# 13 Sill and Floor Construction

## Objectives

After studying this chapter, you will be able to:

- Explain the difference between platform and balloon framing.
- Plan the appropriate floor support using joists or trusses for a structure.
- Determine proper joist sizes using a typical span data chart.
- Describe the components of a floor system.
- Explain the principles of post and beam construction.
- Select the appropriate engineered wood products for specific applications in residential construction.

## Key Terms

Balloon Framing
Beam
Box Sill
Cantilevered Joists
Cement Mortar Mix
Chords
Cross Bridging
Curtain Walls
Engineered Wood Products (EWPs)
Floor Trusses
Glulam Beams
Joists
Laminated Veneer Lumber (LVL)
Longitudinal Method
Mudsill
Oriented Strand Board (OSB)
Parallel Strand Lumber (PSL)
Platform Framing
Post and Beam Construction
Sill
Subfloor
Transverse Method
Web
Wood I-Beams

The commonly used method of floor framing varies from one section of the country to another. Even within a given area, builders may use different methods based on personal preference and experience. However, there are two basic types of floor framing. These are platform and balloon framing. Both types of framing have structural components called plates, joists, and studs. Another type of construction is called post and beam. This construction can be used for framing walls and floors.

## Platform Framing

***Platform framing*** is called as such because the floor joists form a platform on which the walls rest. Another platform, which is either the ceiling joists or floor joists of the upper floor, rests on the walls. Platform framing is used more extensively than balloon framing and popular for several reasons. It is satisfactory for both one- and two-story structures and is easy and fast to construct. Shrinkage is uniform throughout the structure. Also, the platform automatically provides a fire-stop between floors. Construction is safe because the work is performed on solid surfaces.

In platform framing, the sill is the starting point in constructing a floor. A ***sill*** is the lowest member of the frame of a structure. It rests on the foundation and supports the floor joists or the uprights (studs) of the wall. The sill in most residential construction is 2″ × 6″ dimensional lumber (actual dimensions are 1-1/2″ × 5-1/2″). Platform framing uses a method of sill construction known as ***box sill*** construction. The box sill consists of a 2″ × 6″ plate called a sill or ***mudsill*** and a header that is the same size as the floor joists, Figure 13-1. Figure 13-2 shows a detail of the first and second floor of a structure constructed with platform framing and box sill construction.

Generally, a seal is required between the foundation and sill plate. This seal prevents outside air from entering the house. Figure 13-3 shows one method of sealing the space between the foundation and sill plate.

# Balloon Framing

Balloon framing was once used extensively, but in recent years has diminished in importance. The distinguishing features of ***balloon framing*** are that the wall studs rest directly on the sill plate and each floor "hangs" from the studs.

Two advantages of balloon framing are small potential shrinkage and good vertical stability. The vertical shrinkage in a two-story house built with platform framing is sometimes great enough to cause cracking. This is usually not the case with balloon framing. The disadvantages of balloon framing include a less than desirable surface on which to work during construction and the need to add fire-stops.

In balloon framing, one of two types of sill construction are used—solid (standard) sill or T-sill, Figure 13-4. In solid sill construction, the

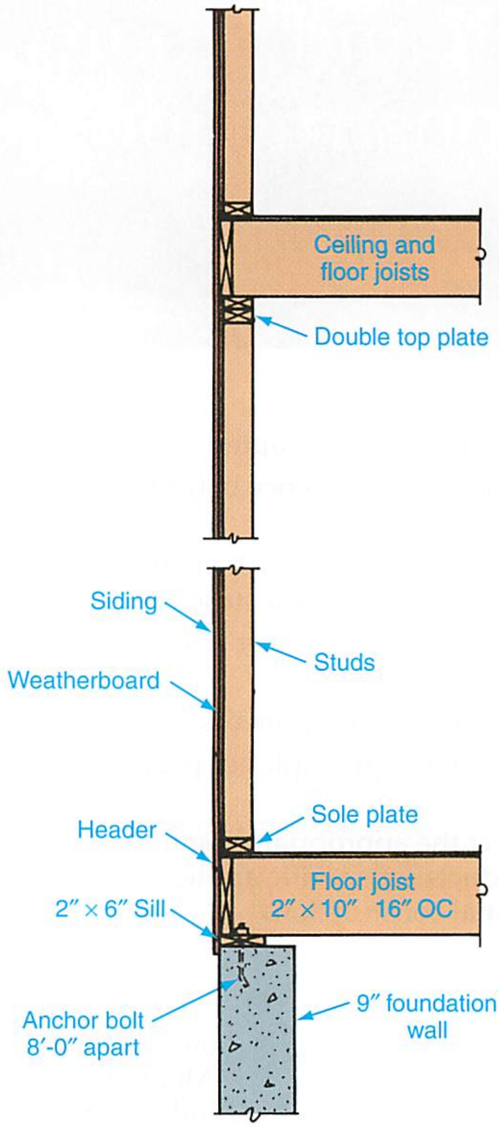



**Figure 13-2.** This section shows the details of a first and second floor constructed using platform framing and box sill construction.

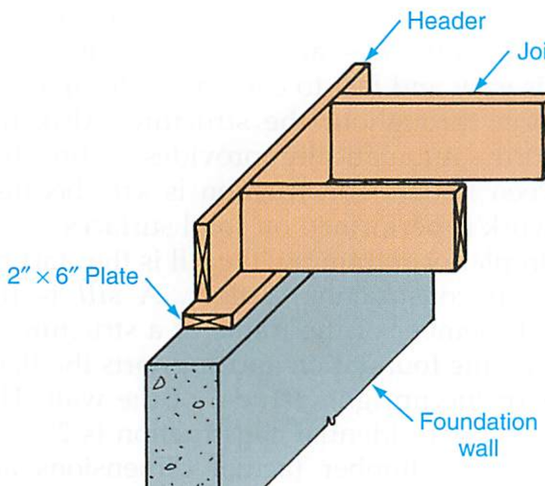



**Figure 13-1.** Box sill construction consists of a sill on which a header and joists rest.

**Figure 13-3.** One-inch thick fiberglass insulation is frequently used as a sill sealer.

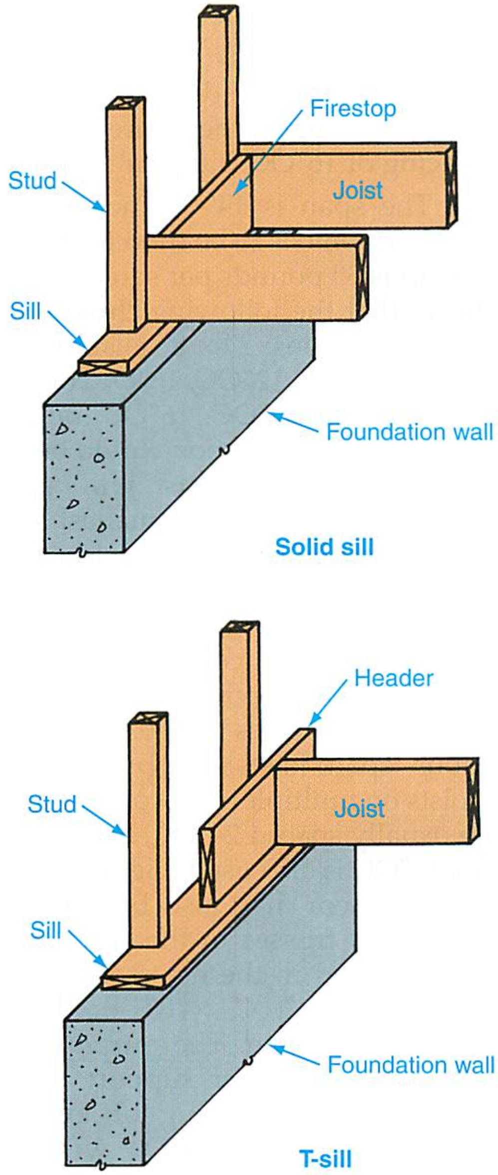



**Figure 13-4.** In balloon framing, either solid sill or T-sill construction is used.

studs are nailed directly to the sill and joists. No header is used. Joists are supported by a ribbon and nailed to the studs on the second floor level, Figure 13-5. A fire-stop must be provided between the studs using pieces cut to the proper length. Solid sill construction is used more extensively than T-sill construction in two-story homes.

In T-sill construction, a header rests on the sill and serves as a fire-stop. The studs rest on the sill and are nailed to the header as well as the sill plate. The sill in T-sill construction may be 8″ or 10″ wide to provide a broader supporting base on which the joists rest.

# Joists and Beams

*Joists* provide support for the floor. They are usually made from a common softwood, such as southern yellow pine, fir, larch, hemlock, or spruce. However, engineered wood joists and metal joists are also available.

The size of floor joists ranges from a nominal size of 2″ × 6″ to 2″ × 12″. Figure 13-6 provides the actual dimensions of dimensional construction lumber. The size of joist required for a given situation depends on the length of the span, load to be supported, species and grade of wood, and distance the joists are

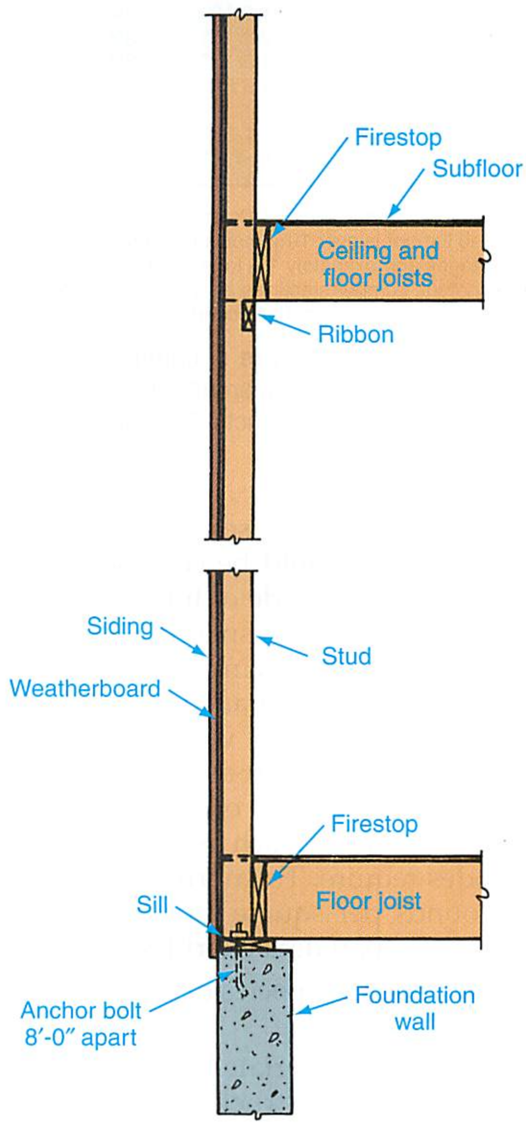



**Figure 13-5.** This section shows the details of a first and second floor constructed balloon framing and solid sill construction.

| Standard lumber sizes | | |
|---|---|---|
| **Dimension lumber** | | |
| **Product classification (nominal size)** | **Actual sizes Unseasoned*** | **Dry*** |
| 2″ × 2″ | 1-9/16″ × 1-9/16″ | 1-1/2″ × 1-1/2″ |
| 2″ × 3″ | 1-9/16″ × 2-9/16″ | 1-1/2″ × 2-1/2″ |
| 2″ × 4″ | 1-9/16″ × 3-9/16″ | 1-1/2″ × 3-1/2″ |
| 2″ × 6″ | 1-9/16″ × 5-5/8″ | 1-1/2″ × 5-1/2″ |
| 2″ × 8″ | 1-9/16″ × 7-1/2″ | 1-1/2″ × 7-1/4″ |
| 2″ × 10″ | 1-9/16″ × 9-1/2″ | 1-1/2″ × 9-1/4″ |
| 2″ × 12″ | 1-9/16″ × 11-1/2″ | 1-1/2″ × 11-1/4″ |
| **Board lumber** | | |
| **Product classification (nominal size)** | **Actual sizes Unseasoned*** | **Dry*** |
| 1″ × 2″ | 25/32″ × 1-9/16″ | 3/4″ × 1-1/2″ |
| 1″ × 3″ | 25/32″ × 2-9/16″ | 3/4″ × 2-1/2″ |
| 1″ × 4″ | 25/32″ × 3-9/16″ | 3/4″ × 3-1/2″ |
| 1″ × 6″ | 25/32″ × 5-5/8″ | 3/4″ × 5-1/2″ |
| 1″ × 8″ | 25/32″ × 7-1/2″ | 3/4″ × 7-1/4″ |
| 1″ × 10″ | 25/32″ × 9-1/2″ | 3/4″ × 9-1/4″ |
| 1″ × 12″ | 25/32″ × 11-1/2″ | 3/4″ × 11-1/4″ |

*Dry lumber is defined as being 19% or less in moisture content. Unseasoned lumber is over 19% moisture content. The size of lumber changes approximately 1% for each 4% change in moisture content. Lumber stabilizes at approximately 15% moisture content under normal use conditions.

