# Anchorage Requirements for Wood Frame Shear Walls

*By John R. Henry, P.E.*

As the 2009 International Building Code® (IBC) is adopted in various jurisdictions across the country, engineers who design wood structures have begun to use the 2008 edition of ANSI/AF&PA *Special Design Provisions for Wind and Seismic* (SDPWS – 08). Unlike the 2006 IBC, which referenced the 2005 SDPWS as an acceptable alternate to the lateral design provisions of Section 2305, the 2009 IBC requires the use of SDPWS – 08. 2009 IBC Section 2305 states, *"Structures using wood shear walls and diaphragms to resist wind, seismic and other lateral loads shall be designed and constructed in accordance with AF&PA SDPWS and the provisions of Sections 2305, 2306 and 2307."* Because the SDPWS is a dual format standard, Section 2307 also references the 2008 SDPWS for lateral design of wood structures using load and resistance factor design (LRFD). Although many requirements in Section 2305 of previous editions of the IBC are very similar to the corresponding requirements in the 2008 SDPWS, they are not all the same. One notable difference is the anchorage requirements for shear walls, which is the subject of this article.

For buildings in Seismic Design Categories D, E and F, 2006 IBC Section 2305.3.11 requires a single 3-inch nominal (3x) foundation wood sill plate where the allowable stress design (ASD) wall shear exceeds 350 plf. An exception permits a 2-inch nominal (2x) plate to be used in lieu of the 3x if the number of required anchor bolts are doubled and the wall shear is less than 600 plf. Based on test results, the requirement for the 3x sill plate is not in the 2005 or 2008 SDPWS. Rather, SDPWS specifies square plate washers at anchor bolt locations to accomplish the same intent, which is to minimize cross-grain bending of the sill plate.

Some historical perspective is worth noting. Considerable sill plate damage and splitting was observed in the aftermath of the 1994 Northridge earthquake. Sill splitting was also observed during laboratory shear wall testing. In response to observed damage and splitting, a footnote was added to the shear wall table in the 1997 Uniform Building Code (UBC) that requires single 3x foundation sills at shear walls in Seismic Zones 3 and 4 where the wall shear exceeds 350 plf. The 3x foundation plate was intended to provide additional resistance (by having the extra 1 inch of thickness) to cross-grain bending that can occur during a design earthquake when uplift results from panel rotation. The UBC requirements for 3x sill plates were subsequently carried over into the 2000, 2003 and 2006 IBC. Footnote 3 in the 1997 UBC shear wall table is essentially the same as footnote "i" in the 2006 IBC shear wall table. (Note that UBC requirements applied to Seismic Zones 3 and 4, whereas the IBC requirements apply to Seismic Design Categories D, E and F). For a detailed discussion of the requirements for 3x foundation sills in the UBC, refer to Section C804.5 of the 1999 edition of *Recommended Lateral Force Requirements and Commentary of the Seismology Committee* of the Structural Engineers Association of California, known as the "SEAOC Blue Book." The SEAOC Blue Book is available from ICC at **www.iccsafe.org**.

Footnote i of IBC Table 2306.3 (ASD) and Section 2307.1.1 (LRFD) are essentially identical. The last sentence of the footnote and section states, "See Sections 4.3.6.1 and 4.3.6.4.3 of AF&PA SDPWS for sill plate size and anchorage requirements." The requirements in the SDPWS have the same intent as the UBC and IBC, which is to minimize foundation sill plate splitting. Based on cyclic tests of engineered shear walls considering different plate washer sizes at Oregon State University (available at **www.awc.org**), the requirement for a 3x sill plate is not in the 2005 or 2008 SDPWS. Rather, the 2005 SDPWS specifies a minimum 2½-inch square by ¼-inch thick plate washer and the 2008 SDPWS specifies a minimum 3-inch square by 0.229 inch thick plate washer for anchor bolts in all seismic design categories.

To account for different bottom plate widths and mitigate the potential for cross-grain bending, the SDPWS requires the edge of the square plate washer to extend to within ½ inch of the sheathed edge of the sill plate. The ½-inch distance from the washer edge to the sheathed edge (2008 SDPWS Figure C4.3.6.4.3) in effect limits the potential for cross grain bending by limiting the moment arm. This ½-inch distance is not required for low strength sheathing materials because failure of the bottom plate is not the failure limit state. For lower strength materials, the failure mechanisms include tear-out and slotting of the sheathing, and fastener head pull-through.

The exception in the SDPWS that allows standard cut washers to be used without plate washers is based on the OSU tests and applies to individual full-height wall segment shear walls with an aspect ratio (h/b) less than or equal to 2:1, and with a nominal seismic shear not exceeding 980 plf or wind shear not exceeding 1370 plf (which is comparable to 7/16-inch OSB with 8d nails spaced at 3 inches o.c. at panel edges), and the hold down devices are designed to resist overturning without any dead load stabilizing moment.

The key differences between the requirements in Section 2305 of the 2006 IBC and the 2005 SDPWS, including an extensive comparison table, can be found in code change proposal S82-06/07. A complete compilation of all the successful code changes to the 2006 IBC that were incorporated into the 2009 IBC can be found in the *Code Changes Resource Collection – 2009 IBC®* available from ICC at **www.iccsafe.org**.

An excellent article that describes some of the more significant changes to the *2008 SDPWS* is available from the American Wood Council website, **www.awc.org**.

A free online webinar on the *2005/2008 Special Design Provisions for Wind and Seismic* was presented by the American Wood Council on October 14, 2010. To view a recorded version of the webinar, go to **www.woodworks.org**.▪

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