Wood Shear Wall Seismic and Wind Design Example per 2015 WFCM and SDPWS

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DESCRIPTION

Two AWC standards utilized throughout the nation for a code compliant design of wood shear walls are 2015 Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings and 2015 Special Design Provisions for Wind and Seismic (SDPWS). The WFCM contains both a prescriptive and engineering design approach. Although the prescriptive design will tend to provide more conservative results than the more efficient engineered design, designers may arrive more readily at a solution. This course will include examples of seismic and wind shear wall designs for segmented and perforated shear walls, utilizing the WFCM and the SDPWS along with a comparison of the results.

LEARNING OBJECTIVES

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

1. Identify and understand the basic shear wall system to resist lateral wind and seismic loads.
2. Understand the differences between segmented and perforated shear wall design.
3. Understand hold down design and special conditions that pertain to seismic and wind hold downs.
4. Be able to identify and analyze shear walls per 2015 WFCM and 2015 SDPWS and understand the differences between them.
POLLING QUESTION

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

OUTLINE

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

2015 WFCM is referenced in 2015 IRC/IBC

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**WFCM AND IRC**

IRC R301.1.1 Alternative Provisions

**R301.1.1 Alternative provisions**. As an alternative to the requirements in Section R301.1 the following standards are permitted subject to the limitations of this code and the limitations therein. Where engineered design is used in conjunction with these standards, the design shall comply with the *International Building Code*.

1. AF&PA *Wood Frame Construction Manual (WFCM).*
WFCM AND IBC

IBC Section 2301.2

2301.2 General design requirements. The design of structural elements or systems, constructed partially or wholly of wood or wood-based products, shall be in accordance with one of the following methods:

1. Allowable stress design in accordance with Sections 2304, 2305 and 2306.
2. Load and resistance factor design in accordance with Sections 2304, 2305 and 2307.
3. Conventional light-frame construction in accordance with Sections 2304 and 2308.
4. AWC WFCM in accordance with Section 2309.

WFCM AND IBC

IBC Section 2309

SECTION 2309
WOOD FRAME CONSTRUCTION MANUAL
2309.1 Wood Frame Construction Manual. Structural design in accordance with the AWC WFCM shall be permitted for buildings assigned to Risk Category I or II subject to the limitations of Section 1.1.3 of the AWC WFCM and the load assumptions contained therein. Structural elements beyond these limitations shall be designed in accordance with accepted engineering practice.
**APPLICABILITY LIMITS**

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<tr>
<th>Attribute</th>
<th>Limitation</th>
<th>Reference Section</th>
<th>Figures</th>
</tr>
</thead>
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<tr>
<td>Mean Roof Height (MRH)</td>
<td>55'</td>
<td>1.1.3.1a</td>
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<td>Number of Stories</td>
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<td>-</td>
</tr>
<tr>
<td>Building Length and Width</td>
<td>80'</td>
<td>1.1.3.1b</td>
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</table>

**LOAD ASSUMPTIONS**

(See Chapter 2 or Chapter 3 tables for load assumptions applicable to the specific tabulated requirements)

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Load Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partition Dead Load</td>
<td>0-8 psf of floor area</td>
</tr>
<tr>
<td>Wall Assembly Dead Load</td>
<td>11-18 psf</td>
</tr>
<tr>
<td>Floor Dead Load</td>
<td>10-20 psf</td>
</tr>
<tr>
<td>Roof/Ceiling Assembly Dead Load</td>
<td>0-25 psf</td>
</tr>
<tr>
<td>Floor Live Load</td>
<td>30-40 psf</td>
</tr>
<tr>
<td>Roof Live Load</td>
<td>20 psf</td>
</tr>
<tr>
<td>Ceiling Live Load</td>
<td>10-20 psf</td>
</tr>
<tr>
<td>Ground Snow Load</td>
<td>0-70 psf</td>
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<tr>
<td>Wind Load</td>
<td>110-115 mph wind speed (700-yr. return period, 3-second gust) Exposure B, C, and D</td>
</tr>
<tr>
<td>Seismic Load</td>
<td>Seismic Design Category (SDC)</td>
</tr>
<tr>
<td></td>
<td>SDC A, B, C, D, D1, D2, and D3</td>
</tr>
</tbody>
</table>

**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
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</tr>
</thead>
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<td>1</td>
</tr>
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</tr>
<tr>
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<td>116</td>
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<td>3.3 Floor Systems</td>
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<tr>
<td>3.4 Wall Systems</td>
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<td>3.5 Roof Systems</td>
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<tr>
<td>Supplement</td>
<td>311</td>
</tr>
<tr>
<td>References</td>
<td>315</td>
</tr>
</tbody>
</table>

### What's Changed

2015 WFCM uses ASCE 7-10 wind and seismic design provisions.
SDPWS AND IBC

2015 SDPWS is referenced in 2015 IBC

SDPWS

2015 SDPWS

- Engineered
- Res and Non-Res
- ASD & LRFD
- Shear wall provisions
  - Segmented
  - Perforated
  - Force Transfer Around Openings
SDPWS AND IBC

SECTION 2305
GENERAL DESIGN REQUIREMENTS FOR LATERAL FORCE-RESISTING SYSTEMS
2305.1 General. Structures using wood-frame shear walls or wood-frame diaphragms to resist wind, seismic or other lateral loads shall be designed and constructed in accordance with AF&PA SDPWS and the applicable provisions of Sections 2305, 2306 and 2307.

SECTION 2306
ALLOWABLE STRESS DESIGN
2306.1 Allowable stress design. The design and construction of wood elements in structures using allowable stress design shall be in accordance with the following applicable standards:
American Wood Council.
NDS National Design Specification for Wood Construction
SDPWS Special Design Provisions for Wind and Seismic

SECTION 2307
LOAD AND RESISTANCE FACTOR DESIGN
2307.1 Load and resistance factor design. The design and construction of wood elements in structures using load and resistance factor design shall be in accordance with AWC NDS and AWC SDPWS.

MINIMUM DESIGN LOADS

ASCE 7-10 Minimum Design Loads for Buildings and Other Structures

14.5.1 Reference Documents
The quality, testing, design, and construction of members and their fastenings in wood systems that resist seismic forces shall conform to the requirements of the applicable following reference documents:
1. AF&PA NDS
2. AF&PA SDPWS
OUTLINE

• 2015 IBC/IRC Recognition
• Background and Assumptions
• Wind Examples
  • 2015 WFCM Prescriptive
  • 2015 WFCM Engineered
  • 2015 SDPWS
• Seismic Examples
  • 2015 WFCM Prescriptive
  • 2015 WFCM Engineered
  • 2015 SDPWS

SEGMENTED SHEAR WALL (SSW) METHOD
PERFORATED SHEAR WALL (PSW) METHOD

POLLING QUESTION

2. WFCM Prescriptive provisions include which of the following:

   a) 110-195 mph wind loads
   b) Exposures B & C
   c) Segmented and perforated shear walls
   d) All of the above
OUTLINE

- 2015 IBC/IRC Recognition
- Background and Assumptions
- Wind Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS

