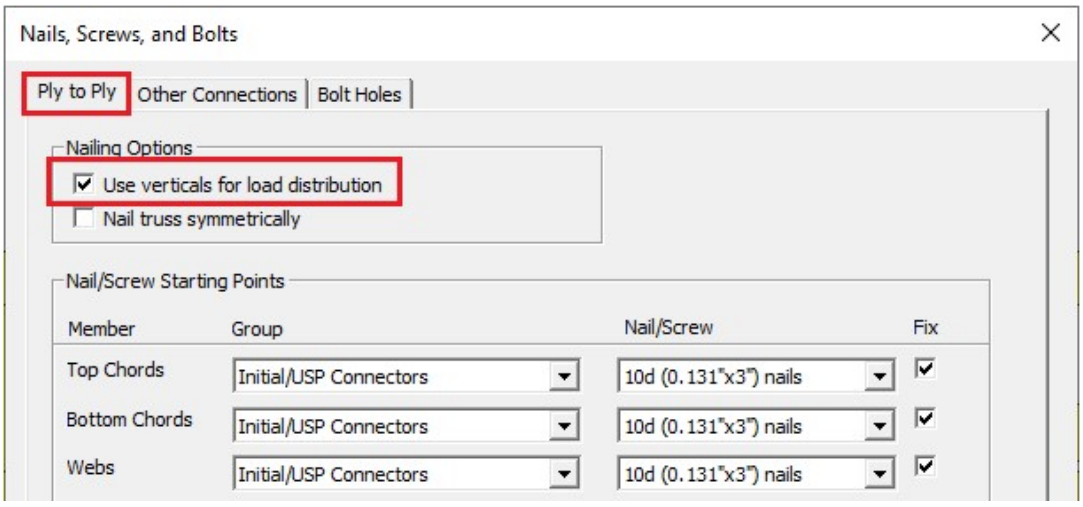
# Multiple-Ply Connections.

Girder trusses are trusses specially designed to carry extra load from tie-in trusses and equipment. If a single ply is insufficient to carry the entire load, the truss designer specifies a multiply girder, that is made of identical trusses and fastened together to act as one unit to support the load. Based on ANSI/TPI Section 7.5.2.4 the maximum number of plies shall be five, if loads are attached to one side of the girder, or six, if loads are attached to both sides of the girder. Fasteners may be nails, screws or bolts depending on the amount of load and number of girder plies. Multiply girders perform according to the design only if all plies are properly attached together.

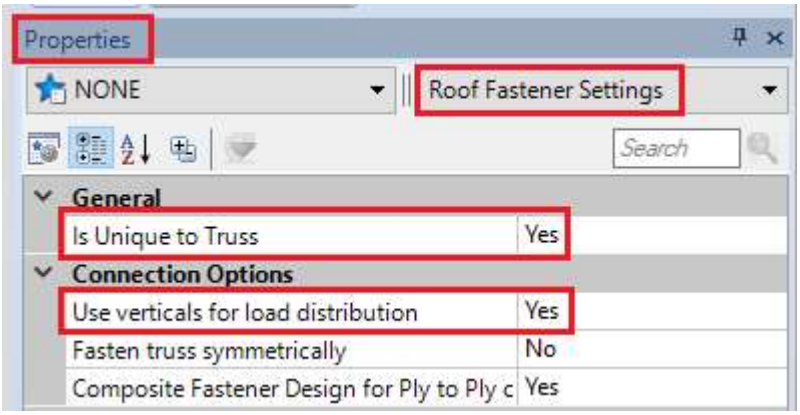
When we have load applied to a multiply girder truss, in order to design the fasteners, we assume all plies take an equal amount of load. According to ANSI/TPI Section 7.5.5.2, multi-ply girder ply-to-ply connections shall be adequate to carry the cumulative load of the remaining plies. For example, if a 2400 lb point load is applied to a 3-ply girder truss, we assume each ply carries 800 lbs. The connection between the 1st and 2nd ply would have to be designed to transfer the sum of the 2nd and 3rd ply loads, or 1600 lbs in this example. But if a 2400 lb point load is applied to a 4-ply girder truss, we assume each ply carries 600 lbs. The connection between the 1st and 2nd ply would have to be designed to transfer the sum of the 2nd, 3rd and 4th ply loads, or 1800 lbs in this example.

