Don't get "all shook up!" – Wood Construction Can Handle High Wind and Seismic Forces

By John "Buddy" Showalter, P.E.

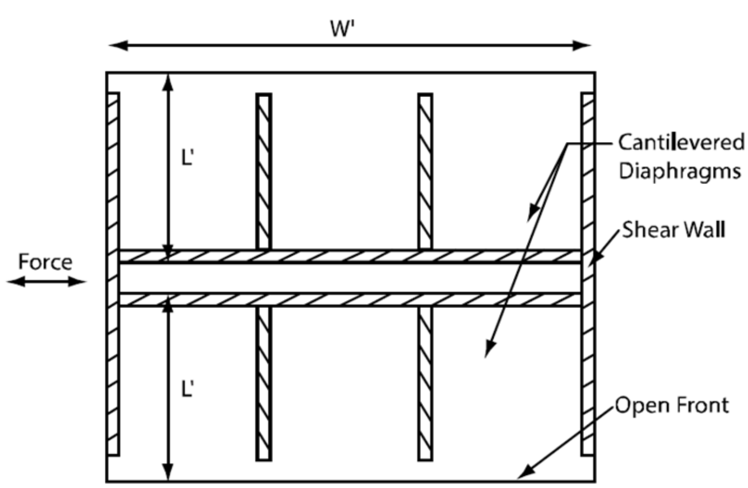
Years of research, real-life events and building code development have proven that wood-frame structures can meet or exceed the most demanding design requirements for high wind and seismic forces. Wood buildings tend to have numerous nail connections - especially in the shear walls and diaphragms - that have inherent ductility. This allows them to dissipate energy when faced with the sudden loads of an earthquake or high wind event.

CAPTION: The Special Design Provisions for Wind and Seismic standard provides criteria for proportioning, designing, and detailing engineered wood systems, members, and connections in lateral force resisting systems.

These facts continue to be recognized in the design community, and the following changes reflected in the 2015 Special Design Provisions for Wind and Seismic (SDPWS) standard provide a brief overview of the more significant enhancements:

- Clarification of open front structures and cantilevered diaphragm provisions
- Updated horizontal shear distribution terms and torsional irregularity provisions consistent with *ASCE 7-10*
- Clarification of high aspect ratio perforated shear wall adjustments
- New section on uplift force resisting systems
- New section outlining anchorage of concrete/masonry walls to wood diaphragms
- Inclusion of minimum depth for framing/blocking in high load diaphragms
- Clarification of two-2x for 3x (nominal) framing substitution
- Addition of minimum end distance for anchor bolts in plates/sills

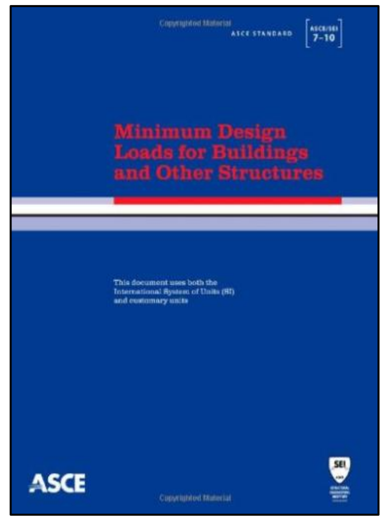
Arguably the primary change reflected in the *2015 SDPWS* is the clarification of open front structures and cantilevered diaphragms. Provisions for open front structures and cantilevered diaphragms were consolidated into one section (Section 4.2.5.2) of the standard to better explain applicability of requirements and improve consistency. Diaphragms in open front structures are considered to be "cantilevered diaphragms" because they are unsupported laterally at one edge.



CAPTION: *Figure 1 includes provides a new example of a cantilevered diaphragm building which was added to depict a simple corridor wall structure.*

The proposed revisions remove ambiguity over intent of the "deflections can be tolerated" provision. Complying with *ASCE 7-10 Minimum Design Loads for Buildings and Other Structures*, maximum allowable story drift at building edges is considered to be the appropriate minimum requirement and larger aspect ratio limits based on materials and construction is also appropriate unless the open front structure is torsionally irregular. In such cases, smaller story-based aspect ratio limits are applicable. Additionally, a limit on diaphragm length of 35' is recommended in lieu of having no limit on diaphragm length or the ambiguity of providing a length limit which could be exceeded where it is shown that "deflections can be tolerated."

