

Farm Structures FACTSHEET



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STRUCTURALLY SOUND FARM BUILDINGS

This factsheet outlines some of the basic structural practices which must be incorporated into a well built structure.

Are your farm buildings structurally sound?

We ask this question of all farmers and ranchers throughout BC. Your answer might be that your buildings have been up for several years and, therefore, must be structurally sound. Farm buildings, however, should be designed to withstand the worst snowfall in a **thirty** year period and the worst wind force in a **ten** year period. Since failure loads are considerably higher than design loads, this criteria provides reasonable assurance that your buildings will outlive their usefulness.

To help prevent some serious structural disasters and possible loss of animal and human life, we are advising producers of some the typical structural deficiencies, which we encounter frequently on BC farms.

Continuous Lateral Bracing of Trusses

Under gravity (snow) loads, certain members of a truss undergo tension and others undergo compression. With longer compression web members, there is a tendency for them to buckle out. **Figure 1** shows some standard truss configurations and locates the members which undergo compression when the truss is supporting a snow load. Compression web members which are over 4'-6" long require continuous **lateral** bracing (as shown on truss manufacturer's drawing). Under gravity loads the top chord of a truss also goes into compression. The roof strapping normally provides the necessary bracing for these members. However,

when strong winds occur, the loading on the truss can reverse. The wind loads cause uplift forces. This results in a compression load in the bottom chord. Continuous lateral bracing should be provided at 6' - 8" intervals along the bottom chord.

Diagonal Bracing of Trusses

Continuous lateral bracing, however, only ensures that if the members under compression buckle, they all must buckle in the same direction. To prevent buckling, additional **diagonal** bracing must be provided to transfer these buckling forces to the posts or walls where other building bracing systems will then transfer the load to the foundations. Such diagonal bracing is usually provided at the ends of the building and at intervals throughout the length of the structure (see **Figures 2** and **3**).

Building Bracing

Building bracing is most important and varies considerably with the size of the building. Wind loads pushing on the side of a building are usually resisted in one of two ways.

1. knee bracing
2. diaphragm ceilings

Knee braces should run from the post or wall stud to the **top chord** of the truss and should be well nailed. In order to develop the strength of the knee braces, it is also **essential** that the trusses be adequately fastened to the top plate or the post. It is this joint that completes the triangle shape which gives strength to the frame.

A diaphragm ceiling acts as a giant I-beam to transfer the loads to the end walls which must in turn be designed to resist these loads (see **Figure 4**). The plywood ceiling must be properly supported and nailed in order that it is stiff enough to transfer the loads. The plywood ceiling acts as the web of the I-beam. The plywood **must** also be nailed to the top plates running down the length of the building on both sides. It is these plates which act as the flanges of the I-beam. The joints in the top plate must be **staggered** so that a continuous member is formed. In longer buildings, large lumber sizes may be required for the top plates.

Longitudinal forces are usually taken out by diagonal wall bracing systems located at the ends of the building and at intervals throughout the length of longer structures. Diagonal roof bracing is provided in the trusses to prevent them from collapsing like a deck of cards (see **Figures 2 and 3**). This roof bracing should transfer the load to the outside walls or posts where additional wall bracing is required to transfer the load to the foundations. (see **Figure 5**).

Truss Support

Trusses must be supported to resist gravity loads and wind uplift loads. Wind uplift loads can result in the total loss of a structure. Once the trusses start to lift off a structure, support for the walls is missing and often complete collapse will occur. **Metal tie-down anchors** are **necessary** to prevent truss uplift. Toe-nailing does **NOT** provide adequate hold down anchorage for trusses. Strapping should be nailed to trusses using 3 1/2" **spiral** nails so that the wind cannot lift off the steel roofing and strapping together. If the strapping goes with the metal, often the trusses will follow since most of the lateral support for the top chord is in the strapping.

Pole type structures present a special problem for supporting the gravity or snow loads. Nailing or bolting the truss to the pole is usually inadequate. Either the pole should be notched to seat the truss, or a very well nailed cleat should be used in addition to spiking the truss to the pole.

Partitions

Trusses are designed to deflect under a heavy load, yet remain structurally strong. When a support or partition wall is installed under the truss, it should be located under a **panel point** of the truss webs. This is where the truss webs are fixed to the bottom chord of the truss. If the wall or support is placed between panel points, the bottom chord is subjected to stress for which it was not designed.

