# Technical Q & A

## Dead Loads & Horizontal Projection

by Rachel Smith

Structural design requires that sloped dead loads be expressed in terms of the horizontal projection.

Dead loads are permanent loads created by the weight of building materials like sheathing, insulation, floor or roof coverings, and the structure itself. Forces and loads are described by two things: their magnitude (amount) and their direction. In structural design, we know that dead load is a gravity load, which means its direction is always is in a downward or vertical orientation. However, the magnitude of a dead load may not be so obvious and is worth some further discussion.

Figure 1 shows a steeply pitched roof with a very short truss span of ten feet. Let's say we added up the weight of all building materials along the slope of the top chord and came up with 10 pounds per square foot (psf). If the adjacent flat roof had the same top chord dead load of 10 psf, which roof would be supporting more dead load?

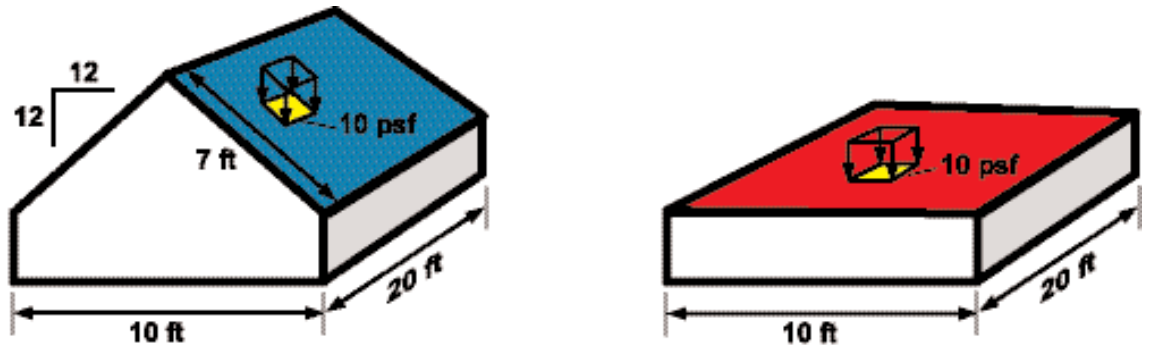


Figure 1.

It's pretty apparent the sloped roof has a larger area and supports more load even though the material weight per square foot is the same. This is an important point in specifying design dead loads on sloped roof framing. Structural design requires that sloped dead loads be expressed in terms of the horizontal projection, meaning they are applied as though the roof was flat even if it is pitched (see Figure 2). The greater the slope, the more load it carries in the horizontal projection. In order for this horizontal simplification to occur, the "per square foot" load must increase so that the total load is the same as it was when it was pitched. This increase is a factor based on the slope, called the slope adjustment factor.

### at a glance

- Dead loads are projected horizontally for truss design.
- Truss technicians must be clear on whether they need to adjust the input design dead load values for slope or if the software will do it for them.
- Slope adjustments become more critical with steeper pitches.

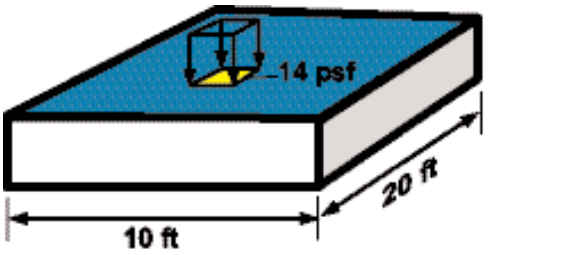


Figure 2.

## Question

*I noticed that section 6.2.1.2 of ANSI/TPI 1-2002, the* National Design Standard for Metal Plate Connected Wood Truss Construction, *says: "When dead loads are applied on a projected horizontal area basis, the effect of the pitch shall be taken into account." How do I make sure that the dead loads I am using in my truss designs are on the horizontal projection?*

## Answer

Taking the pitch into account is not a new idea and your truss design software might already be applying dead loads in the horizontal projection. There is no standard convention on whether your software accepts input for dead loads along the slope or in the horizontal projection so as a truss designer or technician, you must be absolutely certain if you need to adjust for pitch or not. Figure 3 shows a sloped load and its equivalent adjusted horizontal load. Most of the time, the default design value used for dead loads is conservative (higher than the actual dead loads) for both sloped and horizontal projection. The slope adjustment becomes critical for steep pitches like the 12/12 top chord shown here:

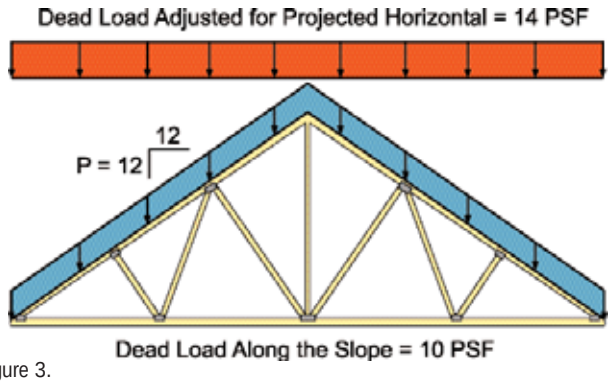


Figure 3.

If you input a sloped dead load of 10 psf for a steep 12/12 pitch, the adjusted load will be 40 percent higher or 14 psf. The adjustment is made according to the following formula:

$$\text{Slope Adjustment Factor} = \frac{\sqrt{P^2 + 144}}{12} = \frac{\sqrt{12^2 + 144}}{12} = 1.4,$$

where P is rise of the top chord

In most cases the dead loads listed on the construction documents have been adjusted for slope, since the building designer should be using this adjusted value when determining the loads on the structure. In other words, the building designer would specify the adjusted 14 psf value. If you input a top chord dead load (TCDL) of 14 psf, some truss design software treats the 14 psf as the adjusted horizontal value and uses that value in the design, which is fine. It gets a little trickier when your software treats your input value of 14 psf as the unadjusted slope value, and applies the adjustment again to come up with 14 x 1.4 = 19.6 psf as the TCDL on the horizontal. Clearly, you want to avoid an unnecessarily high TCDL, so in that case the designer should divide the input TCDL by the adjustment factor (14 psf ÷ 1.4 = 10 psf), input the 10 psf value and allow the software to make the adjustment.

In a few instances the Truss Designer calculates the dead load values based on the weights of the building materials in the construction assembly as described in the construction documents. (You can calculate dead loads with **The Load Guide**. Download a copy at www.woodtruss.com/loads.php and see page 22 for an introduction to **TLG**.) The Truss Designer would have to consider the truss weight with other material dead loads. This input value would have to be adjusted appropriately for slope if this feature is not offered in the software.

If it appears that a dead load value given on the construction documents is understated or overstated, the Truss Designer should confirm the correct value to use with the Building Designer or Owner. A roof truss TCDL value of 7 psf is typical, so a quick evaluation would compare this to design specifications. For the sake of consistency, it is important that the dead load value that appears in the "load box" printed on the Truss Design Drawing should reflect the adjusted value used in design. SBC

*To pose a question for this column, call the WTCA technical department at 608/274-4849 or email technicalqa@sbcmag.info.*

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