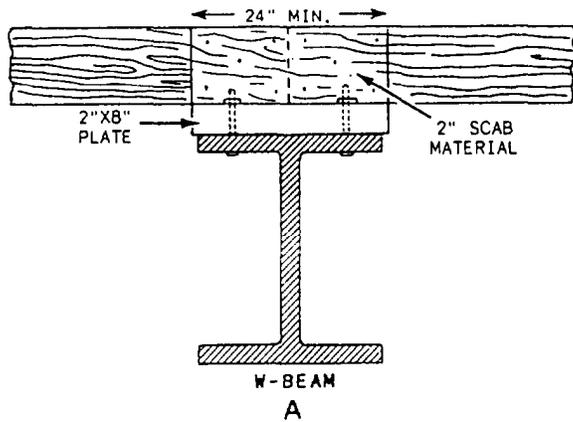


Figure 1-23.—Joists supported by steel beams.

figure 1-21. These can be left out if the line of panels from the plywood subfloor straddles the butt joints.

### Butted against a Girder

Butting joists against (rather than over) a girder allows more headroom below the girder. When it is necessary for the underside of the girder to be flush with the joists to provide an unbroken ceiling surface, the joists should be supported with joist hangers (fig. 1-22).

### Blocking between Joists

Another system of providing exterior support to joists is to place solid blocking between the outside ends of the joists. In this way, the ends of the joists have more bearing on the outside walls.

### Interior Support

Floor joists usually run across the full width of the building. However, extremely long joists are expensive

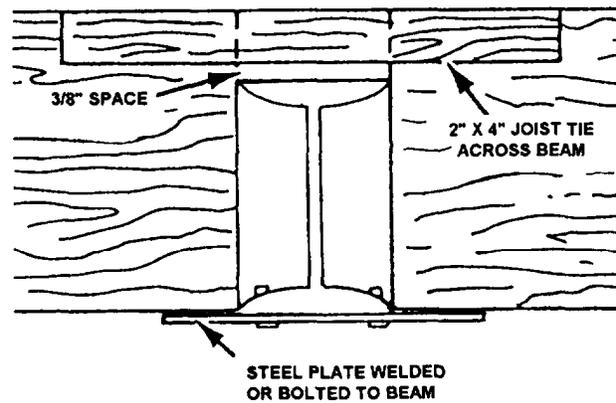


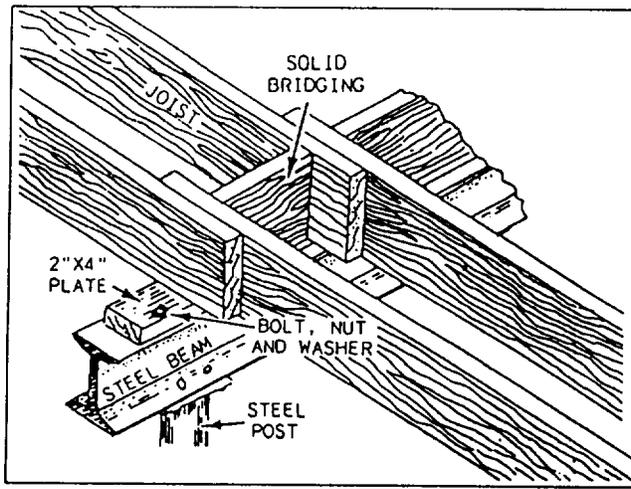
Figure 1-24.—Joists supported on steel plates.

and difficult to handle. Therefore, two or more shorter joists are usually used. The ends of these joists are supported by lapping or butting them over a girder, butting them against a girder, or lapping them over a wall.

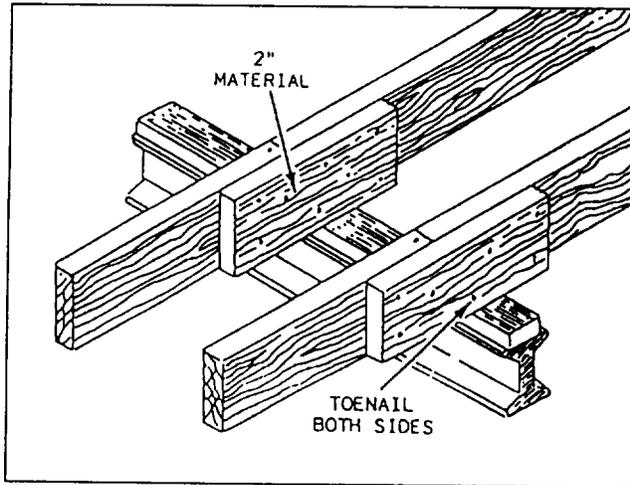
### Supported by a Steel Beam

Wood joists are often supported by a steel beam rather than a wood girder. The joists may rest on top of the steel beam (fig. 1-23, view A), or they may be butted (and notched to fit) against the sides of the beam (view B). If the joists rest on top of a steel beam, a plate is fastened to the beam and the joists are toenailed into the plate. When joists are notched to fit against the sides of the beam, allowance must be made for joist shrinkage while the steel beams remain the same size. For average work with a 2- by 10-inch joist, an allowance of 3/8 inch above the top flange of the steel girder or beam is usually sufficient.

Another method of attaching butted joists to a steel girder is shown in figure 1-24. A 3/8-inch space is shown above the beam to allow for shrinkage. Notching the joists so they rest on the lower flange of an S-beam is not recommended; the flange surface does not provide sufficient bearing surface. A wide plate may be bolted or welded to the bottom of the S-beams to provide better support. Wooden blocks may be placed at the bottoms of the joists to help keep them in position. Wide-flanged beams, however, do provide sufficient support surface for this method of



A



B

Figure 1-25.—Joists supported by S-beam using wooden blocks.

construction. Figure 1-25 shows the lapped (view A) and butt (view B) methods of framing over girders.

### Bridging between Joists

Floor plans or specifications usually call for bridging between joists. Bridging holds the joists in line and helps distribute the load carried by the floor unit. It is usually required when the joist spans are more than 8 feet. Joists spanning between 8 and 15 feet need one row of bridging at the center of the span. For longer spans, two rows of bridging spaced 6 feet apart are required.

**CROSS BRIDGING.**— Also known as herringbone bridging, cross bridging usually consists of 1- by 3-inch or 2- by 3-inch wood. It is installed as shown in figure 1-26. Cross bridging is toenailed at each

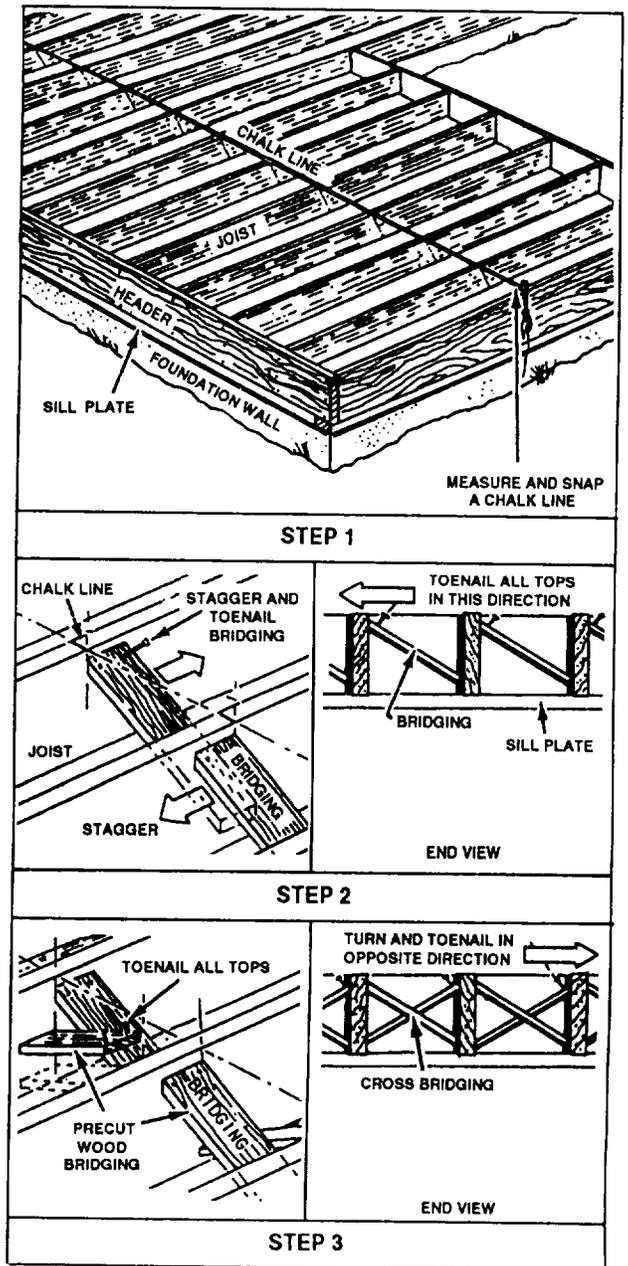


Figure 1-26.—Wood cross bridging.

end with 6d or 8d nails. Pieces are usually precut on a radial-arm saw. Nails are started at each end before the cross bridging is placed between the joists. The usual procedure is to fasten only the top end of the cross bridging. The nails at the bottom end are not driven in until the subfloor has been placed. Otherwise the joist could be pushed out of line when the bridging is nailed in.

An efficient method for initial placement of cross bridging is shown in figure 1-26. In step 1, snap a chalk line where the bridging is to be nailed between the joists. In step 2, moving in one direction, stagger and nail the

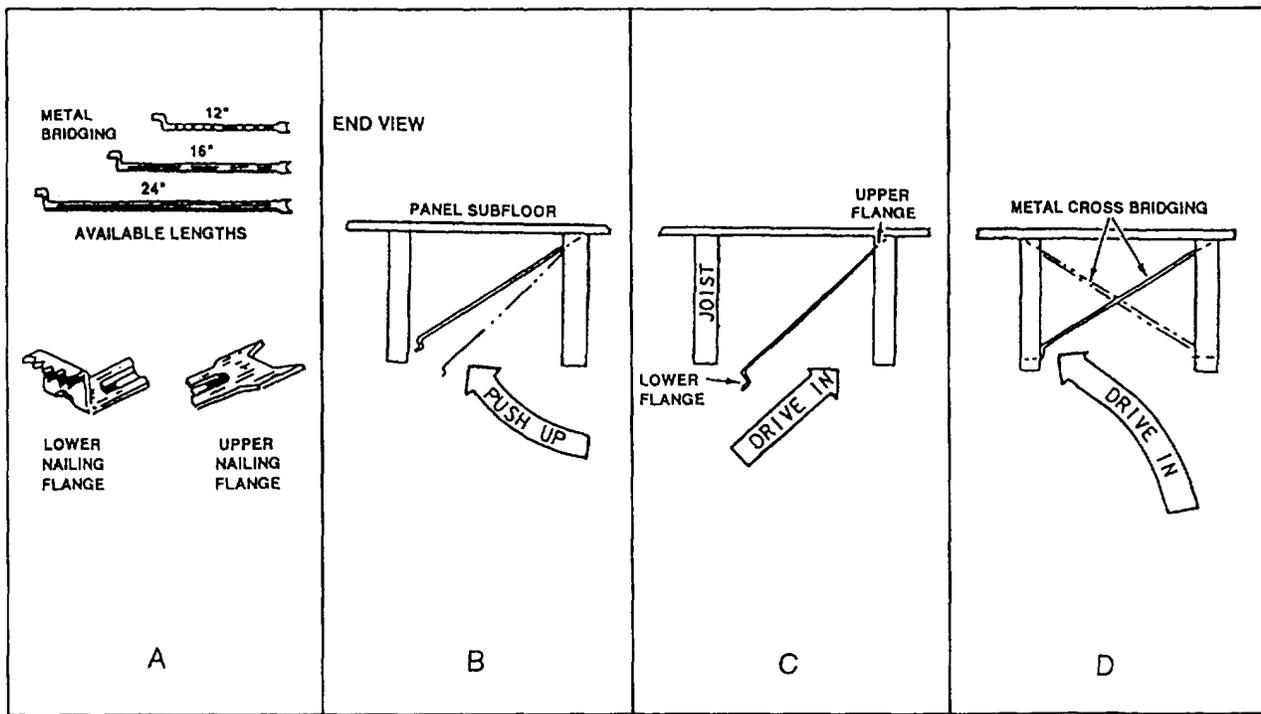


Figure 1-27.—Metal cross bridging.

tops of the bridging. In step 3, reverse direction and nail tops of the opposite pieces into place.

Another approved system of cross bridging uses metal pieces instead of wood and requires no nails. The pieces are available for 12-, 16-, and 24-inch joist spacing (fig. 1-27, view A). You can see how to install this type of cross bridging in views B, C, and D. In view B, strike the flat end of the lower flange, driving the flange close to the top of the joist. In view C, push the lower end of the bridging against the opposite joist. In view D, drive the lower flange into the joist.

**SOLID BRIDGING.**— Also known as solid blocking, solid bridging (fig. 1-28) serves the same purpose as cross bridging. This method is preferred by many Builders to cross bridging. The pieces are cut from lumber the same width as the joist material. They can be installed in a straight line by toenailing or staggering. If staggered the blocks can be nailed from both ends, resulting in a faster nailing operation. Straight lines of blocking may be required every 4 feet OC to provide a nailing base for a plywood subfloor.

### Placing Floor Joists

Before floor joists are placed, the sill plates and girders must be marked to show where the joists are to

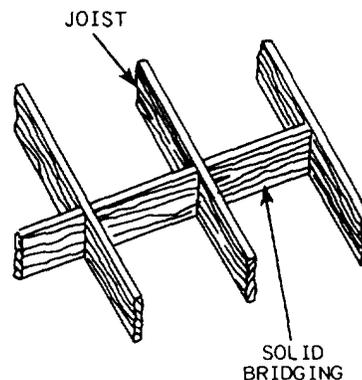


Figure 1-28.—Solid bridging.

be nailed. As we mentioned earlier, floor joists are usually placed 16 inches OC.

For joists resting directly on foundation walls, layout marks may be placed on the sill plates or the header joists. Lines must also be marked on top of the girders or walls over which the joists lap. If framed walls are below the floor unit, the joists are laid out on top of the double plate. The floor layout should also show where any joists are to be doubled. Double joists are required where partitions resting on the floor run in the same direction as the floor joists. Floor openings for stairwells must also be marked.

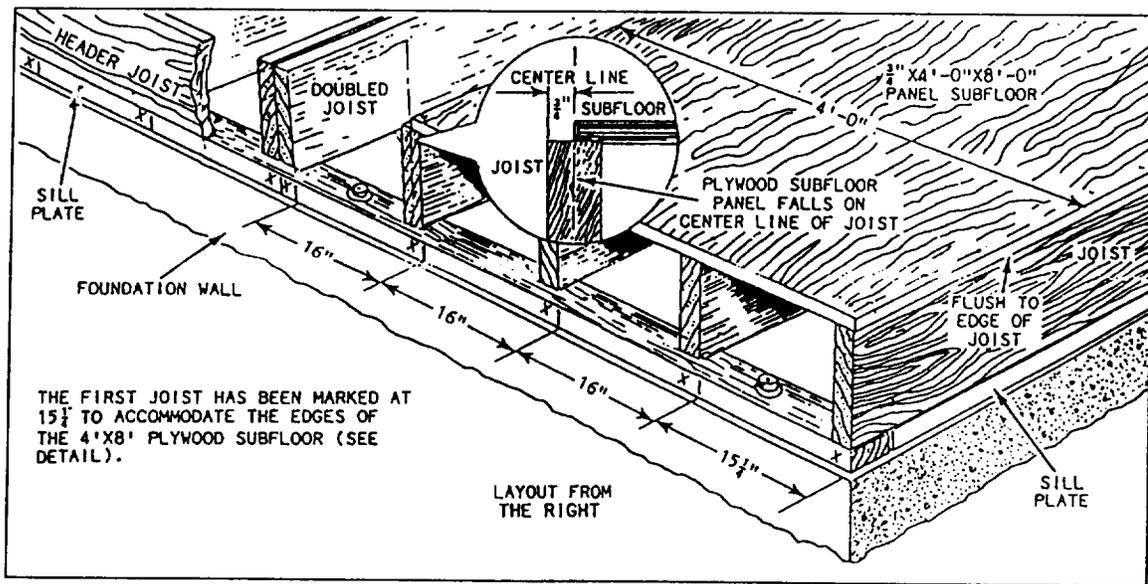


Figure 1-29.—Floor joists layout.

