Reading the PE Palm

Snow Damage Analyzed, Repaired

Spend some time with this new column and learn from one P.E.'s experience with unbalanced snow loads.

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Introduction & Analysis

The late December 2004 snow storm that hit the Midwest brought about 14" of snow to Johnson County, IN where Davidson Lumber Company is located (just south of Indianapolis). Part of the Davidson Lumber facility consists of six identical umbrella sheds built in 1973. Each shed measures 150' x 36'. The ridge of the shed runs due east and west. A 36' 4/12 single ply truss is bolted to each side of treated 9.5" diameter timber poles, with each pole placed at 12' on-center. (See Figures 1-7. To view drawing go to **Support Docs** at www.sbcmag.info .).

Figure 1.

Figure 2. The trusses are a double Pratt design with 2x6 top chords and 2x4 bottom chords constructed of Southern Pine. The chords are all #1 grade and the truss plates 20 gauge. The distance from the concrete slab to the bottom of the trusses measures 15.5'. The 2x8 kingposts extend 14" through and below the bottom chord to allow for more bolts. Each pair of trusses is bolted to their pole with eight ¾" diameter bolts more or less evenly spaced down the kingpost.

Figure 3. Sections of OSB sheathing between the members of the trusses on each side of a pole have been used as bracing for the bottom chords and webs.

Figure 4. While five of the sheds were undamaged in the storm, the sixth received extensive damage. Major damage to the trusses was at the fifth, sixth and seventh poles from the east end of the shed. The seventh pole was split along the bolt holes (**see also Figure 3**). The sole witness to see the roof with the snow on it said the north side of the roof was clean while the south side had a drift that was 4.5' to 5' high at the eave. Where the eave was lowest he could jump up and touch it. He said the undamaged poles were bowed in the plane of the trusses toward the eave with the snow drift. There was about 18" of horizontal displacement at the top. The trusses on each side of the fifth and sixth poles and one side of the seventh pole had the kingposts split. The kingposts split at the bolt holes at the top but the split did not necessarily follow the bolt holes down.

at a glance

- A December 2004 snow storm caused damage to one of Davidson Lumber Company's umbrella shed.
- Trusses were bolted to both sides of round poles. Due to the shed's unbalanced snow load, several kingposts split along the bolts holding the trusses.
- It is clear from this example that unbalanced snow loads are capable of creating significant tension perpendicular to the grain loads in the bolt joints of the trusses and supporting posts.
- Consideration of unbalanced snow loads should be given in any building design or lumber shed that uses the same principles.

Figure 5.

Figure 6.

Figure 7.

The loaded part of the kingposts was broken off at or near the bottom of the peak truss plate (Figure 5). On some trusses, the kingpost was split below the bottom of the bottom chord where two of the eight bolts were located (Figure 6). In no case did the splits or damage to the wood extend past the first row of teeth into the plate area. All wood in the plate areas was intact and undamaged (Figure 7). The one damaged round pole was split at the bolt holes at the top and followed the bolt holes most of the way down the truss depth where it began tapering to one side of the post. The split ended about 4' below the bottom of the truss where it was getting close to one edge of the pole.

Repair

In designing the repair, no attempt was made to analyze the structure as a whole to see if it was adequate for current code requirements. The repair was intended to be equal or better than the pre-damaged condition. The truss was analyzed to get member forces for the repair design only. (To view the drawing, go to **Support Docs** at www.sbcmag.info.)

Repair of the trusses entailed cutting out the existing kingposts at the bottom edge of the peak plate and replacing them with a new posts. A 4'x8' gusset of 7/8" sheathing was used on one side of the truss at the peak and a 2x12 scab was used along the bottom chords on one side also (see Figure 8).

The old bolt holes were used to attach the repaired trusses to the posts again. Screws rather than nails were used for all plywood gussets and scabs in attempt to draw the connections tight in a situation where the construction was especially rough.

Figure 8.

Figure 9.

The split round pole was assumed to be Southern Pine. Only Pacific Coast Douglas-Fir has higher design values of the pole values currently listed in the NDS. The pole was about 9.25" in diameter. A 5.25" x 9.25" parallel strand lumber (PSL) post was applied to each side of the round pole. Wood was used because of the cost and length of time needed to fabricate steel to match the width and strength of the pole. Some decisions about materials used were based on what was available locally. A 7" wide steel C channel was applied to the outside of each PSL post because of edge distance concerns with the bolts and to act as a load distributing element below the truss.

A wider PSL post would have eliminated bolt edge distance concerns. However, it was not readily available. After reinforcing the split pole, the trusses at this pole were repaired in a similar manner to the others except a side-by-side double 2x12 kingpost was used. The new kingpost was then bolted to the PSL posts (see Figure 9). No attempt was made to take advantage of any spaced column effect.

In retrospect it is clear that in umbrella sheds like this, unbalanced snow loads are capable of creating significant tension perpendicular to the grain loads in the bolt joints of the trusses and supporting poles. Consideration of these types of loads should be given in any building design that uses the same principles. The ability of truss plates to reinforce lumber and resist the loads due to the extreme bending of the kingpost was also clearly shown. The type of bracing used on the trusses would seem inadequate by any analysis and yet there was no buckling of the compression bottom chord mentioned by the witness. The difficulty of knowing exactly what design loads should be expected and used in calculations—or predict nature's activities—was also reemphasized by the fact that out of six identical sheds in a relatively open area, five had much less total snow on them including those with what would seem like virtually identical exposure. SBC

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