STRUCTURAL BUILDING COMPONENTS MAGAZINE
January/February 2005

Knowledge Is Power

Rules of Good Truss Design by Rachel Smith

> *"Design is the art of gradually applying constraints until only one solution remains." —Unknown*

Truss technicians have highly specialized truss design software that allows them to design trusses to fit even the most complicated structural framing plans. One thing every good truss technician knows is that the simplest solution for them may not be the best solution for the folks who have to manufacture or install the trusses. I contacted several engineers from truss manufacturing operations all over the country and asked them to list some of the rules of good design they ask their technicians to follow. The list is by no means comprehensive, but it certainly will give every truss technician some food for thought.

RULES FOR SYMMETRY

If the outside geometry is symmetrical, make the webs, plates and splices symmetrical also. If some trusses have interior bearing and others do not, or if some trusses have overhangs and others do not, run both conditions and design one truss to fit both conditions. This can be done often with little or no extra cost. Keeping it simple makes the shop and the framer happy by reducing the number of pieces in the shop and truss types in the field.

RULES FOR GIRDERS & HANGERS

Optimize roof girder trusses by increasing plies and decreasing webs. This can also take care of some bearing length issues. Depending on the company's pricing structure, girders with more plies and fewer webs decrease board footage and metal plate connector size. Another option is to increase bottom chord lumber size and reduce the number of webs, although this may not help bearing length issues.

Try designing floor girder trusses with double chords before resorting to a two-ply floor girder because it can be difficult to implement an effective connection of two-ply members in the 4x orientation.

When a girder carries another girder, make sure there is a large vertical web installed in the carrying truss capable of accepting a large hanger. Also consider building girder trusses symmetrically to avoid backward installations.

Avoid girders that are four plies or more if at all possible. No one likes to deal with the bolts and that includes the shop, the framers and the truss design engineer.

Shorten truss members framing into a beam by 1/4" for each hanger location, that is, 1/4" per end for a total of 1/2" if framing is between two beams. Consider the following for floors, roofs and girders:

- Shorten the span of floor trusses by 1/4" when framing into beams or girders and a hanger is used as the connection. This allows beam thickness variation and still maintains a 1-1/2" truss bearing length when the hanger seat is 1-3/4" (Simpson THA422 or USP MSH422 for example). Top chord bearing floor trusses allow a maximum 1/2" gap, therefore the 1/4" provides some tolerance for the truss to "slide" into position.
- Shorten the span of roof trusses by 1/4" when framing into a girder. This allows for the hanger gauge thickness and accounts for the fact that multi-ply girders are always somewhat thicker because of the metal plates. If the truss is stubbed, contains a raised heel, is a mono or mono-style jack, then recess the end vertical by 1/2" to 1" to allow for the span to be trimmed to fit. This helps ensure the vertical is not ripped. An exception is that if the hanger height is such that fasteners are required to penetrate the wood for uplift resistance, the end vertical probably cannot be

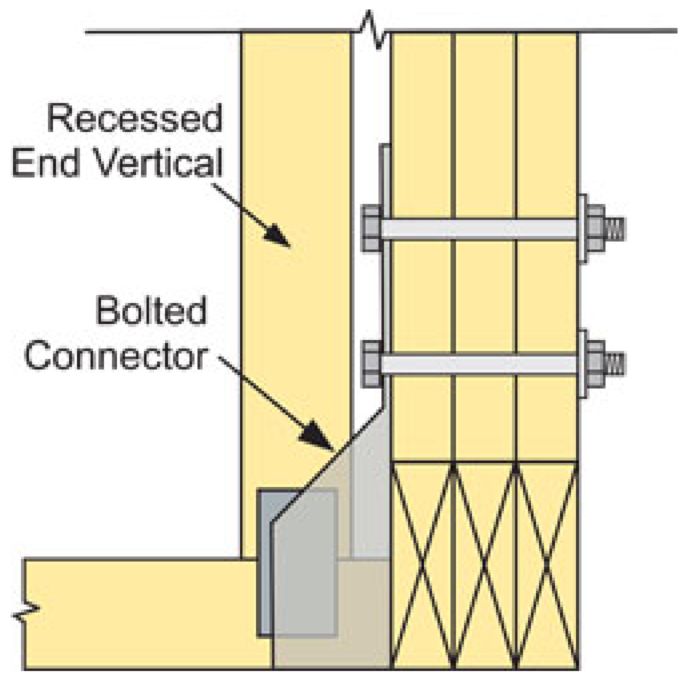

FIGURE 1.