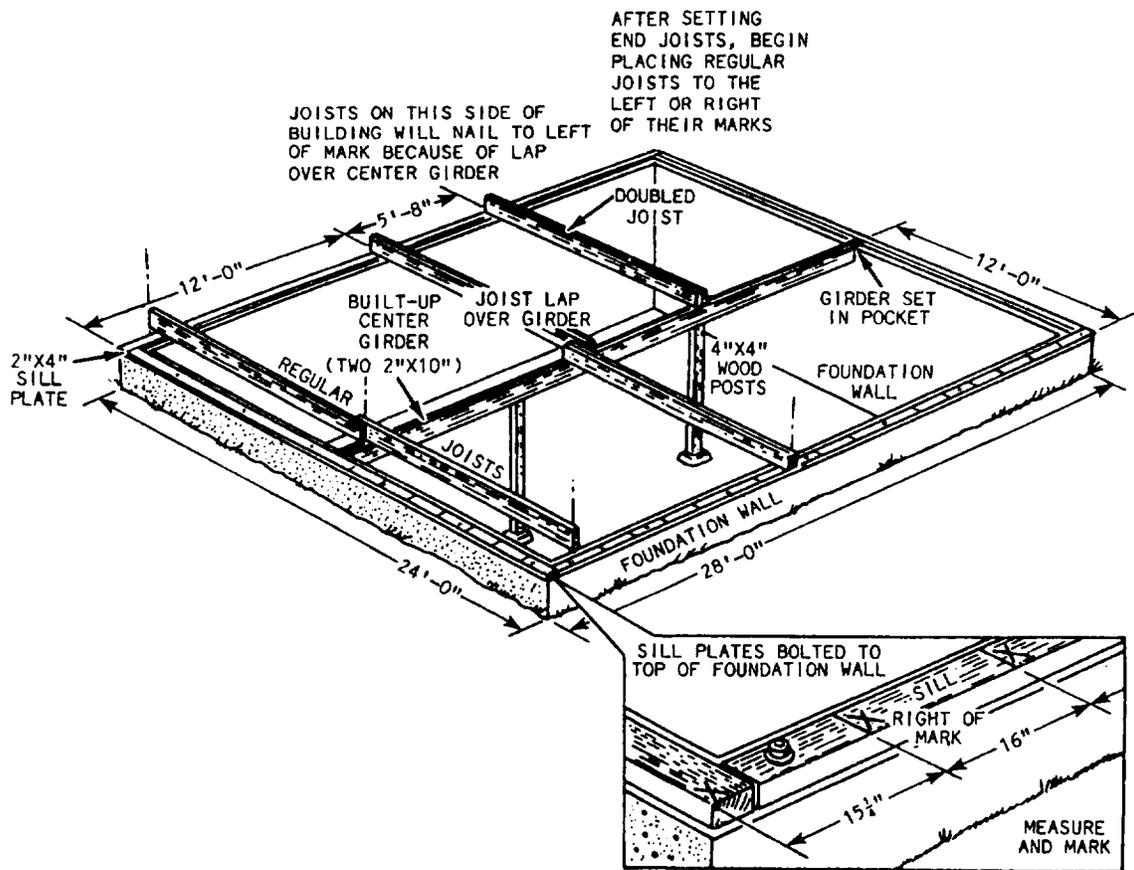


Figure 1-30.—Complete layout for floor joists.

Joists should be laid out so that the edges of standard-size subfloor panels break over the centers of the joists (see insert, fig. 1-29). This layout eliminates additional cutting of panels when they are being fitted and nailed into place. One method of laying out joists this way is to mark the first joists 15 1/4 inches from the

edge of the building. From then on, the layout is 16 inches OC. A layout for the entire floor is shown in figure 1-30.

Most of the framing members should be precut before construction begins. The joists should all be trimmed to their proper lengths. Cross bridging and

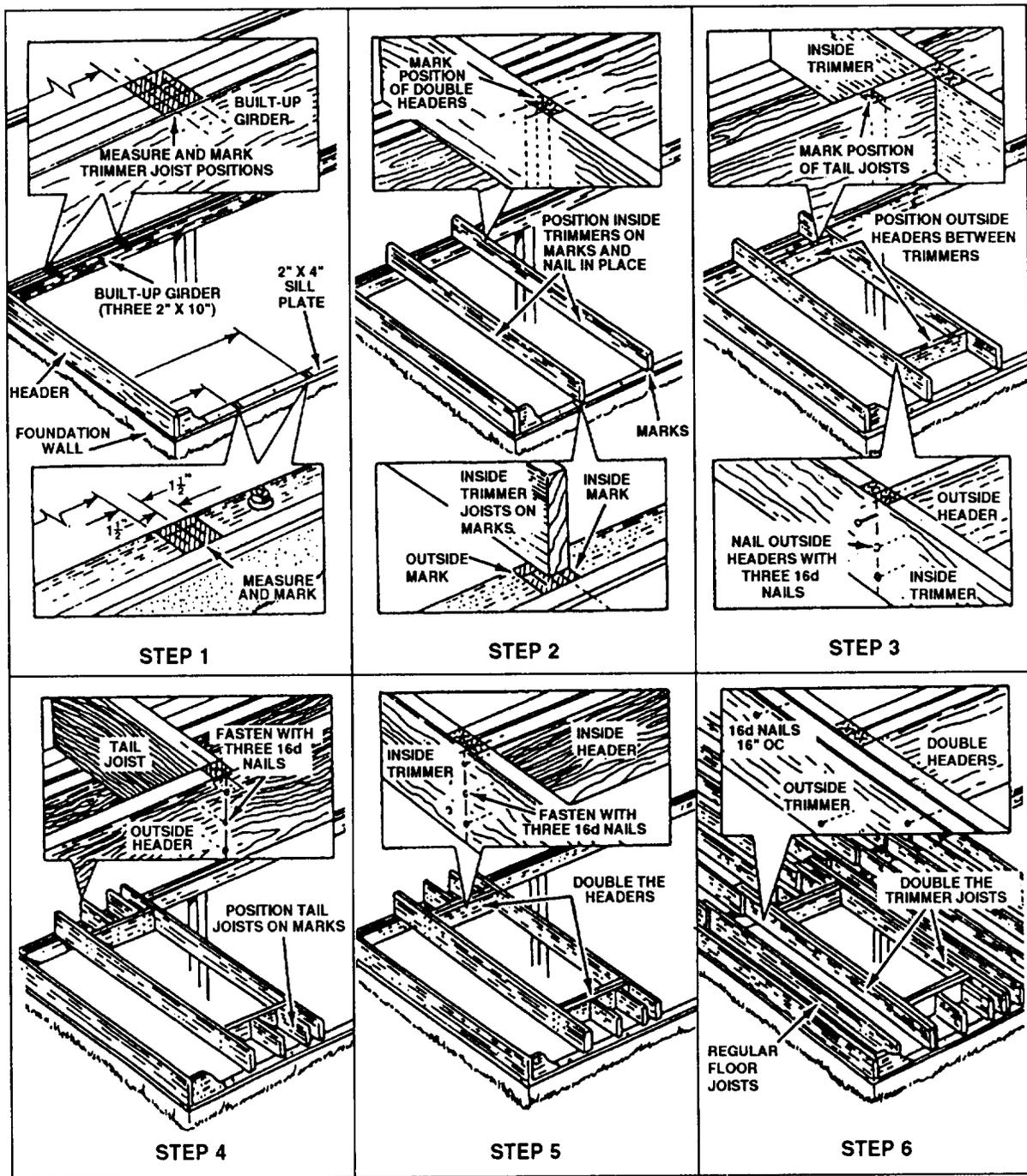


Figure 1-31.—Steps in framing a floor opening.

solid blocks should be cut to fit between the joists having a common spacing. The distance between joists is usually 14 1/2 inches for joists spaced 16 inches OC. Blocking for the odd spaces is cut afterwards.

### Framing Floor Openings

Floor openings, where stairs rise to the floor or large duct work passes through, require special framing. When the joists are cut for such openings, there is a loss

of strength in the area of the opening. You need to frame the opening in a way that restores this strength. The procedure is shown in figure 1-31. Refer to the figure as you study the following steps:

1. Measure and mark the positions of the trimmers on the outside wall and interior wall or girder.
2. Position and fasten the inside trimmers and mark the position of the double headers.

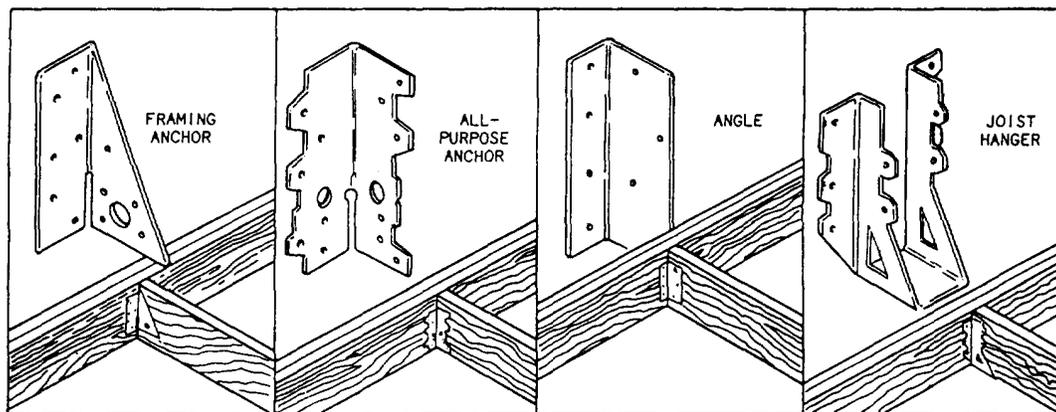


Figure 1-32.—Types of framing anchors.

3. Place the outside pieces between the inside trimmers. Drive three 16d nails through the trimmers into the headers. Mark the position of the tail joists on the headers (the tail joists should follow the regular joist layout).
4. Fasten the tail joists to the outside headers with three 16d nails driven through the headers into the ends of the tail joists.
5. Double the header. Drive three 16d nails through the trimmer joists into the ends of the doubled header pieces. Nail the doubled header pieces to each other with 16d nails staggered 16 inches OC.
6. Double the trimmer joists and fasten them together with 16d nails staggered 16 inches OC.

A pair of joists, called trimmers, is placed at each side of the opening. These trimmers support the headers. The headers should be doubled if the span is more than 4 feet. Nails supporting the ends of the headers are driven through the trimmer joists into the ends of the header pieces. Tail joists (cripple joists) run from the header to a supporting wall or girder. Nails are driven through the header into the ends of the tail joist. Various metal anchors, such as those shown in figure 1-32, are also used to strengthen framed floor openings.

### Crowns

Most joists have a crown (a bow shape) on one side. Each joist should be sighted before being nailed in place to make certain the crown is turned up. The joist will later settle from the weight of the floor and straighten out. Caution should be exercised when sighting the

board for the crown. Some crowns are too large and cannot be turned up for use as a joist.

### SUBFLOOR

The subfloor, also known as rough flooring, is nailed to the top of the floor frame. It strengthens the entire floor unit and serves as a base for the finish floor. The walls of the building are laid out, framed, and raised into place on top of the subfloor.

Panel products, such as plywood, are used for subflooring. Plywood is less labor intensive than board lumber.

Plywood is the oldest type of panel product. It is still the most widely used subfloor material in residential and other light-framed construction. Other types of material available for use as subflooring include nonveneered (reconstituted wood) panels, such as structural particleboard, waferboard, oriented strandboard, and compositeboard.

Plywood is available in many grades to meet a broad range of end uses. All interior grades are also available with fully waterproof adhesive identical with that used in exterior plywood. This type is useful where prolonged moisture is a hazard. Examples are underlayments, subfloors adjacent to plumbing fixtures, and roof sheathing that may be exposed for long periods during construction. Under normal conditions and for sheathing used on walls, standard sheathing grades are satisfactory.

Plywood suitable for the subfloor, such as standard sheathing, structural I and II, and C-C exterior grades, has a panel identification index marking on each sheet.

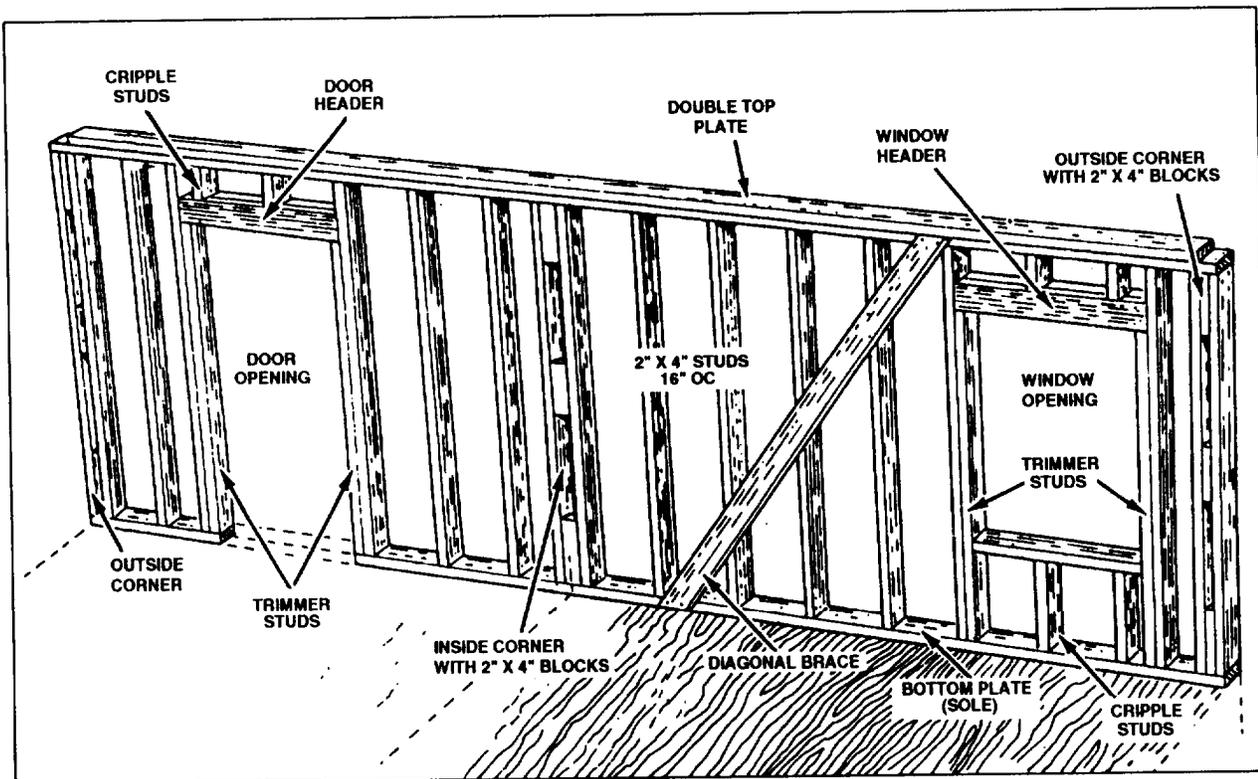


Figure 1-33.—Typical exterior wall.

These markings indicate the allowance spacing of rafters and floor joists for the various thicknesses when the plywood is used as roof sheathing or subfloor. For example, an index mark of 32/16 indicates the plywood panel is suitable for a maximum spacing of 32 inches for rafters and 16 inches for floor joists. Thus, no problem of strength differences between species is involved, as the correct identification is shown for each panel.

Plywood should be installed with the grain of the outer plies at right angles to the joists. Panels should be staggered so that end joints in adjacent panels break over different joists. The nailing schedule for most types of subfloor panels calls for 6d common nails for materials up to 7/8 inch thick and for 8d nails for heavier panels up to 1 1/8 inches thick. Deformed-shank nails are strongly recommended. They are usually spaced 6 inches OC along the edges of the panel and 10 inches OC over intermediate joists.

For the best performance, **do not** lay up plywood with tight joints, whether interior or exterior. Allow for expansion if moisture should enter the joints.

## WALL FRAMING

*LEARNING OBJECTIVE: Upon completing this section, you should be able to identify wall framing members and explain layout and installation procedures for these members in building construction.*

Wall construction begins after the subfloor has been nailed in place. The wall system of a wood-framed building consists of exterior (outside) and interior (inside) walls. The typical exterior wall has door and window openings, as shown in figure 1-33. Interior walls, usually referred to as “partitions,” divide the inside area into separate rooms. Some interior walls have door openings or archways.

Partitions are either bearing or nonbearing. Bearing partitions support the ends of the floor joists or ceiling joists. Nonbearing partitions run in the same direction as the joists and therefore carry little weight from the floor or ceiling above.

