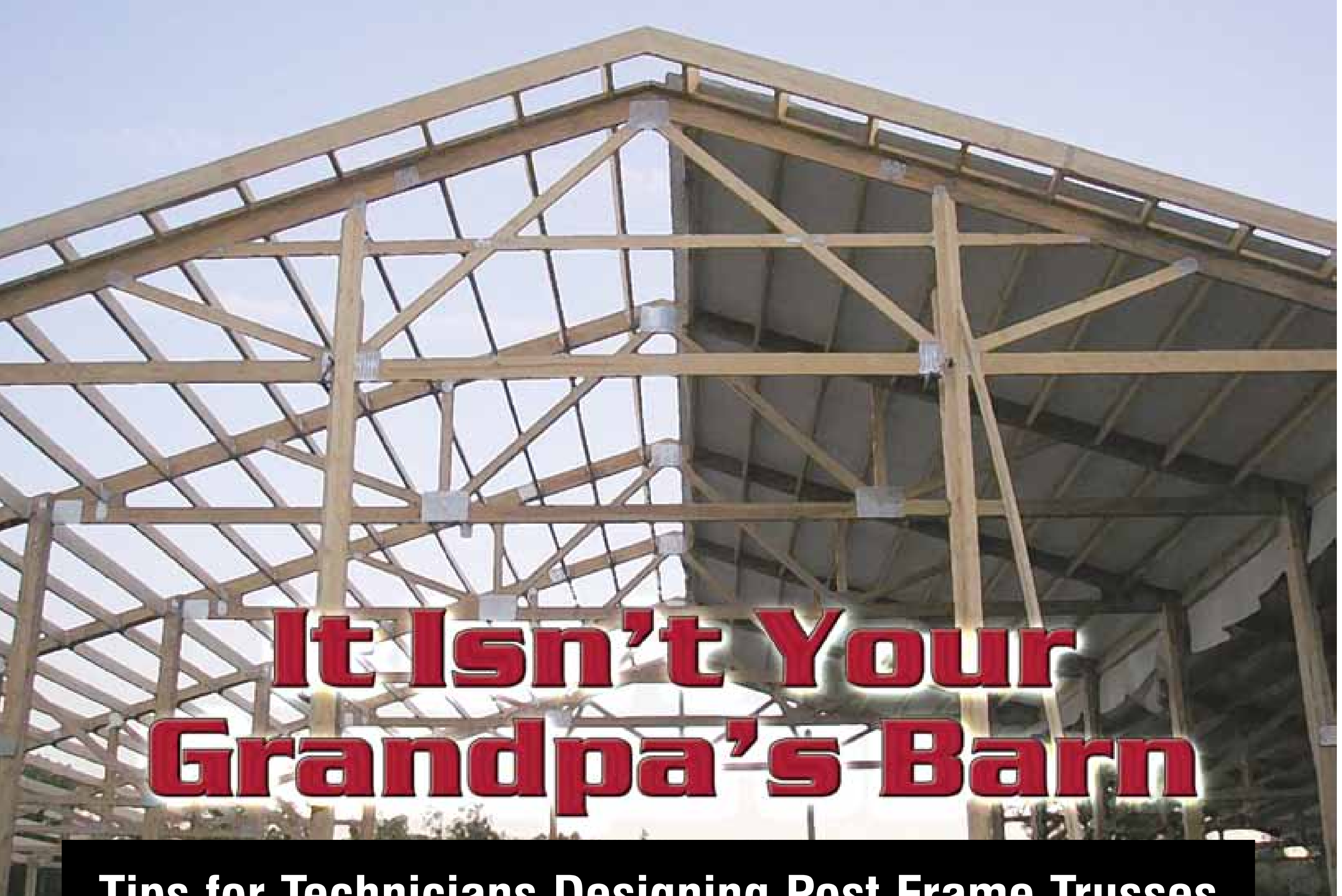

It Isn't Your Grandpa's Barn

Tips for Technicians Designing Post Frame Trusses

by Mike Momb, The Pole Barn Guru

They say a life best lived is one that is about the journey and not the destination. In my case, my journey has sent me on paths I had no idea I would take (or even existed).

