Thus, roof-to-wall connection combined design loads are:

468 lb (uplift)
232 lb (lateral, perpendicular to wall)*

*The lateral load parallel to a wall is not considered to be significant in this example problem, although it may be checked to verify the transfer of lateral wind loads on the roof to shear walls; refer to Chapter 6.

2. Determine a roof-to-wall connection detail to resist the combined design load.

Generally, manufacturers publish loading data for metal connectors for multiple loading directions. The designer should verify that these values are for simultaneous multi-directional loading or make reasonable adjustments as needed. In this example problem, the NDS will be used to design a simple roof tie-down strap and slant nail connection. A tie down strap will be used to resist the uplift load and typical slant nailing will be used to resist the lateral load. The slant nailing, however, does not contribute appreciably to the uplift capacity when a strap or metal connector is used; refer to Section 7.3.6.

<u>Uplift load resistance</u>

Assuming an 18g (minimum 0.043 inches thick) metal strap is used, determine the number of 6d common nails required to connect the strap to the truss and to the wall top plate to resist the design uplift load.

The nail shear capacity is determined as follows:

$Z = 60$ lb (NDS Table 12.3F)
$Z' = ZC_D$ (Section 7.3.2)
$= (60 \text{ lb})(1.6)$
$= 96$ lb

The number of nails required in each end of the strap is

(486 lb)/(96 lb/nail) = 5 nails

The above Z value for metal side-plates implicitly addresses failure modes that may be associated with strap/nail head tear-through. However, the width of the strap must be calculated. Assuming a minimum 33 ksi steel yield strength and a standard 0.6 safety factor, the width of the strap is determined as follows:

$0.6(33{,}000 \text{ psi})(0.043 \text{ in})(w) = 468 \text{ lb}$

$w = 0.55$ in

Therefore, use a minimum 1-inch wide strap to allow for the width of nail holes and an a staggered nail pattern. Alternatively, a thinner strap may be used (i.e., 20g or 0.033 inches thick) which may create less problem with installing finishes over the connection.

<u>Lateral load resistance</u>

Assuming that a 16d pneumatic nail will be used (0.131 in diameter by 3.5 inches long), determine the number of slant-driven nails required to transfer the lateral load from the wall to the roof sheathing diaphragm through the roof trusses. Assume that the wall framing is Spruce-Pine-Fir (G = 0.42).

$Z = 88$ lb (NDS Table 12.3A)*
*A 1-1/4- inch side member thickness is used to account for the slant nail penetration through the truss at an angle.

$Z' = ZC_D$** **The C_{tn} value of 0.83 is not used because the nail is slant driven and is not a toe-nail; refer to Section 7.3.6.

$Z' = (88 \text{ lb})(1.6) = 141$ lb

Therefore, the number of nails required to transfer the transverse shear load is determined as follows:

(232 lb)/(141 lb/nail) = 2 nails

Conclusion

The beginning of the uplift load path is on the roof sheathing which is transferred to the roof framing through the sheathing nails; refer to Example 7.1. The uplift load is then passed through the roof-to-wall connections as demonstrated in this example problem. It should be noted that the load path for wind uplift cannot overlook any joint in the framing.

One common error is to attach small roof tie-straps or clips to only the top member of the wall top plate. Thus, the uplift load must be transferred between the two members of the double top plate which are usually only face nailed together for the purpose of assembly, not to transfer large uplift loads. This would not normally be a problem if the wall sheathing were attached to the top member of the double top plate, but walls are usually built to an 8 ft – 1 in height to allow for assembly of interior finishes and to result in a full 8 ft ceiling height after floor and ceiling finishes. Since sheathing is a nominal 8 ft in length, it cannot span the full wall height and may not be attached to the top member of the top plate. Also, the strap should be placed on the structural sheathing side of the wall unless framing joints within the wall (i.e., stud-to-plates) are adequately reinforced.

Longer sheathing can be special ordered and is often used to transfer uplift and shear loads across floor levels by lapping the sheathing over the floor framing to the wall below. The sheathing may also be laced at the floor band joist to transfer uplift load, but the cross grain tension of the band joist should not exceed a suitably low stress value (i.e., $1/3F_v$); refer to Chapter 5, Section 5.3.1.