

To Bear Or Not To Bear



By Dave Brakeman, P.E., S.E.

Whether 'tis better to set the truss right on the partition wall or leave a gap between them; that is the question. Some would say that it is best to leave a gap equal to a little more than the deflection of the truss at design load. Then the truss reactions will go to the intended bearings and not to a partition wall that was not designed for load. Others would say that the truss and partition should touch and be well connected together. This should reduce the possibility of cracks in gypsum board joints when structural movement occurs, and it ties the building elements together to improve the overall stability and integrity of the structure.

Obviously there is truth in both of these viewpoints. But there is no simple answer that will be best for every situation. Let's examine what goes on in wood structures to see where bearing loads will develop and what happens when these loads get large. Then we'll try to draw some conclusions to help the designer, builder and inspector when they are faced with these weighty decisions.

TYPES OF WALLS

Bearing walls provide the vertical support for a structure. They provide a direct path for floor and roof loads to get to the foundation and they are usually located

directly over a footing. Partition walls, or non-bearing walls, separate one room from another and they are not intended to provide support for anything other than themselves. However, in light frame structures these two types of walls may have the same stud wall construction. They often can be distinguished by looking at what the walls themselves are sitting on. Bearing walls will be located on the foundation wall, over a beam or header, on a thickened slab-on-grade, or maybe even a truss that has been designed to carry it. Partitions are often supported by floor joists, trusses or unthickened grade slabs that are only designed to carry the additional weight of the wall.

The problem is that bearing walls and partition walls often don't know which type they are supposed to be. Since the walls are all built to the same height, and since trusses deflect under load, the non-bearing walls

will carry some load when the trusses sit down on them even though they aren't supposed to. Some partitions and their supports are quite capable of taking truss loads. Other partitions may sit on flexible supports, such as the middle of a floor joist span, and the wall will simply move down when the floor or roof deflects. If such a floor is more flexible than the truss above, then the floor may actually be hanging from the truss! There are many situations in light frame construction where it is not clear which member is carrying which.

WHERE DOES THE LOAD GO?

One of the basic rules of structural engineering is that the stiffest members will carry most of the load. Here's an analogy that illustrates this. Take a string and an elastic cord that are the same length when



Figure 1. (Left) Masonry walls are usually bearing walls. If it is, locate a web joint over the wall and design the truss to bear there.

Figure 2. (Below Left) This partition wall near a web joint may act as a bearing.

Figure 3. (Below Right) Partitions not near a truss joint, with a single top plate, and with studs between trusses, will not pick up much truss reaction.



This is the first of a two part article on interior non-load bearing walls. The second part will appear in the Winter 1991 issue of "Peaks".

unstretched and lay them side by side. Let's say that they both have the same breaking load of 10 pounds. Pick them up together with one end of each cord in each hand between the thumb and finger. Then pull on them together with say 5 pounds of force. You won't be able to stretch the elastic cord much because the string is so much stiffer. If someone were to cut the elastic cord while the two are being stretched together, you wouldn't notice any difference in the tension in the string because it is too stiff to stretch much and so it was carrying all of the force in the first place. If someone were to cut the string instead, the elastic cord would stretch out due to the transfer of load from the string to the elastic.

Next, pull on the string and the elastic together with 15 pounds of force. What will happen? First the string will break, then the elastic will stretch way out and finally it will break too. It is not possible to develop 20 pounds of force in the two together since the elastic must be stretched in order for it to pick up any load. The string is much stiffer than the elastic, so it must do all of the work until it breaks. The whole point is that it takes some movement for the elastic to get any of the load.

Trusses and partitions work in a similar way, even though their stiffnesses are more closely matched than a string and an elastic cord. If a partition is rigid, has a rigid support and makes contact with a rigid point on a truss, then it will act as a bearing. But if the wall, its support or the truss are not all rigid where they meet, then less bearing load will be developed there.

Where partition walls are concerned, trusses are the stiffest at their bottom chord web joints, Figure 1. Walls that are located near the middle of a chord panel will not pick up as much bearing load since the chord can flex when the wall pushes up on it. The closer a wall is to a web joint, the more bearing load will be developed, Figure 2.

An example will help to illustrate these stiff and not-so-stiff places on a truss. Consider a 30'-0" Fink truss ("W" truss) with a 6/12 slope and 2x4 southern pine no. 2 KD15 chords. It is designed for 24" spacing and a 40 pounds per square foot total load. When this truss clear spans between two bearings at the heels, each reaction is 1200 lbs. at design load. If a third solid bearing is placed at one of the interior bottom chord web joints, the reaction at that point would be 1260 lbs. If this interior bearing were then placed at the quarter point of the center

panel, the reaction would be 138 lbs. And finally, if the interior bearing was at the center of the middle panel, the reaction there would be 93 lbs. Note that the reaction drops off as the bearing moves away from the joint. Also note that if the interior support is not completely rigid then the reactions would be less.