**Figure 13-6.** The actual size of common dimensional and board lumber is smaller than the nominal size. (National Forest Products Association)

spaced apart. In the case of metal joists, the gauge of metal should be considered instead of the species and grade of lumber.

Floor joists may be spaced 12″, 16″, or 24″ on center (OC). A spacing of 16″OC is most common. Floor joist span data for the three most common species of wood joists are given in Figure 13-7. The chart assumes a maximum deflection of 1/360th of the span with a normal live load, which is the amount that most codes require. The normal live load is 30 or 40 pounds per square foot. The procedure for using the span data chart is:

1) Determine the species of wood to be used.
2) Select the appropriate live load capacity required for the structure.
3) Determine the lumber grade to be used. Number 2 dense is the usual choice for fir, larch, and southern yellow pine.
4) Scan the lumber grade row and note the maximum spans.
5) Select the joist size and spacing that will adequately support the desired live load. A spacing of 16″OC is typical.

Example: The span is 14′-0″ and Number 1 dense southern pine is to be used for the joists. The live load is 30 pounds per square foot. The chart shows that the following choices would meet these conditions: 2″ × 8″ joists 12″OC or 16″OC; 2″ × 10″ joists 12″OC, 16″OC, or 24″OC; and 2″ × 12″ joists 12″OC, 16″OC, or 24″OC. The most reasonable selection would be 2″ × 8″ joists placed 16″OC. This will span a maximum of 14′-5″, is the smallest dimensional lumber, and allows the greatest spacing at that size.

Steel floor joists are beginning to be accepted for residential construction. Builders generally select joist depths ranging from 6″ to 12″ with steel thicknesses from 0.034″ to 0.101″. Continuous span joists are preferred over lapped joists on multiple span conditions. Steel joists are usually spaced 24″OC, but spacing of 12″OC or 16″OC is also used, Figure 13-8.

A floor system may also be constructed using girders or trusses in the place of floor joists, as discussed in the next section. These are usually 4″ × 6″, 4″ × 8″, or 4″ × 10″ depending on the span. The purpose of this approach is to use fewer support members (joists). The typical spacing of girders or trusses in this system is 48″OC with 1-1/8″ thick tongue-and-groove plywood as the floor decking.

In most house designs, the total distance that joists must span is too great for unsupported joists. A ***beam*** or load-bearing wall is needed to support the joists and effectively reduce the span. The beam may be a solid timber, built-up from dimensional lumber, or a metal S- or W-beam. Load-bearing walls may be concrete block, cast concrete, or frame construction. Several methods of supporting floor joists with a beam are commonly used. Figure 13-9 shows some of these methods.

Partition walls that run parallel to the floor joists require added support, Figure 13-10. It is good practice to double the joists under these partition walls. If the space between the joists is used as a cold air return duct, solid blocking

# FLOOR JOIST SPAN DATA

| 30 PSF LIVE LOAD, 10 PSF DEAD LOAD, DEF. <360 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES OR GROUP | GRADE | 2" x 8" | | | 2" x 10" | | | 2" x 12" | | |
| | | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC |
| Douglas Fir and Larch | Sel. Struc. | 16'-6" | 15'-0" | 13'-1" | 21'-0" | 19'-1" | 16'-8" | 25'-7" | 23'-3" | 20'-3" |
| | No.1 & Btr | 16'-2" | 14'-8" | 12'-10" | 20'-8" | 18'-9" | 16'-1" | 25'-1" | 22'-10" | 18'-8" |
| | No.1 | 15'-10" | 14'-5" | 12'-4" | 20'-3" | 18'-5" | 15'-0" | 24'-8" | 21'-4" | 17'-5" |
| | No.2 | 15'-7" | 14'-1" | 11'-6" | 19'-10" | 17'-2" | 14'-1" | 23'-0" | 19'-11" | 16'-3" |
| | No.3 | 12'-4" | 10'-8" | 8'-8" | 15'-0" | 13'-0" | 10'-7" | 17'-5" | 15'-1" | 12'-4" |
| **40 PSF LIVE LOAD, 10 PSF DEAD LOAD, DEF. <360** | | | | | | | | | | |
| SPECIES OR GROUP | GRADE | 2" x 8" | | | 2" x 10" | | | 2" x 12" | | |
| | | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC |
| Douglas Fir and Larch | Sel. Struc. | 15'-0" | 13'-7" | 11'-11" | 19'-1" | 17'-4" | 15'-2" | 23'-3" | 21'-1" | 18'-5" |
| | No.1 & Btr | 14'-8" | 13'-4" | 11'-8" | 18'-9" | 17'-0" | 14'-5" | 22'-10" | 20'-5" | 16'-8" |
| | No.1 | 14'-5" | 13'-1" | 11'-0" | 18'-5" | 16'-5" | 13'-5" | 22'-0" | 19'-1" | 15'-7" |
| | No.2 | 14'-2" | 12'-7" | 10'-3" | 17'-9" | 15'-5" | 12'-7" | 20'-7" | 17'-10" | 14'-7" |
| | No.3 | 11'-0" | 9'-6" | 7'-9" | 13'-5" | 11'-8" | 9'-6" | 15'-7" | 13'-6" | 11'-0" |

| 30 PSF LIVE LOAD, 10 PSF DEAD LOAD, DEF. <360 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES OR GROUP | GRADE | 2" x 8" | | | 2" x 10" | | | 2" x 12" | | |
| | | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC |
| Southern Pine | Sel. Struc. | 16'-2" | 14'-8" | 12'-10" | 20'-8" | 18'-9" | 16'-5" | 25'-1" | 22'-10" | 19'-11" |
| | No.1 | 15'-10" | 14'-5" | 12'-7" | 20'-3" | 18'-5" | 16'-1" | 24'-8" | 22'-5" | 19'-6" |
| | No.2 | 15'-7" | 14'-2" | 12'-4" | 19'-10" | 18'-0" | 14'-8" | 24'-2" | 21'-1" | 17'-2" |
| | No.3 | 13'-3" | 11'-6" | 9'-5" | 15'-8" | 13'-7" | 11'-1" | 18'-8" | 16'-2" | 13'-2" |
| **40 PSF LIVE LOAD, 10 PSF DEAD LOAD, DEF. <360** | | | | | | | | | | |
| SPECIES OR GROUP | GRADE | 2" x 8" | | | 2" x 10" | | | 2" x 12" | | |
| | | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC |
| Southern Pine | Sel. Struc. | 14'-8" | 13'-4" | 11'-8" | 18'-9" | 17'-0" | 14'-11" | 22'-10" | 20'-9" | 18'-1" |
| | No.1 | 14'-5" | 13'-1" | 11'-5" | 18'-5" | 16'-9" | 14'-7" | 22'-5" | 20'-4" | 17'-5" |
| | No.2 | 14'-2" | 12'-10" | 11'-0" | 18'-0" | 16'-1" | 13'-2" | 21'-9" | 18'-10" | 15'-4" |
| | No.3 | 11'-11" | 10'-3" | 8'-5" | 14'-0" | 12'-2" | 9'-11" | 16'-8" | 14'-5" | 11'-10" |

| 40 PSF LIVE LOAD, 10 PSF DEAD LOAD, DEF. <240 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES OR GROUP | GRADE | 2" x 6" | | | 2" x 8" | | | 2" x 10" | | |
| | | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC | 12"OC | 16"OC | 24"OC |
| Redwood | Cl. All Heart | -- | 7'-3" | 6'-0" | -- | 10'-9" | 8'-9" | -- | 13'-6" | 11'-0" |
| | Const. Heart | -- | 7'-3" | 6'-0" | -- | 10'-9" | 8'-9" | -- | 13'-6" | 11'-0" |
| | Const. Common | -- | 7'-3" | 6'-0" | -- | 10'-9" | 8'-9" | -- | 13'-6" | 11'-0" |

These spans are based on the 1993 AFTA (formerly NFPA) Span Tables for Joists and Rafters. These grades are the most commonly available. Source: Western Wood Products Association, Southern Pine Association, and California Redwood Association.

**Figure 13-7.** Spans are calculated on the basis of dry sizes with a moisture content equal to or less than 19%. Floor joist spans are for a single span with calculations performed based on the modulus of elasticity (E) and maximum fiber bending stress ($F_b$) allowed.

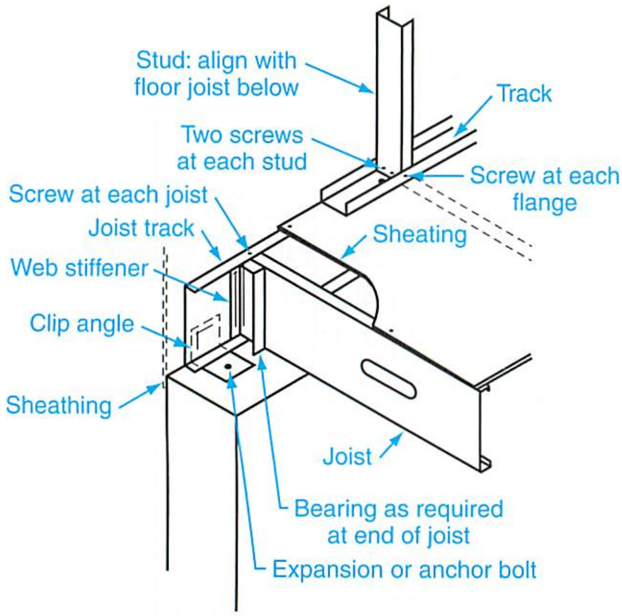



**Figure 13-8.** This is typical steel framing where the floor joists rest directly on the foundation.

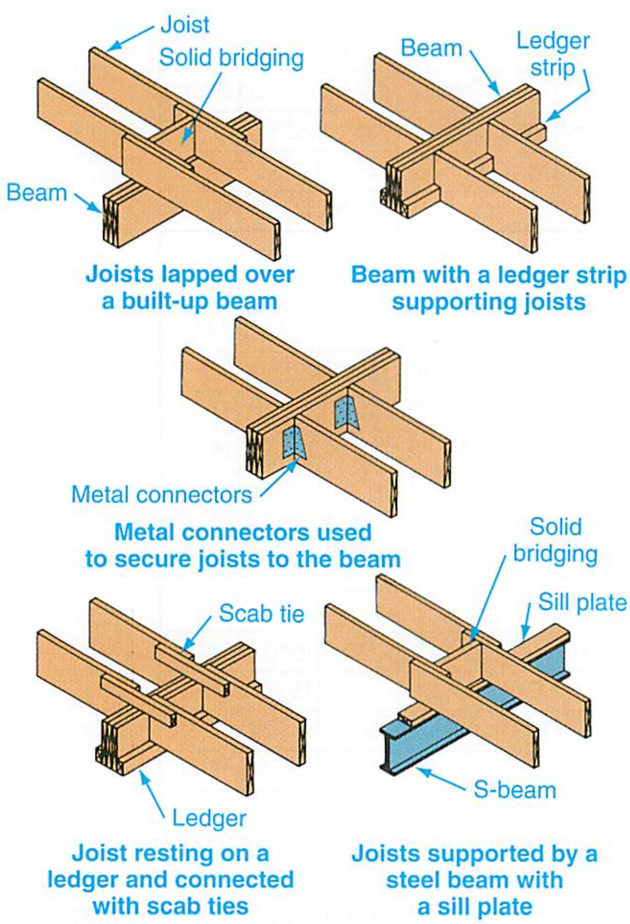



**Figure 13-9.** These are common methods of supporting floor joists with beams.

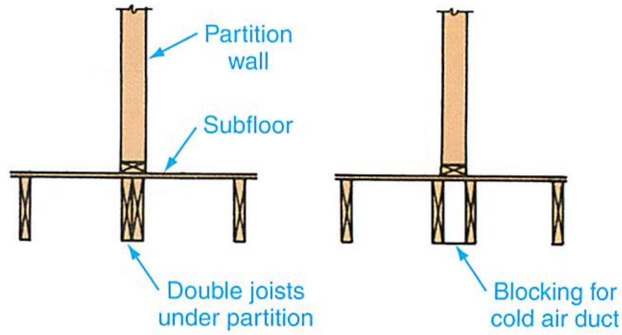



**Figure 13-10.** Joists should be doubled under partition walls that run parallel to the joists.

is used between the joists. Openings in the floor for stairs and chimneys also require double joist framing. Figure 13-11 shows how such an opening is framed and identifies the various parts.

