Wind Solutions - Perforated Wood Structural Panel Shear Walls (DES 416)

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DESCRIPTION

AWC’s 2015 Special Design Provisions for Wind and Seismic (SDPWS), 2015 Wood Frame Construction Manual (WFCM), and 2015 WFCM High Wind Guides contain provisions for the design of perforated wood structural panel shear walls. This presentation will provide examples of perforated shear wall design utilizing the WFCM, High Wind Guides, SDPWS, and the WoodWorks® software using both prescriptive and engineered solutions within the WFCM and SDPWS.

LEARNING OBJECTIVES

At the end of this program, participants will be better able to:

1. Evaluate a prescriptive and engineered design methodology for perforated wood shear walls.
2. Understand how to design wood structural panels to resist wind loads.
3. Design a wood frame wood structural panel shear wall shear loads.
4. Acquire knowledge on resources to develop solutions for resisting wind loads.
POLLING QUESTION

1. What is your profession?
   a) Architect
   b) Engineer
   c) Building Code Official
   d) Fire Service
   e) Other

OUTLINE

• 2015 IBC/IRC Recognition
• Background and Assumptions
• Design Examples
  • 2015 WFCM Prescriptive
  • 2015 WFCM Engineered
  • 2015 SDPWS
  • 2015 WFCM High Wind Guides
**WFCM AND IRC/IBC**

2015 WFCM is referenced in 2015 IRC/IBC

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**APPLICABILITY LIMITS**

<table>
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<th>Limitation</th>
<th>Reference Section</th>
<th>Figures</th>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Mean Roof Height (MRH)</td>
<td>33'</td>
<td>1.1.3.1a</td>
<td>1.2</td>
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<td>Number of Stories</td>
<td>3</td>
<td>1.1.3.1a</td>
<td>-</td>
</tr>
<tr>
<td>Building Length and Width</td>
<td>80'</td>
<td>1.1.3.1b</td>
<td>-</td>
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<td><strong>LOAD ASSUMPTIONS</strong></td>
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<tr>
<td>(See Chapter 2 or Chapter 3 tables for load assumptions applicable to the specific habitable area)</td>
<td></td>
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</tbody>
</table>

**Load Type**:
- Partition Dead Load: 0-8 psf of floor area
- Wall Assembly Dead Load: 11-18 psf
- Floor Dead Load: 10-20 psf
- Roof/Ceiling Assembly Dead Load: 0-25 psf
- Floor Live Load: 50-40 psf
- Roof Live Load: 20 psf
- Ceiling Live Load: 10-20 psf
- Ground Snow Load: 0-70 psf

**Wind Load**:
- 110-195 mph wind speed (700-yr. return period, 3-second gust)
- Exposure B, C, and D

**Seismic Load**
- Seismic Design Category (SDC)
- SDC A, B, C, D, D1, D2, and D3
2015 WFCM – NON-RESIDENTIAL

- Applications
- Single-story
- Slab-on-grade
- L and W < 80’
- Examples
- Commercial/Retail
- Restaurants
- Office Buildings
- Design
- Lateral (Wind and Seismic)
- Gravity

2015 WFCM

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<td></td>
</tr>
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</table>
2015 WFCM

2015 WFCM uses SDPWS for shear capacities and ASCE 7-10 provisions for loads

SDPWS AND IBC

2015 SDPWS is referenced in 2015 IBC
POLLING QUESTION

2. The Special Design Provisions for Wind and Seismic standard includes which of the following that is not included in the WFCM:

a) segmented shear wall  
b) perforated shear wall  
c) force transfer around openings shear wall  
d) Hold-downs
OUTLINE

• 2015 IBC/IRC Recognition
• Background and Assumptions
• Design Examples
  • 2015 WFCM Prescriptive
  • 2015 WFCM Engineered
  • 2015 SDPWS
  • 2015 WFCM High Wind Guides

SEGMENTED SHEAR WALL (SSW) METHOD

• Lots of hold-downs
• Wall need not be fully sheathed
PERFORATED SHEAR WALL (PSW) METHOD

- Only hold-downs @ ends
- Wall must be fully sheathed

WFCM PRESCRIPTIVE

- Wind Speeds 110-195 mph Exp. B & C
- Segmented & Perforated Shear Walls
- Other Application Limits
3.4.4.2 Exterior Shear Walls
   a. Wind Loads Segmented shear walls shall be in accordance with the full height sheathing requirements specified in Table 3.17A. Tabulated values assume wall studs are spaced at a maximum of 15 inches on center, are sheathed with 3/8 inch wood structural panels on the exterior attached with 8d common nails at 6 inches on center at panel edges and 12 inches on center in the field, and 1/2 inch gypsum wallboard on the interior attached with 5d common nails at 7 inches on center at panel edges and 10 inches on center in the field. Exterior sheathing shall be continuous from the bottom plate to the upper top plate, with all panel edges over framing. For other sheathing materials or sheathing configurations see 3.4.4.2.1.

