PERMANENT TRUSS BRACING

In designing a wood truss, the following assumptions are made by the designer :

- Trusses are vertical and are properly spaced.
- Truss chords are straight and are laterally supported by sheathing, purlins, or bracing.
- Webs are laterally braced as required by the design drawing.

To achieve these assumptions the following types or categories of permanent bracing should be considered :

BRACING IN THE PLANE OF THE TOP CHORD

Truss top chords are normally in compression under downward vertical loads and are subject to lateral bowing or buckling if they are not adequately restrained. Truss design drawings show the maximum permissible purlin spacing to prevent lateral buckling for a particular design.

Most building designs involve roof decks that provide sufficient lateral restraint to prevent lateral buckling of truss top chords. These include plywood or oriented strandboard roof sheathing applied with staggered joints and adequate nailing.

Metal roofing applied over purlins, can also provide adequate lateral support provided the metal has sufficient diaphragm capacity, the roofing is adequately fastened to the purlins, and the purlins are adequately fastened to the truss chords. Information on the diaphragm capacity of light gauge metal applied over purlins is available from "The Canadian Sheet Steel Building Institute".

Where receding valley jacks are installed over roof trusses to extend intersecting roof planes, it is important to laterally restrain the top chords of the trusses below the valley jacks. The most reliable method of achieving adequate lateral support is to specify continuation of the roof sheathing over the trusses prior to installing the valley jacks. In the case of metal roofing over purlins, the valley jacks should be installed directly over purlin members or separate strapping members and adequately fastened to transfer horizontal loads and prevent uplift.

Tongue and groove wood lumber decking applied directly to trusses can provide an adequate diaphragm to prevent lateral buckling of top chords but

additional bracing may be required where decking is face nailed to long span trusses and there is no lateral spiking of adjacent decking members. Application of a light plywood or O.S.B. deck over this material can be a simpler and more economic solution than developing a bracing system.

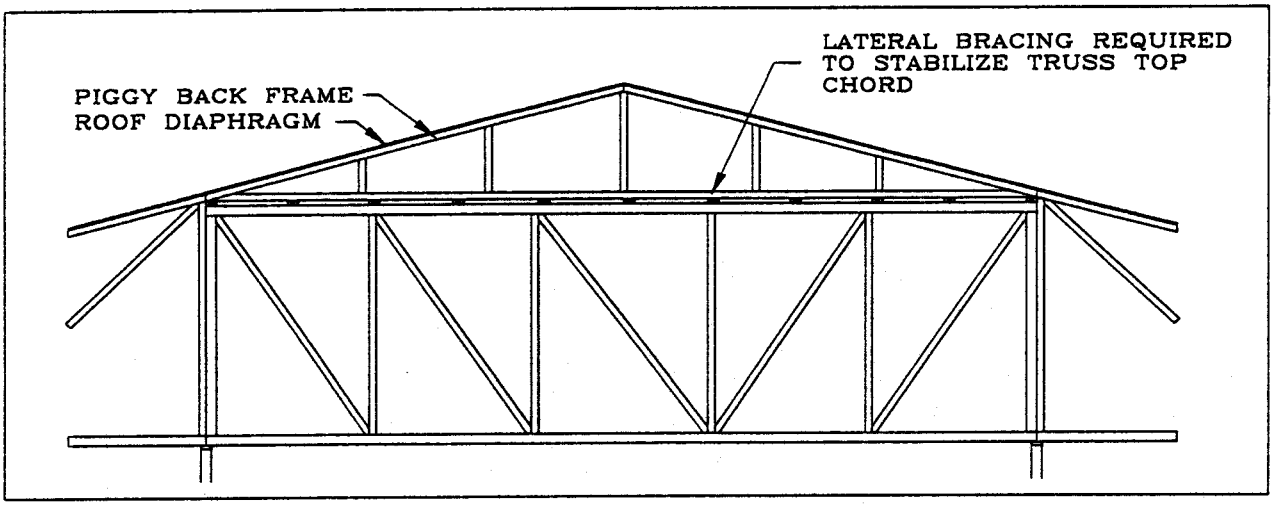
Occasionally, wood trusses are considered as a possible framing system for temporary hoarding to be covered with polyethylene sheets or tarps. In these cases the designer must develop a method of providing lateral restraint for the top chords as these materials have no diaphragm capability. Usually, the solution involves development of a bracing system with purlins and diagonal braces in the plane of the roof.

