MOST FARMERS DON'T KNOW THEIR OWN (BARN'S) STRENGTH

A dairy farmer from Jackson County, Wisconsin called me this winter with some structural concerns about his Freestall dairy barn. Specifically, he observed some truss web members bowing out of plane by an estimated 6" to 8" (YIKES!).

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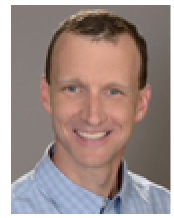

After some phone discussions and a review of his truss design drawing from the 2014 drawings, we determined the trouble was because the web lateral restraints did not include any diagonal bracing which is required to make them effective against bowing. It was obvious to me that adding diagonal bracing to meet BCSI and TPI guidelines would be required, but he also wanted to gain more confidence in the situation, so he hired me to visit his barn to make sure we had correctly identified the extent of the problem and to ensure he knew how repairs should be made.

Before visiting, I noticed there was likely a problem with the truss design loads. The truss design drawing included the information shown in this box:

Loading (psf)	
GSL:	35
TCDL:	5
BCDL:	5

"psf" is Pounds per Square Foot. "GSL" is Ground Snow Load. "TCDL" and "BCDL" are Top / Bottom Chord Dead Load. The immediate concern for me was the appearance of Ground Snow Load, not Roof Snow Load or Top Chord Live Load, so I suspected right away that this truss was likely designed for something much less than 45psf total load (35 + 5 + 5).

The truss design notes stated the truss was designed with user defined input: 35psf ground snow load, Terrain Category C, Exposure Category: Partially Exposed (C_e = 1.0), Building Category: I (I_s = 0.8), Thermal Condition: attic ventilated (C_t = 1.1), Unobstructed Slippery surface. Using these factors and ASCE 7 equations results in a Roof Snow Load (P_s) of 20 psf, about the equivalent of 1ft of "nominal" density snow (snow density varies widely).

When I explained that the truss design loads applied several reductions to the Ground Snow Load, the farmer was immediately concerned: "What do you mean, 'reductions'?!?" I explained such adjustments can be legitimately used in the design process, but the reality is the truss design included some "technically" allowed adjustments I did not agree with. More importantly, this discussion should have taken place with his builder and building designer when the design process first began. He should have also had some education on the factors and been given input on which adjustments are used for his building. After all, it ends up being a roof over HIS head and HIS livelihood if something goes wrong.

Despite some disagreement with the adjustments, the starting point is the Ground Snow Load, and the 35psf starting point for this project should have been 50psf for this location (see Figure 1). The builder may have requested a "35psf truss" (intending roof snow load), but the request appears to have been supplied as 35psf "Ground" snow load, transformed to 20psf roof snow load. Any

continued on page: 28

continued from page: 27

building designer worth his wages would confirm that the snow and wind loads used in the roof truss and building design are appropriate for the location before the trusses are manufactured.

Besides the incorrect Ground Snow Load, the truss should not have used a slippery roof surface assumption because a large area of the barn was tied into the milking parlor in a T-shape with two large valleys on the Freestall barn preventing snow sliding from the roof through a wedging action of the two roof slopes coming together. In addition, they create a 3-dimensional "pocket" where snow commonly drifts in and accumulates in these valleys resulting in a roof snow load that is much more than the calculated roof snow load, possibly by a factor of TWO (or more), based on my observations of snow on roofs over many Northern Wisconsin winters. Just changing the GSL to 50psf and removing the slippery roof assumption would have raised the sloped roof snow load from 20psf to 30.8psf, something much more reasonable as a "minimum" design load appropriate for this area.

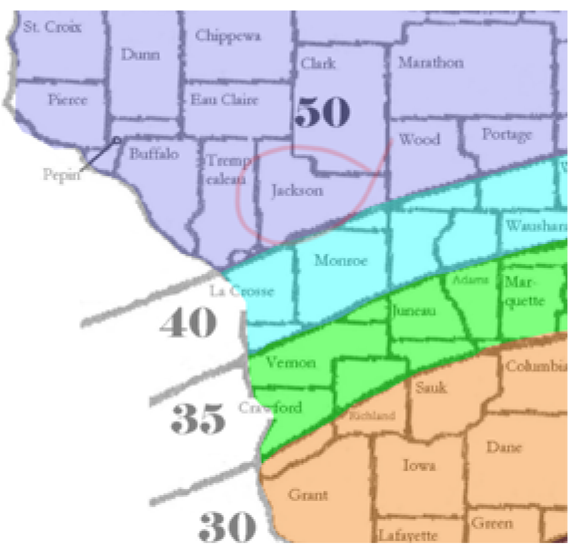

Figure 1 – A portion of Wisconsin's Ground Snow Load Contours from ASCE 7 shows most of Jackson County is clearly in a 50 psf region (not the 35 psf used)

In addition, this farmer should have considered increased safety factors by changing the risk category from "I" (suitable for unoccupied buildings) to category "II" (suitable for occupied buildings) since he and his employees spend significant time in this building and his livestock is continuously in this building. This additional change would result in a calculated roof snow load of 38.5psf. Nearly DOUBLE the roof snow load his trusses were designed for, and this still does not include the suggested increase advisable for the valleys.

Building owners and their builders or building designers SHOULD have a crucial conversation on the design values for their building before any materials are purchased and ensure that the roof snow load is not LESS than what the owner desires after they understand their options. This farmer (along with many, many others) had no idea that his building was designed for such a small amount of snow.

According to the Truss Plate Institute standard TPI-1, the BUILDING designer (NOT the truss designer) is responsible for establishing the proper building design loads, confirming adequate connections and supports, provide truss bracing requirements (see TPI-1, Chapter 2 – Responsibilities). When you see a truss design "stamped" with an engineer's seal, they are NOT certifying the building design, only the design of the truss component to resist the specified loads if installed and supported and braced per the plans sealed by the Building Designer (a different engineer, typically). An engineered truss system supported by a NON-engineered building system will perform much like a building where nothing at all is engineered.

When the farmer realized the trusses were designed for only 20psf snow, he jested that he wasn't sure if he was lucky his building was still standing or if he would have been better off with a collapse so he could have started over with a building designed for a better snow load. Assuming nobody would have gotten hurt in the collapse, I am not sure either. As it is, I will do my best to work with this farmer to reinforce his trusses before next winter arrives, but it is a much more difficult process with less certain results than a building designed correctly at the outset.

Please keep in mind that this particular building had issues with the design snow load and a lack of truss bracing, but if a competent engineer had been employed in the project, he or she would have verified many other building design features, components, and connections to ensure the constructed building is reliable for the owner's needs in the decades to come.