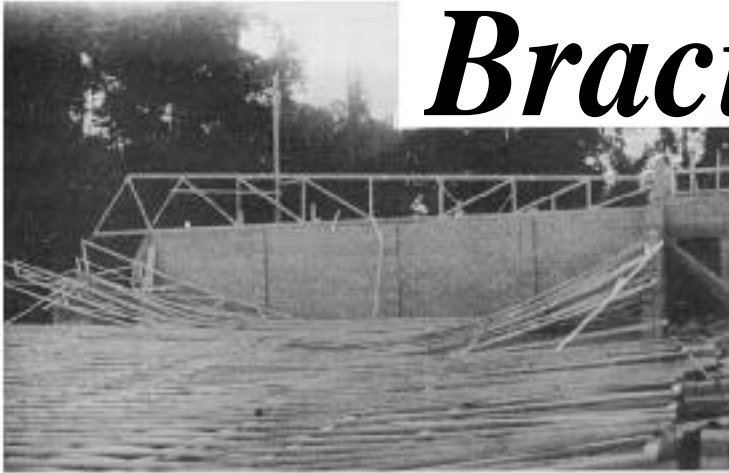


TRUSS Bracing



The truss that was braced—creatively—to a telephone pole was the only one to survive this major collapse. Inadequate temporary bracing was cited as the cause.

The vast majority of truss collapse are due to inadequate temporary bracing. To be safe, follow these guidelines from the Truss Plate Institute.

No matter how carefully wood trusses are designed and fabricated, everything is at stake when they're erected and braced. At this critical stage, the trusses' most significant design assumptions are either fulfilled or ignored. If ignored, the result can be the collapse of the structure. At best, this means a substantial loss of time and materials; at worst, a loss of life.

The theory of bracing is to apply sufficient support at right angles to the plane of the trusses to hold each truss member in the position assumed for it in design. This theory must be applied at three stages.

Stage One: Design

At the design phase, the truss designers determine which compression members are subject to buckling, and specify lateral bracing as required. Lateral bracing shortens the effective "buckling length" of a member by stiffening it at mid-span. Lateral bracing to prevent buckling is the only bracing specified by the truss designer.

Also at the design phase, the building designer must specify how this lateral bracing is to be anchored to prevent all truss members from buckling as a unit, as shown in Figure 1. This can be accomplished by:

1. Anchoring to solid end walls, such as reinforced block (Figure 2).
2. Diagonal bracing in the plane of web members (Figure 3).
3. Other means, as determined by the building designer.

If diagonal bracing is specified, it should be at least nominal 2-inch lumber, and should be installed at about 45 degrees to the lateral braces. The diagonal bracing should attach to the opposite side of the web members with lateral bracing.

The diagonal bracing may be either continuous or intermittent. However, the braces should be spaced no more than 20 feet apart, or twice the horizontal run of the diagonal bracing. (The distance between diagonal braces is measured from the end of the first brace to the beginning of the next.)

Stage Two: Temporary Bracing

The contractor must make sure that the wood trusses are not structurally

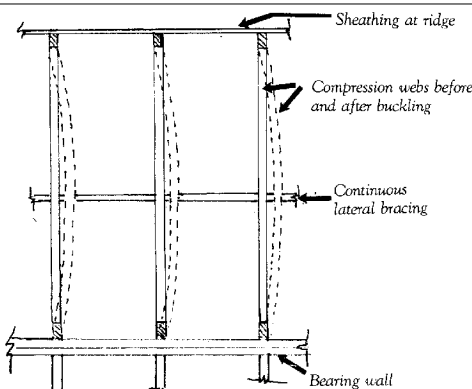


Figure 1. Continuous lateral bracing maintains spacing, but allows all web members to buckle at once.

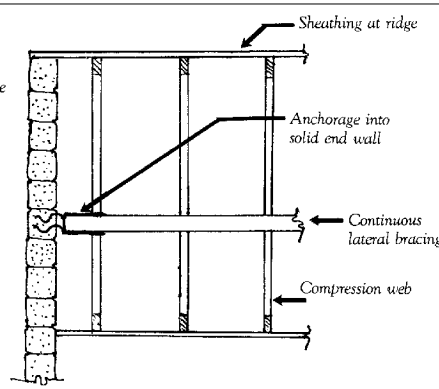


Figure 2. Trusses can be anchored to a solid end wall to secure lateral bracing of the web members.

