

ISSUED: JANUARY 13, 2021

Equivalency of SIP Walls to Light Frame Wood Construction Subjected to Seismic Loading

Light frame wood shear wall construction is the basic method of construction to which all other framing systems are compared to demonstrate equivalency under seismic loading. The International Residential Code (IRC) identifies 16 distinct wall bracing methods having varying aspect ratios that are used to provide shear resistance. The prescriptive provisions of the IRC are limited to sites subjected to seismic design categories A, B or C.

Aspect Ratios

An aspect ratio is defined as the ratio of the height of the wall segment to its length measured parallel to the wall line. The IRC provides for a continuous sheathing bracing method using wood structural panel sheathing (the CS-WSP method) that allows for the use of an aspect ratio as high as 4:1 for certain framing conditions. Section R610 “Structural Insulated Panel Wall Construction” (SIPs) of the IRC states that SIP walls are considered as equivalent to “continuous wood structural panel sheathing” for purposes of computing required wall bracing. Therefore, the use of SIPs in seismic design categories A, B, and C is permitted by the IRC with aspect ratios as high as 4:1.

Seismic Design Categories D, E, and F

The use of SIPs in seismic design categories D, E and F is not covered by the IRC but is permitted when compliance to the International Building Code (IBC) is demonstrated through test reports and/or a manufacturer’s code evaluation report.

ASTM D7989 “Standard Practice for Demonstrating Equivalent In-Plane Lateral Seismic Performance to

Wood-Frame Shear Walls Sheathed with Wood Structural Panels” was developed to demonstrate equivalency of other wall systems such as SIPs to light frame wood shear wall construction. ICC-ES AC04 “Acceptance Criteria for Sandwich Panels” Appendix A “Optional Cyclic-Load Test Requirements for SIP Sandwich Panels” is also applicable for demonstrating this equivalency. Both ASTM D7989 and ICC-ES AC04 use the same criteria to show equivalent seismic performance with light frame shear walls sheathed with wood structural panels. There are three criteria that must be met to demonstrate equivalence for use in seismic design categories D, E and F.

The first criterion is intended to demonstrate similar ductility capacity, which is determined by dividing the ultimate deflection by the deflection at the allowable stress design (ASD) value. The ductility capacity is expected to be equal to or greater than 11. The second criterion is intended to show similar ultimate failure deflection of the walls (drift capacity). The drift capacity is expected to be equal to or greater than $0.028H$, where H is the height of the wall. The final criterion is intended to provide similar load factors (overstrength capacity) by dividing the peak strength by the design value. The overstrength capacity is required to be between 2.5 and 5.0.

A study involving the testing of 54 SIP wall assemblies was undertaken by the USDA Forest Products Laboratory (FPL) in Madison, WI to evaluate the performance of SIP shear walls with respect to the three seismic equivalency criteria. The study evaluated SIP walls with different aspect ratios, 1:1, 2:1, 3:1 and 4:1, and also evaluated



SIP wall assemblies consisting of multiple panels interconnected with block splines. Testing was conducted in accordance with the provisions of ASTM E2126-11. All walls were tested by displacing the top of the specimen in accordance with the CUREE cyclic protocol (Method C, ASTM E2126-11). This represents the industry accepted standard for seismic testing protocol applicable to all seismic design categories.

The results of this study confirmed that SIP shear walls with aspect ratios of 1:1, 2:1 and 3:1 and SIP assemblies consisting of five multiple panels met all three requirements of equivalency in ASTM D7989 and ICC-ES AC04. Full details of this study are provided in FPL report FPL-RP-704. In a corollary study conducted by APA --The Engineered Wood Association, 29 full-size SIP walls of various configurations were tested using the CUREE cyclic testing protocol. These results were published in FPL report FPL-GTR-251, "Lateral Load Performance of SIP Walls with Full Bearing," and confirmed that SIP wall assemblies constructed with 2, 3 and 4 panels also met these equivalency criteria.

These results clearly show that SIPs perform equivalent to conventional light frame shear walls for all seismic design categories based on tests of a wide range of SIPs aspect ratios and SIP assemblies. The FPL reports can be downloaded at no charge from the FPL website (fpl.fs.fed.us) from the SIPA website (www.sips.org).