Lumber Grade

The grade and species of lumber used for any structural part of a building is **very important**. Material should **NOT** be changed from that specified on the plan without first checking with a structural engineer. The following is the basic allowable bending stress for the different grades of Douglas Fir lumber. Note the considerable **difference** between grades.

	Psi	MPa
Select Structural	1860	12.8
No. 1	1600	11.2
No. 2	1290	8.9
No. 3	740	5.1

From this table, it can be seen that the span and spacing of floor joists and roof rafters can vary considerably depending upon the grade of lumber used. This applies to all wood structural parts of a building: i.e. beams, joists, rafters, columns.

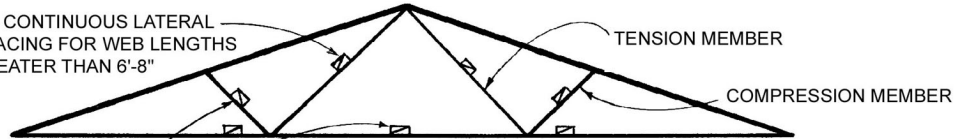
Summary

This article is intended to create an awareness of some of the basic structural practices, which must be incorporated into a well built structure.

The immediate detection and correction of any structural deficiencies in your building may significantly improve the strength and may prevent a costly disaster. It should be emphasized that **good building practice** includes proper design, selection of the correct materials and good construction practice.

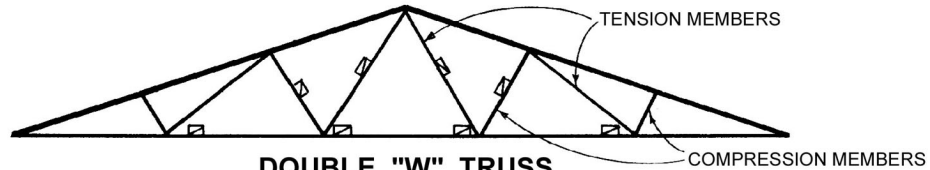
Information for this engineering note was obtained by Harry P. Neumann, Eng. Tech. as part of a D.A.T.E. project under the supervision of Dennis Oldridge, P.Eng.

2x4 CONTINUOUS LATERAL BRACING FOR WEB LENGTHS GREATER THAN 6'-8"



FINK TRUSS

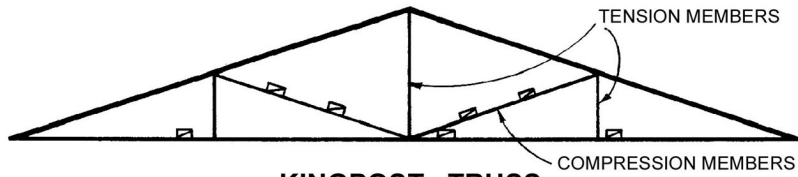
2x4 CONTINUOUS LATERAL BRACING (TYPICAL TO ALL TRUSSES)