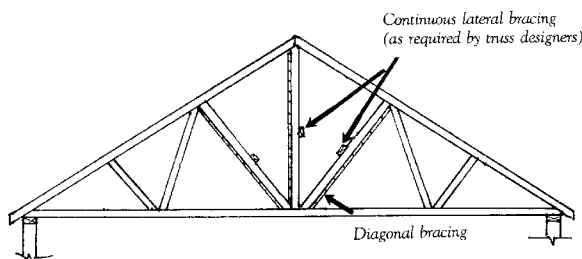


Figure 3. Diagonal bracing in the plane of the web members prevents lateral movement. The diagonal braces are typically arranged in a crisscross fashion.

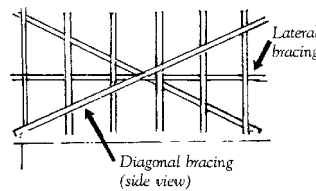
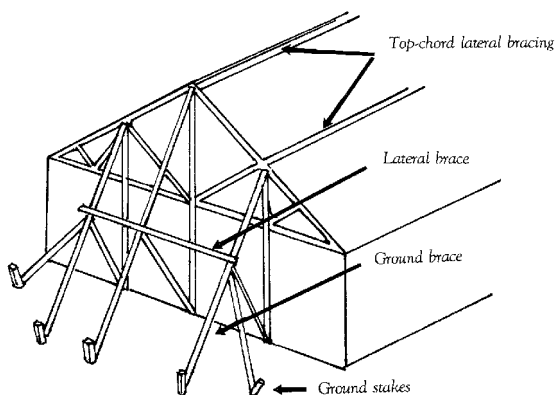


Figure 4. Locate ground braces for first truss directly in line with all rows of top-chord lateral bracing.



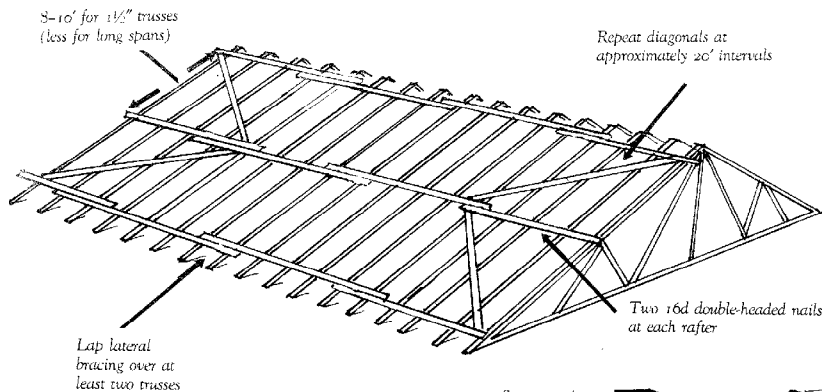


Figure 5. Temporary bracing in the plane of the top chord.