Some building designs involve roof trusses that are too high to manufacture in one piece and transport to a jobsite. A common solution in this case is to build a two piece assembly. A lower structural truss is designed with a separate frame or "piggy back" located above the truss to complete the required shape.

In this case there is no roof diaphragm attached to the horizontal portion of the top chord of the structural truss to prevent lateral buckling. A separate bracing system must be designed to provide the necessary lateral restraint.

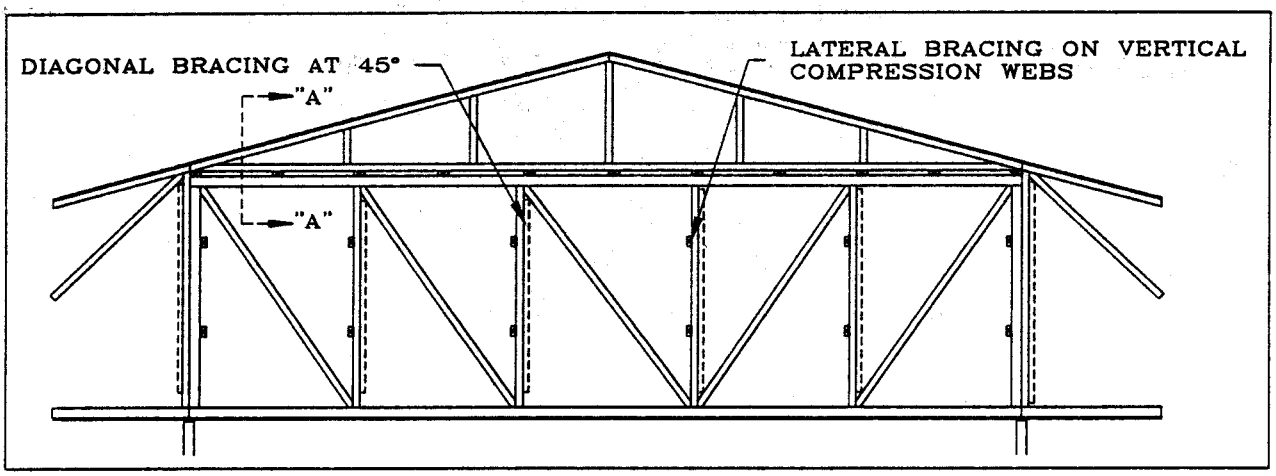
A simple and economical solution may be the addition of a light deck such as 3/8 " plywood or oriented strandboard. In some situations, however, this may not be possible due to the use of a truss spacing larger than 610 mm. or the attic space may have to remain open to accommodate a sprinkler system for fire protection.

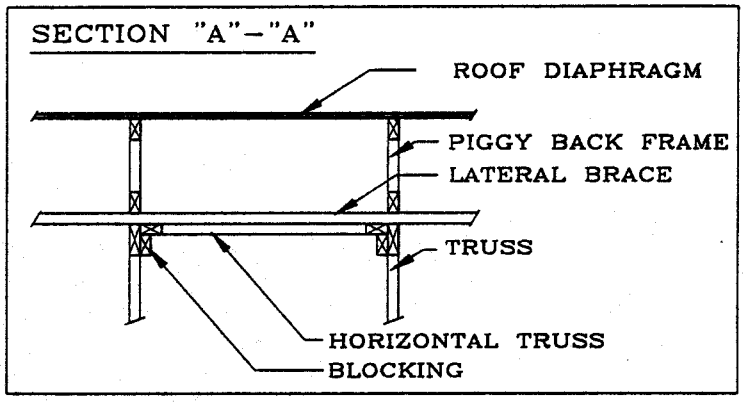
Another potential solution involves the installation of lateral bracing at a spacing that does not exceed the maximum spacing required to stabilize the truss top chord. This maximum spacing is normally shown on the truss design drawing.