Traditionally, 2-by 4-inch structural lumber is used for the framed walls of one-story buildings, although the use of heavier structural lumber is specified at certain locations for particular projects. Multistory buildings,

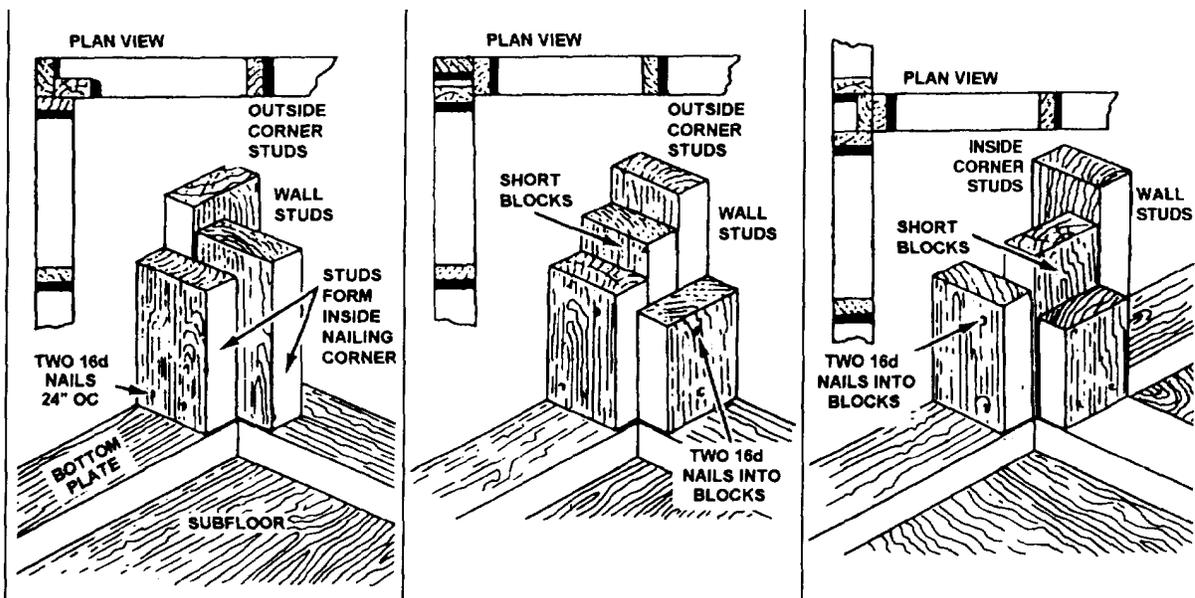


Figure 1-34.—Corner posts.

for example, require heavier structural lumber. This requirement is specific to the lower levels in order to support the weight of the floors above.

## STRUCTURAL PARTS

A wood-framed wall consists of structural parts referred to as “wall components” or “framing members.” The components (shown in fig. 1-33) typically include studs, plates, headers, trimmers, cripples, sills, corner posts, and diagonal braces. Each component is essential to the integrity of the total wall structure.

### Studs

Studs are upright (vertical) framing members running between the top and bottom plates. Studs are usually spaced 16 inches OC, but job specifications sometimes call for 12-inch and 24-inch OC stud spacing.

### Plates

The plate at the bottom of a wall is the soleplate, or bottom plate. The plate at the top of the wall is the top plate. A double top plate is normally used. It strengthens the upper section of the wall and helps carry the weight of the joists and roof rafters. Since top and bottom plates are nailed into all the vertical wall members, they serve to tie the entire wall together.

## Corner Posts

Corner posts are constructed wherever a wall ties into another wall. Outside corners are at the ends of a wall. Inside corners occur where a partition ties into a wall at some point between the ends of the wall.

Three typical designs for corner assemblies are shown in figure 1-34. View A shows outside corner construction using only three studs. View B shows outside corner construction using two studs with short blocks between them at the center and ends. A third full-length stud can be used instead of blocks. View C shows inside corner construction using a block laid flat. A full-length stud can be used instead of a block. Note that all corner assemblies should be constructed from straight stud material and should be well nailed. When framing corners, you can use full-length studs or short blocks.

## Rough Door and Window Openings

A rough opening must be framed into a wall wherever a door or window is planned. The dimensions of the rough opening must allow for the final frame and for the required clearance around the frame.

Figure 1-35 shows details of rough openings for doors and windows in wood-frame construction. The rough opening for atypical door is framed with a header,

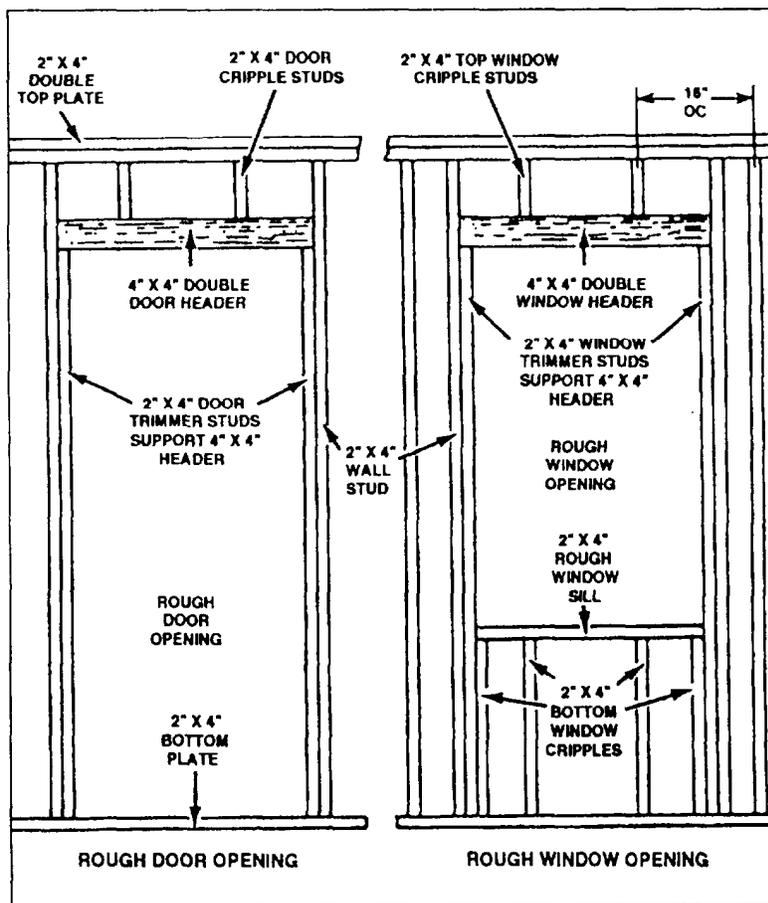


Figure 1-35.—Rough frame openings for doors and windows.

trimmer studs, and, in some cases, top cripple studs. The rough opening for a typical window includes the same members as for a door, plus a rough window sill and bottom cripples.

A header is placed at the top of a rough opening. It must be strong enough to carry the weight bearing down on that section of the wall. The header is supported by trimmer studs fitting between the soleplate and the bottom of the header. The trimmer studs are nailed into the regular studs at each side of the header. Nails are also driven through the regular studs into the ends of the header.

The header may be either solid or built up of two 2 by 4 pieces with a 1/2-inch spacer. The spacer is needed to bring the width of the header to 3 1/2 inches. This is the actual width of a nominal 2 by 4 stud wall. A built-up header is as strong as or stronger than a solid piece.

The type and size of header is shown in the blueprints. Header size is determined by the width of the

opening and by how much weight is bearing down from the floor above.

The tops of all door and window openings in all walls are usually in line with each other. Therefore, all headers are usually the same height from the floor. The standard height of walls in most wood-framed buildings is either 8 feet 3/4 inch or 8 feet 1 inch from the subfloor to the ceiling joists. The standard height of the doors is 6 feet 8 inches.

Cripple studs are nailed between the header and the double top plate of a door opening. These help carry the weight from the top plate to the header. The cripple studs are generally spaced 16 inches OC.

A rough window sill is added to the bottom of a rough window opening. The sill provides support for the finished window and frame to be placed in the wall. The distance between the sill and the header is determined by the dimensions of the window, the window frame, and the necessary clearances at the top and bottom of the frame. Cripple studs, spaced 16 inches OC, are

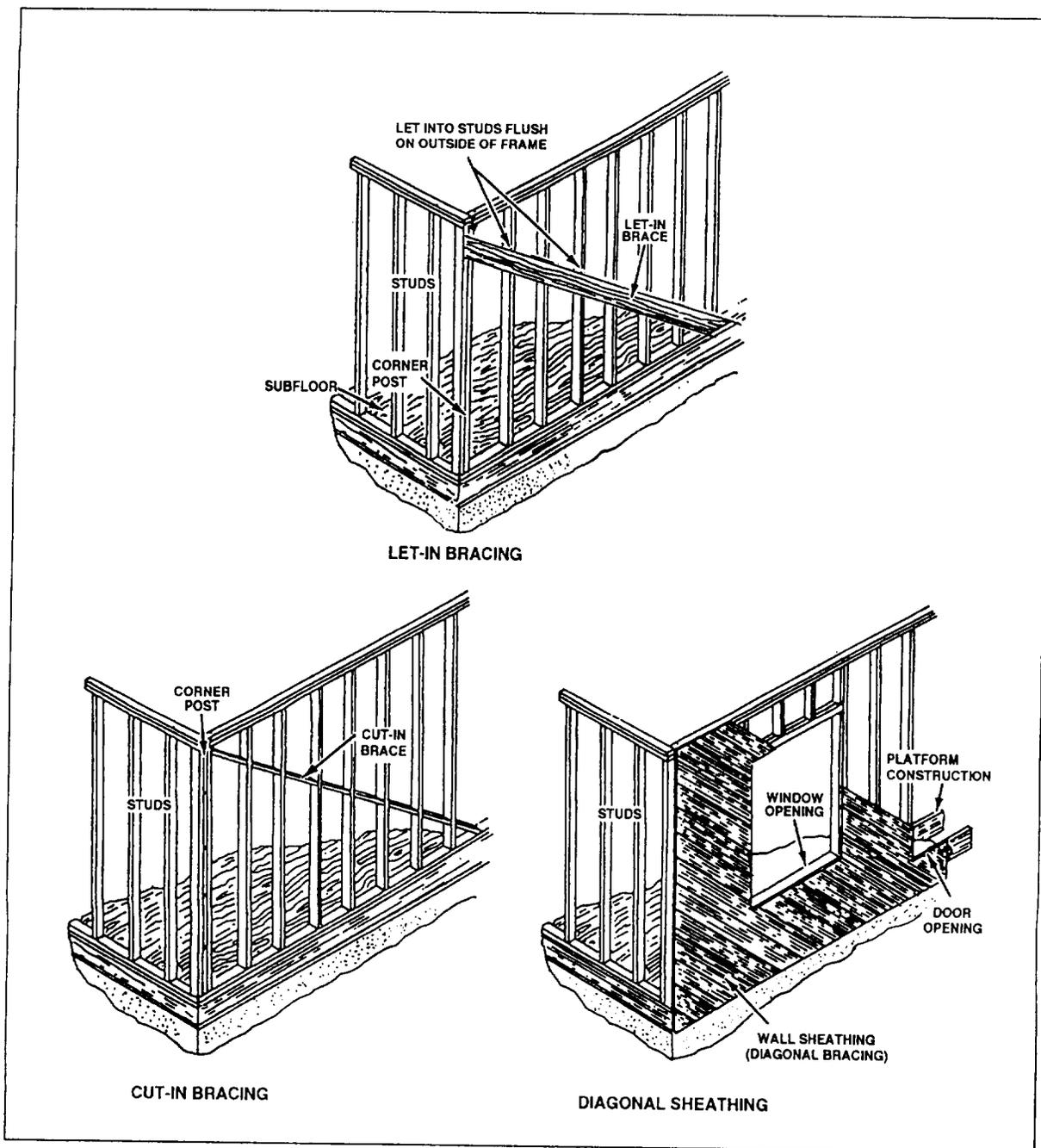


Figure 1-36.—Types of bracing.

nailed between the sill and soleplate. Additional cripple studs may be placed under each end of the sill.

### Bracing

Diagonal bracing is necessary for the lateral strength of a wall. In all exterior walls and main interior partitions, bracing should be placed at both ends (where possible) and at 25-foot intervals. An exception to this

requirement is an outside wall covered with structural sheathing nailed according to building specifications. This type of wall does not require bracing.

Diagonal bracing is most effective when installed at a 45° to 60° angle. You can do this after the wall has been squared and still lying on the subfloor. The most widely used bracing system is the 1 by 4 let-in type, as shown in figure 1-36. The studs are notched so that the 1 by 4 piece is flush with the surface of the studs.

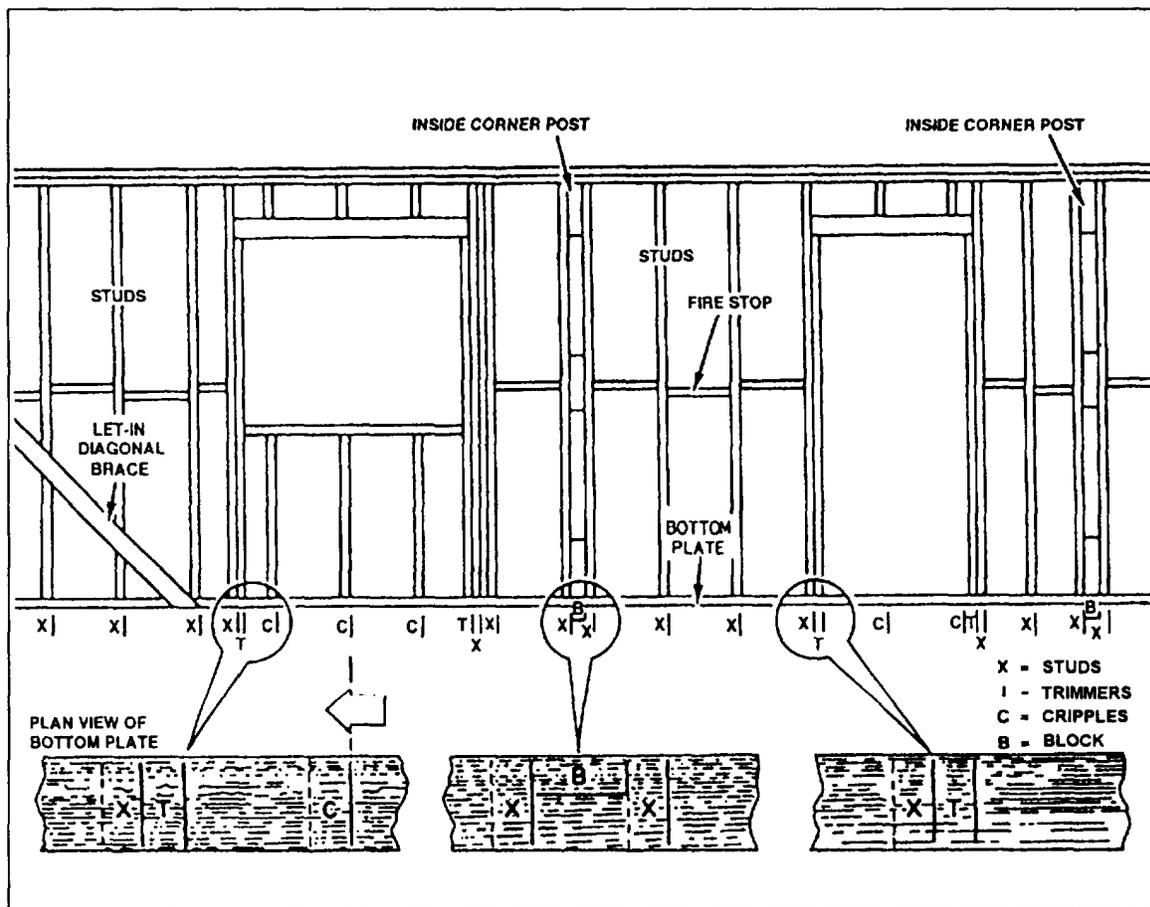


Figure 1-37.—Fire blocking.

Cut-in bracing (fig. 1-36) is another type of diagonal bracing. It usually consists of 2 by 4s cut at an angle and toenailed between studs at a diagonal from the top of a corner post down to the soleplate.

Diagonal sheathing (fig. 1-36) is the strongest type of diagonal bracing. Each board acts as a brace for the wall. When plywood or other panel sheathing is used, other methods of bracing maybe omitted.

### Fire stops

Most local building codes require fire stops (also known as fire blocks) in walls over 8 foot 1 inch high. Fire stops slow down fire travel inside walls. They can be nailed between the studs before or after the wall is raised. Fire stops can be nailed in a straight line or staggered for easier nailing. Figure 1-37 shows a section of a framed wall with fire stops.

It is not necessary to nail fire stops at the midpoint of the wall. They can be positioned to provide additional backing for nailing the edges of drywall or plywood.

### CONSTRUCTION

All major components of a wall should be cut before assembly. By reading the blueprints, you can determine the number of pieces and lengths of all components. The different parts of the wall are then assembled. Any hard, level surface can be used for assembly. After completing nailing, raise the walls in place for securing.

Two layout procedures are used in wall layout: horizontal plate and vertical layout. In horizontal plate layout, the location of the wall is determined from the dimensions found in the floor plan of the blueprints. For vertical layout, the dimension can be found in the sectional views of the building's blueprints.