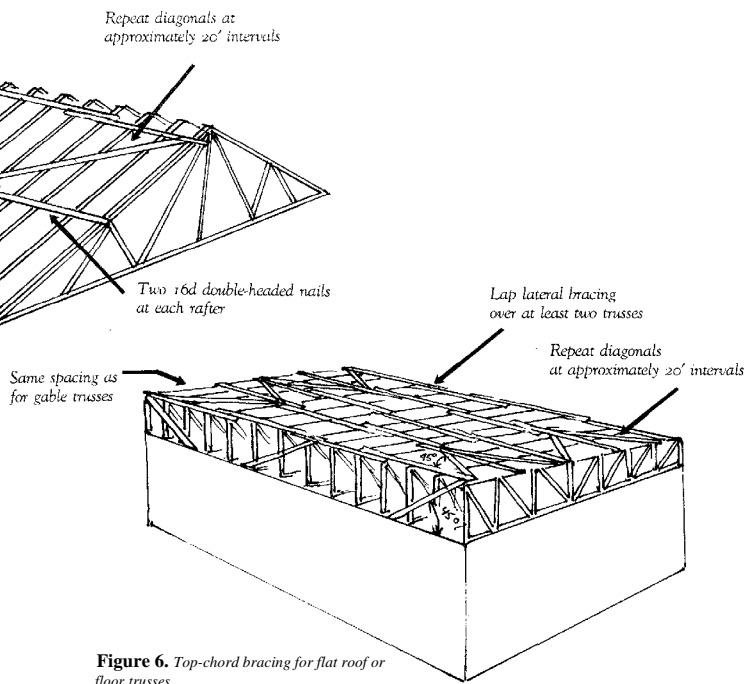


Figure 6. Top-chord bracing for flat roof or floor trusses.

damaged during erection. Proper rigging, including the use of spreader bars and multiple pick-up points where required, is necessary to prevent damage.

It is critical to securely brace the first truss at the end of the building. Since all other trusses are tied to the first one, the system depends to a great extent on how well the first truss is braced.

One method is to securely anchor the top chord of the first truss to a stake driven into the ground. The ground brace itself should be supported, as shown in Figure 4, or it is apt to buckle. Additional ground braces are recommended inside the building, anchored in the opposite direction.

The ground braces should line up with the rows of lateral bracing on the top chords. Otherwise, the top chord of the first truss may bend sideways and allow the trusses to shift. This shift, however slight, would put a tremendous strain on the bracing system—adding the weight of the trusses to any wind force or construction load, such as bundles of plywood or roof shingles—and tend to tip the trusses over.

All braces should be nailed so that if the trusses should buckle or tip, the nails will be loaded in shear, not in withdrawal.

Don't nail scabs to the end of the building to brace the first truss. These scabs can break off or pull out and allow a total collapse.

As the trusses are set in place, it's critical to apply temporary bracing that will hold them plumb, aligned, and safe until the permanent bracing, decking, or sheathing is in place. The temporary bracing should be at least 2x4 dimension lumber and as long as is practical (8 feet, minimum). Short spacer pieces of lumber between adjacent trusses are *not* recommended, unless used only briefly in preparation for continuous bracing.

Nail the temporary braces with two double-headed 16d nails at each member.

One acceptable alternative is to pre-assemble groups of trusses on the

ground into structurally braced units, which are then lifted into place as assemblies.

When you erect the trusses, place them in their exact locations. This eliminates the hazardous practice of removing the bracing in order to adjust the truss spacing as the sheathing is applied. Adjusting the spacing can cause trusses to topple if a key connection is removed at the wrong time.

To ensure stability, temporary truss bracing must be applied to at least two planes of reference in the roof system: (1) top-chord (sheathing) plane; and (2) bottom-chord (ceiling) plane.

1. Top-chord plane. Most important to the builder is bracing the top chords, which are susceptible to lateral buckling before being sheathed. Continuous lateral bracing should be installed within 6 inches of the ridge line, and at approximately 8- to 10-foot intervals between the ridge line and the eaves. For double-member trusses the spacing between laterals may be increased to 12 to 14 feet.

To create stability in the plane of the top chord, place diagonal braces between the lateral bracing at approximately 45-degree angles to form triangles. Note: Long spans or heavy loads may require closer spacing between lateral bracing, and closer intervals between diagonals. Figure 5 illustrates temporary bracing in the plane of the top chord for gable trusses.

If possible, the top-chord bracing should be placed on the underside of the top chords so that the braces will not have to be removed while the plywood decking is laid.

It is equally important to install top-chord bracing for flat trusses, using a similar bracing pattern. Pay particular attention to bracing at the end of flat trusses, as shown in Figure 6.

