Two AWC standards utilized throughout the nation for a code compliant design of wood shear walls are 2018 Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings and 2015 Special Design Provisions for Wind and Seismic (SDPWS). The WFCM has recently been updated and 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 seminar includes 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 2018 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
   e) Builder/Manufacturer/Other

OUTLINE

• 2018 IBC/IRC Recognition
• Background and Assumptions
• Wind Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
• Seismic Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
• Shear Wall Detailing (time permitting)
**WFCM AND IRC/IBC**

2018 WFCM is referenced in 2018 IRC/IBC

---

**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. AWC Wood Frame Construction Manual (WFCM).
WFCM AND IBC

IBC Section 2301.2

SECTION 2302
DESIGN REQUIREMENTS

2302.1 General. 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.
5. The design and construction of log structures in accordance with the provisions of ICC 400.

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

Table 1  Applicability Limitations

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Limitation</th>
<th>Reference Section</th>
<th>Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Height (MFR)</td>
<td>23'</td>
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<td>1.2</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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</tr>
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</table>

LOAD ASSUMPTIONS
(See Chapter 2 or Chapter 3 tables for load assumptions applicable to the specific isolated requirement)

<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>0-30 psf</td>
</tr>
<tr>
<td>Wind Load</td>
<td>90-145 mph wind speed</td>
</tr>
<tr>
<td></td>
<td>(5-second gust)</td>
</tr>
<tr>
<td></td>
<td>Exposure B, C, and D (See Figure 1.1)</td>
</tr>
<tr>
<td>Seismic Load</td>
<td>Seismic Design Category (SDC)</td>
</tr>
<tr>
<td></td>
<td>SDCA, B, C, D, D1, D2, and D3</td>
</tr>
</tbody>
</table>

2018 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

Wood Shear Wall Seismic and Wind Design
2018 WFCM

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<table>
<thead>
<tr>
<th>Chapter/Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
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<td>1 General Information</td>
<td></td>
</tr>
<tr>
<td>1.1 Scope</td>
<td>3</td>
</tr>
<tr>
<td>1.2 Materials Standards</td>
<td>4</td>
</tr>
<tr>
<td>1.3 Definitions</td>
<td>5</td>
</tr>
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<td>1.4 Symbols</td>
<td>9</td>
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<tr>
<td>Figures</td>
<td>11</td>
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<td>2 Engineered Design</td>
<td>13</td>
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<tr>
<td>2.1 General Provisions</td>
<td>15</td>
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<tr>
<td>2.2 Connections</td>
<td>17</td>
</tr>
<tr>
<td>2.3 Floor Systems</td>
<td>19</td>
</tr>
<tr>
<td>2.4 Wall Systems</td>
<td>21</td>
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<tr>
<td>2.5 Roof Systems</td>
<td>23</td>
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<tr>
<td>List of Figures</td>
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<tr>
<td>List of Tables</td>
<td>61</td>
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<tr>
<td>3 Prescriptive Design</td>
<td></td>
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<tr>
<td>3.1 General Provisions</td>
<td>115</td>
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<tr>
<td>3.2 Connections</td>
<td>116</td>
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<tr>
<td>3.3 Floor Systems</td>
<td>119</td>
</tr>
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<td>3.4 Wall Systems</td>
<td>121</td>
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<tr>
<td>3.5 Roof Systems</td>
<td>123</td>
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<td>Appendix A</td>
<td>331</td>
</tr>
<tr>
<td>Supplement</td>
<td>337</td>
</tr>
<tr>
<td>References</td>
<td>341</td>
</tr>
</tbody>
</table>

2018 WFCM

2018 WFCM uses ASCE 7-16 wind and seismic design provisions
**SDPWS AND IBC**

2015 SDPWS is referenced in 2018 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 AWC 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
- ANSI/AWC 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 and structures using load and resistance factor design shall be in accordance with ANSI/AWC NDS and AWC SDPWS.

---

**MINIMUM DESIGN LOADS**

**ASCE 7-16 Minimum Design Loads for Buildings and Other Structures**

14.5 **WOOD**

Structures, including foundations, constructed of wood to resist seismic loads shall be designed and detailed in accordance with this standard including the references and additional requirements provided in this section.