*Cross bridging* is used to stiffen the floor and spread the load over a broader area, Figure 13-12. Bridging boards are ordinarily 1″ × 3″ in size with the ends cut at an angle so they fit snugly against the joist. They are nailed securely in place midway between the beam and wall. Metal bridging is also available, Figure 13-13.

# Floor Trusses

A truss is a rigid framework designed to support a load over a span. Engineered wood *floor trusses,* designed for light-frame

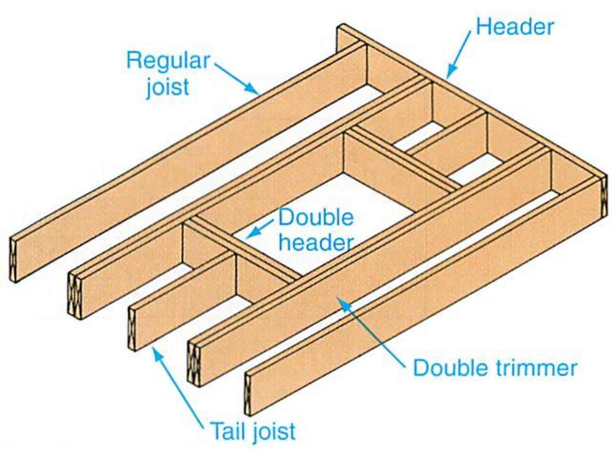



**Figure 13-11.** Framing around openings for fireplaces and stairs require double joists.

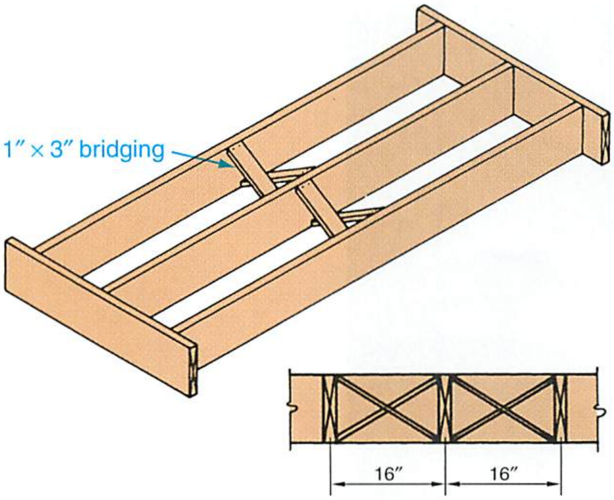



**Figure 13-12.** Bridging is used to stiffen the floor and required by many codes.

construction, are often used in place of floor joists in residential structures. These trusses consist of a top chord, bottom chord, and web. The top and bottom ***chords*** are the horizontal flanges at the top and bottom of the truss. The ***web*** is the framework between the chords.

Trusses provide clear spans with a minimum of depth in a lightweight assembly that is easy to handle, Figure 13-14. In addition, the open web construction reduces sound transmission through the floor/ceiling assemblies and makes the installation of plumbing, heating, and electrical systems easy.

Engineered floor trusses are designed with the aid of computers to ensure accurate load capacities. They are usually fabricated from 2″ × 4″ or 2″ × 6″ lumber and generally spaced 24″OC. Figure 13-15 shows typical specifications for engineered wood floor trusses. Each truss has a built-in camber (upward curve) so that the floor/ceiling will be level once the load of the house is applied. Stress-graded lumber is used in their construction so that a minimum amount of material is required. Some trusses have wood webs.

**Figure 13-13.** Metal bridging can be quickly installed.

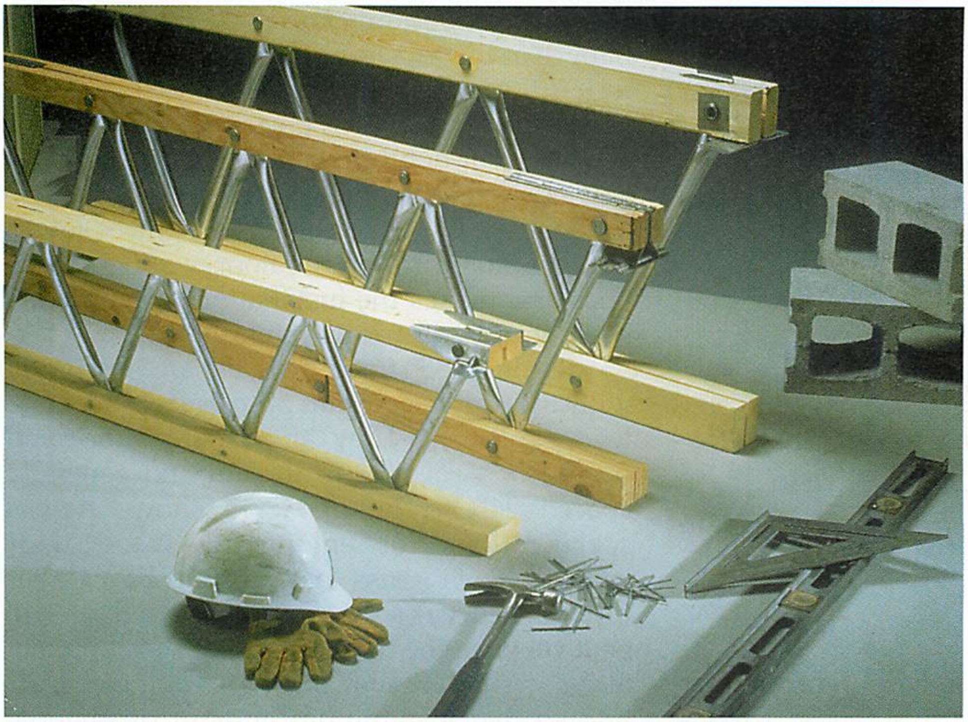


**Figure 13-14.** Engineered wood floor trusses are lightweight, easy to handle, and easy to install. (Trus Joist)

Other trusses are fabricated with wood chords and galvanized steel webs, Figure 13-16. The metal webs have teeth that are pressed into the sides of the chords. A reinforcing rib in the metal web withstands both tension and compression forces.

# Subfloor

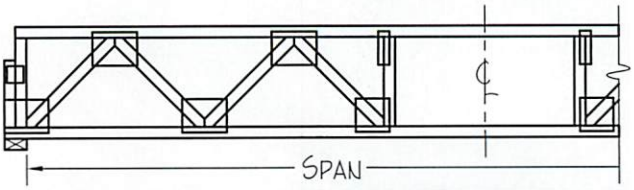
The *subfloor* is affixed to the floor joists and provides the surface on which the underlayment for the final finished floor will rest. Plywood, tongue-and-groove boards, common boards, and other panel products are used for subfloors. The large size (4′ × 8′) of plywood and other panel sheets and the comparatively short time required to nail the sheets in place makes these products very popular as subfloors. One-half inch thick plywood, composite board, waferboard, oriented strand board, and structural particleboard may be used when joists are spaced 16″OC, Figure 13-17. However, some builders prefer 5/8″ stock over 1/2″ stock. When these products are used, it is important that the joist spacing is very accurate. All edges of the panels must be supported, Figure 13-18.

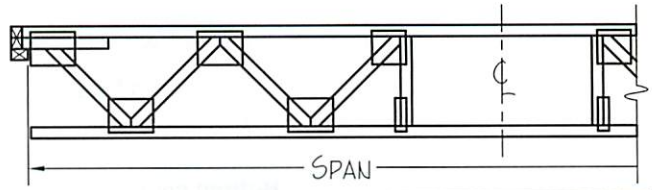
In some areas, there is a trend to combine the subfloor and underlayment (usually 5/8″ particleboard) into a single thickness that is generally 1-1/8″ thick. These sheets have tongue-and-groove edges and require no blocking between the joists. A single thickness sheet of 3/4″ tongue-and-groove plywood may also be used for some applications.

Plywood should be installed so that the grain direction of the outer plies is at right angles to the joists. The floor will be stronger when the plywood is positioned in this manner. Panel products should also be staggered so that end joints in adjacent panels are on different joists. A slight space must be allowed between sheets for expansion.

Subfloor panels may also be glued, as well as nailed, to the joists. Structural tests have shown that stiffness is increased by 25% with 2″ × 8″ joists and 5/8″ plywood. Another advantage to gluing is that the system produces a squeak-free structure, eliminates nail-popping, and reduces labor costs.

**MANUFACTURED 2″ × 4″ WOOD FLOOR TRUSSES**




| Bottom chord bearing type | | | |
|---|---|---|---|
| Depth | Clear spans | #Diagonal webs | Camber |
| 12″ | 7′-2″ | 4 | .063″ |
| | 9′-8″ | 6 | .063″ |
| | 12′-2″ | 8 | .063″ |
| | 14′-8″ | 10 | .134″ |
| | 17′-2″ | 12 | .237″ |
| | 19′-8″ | 14 | .365″ |
| | 21′-4″ | 16 | .507″ |
| 14″ | 9′-8″ | 6 | .063″ |
| | 12′-2″ | 8 | .063″ |
| | 14′-8″ | 10 | .095″ |
| | 17′-2″ | 12 | .178″ |
| | 19′-8″ | 14 | .288″ |
| | 22′-7″ | 16 | .449″ |
| | 24′-0″ | 18 | .569″ |
| 16″ | 12′-2″ | 8 | .065″ |
| | 14′-8″ | 10 | .070″ |
| | 17′-2″ | 12 | .132″ |
| | 19′-8″ | 14 | .228″ |
| | 22′-2″ | 16 | .346″ |
| | 25′-1″ | 18 | .505″ |
| | 26′-1″ | 20 | .596″ |
| 18″ | 14′-8″ | 10 | .065″ |
| | 17′-2″ | 12 | .120″ |
| | 19′-8″ | 14 | .176″ |
| | 22′-2″ | 16 | .268″ |
| | 24′-8″ | 18 | .367″ |
| | 27′-6″ | 20 | .600″ |
| | 27′-10″ | 22 | .630″ |
| 20″ | 14′-8″ | 10 | .063″ |
| | 17′-2″ | 12 | .081″ |
| | 19′-8″ | 14 | .140″ |
| | 22′-2″ | 16 | .226″ |
| | 24′-8″ | 18 | .327″ |
| | 27′-6″ | 20 | .451″ |
| | 29′-6″ | 22 | .630″ |
| 22″ | 17′-2″ | 10 | .066″ |
| | 19′-8″ | 12 | .114″ |
| | 22′-2″ | 14 | .184″ |
| | 24′-8″ | 16 | .266″ |
| | 27′-6″ | 18 | .367″ |
| | 30′-0″ | 20 | .520″ |
| | 31′-1″ | 22 | .630″ |
| 24″ | 17′-2″ | 12 | .063″ |
| | 19′-8″ | 14 | .095″ |
| | 22′-2″ | 16 | .153″ |
| | 24′-8″ | 18 | .235″ |
| | 27′-2″ | 20 | .325″ |
| | 30′-0″ | 22 | .431″ |
| | 32′-6″ | 24 | .630″ |