There are a number of factors that will determine just how much load is put on a partition wall in any particular situation. The effect of wall location was just illustrated. The size and grade of truss chords and the length of the panels will also affect the reaction. Short panels with large, high grade lumber will be the stiffest ones and will develop the most reaction. Walls with double top bearing plates and with studs positioned directly under the trusses will be stiffer than walls with single plates and offset studs, so they will pick up more load, Figure 3. Generally, the stiffer the chord and the wall, the larger the reaction.

The overall stiffness of a truss has an opposite effect. Generally, the stiffer a truss is, the less it deflects down onto the partitions and the less load it places on them. Flexible trusses will tend to put more load on the walls, especially if they make contact at a web joint.

CONSEQUENCES

Fortunately, peaked roof trusses also have fairly long flexible panels. They also tend to have lower stress levels in their interior panels where partitions are likely to occur. Floor trusses, on the other hand, tend to have their highest stress levels near mid-span. Partitions near chases are the biggest concern since they can distort the chase and

cause a bouncy floor (see "Peaks" Vol. 10, No. 1). Contact with partitions near chases should be avoided.

When partition wall and truss stiffnesses match up to cause a bearing condition, what will happen? It is possible for tension and compression members in a truss to reverse their roles. Where a tension web becomes a compression web, continuous lateral bracing may be needed. Connector plate capacities may need to be rechecked if force reversals happen. However, since the truss's load is now spread over more bearings than it was originally designed for, the magnitude of these forces can be less.

Bottom chord quarter panel splices are typically not a concern where partitions act like bearings. When a bearing condition happens near a web joint, the chord force usually decreases. When a bearing lands in the middle of a panel the reaction developed is probably too small to adversely affect a splice.

There is a tendency to over analyze a truss for potential partition wall bearings, uneven bearing elevations, and differential bearing settlement. So let's put this discussion in perspective. Truss movement is required to impart load onto partitions, and the truss contact with the wall must snug up before there is really a bearing condition. If a truss is very stiff, such as for a high slope residential roof, then there should not be much concern about partition location. If a truss is very flexible, then camber and a flexible wall connection may be desirable (see "Peaks" Vol. 11, No. 3). Part II of this article in the upcoming Winter 1991 issue of "Peaks" will look at different methods for attaching trusses to partitions and discuss where each is appropriate. ▲



Figure 4. Contact between floor trusses and partitions should be avoided near chases.

Truss-To-Partition Connections



By Dave Brakeman, P.E., S.E.

When trusses cross over partition walls, some type of connection between the two is usually desirable. In the last issue of "Peaks" we looked at what happens when trusses sit on "non-bearing" walls. In this article we'll look at the different types of connections that can be made and when each is appropriate.

CONNECTION CONCERNS

There are two concerns that must be taken care of when trusses are connected to non-bearing or partition walls. First, the connection should not cause cracks in the wall/ceiling joint, which is typically

This is the second part of two articles on interior non-load bearing walls. The first part appeared in the Autumn 1990 issue of "Peaks".

drywall construction. The connection can be made rigid so the truss and wall can't move apart, or the connection can be made flexible if the wall/ceiling joint is allowed to float.

The second concern is a structural one. Partition walls need lateral support at their tops and the truss is usually the thing that provides it. Also, a partition wall or its support could be overloaded by reaction loads from a truss sitting on it. In this case, the connection would have to prevent the transfer of vertical loads from the truss to the wall. Besides all of this, tying the roof, floor and wall elements together makes good construction sense. This provides alternate load paths which can increase the building's safety. It can also improve the strength and stability of the building; especially for resisting wind and earthquake loads.

TYPES OF CONNECTIONS

Connections between trusses and partition walls can be classified into three different types: flexible, rigid and semi-rigid. They differ in their ability to let the truss and wall move independently in a vertical direction, and in their ability to transfer vertical loads.

Flexible Connections

Flexible connections are easily accomplished by using a slotted framing anchor. These anchors are now made by most wood connection hardware suppliers.

The anchor or clip is nailed down to the top of the partition wall and then nailed to the truss bottom chord through the slot, Figure 1. The nail is located in the middle of the slot so that the truss and wall can move up or down independently. Drywall clips or blocking force the ceiling drywall to stay with the wall and prevent this joint from cracking when movement occurs, Figures 2, 3 and 4. It is very important that the edge of the ceiling drywall be allowed to float. This is done by eliminating all the drywall ceiling fasteners near the partition wall that the applicable code allows, Figures 4 and 5.