WFCM PRESCRIPTIVE

Table 3 Prescriptive Design Limitations

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<th>Limitation</th>
<th>Reference Section</th>
<th>Figures</th>
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<td>1.2</td>
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<td>Number of Stories</td>
<td>3</td>
<td>1.1.3.1a</td>
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<td>Building Length and Width</td>
<td>80'</td>
<td>1.1.3.1b</td>
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<tr>
<td><strong>FLOOR SYSTEMS</strong></td>
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<td></td>
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<tr>
<td>Joint Span</td>
<td>26'</td>
<td>3.1.3.2a</td>
<td>-</td>
</tr>
<tr>
<td>Joint Spacing</td>
<td>24&quot; o.c.</td>
<td>3.1.3.2b</td>
<td>-</td>
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<tr>
<td>Cantilevers - Supporting loadbearing walls²</td>
<td>d</td>
<td>3.1.3.2c</td>
<td>2.1a</td>
</tr>
<tr>
<td>Setbacks - Loadbearing walls²</td>
<td>d</td>
<td>3.1.3.2d</td>
<td>2.1d</td>
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<tr>
<td>Vertical Floor Offset</td>
<td>d₀</td>
<td>3.1.3.2e</td>
<td>2.1i</td>
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<td>Floor Diaphragm Aspect Ratio</td>
<td>Tables 3.16B and 3.16C</td>
<td>3.1.3.2f</td>
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<tr>
<td>Floor Diaphragm Openings</td>
<td>Lesser of 12&quot; or 50% of Building Dimension</td>
<td>3.1.3.2g</td>
<td>2.1k</td>
</tr>
</tbody>
</table>
WFCM PRESCRIPTIVE

- Seismic Design Categories A-D
- Wind Speeds 110-195 mph Exp. B & C
- Segmented & Perforated Shear Walls
- Other Application Limits

WFCM PRESCRIPTIVE – WIND

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 16 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 cooler 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 ($h/b$) greater than 2.1 are multiplied by $2b/h$ 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 $2b/h$, the nominal shear capacities need not be reduced by the adjustment in 4.3.4.2.

DESIGN EXAMPLE

Design first floor shear wall
### DESIGN EXAMPLE - WIND

**Assumptions**
- 130 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
- Vary interior walls – with and without gypsum
- Don’t check deflection

### OUTLINE

- 2015 IBC/IRC Recognition
- Background and Assumptions
- Wind Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS
### WFCM PRESCRIPTIVE - WIND

#### 2015 WFCM Prescriptive – Segmented Shear Wall

### Table 3.17A: Segmented Shear Wall Sheathing Requirements for Wind

<table>
<thead>
<tr>
<th>700-yr. Wind Speed 3-second gust (mph)</th>
<th>110</th>
<th>115</th>
<th>120</th>
<th>130</th>
<th>140</th>
<th>150</th>
<th>160</th>
<th>170</th>
<th>180</th>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof, Ceiling, &amp; 1 Floor</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>20</td>
<td>5.9</td>
<td>6.4</td>
<td>7.0</td>
<td>7.2</td>
<td>8.2</td>
<td>8.9</td>
<td>9.5</td>
<td>10.5</td>
<td>12.4</td>
<td>14.0</td>
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<tr>
<td>24</td>
<td>7.0</td>
<td>7.7</td>
<td>8.4</td>
<td>8.5</td>
<td>9.6</td>
<td>11.4</td>
<td>13.1</td>
<td>14.9</td>
<td>16.8</td>
<td>18.9</td>
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<td>28</td>
<td>8.2</td>
<td>9.0</td>
<td>9.8</td>
<td>11.5</td>
<td>13.3</td>
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<td>30</td>
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<td>11.5</td>
<td>12.8</td>
<td>14.6</td>
<td>17.1</td>
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<td>40</td>
<td>11.7</td>
<td>12.8</td>
<td>14.0</td>
<td>16.4</td>
<td>19.0</td>
<td>21.8</td>
<td>24.8</td>
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<td>50</td>
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<td>43.5</td>
<td>49.1</td>
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<td>80</td>
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<td>25.7</td>
<td>27.9</td>
<td>32.8</td>
<td>38.0</td>
<td>43.7</td>
<td>49.7</td>
<td>56.1</td>
<td>62.9</td>
<td>73.8</td>
</tr>
</tbody>
</table>

Minimum Length of Full Height Sheathing on Exterior Shear Walls Perpendicular to Building Dimension, L or W (m)^xxx

Interpolate = 12.3'

### 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>Roof Pitch</th>
<th>Top Plate to Ridge Height (ft)</th>
<th>Wall Height</th>
<th>Roof Only</th>
<th>Roof + 1 Floor</th>
<th>Roof + 2 Floors</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤6:12</td>
<td>0' (flat)</td>
<td>8'</td>
<td>0.35</td>
<td>0.43</td>
<td>0.58</td>
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<tr>
<td></td>
<td>5'</td>
<td>10'</td>
<td>0.50</td>
<td>0.59</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>10'</td>
<td></td>
<td>0.65</td>
<td>0.74</td>
<td>0.74</td>
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<tr>
<td>&gt;6:12</td>
<td>5'</td>
<td>10'</td>
<td>0.85</td>
<td>0.90</td>
<td>0.95</td>
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<td></td>
<td>15'</td>
<td></td>
<td>1.10</td>
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<td></td>
<td>20'</td>
<td></td>
<td>1.49</td>
<td>1.58</td>
<td>1.58</td>
</tr>
</tbody>
</table>

NP = not permitted

Interpolate = 0.68

Adjusted = 12.3' (0.68) = 8.4'
WFCM PRESCRIPTIVE - WIND

2015 WFCM Prescriptive – Segmented – required = 8.4'

4' + 4' + 2.5' + 2.5' = 13' > 8.4' OK
Assumes blocked gypsum on interior

WFCM PRESCRIPTIVE - WIND

2015 WFCM Prescriptive – 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>Nails and Spacing Requirements</th>
<th>ASD Unit Shear Capacity of Wall Assembly (plf)</th>
<th>Maximum Shear Wall Segment Aspect Ratio</th>
<th>Sheathing Type 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 10&quot; on center</td>
<td>8d common nails - 6&quot; edge spacing</td>
<td>Wind</td>
<td>Seismic</td>
<td></td>
</tr>
<tr>
<td>No Sheathing or Non-Rated Sheathing</td>
<td></td>
<td>Wind</td>
<td>Seismic</td>
<td>Wind</td>
</tr>
<tr>
<td>3/8&quot;, 7/16&quot;, and 15/32&quot; Wood Structural Panels (Blocked)</td>
<td></td>
<td>336</td>
<td>239</td>
<td>3.5:1</td>
</tr>
<tr>
<td>1/2&quot; Gypsum Wallboard (Unblocked)^2</td>
<td>5d cooler nails - 7&quot; edge spacing</td>
<td>436</td>
<td>239</td>
<td>3.5:1</td>
</tr>
</tbody>
</table>

^2 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.
What if we don’t count the gypsum on interior?

\[ 8.4' \times 1.3 = 10.9' \]

Segmented shear wall – assuming no interior gypsum

\[ 4' + 2.5' + 2.5' + 4' = 13' > 10.9' \text{ OK} \]
**WFCM PRESCRIPTIVE - WIND**

2015 WFCM Prescriptive – Segmented – Hold-downs

With and Without Gypsum

Segmented shear wall – requires hold downs on each segment

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**WFCM PRESCRIPTIVE - WIND**

2015 WFCM Prescriptive – Perforated Shear Wall

% Full-height sheathing

- 8.4' / 36' = 23%
- Interpolated = 1.86
- 8.4'(1.86) = 15.6'
  - w/ blocked gypsum
- 10.9' / 36' = 30%
- 10.9'(1.72) = 18.7'
  - w/o gypsum

21' Full-height sheathing > 18.7” OK

Note: Max. aspect ratio = 3.5:1 for PSW segments
PSW requires fully sheathed wall and hold-downs only at the ends

2015 WFCM Prescriptive – Hold-downs

Hold-downs = 3,488 lbs w/ blocked gypsum

3,488 / 1.3 = 2,683 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
OUTLINE