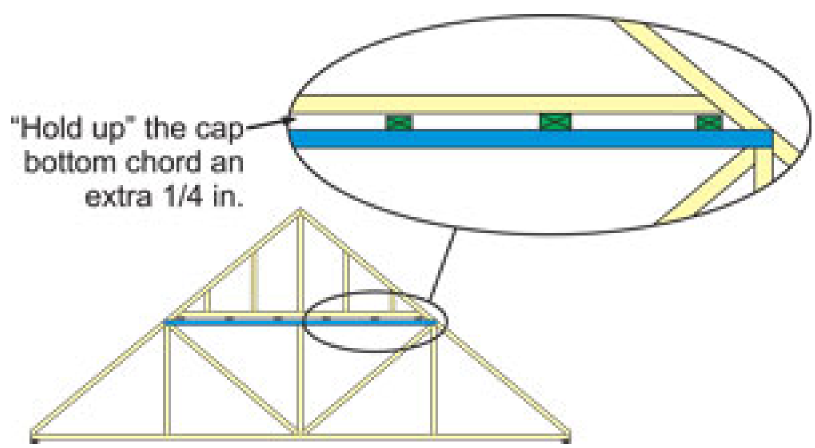

FIGURE 2.

recessed.

- For girder-to-girder truss connections, the amount to shorten the truss is a function of the hanger steel thickness, type of connection, and the number of plies of the supporting girder truss. The worst case is a bolted hanger which may be three gauge (1/4"). Consider shortening the truss 3/8" to 1/2" for this condition to account for the varying thickness of the supporting girder.

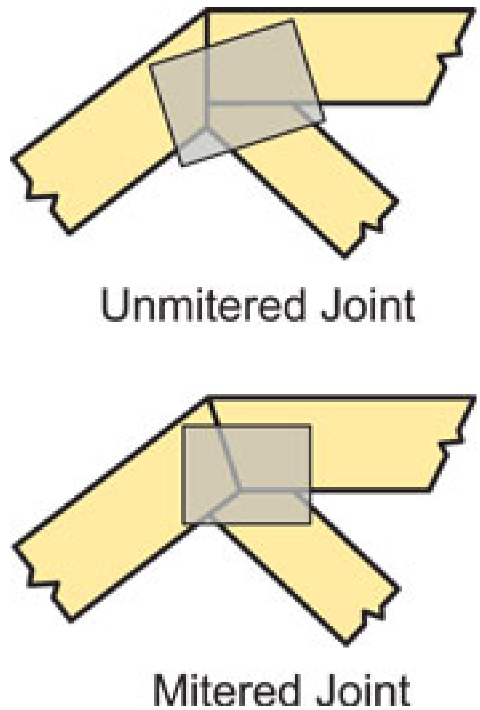

FIGURE 2.

We recommend you check first with your hanger manufacturer on shortening trusses supported by hangers. According to ASTM D1761 Standard Test Methods for Mechanical Fasteners in Wood the gap between the “joist” and “header” shall not exceed 1/8". The listed hanger capacity may be affected if the gap is greater than 1/8".

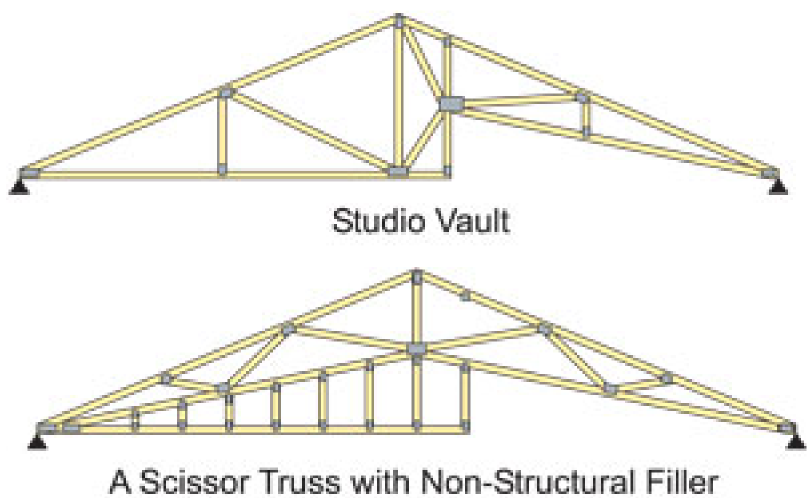

FIGURE 2.

The next consideration is hangers that are attached with bolts—recess end verticals (if there is a raised heel) from 1" to 1-1/2" to accommodate the bolt head (see Figure 1).

RULES FOR DEFLECTION & SPAN-TO-DEPTH RATIOS

Keep all span-to-depth ratios in floor framing to 20 or under. Therefore, attic frame trusses with a 2x10 bottom chord would be limited to a 16' wide room. Keep span-to-depth ratios in roof trusses to around 25. This is critical in tray ceiling locations where local deflections may exceed code allowed ratios.