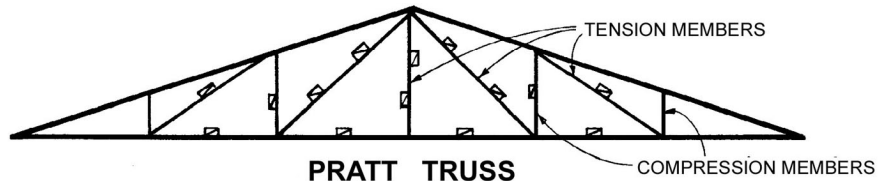
DOUBLE "W" TRUSS



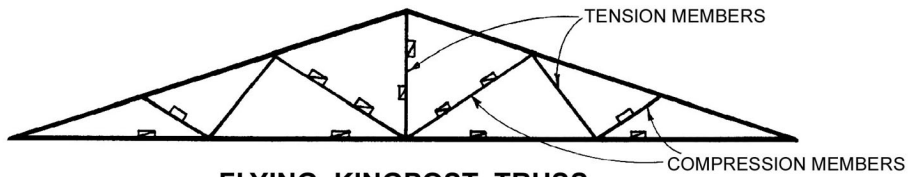
FAN FINK



KINGPOST TRUSS



PRATT TRUSS



FLYING KINGPOST TRUSS

Figure 1