My Dad and his five brothers were sons of a building contractor, and became framing contractors. Growing up, my cousins and I worked for our fathers during the summers. As one of the "gofers" on the job, I didn't learn much, but I set enough trusses to know they were always placed every two feet.

The natural progression led me into architectural school in college. Fresh out of school in 1977, a friend got me a job as a sawyer at a local truss company. Strange things occur in the truss industry. Three weeks after being hired, I was offered the position "truss designer and sales force" at a nearby truss plant partially owned by the same folks who first hired me.

One thing I had learned while framing with my father and uncles carried me a long way in my new career—trusses were set 24 inches on center. Then one day, life changed. A rather scraggly sort came into the sales office. He was ready to place a truss order (good, we liked orders). But here was the shocker to my system. He was planning to put two trusses every 12' on center. I looked at my boss, my boss looked back at me, and we had a serious gut busting laugh at our poor customer's expense. Neither of us had ever heard of such a thing. After we picked ourselves up off the floor from laughing hysterically, we said, "Sure, why not"? We ran a design, gave him a price and took his money.

Author's Note:

I am not a registered design professional. The information contained in this article is provided merely to make the reader aware of the possibilities and to be thought provoking. It is not intended to replace the advice of a licensed professional.

Over 100,000 "pole barn" trusses later, it is no longer a laughing matter. The pole barn industry represents a nice segment of the engineered building industry. My personal post frame truss experience now spans three decades. While I entered the truss industry as a jack-of-all trades, I ended up owning two truss plants for 17 years. I was a registered general contractor in four states, managing as many as 35 post frame building construction crews at once. For a time I was back in the industry as a truss technician. Over the past nine years, I have purchased trusses in nearly every state and resold them as components of complete post frame building packages. All of these experiences have blessed me with the unique advantage of having been on all sides of the industry.

Being in the business as long as I have, there are several things that seem to challenge truss technicians when designing post frame trusses. I've been asked to share them with you.

A Few Challenges to Consider

The first "challenge" to overcome with pole barn or post frame trusses is the same one I first encountered over a generation ago: spacing. Truss companies have told me their policy is to space trusses no further than 4', 6' or 8'. Then there is the ever popular, "the engineering program will not design them," or "we cannot get the engineer to seal them." The building components industry needs to open its eyes to different design possibilities that may seem laughable at first. The fact is, trusses can be designed for almost any spacing desired as long as the framing between them is taken into consideration. This is an area in which the industry has a significant opportunity to increase its market share.

A good truss technician has to be a world class juggler. The balancing act can be quite involved. Designs must make for efficient use of available lumber grades and dimensions, truss plate sizes in inventory, as well as practical to fabricate. Not to mention your boss, the project engineer, architect, building inspectors and consumers each expect truss designs that will not fail. And, of course, the purchaser wants prices that are competitive in the marketplace. If you "over design" them, your price will cost you the job. But "under design" them and even worse things could happen.

Let's talk realities here. Truss spacing does not have much bearing on lumber and connector plates (no pun intended). It is as simple as this—apply a given set of loads at a given spacing and come up with a design which does not exceed the CSI of 1.00. In the end, a total load of 30 psf on trusses 12' apart is the same as a total load of 90 psf 4' apart.

One truss plate manufacturer's preliminary drawings say "Maximum allowed spacing exceeded" if spacing is over 12' on center. If your truss design program says they will otherwise work, a manual engineering review needs to be asked for in order to get seals.

When your current truss design software was set up, chances are the sales rep from your plate company input the default values that are used by your truss technicians day in and day out to design and quote jobs. The occupancy category, snow and wind loads, and every other variable needed were all ready to go and seemingly worked just fine—as long as residential trusses every 24 inches were being quoted.