If fasteners required to distribute loads equally between plies cannot be calculated by software, the warning "***Special connection required to distribute bottom chord / top chord / web loads equally between all plies***" or ***"Ply to ply nailing inadequate"*** will appear in the note section of the truss design drawing. From our examples above, you can see that increasing the number of plies will not help this note to go away, as the more plies you have the more load you must transfer.

If you have a vertical web directly above large concentrated load, you can try to use this vertical to transfer load. To turn it on in MiTek 20/20 Engineering go to Design Info - Nails/Screws/Bolts, check the "Use verticals for load distribution" box as shown below:



In Structure with Truss Design in Properties dialog box select “Roof Fastener Settings”, change to “Yes” in “Is Unique to Truss” in General section and to “Yes” in “Use verticals for load distribution” in Connection Options section as shown below:



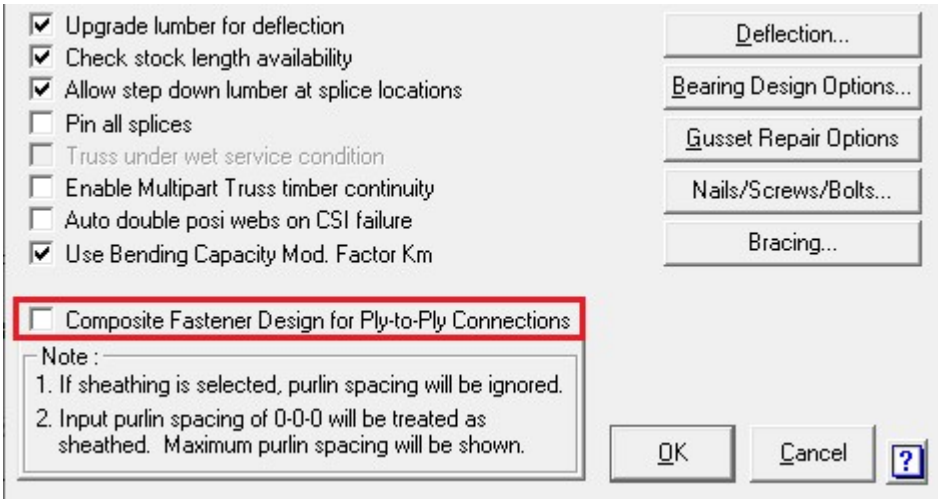

After selection is made, Redesign the truss. If you have the “Use verticals for load distribution” already on and get a ply-to-ply connection note, try to turn the “Use verticals for load distribution” off, may be vertical is too short to transfer load, and Redesign the truss.

You can also try changing the type of nail or fastener you are using. Structural screws can transfer more load than nails. The length of the fasteners used to make ply-to-ply connections should not be less or exceed the thickness of the multiple-ply truss. For example, 2-1/2” long nails cannot be used for ply-to-ply connection, or if you have 3-ply truss, you cannot use 6” long structural screws for ply-to-ply connection.