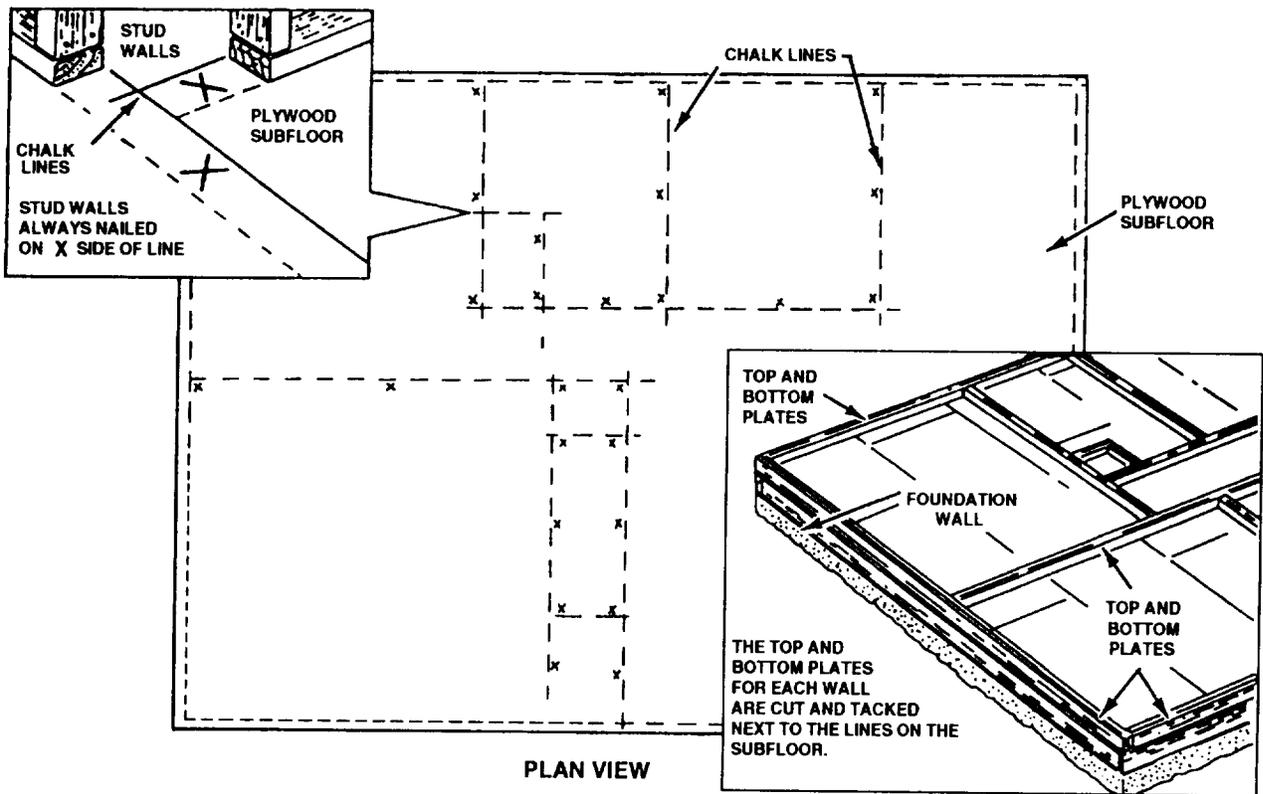


Figure 1-38.—Layout and cutting of plates.

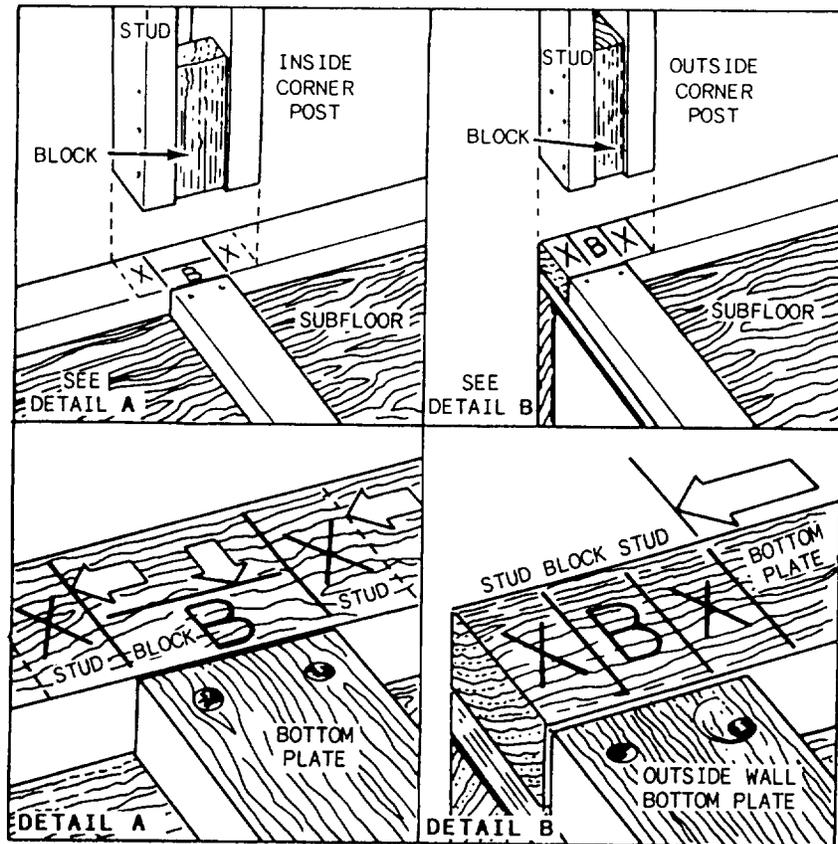


Figure 1-39.—Marking inside and outside corners.

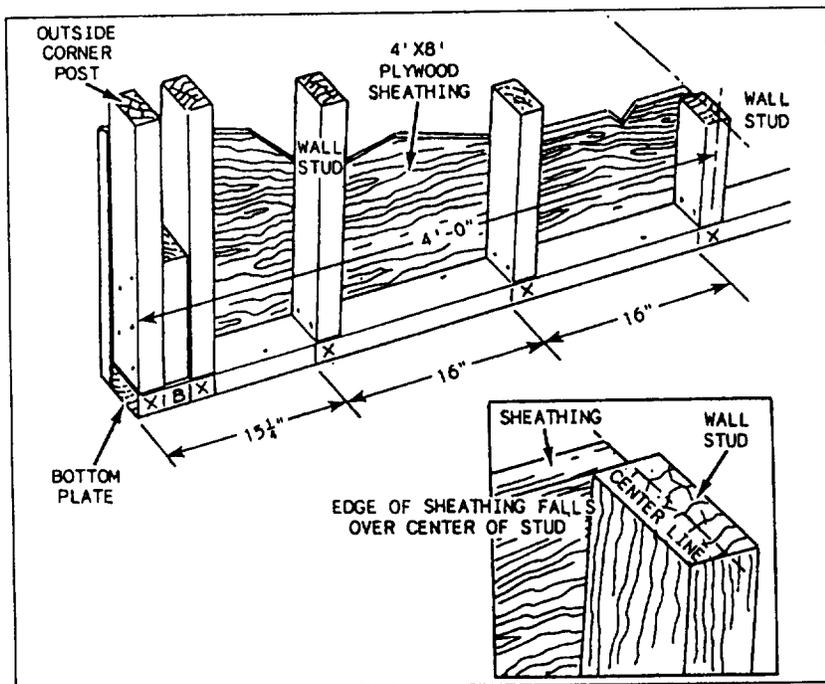


Figure 1-40.—First exterior wall stud layout.

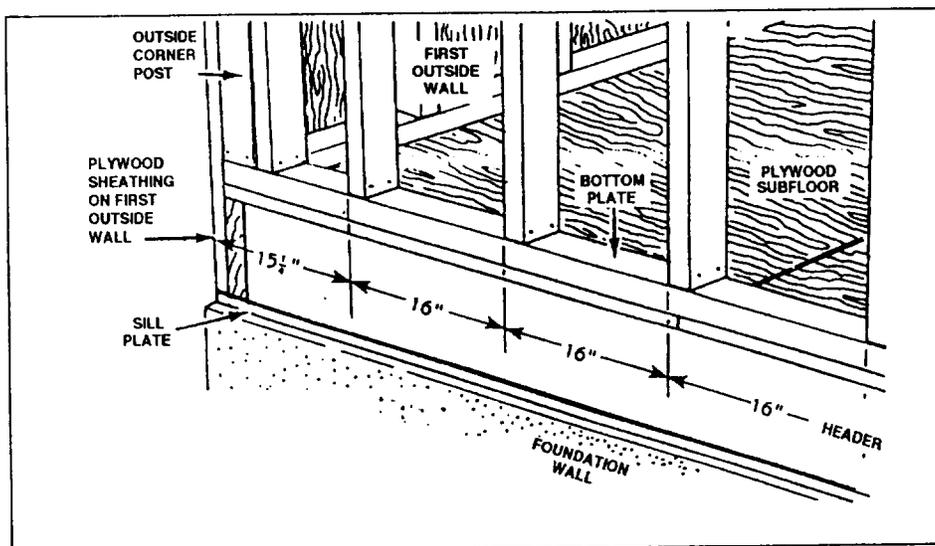


Figure 1-41.—Second exterior wall stud layout.

### Horizontal Plate Layout

After all the lines are snapped, the wall plates are cut and tacked next to the lines (fig. 1-38). The plates are then marked off for corner posts and regular studs, as well as for the studs, trimmers, and cripples for the rough openings. All framing members must be clearly marked on the plates. This allows for efficient and error-free framing. Figure 1-37 shows a wall with framing members nailed in place according to layout markings.

A procedure for marking outside and inside corners for stud-and-block corner post construction is shown in figure 1-39. For laying out studs for the first exterior wall, see figure 1-40. In figure 1-40, the plates are marked for the first stud from a corner to be placed 15 1/4 inches from the end of the runner. Studs after the first stud follow 16 inches OC layout. This ensures the edges of standard-size panels used for sheathing or wallboard fall on the centers of the studs. Cripples are laid out to follow the layout of the studs.

A procedure for laying out studs for the second exterior wall is shown in figure 1-41. The plates are

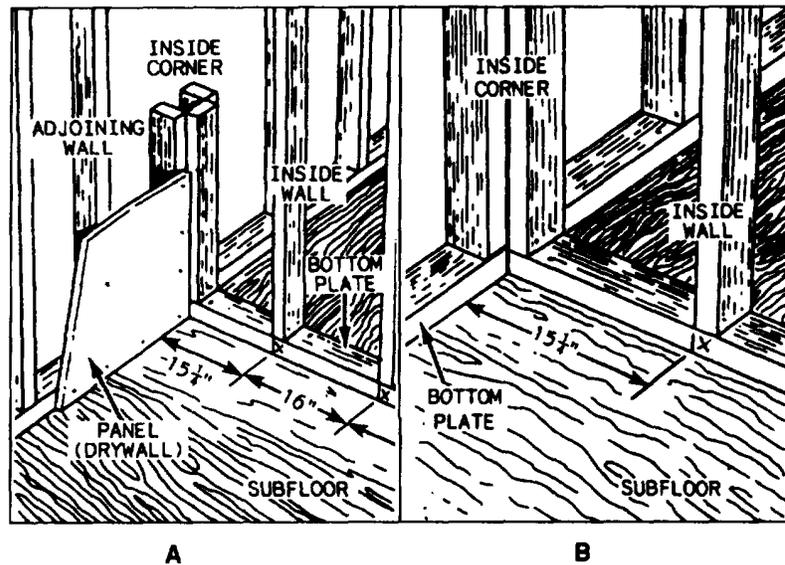


Figure 1-42.—Starting measurement for interior wall.

marked for the first stud to be placed 15 1/4 inches from the outside edge of the panel thickness on the first wall. This layout allows the corner of the first panel on the second wall to lineup with the edge of the first panel on the second wall. Also, the opposite edge of the panel on the second wall will break on the center of a stud.

A procedure for laying out studs for interior walls (partitions) is shown in figure 1-42. If panels are placed on the exterior wall first, the wall plates for the interior wall are marked for the first stud to be placed 15 1/4 inches from the edge of the panel thickness on the exterior wall. If panels are to be placed on the interior wall, the wall plates of the interior wall are marked for the first stud to be placed 15 1/4 inches from the unpaneled exterior wall.

If drywall or other interior finish panels are to be nailed to an adjoining wall (fig. 1-42, view A), you must measure 15 1/4 inches plus the thickness of the material. When panels are to be nailed on a wall first (view B), measure and mark the 15 1/4 inches from the front surface of the bottom plate. These procedures ensure stud alignment remains accurate throughout the nailing process.

Rough openings for doors and windows must also be marked on the wall plates. The rough opening dimensions for a window (fig. 1-43, view A) or wood door (view B) are calculated based on the window or door width, the thickness of the finish frame, and 1/2-inch clearance for shim materials at the sides of the

frame. Some blueprint door and window schedules give the rough opening dimensions, simplifying the layout.

A rough opening for a metal window often requires a 1/2-inch clearance around the entire frame. When the measurements are not given in the window schedule, take them from the manufacturer's installation instructions supplied with the windows.

A completely laid out bottom plate includes markings for corner posts, rough openings, studs, and cripples. The corner posts are laid out first. Next, the 16-inch marks for the studs and cripples are marked, and then the marks for the rough openings are made.

Some Builders prefer to layout the rough openings before the studs and cripples are marked. There is, however, an advantage to laying out the 16-inch OC marks first. Studs and trimmers framing a door and window often fall very close to a 16-inch OC stud mark. Slightly shifting the position of the rough opening may eliminate an unnecessary stud from the wall frame.

### Vertical Layout

Vertical layout is the procedure for calculating the lengths of the different vertical members of a wood-framed wall. This makes it possible to precut all studs, trimmers, and cripples required for a building.

Some blueprints contain section views giving the exact rough heights of walls. The rough height is the distance from the subfloor to the bottom of the ceiling

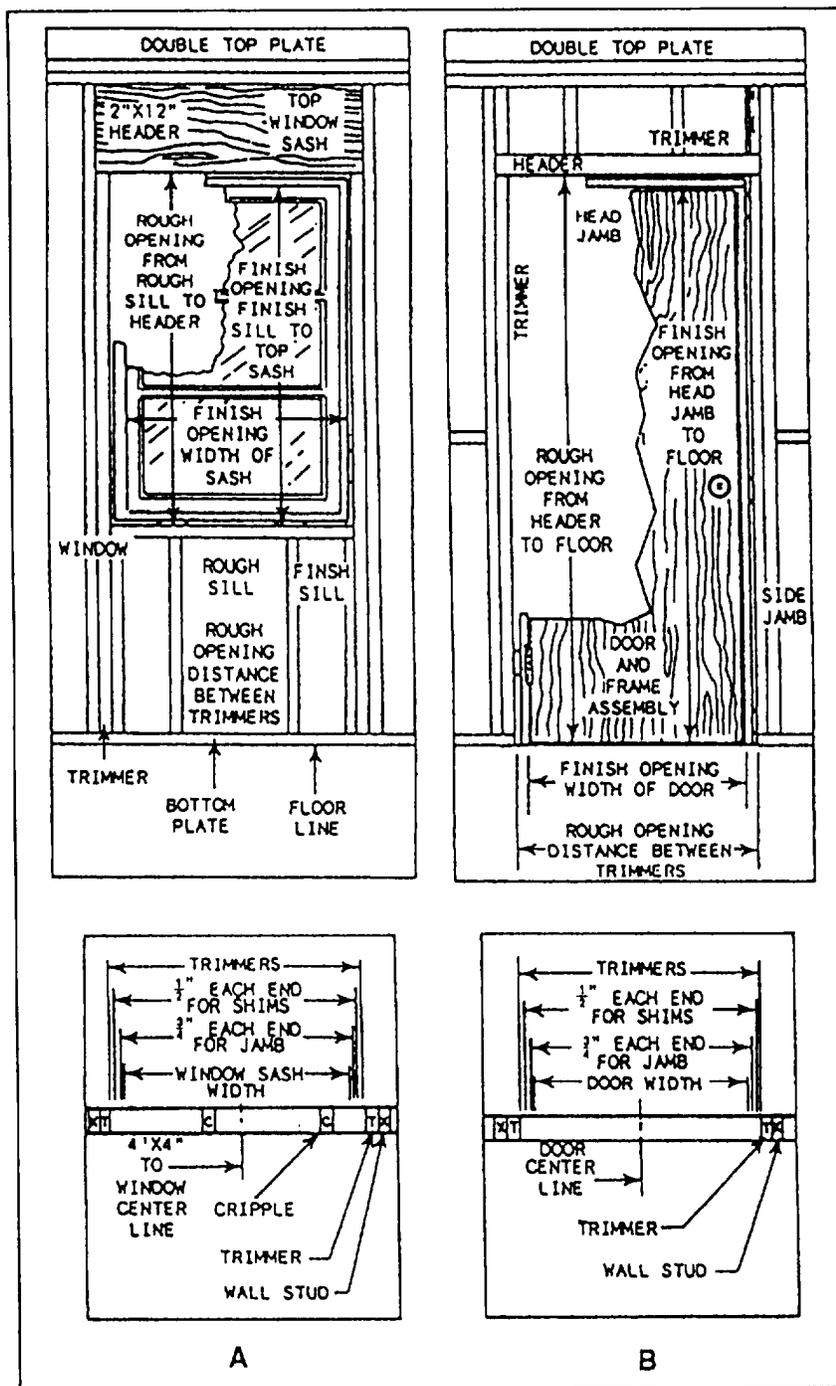


Figure 1-43.—Measurements for windows and doors.

joists. The rough height to the top of the door (the distance from the subfloor to the bottom of the door header) may also be noted on the section drawing. In addition, it may be given in the column for rough opening measurements on the door schedule. The rough height to the top of the door establishes the measurement for the rough height to the top of the window, as window headers are usually in line with door headers.