WFCM PRESCRIPTIVE

SDPWS Shear Distribution

4.3.3.4.1 Shear distribution to individual shear walls in a shear wall line shall provide the same calculated deflection, $\delta_{sw}$, in each shear wall.

Exceptions:
1. Where nominal shear capacities of all wood structural panel shear walls with aspect ratios ($h/b_o$) greater than 2.1 are multiplied by $2b_o/h$ for design, shear distribution to individual full-height wall segments shall be permitted to be taken as proportional to the shear capacities of individual full height wall segments used in design. Where multiplied by $2b_o/h$, the nominal shear capacities need not be reduced by the adjustment in 4.3.4.2.
POLLING QUESTION

3. The minimum shear walls construction consists of:

a) 3/8” wood structural panels on wall exterior
b) 8d common nails @ 6” oc at panel edges
c) 8d common nails @ 10” oc in panel field
d) All of the above
e) a) and b) only

OUTLINE

• 2015 IBC/IRC Recognition
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  • 2015 WFCM Prescriptive
  • 2015 WFCM Engineered
  • 2015 SDPWS
  • 2015 WFCM High Wind Guides
**DESIGN EXAMPLE**

Using the 2015 *Wood Frame Construction Manual* (WFCM), design the first floor wall shown in the diagram below as a perforated shear wall for a two-story house using Allowable Stress Design (ASD) provisions.

Design first floor shear wall

---

**DESIGN EXAMPLE**

Check maximum segment length based on Aspect Ratio Limits.

Maximum aspect ratio for Wood Structural Panel Shear Walls = 3.5:1 (SDFWS 4.3.4.3)

Minimum segment length = Wall Height / Aspect Ratio

\[
I_{\text{min}} = \frac{9}{3.5} = 2.6 \quad \text{Minimum full height wall segment length (ft)}
\]

All full height segments satisfy aspect ratio requirements.
**DESIGN EXAMPLE**

Design Wind Speed = 160 mph (3 sec. gust, 700 year return)
Exposure B
Building dimensions:
L = 40 ft
W = 32 ft
Roof pitch = 7:12
Top plate to ridge height = 9.3 ft
Wall height = 9 ft
Door height = 7 ft 6 in.
Window height = 4.5 ft
Stud spacing = 16 in. on c.c.
Studs are Southern Pine (G=0.55)

Check design with and without interior gypsum, neglect deflection.

Use Minimum Design Loads for Building and Other Structures (ASCE 7-10) to determine loads.

**WFCM PRESCRIPTIVE**

2015 WFCM Prescriptive – Segmented Shear Wall

<table>
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<tr>
<th>Table 3.17a Segmented Shear Wall Sheathing Requirements for Wind</th>
<th>Exposure B</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-yr. Wind Speed</td>
<td>110</td>
</tr>
<tr>
<td>3-second gust (mph)</td>
<td></td>
</tr>
<tr>
<td>Shear Wall Line Beneath</td>
<td>20</td>
</tr>
<tr>
<td>Roof, Ceiling, &amp; 1 Floor</td>
<td>5.5</td>
</tr>
<tr>
<td>24</td>
<td>7.0</td>
</tr>
<tr>
<td>32</td>
<td>8.2</td>
</tr>
<tr>
<td>40</td>
<td>9.4</td>
</tr>
<tr>
<td>50</td>
<td>10.0</td>
</tr>
<tr>
<td>60</td>
<td>11.7</td>
</tr>
<tr>
<td>70</td>
<td>14.7</td>
</tr>
<tr>
<td>80</td>
<td>17.5</td>
</tr>
</tbody>
</table>

Minimum Length of Full Height Sheathing on Exterior Shear Walls Perpendicular to Building Dimension, L or W (ft)
**WFCM PRESCRIPTIVE**

2015 WFCM Prescriptive – Segmented

**Footnotes to Table 3.17A**
4. Tabulated sheathing lengths are based on 10 foot walls and 10 foot top plate-to-ridge height. For other configurations, the value may be multiplied by the adjustment factor below:

<table>
<thead>
<tr>
<th>Wall Height</th>
<th>Roof Only</th>
<th>Roof + 1 Floor</th>
<th>Roof + 2 Floors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8'</td>
<td>10'</td>
<td>8'</td>
</tr>
<tr>
<td><strong>Roof Pitch</strong></td>
<td><strong>Top Plate to Ridge Height (ft)</strong></td>
<td><strong>Adjustment Factor</strong></td>
<td></td>
</tr>
<tr>
<td>5:6:12</td>
<td>0' (flat)</td>
<td>0.35</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>5'</td>
<td>0.50</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>10'</td>
<td>0.65</td>
<td>0.74</td>
</tr>
<tr>
<td>&gt;6:12</td>
<td>5'</td>
<td>0.63</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>10'</td>
<td>0.92</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>15'</td>
<td>1.21</td>
<td>1.14</td>
</tr>
<tr>
<td></td>
<td>20'</td>
<td>1.49</td>
<td>1.13</td>
</tr>
</tbody>
</table>

NP = not permitted

Interpolate = 0.91

---

**WFCM PRESCRIPTIVE**

For this example the wall construction will vary from the WFCM baseline wall. The wall in this example will have the following construction:
- Studs: 16 in. o.c.
- Exterior Sheathing: 15/32 in. WSP w/ 8d common nails @ 3 in. edge/12 in. field o.c.
- Interior Sheathing: 1/2 in. GWB w/ 5d cooler nails @ 7 in. edge/10 in. field o.c.

