

BUILDING ROOF-TO-WALL CONTINUOUS LOAD PATH CONNECTIONS

Eccentric loading at the connection that ties the roof framing, top plate and stud together can cause significantly reduced connection loads. This technical bulletin explains eccentric loading and specifies the steps to ensure a continuous load path needed for structural integrity.

Eccentric loading occurs when points of application of a set of forces are not in a line vertically. Specifically, this can occur in wood-frame construction when the roof framing-to-top plate connection is made on the inside of the wall and the top plate-to-stud connection is made on the outside of the wall. For example, when a hurricane tie connects roof framing to a top plate and wood structural panel (WSP) sheathing is used to make the plate-to-stud connection.

Research conducted in the mid 1990s first demonstrated the effect of eccentric loading through testing. Compared to an assembly with the rafter-to-top plate and top plate-to-stud connection on the same side of the wall, an assembly with the rafter to top plate connector on the inside and sheathing on the outside as the only plate-to-stud connection had a nearly 60% reduction in uplift capacity. The researchers at Clemson University dubbed this a “top-plate roll” to describe the top plate rotating and separating from the studs on the inside of the wall, while the outside of the plate remained fastened to the sheathing.

Top-plate roll is only dependent upon the location of the connections and is independent of connector model or manufacturer. Furthermore, recent testing at Simpson Strong-Tie has demonstrated that gypsum wall board on the inside of the wall does not provide adequate load path resistance to prevent this effect as shown in Figure 1.

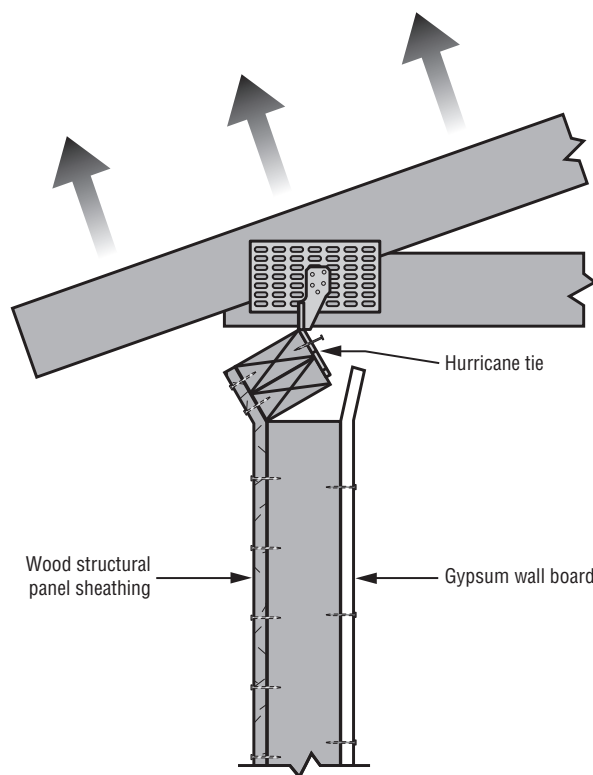


Figure 1

REDUCED LOAD CAUSED BY ECCENTRIC LOADING

Simpson Strong-Tie has performed testing to determine reduced hurricane tie allowable uplift loads caused by eccentric loading when the following conditions exist.

- A hurricane tie is installed on the inside of the wall
- ½" gypsum wall board is installed on the inside over the connector with 1 ¼" drywall screws at 7" o.c.
- Double 2x4 top plates are used (not applicable to 2x6)
- WSP sheathing is installed on the outside of the wall to resist wind uplift in accordance with the *2008 International Code Council Standard for Residential Construction in High-Wind Regions* (ICC-600), Section 307; *2008 AF&PA Special Design Provisions for Wind and Seismic* (SDPWS), Section 4.4; or *2009 North Carolina Residential Code* (NCRC), Section 4408.4

For this type of wall assembly, Simpson Strong-Tie determined that the maximum allowable uplift load, limited by top-plate roll, is just 165 plf. This load is independent of the connector model or manufacturer.

CODE-REFERENCED STANDARDS ADDRESS ECCENTRIC LOADING

Prevention of eccentric loading of hurricane tie installations has also been recognized in two reference standards, such as the *2008 ICC-600*. Section 304.1, which states:

"... Connectors resisting uplift of the roof framing shall be fastened to the top plate on the same side of the wall as the top plate to wall uplift connection."

The *2008 AF&PA SDPWS* reference standard addresses the design of wood structural panels to resist uplift or combined shear and uplift. Section 4.4.1.5 states:

"Roof or upper level uplift connectors shall be on the same side of the wall as the sheathing unless other methods are used to prevent twisting of the top plate due to eccentric loading."

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CONNECTION DETAILS FOR FULL ALLOWABLE UPLIFT

Simpson Strong-Tie offers three possible solutions to attain the published allowable connector capacity and prevent top-plate roll when WSP sheathing is designed to transfer uplift loads from the top plate of the wall to the framing below.