The distance from the bottom to the top of a rough window opening can be found by measuring down from the bottom of the window header using dimensions provided in the rough opening column of the window schedule.

Many Builders prefer to frame the door and window openings before assembling the wall. View A of

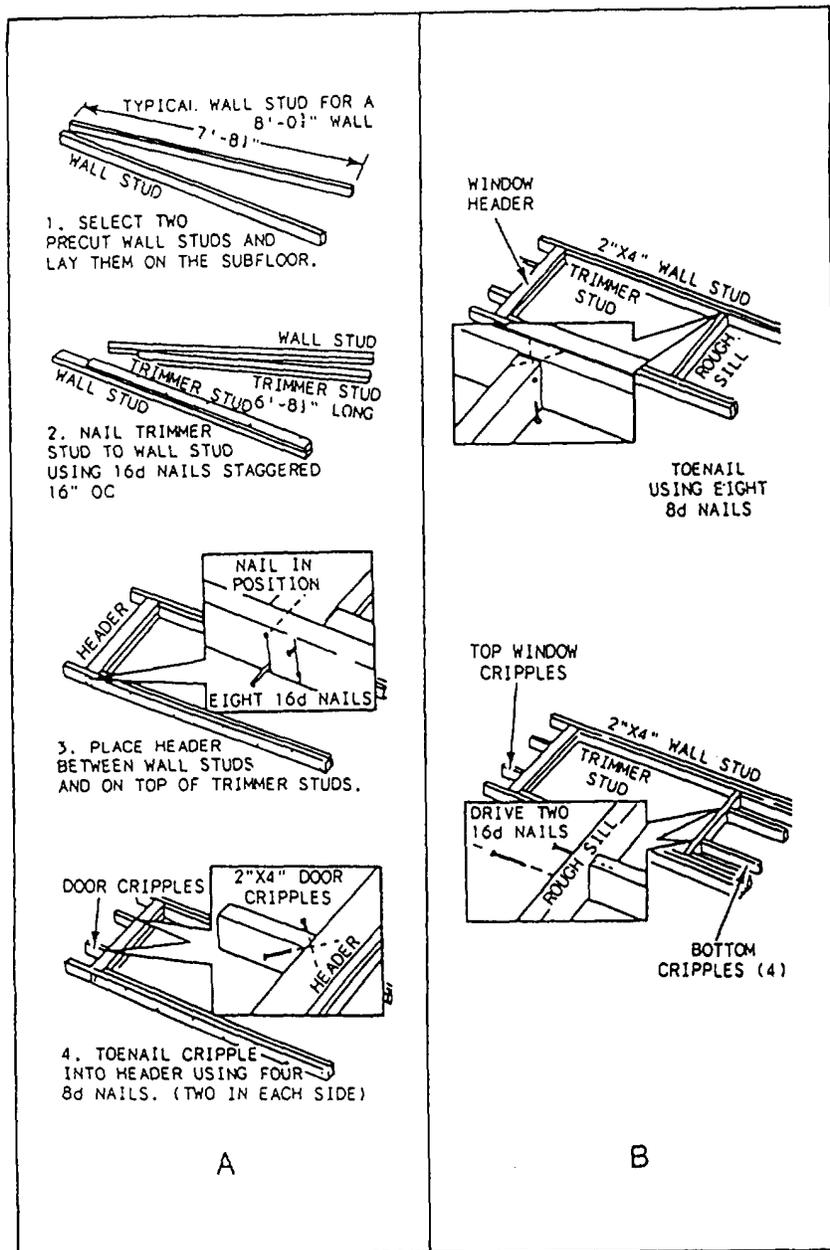


Figure 1-44.—Framing typical door and window openings.

figure 1-44 shows typical door framing; view B shows typical window framing. After stud layout, cripple studs are laid out (usually 16 inches OC) and nailed between the header and top plate and rough window sill and soleplate. It is a good practice to place a cripple stud under each end of a sill.

### ASSEMBLY

After the corners and openings for doors and windows have been made up, the entire wall can be nailed together on the subfloor (fig. 1-45). Place top

and bottom plates at a distance slightly greater than the length of the studs. Position the corners and openings between the plates according to the plate layout. Place studs in position with the crown side up. Nail the plates into the studs, cripples, and trimmers. On long walls, the breaks in the plates should occur over a stud or cripple.

### Placing the Double Top Plate

The double top plate (fig. 1-46) can be placed while the wall is still on the subfloor or after all the walls have

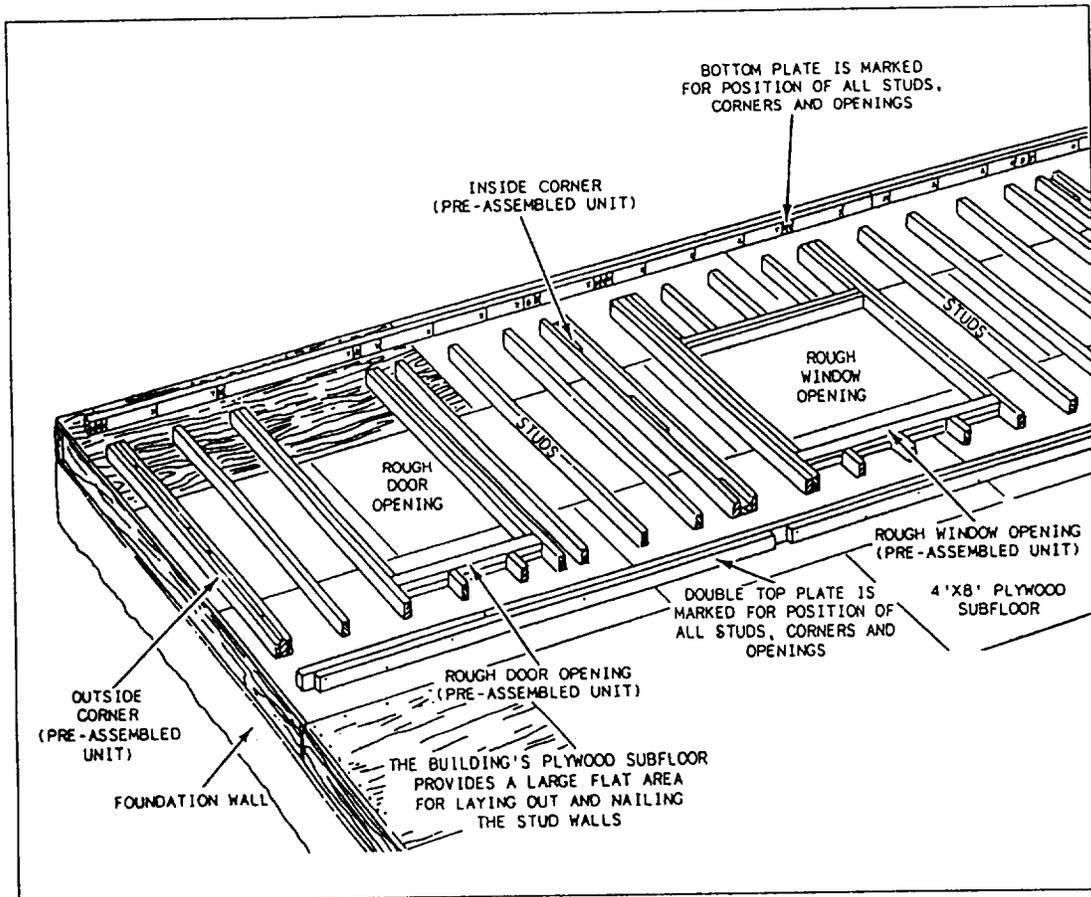


Figure 1-45.—Assembly of wall components.

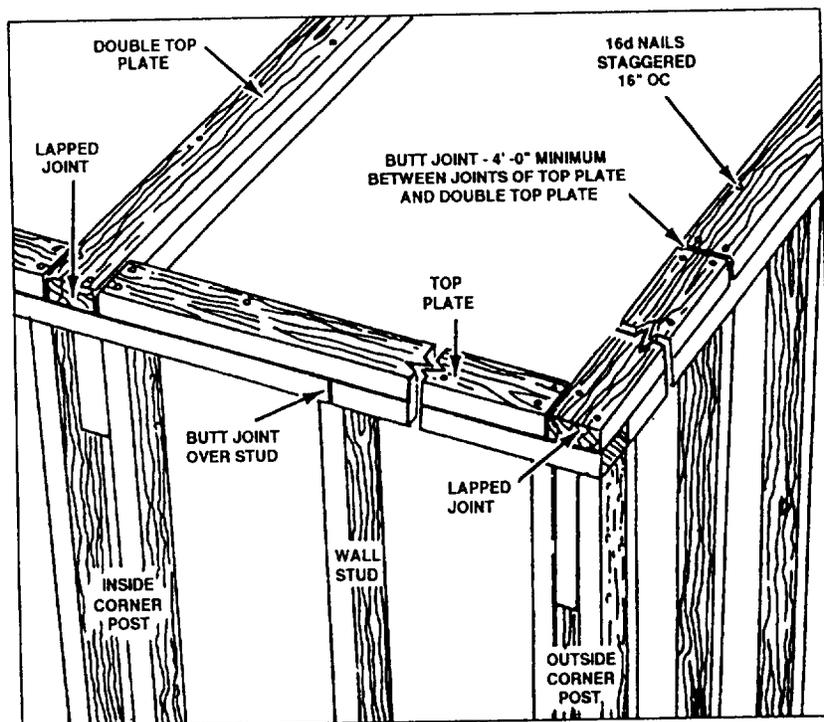


Figure 1-46.—Double top plate.

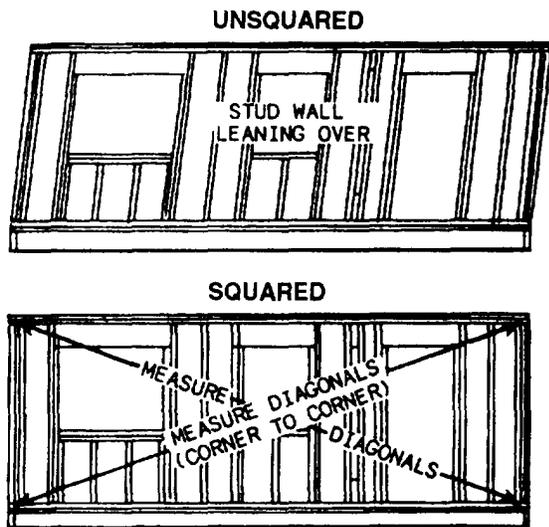


Figure 1-47.—Squaring a wall.

been raised. The topmost plates are nailed so that they overlap the plates below at all corners. This helps to tie the walls together. All ends are fastened with two 16d nails. Between the ends, 16d nails are staggered 16 inches OC. The butt joints between the topmost plates should be at least 4 feet from any butt joint between the plates below them.

### Squaring Walls and Placing Braces

A completely framed wall is often squared while it is still lying on the subfloor. In this way, bracing, plywood, or other exterior wall covering can be nailed before the wall is raised. When diagonal measurements are equal, the wall is square. Figure 1-47 shows examples of unsquared and squared walls.

A let-in diagonal brace maybe placed while the wall is still on the subfloor. Lay out and snap a line on the studs to show the location of the brace (fig. 1-48). The studs are then notched for the brace. Tack the brace to the studs while the wall is still lying on the subfloor. Tacking instead of nailing allows for some adjustment after the wall is raised. After any necessary adjustment is made, the nails can be securely driven in.

### Raising

Most walls can be raised by hand if enough help is available. It is advisable to have one person for every 10 feet of wall for the lifting operation.

The order in which walls are framed and raised may vary from job to job. Generally, the longer exterior walls are raised first. The shorter exterior walls are then raised, and the comers are nailed together. The order of framing interior partitions depends on the floor layout.

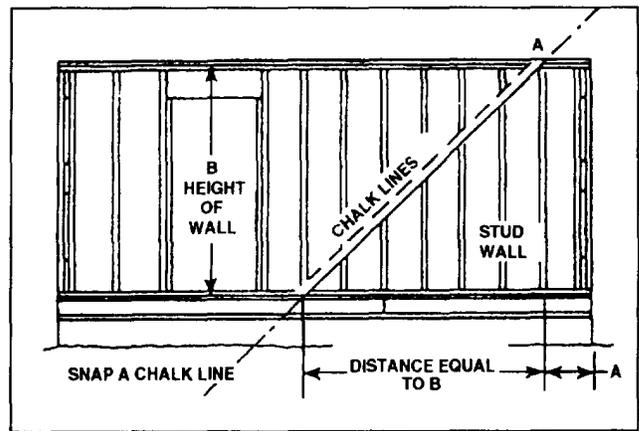


Figure 1-48.—Let-in diagonal brace.

After a wall has been raised, its bottom plates must be nailed securely to the floor. Where the wall rests on a wood subfloor and joists, 16d nails should be driven through the bottom plate and into the floor joists below the wall.

### Plumbing and Aligning

Accurate plumbing of the comers is possible only after all the walls are up. Most framing materials are not perfectly straight; walls should never be plumbed by applying a hand level directly to an end stud. Always use a straightedge along with the level, as shown in figure 1-49, view A. The straightedge can be a piece ripped out of plywood or a straight piece of 2 by 4 lumber. Blocks 3/4 inch thick are nailed to each end. The blocks make it possible to accurately plumb the wall from the bottom plate to the top plate.

Plumbing corners requires two persons working together—one working the bottom area of the brace and the other watching the level. The bottom end of the brace is renailed when the level shows a plumb wall.

The tops of the walls (fig. 1-49, view B) are straightened (aligned or lined up) after all the corners have been plumbed. Prior to nailing the floor or ceiling joists to the tops of the walls, make sure the walls are aligned. Here's how: Fasten a string from the top plate at one corner of the wall to the top plate at another corner of the wall. You then cut three small blocks from 1 by 2 lumber. Place one block under each end of the string so that the line is clear of the wall.

The third block is used as a gauge to check the wall at 6- or 8-foot intervals. At each checkpoint, a temporary brace is fastened to a wall stud.

When fastening the temporary brace to the wall stud, adjust the wall so that the string is barely touching the gauge block. Nail the other end of the brace to a short 2 by 4 block fastened to the subfloor. These temporary

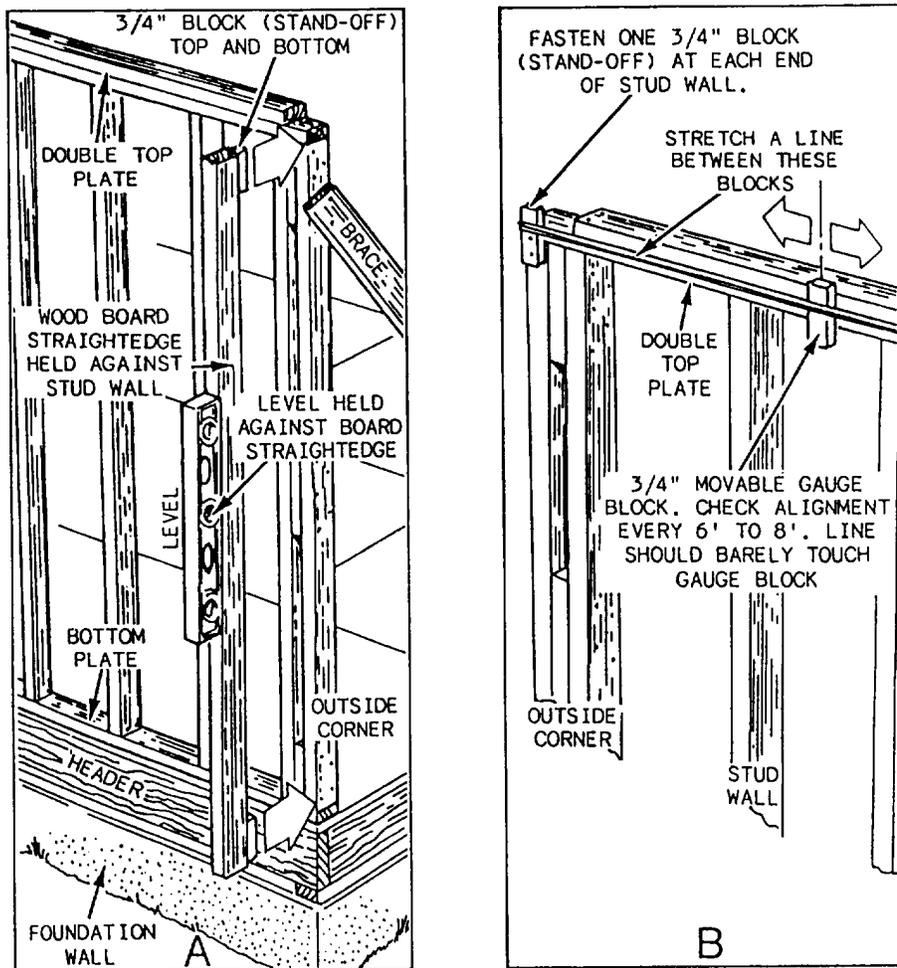


Figure 1-49.—Plumbing and aligning corners and walls.

braces are not removed until the framing and sheathing for the entire building have been completed.