Rigid Connections

A rigid connection may be desirable to transfer a vertical load from the truss to a bearing wall, but it may not be appropriate for most partition wall connections. Even so rigid connections are easily accomplished by using common framing hardware (without slotted nail holes). The anchor is installed so that the nails are loaded in shear, and not in withdrawal. This type of connection forces the truss and wall to stay together. If the truss does arch up, or if the floor under the partition moves down, then it is possible that the partition will separate from the floor.

Semi-rigid Connections

Semi-rigid connections fall somewhere between the flexible and the rigid types. They typically act like a rigid connection when there is only slight movement between a truss and partition. But when the

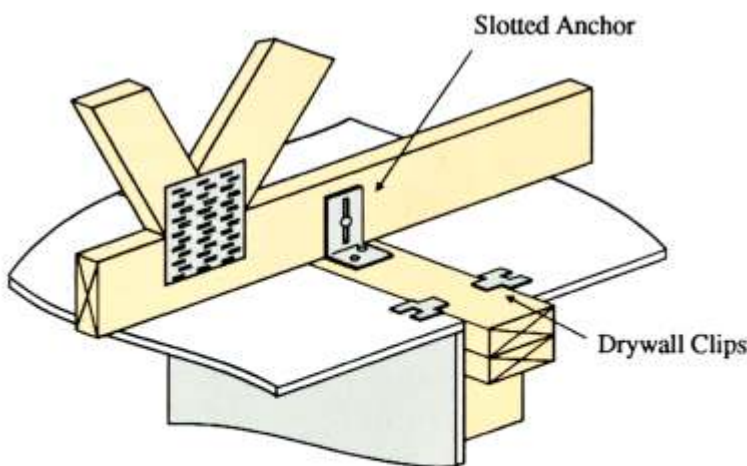


Figure 1. This shows both a slotted truss anchor and drywall clips before truss movement.

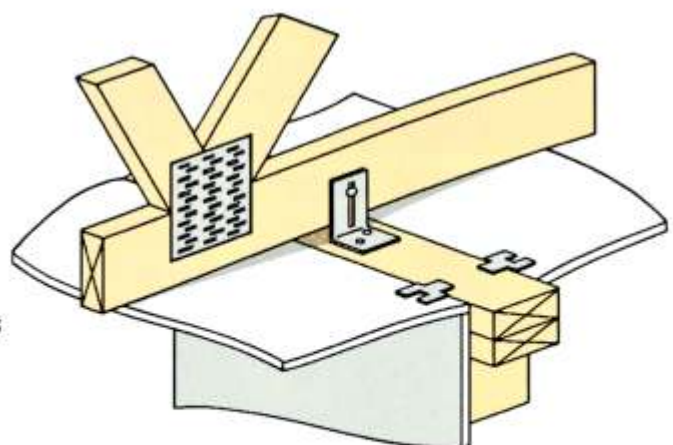


Figure 2. The slotted anchor permits truss movement and the clips hold the ceiling and wallboard joints together.

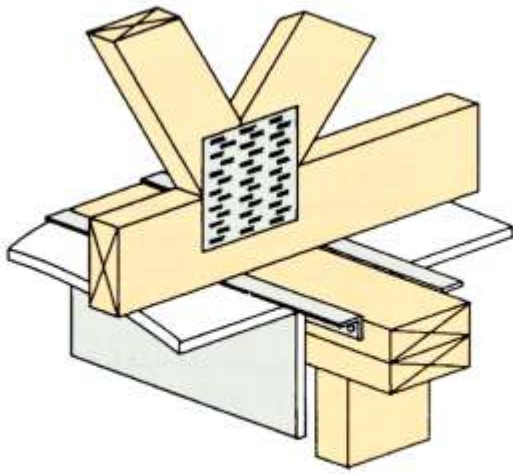


Figure 3. Here continuous metal angles are used to block the ceiling drywall.

movement gets large enough, the connection gives way and becomes flexible. Toenailing (actually slant-nailing) a chord to a partition is one example of this. Nailing from below the top wall plate straight up into the bottom of the bottom chord is another example. Both types of nailing result in a withdrawal load on the nail when vertical movement occurs. The nails can eventually let go under this kind of load and then drywall joints will crack if they are not properly floated. Once this happens, there is not much lateral support left for the top of the wall, and the exposed nails may not let the truss and wall come back together.