It is necessary, of course, to stabilize these lateral braces to prevent them from all moving together. This can be accomplished by :

- using diagonal braces in the plane of the horizontal top chord to transfer load to the roof diaphragm at each end.
- installing flat trusses at intervals in the plane of the horizontal top chords to connect to the roof diaphragm.
- where there is a rigid ceiling attached to the bottom chord of the truss, diagonal bracing in the plane of the vertical webs can be used to connect the horizontal top chords to the ceiling diaphragm. Horizontal diagonal bracing or horizontal flat trusses can then be used to prevent lateral buckling of the top chords between panel points. This is usually the best solution as diagonal bracing in the plane of the vertical webs will be required anyway to stabilize the lateral bracing that will be necessary on such long compression webs and will be helpful to provide stability during construction.

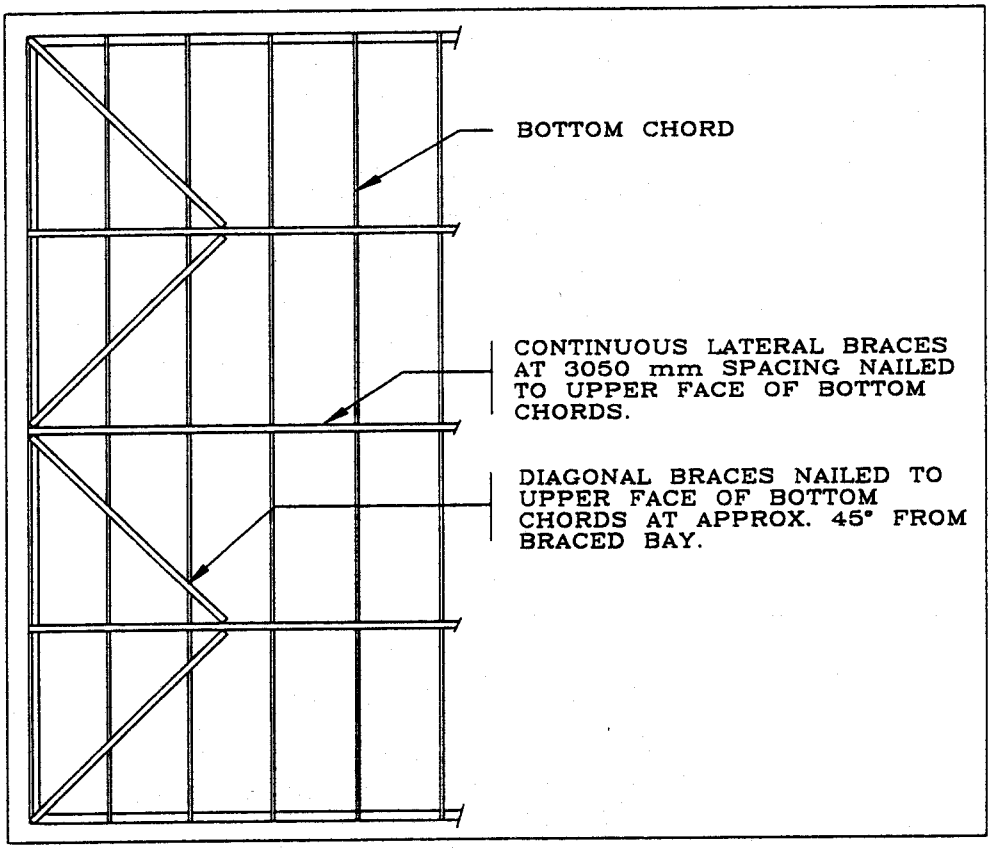




BRACING IN THE PLANE OF THE BOTTOM CHORD

Lateral bottom chord bracing is used to maintain the truss spacing, reduce possible vibration, and to provide lateral support for the bottom chord to resist buckling in the event of stress reversal due to wind uplift or unbalanced loading of trusses with intermediate supports.