2. Bottom-chord plane. The bottom chords need continuous lateral bracing to keep them spaced properly. The rows of bracing should be spaced no more than 10 feet apart, and should lie close to the panel points (joints) along the bottom chord. The bottom-chord

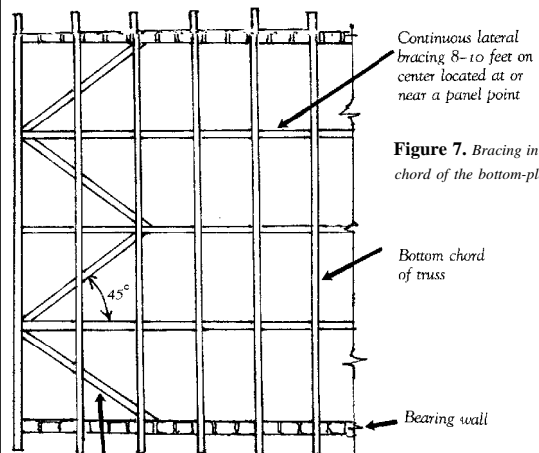


Figure 7. Bracing in the chord of the bottom-plane.

Diagonals form braced bay. Repeat at other end of building and at approximately 20' intervals

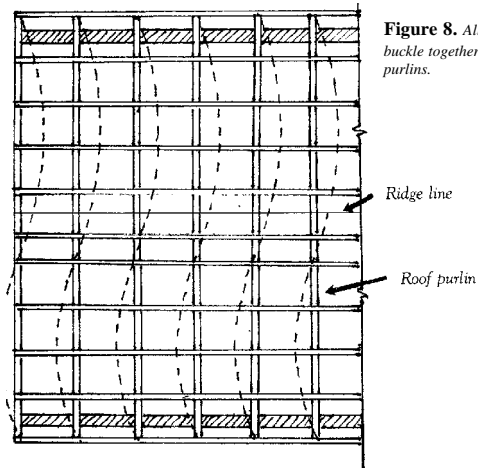


Figure 8. All top chords can buckle together despite frequent purlins.

braces run the full length of the building, and are nailed to the top of the bottom chord.

To keep the bottom chords stable, diagonal bracing should be placed between laterals at about 45 degrees. The diagonals should go at each building end, but generally aren't needed along the entire building. In most cases, temporary bottom-chord bracing goes where permanent bracing is specified—and is left in place as permanent bracing. Figure 7 illustrates bracing in the plane of the bottom chord.

Never place full bundles of plywood on trusses, and limit any plywood stacks to eight sheets. Locate any stored materials near support from a bearing wall. Also, don't concentrate any loads of construction materials (such as gravel or shingles) in any one area; spread them out so you won't overload a truss.

Mechanical equipment should be located only on those trusses specifically designed to support it. Don't drop equipment—or even set it temporarily in any other area—unless the trusses are adequately shored. Shore all floor trusses if pallets of masonry materials are to be stored temporarily until the next higher walls are finished.

Stage Three: Permanent Bracing

Permanent bracing is designed and specified by the architect or engineer for the structural safety of the building. It is the responsibility of the building designer to indicate the size, location, and attachments for all permanent bracing.

Permanent bracing must provide sufficient support at right angles to the plane of the trusses to hold every truss member in the position assumed for it in design. Permanent bracing must also resist lateral forces imposed on the completed building by wind or seismic forces.

Permanent bracing can be subdivided into three logical components:

1. Top-chord plane. If plywood floor or roof sheathing is properly applied with staggered joints and adequate nailing, a continuous diaphragm action is developed and additional bracing in the top-chord plane is generally not needed. Some metal roofing materials may also act as a diaphragm when properly lapped and nailed.

If purlins are used, however, diagonal bracing should be applied to the underside of the top chords to prevent lateral shifting of the purlins. Figure 8 illustrates why diagonal bracing is needed despite the use of closely spaced purlins.

It is recommended that this diagonal bracing be installed on both sides of the ridge line in all end bays. If the building is more than 60 feet long, this bracing should be repeated at intervals of no more than 20 feet.

2. Web-member plane. Lateral bracing of the webs holds the trusses in a vertical position and maintains the design spacing. In addition, this lateral bracing may be required to shorten the buckling length of a web member. As described earlier, diagonal bracing or end anchorage is essential to stabilize the lateral bracing.