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: AWC NDS and AWC SDPWS.
OUTLINE

- 2018 IBC/IRC Recognition
  - Background and Assumptions
  - Wind Examples
    - 2018 WFCM Prescriptive
    - 2018 WFCM Engineered
    - 2015 SDPWS
  - Seismic Examples
    - 2018 WFCM Prescriptive
    - 2018 WFCM Engineered
    - 2015 SDPWS
  - Shear Wall Detailing (time permitting)

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

- 2018 IBC/IRC Recognition
- Background and Assumptions
- Wind Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS

---

WFCM PRESCRIPTIVE

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</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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>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>
<tr>
<td><strong>FLOOR SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Joists</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joist Span</td>
<td>26”</td>
<td>3.1.3.2a</td>
<td>-</td>
</tr>
<tr>
<td>Joist Spacing</td>
<td>24” o.c.</td>
<td>3.1.3.2b</td>
<td>-</td>
</tr>
<tr>
<td>Cantilevers - Supporting Loadbearing walls¹</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>
</tr>
<tr>
<td>Floor Diaphragm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Floor Offset</td>
<td>d&lt;sub&gt;v&lt;/sub&gt;</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 Design Categories A-D
• Wind Speeds 95-195 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, \( \delta_{cw} \), in each shear wall.

Exceptions:
1. Where nominal shear capacities of all wood structural panel shear walls with aspect ratios \( h/b_{w} \) greater than 2.1 are multiplied by \( 2b_{w}/h \) 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 \( 2b_{w}/h \), 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

• 2018 IBC/IRC Recognition
• Background and Assumptions
• Wind Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
• Seismic Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
Interpolate = 12.9'

Interpolate = 0.68
Adjusted = 12.9' (0.68) = 8.8'
**WFCM PRESCRIPTIVE - WIND**

2018 WFCM Prescriptive – Segmented – required = 8.8'

4' + 4' + 4' + 4' = 16' > 8.8' OK
Assumes blocked gypsum on interior

---

**WFCM PRESCRIPTIVE - WIND**

2018 WFCM Prescriptive – Segmented

<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>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>3.5:1</td>
<td>2:1</td>
</tr>
<tr>
<td>No Sheathing or Non-Rated Sheathing</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>336</td>
<td>239</td>
</tr>
<tr>
<td>3/8&quot;, 7/16&quot;, and 15/32&quot; Wood Structural Panels (Blocked)</td>
<td>8d common nails - 6&quot; edge spacing</td>
<td>672</td>
<td>478</td>
</tr>
</tbody>
</table>

² Walls having aspect ratios exceeding 1.5:1 shall be blocked shear walls in accordance with SDPWS Table 4.3.4.
**WFCM PRESCRIPTIVE - WIND**

2018 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 (psf)</th>
<th>Maximum Shear Wall Segment Aspect Ratio</th>
<th>Sheathing Type Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>interior Wall Sheathing</strong></td>
<td></td>
<td>Wind</td>
<td>Seismic</td>
<td>Wind</td>
</tr>
<tr>
<td>8d common nails - 6&quot; edge spacing</td>
<td>356</td>
<td>229</td>
<td>1.5</td>
<td>1.04</td>
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<tr>
<td>No Sheathing or Non-Rated Sheathing</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1/2&quot; Gypsum Wallboard (Unblocked)²</td>
<td>5d cooler nails - 7&quot; edge spacing</td>
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<td>229</td>
<td>1.5</td>
</tr>
<tr>
<td>3/8&quot;, 7/16&quot;, and 15/32&quot; Wood Structural Panels (blocked)</td>
<td>8d common nails - 6&quot; edge spacing</td>
<td>672</td>
<td>478</td>
<td>1.5</td>
</tr>
</tbody>
</table>

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

8.8’ x 1.3 = 11.4’

---

**WFCM PRESCRIPTIVE - WIND**

2018 WFCM Prescriptive Segmented – required = 11.4’

Segmented shear wall – assuming no interior gypsum  

4’ + 4’ + 4’ + 4’ = 16’ > 11.4’ OK
WFCM PRESCRIPTIVE - WIND

2018 WFCM Prescriptive – Segmented – Hold-downs
With and Without Gypsum

Segmented shear wall – requires hold downs on each segment

---

WFCM PRESCRIPTIVE - WIND

2018 WFCM Prescriptive – Perforated Shear Wall
% Full-height sheathing
8.8’ / 36’ = 24.4%
Interpolated = 1.83
8.8’(1.83) = 16.1’
w/ blocked gypsum