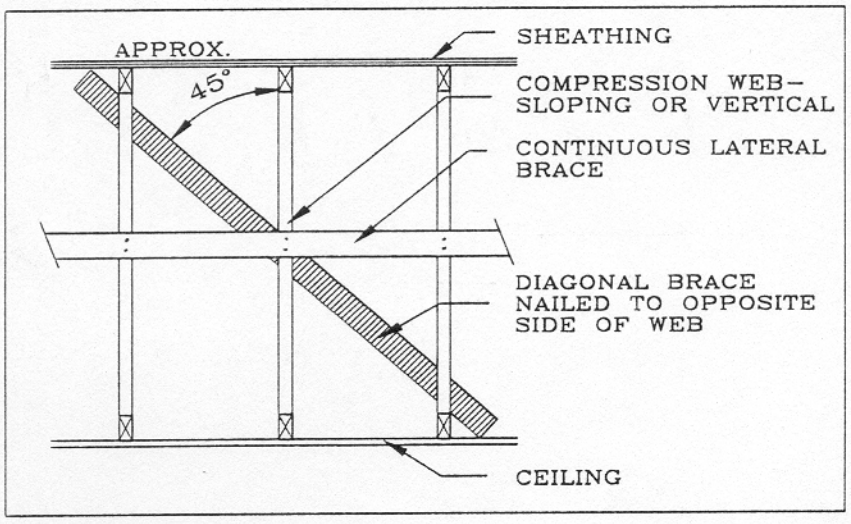
Where a rigid ceiling material, such as plywood, oriented strandboard, or corrugated metal is not attached directly to the bottom chords, permanent lateral braces are required at maximum intervals of 3050 mm. (10 ft.) to achieve a maximum slenderness ratio of 80 for tension members, assuming 38 mm. thick chords. In this case, cross bracing in the plane of the bottom chords should be installed at 45 degrees to prevent movement of these lateral braces. With no rigid ceiling, one complete bay of horizontal diagonal bracing should be installed at each end of the building with additional intermediate bays located at approximately 6100 mm. (20 ft.) intervals along the building.



For multiple bearing trusses or cantilever conditions, portions of the bottom chord become compression members and should be laterally braced to resist buckling in the same manner as the top chords. Truss design drawings show the maximum spacing of lateral braces in these cases, assuming no rigid ceiling material will be installed.

WEB BRACING

Truss web members are designed considering potential buckling about both axis of their section. Where lateral restraint of a compression web is required to reduce slenderness considering buckling about it's weak axis , such lateral restraint is specified on the truss design drawing in the form of a continuous lateral brace attached to the web of each truss of that type. As the truss receives load, forces increase in the compression webs, initiating some tendency for these webs to buckle and transfer load to the lateral brace. Forces can develop in the lateral brace causing all of the webs tied together to buckle in the same direction, carrying the lateral brace with them. To prevent this, the lateral brace must be stabilized by bracing it to the roof and/or ceiling diaphragm. This is accomplished by installing diagonal bracing (at approximately 45 degrees) in the plane of the webs, located at intervals along the building.