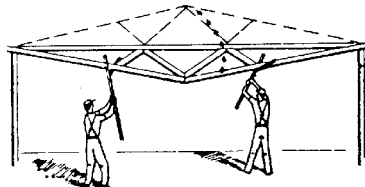
Diagonal bracing in the plane of the web members also transfers lateral forces in the truss system to diaphragms or shear walls, and distributes unequal loading to adjacent trusses.

The spacing of rows of diagonal bracing in the plane of the webs is up to the building designer, based upon the span, truss configuration, type of building, and loading. For roof trusses, the spac-

ERECTING TRUSSES



20' and under
Figure A



30' and under
Figure B

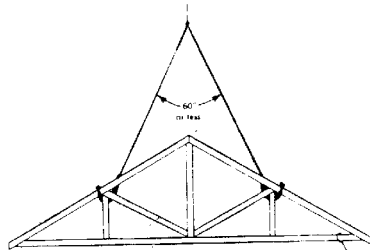


Figure C

Depending on the span and wall height, trusses can be erected either manually or mechanically.

When erected by hand, the trusses are slid over the sidewalls and rotated into position using a fork-like lifting pole. The longer the span, the more workers you'll need to avoid putting lateral strain on the truss. During lifting, support the truss at the peak or quarter points as in Figures A and B.

Trusses large enough to be erected by cranes, forklifts, or similar equipment will need adequate slings, taglines, booms, and spreader bars to control movement of the truss and prevent lateral bending.

For truss spans of less than 30 feet, you can use the lifting method

shown in Figure C. For spans between 30 and 60 feet a suggested procedure is shown in Figure D. Note that the lines from the ends of the spreader bar toe-in. If the lines toe-out, they can cause the truss to buckle.

For trusses in excess of 60 feet, a strongback should be used, as shown in Figure E. Attach the strongback to the top chord and web members at intervals of about 10 feet. Also, the strongbacks should be at or above the mid-height of the truss to prevent overturning. The strongback can be any material strong enough to safely carry the weight of the truss, and sufficiently rigid to keep the truss from bending.

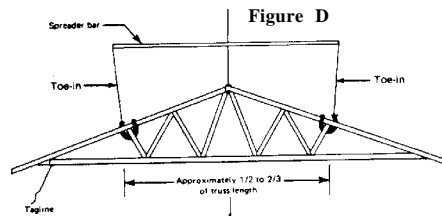


Figure D

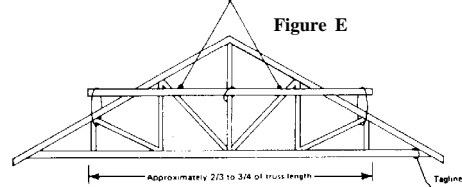


Figure E

ing generally ranges from 12 to 16 feet, depending on the top-chord bracing. For floor trusses, the bracing should be approximately 8 feet on center. Lateral 2x6 strongbacks may also be used for web bracing in some floor systems.

Figure 3 illustrates bracing in the plane of the webs, which is typically placed in a crisscross fashion.

3. Bottom-chord plane. This bracing maintains the truss spacing, and resists buckling forces in the bottom chords in the event of stress reversal due to wind uplift or unequal roof or floor loadings.

With multiple bearing trusses or cantilever conditions, portions of the bottom chord become compression members and should be braced laterally to resist buckling in the same manner as the top chord of simple-span trusses.

Bracing in the plane of the bottom chord is also designed to transfer lateral forces due to wind or seismic loads into sidewalls, shear walls, or other resisting structural elements.

Diagonals between the continuous lateral bracing stabilize the bottom chords. One complete bay of diagonal bracing should be installed at each end of any building, and additional bays should be located at intervals of no more than 20 feet. ■

This article was adapted from recommendations published by the Truss Plate Institute (TPI) in consultation with the Component Manufacturers Council. While these recommendations represent the collective experience of leaders in the wood-truss industry, they are not the only method for bracing a roof system, and should not be used in lieu of an architect's or engineer's design. TPI expressly disclaims any responsibility for damages arising from the use of these recommendations.