1. Install the roof-to-wall connectors (hurricane ties) on the outside of the wall beneath the WSP sheathing.

- Best hurricane tie performance when fastened directly to framing
- Some inspection challenges may be introduced
- Nails used to fasten sheathing to wall framing shall not be installed through underlying connector

2. Install hurricane ties on the outside of the wall over the exterior side of WSP sheathing (see Figure 2). Applies only to hurricane ties listed.

The following WSP sheathing installation requirements must be met:

- WSP sheathing flush with the top of the double top plates
- WSP sheathing fastened to the top plates to transfer uplift in compliance with the 2008 ICC-600, 2008 AF&PA SDPWS, or 2009 NCRC
- WSP sheathing with a maximum thickness of $1\frac{5}{32}$ " and a minimum thickness of $\frac{7}{16}$ "

The following hurricane tie installation requirements must be met:

- Simpson Strong-Tie® H1, H2.5, H2.5A and H8 connectors installed to top plates with minimum $2\frac{1}{2}$ " long nails
- Simpson Strong-Tie H10 and H10A installed with minimum $1\frac{1}{2}$ " long nails
- A minimum roof framing overhang of $3\frac{1}{2}$ " beyond the WSP sheathing
- Lateral loads have not been evaluated for any of the hurricane ties in this application and additional connections must be considered

3. Install roof-to-wall and top plate-to-stud connectors on the inside of the wall (see figure 3).

- Top plate-to-stud connectors shall be designed to transfer 100% of the roof uplift from the top plates to studs
- Use a single roof framing-to-stud connector where rafters/trusses and studs line up, such as Simpson Strong-Tie H2A or H10S hurricane ties.
- Below the top plate-to-stud connection location, WSP sheathing on the exterior may be designed to transfer the uplift load down to the bottom plate in accordance with the standards referenced in this bulletin

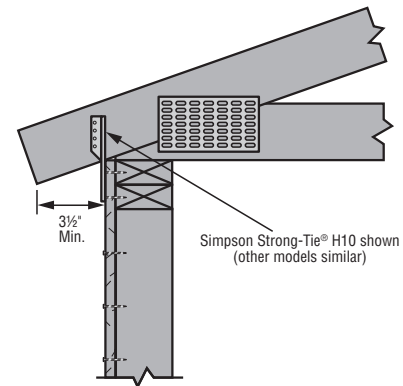


Figure 2

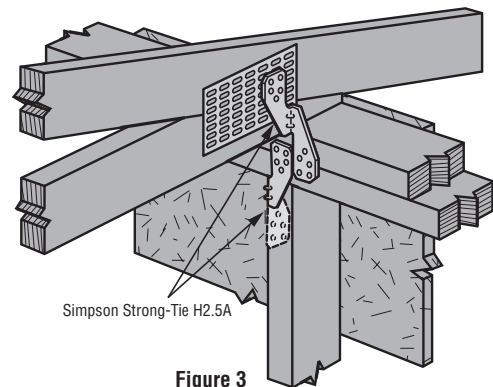


Figure 3

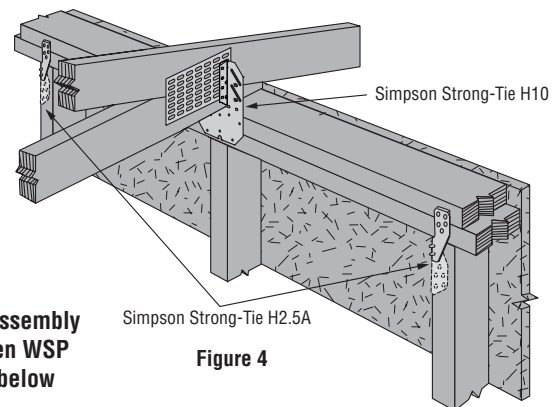


Figure 4

CONNECTION DETAIL FOR REDUCED ALLOWABLE UPLIFT

Through system testing, Simpson Strong-Tie has determined that the following assembly will provide the listed capacity per roof framing-to-wall framing connection when WSP is designed to transfer uplift loads from the top plate of the wall to the framing below (see Figure 4). This option is not applicable to systems using other connectors.

- Simpson Strong-Tie® H10 connectors at every roof framing-to-top plate location on the inside of the wall installed with 8d x $1\frac{1}{2}$ " nails
- Simpson Strong-Tie H2.5 or H2.5A connectors at every second top plate-to-stud location on the inside of the wall installed with 8d common ($2\frac{1}{2}$ " long x 0.131" diameter) nails
- Rafter/truss spaced 24" o.c.
- Studs spaced 16" o.c.
- WSP sheathing nailed to the top plate per 2008 ICC-600, 2008 AF&PA SDPWS, or 2009 NCRC
- Maximum 700 lbs uplift for Spruce-Pine-Fir roof and wall framing
- Maximum 805 lbs uplift for SP or DF-L roof and wall framing