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• Background and Assumptions
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  • 2015 WFCM Prescriptive
  • 2015 WFCM Engineered
  • 2015 SDPWS

WFCM ENGINEERED
2015 WFCM Engineered

\[ w_{\text{roof}} = 94 \text{ plf} \]
\[ w_{\text{floor}} = 128 (0.82)^* = 105 \text{ plf} \]
\[ w_{\text{total}} = 199 \text{ plf} \]
\[ 199(30')/2 = 2,985 \text{ lbs} \]

*Footnote 2: \((H+1)/11\) adjustment = \((8+1)/11\)
2015 WFCM Engineered – Segmented

Required Capacity = 2,985 lbs
7/16” WSP Capacity = 336 plf
1/2” Gypsum Capacity = 100 plf
Total = 436 plf

2,985/436 = 6.8’ (w/ blocked gypsum)
2,985/336 = 8.9’ (w/o gypsum)

4’ + 4’ = 8’ > 6.8’
assuming interior blocked gypsum  OK
**WFCM ENGINEERED – WIND**

2015 WFCM Engineered - Segmented

- 4’ + 2.5’ + 2.5’ + 4’ = 13’ > 8.9’
- assuming NO interior gypsum OK

---

**WFCM ENGINEERED – WIND**

2015 WFCM Engineered - Perforated

Reference SDPWS Capacities and Adjustments

- \( V = 2,985 \) lbs
- \( v = 436 \) plf (w/ blocked gypsum)
- \( v = 336 \) plf (w/o gypsum)
- \( \%FHS = \frac{L_i}{L_{tot}} \)
- \( L_i = 16’ + 2[2(2.5)/8]2.5’ = 19.1’ \)
- \( L_{tot} = 36’ \)
- \( \%FHS = 19.1’ / 36’ = 53\% \)
- Interpolated \( C_v \) Factor = 0.59

- \( 436(0.59) = 257 \) plf
- \( 2,985/257 = 11.6’ < 21’ \) (w/ blocked gypsum)

- \( 336(0.59) = 198 \) plf
- \( 2,985/198 = 15.1’ \) (w/o gypsum)

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

---

**Table 4.3.3.5 Shear Capacity Adjustment Factor, \( C_v \)**

<table>
<thead>
<tr>
<th>Window Height</th>
<th>Door Height</th>
<th>Maximum Unrestricted Opening Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>H2</td>
<td>S1/H2</td>
</tr>
<tr>
<td>8’ Wall</td>
<td>2.4’</td>
<td>4.4’</td>
</tr>
<tr>
<td>10’ Wall</td>
<td>2.4’</td>
<td>4.4’</td>
</tr>
</tbody>
</table>

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{Percent Full-Height Sheathing} & \text{Window Height} & \text{Door Height} & \text{Maximum Unrestricted Opening Height} \\
\hline
0% & 1.00 & 1.00 & 0.56 & 0.46 & 0.33 \\
10% & 1.00 & 0.69 & 0.53 & 0.43 & 0.36 \\
20% & 1.00 & 0.71 & 0.36 & 0.38 & 0.30 \\
30% & 1.00 & 0.74 & 0.39 & 0.40 & 0.32 \\
40% & 1.00 & 0.77 & 0.43 & 0.42 & 0.35 \\
50% & 1.00 & 0.80 & 0.47 & 0.45 & 0.39 \\
60% & 1.00 & 0.83 & 0.51 & 0.48 & 0.42 \\
70% & 1.00 & 0.87 & 0.54 & 0.51 & 0.45 \\
80% & 1.00 & 0.91 & 0.57 & 0.56 & 0.50 \\
90% & 1.00 & 0.95 & 0.60 & 0.60 & 0.56 \\
100% & 1.00 & 1.00 & 1.00 & 1.00 & 1.00 \\
\hline
\end{array}
\]
**WFCM ENGINEERED – WIND**

2015 WFCM Engineered - Perforated

![Diagram of perforated wood sheathing](image)

19.1' Effective Full-height sheathing > 15.1' OK

---

**WFCM ENGINEERED – WIND**

2015 WFCM Engineered – Hold-downs

\[ T = v \cdot h \]

- \[ v = 436 \text{ plf (w/ blocked gypsum)} \]
- \[ v = 336 \text{ plf (w/o gypsum)} \]
- \[ h = 8' \]
- \[ T = 436(8') = 3,488 \text{ lbs} \]
- \[ T = 336(8') = 2,688 \text{ lbs} \]

- 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)
POLLING QUESTION

3. The WFCM tabulated hold-down capacity requirements:
   a) Are based on capacity of the first shear wall panel
   b) Do not account for dead load unless specified by the designer
   c) Are cumulative with floors above
   d) All of the above
### 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>Fastener Type &amp; Size</th>
<th>Panel Edge Fastener Spacing (in.)</th>
<th>ASD Capacity = 670/2 = 335 plf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Structural Panels - Structural</td>
<td>1-1/4</td>
<td></td>
<td>6d</td>
<td></td>
</tr>
<tr>
<td>7/16”</td>
<td>1-3/8</td>
<td>8d</td>
<td>670</td>
<td></td>
</tr>
<tr>
<td>5/16”</td>
<td>1-1/2</td>
<td>10d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/16”</td>
<td>1-1/4</td>
<td>6d</td>
<td>670</td>
<td></td>
</tr>
<tr>
<td>3/8”</td>
<td>1-3/8</td>
<td>8d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8”</td>
<td>1-1/2</td>
<td>10d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8”</td>
<td>1-1/4</td>
<td>6d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 (in.)</th>
<th>Max. Shear Spacing (ft.)</th>
<th>ASD Capacity = 200/2 = 100 plf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum and Portland Cement Plaster</td>
<td>5/8”</td>
<td>10d</td>
<td>16</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>No. 6 Type 2 or Type 5 drywall screws, 3/16” long</td>
<td>5/8”</td>
<td>10d</td>
<td>16</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>No. 6 Type 2 or Type 5 drywall screws, 3/8” long</td>
<td>5/8”</td>
<td>10d</td>
<td>16</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>
**SDPWS**

**2015 SDPWS**

<table>
<thead>
<tr>
<th>Shear Wall Type</th>
<th>Maximum h/b Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood structural panels, unblocked</td>
<td>2:1</td>
</tr>
<tr>
<td>Particleboard, blocked</td>
<td>2:1</td>
</tr>
<tr>
<td>Diagonal sheathing, conventional</td>
<td>2:1</td>
</tr>
<tr>
<td>Gypsum wallboard</td>
<td>2:1</td>
</tr>
<tr>
<td>Portland cement plaster</td>
<td>2:1</td>
</tr>
<tr>
<td>Structural Fiberboard</td>
<td>3.5:1</td>
</tr>
</tbody>
</table>

*1. Walls having aspect ratios exceeding 1.5:1 shall be blocked shear walls.*

Adjustment factor (based on stiffness)

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 \( h/b \), greater than 2:1 are multiplied by \( 2b/h \) 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 \( 2b/h \), the nominal shear capacities need not be reduced by the adjustment in 4.3.4.2.