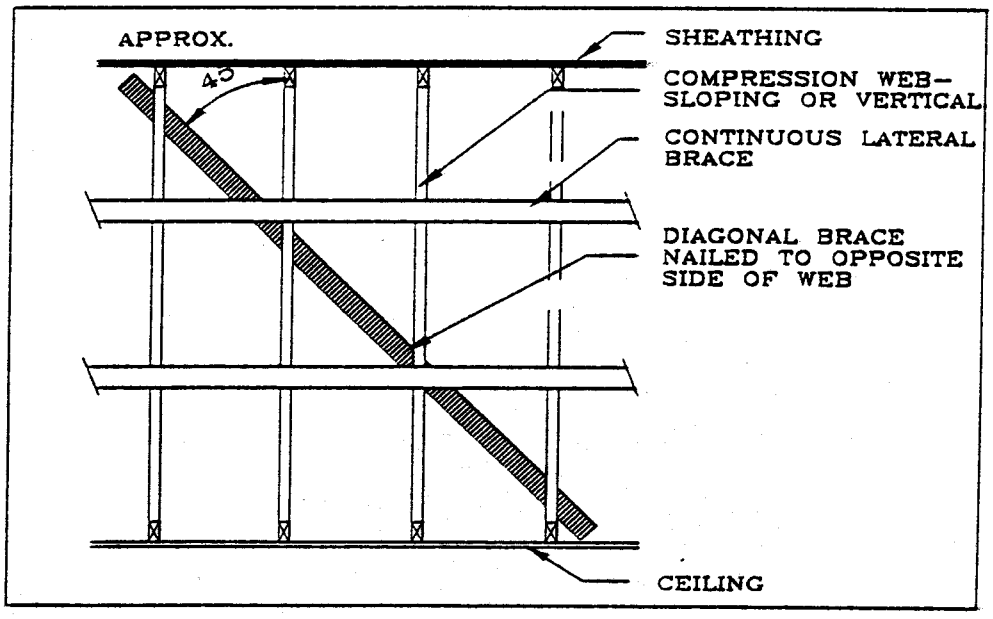


The frequency at which the diagonal or tie-back braces should be installed is governed by the ability of the nails in the diagonal brace to transfer the loads. Assuming the use of two nails at each connection, the necessary frequency of the diagonal braces can be determined by the following formula :

$$N = P/C$$

Where : N = maximum number of trusses per diagonal brace
P = summation of factored axial forces in webs braced by one diagonal brace (lbs) - see accompanying table
C = factored compression force in one web from truss design drawing (lbs)

NAIL TYPE	P (lbs)
3 ½ " common wire nail	20,800
3 ½ " spiral nail	19,000
3 ¼ " power driven framing nail	
0.12" diam. (3.05 mm)	12,000
0.11" diam. (2.8 mm)	8,800

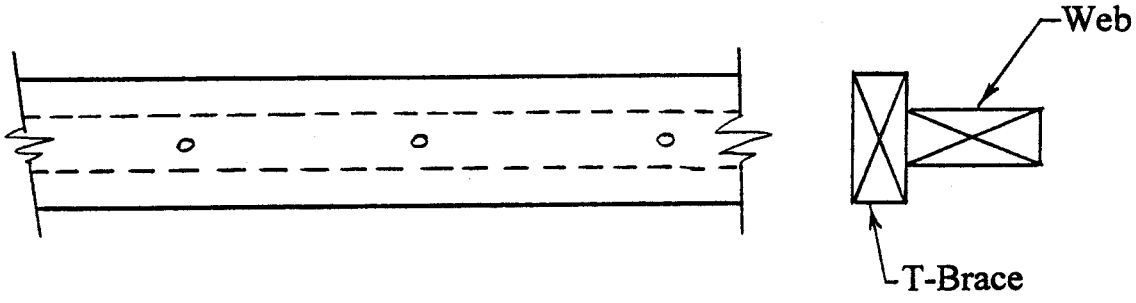


The recommended maximum number of trusses per diagonal brace is 10. This means starting a diagonal brace every 10th truss or every 6100 mm. (20 ft) for trusses at 610 o.c.. The same formula applies where a compression web is restrained by two lateral braces, providing there is a rigid ceiling available to receive load from the diagonal brace. With no ceiling, the diagonal braces should occur more frequently to prevent overloading of the connection at the upper end of the diagonal brace.

The diagonal brace should be connected to one of the truss webs at the same location as the lateral brace but on the opposite edge of the web to avoid creating bending forces in the web.

Should a compression web require lateral restraint at more than two locations, the truss designer should revise the lumber size and/or grade of the web to obtain stiffer material, or revise the web orientation to avoid a long, heavily loaded web.

In some situations, a roof system may involve a truss with a different shape and web configuration than the adjacent trusses on either side. In this case, there may be no opportunity to provide lateral restraint for a compression web by bracing to adjacent trusses. This problem can be overcome by attaching a second member, referred to as a "T" brace, to the web requiring lateral restraint, to reduce the tendency of the web to buckle about it's weak axis. This member extends the full length of the web and is nailed to one edge of the web as shown in the illustration below. The accompanying table is taken from the "Design Procedures for Metal Plate Connected Wood Trusses" published by the Truss Plate Institute of Canada and referenced in the N.B.C.C..



