

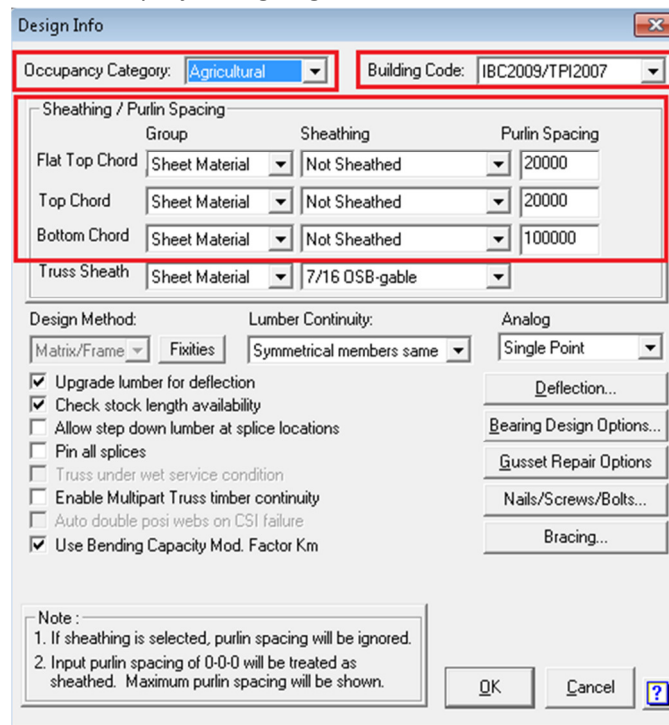
Understanding loading, geometry and available materials (lumber and plating) can reduce the cost of an agricultural truss by as much as 20 percent when compared to an "out of the box" run. While this article is lengthy, it covers loading and advanced techniques of high performance agricultural truss design. It might take time to adjust your designs, but money saved could provide for a nice profit if the job is already bid. If you are still in the bidding stage, the savings can make the difference between getting the job or giving the business to a competitor.

Part I – Economic Loading of Agricultural Use Trusses

The following is a way to load agricultural trusses in order to be competitive in the marketplace and at the same time produce sealable designs. It is important to note that the applicability of these suggestions be verified by the authority having jurisdiction and or by the building designer for the truss designs in question. MiTek is not specifying how to load trusses. All of these design parameters must be verified by others.

Design Info

Beginning in the Design Info screen (see Figure 1), start by selecting the "Occupancy Category" and "Building Code" as shown below. Your Building Code may be determined by the authority having jurisdiction for the area where the project is going.



Sheathing / Purlin Spacing			
	Group	Sheathing	Purlin Spacing
Flat Top Chord	Sheet Material	Not Sheathed	20000
Top Chord	Sheet Material	Not Sheathed	20000
Bottom Chord	Sheet Material	Not Sheathed	100000
Truss Sheath	Sheet Material	7/16 OSB-gable	

Design Method: Matrix/Frame | Fixities | Lumber Continuity: Symmetrical members same | Analog: Single Point

- Upgrade lumber for deflection
- Check stock length availability
- Allow step down lumber at splice locations
- Pin all splices
- Truss under wet service condition
- Enable Multipart Truss timber continuity
- Auto double post webs on CSI failure
- Use Bending Capacity Mod. Factor Km

Note:
 1. If sheathing is selected, purlin spacing will be ignored.
 2. Input purlin spacing of 0-0-0 will be treated as sheathed. Maximum purlin spacing will be shown.

Figure 1 - Design Info

Note also that the top chord restraint/bracing is set to 2'- 0" on center and the bottom chord restraint/bracing is set to 10'- 0" on center as is typical in agricultural framing. If the bottom chord bracing spacing is flexible, you may enter "0" in the "Purlin Spacing" box. This option will design the bracing spacing for the bottom chord material selected, rather than calculate the chord material based upon the selected 10' o.c. bracing/purlin spacing.