| Top chord bearing type | | | |
|---|---|---|---|
| Depth | Clear spans | #Diagonal webs | Camber |
| 12″ | 6′-10″ | 4 | .063″ |
| | 9′-4″ | 6 | .063″ |
| | 11′-10″ | 8 | .063″ |
| | 14′-4″ | 10 | .122″ |
| | 16′-10″ | 12 | .233″ |
| | 19′-10″ | 14 | .376″ |
| | 21′-4″ | 16 | .507″ |
| 14″ | 9′-5″ | 6 | .063″ |
| | 11′-11″ | 8 | .063″ |
| | 14′-5″ | 10 | .088″ |
| | 16′-11″ | 12 | .167″ |
| | 19′-5″ | 14 | .273″ |
| | 21′-4″ | 16 | .429″ |
| | 24′-0″ | 18 | .569″ |
| 16″ | 12′-0″ | 8 | .063″ |
| | 14′-6″ | 10 | .067″ |
| | 17′-0″ | 12 | .126″ |
| | 19′-6″ | 14 | .219″ |
| | 22′-4″ | 16 | .337″ |
| | 24′-10″ | 18 | .489″ |
| | 26′-1″ | 20 | .596″ |
| 18″ | 14′-6″ | 10 | .063″ |
| | 17′-0″ | 12 | .098″ |
| | 19′-6″ | 14 | .170″ |
| | 22′-0″ | 16 | .260″ |
| | 24′-10″ | 18 | .378″ |
| | 27′-8″ | 20 | .617″ |
| | 27′-10″ | 22 | .630″ |
| 20″ | 14′-6″ | 10 | .063″ |
| | 17′-0″ | 12 | .079″ |
| | 19′-6″ | 14 | .136″ |
| | 22′-0″ | 16 | .221″ |
| | 24′-10″ | 18 | .337″ |
| | 27′-4″ | 20 | .442″ |
| | 29′-6″ | 22 | .630″ |
| 22″ | 17′-1″ | 12 | .065″ |
| | 19′-7″ | 14 | .112″ |
| | 22′-1″ | 16 | .181″ |
| | 24′-10″ | 18 | .275″ |
| | 27′-4″ | 20 | .381″ |
| | 30′-2″ | 22 | .534″ |
| | 31′-1″ | 24 | .630″ |
| 24″ | 17′-1″ | 12 | .063″ |
| | 19′-7″ | 14 | .093″ |
| | 22′-1″ | 16 | .150″ |
| | 24′-7″ | 18 | .231″ |
| | 27′-5″ | 20 | .335″ |
| | 30′-2″ | 22 | .443″ |
| | 32′-6″ | 24 | .630″ |

Wood floor trusses are typically manufactured from #3 southern yellow pine. Pieces are joined together with 18 and 20 gauge galvanized steel plates applied to both faces of the truss at each joint. Where no sheathing is applied directly to top chords, they should be braced at intervals not to exceed 3′-0″. Where no rigid ceiling is applied directly to bottom chords, they should be braced at intervals not to exceed 10′-0″.

Manufactured wood floor trusses are generally spaced 24″OC and are designed to support various loads. Typical trusses shown here were designed to support 55 psf (live load - 40 psf, dead load - 10 psf, ceiling dead load - 5 psf). A slight bow (camber) is built into each joist to that it will produce a level floor when loaded. Allowable deflection is 1/360 of the span.

Some of the longer trusses require one or more double diagonal webs at both ends. Wood floor trusses are a manufactured product which must be engineered and produced with a high degree of accuracy to attain the desired performance. See your local manufacturer or lumber company for trusses available in your area.

**Figure 13-15.** Design specifications for typical engineered wood floor trusses.

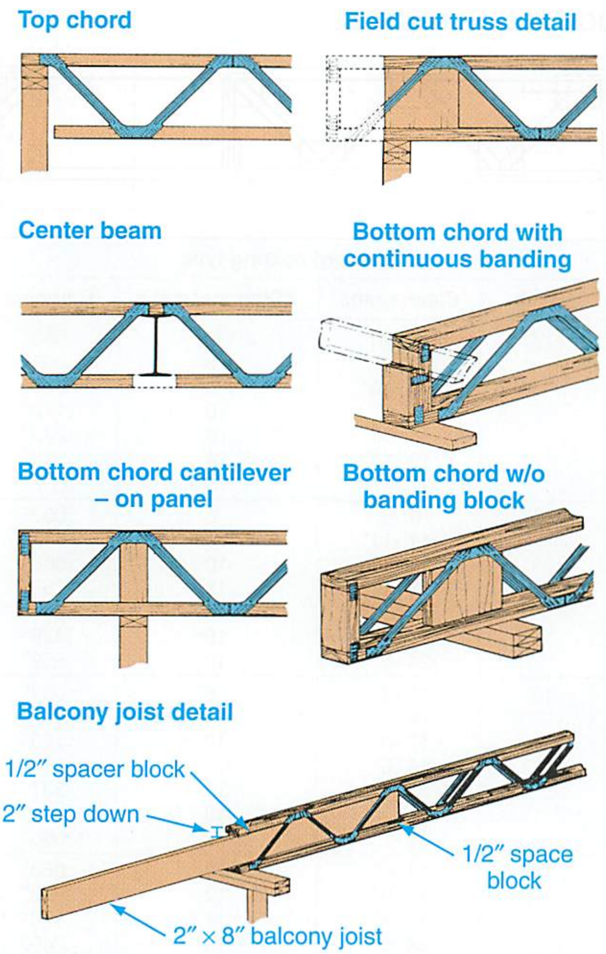



**Figure 13-16.** These trusses have wood chords, but the webs are galvanized steel. (TrusWal Systems, Inc.)

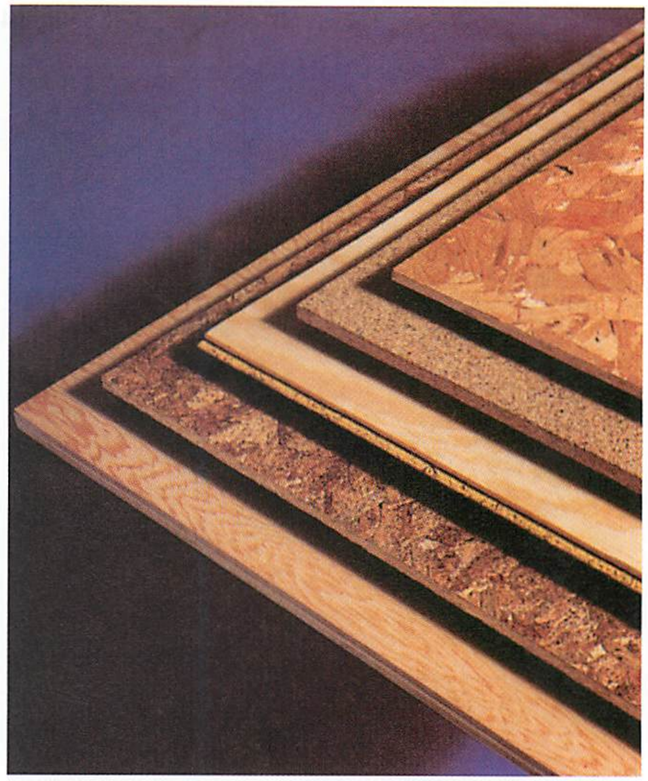


**Figure 13-17.** Many structural wood panels are manufactured for construction uses. The products shown here are (from top to bottom): waferboard, structural particleboard, composite plywood, oriented strand board, and plywood. (Georgia-Pacific Corporation)

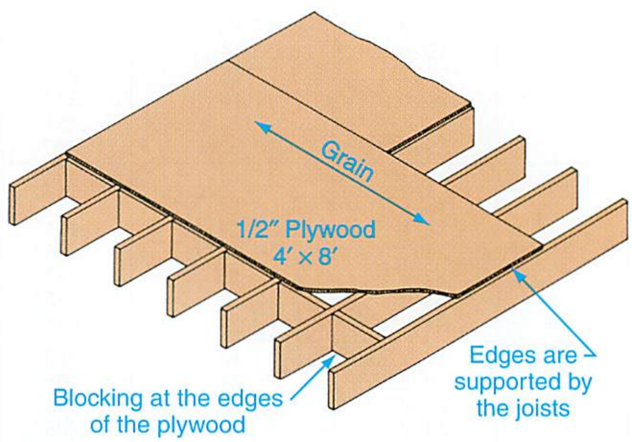



**Figure 13-18.** Blocking is used to support the edges of 1/2″ plywood used for the subfoor. All edges of the panel must be supported.

# Cantilevered Joists

Some home designs include a section of the floor that projects beyond a lower level. This design element is called a cantilever. When the floor joists run perpendicular to the cantilevered section, joists with extra length form the cantilever. However, when the joists are parallel to the overhanging area, ***cantilevered joists*** are required. Figure 13-19 illustrates a typical framing technique for a cantilevered floor section.

A rule of thumb to follow in determining the necessary length of the cantilevered joists is to extend the joists inside the structure a distance at least twice the distance that they overhang outside the structure. If the inside distance is too short, the floor along the outside wall may sag over time. If a ledger strip is used, it should be located along the top of the inside double header joist. This is because the force will be up rather than down as in a normal situation.

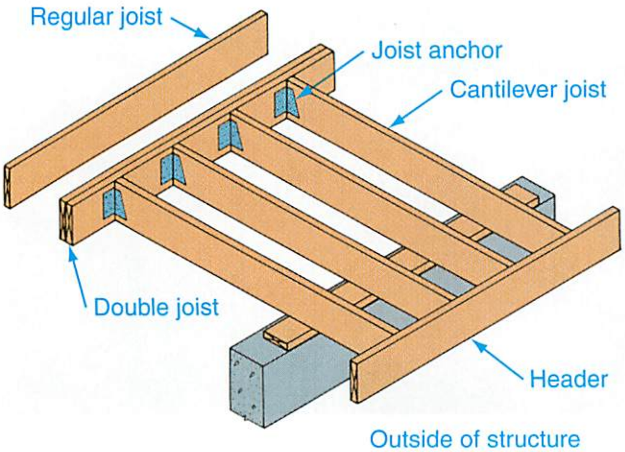



**Figure 13-19.** Cantilevered joists should extend at least twice as far inside the house as they extend outside of it.

# Framing Under Slate or Tile

Certain areas of the home frequently have ceramic tile, slate, or stone floors. These materials require a substantial base. If a concrete base is provided, the floor framing must be lowered to provide for the concrete. The dead weight may be as much as 50 pounds per square foot in a bathroom with a tile floor and heavy fixtures. Several techniques are used to provide the needed support. A smaller size joist may be used and the space between joists reduced to provide adequate support, Figure 13-20. This is a common solution to the problem. Another technique is to use one or more beams under the section to support the added weight.

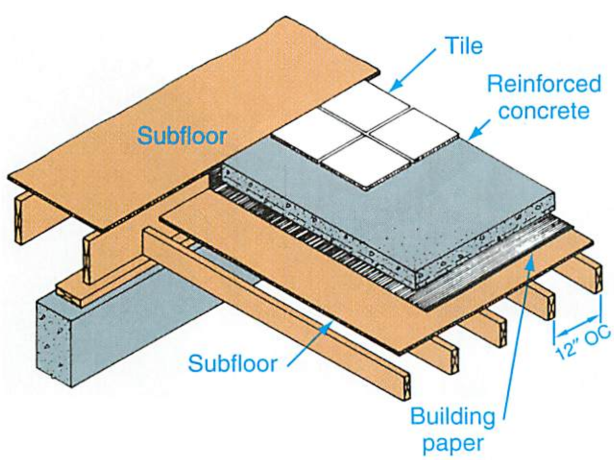



**Figure 13-20.** Using smaller size joists placed closer together than normal can provide the additional support needed for areas of slate and ceramic tile.