It is important to note a story drift check at building edges is required to be met for all open front buildings regardless of torsional irregularity. While torsionally irregular provisions are applied to open front buildings, it is not the intent of new provisions to broadly classify all open front structures as torsionally irregular and invoke a variety of *ASCE 7-10* requirements. An exception is added in the standard that exempts open front buildings with small cantilevers of 6' or less from the standard requirements. The 6' cantilever dimension is based on an *International Residential Code (IRC)* provision in which a portion of the floor may extend up to 6' beyond the nearest braced wall line. It is also viewed as a practical approach to prevent unnecessarily triggering special open front provisions where cantilevers are small.



CAPTION: Many definitions and provisions of *2015 SDPWS* are revised to harmonize with comparable *ASCE 7-10* provisions for wood construction.

Sections 4.3.4.1 and 4.3.4.2 of the *2015 SDPWS* were additionally revised to clarify high aspect ratio perforated shear wall adjustments and decreased shear for higher aspect ratio walls. Using more recent perforated shear wall test data, section 4.3.4.1 was revised to adjust the length of each perforated shear wall segment with an aspect ratio (h/b_s) exceeding 2:1 (not to exceed 3.5:1) by multiplying by $2b_s/h$ for that segment; compared to aspect ratios of 2:1 or less in previous iterations of the standard. Similarly, section 4.3.4.2 was added to account for decreases in unit shear for higher aspect ratio walls observed from testing. The strength reduction for wood structural panels is based on test data reported by Salenkovich and Dolan (2003).

Section 3.4 was added and section 3.2.1 was modified to address wind uplift force resisting systems. New section 3.4 addresses uplift resistance provided by methods or devices other than wood structural panels. Provisions were added requiring consideration of element strengths (members and connections) in the load path as well as effects of eccentric loading in the uplift load path.

Section 4.1.5.1 was added to address anchorage of concrete or masonry structural walls to diaphragms. Provisions for anchorage of concrete or masonry structural walls to wood diaphragms for seismic force resistance are subject to special detailing requirements as specified in *ASCE 7-10* Section 12.11. Those provisions specify use of continuous ties or sub-diaphragms or a combination thereof, to address load path for anchorage forces. The new section 4.1.5.1 has been developed based on provisions of *ASCE 7-10* and modifications approved for inclusion in the *2015 IBC.*

Section 4.2.7.1.2 on high load blocked diaphragms was updated to include requirements for minimum depth of framing members and blocking. Minimum requirements for width of the nailed face were provided for high load blocked diaphragms in the *2008 SDPWS*; however, requirements for minimum depth of framing members and blocking were not included. Requirements for minimum depth are important to avoid splitting due to the relatively large 10d nails and higher density of nailing required for high load blocked diaphragms. The proposed revision is also consistent with similar provisions for high load diaphragms outlined in the 2012 *IBC.*

Section 4.3.6.1.1 was newly added for common framing members in wood structural panel shear walls, and construction provisions for wood structural panel and particleboard shear walls were revised to permit two nominal 2x framing members to replace a nominal 3x framing member. Previously in the *2008 SPDWS*, the provision for use of two nominal 2x members in lieu of a single member was only permitted as an exception for wood structural panel shear walls where nominal 3x members are required. The 2015 revisions extend this provision more broadly to all framing.

And finally, section 4.4.1.6 of the *SDPWS* was revised to permit determination of anchor bolt spacing for plates and sills in accordance with new testing and analysis (see Figure 2). The new standard eliminates the prescriptive 16" spacing requirement that was originally developed per the *2008 SDPWS*.

Nail Size	Nominal Unit Shear Capacity (plf)		Nominal Uplift Capacity (plf)							
	G=0.50		0	216	432	648	864	1080	1296	1458
		G=0.42	0	200	400	600	800	1000	1200	1350
8d common (0.131" x 2-1/2")	0	0	48[3]	42	36	36	32	24	24	19.2
	400	368	48	42	36	36	32	24	24	19.2
	670	616	36	32	24	24	24	24	19.2	19.2
	980	902	24	24	19.2	19.2	19.2	16	16	-

CAPTION: *Figure 2 showcases the new maximum anchor bolt spacing as permitted for wood framing based on the 2015 SDPWS. This table is included in Section 4.4.1.6 of the updated standard.*

From expanded options for open front structures and cantilevered diaphragms, to new provisions for torsional irregularity, shear wall adjustments and other considerations for wood-frame construction based on new testing and analysis, the changes outlined in the *2015 SDPWS* are significant new options for building design. While wind and seismic load requirements may vary from jurisdiction to jurisdiction, national standards recognize wood buildings can be designed to resist these forces.

Several self-study courses awarding free continuing education credits are available on this topic in the education section of the AWC website:

- STD415 – 2015 Special Design Provisions for Wind and Seismic Overview and Changes
- STD415-A – 2015 Special Design Provisions for Wind and Seismic

The *2015 SDPWS* is available for download on the American Wood Council website, www.awc.org.

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