---

**SDPWS - WIND**

**2015 SDPWS**

Required Capacity = 2,985 lbs

WSP = 335 plf

Gypsum = 100 plf

Total = 435 plf

\[
\frac{2,985}{435} = 6.9' \text{ (w/ blocked gypsum)}
\]

\[
\frac{2,985}{335} = 8.9' \text{ (w/o gypsum)}
\]
**SDPWS - WIND**

2015 SDPWS – Segmented Shear Wall

\[
4' + 4' = 8' > 6.9' \text{ OK assuming interior blocked gypsum}
\]

- Wood Shear Wall Seismic and Wind Design

---

**SDPWS - WIND**

2015 SDPWS – Segmented Shear Wall

\[
4' + 2.5'(0.625) + 2.5'(0.625) + 4' = 11.1' > 8.9' \text{ OK assuming NO interior gypsum}
\]

Note: 0.625 per SDPWS 4.3.3.4.1 Exception 1 = 2b/h
**SDPWS - WIND**

2015 SDPWS – Perforated Shear Wall

Shear Capacity Adjustment Factor

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

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

\( h = 8' \)

\( L_i = 16' + 2[2(2.5)/8]2.5' = 19.1' \)

\( L_{tot} = 36' \)

\( A_o = 4(4')(2.5') + (5')(6.67') = 73.4 \text{ ft}^2 \)

\( r = 0.68 \)

\( C_o = 0.77 \) (based on total sheathed area)

Comparison: SDPWS/WFCM Engineered (tabulated) \( C_o = 0.59 \)

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

---

**SDPWS - WIND**

2015 SDPWS – Perforated Shear Wall

\( C_o = 0.77 \)

**w/ blocked gypsum**

435 (0.77) = 335

\( 2,985/335 = 8.9' \)

**w/o gypsum**

335 (0.77) = 258

\( 2,985/258 = 11.6' \)

19.1' Effective Full-height sheathing > 11.6' OK
**SDPWS - WIND**

2015 SDPWS – Perforated Shear Wall

2,985 lbs

19.1' Effective Full-height sheathing > 11.6' OK

**SDPWS - WIND**

2015 SDPWS – Hold-downs (Segmented)

\[
T = v h
\]

\[
v = \frac{2,985}{8'} = 347 \text{ plf (blocked gyp)}
\]

\[
v = \frac{2,985}{13'} = 230 \text{ plf (w/o gyp)}
\]

\[
h = 8'
\]

\[
T = 347(8') = 2,985 \text{ lbs (blocked gyp)}
\]

\[
T = 230(8') = 1,840 \text{ lbs (w/o gyp)}
\]

\[
T = C = v h \quad (4.3-7)
\]

where:

- \(C\) = compression force, lbs
- \(h\) = shear wall height, ft
- \(T\) = tension force, lbs
- \(v\) = induced unit shear, lbs/ft

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

2015 SDPWS – Hold-downs (Perforated)

\[ V = 2,985 \text{ lbs} \quad h = 8' \]

\[ C_o = 0.77 \]

\[ L_i = 16' + 2[2(2.5)/8]2.5' \]

\[ L_i = 19.1' \]

\[ T = 1,624 \text{ lbs} \]

Req’d Hold-down Capacity = 1624 lbs

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

WIND DESIGN EXAMPLE - SUMMARY

2015 WFCM/SDPWS Shear Wall Length Comparison

<table>
<thead>
<tr>
<th>AWC Standard</th>
<th>Segmented (SSW)</th>
<th>Perforated (PSW)</th>
<th>Hold-downs, lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 WFCM</td>
<td>8.4’ [10.9’] (6/12)</td>
<td>15.6’ [18.8’] (6/12)</td>
<td>3,488 [2,683]</td>
</tr>
<tr>
<td>2015 WFCM</td>
<td>6.8’ [8.9’] (6/12)</td>
<td>11.6’ [15.1’] (6/12)</td>
<td>3,488 [2,683]</td>
</tr>
<tr>
<td>2015 SDPWS</td>
<td>6.9’ [8.9’] (6/12)</td>
<td>8.9’ [11.6’] (6/12)</td>
<td>2,985 [1,840] [SSW] 1,624 [1,001] [PSW]</td>
</tr>
</tbody>
</table>
OUTLINE

- 2015 IBC/IRC Recognition
- Background and Assumptions
- Wind Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS

DESIGN EXAMPLE - SEISMIC

Assumptions
Seismic Design Category D,
7/16 Wood Structural Panel Exterior Sheathing
16” o.c. SPF studs (G=0.42)
Ground Snow Load = 30 psf
Partial Attic = Roof/Ceiling Dead Load = 25 psf
Floor Dead Load = 12 psf
Partition Load = 8 psf
Wall = 110 plf
L=36’
W=30’
L/W=1.2
2-story
8’ wall height
6’8” door height
4’ window height
Don’t check deflection
DESIGN EXAMPLE - SEISMIC

Design first floor shear wall

OUTLINE

- 2015 IBC/IRC Recognition
  - Background and Assumptions
  - Wind Examples
    - 2015 WFCM Prescriptive
    - 2015 WFCM Engineered
    - 2015 SDPWS
- Seismic Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS
WFCM PRESCRIPTIVE - SEISMIC

• Seismic Design Categories A-D
• Segmented & Perforated Shear Walls
• Other Application Limits

APPLICABILITY LIMITS

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Limitation</th>
<th>Reference Section</th>
<th>Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILDING DIMENSIONS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Roof Height (MRH)</td>
<td>39'</td>
<td>1.1.3.1a</td>
<td>12</td>
</tr>
<tr>
<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>
</tr>
</tbody>
</table>

LOAD ASSUMPTIONS

(See Chapter 2 or Chapter 3 tables for load assumptions applicable to the specific tabulated measurement)

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Load Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partition Dead Load</td>
<td>0-8 psf of floor area</td>
</tr>
<tr>
<td>Wall Assembly Dead Load</td>
<td>11-18 psf</td>
</tr>
<tr>
<td>Floor Dead Load</td>
<td>10-20 psf</td>
</tr>
<tr>
<td>Roof/Ceiling Assembly Dead Load</td>
<td>0-25 psf</td>
</tr>
<tr>
<td>Floor Live Load</td>
<td>50-40 psf</td>
</tr>
<tr>
<td>Roof Live Load</td>
<td>20 psf</td>
</tr>
<tr>
<td>Ceiling Live Load</td>
<td>10-20 psf</td>
</tr>
<tr>
<td>Ground Snow Load</td>
<td>0-70 psf</td>
</tr>
<tr>
<td>Wind Load</td>
<td>110-195 mph wind speed</td>
</tr>
<tr>
<td>(700-yr. return period, 3-second gust) Exposure B, C, and D</td>
<td></td>
</tr>
<tr>
<td>Seismic Load</td>
<td>Seismic Design Category (SDC) SDC A, B, C, D, E, F, and G</td>
</tr>
</tbody>
</table>
### WFCM PRESCRIPTIVE - SEISMIC

#### Table 3: Prescriptive Design Limitations

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Limitation</th>
<th>Reference Section</th>
<th>Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BUILDING DIMENSIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Mean Roof Height (MRH)</td>
<td>33’</td>
<td>2.1.3.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Number of Stories</td>
<td>3</td>
<td>11.3.1a</td>
<td>-</td>
</tr>
<tr>
<td>Building Length and Width</td>
<td>80’</td>
<td>11.3.1b</td>
<td>-</td>
</tr>
<tr>
<td><strong>FLOOR SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Joint Span</td>
<td>26’</td>
<td>3.1.3.2a</td>
<td>-</td>
</tr>
<tr>
<td>Joists Joint Spacing</td>
<td>24’ o.c.</td>
<td>3.1.3.2b</td>
<td>-</td>
</tr>
<tr>
<td>Cantilevers - Supporting loadbearing walls</td>
<td>d</td>
<td>3.1.3.2c</td>
<td>2.1a</td>
</tr>
<tr>
<td>Setbacks - Loadbearing walls</td>
<td>d</td>
<td>3.1.3.2d</td>
<td>2.1d</td>
</tr>
<tr>
<td>Floor Diaphragm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Floor Offset</td>
<td>d_0</td>
<td>3.1.3.2e</td>
<td>2.1i</td>
</tr>
<tr>
<td>Floor Diaphragm Aspect Ratio</td>
<td>Tables 3.16B and 3.16C</td>
<td>3.1.3.2f</td>
<td>-</td>
</tr>
<tr>
<td>Floor Diaphragm Openings</td>
<td>Lesser of 12’ or 50% of Building Dimension</td>
<td>3.1.3.2g</td>
<td>2.1k</td>
</tr>
</tbody>
</table>