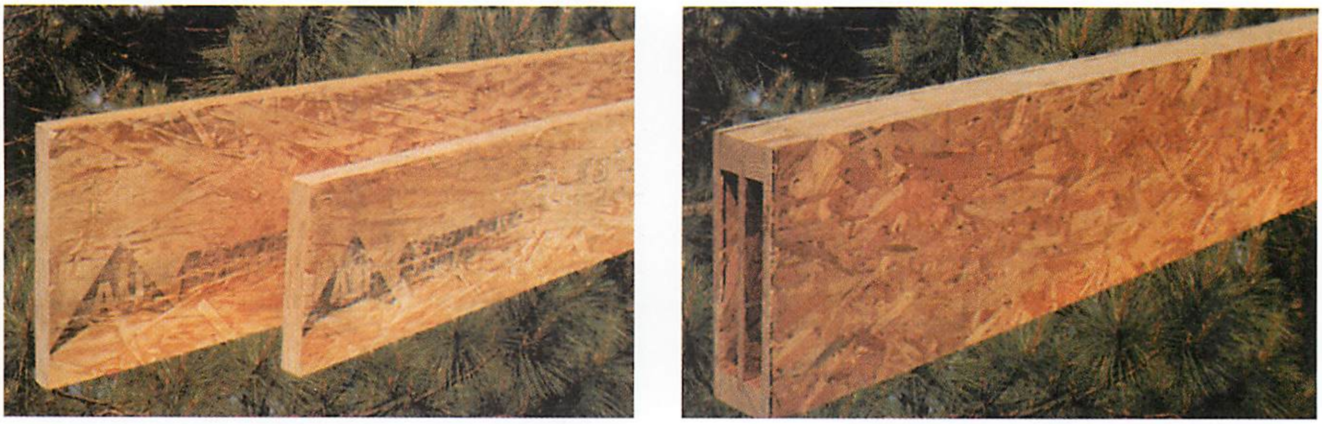
The concrete base for the tile or stone should be reinforced with wire mesh and cast on a plywood subfloor covered with building paper. A special type of concrete, known as a ***cement mortar mix,*** is generally used. It is a mixture of one part Portland cement and six parts sand.

# Engineered Wood Products

***Engineered wood products (EWPs)*** are in a new class of structural wood members that has been evolving for over twenty years. These products are being used more and more in new construction. EWPs combine wood veneers and fibers with adhesives to form beams, headers, joists, and panels that have uniformly high quality and strength, Figure 13-21. In addition, EWPs address the lumber industry's most pressing problem—supply—by making more efficient use of material that was generally thought to be unusable. Wood from smaller trees and inferior species are now being used in engineered wood products to make high-quality products.

Industry analysts predict that the use of engineered wood products will continue to grow. In 1999, engineered wood I-beam production in North America increased by 27%. In that same year, laminated veneer lumber (LVL) production in North America grew by 21%. Total EWP production in 1999 represented more than 5% of the dimensional lumber supply in North America.

Advances in adhesive technology over the past 50 years have made EWPs possible. Phenol-formaldehyde and urea-formaldehyde resins are the most common adhesives for EWPs. The resins of choice for structural-use products are the waterproof phenolics, but they are much more expensive than the urea resins. Some manufacturers are beginning to use methylene diphenylisocynate (MIDI) and polymeric MIDI (PMDI) adhesives because they have a shorter press time. Some claim that



A B

**Figure 13-21.** A—Band boards are available in 9-1/4″, 11-1/4″, 12″, 14″, and 16″ depths. They eliminate the need for ripped plywood bands and provide solid backing for deck and siding attachments. (Alpine Structures) B—Engineered headers are available in 1-1/4″ depth and 3-1/2″ width, which matches other framing members for one-piece installation. (Alpine Structures)

they also have increased dimensional stability and release less gas during production than the formaldehydes.

Engineered wood products as a whole have certain advantages and disadvantages that should be considered. These products have increased quality and consistency. Weaknesses, such as knots, are not found in EWPs as they are in solid lumber. In addition, the uniform drying of EWP components to 8% to 12% moisture content before they are compressed into the final stage produces a more predictable, consistent product from piece to piece. Traditional kiln-dried lumber is usually dried to a 15% to 19% moisture content that is more prone to shrinking and warping. EWPs provide superior design flexibility through greater widths, depths, and beam lengths that are not possible with solid lumber, Figure 13-22. Appearance is also a consideration in some applications. Certain EWPs have a distinctive grain-like pattern that some people prefer over the appearance of framing lumber and can be left exposed for painting or staining.

The greatest disadvantage for EWPs as a group is the lack of industry standards. Products within the same general category can vary greatly because of different proprietary production methods. Each product has its own characteristics making it difficult to make comparisons.

## Oriented Strand Board (OSB)

***Oriented strand board (OSB)*** is a product in which long strands of wood are mixed with resin, placed in layers, and pressed and cured, Figure 13-23. It has been commercially available for many years, first appearing on the market in 1978. However, OSB was not readily accepted at the time due to the poor reputation of earlier, low-quality particleboard panels. OSB has since established itself as a quality product and is widely used for roof and wall sheathing, subflooring, siding, and webs for wood I-beams.

**Figure 13-22.** This roof system has long spans that would require support if built with traditional dimensional lumber. However, these parallel strand beams can span the distance with no inner support.

**Figure 13-23.** Oriented strand board is a high-quality, engineered wood panel product that is replacing plywood in many applications. (The Engineered Wood Association)

Aspen is the preferred wood for making OSB. It is a low-density wood that is easily cut into long strands parallel to the grain. Longer strands produce stronger boards. The strands are mixed with a resin and then mechanically oriented in layers. The outer layers are oriented parallel to the long dimension while the inner layers (core) are parallel to the short dimension. Once the strands are laid, the panel is compressed to its final thickness and the resin cures.

Additional information about oriented strand board can be obtained from:
American Forest & Paper Association
1111 19th St., NW, Suite 800
Washington, DC 20036
info@afandpa.org

The Engineered Wood Association (APA)
PO Box 11700
Tacoma, WA 98411
help@apawood.org

### Advantages of OSB

- OSB is less expensive to manufacture than plywood because it is made from abundant, fast-growing trees.
- OSB has an unique appearance that is appealing as a design element for certain applications.

### Disadvantages of OSB

- OSB is subject to swelling because it is manufactured to a 2% to 5% moisture content. Plywood is generally about 6%.
- OSB is not designed for applications subject to permanent exposure to the elements. Therefore, it is not an acceptable replacement for exterior grade plywood in all instances.

### Installation/application

Oriented strand board is made in panel sizes similar to plywood, typically 4′ × 8′, but it is generally available in sizes up to 8′ × 24′. Manufacturers recommend leaving a space of 1/8″ along all edges to prevent buckling problems when used in roof and wall applications. Installation of OSB near plumbing is not recommended because of potential water drips or leaks. The same nailing schedules that apply to plywood apply to OSB, but it can be nailed to within 1/4″ from the edge of the panel without breaking out.

## Parallel Strand Lumber (PSL)

***Parallel strand lumber (PSL)*** is a product in which thin strands of wood are glued together under pressure, Figure 13-24. This is a fairly new category of engineered wood products. PSL products have been commercially available in the United States since about 1990. It was developed in 1969, but endured 19 years of research and development before being commercialized in Canada in 1988.

PSL is used for beams, columns, and headers. The products provide high strength and span capacity. Low-moisture content virtually eliminates shrinking and checking. According to the manufacturer, pressure-treated PSL is also available for exterior applications. Use of PSL products has increased dramatically in the past few years.

The manufacturing process for PSL begins with debarking logs and peeling them into

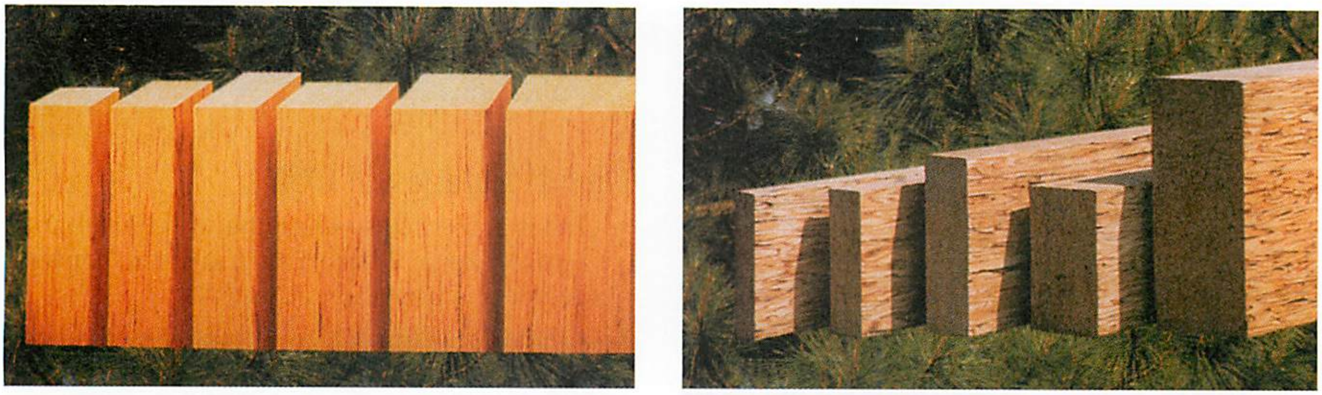


**Figure 13-24.** Both post and beams are available as parallel strand lumber. (Alpine Structures)

thin veneers. The veneers are then clipped into 1/2″ wide strands, which are then combined with adhesives and cured under pressure using microwave-generated heat. Large billets 12″ wide by 17″ deep are formed and then sawed to specified sizes.

### Advantages of PSL

- PSL is very strong.
- PSL allows long spans and more design flexibility.

### Disadvantages of PSL

- Engineered connections are required for side-loading or hanging joists on only one side of a multiple-ply PSL beam.
- PSL should not be drilled or notched and should be stored on site according to manufacturer's recommendations to avoid swelling.

### Installation/application

Parallel strand lumber is available in widths ranging from 1-3/4″ to 7″. Two plies of the 2-11/16″ thick members will match a typical 5-1/2″ thick wall. Lengths up to 66′ are available.

PSL beams can support higher loads than solid beams, so a greater bearing area may be required. Contact the manufacturer for tables outlining the required bearing lengths. PSL beams eliminate the need for on-site construction of built-up beams since they are available in large widths and lengths. The proper connectors must always be used, Figure 13-25.

Additional information about parallel strand lumber can be obtained by contacting:
Trus Joist Headquarters
200 East Mallard Drive
Boise, ID 83706
www.tjm.com

## Laminated Veneer Lumber (LVL)

***Laminated veneer lumber (LVL)*** is a product in which veneers of wood are stacked in parallel and glued under pressure. LVL was

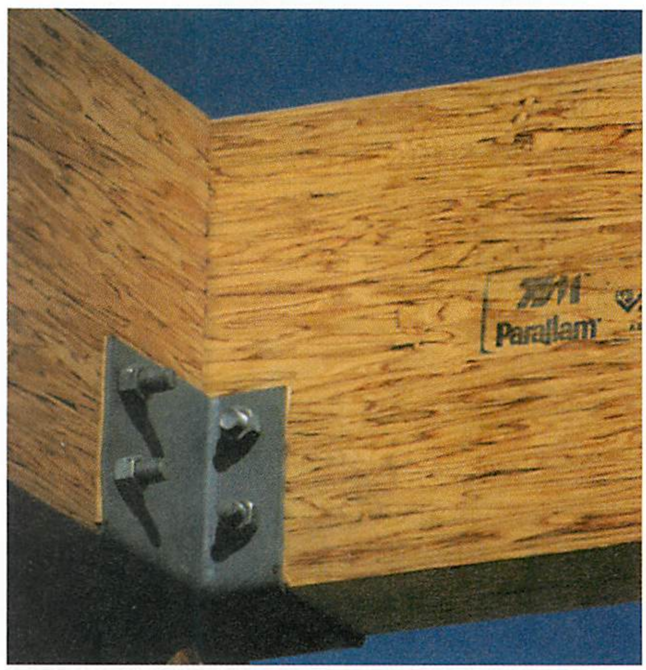



**Figure 13-25.** Large parallel strand beams should be connected using standard steel beam connectors. (Alpine Structures)

first used for high strength aircraft parts in the 1940s. However, commercial production of LVL for high-grade structural members did not begin until 1971. Only recently has LVL received much attention from the building industry. LVL has gained code approval from the Council of American Building Officials (CABO). Laminated veneer lumber is used for headers, beams, columns, joists, and as flanges for wood I-beams, Figure 13-26.