General Loading

Begin in the general tab and turn on snow and wind as shown in Figure 2:

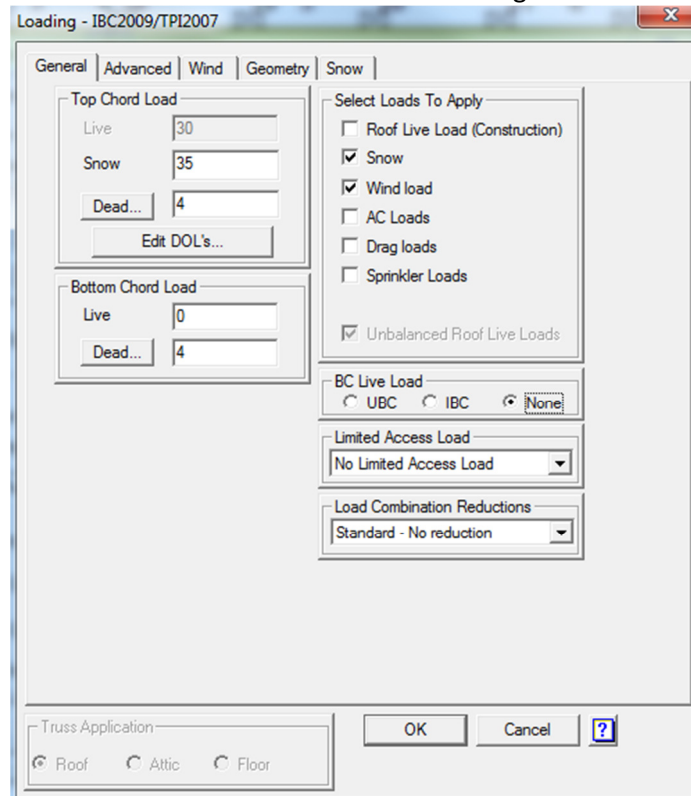


Figure 2 - General Loading Tab

In the example shown here, snow load has been selected. If you are in an area where snow is not considered a factor such as the state of Florida, the snow load may be unchecked and instead roof live load should be selected. The minimum roof live load generally used in agricultural truss design ranges between 16 to 20 PSF and is based on the tributary area supported by one truss, as well as the pitch.

The snow load value shown above is for example only and will be dictated by the location of the building.

Also note that no bottom chord live loads are generally required on agricultural type trusses.

Snow Loading

Under the Snow load tab (see Figure 3) you will note that the appropriate edition of ASCE 7 is selected for you based on the building code selected in the “Design Info” screen. The “Terrain” and “Roof Exposure” should be set to those dictated by the job site. The “Thermal Factor” (Ct factor) should be set to 1.2 (cold roof) if the building is not going to be heated. Turn on “Apply slope reduction factors”. The surface condition may only be set to slippery if the roof is a metal roof with no anti-snow-slide devices. “Occupancy Category” is set to “I” assuming the building to be “Low hazard to human life in failure”. The building “Lu” should be the length of the building measured perpendicular to the truss span.

The “Ground” snow should be selected from the snow map, or as specified by the authority having

jurisdiction or the building owner/designer. The “Ground” radio button should then be selected. Finally, verify that the unbalanced snow load is set to “Do for any geometry” as shown below:

