From: WDSC Ballot I for Special Provisions for Wind & Seismic (SDPWS)

(04/2014)

Finding of Non-Persuasive on Ballot I-1 Lawless Negative

Item	Section	Item Description
I-1	All	Approve SDPWS as shown in "Attachment A – SDPWS Running Version.pdf". Proposed revisions resulting from WSTC Ballots 1 through 6 are incorporated into the running draft. A summary of changes is provided in "Attachment B – Summary of SDPWS Changes.pdf".

Item	Voter	Vote	Comments	Finding	Response
I-1	Lawless	Neg.	The basis of this negative vote is the failure of the WSTC to address the safety margins/design values concerns voiced in the Wind and Seismic Task Group 1: Aspect Ratio/Design Value Transparency Task Group. Below are two of the most important Committee Change Proposals (CCP) that are not addressed in the running draft of SDPWS. WSTG 1: Aspect Ratio/Design Value Transparency Task Group Committee Change Proposal (CCP) 15(2): By Jay Crandell In relation to the above, it appears that the performance basis of nominal design values is not well documented and needs more transparency as to actual safety margins (relative to minimum values or average values) and deflection limits represented. What is the deflection limit for WSP when the value is based on multiplying a design value that might be determined based on an E72 test at a 0.2" deflection limit? Is the deflection limit for Fiberboard (about 0.5" per commentary) at design wind load representative of the minimum performance expectation in SDPWS? Again, the issue here is transparency and clarity of intent as well as with regard to available test data and variability in that data. WSTG 1: Aspect Ratio/Design Value Transparency Task Group Committee Change Proposal (CCP) 15(3): By Jay Crandell Re-evaluate nominal design values based on newer information. For example, the attached PEI lab report* shows values for 3/8" WSP with SPF framing and 6d common nails at 6"/12" falling about 15% below the 515 plf value calculated using SPDWS nominal value and species adjustment factor. This implies safety margins could be 1.7, not 2.0 minimum. I don't believe this is an odd result.	NP	There are several topics raised in this negative. All of these items have been discussed previously at some level by the WSTC. The Aspect Ratio/Design Value Transparency Task Group met and made the following recommendation to the WSTC at the July 2013 meeting: "Seek to address and clarify through commentary." The intent is to add Commentary to explain that various product standards contain deflection limits based on the desired performance of the product. Those deflection limits may be different than the deflection limits necessary for design. The Aspect Ratio/Design Value Transparency Task Group met and made the following recommendation to the WSTC at the July 2013 meeting: "Seek to address and clarify through commentary." The intent is to review the commentary to ensure that the description of reference shear walls and derivation of nominal unit shear

			Maybe the problem is exacerbated by the species adjustment factor. For this same wall assembly, values in APA 154 report (appendix) show variation of about 100% (for DF/SP), yet minimum value is not used in SPDWS. This lends confusion as to the reliability of the design values as well as the real performance levels intended or achieved (proposal #2 above). On this note, using minimum values for APA 154 shows load factors of less than 2 in some cases. Given all this, should minimum values be used to define nominal values? How should variation in species density be handled with species adjustment factors? **Report will be distributed to the WDSC once permission to do so is obtained.*		values for reference shear walls is clear. The PEI report, provided to the TG was discussed at the July 2012 meeting and several issues were identified that would likely have explained the low test results (e.g. missing corner nails).
			In addition to the concerns in the above CCP items, a SBCA letter regarding Wood Structural Panel Nominal Unit Shear Capacity Resistance Values dated November 11, 2012 (see attached "Lawless1.pdf") has also not been addressed or reviewed by the Task Group. Our main concern is that there is the very real potential that actual design values are significantly below the nominal unit shear capacities divided by a factor of safety of 2 as given in SDPWS, WFCM, the IBC, and the IRC. Testing by the SBCRI has confirmed that there is significant variability in the results of WSP tests. Figure 1 and Figure 2 below show the ranged of shear wall ultimate capacities for 8d box (0.113" x 2⅜") and 8d common (0.131" x 2½") nails. For both nail sizes, a significant number of tests did not make the design value contained in the SDPWS. On the low end of the spectrum, the factor of safety was 1.27 and 1.6 for 8d box (0.113" x 2⅜") and 8d common (0.131" x 2½") nails, respectively. The professional engineering, building design, and specification community need to be aware of the variability and the actual factor of safety of by WSP shear walls to prevent to provide adequate lateral load resistance. The SBCRI testing minimized the variation in the results by carefully controlling the tested materials, construction, and boundary conditions for each shear wall test set-up. SBCRI staff always chalk-lined the panel edges to ensure the sheathing fasteners were placed a minimum of 3/8" from the panel edge per SDPWS. Any shiners (when present) were removed and a new fastener was installed. The studs were always straight and spaced precisely. In other words, these walls represented an ideal case from a construction practice perspective. It is expected that the variability in the SBCRI tests represent quality control issues with the OSB sheathing, wood framing, and nail specifications. Greater variability than is shown in Figures 1 and 2 will likely exist in real-world applications using common OSB field construction practices for shear walls. In the normal field environment, there is little or no quality control on the required minimum edge distance for fasteners, and no guidance is available on the		Issues in the SBCA letter were raised at the July 2012 WDSC meeting. Kirk Grundahl presented information similar to the information provided in Figure 5 of Lawless 1.pdf. In general, the discussion highlighted the problems with using non-standard test procedures resulting in undefined levels of overturning restraint which is not the basis of reference nominal unit shear values in SDPWS. There were no specific changes proposed at that meeting. At TG meetings, participants were invited to provide specific changes for the TG to consider – all specific proposals for change were considered. Lawless disagreed that the tests were non-standard, but others point at particular issues. Lawless agreed to provide test reports so that the test procedures and test boundary conditions could be compared against reference conditions assumed for SDPWS nominal unit shear values. If the test reports are provided, this issue will be considered next cycle.