The manufacturing process for LVL is similar to the process used to make plywood. The primary difference between plywood and LVL is that the plies are parallel in LVL, rather than perpendicular, to maximize strength. Southern yellow pine and Douglas fir are generally the woods of choice. Stressed-graded veneer panels are peeled on a veneer lathe in thicknesses of 1/10″ or 1/8″ thick. A waterproof adhesive is applied to the plies before bonding with heat and pressure. The end joints are staggered, which results in a continuous billet of lumber up to 1-3/4″ thick and 4′ wide. Two or more billets can be glued together to form thicker members. The billet is then cut to the desired widths.

### Advantages of LVL

- The high strength of LVL allows long spans, thereby increasing design flexibility.
- LVL can be built-up on site to form larger members.


**Figure 13-26.** Laminated veneer lumber has excellent strength and span capacity. It is used as a header in this wall. (Trus Joist)

### Disadvantages of LVL

- LVL is more expensive than solid lumber.
- LVL is manufactured to a lower moisture content than solid lumber and, therefore, reaches equilibrium on the job site at a different rate than solid lumber.
- LVL must be sized for specific load conditions and cannot be used as a standard material.

### Installation/application

The 1-3/4″ thick billet is the most common LVL material. It can be used individually for joists or combined with other billets to form headers or beams. It is available in depths from 5-1/2″ to 14″ and in lengths up to 66′. LVL is also produced in a horizontal orientation. It is available in widths of 8-1/2″ and 5-1/2″ and in depths from 5-1/2″ to 24″. Lengths are produced up to 66′.

LVL generally should not be mixed with solid lumber in the same floor assembly due to different moisture content of the products. Like any other girder, header, or beam, LVL beams should not be drilled or notched for electrical or plumbing pass-throughs.

Additional information about laminated veneer lumber can be obtained by contacting:
Boise Cascade Engineered Wood Products
Corporate Headquarters:
PO Box 50
Boise, ID 83728-0001
info@bcewp.com

Louisiana-Pacific Corporation (LP)
Headquarters/Corporate Office
805 SW Broadway
Portland, OR 97205
customer.support@lpcorp.com

## Glue-Laminated Lumber

Glue-laminated beams, columns, and arches were the first engineered wood products. They were first produced in the 1950s. Glue-laminated members, also called *glulam beams,* consist of 1× or 2× lumber that is glued in stacks to the desired shape and size, Figure 13-27. The individual laminations may


**Figure 13-27.** This home makes extensive use of glue-laminated members. (The Engineered Wood Association)

be end-joined with adhesives to provide continuous lengths. Therefore, virtually any length and depth can be produced. This product relies on solid sawed lumber produced with traditional milling techniques, which recovers only about 50% of the log.

Glue-laminated beams are manufactured to a national standard (ANSI, AITE A190.1-1983) that has been accepted by all three United States model building codes. Three appearance grades are available: industrial, architectural, and premium. The industrial grade is the least attractive with visible glue stains, press marks, and knotholes. The architectural grade is sanded on four sides with large knotholes filled with putty. The premium grade beam has all checks and holes filled.

## Advantages of glue-laminated lumber

- High Strength. The high strength of glue-laminated lumber is probably the greatest advantage.
- Glue-laminated beams are available either straight or with a camber to offset dead-load deflection.
- Glue-laminated beams are dimensionally stable and are very attractive.

## Disadvantages of glue-laminated lumber

- The cost of glue-laminated lumber is high.
- Glue-laminated lumber requires special handling and storage to prevent damage.
- The large beams are very heavy and require special equipment to handle them.

## Installation/application

Technical support from the manufacturer is required for most glue-laminated lumber products. Manufacturers provide span charts, installation details, and technical assistance. Special connectors are needed for these large members and heavy loads. Generally, for beams that remain exposed, the connection can be custom made. Manufacturers offer these suggestions to reduce checking and preserve the finished surface.

- Keep the beams covered, but allow the wood to breathe.
- Keep the beam off the ground, even if the wrapper is still on.
- Keep the beams out of the direct sunlight to prevent tanning.
- Keep the beams from rapid or extreme drying.
- Avoid sudden humidity changes.
- Seal the beams as soon as possible after unwrapping.
- Seal any new cuts immediately.
- If possible, condition the beams by allowing them to slowly acclimate to the interior of the building.

Additional information about glue-laminated lumber can be obtained by contacting:
American Institute of Timber Construction
7012 S. Revere Parkway Suite 140
Englewood, CO 80112
info@aitc-glulam.org

Engineered Wood Systems
PO Box 11700
Tacoma, WA 98411
www.glulambeams.org
help@apawood.org

## Wood I-Beams or Joists

***Wood I-beams*** or joists are typically made from 2″ × 4″ machine-stressed lumber or LVL flanges grooved to receive a 3/8″ OSB or plywood web that is glued in place, Figure 13-28. They are high-strength, low-weight, and produced by a variety of manufacturers. Wood I-beams are available in flange widths of 1-3/4″ and 2-5/16″ and depths from 9-1/2″ to 20″. Lengths up to 66′ are produced.

The American Society for Testing and Materials standard ASTM D5055-90 lists common criteria for I-beams and was approved and published in July 1990. This standard includes accepted measures for the industry-wide development of design values and quality control, but presently each manufacturer uses their own proprietary process. These processes include variations related to production techniques, joints for the flange-web connection, types of adhesives, and the grade and types of flange and web material. Further, each manufacturer formulates their own design and materials to meet the performance specifications, which include criteria for vertical loads, lateral bracing, joist depth and spacing, and deflection.

### Advantages of wood I-beams

- Speed of construction is most likely the chief advantage of wood I-beams. Beams are light for their length and may span the entire width of a house, thereby reducing by half the number of joists that need to be handled.

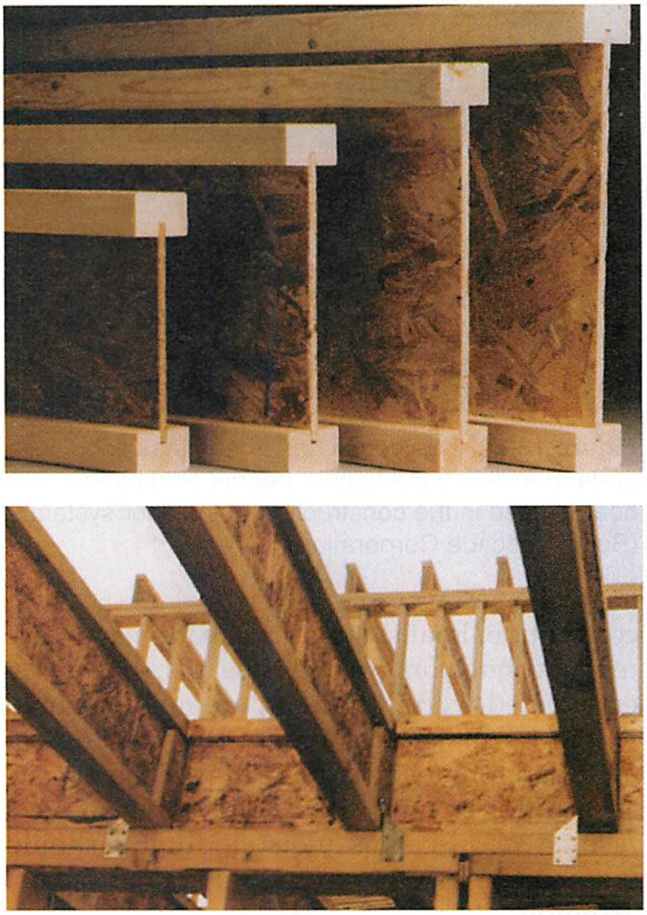


**Figure 13-28.** Wood I-beams are used primarily for long span applications in floor and roof systems. (Boise Cascade Corporation)

- Some wood I-beams have knockout holes to speed the installation of plumbing and electrical cable.
- Wood I-beams are dimensionally stable. They are also very straight.

### Disadvantages of wood I-beams

- Wood I-beams require more effort to cut than solid lumber because of the uneven surface.
- Some building departments do not allow the use of wood I-beams.
- Wood I-beams are more expensive than solid lumber or roof trusses.

### Installation/application

Wood I-beams are used in a similar manner as traditional floor joists or rafters, Figure 13-29. They can be worked with using

**Figure 13-29.** This house has I-beams as floor joists, parallel strand lumber beams, and band boards used in the construction of the floor system. (Boise Cascade Corporation)

conventional nails, tools, and readily available metal connectors. Wood I-beams, like other engineered wood products, are manufactured to a lower moisture content than solid lumber and therefore reach equilibrium at the job site at a different rate than solid lumber. As a result, wood I-beams and solid lumber should not be used together in the same floor or roof assembly.

Web stiffeners or blocks are normally used at bearing points to help reduce the load on the flange-web connection. This is very important in the case of deeper joists. Manufacturers also have recommendations for nail size and the size and location of holes through the web. The flange material should not be cut.

Additional information about wood I-beams can be obtained by contacting:

Boise Cascade Engineered Wood Products
Corporate Headquarters:
PO Box 50
Boise, ID 83728-0001
info@bcewp.com

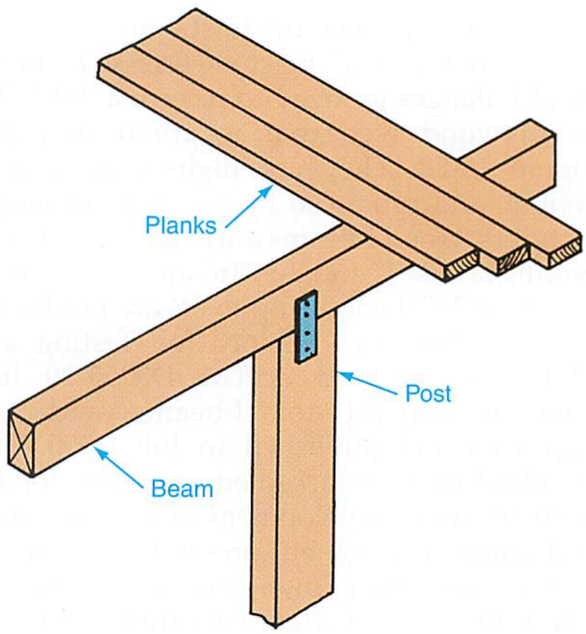
Georgia-Pacific Corporation
133 Peachtree Street, NE
Atlanta, GA 30303
www.gp.com

Louisiana-Pacific Corporation (LP)
Headquarters/Corporate Office
805 SW Broadway
Portland, OR 97205
customer.support@lpcorp.com

Weyerhaeuser Company
PO Box 9777
Federal Way, WA 98063-9777
bldgmaterials@weyerhaeuser.com

# Post and Beam Construction

***Post and beam construction*** uses posts, beams, and planks as framing members that are larger and spaced farther apart than conventional framing members, Figure 13-30. Post and beam construction provides a greater




A

B

**Figure 13-30.** A—The three components of post and beam construction. B—An example of post and beam construction. (The Engineered Wood Association) freedom of design than conventional framing techniques. The system is basically simple, but presents problems related to larger structural sizes, framing connectors, and joining methods.

Most of the weight of a post and beam building is carried by the posts. The walls do not support much weight and are called ***curtain walls.*** Curtain walls provide for wide expanses of glass without the need for headers, Figure 13-31. Wide overhangs are also possible by extending the large beams to the desired length. Spacing of the posts is determined by the design of the building and the load to be supported.