Understand where differential deflection will create problems and know how to address it. (See Technical Q&A) One suggestion was that total load deflection should be limited to 0.25 in between adjacent roof trusses with gypsum board ceilings.

Always consider shortening the span of scissor trusses framed between two girders to account for the horizontal deflection as load is applied to the trusses.

RULES FOR CHORDS & WEBS

When stubbing roof or floor trusses, maintain the same web pattern as the full profile truss in order for any web bracing to run through continuously.

“Hold-up” bottom chords of cap or piggyback trusses by 1-3/4" for the top chord continuous lateral braces of the base truss. The additional 1/4" allows for variations in lumber thickness. See if the on-center spacing of the top chord bracing can be increased from 24" (see Figure 2).

Increase the web size before requiring another row of lateral bracing. Have you ever seen a truss design with 2x3 webs and two rows of continuous lateral braces? Don’t be that designer.

Drop top chords to allow continuous 4x2 purlins along the end slope of step-down hip trusses to eliminate the need for the contractor to have to cut blocks. Alternatively, design and provide an end-slope gable “lay-in” truss.

For truss spans over 45', investigate the economy of bumping up to a 2x6 top or bottom chord. The design may allow wider panels and fewer webs which typically means less board footage. If you bump up the top chord, remember that the heel heights for all trusses in the entire project may need to change.

Miter top chord breaks that are over 8/12 in slope typically reduce plate size (see Figure 3).

Use non-structural fillers in lieu of structural members for partial vaults, small flat ceiling sections in scissor-type trusses, or at tray ceilings. This allows site modifications to the profile without interfering with the structural design (see Figure 4).

Non-structural trusses with tall heels on both ends should have at least one diagonal web to keep truss square and prevent racking.

Automatic web placement speeds up the design, but it can cause inefficient lumber use. An hour of extra design time can save hundreds of dollars in the shop and make your sales people and customers happier as well.

RULES FOR SPLICES

- Keep splice locations consistent through similar truss profiles.
- For step down hip trusses, keep the same bottom chord splice locations and splice top chords using the overhang end as the measurement start point to maintain similar splices.
- Don’t splice top chords in the panel next to the heel joint.
- Don’t splice in the center of an attic room.

- Don’t splice within the half panel next to a pitch break.
- Don’t allow more than one splice within an attic room.
- Don’t splice the sloping section of an attic top chord within the room area.
- Locate panel splices within one quarter of the panel length (+/- 12") from the joint on 2x trusses.
- Don’t allow top and bottom chord splices to line up; they should be spaced at least a half panel apart.

RULES FOR LOADS

Understanding loads and how to apply them is an epic topic that is being addressed by a current WTCA project called Guide to Good Practice for Loading Metal Plate Connected Wood Trusses. Please check www.woodtruss.com for its availability.

KNOW THY CUSTOMER

Think like a framer. Get out to jobsites and talk to framers about what they want. Framer-friendly design may add a little cost to the package, but they will be demanding your trusses from the decision-makers. Check out what your competition is doing. You can learn a lot from them. Have an up-to-date design policy and customer preferences/requirements manual.

Don’t assume anything. If there is any uncertainty, ask and get it in writing. Make sure the person you are talking to has the authority to give the answer. If you want to make changes, get approval in writing. Write down anything anyone tells you about the job with source and date including internal sources.

“Why is there never enough time to do the job right the first time, but always time to do it over?” Avoid the rush job. If you know far enough ahead it will be a rush, price it to make it worth your while and cover the inevitable problems. Refuse to be rushed into not getting all the answers you need. The customer will be more angry when it’s wrong.

RULES FOR ESTIMATING & JOBS

Don’t sweat the details on bids. For example, overall dimensions are off by an inch, is the 12" overhang gross or net, what is the exact location of a plumbing trap, etc. You will waste your time if you don’t get the job and you won’t get them all.

Understand the things that have a big effect on a bid price and must be correct. For example, big dead loads: is the snow load specified as ground snow or roof snow, non-standard heel heights, specs for 2x6 chords, or required minimum lumber values?

Check for first floor planes getting into second floor windows. Check for heel heights that cause fascia and frieze boards to interfere with window and door openings. Just because it looks fine in the plans doesn’t make the drawing a reality.

When you finish a job, step away from it a while, and then double check it.

Most importantly, know when to break the rules. In order to pull this off, you have to know the purpose of the rule and have the experience to recognize when the rule is hurting the larger goals of economy, efficiency and quality.

Thanks to these truss engineers who shared their design expertise with us: Scott Coffman in South Carolina, Joe Heinsman in Indiana, Steve Kennedy in Iowa, Joe Michels in Wisconsin, Stan Koehlinger in Ohio and Ian Richards in Ontario.

SBC HOME PAGE