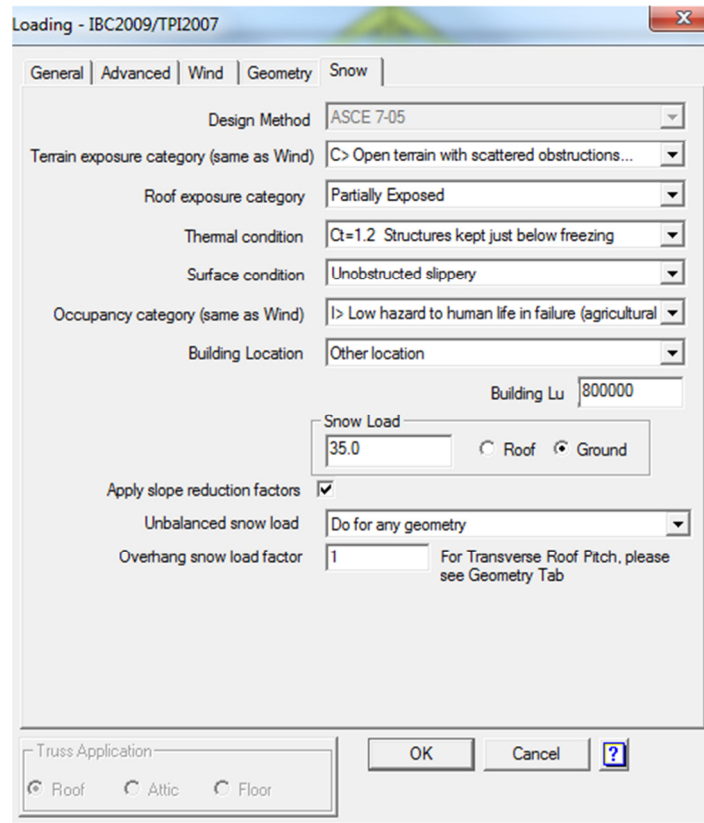


Figure 3 - Snow Loading Tab

Note: If trusses are capped, the transverse roof pitch should be set to the roof pitch so that trusses with flat sections are not overloaded with rain on snow or controlled by the minimum flat roof live load.

Additionally, if your truss is to be capped and you are designing for snow loads, you should turn on the “Geometry” tab and select “Use the following Geometry information for creating unbalanced load cases” as shown in Figure 4 below. For a common shape truss, all of the fields of information on the rest of the tab will automatically be filled in for you. Turning this on will tell the program that the truss in question is not a hip and is therefore not subjected to the drifts that accumulate on a hip end.

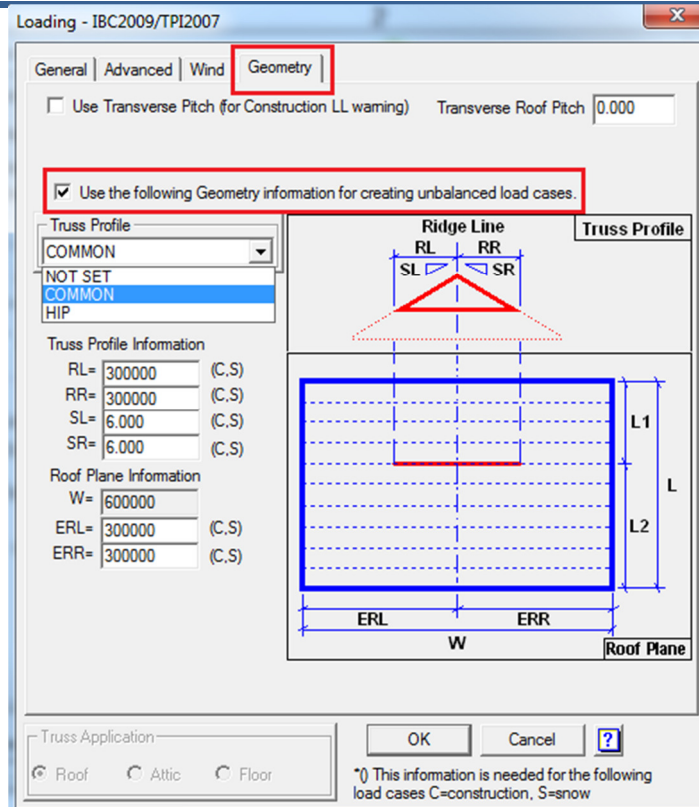


Figure 4 - Geometry Tab

Wind Loading

Under the "Wind" load tab (see Figure 5) "Exposure" and "Occupancy Categories" were already set in the Snow tab. The wind design method should be set to Main Wind Force Resisting System. The roof zone for agricultural trusses may be set to interior with the exception of the gable end truss that needs to be run in the gable end zone. The opening condition is typically set to "Enclosed", unless the building does not have walls. Then it should be run as "Open". The wind Duration of Loads (DOL's) should be set to 1.6 in most locations. You may use the same dead loads as specified in the "General Loading" tab on agricultural truss designs, as shown below, if the dead load does not exceed 4 psf per chord, and the occupancy category is set to "I".