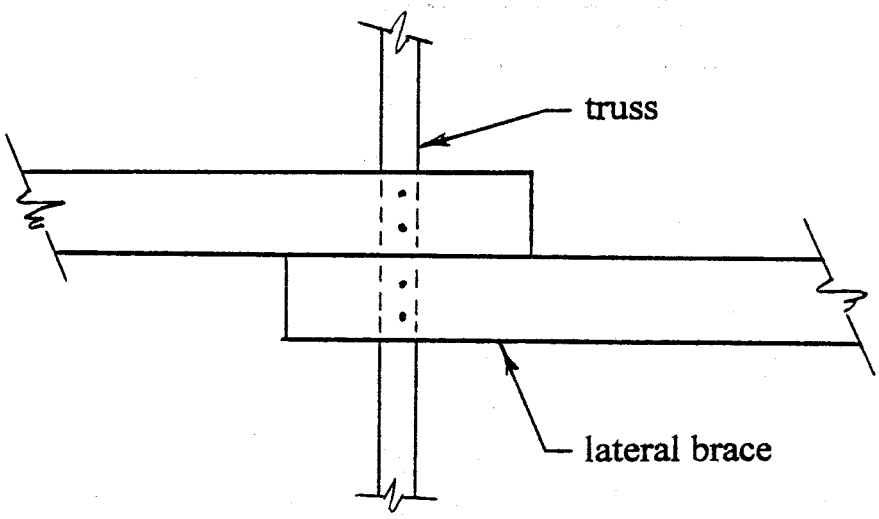
Nailing - 3″ common wire nails at 6″ o.c. or
3 1/4″ - 0.12″ diam. power driven nails at 4″ o.c.

MAXIMUM FACTORED WEB FORCES IN COMPRESSION WEBS WITH T-BRACES (lbs)

WEB LENGTH (ins.)	WEB MEMBER SIZE		
	2x4	2x5	2x6
36″	8,542	10,750	12,880
48″	7,107	8,768	10,320
60″	5,565	6,723	7,767
72″	4,205	4,987	5,674
84″	3,135	3,666	4,124
96″	2,342	2,711	3,024
108″	1,768	2,031	2,253
120″	1,354	1,547	1,708

Note: - Nailing - 3″ common wire nails at 6″ o.c.
or 3 1/4″ - 0.12″ diam. power driven nails at 4″ o.c.
- Web and T-brace to be S-P-F No 2 or better.
- Includes load duration factor for standard term loading.
- Includes load sharing (system factor). Divide by 1.1 for non load sharing situations.

When continuous lateral web braces are properly restrained at intervals with diagonal braces, the maximum factored force in the lateral braces will be approximately 300 lbs. A force of this magnitude can be restrained with two 3 1/2" spiral or common wire nails (3 1/4" power driven nails would not be adequate). The connection between lateral bracing members can be a simple overlap at a truss.



VERTICAL BRACING BETWEEN TRUSSES

Pitched trusses up to approximately 12 m. in length may require little or no permanent bracing in the vertical plane between trusses if adequate roof and ceiling diaphragms are available. In this case, truss alignment is maintained by these elements.

Long span pitched trusses and flat trusses require this type of bracing applied to vertical or near vertical webs at intervals of 3.5 m. to 5.5 m. across the width of the building. Exact spacing is a matter of judgement to be made by the building designer. In many cases where the truss designer uses a web configuration involving vertical compression webs with appropriate lateral and diagonal bracing, no additional vertical bracing is required to stabilize the trusses.

Diagonal bracing in the plane of the supporting wall is required in the case of bottom chord bearing flat trusses or pitched trusses with deep heels, where there is a substantial separation between the roof deck and the supporting wall. This is important where wall sheathing is not extended past the top of the wall to the underside of the roof to maintain truss alignment and carry shear loads between the roof diaphragm and the wall below. This bracing is particularly important in livestock buildings where the space between the ends of the trusses may be left open to allow for air intake for the ventilating system.