Sheathing Type Adjustment Factor (Wind) = 0.80 (WFCM Table 3.17D)

\[
L_{SSW} := 19.9 - 0.6 - 0.91
\]

\[
L_{SSW} = 10.9 \quad \text{Required Full Height Sheathing Length on Segmented Shear Wall (ft)}
\]

\[
\frac{L_{SSW}}{L_{tot}} = 0.272 \quad \text{Required Full Height Sheathing Segmented Shear Wall (%)}
\]

Perforated Shear Wall Length Adjustment Factor = 1.80 (WFCM Table 3.17E)

\[
L_{PSW} := L_{SSW} \times 1.78
\]

\[
L_{PSW} = 19.3 \quad \text{Required Full Height Sheathing Length on Perforated Shear Wall (ft)}
\]
For this example the wall construction will vary from the WFCM baseline wall. The wall in this example will have the following construction:

Studs: 16 in. o.c.
Exterior Sheathing: 15/32 in. WSP w/ 8d common nails @ 3 in. edge/12 in. field o.c.
Interior Sheathing: None/Unrated

Sheathing Type Adjustment Factor (Wind) = 0.69 (WFCM Table 3.17D)

\[ L_{SSW} = 19.9 - 0.69 \cdot 0.91 \]
\[ L_{SSW} = 12.5 \]  
Required Full Height Sheathing Length on Segmented Shear Wall (ft)

\[ \frac{L_{SSW}}{L_{tot}} = 0.312 \]  
Required Full Height Sheathing Segmented Shear Wall (%)

Perforated Shear Wall Length Adjustment Factor = 1.70 (WFCM Table 3.17E)

\[ L_{PSW} = L_{SSW} \cdot 1.70 \]
\[ L_{PSW} = 21.2 \]  
Required Full Height Sheathing Length on Perforated Shear Wall (ft)

Perforated Wood Shear Wall Design

2015 WFCM Prescriptive – Perforated Shear Wall

% Full-height sheathing

10.9’ / 40’ = 27%
Interpolated = 1.78
10.9’(1.78) = 19.3’
w/ blocked gypsum

12.5’ / 40’ = 31%
12.5’(1.70) = 21.2’
w/o gypsum

Table 3.17E Perforated Shearwall Full Height Sheathing Adjustments

Maximum Unrestrained Opening Height (ft - in.)

<table>
<thead>
<tr>
<th>Window Height</th>
<th>1’/3”</th>
<th>1’/6”</th>
<th>2’/6”</th>
<th>3’/6”</th>
<th>4’/6”</th>
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</thead>
<tbody>
<tr>
<td>9’ Wall</td>
<td>2’-8”</td>
<td>4’-0”</td>
<td>5’-4”</td>
<td>6’-9”</td>
<td>8’-0”</td>
</tr>
<tr>
<td>9’ Wall</td>
<td>3’-4”</td>
<td>5’-0”</td>
<td>6’-8”</td>
<td>8’-4”</td>
<td>10’-0”</td>
</tr>
</tbody>
</table>

Percent Full Height Sheathing on Segmented Shearwall

<table>
<thead>
<tr>
<th>Percent Full Height</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>99%</th>
</tr>
</thead>
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<tr>
<td>1.00</td>
<td>1.30</td>
<td>1.54</td>
<td>1.72</td>
<td>1.92</td>
</tr>
<tr>
<td>1.00</td>
<td>1.25</td>
<td>1.43</td>
<td>1.56</td>
<td>1.67</td>
</tr>
<tr>
<td>1.00</td>
<td>1.20</td>
<td>1.33</td>
<td>1.43</td>
<td>1.50</td>
</tr>
<tr>
<td>1.00</td>
<td>1.15</td>
<td>1.25</td>
<td>1.32</td>
<td>1.36</td>
</tr>
<tr>
<td>1.00</td>
<td>1.11</td>
<td>1.18</td>
<td>1.22</td>
<td>1.25</td>
</tr>
<tr>
<td>1.00</td>
<td>1.07</td>
<td>1.11</td>
<td>1.14</td>
<td>1.15</td>
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<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

22’ Full-height sheathing > 21.2’ OK

Note: Max. aspect ratio = 3.5:1 for PSW segments
**WFCM PRESCRIPTIVE**

2015 WFCM Prescriptive – Hold-downs

Hold-downs

- \( \frac{3,924}{0.60} = 6,540 \text{ lbs} \) w/ blocked gypsum
- \( \frac{3,924}{0.69} = 5,687 \text{ lbs} \) w/o gypsum

- Need to combine with top floor hold-down requirements
- Based on capacity of first shear wall panel
- Does not include dead load