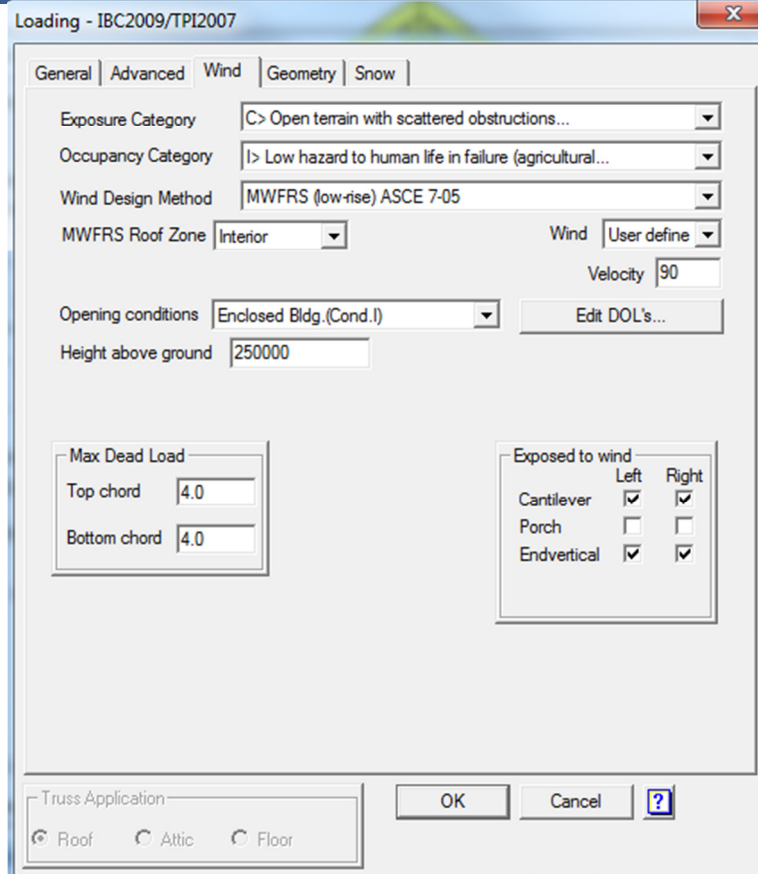


Figure 5 - Wind Loading Tab

Once again, all of these parameters must be verified by the authority having jurisdiction and/or by the building owner/designer. Please feel free to contact your MiTek engineer for any further clarification on this topic.

Part II – Economic Design of Agricultural Use Trusses

Please note that the techniques described below involve a heavy use of the Tool “VersaTruss”. When using VersaTruss, it is vital to pay close attention to member definitions (web, chord, etc).

Perimeter Geometry

Truss geometry can play a sizable roll in the performance of agricultural trusses. Such geometry includes the roof pitch, heel heights, overall heights, and span. Typically, a truss pitch and span is dictated by the building designer. Unlike normal commercial and residential jobs, truss heel height is often a variable that can be easily changed on ag trusses. There is an old saying that “Deeper is cheaper,” which holds true with heel heights. If the heel height can be increased, it is important to keep in mind this adjustment during the truss design phase.

Materials (Lumber/Plating)

Available materials (lumber, stocked plates) often control a design. There can be times where a chord force is high enough, that a large, high gauge splice plate is required. Typically this occurs on bottom chord splices. It is possible that such a large splice plate is required that a larger chord size is required just to get the splice joints to plate. There are several options available that can eliminate the requirement of larger chords.

One option is to turn on “Solid Bar Tension Values” in “Edit - Plate Options”. TPI requires that connector plate manufacturers utilize a tension value when the slots of a plate are located directly over the splice. Due to the decreased cross section of steel in this situation, the allowable tension value is limited compared to when the “solid bar” of steel is over the splice. Special measures should be taken to ensure that the shop understands the high degree of accuracy required on these splice joints.