However, because default truss design software settings are not always the most appropriate for designing post frame trusses, truss technicians should be aware of which factors and settings to change when designing components for these buildings. Altering these settings in accordance with the governing building code will ensure proper loading of the components and maximize material efficiency. This, in turn, will reduce material cost. The following considerations should be addressed when designing post frame buildings.

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TABLE 7-2 EXPOSURE FACTOR, C_e

Terrain Category	Fully Exposed	Exposure of Roof[a] Partially Exposed	Sheltered
B (see Section 6.5.6)	0.9	1.0	1.2
C (see Section 6.5.6)	0.9	1.0	1.1
D (see Section 6.5.6)	0.8	0.9	1.0
Above the treeline in windswept mountainous areas.	0.7	0.8	N/A
In Alaska, in areas where trees do not exist within a 2-mile (3 km) radius of the site.	0.7	0.8	N/A

The terrain category and roof exposure condition chosen shall be representative of the anticipated conditions during the life of the structure. An exposure factor shall be determined for each roof of a structure.

[a]Definitions: Partially Exposed: All roofs except as indicated in the following text. Fully Exposed: Roofs exposed on all sides with no shelter[b] afforded by terrain, higher structures, or trees. Roofs that contain several large pieces of mechanical equipment, parapets that extend above the height of the balanced snow load (h_b), or other obstructions are not in this category. Sheltered: Roofs located tight in among conifers that qualify as obstructions.

[b]Obstructions within a distance of $10h_o$ provide "shelter," where h_o is the height of the obstruction above the roof level. If the only obstructions are a few deciduous trees that are leafless in winter, the "fully exposed" category shall be used. Note that these are heights above the roof. Heights used to establish the terrain category in Section 6.5.3 are heights above the ground.

Table 7-2 from ASCE 7-05, Exposure Factor, Ce

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Snow. The International Codes (IBC and IRC) identify the appropriate Ground Snow Load (Pg) to use on a building based on its location. The ground snow loads identified in these codes are taken from the referenced standard ASCE 7. Your truss design program will calculate the roof snow load using Pg as the basis and multiplying it by several factors. This is the relationship between the ground snow load and the roof snow load:

$$p\ s = 0.7C_s\ CeCt\ I\ pg$$

where:

Cs= sloped roof factor Ct= thermal factor

Ce= Exposure factor I= Importance factor

The formula above shows how the ground snow loads are adjusted by several factors to get to a Top Chord Live Load. The ones to be most aware of with post frame construction are the Importance factor (derived from the nature of the occupancy), Exposure Factor and Thermal Factor.

Your default setting for occupancy is probably Category II (shown as "Is" or "Importance" factors on truss design drawings). Most post frame buildings will not result in the loss of human life if there are serviceability issues given the majority are used in the agricultural/industrial arena. Because of this, post frame buildings are occupancy Category I. This alone can reduce the roof snow load by 20 percent as compared to residential, office or manufacturing-type structures.

The Exposure Factor (Ce), is normally defaulted to 1.0, but can vary from 0.7 to 1.2 and can make huge differences in both design and price. The best examples of how to determine Exposure Factor can be found in Table 7-2 of ASCE 7-05 (referenced in IBC Section 1608.1; see above).

The Thermal Factor (Ct) is normally defaulted to either 1.0 or 1.1. However, most post frame buildings are not heated year round, so the factor should be 1.2. This will increase the roof snow load, and therefore increase the design load the trusses must withstand.

Metal roofs are assumed to be slippery surfaces unless the presence of snow guards or other obstructions prevent snow from sliding. Do not automatically assume there will be no snow guards, even if they are not shown on the building plans. A roof slope factor (Cs) is calculated based on whether the roof is warm or cold, the nature of the roofing material, and slope of the roof. With heated, steeply sloped and/or slippery roofs, these reductions can be significant. If the building plans do not specify the values of these factors, consult with the registered design professional in charge or ask the owner for the loads and factors. It is best to get the values in writing or send them written notification that you will consider the loading assumptions are accurate unless they tell you otherwise.