number of allowable shiners.

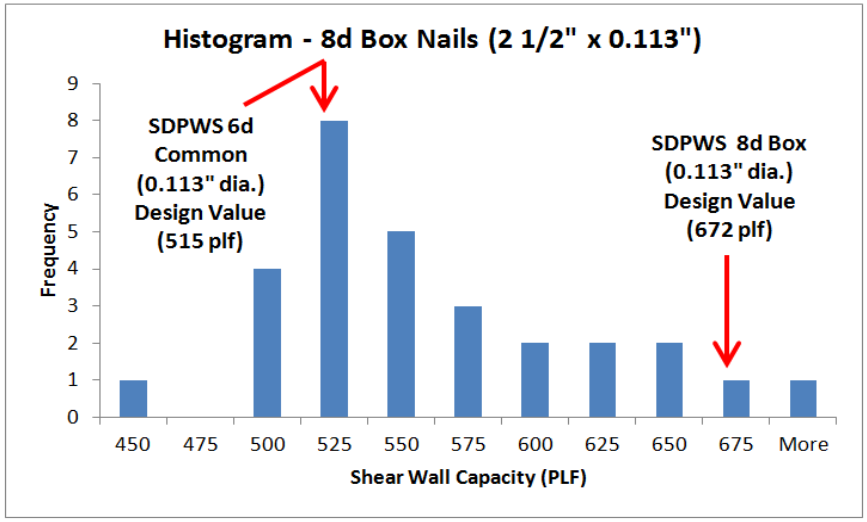

Figure 1: Histogram of Tested Shear Wall Capacity for 8d Box (2 ⅜" x 0.113") Nails (Per *SDPWS*, ⅜" WSP with SPF framing 16" o.c. has a design value of 515 plf for 6d common (2" x 0.113") nails and 672 plf for 8d box (2 ½" x 0.113") nails.)