### Framing over Concrete Slabs

Often, the ground floor of a wood-framed building is a concrete slab. In this case, the bottom plates of the walls must be either bolted to the slab or nailed to the slab with a powder-actuated driver. If bolts are used, they must be accurately set into the slab at the time of the concrete pour. Holes for the bolts are laid out and drilled in the bottom plate when the wall is framed. When the wall is raised, it is slipped over the bolts and secured with washers and nuts.

Occasionally, on small projects, the soleplate is bolted or fastened down first. The top plate is nailed to the studs, and the wall is lifted into position. The bottom ends of the studs are toenailed into the plate. The rest of the framing procedure is the same as for walls nailed on top of a subfloor.

### SHEATHING THE WALLS

Wall sheathing is the material used for the exterior covering of the outside walls. In the past, nominal 1-inch-thick boards were nailed to the wall horizontally or at a 45° angle for sheathing. Today, plywood and other types of panel products (waferboard, oriented strandboard, compositeboard) are usually used for sheathing. Plywood and nonveneered panels can be applied much quicker than boards. They add considerable strength to a building and often eliminate the need for diagonal bracing.

Generally, wall sheathing does not include the finished surface of a wall. Siding, shingles, stucco, or brick veneer are placed over the sheathing to finish the wall. Exterior finish materials are discussed later in this TRAMAN.

### Plywood

Plywood is the most widely used sheathing material. Plywood panels usually applied to exterior

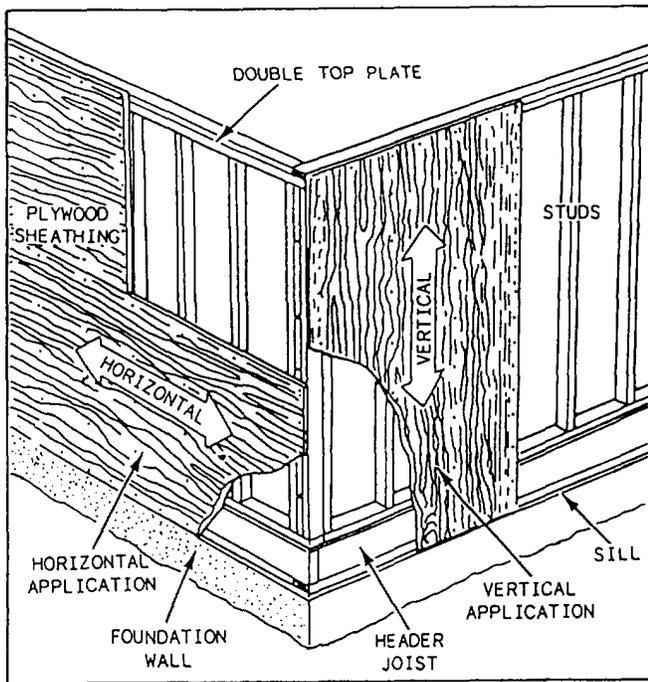


Figure 1-50.—Plywood sheathing.

walls range in size from 4 by 8 feet to 4 by 12 feet with thicknesses from 5/16 inch to 3/4 inch. The panels may be placed with the grain running vertically or horizontally (fig. 1-50). Specifications may require blocking along the long edges of horizontally placed panels.

Typical nailing specifications require 6d nails with panels 1/2 inch or less in thickness and 8d nails for panels more than 1/2 inch thick. The nails should be spaced 6 inches apart along the edges of the panels and 12 inches apart at the intermediate studs.

When nailing the panels, leave a 1/8-inch gap between the horizontal edges of the panels and a 1/16-inch gap between the vertical edges. These gaps allow for expansion caused by moisture and prevent panels from buckling.

In larger wood-framed buildings, plywood is often nailed to some of the main interior partitions. The result is called a shear wall and adds considerable strength to the entire building.

Plywood sheathing can be applied when the squared wall is still lying on the subfloor. However, problems can occur after the wall is raised if the floor is not perfectly straight and level. For this reason, some Builders prefer to place the plywood after the entire building has been framed.

#### Nonveneered Panels

Although plywood is the most commonly used material for wall sheathing, specs sometimes call for

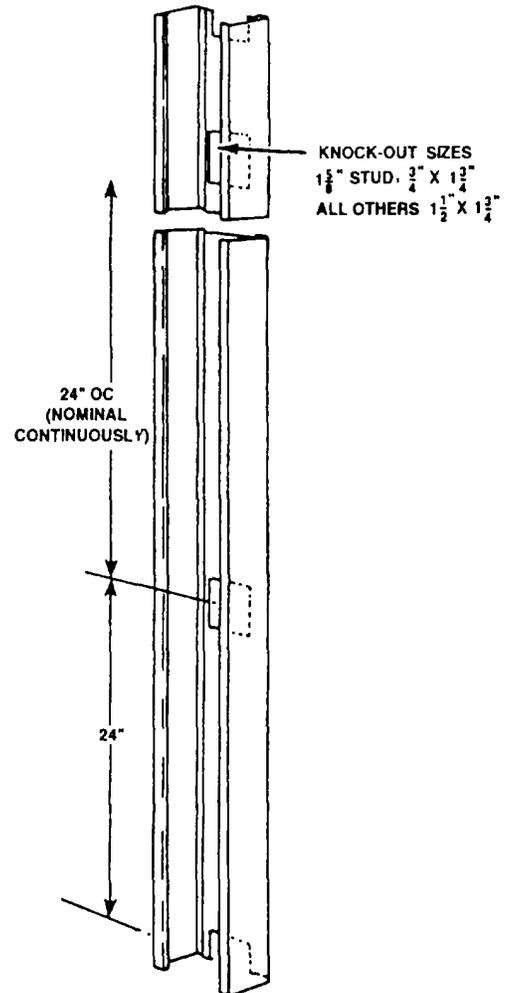


Figure 1-51.—Typical metal stud construction.

nonveneered (reconstituted wood) panels. Panels made of waferboard, oriented strandboard, and composite-board have been approved by most local building codes for use as wall sheathing. Like plywood, these panels resist racking, so no corner bracing is necessary in normal construction. However, where maximum shear strength is required, conventional veneered plywood panels are still recommended.

The application of nonveneered wall sheathing is similar to that for plywood. Nailing schedules usually call for 6d common nails spaced 6 inches OC above the panel edges, and 12 inches OC when nailed into the intermediate studs. Nonveneered panels are usually applied with the long edge of the panel in a vertical position.

#### METAL FRAMING

Metal is an alternative to wood framing. Many buildings are framed entirely of metal, whereas some

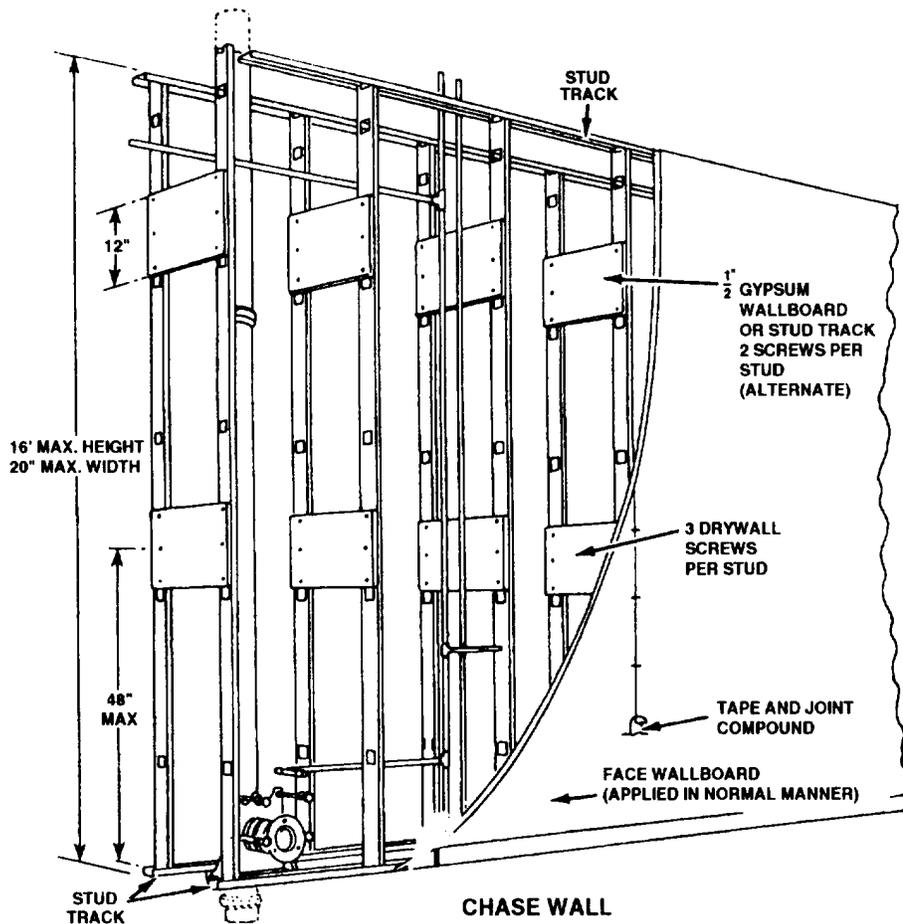


Figure 1-52.—Chase wall construction.

buildings are framed in a combination of metal and wood.

The metal framing members generally used are cold-formed steel, electrogalvanized to resist corrosion. Thicknesses range from 18 gauge to 25 gauge, the latter being most common. Most metal studs have notches at each end and knockouts located about 24 inches OC (fig. 1-51) to facilitate pipe and conduit installation. The size of the knockout, not the size of the stud, determines the maximum size of pipe or other material that can be passed through horizontally.

Chase (or double stud) walls (fig. 1-52) are often used when large pipes, ducts, or other items must pass vertically or horizontally in the walls. Studs are generally available in thicknesses of 1 5/8, 2 1/2, 3 5/8, 4, and 6 inches. The metal runners used are also 25-gauge (or specified gauge) steel or aluminum, sized to complement the studs. Both products have features advantageous to light-frame construction. The metal studs and runners do not shrink swell, twist, or warp. Termites cannot affect them, nor are they susceptible to

dry rot. Also, when combined with proper covering material, they have a high fire-resistance rating.

A variety of systems have been developed by manufacturers to meet various requirements of attachment, sound control, and fire resistance. Many of the systems are designed for ease in erection, yet they are still remountable for revising room arrangements.

The framing members are assembled with power screwdrivers and using self-drilling, self-tapping screws. The floor assembly is fastened to the foundation or concrete slab with studs (special nails) driven through the stud track (runner) by a powder-actuated stud driver. The plywood subfloor is installed over the metal floor framing system with self-drilling, self-tapping screws and structural adhesive. Wall sections are assembled at the jobsite or delivered as preassembled panels from an off-site prefabrication shop. Conventional sheathing is attached to the framework with self-tapping screws.

Door frames for both the interior partitions and exterior walls are integral with the system. They are preprinted and may come complete with necessary

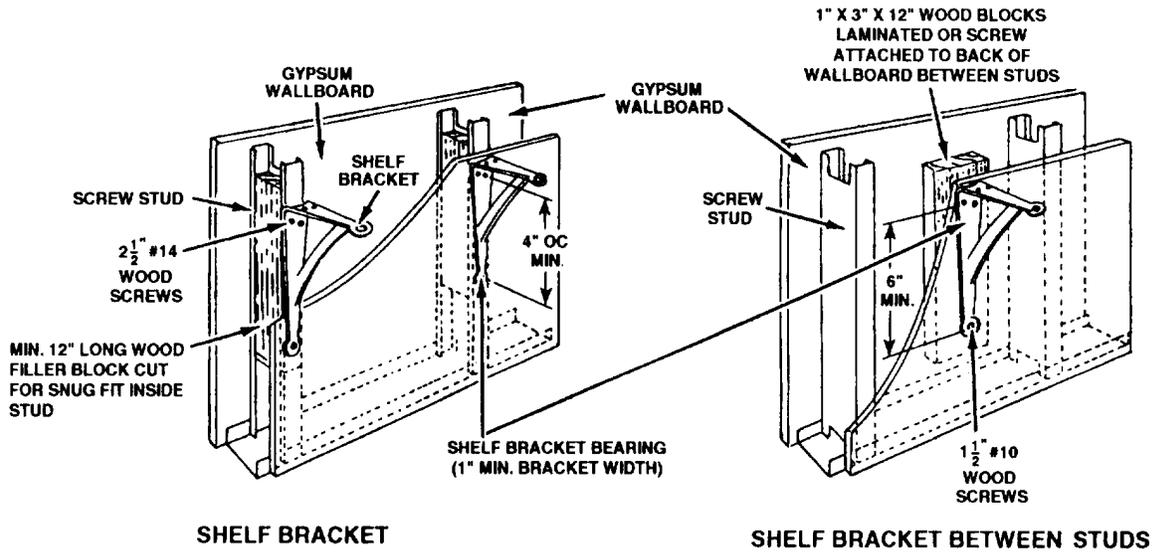


Figure 1-53.—Wood blocking for ceiling or wall-mounted fixtures.



Figure 1-54.—Standard corner bead.



Figure 1-55.—Multiflex tape bead.

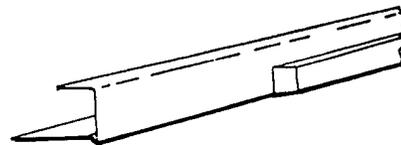


Figure 1-56.—Casing and trim beads.

hinges, locks, rubber stops, and weather stripping. The windows are also integral to the system, prefabricated and painted. These units may include interior and exterior trim designed to accept 1/2-inch wallboard and 1/2-inch sheathing plus siding on the outside.

Plumbing is installed in prepunched stud webs. Wiring is passed through insulated grommets inserted in the prepunched webs of the studs and plates. Wall and ceiling fixtures are mounted by attaching wood blocking spaced between the flanges of the wall studs or trusses

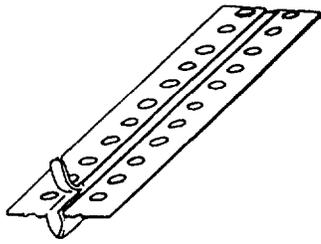


Figure 1-57.—Expansion joint.

(fig. 1-53). Friction-tight insulation is installed by placing the batts (bundles of insulating material) between the studs on the exterior walls. Studs are spaced 12, 16, or 24 inches OC as specified in the blueprints.

### Corner and Casing Beads

Standard wallboard corner bead is manufactured from galvanized steel with perforated flanges, as shown in figure 1-54. It provides a protective reinforcement of straight corners. The corner bead is made with 1-inch by 1-inch flanges for 3/8- or 1/2-inch single-layer wallboard; 1 inch by 1 1/4 inches for 1/2-inch

or 5/8-inch single-layer wallboard; 1 1/4 inches by 1 1/4 inches for two-layer wallboard application. It is available in 10-foot lengths.

Multiflex tape bead consists of two continuous metal strips on the undersurface of 2 1/8-inch-wide reinforcing tape (fig. 1-55). This protects corners formed at any angle. Multiflex tape bead comes in 100-foot rolls.

Casing and trim beads (examples are shown in fig. 1-56) are used as edge protection and trim around window and door openings and as moldings at ceiling angles. They are made from galvanized steel in three styles to fit 3/8-inch, 1/2-inch, and 5/8-inch wallboard and come in 10-foot lengths.

### Expansion Joints

Expansion joints are vinyl extrusions used as control joints in drywall partitions and ceilings. A typical form is shown in figure 1-57.