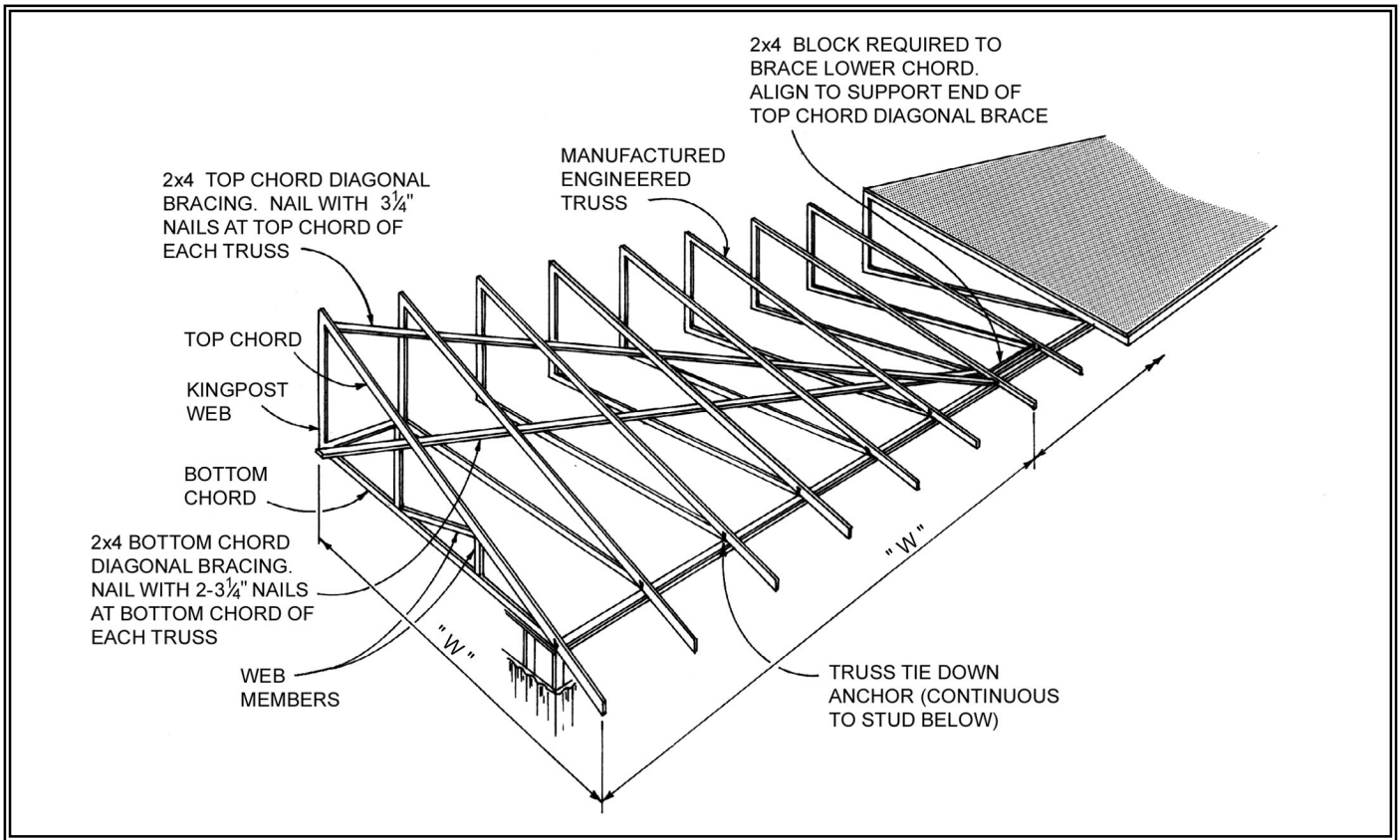


Figure 2 MONO TRUSS DIAGONAL ROOF BRACING

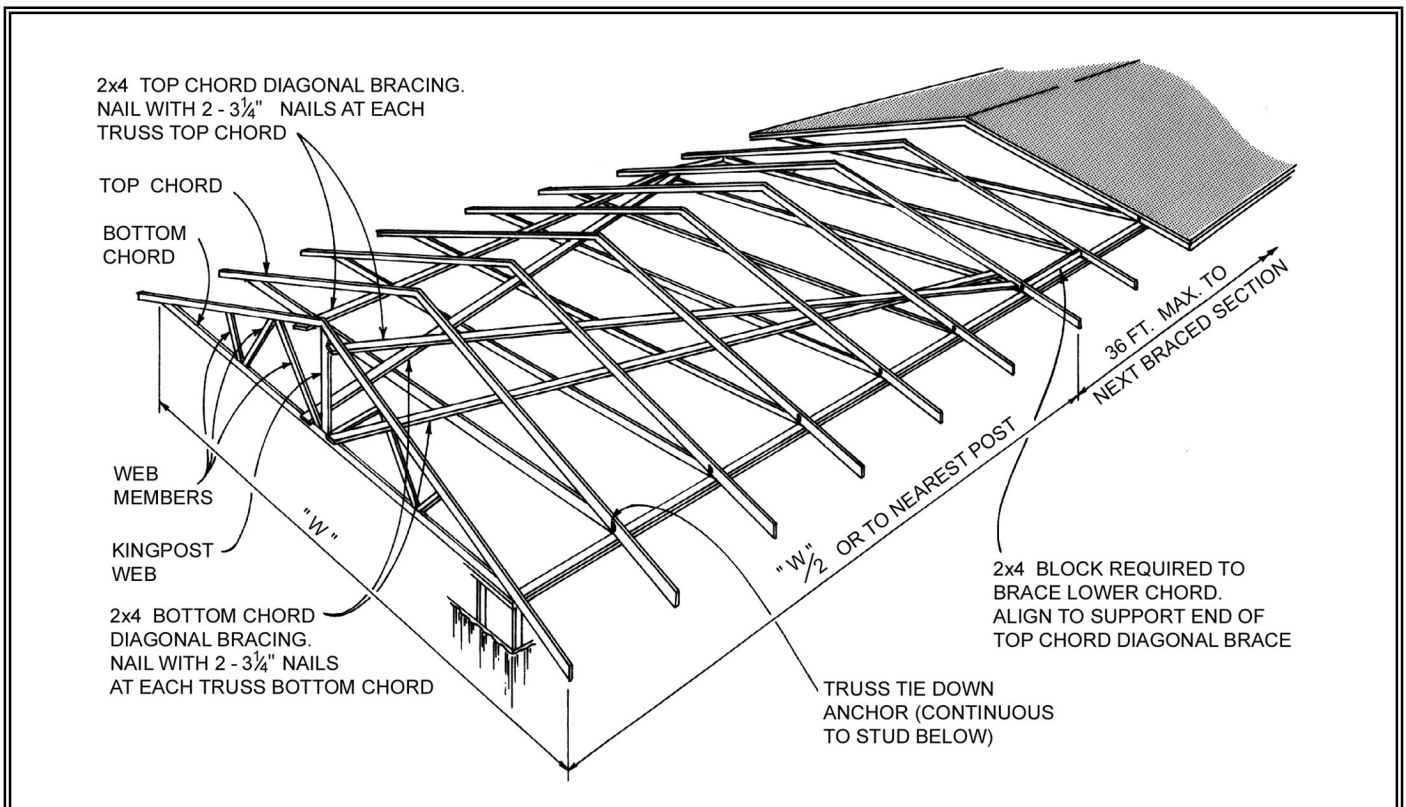


Figure 3 GABLE TRUSS DIAGONAL ROOF BRACING