**Table 3.17F**

<table>
<thead>
<tr>
<th>Wall Height (ft)</th>
<th>Wind</th>
<th>Static</th>
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<tbody>
<tr>
<td>8</td>
<td>3458</td>
<td>1912</td>
</tr>
<tr>
<td>12</td>
<td>5232</td>
<td>2805</td>
</tr>
<tr>
<td>14</td>
<td>6104</td>
<td>3346</td>
</tr>
<tr>
<td>16</td>
<td>6576</td>
<td>3824</td>
</tr>
<tr>
<td>18</td>
<td>7848</td>
<td>4302</td>
</tr>
<tr>
<td>20</td>
<td>8720</td>
<td>4780</td>
</tr>
</tbody>
</table>

1. Required hold-down capacities assume walls are sheathed in accordance with Section 3.4.4.2. For other wall sheathing types, the tabulated hold-down capacity shall be divided by the appropriate sheathing type adjustment factor in Table 3.170.
2. Hold-down capacities are tabulated per story. Required hold-down capacities shall be summed from the story above to the story below.

**WFCM ENGINEERED**

2015 WFCM Engineered

- \( w_{\text{roof}} = 169 \text{ plf} \)
- \( w_{\text{floor}} = 194(0.91)^* = 177 \text{ plf} \)
- \( w_{\text{total}} = 346 \text{ plf} \)
- \( 346 \times 32' = 5,536 \text{ lbs} \)

*Footnote 2: \( (H+1)/11 \) adjustment = \( (9+1)/11 \)
WFCM ENGINEERED

2015 WFCM Engineered – Segmented

Table 3.17D Shear Wall Assembly Allowable Unit Shear Capacities, Maximum Shear Wall Segment Aspect Ratios, and Sheathing Type Adjustments

<table>
<thead>
<tr>
<th>Exterior Wall Sheathing</th>
<th>ASD Unit Shear Capacity of Wall Assembly (plf)</th>
<th>Maximum Shear Wall Segment Aspect Ratio</th>
<th>Sheathing Type</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;, 7/16&quot;, and 15/32&quot; Wood Structural Panels (Blocked), maximum stud spacing 16&quot; on center</td>
<td>630</td>
<td>451</td>
<td>3.51</td>
<td>2.14</td>
</tr>
<tr>
<td>No Sheathing or Non-Rated Sheathing</td>
<td>1260</td>
<td>902</td>
<td>3.51</td>
<td>2.14</td>
</tr>
<tr>
<td>1/2&quot; Gypsum Wallboard (Unblocked)</td>
<td>1260</td>
<td>902</td>
<td>3.51</td>
<td>2.14</td>
</tr>
</tbody>
</table>

Walls having aspect ratios exceeding 1.5:1 shall be blocked shear walls and the maximum aspect ratio shall not exceed 2.1 in accordance with SDPWS Table 4.3.4.

WFCM ENGINEERED

2015 WFCM Engineered – Segmented

Required Capacity = 5,536 lbs
7/16” WSP Capacity = 630 plf
1/2” Gypsum Capacity = 100 plf
Total = 730 plf

5,536/730 = 7.6’ (w/ blocked gypsum)
5,536/630 = 8.7’ (w/o gypsum)
Perforated Wood Shear Wall Design

2015 WFCM Engineered - Perforated Reference SDPWS Capacities and Adjustments

\[ V = 5,536 \text{ lbs} \]
\[ v = 730 \text{ plf (w/ blocked gypsum)} \]
\[ v = 630 \text{ plf (w/o gypsum)} \]

\[ \%FHS = \frac{L_i}{L_{tot}} \]
\[ L_i = 2(5') + 4[(2*3'/9')*3'] = 18' \]
\[ L_{tot} = 40' \]

\[ \%FHS = 18' / 40' = 45\% \]

Interpolated \( C_o \) Factor = 0.55

\[ 730(0.55) = 402 \text{ plf} \]
\[ 5,536 / 402 = 13.8' < 18' \text{ (w/ blocked gypsum)} \]

\[ 630(0.55) = 347 \text{ plf} \]
\[ 5,536 / 347 = 16' < 18' \text{ (w/o gypsum)} \]

Note: \( L_i \) per SDPWS 4.3.4.3 adjustment = \( 2b/d/h \)

---

WFCM ENGINEERED

2015 WFCM Engineered – Hold-downs

\[ T = v \cdot h \]
\[ v = 730 \text{ plf (w/ blocked gypsum)} \]
\[ v = 630 \text{ plf (w/o gypsum)} \]
\[ h = 9' \]
\[ T = 730(9') = 6,570 \text{ lbs} \]
\[ T = 630(9') = 5,670 \text{ lbs} \]

- Need to combine with top floor hold-down requirements
- Based on capacity of first shear wall panel
- Can account for dead load (WFCM 2.2.4)
2015 SDPWS – WSP CAPACITY