Figure 1-58 shows a typical metal frame layout and use of corner and casing beads for corners, partition intersections, and partition ends. It also shows a typical

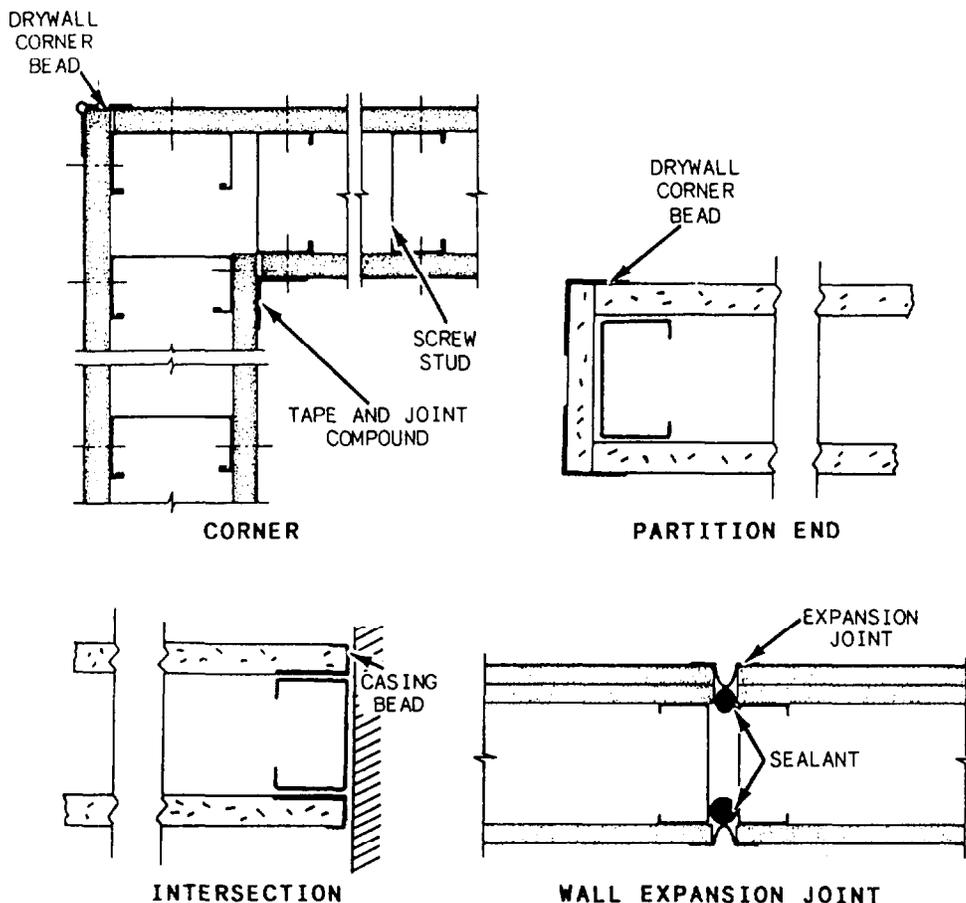
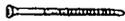
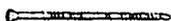
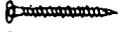
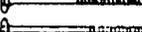
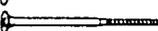
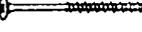
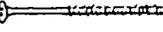
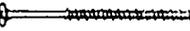


Figure 1-58.—Metal frame layout with various beads and joints.

	HEAD	LENGTH	FASTENING APPLICATION
	LOW PROFILE	$\frac{1}{2}$ "	METAL-TO-METAL, REDUCES DRYWALL BULGE OVER SCREW.*
	TRIM	1"	BATTEN TO METAL STUD.*
	TRIM	$1\frac{5}{8}$ "	WOOD TRIM ON SINGLE LAYER DRYWALL TO METAL FRAMING.*
	TRIM	$2\frac{1}{4}$ "	WOOD TRIM ON DOUBLE LAYER DRYWALL TO METAL FRAMING.*
	WASHER HEAD	$\frac{1}{2}$ "	METAL LATH TO STEEL FRAMING.*
	BUGLE	$1\frac{1}{2}$ "	BOARD-TO-BOARD DURING LAMINATION.
	BUGLE	$1\frac{1}{4}$ "	DRYWALL OR CHANNELS TO WOOD FRAMING.
	PAN	$\frac{3}{8}$ "	METAL-TO-METAL*
	PAN	$\frac{1}{2}$ "	METAL STUDS TO RUNNERS. DOOR FRAME CLIPS TO METAL STUDS.*
	PAN	$\frac{3}{8}$ "	METAL STUDS TO METAL RUNNERS SPLICING STUDS.
	BUGLE	1"	$\frac{1}{2}$ " OR $\frac{5}{8}$ " DRYWALL TO METAL FRAMING.*
	BUGLE	$1\frac{1}{4}$ "	METAL LATH TO METAL STUDS.*
	BUGLE	$1\frac{5}{8}$ "	DOUBLE LAYER $\frac{1}{2}$ " OR $\frac{5}{8}$ " DRYWALL TO METAL FRAMING.*
	BUGLE	$1\frac{7}{8}$ "	MULTI-LAYER DRYWALL TO METAL FRAMING.*
	BUGLE	2"	LAMINATED DRYWALL UP TO $1\frac{5}{8}$ " THICK TO METAL FRAMING.*
	BUGLE	$2\frac{1}{4}$ "	DOUBLE LAYER 1" SHAFTLINER TO METAL FRAMING.*
	BUGLE	$2\frac{5}{8}$ "	LAMINATED DRYWALL UP TO $2\frac{1}{4}$ " THICK TO FRAMING.*
	BUGLE	3"	MULTI-LAYER DRYWALL UP TO $2\frac{1}{2}$ " THICK TO FRAMING.*
	TRIM	1"	BATTEN OVER DRYWALL TO METAL STUD.
	TRIM	$1\frac{5}{8}$ "	WOOD TRIM OVER DRYWALL TO METAL STUD.
	TRIM	$2\frac{1}{4}$ "	WOOD TRIM OVER DOUBLE LAYER DRYWALL TO METAL STUD.
	BUGLE	1"	$\frac{1}{2}$ " OR $\frac{5}{8}$ " DRYWALL TO METAL STUD UP TO 20 GAUGE. STEEL CHANNELS TO WOOD FRAMING.
	BUGLE	$1\frac{1}{8}$ "	$\frac{5}{8}$ " DRYWALL CEILING ATTACHMENTS.
	BUGLE	$1\frac{1}{4}$ "	$\frac{5}{8}$ " DRYWALL CEILING ON RESILIENT FURRING CHANNELS.
	BUGLE	$1\frac{5}{8}$ "	DOUBLE LAYER $\frac{5}{8}$ " DRYWALL TO METAL STUD.
	BUGLE	$1\frac{7}{8}$ "	$\frac{1}{2}$ " DRYWALL THROUGH SHAFTLINER TO METAL RUNNERS.
	BUGLE	$2\frac{1}{4}$ "	$\frac{5}{8}$ " DRYWALL THROUGH SHAFTLINER TO METAL RUNNERS.
	BUGLE	$2\frac{5}{8}$ "	DOUBLE LAYER 1" SHAFTLINER TO METAL STUD.
	BUGLE	3"	$\frac{1}{2}$ " DRYWALL OVER 2 LAYERS OF 1" SHAFTLINER TO METAL FRAMING.

\*FRAMING NOT EXCEEDING .1084 THICKNESS (12 GAUGE).

Figure 1-59.—Drywall screws and fastening application.

cross section of a metal frame stud wall control joint. Figure 1-59 lists the different types of fasteners used in metal frame construction and explains the application of each type.

### CEILING FRAMING

*LEARNING OBJECTIVE: Upon completing this section, you should be able to state the purpose of ceiling frame members and describe layout and installation procedures.*

Ceiling construction begins after all walls have been plumbed, aligned, and secured. One type of ceiling

supports an attic area beneath a sloping (pitched) roof. Another type serves as the framework of a flat roof. When a building has two or more floors, the ceiling of a lower story is the floor of the story above.

One of the main structural functions of a ceiling frame is to tie together the outside walls of the building. When located under a pitched roof, the ceiling frame also resists the outward pressure placed on the walls by the roof rafters (fig. 1-60). The tops of interior partitions are fastened to the ceiling frame. In addition to supporting the attic area beneath the roof, the ceiling frame supports the weight of the finish ceiling materials, such as gypsum board or lath and plaster.

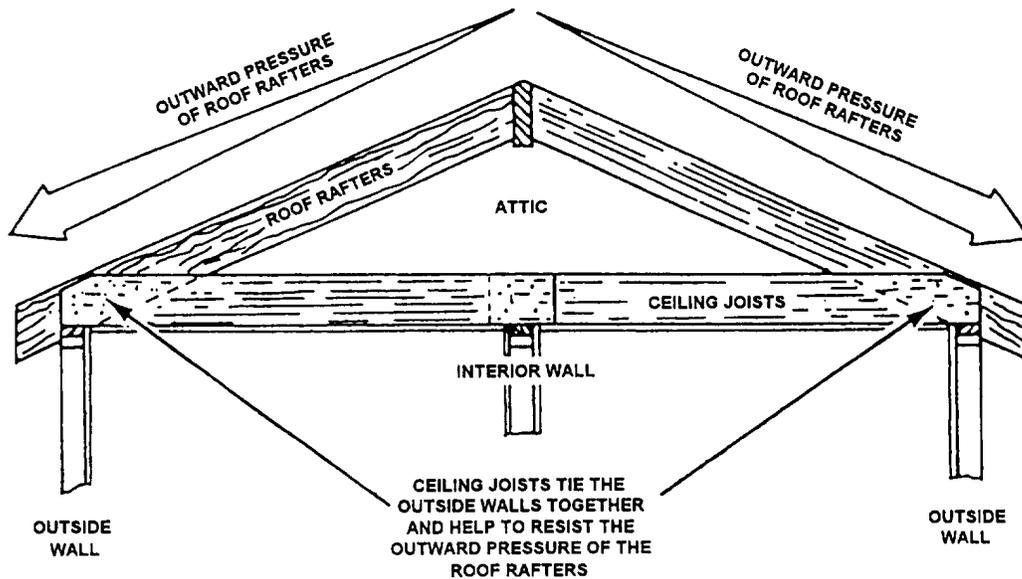


Figure 1-60.—Ceiling frame tying exterior walls together.

## JOISTS

Joists are the most important framing members of the ceiling. Their size, spacing, and direction of travel are given on the floor plan. As mentioned earlier, the spacing between ceiling joists is usually 16 inches OC, although 24-inch spacing is also used. The size of a ceiling joist is determined by the weight it carries and the span it covers from wall to wall. Refer to the blueprints and specifications for size and OC spacing. Although it is more convenient to have all the joists running in the same direction, plans sometimes call for different sets of joists running at right angles to each other.

### Interior Support

One end of a ceiling joist rests on an outside wall. The other end often overlaps an interior bearing partition or girder. The overlap should be at least 4 inches. Ceiling joists are sometimes butted over the partition or girder. In this case, the joists must be cleated with a 3/4-inch-thick plywood board, 24 inches long, or an 18-gauge metal strap, 18 inches long.

Ceiling joists may also butt against the girder, supported by joist hangers in the same manner as floor joists.

## Roof Rafters

Whenever possible, the ceiling joists should run in the same direction as the roof rafters. Nailing the outside end of each ceiling joist to the heel of the rafter as well as to the wall plates (fig. 1-61) strengthens the tie between the outside walls of the building.

A building maybe designed so that the ceiling joists do not run parallel to the roof rafters. The rafters are therefore pushing out on walls not tied together by ceiling joists. In this case, 2 by 4 pieces are added to run

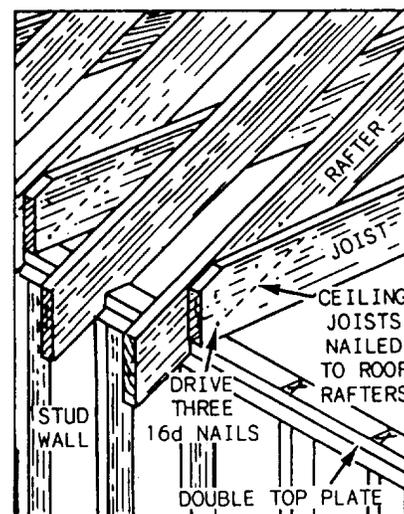


Figure 1-61.—Nailing of ceiling joists.

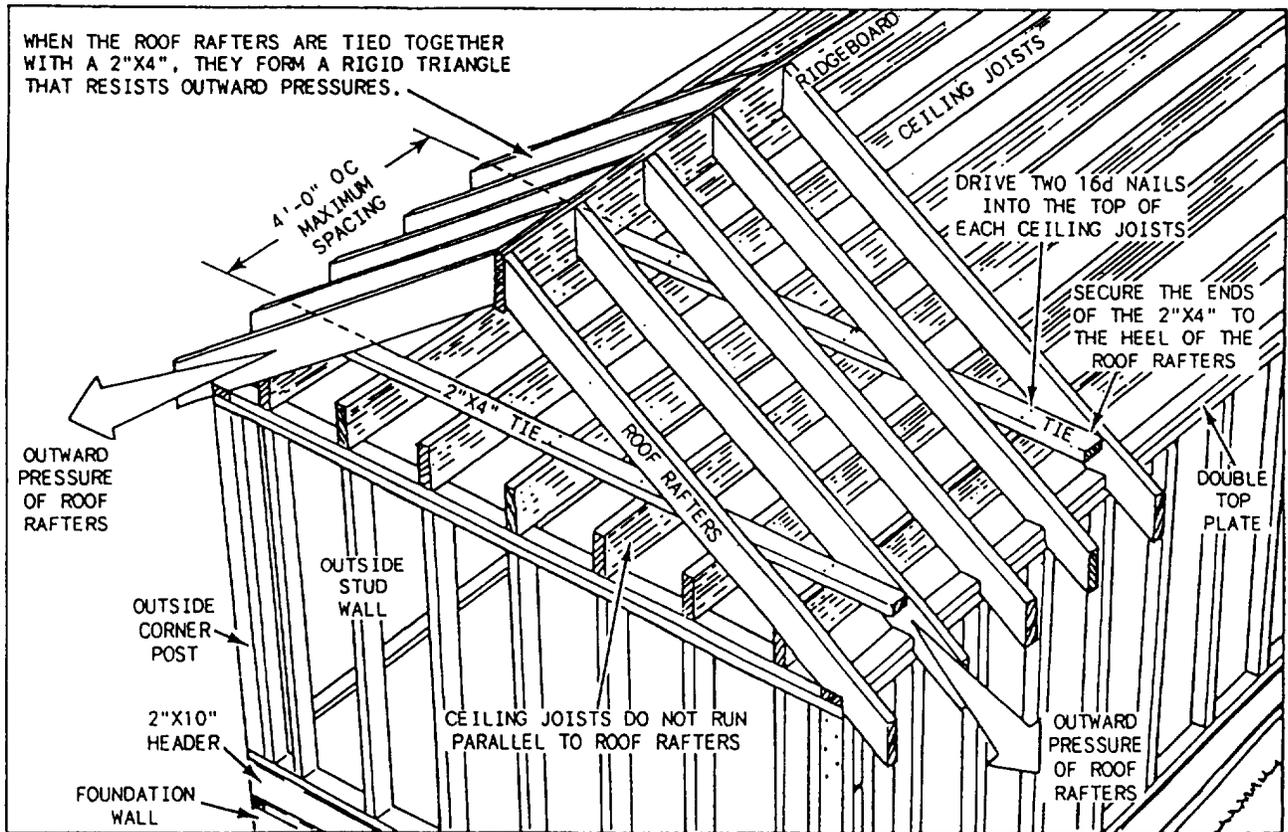


Figure 1-62.—2 by 4 ties.

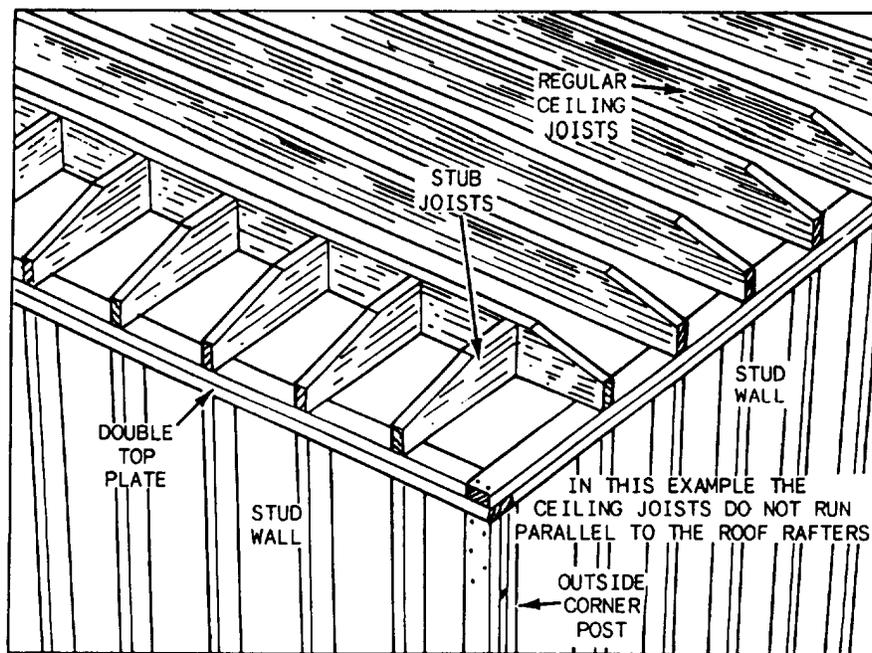


Figure 1-63.—Stub joists.