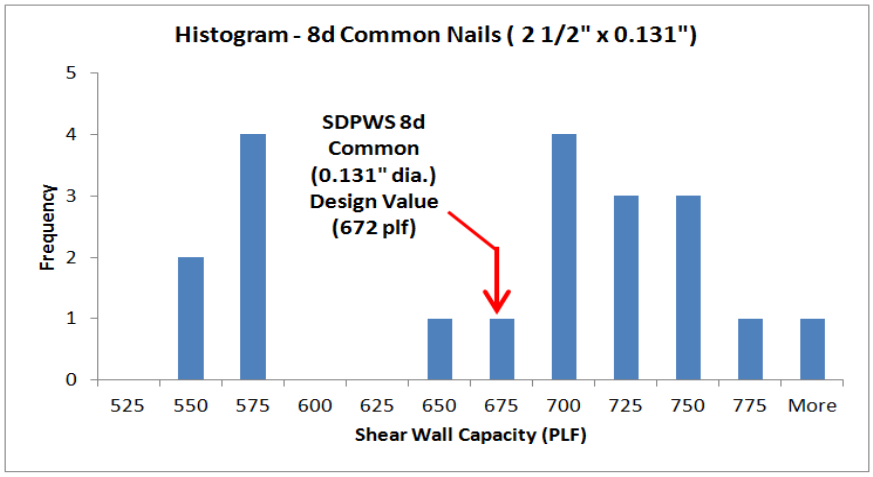

Figure 2: Histogram of Tested Shear Wall Tests for 8d Common (2 ½" x 0.131") Nails (Per *SDPWS*, ⅜" to 15/32" WSP with SPF framing 16" o.c. has a design value of 672 plf for 8d common (2 ½" x 0.131") nails)

			In addition to the testing by SBCRI, test data contained in APA Form M410 show that the factor of safety for 3.5:1 aspect ratio shear walls constructed with 15/32" Structural I OSB sheathing fastened with 10d common (3" x 0.148") nails spaced 2" on center is between 1.4 and 1.5 for seismic and 0.99 and 1.07 for wind. Even when the proposed aspect ratio reduction factor of $1.25\text{-}0.125h/b_s$ contained in the 2015 SDPWS draft is applied to the results, the factors of safety for wind are only 1.22 and 1.32.		Report M410 is a report on research testing of shear walls designed for force-transfer around openings. The specific configuration cited does not appear to be constructed per the load path requirements in SDPWS and should not be used for comparison purposes. APA staff reported that the inter-stud "stitch" fastening was not adequate to achieve the full shear capacity of the shear wall.
			Furthermore, as currently written, Table 4.3A in *SDPWS* shows that a ⅜" WSP shear wall with 8d galvanized box (2⅜" x 0.113") nails and a ⅜" WSP shear wall with 8d common (2½" x 0.131") nails both have the same nominal unit shear capacity of 672 plf (730 plf multiplied by 0.92 for DF to SPF reduction). However, as shown in Figure 1, the nominal unit shear capacity for the 8d galvanized box (2⅜" x 0.113") nail has a median value between 500 and 525 plf, about 150 plf less than the design value given in *SDPWS*. Since an 6d common (2" x 0.113") nail has the same diameter as the 8d galvanized box nail (2⅜" x 0.113"), the test results in Figure 1 were compared to the *SDPWS* design value for 6d common nails. Table 4.3A in *SDPWS* gives a nominal unit shear capacity of 515 plf (560 plf times 0.92 for DF to SPF reduction) for a ⅜" WSP shear wall with 6d common (2" x 0.113") nails. This is comparable to the median shear capacity for the shear walls 8d galvanized box (2⅜" x 0.113") nails. It seems that the 8d galvanized box (2⅜" x 0.113") nail and the 6d common (2" x 0.113") nail should have the same design value as the only difference between the two fasteners is the ⅜" greater fastener penetration of the 8d galvanized box nail. However, the provisions of *SDPWS* inaptly state otherwise. See the attached article ("Lawless2.pdf") titled "Installation & Fastening of Wood Structural Panel Wall Bracing" from the March 2014 SBC Magazine for further information on the differences between box and common nails. It is clear that the design values used for fastening systems in WSP shear walls need to be seriously reviewed and updated. The concern is that there is a high degree of variability in both nails and OSB that may cause unintended WSP design value consequences that are typically unknown and unappreciated by the professional engineering and building design community and further this result occurs under ideal laboratory construction conditions.		There are many failure modes that limit the capacity of a shear wall, but nail yielding is not one of them. Common failure modes are nail withdrawal, panel edge tear-out, nail head pull-through, and when subjected to excessive cycling, nail fatigue. Shear wall capacity should not be confused with nail or shear wall yield levels. Substitution of galvanized box nails for common nails in shear walls has been raised in the past. Both APA and CUREe studied this issue and concluded that the difference was insignificant. However, the group encouraged Lawless to provide the full test reports of SBCA's shear wall tests if he felt they provided more information that needs to be considered. If the test reports are provided, this issue will be considered next cycle.

It is our recommendation that the substitution of box nails in the place of common nails be prohibited in SDPWS. The nail minimum nail diameter should be called out in Table 4.3A of SDPWS and that the use of the terms ”common” and “box” nails should be removed. This would result in the design values for 6d, 8d, and 10d nails requiring a minimum nail diameter of 0.113”, 0.131”, and 0.148”, respectively. This would address some of the more pressing issues/inconsistencies with the current design values and allow for more time to collect and review the recent WSP test data.

