Design of SIP Shear Walls with Openings

The American Wood Council (AWC) Special Design Provisions for Wind and Seismic (SDPWS-2015) outlines three methodologies for Wood Frame Shear Wall design: Individual Full-height Wall Segments (segmented), Force-Transfer Shear Walls, and Perforated Shear Walls (PSW).

The Segmented shear wall method is widely used and applicable to various wood shear wall types, including SIPs. It assumes that only full-height segments in the wall line resist lateral forces, with resistance of each segment summed to determine the entire wall's resistance. While considered conservative, it requires hold-downs at each edge of every full-height segment and at both ends of the wall, increasing labor and cost.

The Force-Transfer methodology, introduced in the McGraw-Hill Wood Engineering and Construction Handbook in 1989, relies on engineering calculations and additional framing members to transfer lateral shear forces. Despite its effectiveness, it necessitates the incorporation of additional 2x lumber framing members around openings during construction, making it less suitable for SIP wall design.

In 1994, Japanese researchers devised an empirical equation to relate shear capacity and sheathing area ratio, providing a method to correlate the shear load of a light framed wood wall with openings to that of a fully sheathed wall. This method, known as the Perforated Shear Wall (PSW) method, was integrated into the design provisions for wood frame shear walls in the SPDWS and is referenced in the International Building Code (IBC).

The PSW method is favored for its simplicity in calculations and minimal hold-down requirements, typically needing only two hold-downs at each end of a wall. This contrasts with other methods, such as the segmented design, which demand more hold-downs, resulting in more complex and costly construction.

Despite its popularity for light frame wood shear walls, doubts have arisen regarding its suitability for other wood framed wall systems like SIPs due to the absence of supporting test data, a concern raised by design professionals and building code officials.



www.preflexinc.com 3411 3rd Ave. San Diego, CA. 92103, USA +1 866 784 4462 To address this concern, the USDA Forest Products Laboratory (FPL), in collaboration with other organizations, conducted two research studies on SIP shear walls with openings. The first study, conducted at the NAHB Home Innovation Research Labs (HIRL), aimed to preliminarily assess the applicability of the PSW method to SIP shear walls. This involved testing three multiple segment SIP walls under simulated seismic loading with various door and window openings. Each wall, 20 feet in length, had hold-downs installed at each end and was tested according to ASTM E2126-11 Standard Test Methods for Cyclic Load Test for Shear Resistance of Walls (CUREE Method).

The results, reported in FPL-RP-682, indicated that multiple segment SIP shear walls with openings aligned with the overall trend predicted by the PSW method for both strength and stiffness. However, further study was recommended to validate these findings across a broader range of wall opening configurations.

The second study, conducted at the FPL, involved testing seven different multiple segment SIP wall configurations to further assess the impact of openings on lateral resistance. Each 20-foot wall featured door-sized openings ranging from 2 to 12 feet in width. Walls were constructed with full-height panels interconnected with block splines, and hold-downs were placed at the ends of the walls. Three replicates of each wall configuration were tested using the CUREE cyclic protocol. The results, detailed in FPL-RP-704, demonstrated that the PSW method yielded conservative results for strength ratio predictions across all evaluated SIP wall configurations. Consequently, applying the PSW approach to SIP walls with openings was deemed suitable for both stiffness and strength.

All three methodologies outlined in the SPDWS permit wall segments with aspect ratios up to 3.5:1 for blocked wood structural panel walls, with adjustments required for segments exceeding 2:1. The FPL study confirmed that SIP walls are equivalent to blocked wood structural panel walls for aspect ratios up to 3:1. Therefore, SIP shear walls designed using any of the SPDWS methodologies can incorporate wall segments with aspect ratios up to 3:1 while adhering to the shear capacity limitations for segments exceeding 2:1.

Both FPL reports mentioned above are available for download free of charge from the FPL website (fpl.fs.fed.US) and SIPA website (www.sips.org).



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