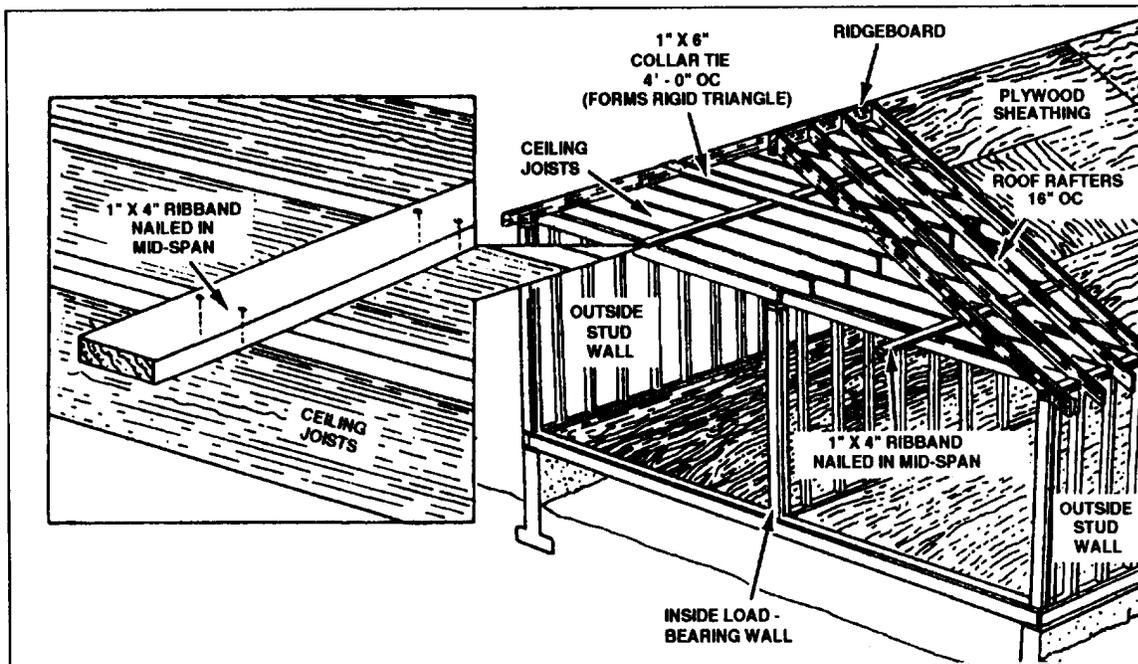


Figure 1-64.—Ribband installation.

in the same direction as the rafters, as shown in figure 1-62. The 2 by 4s should be nailed to the top of each ceiling joist with two 16d nails. The 2 by 4 pieces should be spaced no more than 4 feet apart, and the ends secured to the heels of the rafters or to blocking over the outside walls.

### Roof Slope

When ceiling joists run in the same direction as the roof rafters, the outside ends must be cut to the slope of the roof. Ceiling frames are sometimes constructed with stub joists (fig. 1-63). Stub joists are necessary when, in certain sections of the roof, rafters and ceiling joists do not run in the same direction. For example, a low-pitched hip roof requires stub joists in the hip section of the roof.

### Ribbands and Strongbacks

Ceiling joists not supporting a floor above require no header joists or blocking. Without the additional header joists, however, ceiling joists may twist or bow at the centers of their span. To help prevent this, nail a 1 by 4 piece called a ribband at the center of the spans (fig. 1-64). The ribband is laid flat and fastened to the top of each joist with two 8d nails. The end of each ribband is secured to the outside walls of the building.

A more effective method of preventing twisting or bowing of the ceiling joists is to use a strongback. A strongback is made of 2 by 6 or 2 by 8 material nailed to the side of a 2 by 4 piece. The 2 by 4 piece is fastened

with two 16d nails to the top of each ceiling joist, as shown in figure 1-65. The strongbacks are blocked up and supported over the outside walls and interior partitions. Each strongback holds a ceiling joist in line and also helps support the joist at the center of its span.

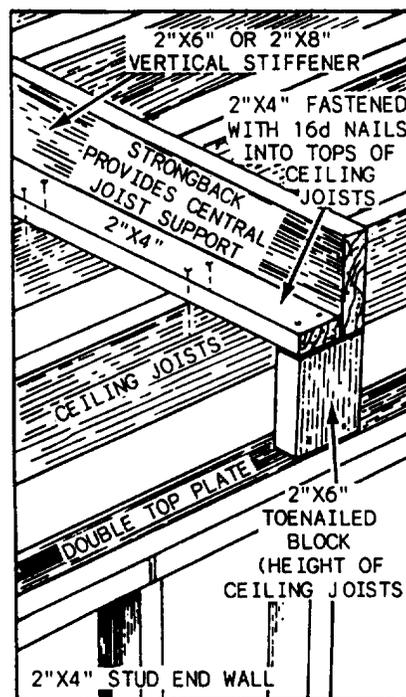


Figure 1-65.—Strongback.

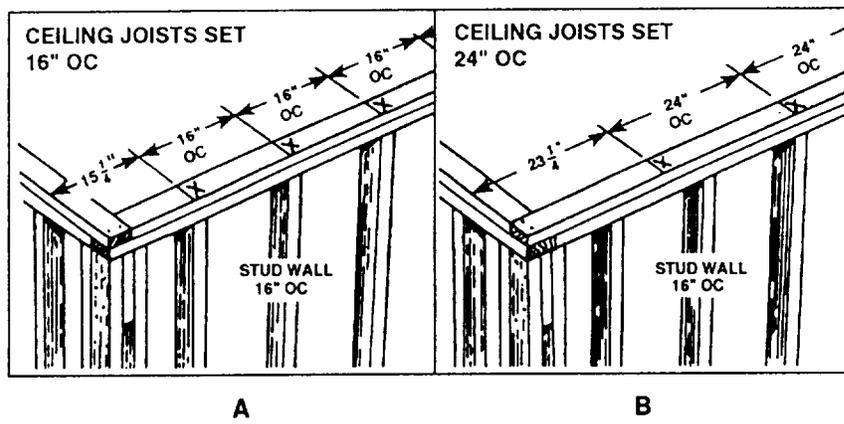


Figure 1-66.—Ceiling joist spacing.

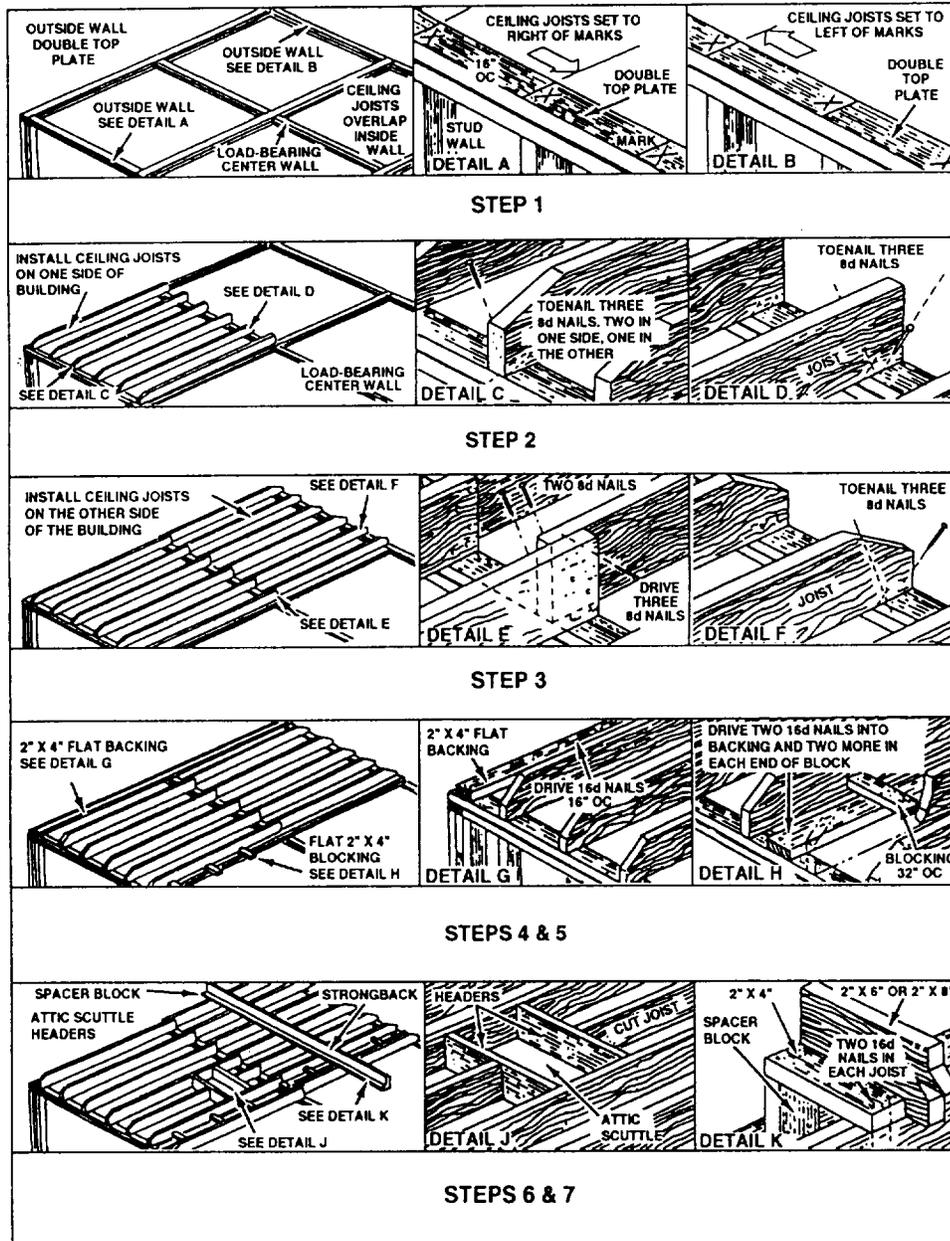


Figure 1-67.—Constructing a typical ceiling frame.

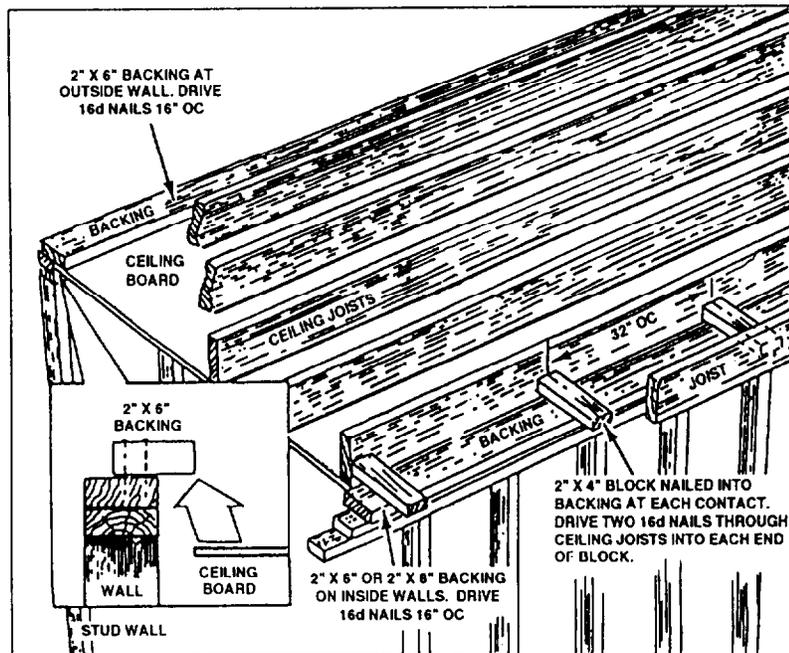


Figure 1-68.—Backing for nailing joists to ceiling frame.

## Layout

Ceiling joists should be placed directly above the studs when the spacing between the joists is the same as between the studs. This arrangement makes it easier to install pipes, flues, or ducts running up the wall and through the roof. However, for buildings with walls having double top plates, most building codes do not require ceiling joists to line up with the studs below.

If the joists are being placed directly above the studs, they follow the same layout as the studs below (fig. 1-66, view A). If the joist layout is different from that of the studs below (for example, if joists are laid out 24 inches OC over a 16 inch OC stud layout), mark the first joist at 23 1/4 inches and then at every 24 inches OC (fig. 1-66, view B).

It is a good practice to mark the positions of the roof rafters at the time the ceiling joists are being laid out. If the spacing between the ceiling joists is the same as between the roof railers, there will be a rafter next to every joist. Often, the joists are laid out 16 inches OC and the roof rafters 24 inches OC. Therefore, every other rafter can be placed next to a ceiling joist.

## FRAME

All the joists for the ceiling frame should be cut to length before they are placed on top of the walls. On structures with pitched roofs, the outside ends of the joists should also be trimmed for the roof slope. This

angle must be cut on the crown (top) side of the joist. The prepared joists can then be handed up to the Builders working on top of the walls. The joists are spread in a flat position along the walls, close to where they will be nailed. Figure 1-67 shows one procedure for constructing the ceiling frame. In this example, the joists lap over an interior partition. Refer to the figure as you study the following steps:

1. Measure and mark for the ceiling joists.
2. Install the ceiling joists on one side of the building.
3. Install the ceiling joists on the opposite side of the building.
4. Place backing on walls running parallel to the joists.
5. Install 2 by 4 blocks flat between joists where needed to fasten the tops of inside walls running parallel to the joists.
6. Cut and frame the attic scuttle.
7. Place strongbacks at the center of the spans.

## Fastening Walls

The tops of walls running in the same direction as the ceiling joists must be securely fastened to the ceiling frame. The method most often used is shown in figure 1-68. Blocks, 2 inches by 4 inches, spaced 32 inches OC, are laid flat over the top of the partition. The ends of

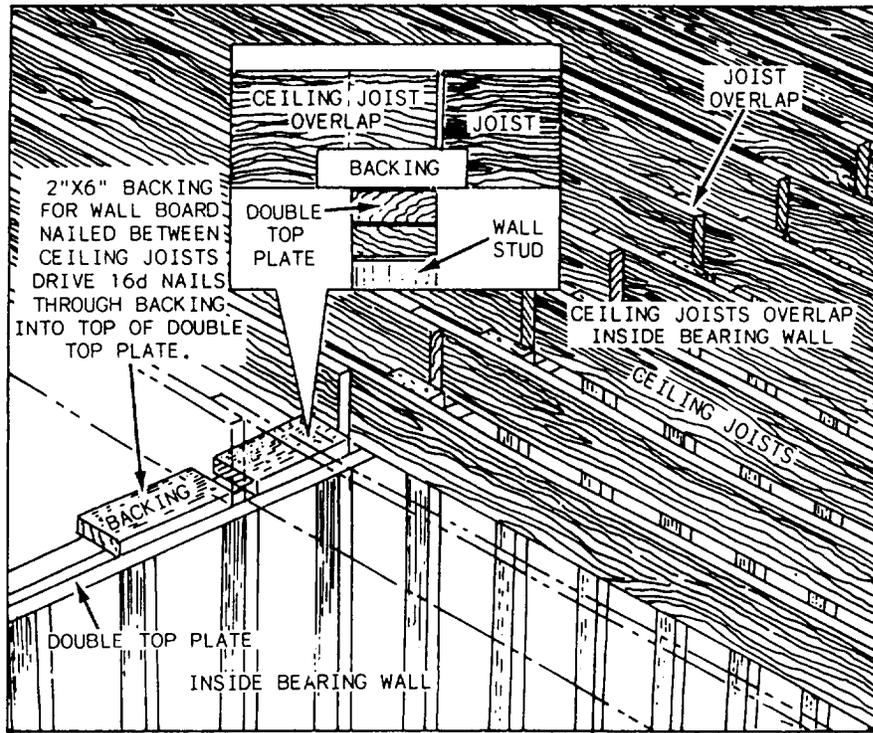


Figure 1-69.—Backing for interior wall plates.

each block are fastened to the joists with two 16d nails. Two 16d nails are also driven through each block into the top of the wall.

### Applying Backing

Walls running in the same direction as the ceiling joists require backing. Figure 1-68 (insert) shows how backing is nailed to the top plates to provide a nailing surface for the edges of the finish ceiling material. Lumber used for backing usually has 2-inch nominal thickness, although 1-inch boards are sometimes used.

Figure 1-68 shows backing placed on top of walls. The 2 by 4 pieces nailed to the exterior wall projects from one side of the wall. The interior wall requires a 2 by 6 or 2 by 8 piece extending from both sides of the wall. Backing is fastened to the top plates with 16d nails spaced 16 inches OC. Backing is also used where joists run at right angles to the partition (fig. 1-69).

### Attic Scuttle

The scuttle is an opening framed in the ceiling to provide an entrance into the attic area. The size of the opening is decided by specification requirements and should be indicated in the blueprints. It must be large enough for a person to climb through easily.

The scuttle is framed in the same way as a floor opening. If the opening is no more than 3 feet square, it is not necessary to double the joists and headers. Scuttles must be placed away from the lower areas of a sloping roof. The opening may be covered by a piece of plywood resting on stops. The scuttle opening can be cut out after all the regular ceiling joists have been nailed in place.

## RECOMMENDED READING LIST

### NOTE

Although the following references were current when this TRAMAN was published, their continued currency cannot be assured. You therefore need to ensure that you are studying the latest revisions.

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

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

*Exterior and Interior Trim*, John E. Ball, Delmar Publishers, Inc., Albany, N.Y., 1975.