In addition, as detailed in the attached letter, the actual factor of safety for the design values given in Table 4.3A should be transparently stated. This requires that the definition of the nominal unit shear capacities for WSP be clearly defined as the expected ultimate strength of the WSP shear wall based on the test performance. Any adjustment factors and safety factors that are to be applied to the nominal design values should then be clearly defined. Based on the minimum tested ultimate capacities, a very reasonable, extremely representative, and conservative NUSC value is 475 plf and 535 plf for WSP shear walls fastened with 6d (0.113" dia.) and 8d (0.131" dia.) nails, including 24” o.c. stud spacing. Table 1 below is an example of a possible revised version of SDPWS Table 4.3A

Table 4.3A Nominal Unit Shear Capacities for Wood-Frame Shear Walls

Wood-based Panels

Sheathing Material	Minimum Nominal Panel Thickness (in.)	Minimum Fastener Penetration in Framing Member or Blocking (in.)	Fastener Type & Size	Panel Edge Fastener Spacing (in.)			
				6	4	3	2
				v_n (plf)	v_n (plf)	v_n (plf)	v_n (plf)
Wood Structural Panels - Structural I or Sheathing			**Nail**				
	5/16	1-1/4	6d (min. 0.113" dia.)	???	???	???	???
	3/8			475	???	???	???
	3/8	1-3/8	8d (min. 0.131" dia.)	535	???	???	???
	7/16				???	???	???
	15/32				???	???	???
	15/32	1-1/2	10d (min. 0.148" dia.)	???	???	???	???
	19/32			???	???	???	???

Table 1: Example of Revised SDPWS Table 4.3A

Table 4.3A Nominal Unit Shear Capacities for Wood-Frame Shear Walls[1,3,6,7]

Wood-based Panels[4]

Sheathing Material	Minimum Nominal Panel Thickness (in.)	Minimum Fastener Penetration in Framing Member or Blocking (in.)	Fastener Type & Size	A SEISMIC: Panel Edge Fastener Spacing (in.) 6: v_s (plf)	6: G_a (kips/in.) OSB	6: G_a (kips/in.) PLY	4: v_s (plf)	4: G_a (kips/in.) OSB	4: G_a (kips/in.) PLY	3: v_s (plf)	3: G_a (kips/in.) OSB	3: G_a (kips/in.) PLY	2: v_s (plf)	2: G_a (kips/in.) OSB	2: G_a (kips/in.) PLY	B WIND: Panel Edge Fastener Spacing (in.) 6: v_w (plf)	4: v_w (plf)	3: v_w (plf)	2: v_w (plf)
			Nail (common or galvanized box)																
Wood Structural Panels – Structural I[4,5]	5/16	1-1/4	6d	400	13	10	600	18	13	780	23	16	1020	35	22	560	840	1090	1430
	3/8[2]	1-3/8	8d	460	19	14	720	24	17	920	30	20	1220	43	24	645	1010	1290	1710
	7/16[2]			510	16	13	790	21	16	1010	27	19	1340	40	24	715	1105	1415	1875
	15/32			560	14	11	860	18	14	1100	24	17	1460	37	23	785	1205	1540	2045
	15/32	1-1/2	10d	680	22	16	1020	29	20	1330	36	22	1740	51	28	950	1430	1860	2435
Wood Structural Panels – Sheathing[4,5]	5/16	1-1/4	6d	360	13	9.5	540	18	12	700	24	14	900	37	18	505	755	980	1260
	3/8			400	11	8.5	600	15	11	780	20	13	1020	32	17	560	840	1090	1430
	3/8[2]	1-3/8	8d	440	17	12	640	25	15	820	31	17	1060	45	20	615	895	1150	1485
	7/16[2]			480	15	11	700	22	14	900	28	17	1170	42	21	670	980	1260	1640
	15/32			520	13	10	760	19	13	980	25	15	1280	39	20	730	1065	1370	1790
	15/32	1-1/2	10d	620	22	14	920	30	17	1200	37	19	1540	52	23	870	1290	1680	2155
	19/32			680	19	13	1020	26	16	1330	33	18	1740	48	22	950	1430	1860	2435
			Nail (galvanized casing)																
Plywood Siding	5/16	1-1/4	6d	280	13		420	16		550	17		720	21		390	590	770	1010
	3/8	1-3/8	8d	320	16		480	18		620	20		820	22		450	670	870	1150
			Nail (common or galvanized box)																
Particleboard Sheathing - (M-S "Exterior Glue" and M-2 "Exterior Glue")	3/8		6d	240	15		360	17		460	19		600	22		335	505	645	840
	3/8		8d	260	18		380	20		480	21		630	23		365	530	670	880
	1/2			280	18		420	20		540	22		700	24		390	590	755	980
	1/2		10d	370	21		550	23		720	24		920	25		520	770	1010	1290
	5/8			400	21		610	23		790	24		1040	26		560	855	1105	1455
Structural Fiberboard Sheathing	1/2		Nail (galvanized roofing) 11 ga. galv. roofing nail (0.120" x 1-1/2" long x 7/16" head)				340	4.0		460	5.0		520	5.5			475	645	730
	25/32		11 ga. galv. roofing nail (0.120" x 1-3/4" long x 3/8" head)				340	4.0		460	5.0		520	5.5			475	645	730