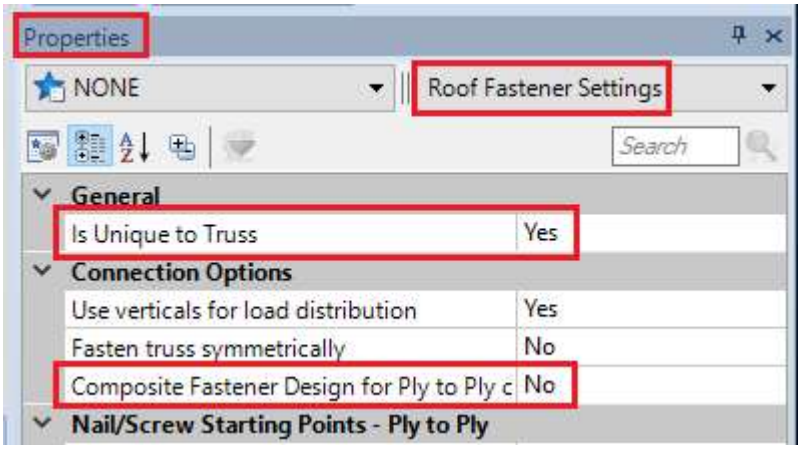
To ensure composite action provided by the fasteners (in other words to ensure connected plies act as a single unit), section 15.3.3 of NDS limits the maximum spacing between adjacent fasteners in a row to $6t_{min}$, where $t_{min}$ is thickness of the rectangular truss member, i.e. 1-1/2”. That is why, when fasteners are designed to provide composite action for ply-to-ply connections, this limits the fasteners to 9” o.c. maximum spacing. It does not matter what fasteners are being used to transfer load: nails, screws or bolts.

Section 7.5.5.4 of ANSI/TPI allows up to 12” o.c. nails spacing for ply-to-ply connection. However, with spacing over 9” o.c., composite action is only partially developed, that is why each ply must be checked for buckling as a single ply.

To turn off composite member design in MiTek 20/20 Engineering, go to “Design Info” and uncheck “Composite Fasteners Design for Ply-to-Ply Connections”.




To turn off composite member design in Structure with Truss Design, in Properties dialog box select “Roof Fastener Settings”, change to “Yes” in “Is Unique to Truss” in General section and to “No” in “Composite Fasteners Design for Ply-to-Ply Connections” in Connection Options section.




This will allow for greater ply-to-ply fasteners spacing:

Nails:

- 12” max spacing
- 1 row for depths less than 5.5”
- 2 rows for depths equal to and larger than 5.5”

Screws:

- 24” max spacing
- 1 row for depths less than 7.25”
- 2 rows for depths equal to and larger than 7.25”

The advantage is that this will reduce the number of nails or screws required for ply-to-ply connection of multi-ply trusses. The disadvantage is that chord analysis may have a greater CSI and could require more bracing, and you may see additional bracing on webs.

Multi-ply girder trusses are to be connected together using the fasteners schedule provided by Mitek software. Two-ply trusses may be nailed / screwed together from one face. For three-ply trusses, the first two plies are nailed / screwed together from one face. The third ply is then attached to either face of the first two. Four-ply trusses are attached in the same as three-ply trusses, with the fourth ply attached to either face of the first three.

In addition to the nailing typically specified for four-ply trusses, 1/2” dia. bolts are sometimes specified throughout certain chords as indicated on the truss design drawing. In lieu of these bolts, the USP WS6, MiTek Pro Series WSWH6, FastenMaster Trusslok-Z6", FastenMaster FlatLOK FL006, or Simpson SDW wood screws may be used. These screws are to be installed in two rows spaced 24"o.c. in 2x6 and larger chords (use one row in 2x4 chords). These connections are intended to provide clamping force to aid in allowing the four-ply assembly to act as a unit and are not included in the calculation of ply to ply load transfer. It is vitally important that the plies are tightly clamped together during the installation of the screws to prevent gaps between the plies. USP WS6, MiTek Pro Series WSWH6, FastenMaster Trusslok-Z6", FastenMaster FlatLOK FL006, and Simpson SDW screws may be installed from either face. *Note that Simpson SDS Screws must be installed from the loaded face. For four-ply trusses where screws are specified for the ply to ply connection instead of nails, the bolts called out in the connection notes on the truss design may be omitted. Five or six-ply trusses may not have the bolts replaced with screws.

For additional information, or if you have questions, please contact the MiTek Engineering department.