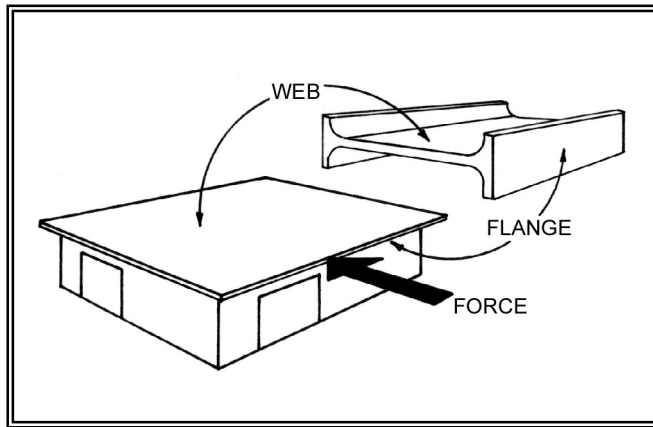


Figure 4 DIAPHRAGM ANALOGY

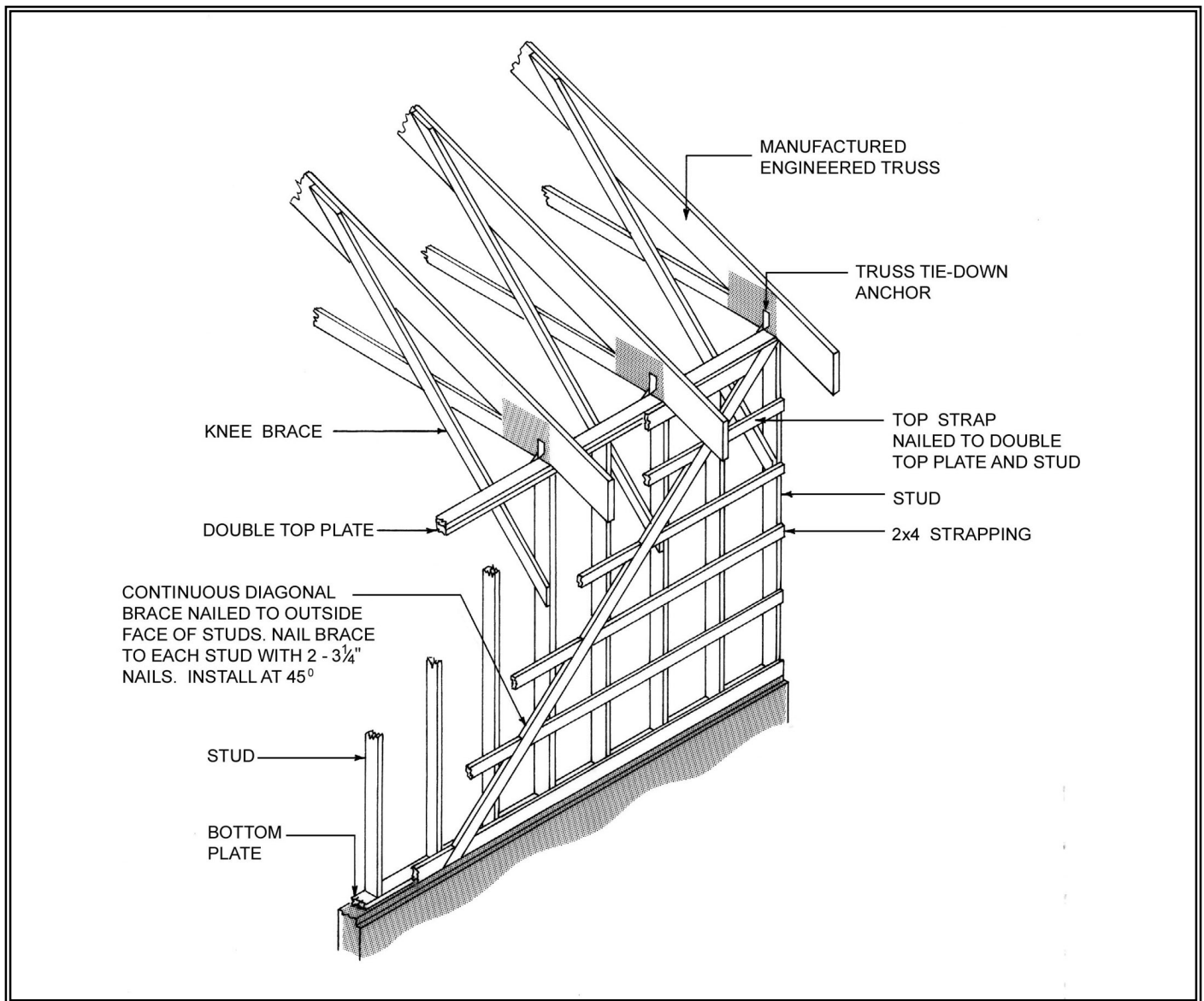


FIGURE 5

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