1. Nominal unit shear values shall be adjusted in accordance with 4.3.3 to determine ASD allowable unit shear capacity and LRFD factored unit resistance. For general construction requirements see 4.3.6. For specific requirements, see 4.3.7.1 for wood structural panel shear walls, 4.3.7.2 for particleboard shear walls, and 4.3.7.3 for fiberboard shear walls. See Appendix A for common and box nail dimensions.
2. Shears are permitted to be increased to values shown for 15/32 inch sheathing with same nailing provided (a) studs are spaced a maximum of 16 inches on center, or (b) panels are applied with long dimension across studs.
3. For species and grades of framing other than Douglas-Fir-Larch or Southern Pine, reduced nominal unit shear capacities shall be determined by multiplying the tabulated nominal unit shear capacity by the Specific Gravity Adjustment Factor = [1-(0.5-G)], where G = Specific Gravity of the framing lumber from the *NDS* (Table 11.3.2A). The Specific Gravity Adjustment Factor shall not be greater than 1.
4. Apparent shear stiffness values G_a, are based on nail slip in framing with moisture content less than or equal to 19% at time of fabrication and panel stiffness values for shear walls constructed with either OSB or 3-ply plywood panels. When 4-ply or 5-ply plywood panels or composite panels are used, G_a values shall be permitted to be increased by 1.2.
5. Where moisture content of the framing is greater than 19% at time of fabrication, G_a values shall be multiplied by 0.5.
6. Where panels are applied on both faces of a shear wall and nail spacing is less than 6" on center on either side, panel joints shall be offset to fall on different framing members. Alternatively, the width of the nailed face of framing members shall be 3" nominal or greater at adjoining panel edges and nails at all panel edges shall be staggered.
7. Galvanized nails shall be hot-dipped or tumbled.

Table A1 Standard Common, Box, and Sinker Nails[1]

Common or Box Sinker

Type		Pennyweight 6d	7d	8d	10d	12d	16d	20d	30d	40d	50d	60d
Common	L	2"	2-1/4"	2-1/2"	3"	3-1/4"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"
	D	0.113"	0.113"	0.131"	0.148"	0.148"	0.162"	0.192"	0.207"	0.225"	0.244"	0.263"
	H	0.266"	0.266"	0.281"	0.312"	0.312"	0.344"	0.406"	0.438"	0.469"	0.5"	0.531"
Box	L	2"	2-1/4"	2-1/2"	3"	3-1/4"	3-1/2"	4"	4-1/2"	5"		
	D	0.099"	0.099"	0.113"	0.128"	0.128"	0.135"	0.148"	0.148"	0.162"		
	H	0.266"	0.266"	0.297"	0.312"	0.312"	0.344"	0.375"	0.375"	0.406"		
Sinker	L	1-7/8"	2-1/8"	2-3/8"	2-7/8"	3-1/8"	3-1/4"	3-3/4"	4-1/4"	4-3/4"		5-3/4"
	D	0.092"	0.099"	0.113"	0.12"	0.135"	0.148"	0.177"	0.192"	0.207"		0.244"
	H	0.234"	0.250"	0.266"	0.281"	0.312"	0.344"	0.375"	0.406"	0.438"		0.5"

1. Tolerances specified in ASTM F 1667. Typical shape of common, box, and sinker nails shown. See ASTM F1667 for other nail types.