The foundation for a post and beam structure may be a continuous wall or a series of piers on which each post is located. The size of the wall footings or piers is determined by the weight to be supported, soil bearing capacity, and local building codes.

The posts should be at least 4″ × 4″. The posts should be at least 6″ × 6″ if they are supporting the floor. The vertical height of the posts is also a factor in determining the post size. Check local codes for requirements.

Beams may be solid, laminated, reinforced with steel, or plywood box beams. Figure 13-32 shows a variety of beam types. The spacing and span of the beams will be determined by the size and kind of materials and load to be supported. In most normal situations, a span of 7′-0″ may be used when 2″ thick tongue-and-groove subfloor or roof decking is applied to the beams. Thicker beams must be used if a span greater

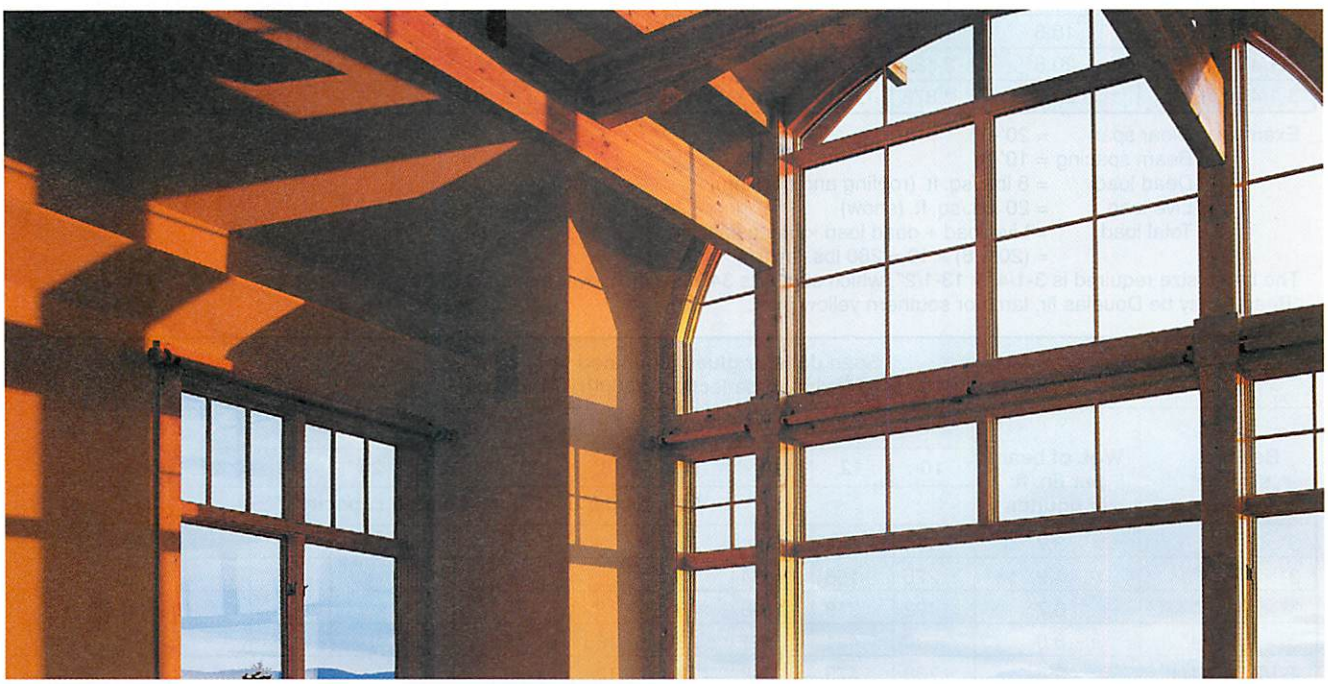


**Figure 13-31.** Post and beam construction permits broad expanses of glass and provides the warm glow of natural wood. (Pozzi Wood Windows)

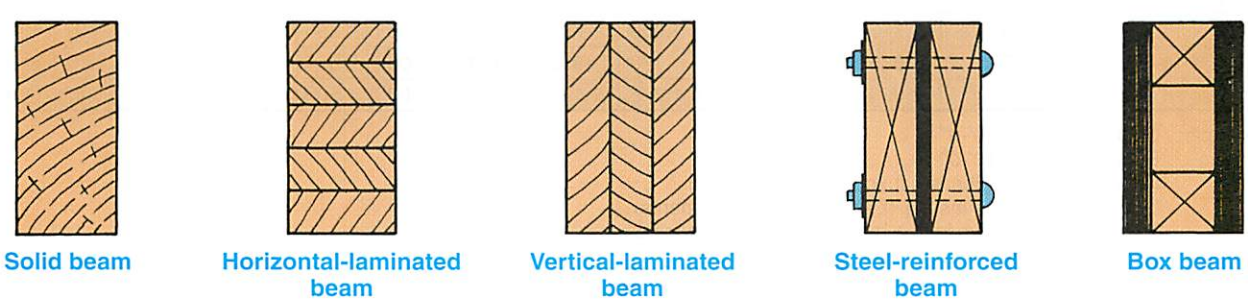



**Figure 13-32.** A variety of beams are used in post and beam construction.

than 7′-0″ is required. See the span tables shown in Figure 13-33.

Two systems of roof beam placement are possible with post and beam construction. See Figure 13-34. The first system is the ***longitudinal method.*** Here, the beams are placed at right angles to the roof slope. Therefore, roof decking is laid from the ridge pole to the eaves

| Span data for glued laminated roof beams* Maximum deflection 1/240th of the span | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beam size (actual) | Wgt. of beam per lin. ft. in pounds | Span in feet | | | | | | | | | | | |
| | | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 |
| | | Pounds per lin. ft. load bearing capacity | | | | | | | | | | | |
| 3″ × 5-1/4″ | 3.7 | 151 | 85 | | | | | | | | | | |
| 3″ × 7-1/4″ | 4.9 | 362 | 206 | 128 | 84 | | | | | | | | |
| 3″ × 9-1/4″ | 6.7 | 566 | 448 | 300 | 199 | 137 | 99 | | | | | | |
| 3″ × 11-1/4″ | 8.0 | 680 | 566 | 483 | 363 | 252 | 182 | 135 | 102 | | | | |
| 4-1/2″ × 9-1/4″ | 9.8 | 850 | 673 | 451 | 299 | 207 | 148 | 109 | | | | | |
| 4-1/2″ × 11-1/4″ | 12.0 | 1,036 | 860 | 731 | 544 | 378 | 273 | 202 | 153 | | | | |
| 3-1/4″ × 13-1/2″ | 10.4 | 1,100 | 916 | 784 | 685 | 479 | 347 | 258 | 197 | 152 | 120 | | |
| 3-1/4″ × 15″ | 11.5 | 1,145 | 1,015 | 870 | 759 | 650 | 473 | 352 | 267 | 206 | 163 | 128 | 104 |
| 5-1/4″ × 13-1/2″ | 16.7 | 1,778 | 1,478 | 1,266 | 1,105 | 773 | 559 | 415 | 316 | 245 | 193 | 154 | 124 |
| 5-1/4″ × 15″ | 18.6 | 1,976 | 1,647 | 1,406 | 1,229 | 1,064 | 771 | 574 | 438 | 342 | 269 | 215 | 174 |
| 5-1/4″ × 16-1/2″ | 20.5 | 2,180 | 1,810 | 1,550 | 1,352 | 1,155 | 933 | 768 | 586 | 457 | 362 | 290 | 236 |
| 5-1/4″ × 18″ | 22.3 | 2,378 | 1,978 | 1,688 | 1,478 | 1,308 | 1,113 | 918 | 766 | 598 | 478 | 382 | 311 |

Example: Clear span = 20′-0″
Beam spacing = 10′-0″
Dead load = 8 lbs./sq. ft. (roofing and decking)
Live load = 20 lbs./sq. ft. (snow)
Total load = Live load + dead load × beam spacing
= (20 + 8) × 10 = 280 lbs./lin. ft.

The beam size required is 3-1/4″ × 13-1/2″, which supports 347 lbs./lin. ft. over a span of 20′-0″.
*Beams may be Douglas fir, larch or southern yellow pine.

| Span data for glued laminated floor beams* Maximum deflection 1/360th of the span | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beam size (actual) | Wgt. of beam per lin. ft. in pounds | Span in feet | | | | | | | | | | | |
| | | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 |
| | | Pounds per lin. ft. load bearing capacity | | | | | | | | | | | |
| 3″ × 5-1/4″ | 3.7 | 114 | 64 | | | | | | | | | | |
| 3″ × 7-1/4″ | 4.9 | 275 | 156 | 84 | 55 | | | | | | | | |
| 3″ × 9-1/4″ | 6.7 | 492 | 319 | 198 | 130 | 89 | | | | | | | |
| 3″ × 11-1/4″ | 8.0 | 590 | 491 | 361 | 239 | 165 | 119 | | | | | | |
| 4-1/2″ × 9-1/4″ | 9.8 | 738 | 479 | 298 | 196 | 134 | 96 | | | | | | |
| 4-1/2″ × 11-1/4″ | 12.0 | 900 | 748 | 541 | 359 | 248 | 178 | 131 | 92 | | | | |
| 3-1/4″ × 13-1/2″ | 10.4 | 956 | 795 | 683 | 454 | 316 | 228 | 169 | 128 | 98 | | | |
| 3-1/4″ × 15″ | 11.5 | 997 | 884 | 756 | 626 | 436 | 315 | 234 | 178 | 137 | 108 | | |
| 5-1/4″ × 13-1/2″ | 16.7 | 1,541 | 1,283 | 1,095 | 732 | 509 | 367 | 271 | 205 | 158 | 123 | 96 | |
| 5-1/4″ × 15″ | 18.6 | 1,713 | 1,423 | 1,219 | 1,009 | 703 | 508 | 376 | 286 | 221 | 173 | 137 | 109 |
| 5-1/4″ × 16-1/2″ | 20.5 | 1,885 | 1,568 | 1,340 | 1,170 | 939 | 678 | 505 | 384 | 298 | 235 | 187 | 151 |
| 5-1/4″ × 18″ | 22.3 | 2,058 | 1,710 | 1,464 | 1,278 | 1,133 | 886 | 660 | 503 | 391 | 309 | 247 | 200 |

Example: Clear span = 20′-0″
Beam spacing = 10′-0″
Dead load = 7 lbs./sq. ft. (decking and carpet)
Live load = 40 lbs./sq. ft. (furniture and occupants)
Total load = Live load + dead load × beam spacing
= (40 + 7) × 10 = 470 lbs./lin. ft.

The beam size required is 5-1/4″ × 15″, which supports 508 lbs./lin. ft. over a span of 20′-0″.
*Beams may be Douglas fir, larch or southern yellow pine.

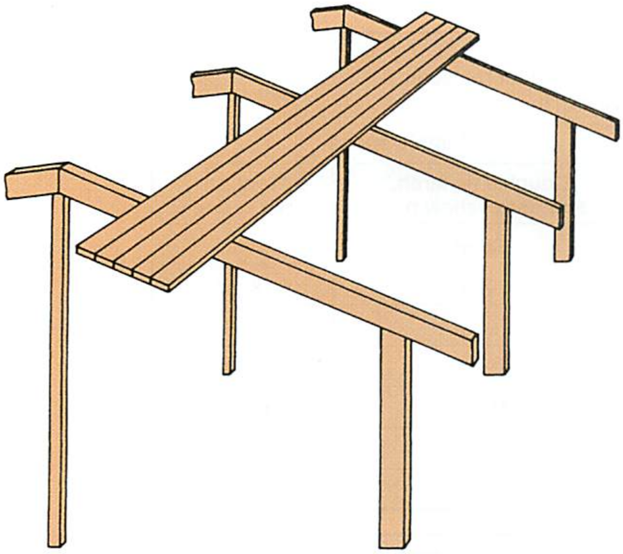
**Figure 13-33.** Span data for glued laminated floor and roof beams. Local building codes should be checked for specific requirements. (Potlatch Forests, Inc.)

line. The second system is called the ***transverse method.*** The beams follow the roof slope and decking runs parallel to the roof ridge.

