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Wall Aspect Ratios for SIPs

Question: A frequent question posed by design professionals is what wall aspect ratios are applicable to structural insulated panels (SIPs)? A wall aspect ratio is defined as the ratio of the height of the wall segment to its length measured parallel to the wall line. For example a wall segment having a height of 8 feet and a length of 4 feet has an aspect ratio of 2:1. Similarly, a wall with a height of 8 feet and a length of 32 inches has an aspect ratio of 3:1. The length of the wall is also often referred to as the width of the wall.

Response: Aspect ratios applicable to SIP wall segments depend on whether the wall is being analyzed as a prescriptive braced wall in accordance with the 2012 International Residential Code (IRC) or as an engineered shear wall per the 2012 International Building Code (IBC). It is noted that the IRC and IBC provisions for SIPs only apply to SIPs with wood structural panel facings and a foam core.

Prescriptive Braced Wall Segments: The 2012 IRC identifies 16 distinct wall bracing methods in Section R602.10.4 with minimum braced lengths of 48 inches for some panel-type methods or an aspect ratio of 2:1. Section R602.10.4.2 provides for a continuous sheathing bracing method using wood structural panel sheathing (the CS-WSP method) that allows a braced length of 24 inches or an aspect ratio of 4:1 for an 8-foot wall. But there are some limitations to this 24-inch element such as being next to a garage door in Seismic Design Categories (SDCs) A-C. The CS-WSP method also permits a braced wall length of 24 inches in an 8-foot wall next to an opening less than or equal to 64 inches high such as a window, which is shown in Table R602.10.5. Placed next to an opening up to a height of 80 inches, such as a door, the minimum length is 32 inches or a 3:1 aspect ratio.

Section R613.5.3 of the 2012 IRC states that SIP walls shall be considered as “continuous wood structural panel sheathing” (CS-WSP method) for purposes of computing required wall bracing. Therefore, a SIP wall following the prescriptive requirements of the 2012 IRC can have a braced length as narrow as 24 inches or an aspect ratio of 4:1 under certain circumstances such as garage doors in low SDCs or applications next to windows up to and including 64 inches in height, or an aspect ratio of 3:1 adjacent to full height door openings up to 80 inches without limit.

Engineered Shear Walls: The 2012 IBC refers designers to the 2008 ANSI/AF&PA Special Design Provisions for Wind and Seismic (SDPWS) for requirements on the design of lateral force resisting systems including wood frame shear walls and wood frame diaphragms. Table 4.3.4 of the 2008 SDPWS provides maximum shear wall aspect ratios for seven different wall sheathing types.

For blocked wood structural panels, the aspect ratio can be as high as to 3.5:1. For designs resisting seismic forces, the shear wall aspect ratio shall not exceed 2:1 unless the nominal unit shear capacity is multiplied by $2b/h$ where b is the length of the shear wall segment and h is the height.

There is no specific mention of SIPs as a wall sheathing type in Table 4.3.4 and an interpretation whether the SIP can be considered as a blocked wood structural panel system is necessary.

Recent Shear Wall Research: To further evaluate the performance of a SIP shear wall with openings, a study was completed at the Home Innovation Research Labs (formerly the NAHB Research Center). This study addressed the aspect ratio limitations imposed on the SIP shear walls by product evaluation agencies. The NTA listing reports limits the aspect ratio to 2:1 for low seismic risk areas and 1:1 for high seismic risk areas. Many ICC-ES evaluation reports currently limit the aspect ratio for SIP shear walls to 1:1. These limitations have significant implications for engineered shear walls in nonresidential and residential construction where narrow aspect ratio segments are common as a result of doors and windows closely spaced or placed near building corners.

The 2013 study evaluated a series of walls with various openings and aspect ratios in 2013 and the results were reported in HIRL Report “SIP Shear Walls: Cyclic Performance of High Aspect Ratio Segments and Perforated Walls.” Testing was conducted in accordance with general provisions of ASTM E 2126-11 “Standard Test Methods for Cyclic (Reversed) Load Test for Shear Resistance of Walls for Buildings.”

A key objective of this study was to determine the applicability of applying the perforated shear wall (PSW) method to SIP shear walls based on an initial limited set of perforated shear walls with high aspect ratio segments. The PSW method is a widely used design method in the 2008 ANSI/AF&PA Special Design Provisions for Wind and Seismic (SDPWS). For the walls evaluated in this study the results confirmed that perforated SIP shear walls closely follow the overall PSW method trend for both strength and stiffness.

Summary: For residential construction, SIPs used in accordance with the wall bracing provisions of the 2012 IRC can be considered as being equivalent to continuously sheathed wood frame walls with aspect ratios as high as 4:1 under certain circumstances and 2:1 without limit.

For nonresidential construction governed by the 2012 IBC an interpretation is required as to whether the maximum shear wall aspect ratios of Table 4.3.4 of the 2008 ANSI/AF&PA SDPWS apply to SIPs. However, the results of the HIRL study reported above strongly support the use of the PSW method for the design of SIP shear walls.