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

<table>
<thead>
<tr>
<th>Sheathing Material</th>
<th>Minimum Nominal Panel Thickness (in.)</th>
<th>Minimum Fastener Penetration in Framing Member or Blocking (in.)</th>
<th>Fastener Type &amp; Size</th>
<th>Panel Edge Fastener Spacing (in.)</th>
<th>ASD Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Structural Panels – Structural f12</td>
<td>5/16</td>
<td>1-1/4</td>
<td>Nail (common or galvanized box)</td>
<td>10d</td>
<td>650</td>
</tr>
<tr>
<td>Wood Structural Panels – Sheathing</td>
<td>3/8</td>
<td>1-3/8</td>
<td>8d</td>
<td>650</td>
<td>440</td>
</tr>
<tr>
<td>Wood Structural Panels – Sheathing</td>
<td>7/16</td>
<td>1-3/8</td>
<td>8d</td>
<td>650</td>
<td>440</td>
</tr>
<tr>
<td>Wood Structural Panels – Sheathing</td>
<td>15/32</td>
<td>1-1/2</td>
<td>6d</td>
<td>550</td>
<td>385</td>
</tr>
<tr>
<td>Wood Structural Panels – Sheathing</td>
<td>5/16</td>
<td>1-1/4</td>
<td>6d</td>
<td>550</td>
<td>385</td>
</tr>
</tbody>
</table>

**Perforated Wood Shear Wall Design**

ASD Capacity = 1065/2 = 533 plf

---

2015 SDPWS – WSP CAPACITY

### Table 4.3C Nominal Unit Shear Capacities for Wood-Frame Shear Walls

<table>
<thead>
<tr>
<th>Sheathing Material</th>
<th>Material Thickness</th>
<th>Fastener Type &amp; Size</th>
<th>Min. Fastener Edge Spacing (R)”</th>
<th>Max. Fastener Edge Spacing (R)”</th>
<th>ASD Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum and Portland Cement Plaster</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Perforated Wood Shear Wall Design**

ASD Capacity = 200/2 = 100 plf
SDPWS

2015 SDPWS – Perforated Shear Wall
Shear Capacity Adjustment Factor (SDPWS Eqns. 4.3-5 & 4.3-6)

\[ C_o = \left( \frac{r}{3 - 2r} \right) \frac{L_{\text{tot}}}{\sum L_i} \leq 1 \]

\[ r = \frac{1}{1 + \frac{A_o}{h \sum L_i}} \]

\[ h = 9' \]
\[ L_i = 2(5) + 4[(2*3/9)*3] = 18' \]
\[ L_{\text{tot}} = 40' \]
\[ A_o = 4(4.5')(3') + (6')(7.5') = 99 \text{ ft}^2 \]
\[ r = 0.62 \]
\[ C_o = 0.78 \text{ (based on total sheathed area)} \]

Note: \( L_i \) per SDPWS 4.3.4.3 adjustment = \( 2b_i/h \)

SDPWS

2015 SDPWS – Perforated Shear Wall

\[ C_o = 0.78 \]
\[ \text{w/ blocked gypsum} \]
\[ 633 (0.78) = 494 \]
\[ 5,536/494 = 11.2' \]

\[ \text{w/o gypsum} \]
\[ 533 (0.78) = 416 \]
\[ 5,536/416 = 13.3' \]

18' Effective Full-height sheathing > 13.3' OK
Perforated Wood Shear Wall Design

2015 SDPWS – Perforated Shear Wall

- 18’ Effective Full-height sheathing > 13.3’ OK

Perforated Wood Shear Wall Design

2015 SDPWS – Hold-downs (Perforated)

- Need to combine with top floor hold-down requirements
- Based on loads
- Can account for dead load (4.3.6.4.2)

\[ T = C = \frac{Vh}{C_o \sum L_i} \]  

where:

- \( V \) = induced shear force in perforated shear wall, lbs
- \( h \) = height
- \( C_o \) = 0.78
- \( L_i \) = 18’
- \( T \) = 3,549 lbs
- Req’d Hold-down Capacity = 3,549 lbs

4.3.4.3... In the design of perforated shear walls, the length of each perforated shear wall segment with an aspect ratio greater than 2:1 shall be multiplied by \( 2b/h \) for the purposes of determining \( L \) and \( \sum L \).
## WIND DESIGN EXAMPLE - SUMMARY

2015 WFCM/SDPWS Shear Wall Length Comparison  
[Bracketed text indicates values without gypsum]

<table>
<thead>
<tr>
<th>AW Standard</th>
<th>Full Height Sheathing</th>
<th>Hold-downs, lbs</th>
</tr>
</thead>
</table>
| **2015 WFCM**  
Prescriptive | 19.3' [21.2'] (3/12) | 6,540 [5,687] |
| **2015 WFCM**  
Engineered | 13.8' [16'] (3/12)   | 6,570 [5,670] |
| **2015 SDPWS** | 11.2' [13.3'] (4/12) | 3,549 [PSW]    |