---

### WFCM PRESCRIPTIVE - SEISMIC

#### WFCM 3.4.4.2 Exterior Shear Walls

b. Seismic Loads Segmented shear walls shall be in accordance with the full height sheathing requirements specified in Table 3.17C. Tabulated values assume wall studs are spaced at a maximum of 16 inches on center and 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. 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 - SEISMIC**

2015 WFCM Prescriptive – Segmented Shear Wall

---

**Table 3.17C1**  
Segmented Shear Wall Sheathing Requirements for Seismic  

<table>
<thead>
<tr>
<th>Shear Wall Line Beneath</th>
<th>Minimum Building Dimension, W (ft)</th>
<th>SDC D1 L/W</th>
<th>SDC D1 L/W</th>
<th>SDC D3 L/W</th>
<th>SDC D3 L/W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1.5</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Roof, Ceiling, &amp; 1 Floor</td>
<td>12</td>
<td>2.9</td>
<td>3.9</td>
<td>4.9</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>3.5</td>
<td>4.5</td>
<td>5.8</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>4.3</td>
<td>6.1</td>
<td>9.0</td>
<td>12.6</td>
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<td></td>
<td>24</td>
<td>5.1</td>
<td>7.9</td>
<td>11.3</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>7.7</td>
<td>10.7</td>
<td>16.0</td>
<td>21.6</td>
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<td></td>
<td>32</td>
<td>9.8</td>
<td>15.2</td>
<td>21.5</td>
<td>28.3</td>
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<tr>
<td></td>
<td>36</td>
<td>12.1</td>
<td>17.0</td>
<td>21.9</td>
<td>26.8</td>
</tr>
</tbody>
</table>

Ground Snow Load - 20 psf Lateral force resisting system: Wood structural panel shear walls.

**Dead Load Assumptions:** Roof/ceiling = 15 psi, Floor = 12 psi, Partition = 9 psi, Wall = 110 psi.

**GSL = 30**

**Interpolate = 15.8’**

Required length of full height sheathing (FHS)

---

**Footnotes to Table 3.17C**

4. Full-height sheathing lengths can be determined for other dead load cases by multiplying the full-height sheathing length adjustment factor given in the following table:

<table>
<thead>
<tr>
<th>Shear Wall Line Beneath</th>
<th>Minimum Building Dimension, W (ft)</th>
<th>Roof/Ceiling Assembly = 15 psf</th>
<th>Roof/Ceiling Assembly = 30 psf</th>
<th>Roof/Ceiling Assembly = 45 psf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Floor = 12 psi Wall = 130 psi</td>
<td>Floor = 20 psi Wall = 100 psi</td>
<td>Floor = 30 psi Wall = 110 psi</td>
</tr>
<tr>
<td>Roof, Ceiling, &amp; 1 Floor</td>
<td>12</td>
<td>1.34</td>
<td>1.40</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>1.14</td>
<td>1.10</td>
<td>1.11</td>
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<tr>
<td></td>
<td>20</td>
<td>1.24</td>
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<td></td>
<td>24</td>
<td>1.34</td>
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<td></td>
<td>28</td>
<td>1.44</td>
<td>1.55</td>
<td>1.60</td>
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<tr>
<td></td>
<td>32</td>
<td>1.54</td>
<td>1.65</td>
<td>1.70</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>1.64</td>
<td>1.75</td>
<td>1.80</td>
</tr>
</tbody>
</table>

5. Effective seismic weight used to determine tabulated full-height sheathing lengths include 20% of ground snow load where the ground snow load exceeds 50 psf. $S_{\text{GWL}}$ used for SDC A, B, C, D1, D2 and D are as follows: $S_{\text{GWL}} = 0.17$ for SDC A, $S_{\text{GWL}} = 0.33$ for SDC B, $S_{\text{GWL}} = 0.50$ for SDC C, $S_{\text{GWL}} = 0.67$ for SDC D, $S_{\text{GWL}} = 0.83$ for SDC D1, $S_{\text{GWL}} = 1.17$ for SDC D2.

Adjusted = 15.8’ (1.2) = 19’

Required length of FHS
WFCM PRESCRIPTIVE - SEISMIC

2015 WFCM Prescriptive – 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>Nails and Spacing Requirements</th>
<th>ASD Unit Shear Capacity of Wall Assembly (lb)</th>
<th>Maximum Shear Wall Segment Aspect Ratio</th>
<th>Sheathing Type Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wind</td>
<td>Solmik</td>
<td>Wind</td>
<td>Solmik</td>
</tr>
<tr>
<td>9/8&quot;, 7/16&quot;, and 15/32&quot; Wood Structural Panels (Blocked), maximum stud spacing 16&quot; on center</td>
<td>8d common nails - 6&quot; edge spacing</td>
<td>306</td>
<td>219</td>
<td>3.15</td>
</tr>
<tr>
<td>No Sheathing or Non-Rated Sheathing</td>
<td>8d common nails - 6&quot; edge spacing</td>
<td>406</td>
<td>219</td>
<td>3.15</td>
</tr>
<tr>
<td>1/2&quot; Gypsum Wallboard (Unblocked)</td>
<td>8d common nails - 6&quot; edge spacing</td>
<td>672</td>
<td>478</td>
<td>3.5</td>
</tr>
</tbody>
</table>

4 The aspect ratio is permitted to be increased to a maximum value of 3.5:1 provided the unit shear capacity and sheathing type adjustment factor are adjusted in accordance with SDPWS Section A3.3.4.1 Exception 2 for wood structural panel shear walls or Exception 2 for structural fiberglass shear walls.

SDPWS adjustment = 2b_s/h (for stiffness)

WFCM PRESCRIPTIVE - SEISMIC

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, δ_{wall}, in each shear wall.

Exceptions:
1. Where nominal shear capacities of all wood structural panel shear walls with aspect ratios (h/b_s) greater than 2:1 are multiplied by 2b_s/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_s/h, the nominal shear capacities need not be reduced by the adjustment in 4.3.4.2.
**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Segmented – required = 19'

4(4') + 2(2.5') = 21' actual length

4(4')+ 2(2.5')(2(2.5)/8) = 19.1’ effective length

Effective length of FHS > 19’ req’d FHS OK

---

**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Segmented – Hold-downs

Segmented shear wall – requires hold downs on each segment
% Full-height sheathing
19' / 36' = 53%
Interpolated = 1.40

19'(1.40) = 26.6'
Req’d length of FHS

19.1' effective FHS < 26.6' req’d FHS NG

---

SDPWS adjustment = 2b/h (stiffness)
**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Perforated Shear Wall

With 4/12 nailing

19'(0.68) = 12.9’ (segmented)

% Full-height sheathing

12.9’ / 36’ = 36%

Interpolated = 1.62

12.9'(1.62) = 20.9’

Req’d length FHS

19.1’ effective FHS < 20.9’ req’d FHS NG

**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Segmented

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

---

4 The aspect ratio is permitted to be increased to a maximum value of 3.5:1 provided the unit shear capacity and sheathing type adjustment factor are adjusted in accordance with SDPWS Section 4.3.3.4.1 Exception 1 for wood structural panel shear walls or Exception 2 for structural fiberboard shear walls.