SELECTING A CONNECTION

Flexible type connections are usually the first choice because they take care of the structural concerns and protect the drywall joint at the same time. This type of connec-

tion will permit the wall or the truss to move without adversely affecting the other. The wall can move down if the floor under it deflects, if the framing shrinks, or if the foundation settles. The truss will move down when load is applied to it, and it can move up if the truss arching phenomenon happens.

When trusses are cambered so that the truss and partition do not touch, the flexible connection is still best since it allows the trusses to deflect without loading the wall. Pulling the camber out of a truss to force it down to the partition is not a good idea. The truss will probably return back to its cambered position over time. A flexible type connection makes a good lateral connection without having to force out the camber. Shims can be used to fill the gap if a bearing condition at the partition will not be large or it won't hurt the truss or wall (see Part I of this article in the Winter 1990 issue of "Peaks").

Rigid and semi-rigid connections are best saved for interior walls that are actually designed to be bearing walls. There are situations though when they can be used successfully at non-bearing partition walls. Where roof and floor spans are short, there probably won't be enough movement to cause any problems. They could also be used when a partition is at the middle of a long, flexible truss panel. In this case, there

often is not enough load transferred to hurt the truss or wall, and the connection can hold the two together.

The semi-rigid toe-nailed connection is obviously the most common type since it is the simplest. Its use must be justified by experience. When you evaluate performance, consider the following. Have the trusses had much load on them yet? How much do you really know about past performance? Are you in a region with weather conditions that can produce truss arching? Are framing materials typically installed dry or wet? Do the drywall installers always float the corner joints? Do you use floor trusses? Floor trusses may be stiffer than joists, but since they span farther, their total movement can be more. Do you have crawl space construction? For a variety of reasons, buildings with crawl spaces seem to be prone to more movement.

CONCLUSIONS

Builders are usually not in a position to decide which type of connection to use in a particular situation, or they don't want to be in this position. This makes the flexible connection the best recommendation since it covers the most situations. Problems with this connection are not really widespread problems. But when problems do occur, no one knows what to do, no one knows who is responsible, and repairs are costly. Cutting truss members to make the truss sag down to the wall is not the solution. The repair is to do what could have been done in the first place; float the drywall joint and make a flexible connection between the truss and partition. ▲

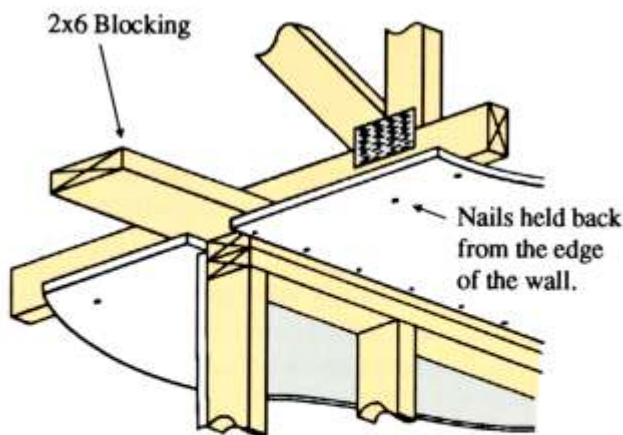


Figure 4. This shows trusses perpendicular to the wall. Be sure to hold drywall fasteners into the truss away from the wall.

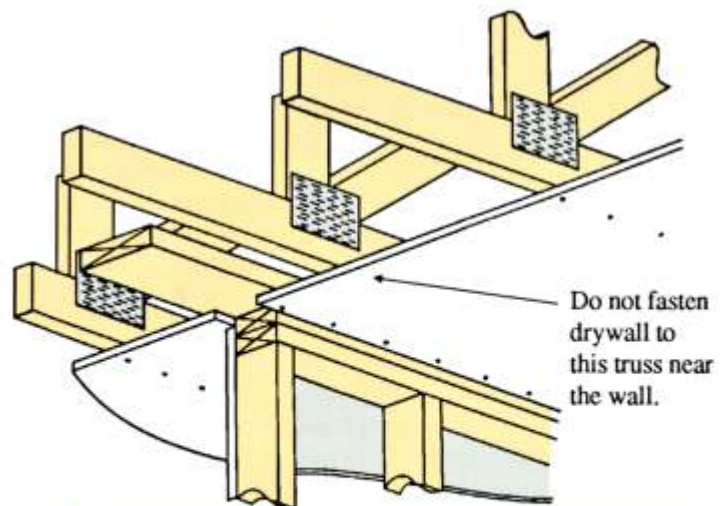


Figure 5. These trusses are parallel to the non-bearing wall below. Do not fasten drywall to the truss near wall.