---

## WOODWORKS® DESIGN OFFICE 11 SOFTWARE

**SIZER**  
Gravity Design  
Concept mode  
Beam mode  
Column mode

**SHEARWALLS**  
Lateral Design (Wind and Seismic)

**CONNECTIONS**  
Fasteners

**DATABASE EDITOR**  
Add proprietary products

[woodworks-software.com]
WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

CAD IMPORT

1. Specify # of levels
2. Export metafile (.pdf, .emf, .wmf, .bmp) for each level from CAD & import each level
3. Select “Start positioning”
4. Use Zoom controls to place crosshairs on CAD drawing
5. Input (x,y) coordinates & distances

DESIGN SETTINGS

Settings
WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

Wall height = 9 ft

Assume 15/32 in. thick Wood Structural Panel (WSP) Sheathing, 8d nails @ 4 in. o.c. edge spacing. SDPWS Table 4.3A nominal capacity = 1065 lbs/ft (Wind)
WOODBWORKS® SHEARWALLS SOFTWARE EXAMPLE

Perforated Wood Shear Wall Design

Stud spacing = 16 in. o.c.
Studs are Southern Pine (G=0.55)

WOODBWORKS® SHEARWALLS SOFTWARE EXAMPLE

L = 40 ft
W = 32 ft

Perforated Wood Shear Wall Design
WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

Effective length of Full Height Segments (ft) using adjustment from SDPWS 4.3.3.4.1 Exception

Area of openings (ft²)
(SDPWS Eqn. 4.3-6)
(SDPWS Eqn. 4.3-5)
WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

Design Wind Speed = 160 mph (3 sec. gust, 700 year return)
Exposure B

Perforated Wood Shear Wall Design

WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

Seismic load generation
ASCE 7-10 12.9 Equivalent Lateral Force Procedure

Risk Category
Period T (sec)
Use calculated approximate period T

Force-resisting system design factors
Bearing wall system
Building frame system
Response modification R
Deflection amplification Cd

Spectral response accelerations [g/s]
Ss - short period
S1 - 1 second period
Fs 1.2
Fv 1.6

Redundancy factor rho
East-west
North-south

Site class D
Seismic Design Category D
Horizontal irregularity or in-plane vertical discontinuity irregularity
Other vertical irregularity

Perforated Wood Shear Wall Design
WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

Perforated Wood Shear Wall Design

WoodWorks® Shearwalls 11.1 - [AWC_perforated.wsw -

Generate loads on selected levels
Delete all generated loads
Delete all and regenerate

Perforated Wood Shear Wall Design

WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

WoodWorks® Shearwalls 11.1 - [AWC_perforated.wsw -

Generate loads on selected levels
Delete all generated loads
Delete all and regenerate

Perforated Wood Shear Wall Design
Perforated Wood Shear Wall Design

V := 5520  Wind reaction on shear wall (lbs)

Perforated Wood Shear Wall Design

Co = 0.78  Factored Forces

Horizontal
Holddown force (lbs)  Vertical
Compression force (lbs)  Anchorage force (lbf)  V - Shear overturning (lbs)
S - Shear horizontal (lbs)  Drag strut force (lbf)
### SHEATHING MATERIALS by WALL GROUP

<table>
<thead>
<tr>
<th>Grp</th>
<th>Surf</th>
<th>Material</th>
<th>Rating</th>
<th>Sheathing Thick in GU</th>
<th>Ply</th>
<th>Or</th>
<th>Gvtr lbs/in</th>
<th>Size</th>
<th>Type</th>
<th>Df</th>
<th>Eg</th>
<th>Fd</th>
<th>Bk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ext</td>
<td>Structural sheath</td>
<td>32/16</td>
<td>15/32</td>
<td>-</td>
<td>3</td>
<td>Vert</td>
<td>27000</td>
<td>8d</td>
<td>Nail</td>
<td>N</td>
<td>4</td>
<td>12 Y</td>
</tr>
<tr>
<td></td>
<td>int</td>
<td>Gyp WB 1-ply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### FRAMING MATERIALS and STANDARD WALL by WALL GROUP

<table>
<thead>
<tr>
<th>Wall Grp</th>
<th>Species</th>
<th>Grade</th>
<th>b in</th>
<th>d in</th>
<th>SpcG</th>
<th>SG</th>
<th>E psi*6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S. Pine</td>
<td>Stud</td>
<td>1.50</td>
<td>5.50</td>
<td>16</td>
<td>0.55</td>
<td>1.30</td>
</tr>
</tbody>
</table>

Perforated Wood Shear Wall Design
### WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

#### WIND SHEAR FORCES (Directly Applied by User)

<table>
<thead>
<tr>
<th>Shear Line</th>
<th>Level</th>
<th>Profile</th>
<th>Distribution Method</th>
<th>Magnitude [lbs]</th>
<th>Wind Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>Point</td>
<td>Both</td>
<td>5520</td>
<td>Both</td>
</tr>
</tbody>
</table>

### WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

#### SHEAR RESULTS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Line A</td>
<td>1</td>
<td>Both</td>
<td>306.7</td>
<td>1.0 1.0 100 532 0.78 A 496 8922 0.62</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- W Gp - Wall design group defined in Sheathing and Framing Materials tables, where it shows associated Standard Wall. "M" means that the wall is critical for all walls in the Standard Wall group.
- For Dir - Direction of wind force along shearline.
- v - Design shear force on segment + ASD factored shear force per unit FHS.
- vmax - Collector shear force for perforated walls as per SDPWS eqn. 4.3.6 = V/FHS/Co. Full height sheathing (FHS) factored for narrow segments as per 4.3.4.3
- V - ASD factored shear force. For shearline, total shearline force. For wall, total of all segments on wall. For segment, force on segment.
- ASD-Cub = For wall: Unblocked structural wood panel factor Cub from SDPWS 4.3.2.2. For segment: Aspect ratio adjustment from SDPWS 4.3.2.1.4
- Int - Unit shear capacity of interior sheathing; Ext - Unit shear capacity of exterior sheathing. For wall: Unfactored. For segment: Include Cub factor and aspect ratio adjustments.
- Co - Adjustment factor for perforated walls from SDPWS Equation 4.3-3.
- S - Sheathing combination rule. A = Add capacities, S = Strongest side or twice weakest, G = Stiffness-based using SDPWS 4.3-3.
- Cmb - Combined interior and exterior unit shear capacity including perforated wall factor Co.
- V - Total factored shear capacity of sheathing, wall or segment.
- Resp. Ratio - Response ratio = u/Cmb = design shear force/unit shear capacity. "S" indicates that the wind design criterion was critical in selecting.
WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

Assume 15/32 in. thick Wood Structural Panel (WSP) Sheathing, 8d nails @ 4 in. o.c. edge spacing. SDPWS Table 4.3A nominal capacity = 1065 lbs/ft (Wind)

WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE

SHEATHING MATERIALS by WALL GROUP

<table>
<thead>
<tr>
<th>Grp</th>
<th>Surf</th>
<th>Material</th>
<th>Rating</th>
<th>Thick</th>
<th>GU</th>
<th>Ply</th>
<th>Or</th>
<th>Gvty</th>
<th>Size</th>
<th>Fasteners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ext</td>
<td>Structural sheathing</td>
<td>32/16</td>
<td>15/32</td>
<td>-</td>
<td>3</td>
<td>Vert</td>
<td>27000</td>
<td>8d</td>
<td>Nail N 4</td>
</tr>
</tbody>
</table>

FRAMING MATERIALS and STANDARD WALL by WALL GROUP

<table>
<thead>
<tr>
<th>Wall Grp</th>
<th>Species</th>
<th>Grade</th>
<th>b</th>
<th>d</th>
<th>Spcg</th>
<th>SG</th>
<th>E psi²6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S. Pine</td>
<td>Stud</td>
<td>1.50</td>
<td>5.50</td>
<td>16</td>
<td>0.55</td>
<td>1.30</td>
</tr>
</tbody>
</table>
**WOODWORKS® SHEARWALLS SOFTWARE EXAMPLE**

**MWFRS DEFLECTION (flexible wind design)**

<table>
<thead>
<tr>
<th>Wall segment</th>
<th>W Gp</th>
<th>Dir</th>
<th>Srf</th>
<th>v plf</th>
<th>b ft</th>
<th>h ft</th>
<th>Bending Defl A sq.in</th>
<th>Ga kips/ in</th>
<th>Nail slip Vn lbs</th>
<th>Shear Defl in</th>
<th>Hold Defl in</th>
<th>Total Defl in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 Line A</td>
<td>A-1</td>
<td>1 Both</td>
<td>Ext</td>
<td>391.0</td>
<td>18.00</td>
<td>9.00</td>
<td>16.5</td>
<td>0.006</td>
<td>13.1</td>
<td>177</td>
<td>0.028</td>
<td>0.269</td>
</tr>
</tbody>
</table>

**SERVICEABILITY DEFLECTION (flexible wind design)**

<table>
<thead>
<tr>
<th>Wall segment</th>
<th>W Gp</th>
<th>Dir</th>
<th>Srf</th>
<th>v plf</th>
<th>b ft</th>
<th>h ft</th>
<th>Bending Defl A sq.in</th>
<th>Ga kips/ in</th>
<th>Nail slip Vn lbs</th>
<th>Shear Defl in</th>
<th>Hold Defl in</th>
<th>Total Defl in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 Line A</td>
<td>A-1</td>
<td>1 Both</td>
<td>Ext</td>
<td>254.6</td>
<td>18.00</td>
<td>9.00</td>
<td>16.5</td>
<td>0.004</td>
<td>18.6</td>
<td>115</td>
<td>0.008</td>
<td>0.123</td>
</tr>
</tbody>
</table>

**STORY DRIFT (flexible wind design)**

<table>
<thead>
<tr>
<th>Level</th>
<th>Dir</th>
<th>Wall height ft</th>
<th>Actual Story Drift (in)</th>
<th>Max defl</th>
<th>Line</th>
<th>Allowable Story Drift ft</th>
<th>Drift in</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E&lt;-W</td>
<td>9.00</td>
<td>0.19</td>
<td>A</td>
<td></td>
<td>9.00</td>
<td>0.22</td>
<td>0.87</td>
</tr>
</tbody>
</table>