SDPWS adjustment = \(2b_s/h\)
**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Perforated Shear Wall

With 3/12 nailing
19' (0.53) = 10.1'
(segmented)

% Full-height sheathing
10.1' / 36' = 28%
Interpolated = 1.76

10.1'(1.76) = 17.8'
Req’d length FHS

19.1' effective FHS > 17.8’ req’d FHS **OK**

---

**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Perforated

PSW requires fully sheathed wall

- Nailing at 3/12
PSW requires hold-downs only at the ends

**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Perforated – Hold-downs

Hold-downs
- = 1,912 lbs
- For segmented wall @ 6/12 nailing
- $1,912 / 0.53$
- = 3,608 lbs
- For PSW @ 3/12 nailing

**WFCM PRESCRIPTIVE - SEISMIC**

2015 WFCM Prescriptive – Hold-downs

### Table 3.17F

<table>
<thead>
<tr>
<th>Wall Height (ft)</th>
<th>Required Hold-down Connection Capacity (lbs)(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>3488</td>
</tr>
<tr>
<td>10</td>
<td>3924</td>
</tr>
<tr>
<td>12</td>
<td>4360</td>
</tr>
<tr>
<td>14</td>
<td>5322</td>
</tr>
<tr>
<td>16</td>
<td>6104</td>
</tr>
<tr>
<td>18</td>
<td>6975</td>
</tr>
<tr>
<td>20</td>
<td>7848</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.

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

4. WFCM Seismic tabulated shear wall values assume which of the following?

   a) Studs are spaced at 24”oc max.
   b) 19/32” wood structural panels on the exterior
   c) 8d common nails at 6”oc panel edges
   d) ½” gypsum wallboard capacity

---

**OUTLINE**

- 2015 IBC/IRC Recognition
  - Background and Assumptions
  - Wind Examples
    - 2015 WFCM Prescriptive
    - 2015 WFCM Engineered
    - 2015 SDPWS
  - Seismic Examples
    - 2015 WFCM Prescriptive
    - 2015 WFCM Engineered
    - 2015 SDPWS
**WFCM ENGINEERED - SEISMIC**

**Table 2.6 Lateral Loads from Seismic**
(For Calculating In-Plane Shear at Roof and Floor Diaphragm Levels)

<table>
<thead>
<tr>
<th>Diaphragm level</th>
<th>Effective seismic weight at each level (lbs)</th>
<th>Shear at each level (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof/Ceiling (RO)</td>
<td>$W_{RO} + W_{SDS} + W_{VFD2}/2 + W_{VFD1}/2 + W_{LFD2} + W_{LFD1}$</td>
<td>$V_{RO} = 1.1 \times W_{ASD}$</td>
</tr>
<tr>
<td>2nd Floor (FD2)</td>
<td>$W_{FD2} = W_{SDS} + W_{VFD2}/2 + W_{VFD1}/2 + W_{LFD2} + W_{LFD1}$</td>
<td>$V_{FD2} = 0.83 \times W_{ASD}$</td>
</tr>
</tbody>
</table>

Two-Story Building Above Grade Plane

- $W_{FD2} = 83,680$ lbs
- $V_{FD2} = 1.1 \times (83,680) \times 0.83 / 6.5 = 8,228$ lbs

<table>
<thead>
<tr>
<th>Diaphragm level</th>
<th>Calculating diaphragm unit shear capacity requirements (lbf)</th>
<th>Calculating total shear at each level (lbs) for shear capacity requirements for shear wall and connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof/Ceiling (RO)</td>
<td>$\gamma_{CW} \times V_{ASD}/2 + \gamma_{LW} \times V_{ASD}/2$</td>
<td>$V_{RO} = V_{ASD}$</td>
</tr>
<tr>
<td>2nd Floor (FD2)</td>
<td>$\gamma_{CW} \times V_{ASD}/2 + \gamma_{LW} \times V_{ASD}/2$</td>
<td>$V_{FD2} = V_{ASD}$</td>
</tr>
</tbody>
</table>

$V_{ASD} = 1.1 \times (83,680)$

*SDS for D1 = 0.83
R = 6.5
1.1 = vertical force distribution factor
0.7 = ASD load factor*
Simplified Approach

ASCE 7-10 Section 12.14.8

Shear at the roof diaphragm level, \( V_{\text{SDPWS}} \):

\[ V_{\text{SDPWS}} = 1.1 \times W_{\text{clf}} \times S_{\text{dyn}} / R \]

where:

- 1.1: vertical force distribution factor for two-story construction in accordance with simplified procedures of ASCE 7-10 Section 12.14.8. A factor of 1.0 applies for one-story construction and a factor of 1.2 applies for three-story construction.
- \( S_{\text{dyn}} \): design 5 percent damped spectral response acceleration parameter at short periods in accordance with ASCE 7-10
- \( R \): seismic response modification coefficient in accordance with ASCE 7-10

Shear at the second floor diaphragm level, \( V_{\text{SDPWS}} \):

\[ V_{\text{SDPWS}} = 1.1 \times W_{\text{clf}} \times S_{\text{dyn}} / R \]

Shear at the first floor diaphragm level, \( V_{\text{SDPWS}} \):

\[ V_{\text{SDPWS}} = 1.1 \times W_{\text{clf}} \times S_{\text{dyn}} / R \]

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 (psf)</th>
<th>Maximum Shear Wall Segment Aspect Ratio</th>
<th>Sheathing Type Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wind</td>
<td>Seismic</td>
<td>Wind</td>
</tr>
<tr>
<td>3/8&quot;, 7/16&quot;, and 15/32&quot; Wood Structural Panels (Blocked)</td>
<td>3672</td>
<td>478</td>
<td>3.5</td>
</tr>
</tbody>
</table>

4 The aspect ratio is permitted to be increased to a maximum value of 3.5 provided the unit shear capacity and sheathing type adjustment factor are adjusted in accordance with SDPWS Section 6.3.3.4.1 Exception 2 for structural fiberboard shear walls.

SDPWS adjustment = \( 2b_g / h \) (for stiffness)
Required Capacity = 8,228/2 = 4,114 lbs
7/16\" WSP Capacity = 239 plf

4,114 lbs / 239 plf = 17.2\'
Req\’d length of FHS

4,114 lbs
21\’ actual length
4(4\')+ 2(2.5')(2(2.5)/8) = 19.1\'

• Effective length of FHS > 17.2\’ req\’d FHS OK
Reference SDPWS Capacities and Adjustments

\( V = 4,114 \text{ lbs} \)
\( v = 239 \text{ plf} \)

\( \%\text{FHS} = \frac{L_i}{L_{\text{tot}}} \)
\( L_i = 16' + 2\left[2(2.5)/8\right]2.5' = 19.1' \)
\( L_{\text{tot}} = 36' \)

\( \%\text{FHS} = \frac{19.1'}{36'} = 53\% \)

Interpolated \( C_v \) Factor = 0.59

\( 239(0.59) = 141 \text{ plf} \)
\( 4,114/141 = 29.2' \text{ Req'd FHS} \)

29.2’ > 19.1’ effective FHS \( \text{NG} \)

Note: \( L_i \) per SDPWS 4.3.4.3 adjustment = 2\( b_j/\text{h} \)

---

**WFCM ENGINEERED - SEISMIC**

2015 WFCM Engineered – Segmented

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

4 The aspect ratio is permitted to be increased to a maximum value of 3.5:1 provided the unit shear capacity and sheathing type adjustment factor are adjusted in accordance with SDPWS section 4.3.2.4.1 Exception 2 for wood structural panel shear walls or Exception 2 for structural fiberglass shear walls:

SDPWS adjustment = 2\( b_j/\text{h} \) for stiffness
### 2015 WFCM Engineered - Perforated

**Reference SDPWS Capacities and Adjustments**

- \( V = 4,114 \text{ lbs} \)
- \( v = 350 \text{ plf} \)
- \( \%FHS = \frac{L_i}{L_{tot}} \)
- \( L_i = 16' + 2[2(2.5)/8]2.5' = 19.1' \)
- \( L_{tot} = 36' \)
- \( \%FHS = 19.1' / 36' = 53\% \)
- Interpolated \( C_o \) Factor = 0.59

- \( 350(0.59) = 207 \text{ plf} \)
- \( 4,114/207 = 19.9' \) Req'd FHS

\[ \text{19.9'} > 19.1' \text{ effective FHS NG} \]

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

### 2015 WFCM Engineered - Segmented

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

#### Exterior Wall Sheathing

- 3/8", 7/16", and 15/32" Wood Structural Panels (Blocked), maximum stud spacing 16" on center
  - 6d common nails - 3" edge spacing

- 1/2" Gypsum Wallboard (Unblocked)\(^4\)
  - 5d cooler nails - 7" edge spacing

#### Inside Wall Sheathing

- No Sheathing or Non-Rated Sheathing
  - 1/2" Gypsum Wallboard (Unblocked)\(^4\)
    - SDPWS adjustment = 2b\(_s\)/h

\(^4\) The aspect ratio is permitted to be increased to a maximum value of 3.5:1 provided the unit shear capacity and sheathing type adjustment factor are adjusted in accordance with SDPWS Section 5.3.3.1 Exception 3 for wood structural panel shear walls or Exception 2 for structural fiberboard shear walls.
Reference SDPWS Capacities and Adjustments

\[ V = 4,114 \text{ lbs} \]

\[ v = 451 \text{ plf} \]

\[ \%FHS = \frac{L_i}{L_{tot}} \]

\[ L_i = 16' + 2[2(2.5)/8]2.5' = 19.1' \]

\[ L_{tot} = 36' \]

\[ \%FHS = \frac{19.1'}{36'} = 53\% \]

Interpolated \( C_p \) Factor = 0.59

\[ 451(0.59) = 266 \text{ plf} \]

\[ 4,114/266 = 15.5' \text{ Req'd FHS} \]

15.5' < 19.1' effective FHS OK

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

---

**WFCM ENGINEERED - SEISMIC**

2015 WFCM Engineered - Perforated

<table>
<thead>
<tr>
<th>Maximum Unrestrained Opening Height</th>
<th>Window Height</th>
<th>Door Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>8' Wall</td>
<td>2'-8&quot;</td>
<td>4'-0&quot;</td>
</tr>
<tr>
<td>10' Wall</td>
<td>3'-4&quot;</td>
<td>5'-0&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Full-Height Sheathing</th>
<th>Shear Capacity Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>1.00</td>
</tr>
<tr>
<td>10%</td>
<td>1.00</td>
</tr>
<tr>
<td>20%</td>
<td>1.00</td>
</tr>
<tr>
<td>30%</td>
<td>1.00</td>
</tr>
<tr>
<td>40%</td>
<td>1.00</td>
</tr>
<tr>
<td>50%</td>
<td>1.00</td>
</tr>
<tr>
<td>60%</td>
<td>1.00</td>
</tr>
<tr>
<td>70%</td>
<td>1.00</td>
</tr>
<tr>
<td>80%</td>
<td>1.00</td>
</tr>
<tr>
<td>90%</td>
<td>1.00</td>
</tr>
<tr>
<td>100%</td>
<td>1.00</td>
</tr>
</tbody>
</table>

19.1' effective FHS > 15.5' req'd FHS OK

---

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**WFCM ENGINEERED - SEISMIC**

2015 WFCM Engineered – Hold-downs

\[ T = v \cdot h \]

- \( v = 239 \text{ plf} \) – segmented @ 6/12
- \( v = 451 \text{ plf} \) – perforated @ 3/12
- \( h = 8' \)

- \( T = 239(8') = 1,912 \text{ lbs} \) - segmented
- \( T = 451(8') = 3,608 \text{ lbs} \) - perforated

- 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)

---

**POLLLING QUESTION**

5. The tabulated perforated shear wall shear capacity adjustment factor is not based on the maximum unrestrained opening height.

**True or False**
OUTLINE

- 2015 IBC/IRC Recognition
- Background and Assumptions
- Wind Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2015 WFCM Prescriptive
  - 2015 WFCM Engineered
  - 2015 SDPWS

SDPWS

2015 SDPWS

- Engineered
- Res and Non-Res
- ASD & LRFD
- Efficiencies in designs
- Shear wall provisions
  - Segmented
  - Perforated
  - Force Transfer Around Openings
MINIMUM DESIGN LOADS

ASCE 7-10 Minimum Design Loads for Buildings and Other Structures

14.5.1 Reference Documents

The quality, testing, design, and construction of members and their fastenings in wood systems that resist seismic forces shall conform to the requirements of the applicable following reference documents:

1. AF&PA NDS
2. AF&PA SDPWS

Footnote 1: ASD capacity = half the nominal capacity
Footnote 2: use 15/32 capacity for studs at 16" o.c.
Footnote 3: SG adjustment factor = 0.92 for SPF
ASD Capacity = 520 (0.92) / 2 = 239 plf

2015 SDPWS – SEISMIC 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</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Structural Panels</td>
<td>5/8</td>
<td>1/2</td>
<td>6d</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3/4</td>
<td>1 3/4</td>
<td>6d</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>7/16</td>
<td>1</td>
<td>6d</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>15/32</td>
<td>1 1/2</td>
<td>8d</td>
<td>4</td>
</tr>
</tbody>
</table>

Footnote 1: ASD capacity = half the nominal capacity
Footnote 2: use 15/32 capacity for studs at 16" o.c.
Footnote 3: SG adjustment factor = 0.92 for SPF
ASD Capacity = 520 (0.92) / 2 = 239 plf
### Adjustment factor (based on stiffness)

**Table 4.3.4 Maximum Shear Wall Aspect Ratios**

<table>
<thead>
<tr>
<th>Shear Wall Sheathing Type</th>
<th>Maximum h/b, Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood structural panels, unblocked</td>
<td>2:1</td>
</tr>
<tr>
<td>Wood structural panels, blocked</td>
<td>3.5:1</td>
</tr>
<tr>
<td>Particleboard, blocked</td>
<td>2:1</td>
</tr>
<tr>
<td>Diagonal sheathing, conventional</td>
<td>2:1</td>
</tr>
<tr>
<td>Gypsum wallboard</td>
<td>2:1</td>
</tr>
<tr>
<td>Portland cement plaster</td>
<td>2:1</td>
</tr>
<tr>
<td>Structural fiberboard</td>
<td>3.5:1</td>
</tr>
</tbody>
</table>

*Walls having aspect ratios exceeding 1.5:1 shall be blocked shear walls.*

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

**Exceptions:**

1. Where nominal shear capacities of all wood structural panel shear walls with aspect ratios (h/b) greater than 2:1 are multiplied by $2b_h$ 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 $2b_h$, the nominal shear capacities need not be reduced by the adjustment in 4.3.4.2.