Will the building be in an area with little or no snowfall? Don't forget area reductions. If the truss span times the truss spacing is over 200 sq ft, a reduction is in order. This calculated value can reduce the roof live load (Lr) to as little as 12 psf. Further, if Lr is greater than Ps (sloped roof snow load), the Duration of Load for roof loads is now 1.25, instead of the 1.15 typical default value.

Wind. Fairly straightforward right? You enter the wind speed and go! It is not that easy; the wind exposure must be correct to match the building site (B, C or D). ASCE 7/IBC specify that Exposure B shall be assumed unless the site meets the definition of another exposure. This does place some onus on the technician to ensure that the person building the trusses provides information so that proper exposure category is used in the design. Loosely defined, Exposure C is open terrain with scattered obstructions, while Exposure D is flat, unobstructed areas exposed to wind flowing over open water for a distance of at least one mile. Exposure D is excluded in hurricane prone regions.

Nature of Occupancy affects wind designs, as Iw (Importance factor for wind). The standard default of Category II results in Iw = 1.0, however most post frame buildings are low risk and Iw = 0.87, so a reduction factor of 0.87 is applied for wind (0.77 in hurricane prone regions where wind speed is over 100 mph).[1]

Older codes usually define the Duration of Load for Wind as 1.33. The International Codes and NDS now use a value of 1.6.

Where is the truss located on the roof? Trusses located in the "end zone" require a higher wind load than those located in "interior zones." For most buildings the end zone extends from the corner of the building a distance equal to ten percent of the building width. For example, if the building is 60 feet wide, the end zone extends 6' in from the corner of the building. With widely spaced trusses, often only the end truss is in an end zone. Making the wrong wind choices can result in the need for larger or higher graded truss members as well as increased bracing requirements.

[1] ASCE 7-05 Table 6-1

Dead loads. Using artificially high dead loads can create the possibility of severe serviceability issues. You may be asking what this means. A light gauge steel roof over purlins creates a Top Chord Dead Load of about 2.5 psf. It is more than conservative to use 3.3 psf. Depending on the truss spacing and the lumber used in the trusses, with no ceiling or sprinklers, a Bottom Chord Dead Load of 1.0 psf is usually adequate. Building design professionals use the uplift values from your truss drawings to design the uplift connections for the trusses. Even though they can only use 60 percent of the dead loads to resist uplift, if the truss is designed for dead loads of 10 psf on both the top and bottom chords, the uplift resistance from dead loads is 12 psf. Using the actual dead load the resistance is only 2.58 psf. Designing with the higher dead loads inappropriately results in an uplift calculation that is not conservative because dead loads that are not present are assumed to be resisting a portion of the uplift. This could easily result in lumber distress and/or cracking of the connection during a high wind event.

Often overlooked is the effect of end overhangs on the end trusses. An example is placing trusses every 10' with an 18-inch end overhang. The end trusses need to support half the distance to the first truss (5') *plus* the distance of the overhang for a total supported load of 78".

Drop Preconceived Notions, Find Success

There are two keys to success in designing trusses for post frame buildings. First, approach the design solution with an open mind, leaving behind preconceived notions of spacing and loading. Second, take the extra time to gather the correct load criteria from the registered design professional or building owner and input it right the first time. Alternatively, provide all your loading conditions and assumptions to the RDP or owner with your submittal drawings for approval.

I hope I have opened your eyes to the post frame market and its design nuances. Your clients listen to everyone's favorite radio station WII-FM (What's In It For Me). Armed with the information in this article, you can now point out how you have looked out for their best interests. When your customer realizes you are protecting his pocketbook with efficient designs, and his safety with the correct load combinations, you will win both his loyalty and his order. SBC

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