**Legend:**
- Max defl = Largest deflection for any shearline on level in this direction; refer to Serviceability Deflections table
- Line = Shearline with largest deflection on level in this direction
- hs = Story height = Height of walls plus joist depth between this level and the one above.
- Drift = Allowable story drift on this level = story height / 500
- Ratio = Proportion of allowable story drift experienced, on this level in this direction.
POLLING QUESTION

4. The WoodWorks® Shearwalls software has the ability to automatically generate wind and seismic loads, as well as the ability to manually input lateral loads?
   a) True
   b) False
**2015 WFCM HIGH WIND GUIDES**

**Scope restrictions**
- Mean Roof Height (MRH) maximum = 33’
- Top plate to ridge height maximum = 10’
- Roof truss/rafter maximum span = 36’
- Maximum building dimension (L or W) = 80’

**2015 WFCM HIGH WIND GUIDES**

**Additional restrictions beyond WFCM**
- Openings limited to 6’-8”
  - Can go up to 8’ with 5% increase in FHS lengths (Tables 12/13)
- Aspect Ratios are limited based on wind speed
- Buildings must be rectangular (max. 4’ wall offset)
  - Non-rectangular buildings can use inscribed method
  - Separate structures must be designed per WFCM
**DESIGN EXAMPLE**

**Assumptions**

140 mph (700-yr, 3-second gust) Exposure B  
L=36’  
W=30’  
5/12 roof pitch  
Top plate to ridge = 6.25’  
2-story  
8’ wall height  
6’8” door height  
4’ window height  
Wood Structural Panel Exterior Sheathing w/  
Gable End Walls

**DESIGN EXAMPLE**

\[
\text{L/W} = \frac{36'}{30'} = 1.2
\]
**DESIGN EXAMPLE**

Wall Heights = 8’ OK

Table 5. Exterior Wall - Maximum Wood Stud Lengths

<table>
<thead>
<tr>
<th>Exterior Studs</th>
<th>Stud Spacing</th>
<th>Maximum Stud Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Loadbearing Studs</td>
<td>16” O.C.</td>
<td>9’ - 9”</td>
</tr>
<tr>
<td></td>
<td>24” O.C.</td>
<td>9’ - 9”</td>
</tr>
<tr>
<td>Loadbearing Studs Supporting Roof and Ceiling Only</td>
<td>16” O.C.</td>
<td>9’ - 9”</td>
</tr>
<tr>
<td></td>
<td>24” O.C.</td>
<td>9’ - 9”</td>
</tr>
<tr>
<td>Loadbearing Studs Supporting Roof, Ceiling, and 1 Floor Only</td>
<td>16” O.C.</td>
<td>9’ - 9”</td>
</tr>
<tr>
<td></td>
<td>24” O.C.</td>
<td>NP</td>
</tr>
</tbody>
</table>

NP = Not Permitted

1 Maximum stud lengths are for studs located in interior wind zones. For studs located within 4 feet of corners, space stud at 80% of the tabulated spacing or design studs per the WFCM.
Assumes perforated shear wall with hold-downs only at the ends

Load Bearing Walls

Second Floor
Using 6" edge/ 12" field spacing:
L/W = 36’/30’ = 1.2
Interpolated = 36.2% = 13’
Available = 23.5’ OK
Hold Down Capacity = 4,360 lb
**Load Bearing Walls**

**First Floor**

Using 6” edge/12” field spacing:

- L/W = 36'/30' = 1.2
- Interpolated = 59.8% = 21.5’
- Available = 21’ NG!

Using 4” edge/12” field spacing:
- L/W = 36'/30' = 1.2
- Interpolated = 46.8% = 16.9’
- Available = 21’ OK

Hold Down Capacity = 5,900 lb

Combined Hold-down

5,900 + 4,360 = 10,260 lb

**Gable End – Second Floor**

Using 6” edge/12” field spacing:

- L/W = 36'/30' = 1.2
- Interpolated = 47.4% = 14.2’
- Maximum Openings = 15.8’
- Hold Down Capacity = 4,360 lb

**Gable End – First Floor**

Using 6” edge/12” field spacing:

- L/W = 36'/30' = 1.2
- Interpolated = 75% = 22.5’
- Maximum Openings = 7.5’
- Hold Down Capacity = 4,360 lb

Combined Hold-down

4,360 + 4,360 = 8,720 lb
**WFCM HIGH WIND GUIDE**

**Controlling Hold-Down**

10,260 lb > 8,720 lb
10,260 lb can be used at all 4 corners

---

**POLLING QUESTION**

5. The 2015 WFCM uses shear wall design capacities from which of the following:
   a) 2015 International Building Code
   b) 2015 SDPWS
   c) ASCE 7-10
   d) None of the above
This concludes the American Institute of Architects Continuing Education Systems Course.

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Beam mode
Column mode

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Fasteners

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Promo code: awc

For more information contact:
sales@woodworks-software.com
or
support@woodworks-software.com