### Aspect Ratio factor (for strength)

4.3.4.1 The size and shape of shear walls shall be limited to the aspect ratios in Table 4.3.4.

4.3.4.2 For wood structural panel shear walls with aspect ratios (h/b) greater than 2:1, the nominal shear capacity shall be multiplied by the Aspect Ratio Factor (WSP) = 1.25 - 0.125h/b. For structural fiberboard shear walls with aspect ratios (h/b) greater than 1:1, the nominal shear capacity shall be multiplied by the Aspect Ratio Factor (fiberboard) = 1.09 - 0.09 h/b.
**SDPWS - SEISMIC**

Shear Distribution

- Required Capacity = 4,114 lbs
- WSP = 239 plf
- Aspect Ratio > 2:1
- Adjustment factor (based on stiffness) = \(2b/h\)
  \[= 2(2.5)/8 = 0.625 \quad \textcolor{red}{\text{Governed}}\]
- Aspect Ratio Factor (strength) = \(1.25 - 0.125h/b_s\)
  \[= 1.25 - 0.125(8)/2.5 = 0.84\]

- WSP = 239(0.625) = 149 plf

SDPWS - SEISMIC

2015 SDPWS – Segmented Shear Wall

- 4,114 lbs

- 239plf(4')(4') + 149plf(2')(2.5') = 4569 lbs adjusted capacity

- 4569 lbs > 4114 lbs (req'd capacity) \textbf{OK}
**SDPWS - SEISMIC**

**Required Length of FHS**

Required Capacity = 4,114 lbs

\[ 239(4')(4') + 149(2)(x) = 4,114 \]

\[ x = 0.97 \]

Required length FHS = 16' + 0.97' = 17.0'

Actual length = 21' **OK**

---

**SDPWS - SEISMIC**

**2015 SDPWS – Perforated Shear Wall**

Shear Capacity Adjustment Factor

\[ h = 8' \]

\[ L_i = 16' + 2[2(2.5)/8]2.5' = 19.1' \]

\[ L_{tot} = 36' \]

\[ A_o = 4(4')(2.5') + (5')(6.67') = 73.4 \text{ ft}^2 \]

\[ r = 0.68 \]

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

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

\[ C_o = 0.77 \] (based on total sheathed area)

Comparison: SDPWS/WFCM Engineered (tabulated) \( C_o = 0.59 \)

Note: \( L_i \) per SDPWS 4.3.4.3 adjustment = 2b_s/h
SDPWS - SEISMIC

2015 SDPWS – Perforated Shear Wall

\[ C_0 = 0.77 \]

239 plf \((0.77)\) = 184 plf

\[ \frac{4,114}{184} = 22.3' \text{ req'd FHS} \]

22.3' > 21' actual FHS \( \text{NG} \)

6/12 nail spacing

---

2015 SDPWS – SEISMIC 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>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Structural Panels - Sheathing</td>
<td>5/8</td>
<td>1-1/4</td>
<td>3d</td>
</tr>
<tr>
<td>3/8</td>
<td>1-3/8</td>
<td>3d</td>
<td></td>
</tr>
<tr>
<td>5/32</td>
<td>1-1/2</td>
<td>3d</td>
<td></td>
</tr>
<tr>
<td>7/32</td>
<td>1-1/2</td>
<td>2d</td>
<td></td>
</tr>
<tr>
<td>13/32</td>
<td>1-1/2</td>
<td>2d</td>
<td></td>
</tr>
<tr>
<td>15/32</td>
<td>1-1/2</td>
<td>2d</td>
<td></td>
</tr>
<tr>
<td>19/32</td>
<td>1-1/2</td>
<td>2d</td>
<td></td>
</tr>
</tbody>
</table>

Footnote 1: ASD capacity = half the nominal capacity
Footnote 2: use 15/32 capacity for studs at 16” o.c.
Footnote 3: SG adjustment factor = 0.92 for SPF
ASD Capacity = 760 (0.92) / 2 = 350 plf
**SDPWS - SEISMIC**

**2015 SDPWS – Perforated Shear Wall**

\[ C_o = 0.77 \]

\[ 350 \text{ plf (0.77)} = 270 \text{ plf} \]

\[ 4,114/270 = 15.2' \text{ req’d FHS} \]

15.2’ < 21’ actual FHS OK

4/12 nail spacing

---

**SDPWS - SEISMIC**

**2015 SDPWS – Perforated Shear Wall**

4,114 lbs

21’ actual FHS > 15.2’ req’d FHS  OK
SDPWS - SEISMIC

2015 SDPWS – Hold-downs (Segmented)

\[ T = C = \frac{Vh}{h} \quad (4.3-7) \]

where:
- \( T \) = tension force, lbs
- \( C \) = compression force, lbs
- \( V \) = induced unit shear, lbs/ft
- \( h \) = shear wall height, ft

\[ v = \frac{4,114}{19.1'} = 215 \text{ plf} \]

\[ h = 8' \]

\[ T = 215(8') = 1,723 \text{ lbs} \]

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

SDPWS - SEISMIC

2015 SDPWS – Hold-downs (Perforated)

\[ V = 4,114 \text{ lbs} \]

\[ h = 8' \]

\[ C_0 = 0.77 \]

\[ L_i = 16' + 2[2(2.5)/8]2.5' \]

\[ L_i = 19.1' \]

\[ T = 2,238 \text{ lbs} \]

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

**2015 WFCM/SDPWS Shear Wall Length Comparison**

1st of 2-story; W=30'; L = 36'; GSL = 30psf; SDC D_1

<table>
<thead>
<tr>
<th>AWC Standard</th>
<th>Segmented (SSW)</th>
<th>Perforated (PSW)</th>
<th>Hold-downs, lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 WFCM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescriptive</td>
<td>19.0' (6/12)</td>
<td>17.8' (3/12)</td>
<td>1,912 [SSW]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3,608 [PSW]</td>
</tr>
<tr>
<td>2015 WFCM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineered</td>
<td>17.2' (6/12)</td>
<td>15.5' (3/12)</td>
<td>1,912 [SSW]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3,608 [PSW]</td>
</tr>
<tr>
<td>2015 SDPWS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>15.2' (4/12)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2,238 [PSW]</td>
</tr>
</tbody>
</table>

Parenthetical values show nail spacing: (edge/field)

### WIND & SEISMIC DESIGN EXAMPLE - SUMMARY

**2015 WFCM/SDPWS Shear Wall Length Comparison**

1st of 2-story; W=30'; L = 36'; GSL = 30psf; 130 mph Exposure B; SDC D_1

**Wind**

<table>
<thead>
<tr>
<th>AWC Standard</th>
<th>Segmented (SSW)</th>
<th>Perforated (PSW)</th>
<th>Hold-downs, lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 WFCM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescriptive</td>
<td>8.4' [10.9']</td>
<td>15.6' [18.8']</td>
<td>3,488 [2,683]</td>
</tr>
<tr>
<td></td>
<td>(6/12)</td>
<td>(6/12)</td>
<td></td>
</tr>
<tr>
<td>2015 WFCM</td>
<td>6.8' [8.9']</td>
<td>11.6' [15.1']</td>
<td>3,488 [2,683]</td>
</tr>
<tr>
<td>Engineered</td>
<td>(6/12)</td>
<td>(6/12)</td>
<td></td>
</tr>
<tr>
<td>2015 SDPWS</td>
<td>6.9' [8.9']</td>
<td>8.9' [11.6']</td>
<td>2,985 [1,840]</td>
</tr>
<tr>
<td></td>
<td>(6/12)</td>
<td>(6/12)</td>
<td>1,624 [1,001]</td>
</tr>
</tbody>
</table>

**Seismic**

<table>
<thead>
<tr>
<th>AWC Standard</th>
<th>Segmented (SSW)</th>
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<th>Hold-downs, lbs</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>2,238 [PSW]</td>
</tr>
</tbody>
</table>

Parenthetical values show nail spacing: (edge/field)
This concludes the American Institute of Architects Continuing Education Systems Course