A second option in bottom chord splicing includes the use of “Pin all Splices” (located in Design Info). This selection modifies the truss model such that the moment is always zero at a splice location. This reduces the total overall stresses induced on a splice to only the tension force, which can significantly affect a splice that is located in a long bottom chord panel. This however, can increase chord stresses, therefore caution is advised.

A third option is to cut the splice at a beveled angle. Typically, you would start by modifying the splice in Versatruss to be cut at a 45 degree angle. Special attention should be paid to chord lengths to ensure that the chord member being modified is within the stocked lumber lengths. The principle at play with beveled splices is that you can increase the shear length across the splice. See Figure 6 for an example of this joint design.

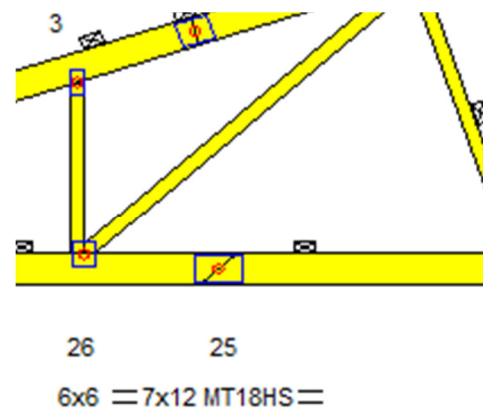


Figure 6 - Beveled Cut Splice

Yet another option is to consider expanding your plate inventory. MiTek offers several high strength plate options and sizes, and you should not overlook the use of the MiTek 18 gauge Super High Strength “M18SHS” plate. This plate type is manufactured with a higher grade of steel compared to the standard MT18HS and offers superior performance in tension splice utilizations.

Webbing / Panel Points

Another technique that is often beneficial to agricultural truss design includes the location of panel points and optimization of those panel points. Often, a short vertical web located close to the heel of the truss can accomplish multiple goals. You can place a web (recommended length of 0-11-14 to economize cutting) just inside the heel which serves to share heel panel moments between both chords, effectively engaging the bottom chord to share in the top chord heel panel moments. See Figure 7 for an example. While this short web is inexpensive, it can make great improvements in the performance of an agricultural truss heel. If a heel panel remains overstressed, you might consider adding a wedge via “Edit - Heel Options”. A secondary benefit of this short web, and specifically, its location, is that now the first panel point is typically 3-4 feet from the truss heel. This enables the truss designer to move the remainder of the truss panel points closer together (which helps to alleviate high bending moments within the truss), or eliminate a panel point altogether.

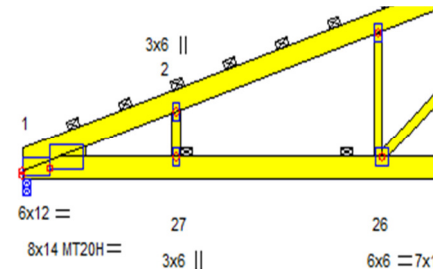


Figure 7 - Web Location

After adjusting the webbing as described above, it is often beneficial to manually decrease chord sizes and grades. Due to the nature of a truss, higher overall forces are typically located at the ends of a truss. Knowing this, you can often change chord sizes and grades at the interior of the truss. When doing so, splice plates can often become an issue, and you should utilize the principles described earlier in this article to mitigate problems. Additionally, if a chord size or grade is slightly overstressed, you should proceed to the next step in this article.

Modifying panel points and their locations should be an iterative process. You can accomplish panel point adjustments with VersaTruss, however under the “Tools” menu in engineering, you will find a tool called “Move Joint”. This allows the user to move a joint left or right a specified distance. Using this tool can easily move panel points for chords that are slightly overstressed, and in doing so, reduce the stresses enough to achieve an efficient use of lumber.

While the steps described in this article can take a bit of time to complete, we are confident that you will find these tools to be helpful. For additional information, or if you have questions on these features, please contact MiTek Engineering.