The conventional method of fastening small members by nailing does not provide a satisfactory connection in post and beam construction. Therefore, metal plates or connectors are used. These are fastened to the post and beam with lag screws or bolts. Figure 13-35 shows a number of metal fasteners used to connect various beam segments.

Decking planks for the roof and floor range in thickness from 2″ to 4″. The planks are usually tongue-and-grooved along the long edges and they may be tongue-and-grooved on the ends as well. Figure 13-36 illustrates several plank designs which are available. Roof decking span information is given in Figure 13-37.

The underside of the planked roof is usually left exposed. If insulation is required, it may be placed above the decking and under the roofing material. Rigid type insulation should be used.



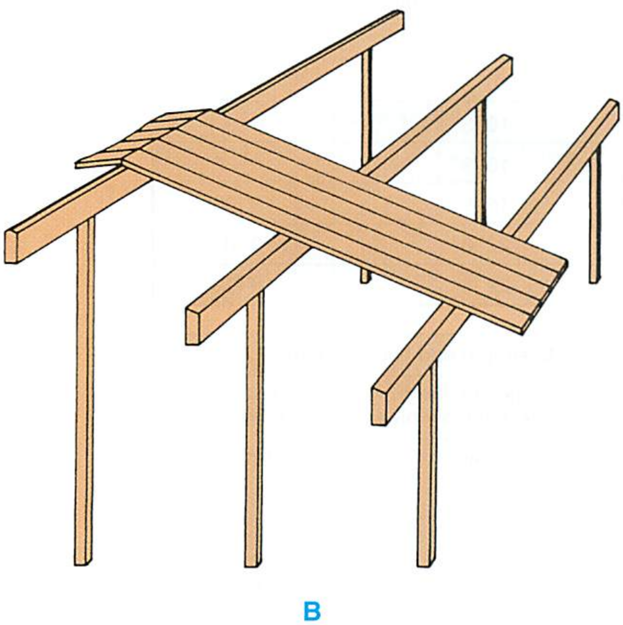




**Figure 13-34.** A—The longitudinal method of placing roof beams. B—The transverse method of placing roof beams.

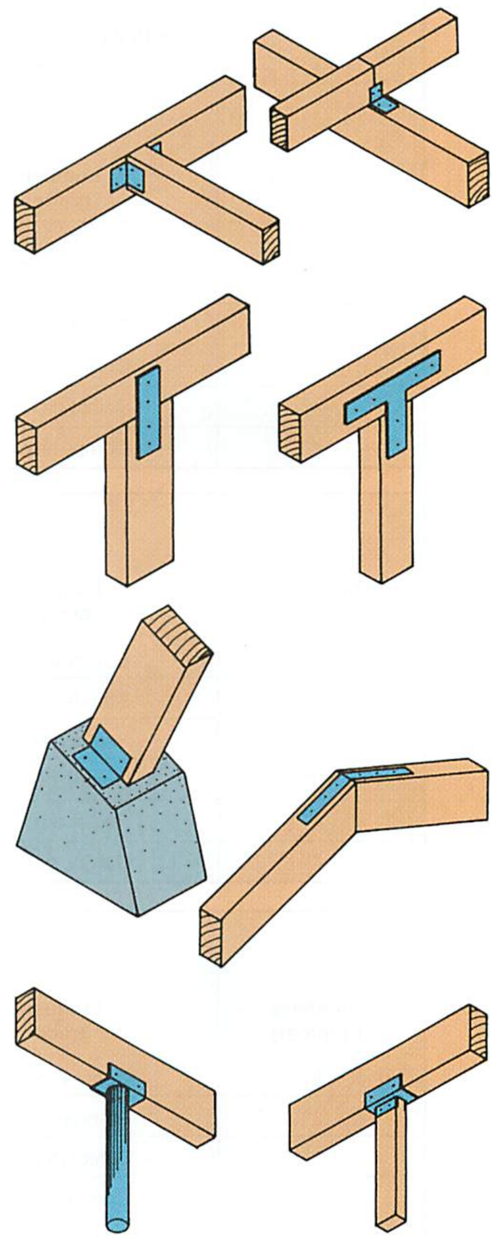


**Figure 13-35.** Typical metal fasteners used to connect large beam segments.

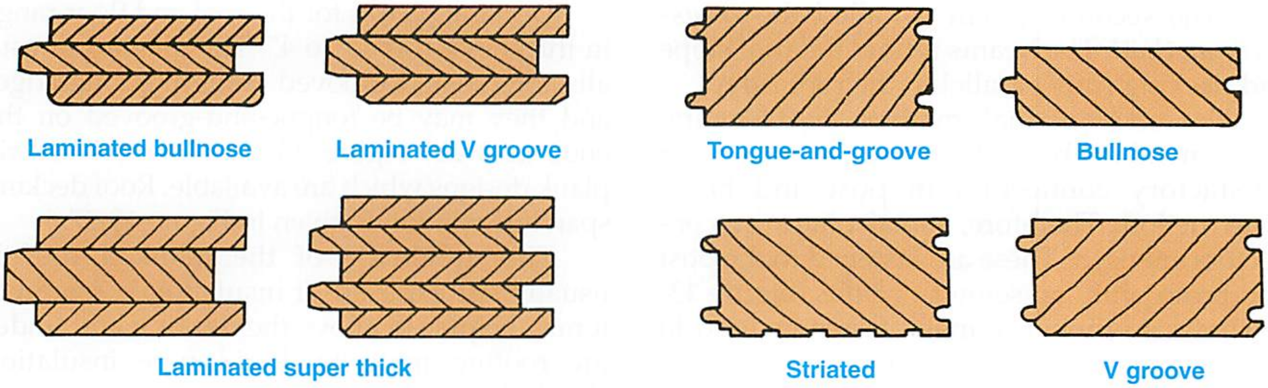



**Figure 13-36.** Planks are available in several designs for use in post and beam construction.

**Span data for roof decking with a maximum deflection of 1/240th of the span Live load = 20 lbs./sq. ft.**

| Thickness (nominal) | Lumber grade | Simple spans | |
|---|---|---|---|
| | | Douglas fir, larch, southern yellow pine | Western red cedar |
| | | Span | Span |
| 2″ | Construction | 9′-5″ | 8′-1″ |
| 2″ | Standard | 9′-5″ | 6′-9″ |
| 3″ | Select dex. | 15′-3″ | 13′-0″ |
| 3″ | Compl. dex. | 15′-3″ | 13′-0″ |
| 4″ | Select dex. | 20′-3″ | 17′-3″ |
| 4″ | Compl. dex. | 20′-3″ | 17′-3″ |

| Thickness (nominal) | Lumber grade | Random lengths | |
|---|---|---|---|
| | | Douglas fir, larch, southern yellow pine | Western red cedar |
| | | Span | Span |
| 2″ | Construction | 10′-3″ | 8′-10″ |
| 2″ | Standard | 10′-3″ | 6′-9″ |
| 3″ | Select dex. | 16′-9″ | 14′-3″ |
| 3″ | Compl. dex. | 16′-9″ | 13′-6″ |
| 4″ | Select dex. | 22′-0″ | 19′-0″ |
| 4″ | Compl. dex. | 22′-0″ | 18′-0″ |

| Thickness (nominal) | Lumber grade | Comb. simple and two-span continuous | |
|---|---|---|---|
| | | Douglas fir, larch, southern yellow pine | Western red cedar |
| | | Span | Span |
| 2″ | Construction | 10′-7″ | 8′-9″ |
| 2″ | Standard | 10′-7″ | 6′-9″ |
| 3″ | Select dex. | 17′-3″ | 14′-9″ |
| 3″ | Compl. dex. | 17′-3″ | 13′-6″ |
| 4″ | Select dex. | 22′-9″ | 19′-6″ |
| 4″ | Compl. dex. | 22′-9″ | 18′-0″ |

**Figure 13-37.** Span data for Douglas fir, larch, southern yellow pine, and western red cedar planking.

## Internet Resources

www.fpl.fs.fed.us
*Forest Products Laboratory*

www.apawood.org
*The Engineered Wood Association*

www.southernpine.com
*Southern Pine Council*

www.wwpa.org
*Western Wood Products Association*

www.gaf.com
*GAF Materials Corporation, manufacturer of roofing materials*

www.bcewp.com
*Boise Cascade Engineered Wood Products*

www.rewardwallsystems.com
*Reward Wall Systems, supplier of insulated concrete form wall systems*

www.builderonline.com
*Builder Magazine*

www.reemay.com
*Reemay, Inc., manufacturer of nonwoven spunbonded products (like house wrap)*

www.alcoahomes.com
*Aluminum Company of America (ALCOA) Building Products, Inc*

## Review Questions – Chapter 13

Write your answers on a separate sheet of paper. Do not write in this book.

1. The two basic types of floor framing being used today are _____ and _____ framing.
2. The lowest member of the frame of a structure, which rests on the foundation and supports the floor joists and wall studs, is the _____.
3. The actual dimensions of a 2″ × 6″ framing member are _____.
4. Platform framing utilizes a method of sill construction known as _____ sill construction.
5. Two types of sill construction used with balloon framing are _____ and _____ construction.
6. List two advantages of balloon framing.
7. The floor of a house is supported by _____ or trusses.
8. Name three softwoods that are commonly used for joists.
9. The most common spacing for floor joists is _____ OC.
10. Traditional kiln-dried lumber has a _____ percent moisture content.
11. What size floor joist should be used if the span is 14′-0″, Number 1 southern pine is to be used, the live load is 30 pounds per square foot, and the joist spacing is 16″OC? Use the span data chart.
12. The purpose of cross bridging is to stiffen the floor and _____.
13. The thickness of plywood commonly used for subfloors is _____.
14. Identify five types of panel products that may be used for subflooring.
15. Name four advantages of engineered wood floor trusses.
16. Why do floor trusses have a built-in camber?
17. A _____ is a part of the house that extends out over a lower section.
18. List the three elements of post and beam construction.
19. Identify four types of beams used in post and beam construction.
20. Two systems of roof beam placement are used in post and beam construction. They are the _____ method and the _____ method.
21. List three common thicknesses in which roof decking is manufactured.
22. What type of insulation is used with a planked roof?
23. What is the greatest single disadvantage of EWPs as a group?
24. One of the disadvantages of OSB is that it is subject to _____ because it is manufactured to a 2% to 5% moisture content.
25. What are the three common uses for parallel strand lumber (PSL)?
26. PSL is available in lengths up to _____ feet.
27. What is the main difference between plywood and LVL?
28. Name the three appearance grades of glue-laminated lumber.
29. Wood I-beams are available in lengths up to _____ feet.

## Suggested Activities

1. Obtain a set of house plans and identify:
   a) Size of floor joists or trusses required.
   b) Spacing of floor joists or trusses.
   c) Type of sill construction specified.
   d) Thickness and type of subfloor material to be used.
   e) Size of sill plate.
   f) Type and size of bridging.
   g) Specie and grade of lumber specified for joists or trusses.
   h) Method of framing used (such as balloon or platform).
   i) Type of construction details shown relating to sill and floor.
2. In small groups, write out definitions for the following terms. Then, provide examples of each using the plans from Activity 1. If no examples appear on the plans, provide an example of where the item/term may be used.
   a) span
   b) live load
   c) dead load
   d) cantilevered
   e) beam
   f) partition
   g) post
   h) reinforced concrete
   i) construction grade
   j) nominal dimension
   k) fire-stop
   l) dimension lumber
   m) header
   n) sill
   o) laminated
   p) slope
   q) tongue-and-groove
   r) striated
3. Select a floor plan of a house and prepare a list of materials for the first floor, such as the sill, header, joists, and subfloor materials.
4. Using your CADD system, design and draw the floor framing for a house of your design. Show the spacing, size, specie, and grade of joists used. Draw the necessary construction details.
5. Using your CADD system, draw a typical foundation section for a house with a crawlspace in your area of the country. Assume the foundation to be 8″ concrete blocks and the footing 8″ × 16″ concrete. Show proper material hatch patterns.