11.4’ / 36’ = 31.7%
11.4’(1.69) = 19.3’
w/o gypsum

21’ Full-height sheathing > 19.3’ OK
Note: Max. aspect ratio = 3.5:1 for PSW segments
**WFCM PRESCRIPTIVE - WIND**

2018 WFCM Prescriptive – Perforated – Hold-downs

**Hold-downs**

- Requires fully sheathed wall and hold-downs only at the ends

**WFCM PRESCRIPTIVE - WIND**

2018 WFCM Prescriptive – Hold-downs

<table>
<thead>
<tr>
<th>Hold-downs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,488 lbs w/ blocked gypsum</td>
</tr>
<tr>
<td>3,488 / 1.3 = 2,683 lbs w/o gypsum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wall Height (ft)</th>
<th>Wind</th>
<th>Seismic</th>
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<tr>
<td>8</td>
<td>3488</td>
<td>1912</td>
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<td>9</td>
<td>3924</td>
<td>2151</td>
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<td>18</td>
<td>7948</td>
<td>4302</td>
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<tr>
<td>20</td>
<td>8720</td>
<td>4780</td>
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</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
OUTLINE

- 2018 IBC/IRC Recognition
- Background and Assumptions
- Wind Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS

WFCM ENGINEERED

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Engineered Design Limitations</th>
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<tbody>
<tr>
<td>Attribute</td>
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<tr>
<td>BUILDING DIMENSIONS</td>
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<tr>
<td>Building</td>
<td>Mean Roof Height (ft)</td>
</tr>
<tr>
<td>Number of Stories</td>
<td></td>
</tr>
<tr>
<td>Building Length and Width</td>
<td></td>
</tr>
<tr>
<td>FLOOR SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>Lumber Joists</td>
<td>Joint Span</td>
</tr>
<tr>
<td>Joint Spacing</td>
<td>24&quot;</td>
</tr>
<tr>
<td>Cantilevers - Supporting loadbearing</td>
<td>d</td>
</tr>
<tr>
<td>Setbacks - Loadbearing walls</td>
<td>d</td>
</tr>
<tr>
<td>Wood Joists</td>
<td>Joint Spacing</td>
</tr>
<tr>
<td>Joint Spacing</td>
<td>24&quot;</td>
</tr>
<tr>
<td>Cantilevers</td>
<td>(see manufacturer)</td>
</tr>
<tr>
<td>Setbacks</td>
<td>(see manufacturer)</td>
</tr>
<tr>
<td>Wood Floor Trusses</td>
<td>Truss Span</td>
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<tr>
<td>Truss Spacing</td>
<td>24&quot;</td>
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<tr>
<td>Cantilevers</td>
<td>(see truss plans)</td>
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<td>Setbacks</td>
<td>(see truss plans)</td>
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<tr>
<td>Floor Diaphragms</td>
<td>Vertical Floor Offset</td>
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<tr>
<td>Floor Diaphragm Aspect Ratio</td>
<td>2:1</td>
</tr>
<tr>
<td>Floor Diaphragm Openings</td>
<td>Lesser of 12% or 50% of Building Dimension</td>
</tr>
</tbody>
</table>
**WFCM ENGINEERED – WIND**

2018 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 = \((8+1)/11\)

---

**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”, 7/16”, and 15/32” Wood Structural Panels (Blocked), maximum stud spacing 16” on center</td>
<td>8d common nails - 6” edge spacing</td>
<td>3.5:1</td>
<td>2.1*</td>
</tr>
<tr>
<td>No Sheathing or Non-Rated Sheathing</td>
<td>320</td>
<td>229</td>
<td>3.5:1</td>
</tr>
<tr>
<td>1/2” Gypsum Wallboard (Unblocked)</td>
<td>456</td>
<td>229</td>
<td>3.5:1</td>
</tr>
<tr>
<td>3/8”, 7/16”, and 15/32” Wood Structural Panels (Blocked)</td>
<td>672</td>
<td>478</td>
<td>3.5:1</td>
</tr>
</tbody>
</table>

* Walls having aspect ratios exceeding 1.5:1 shall be blocked shear walls in accordance with SDPWS Table 4.3.4.
**WFCM ENGINEERED – WIND**

2018 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)

*Assuming interior blocked gypsum - OK*
**WFCM ENGINEERED – WIND**

2018 WFCM Engineered - Segmented

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

---

**WFCM ENGINEERED – WIND**

2018 WFCM Engineered - Perforated
Reference SDPWS Capacities and Adjustments
V = 2,985 lbs

\[ v = 436 \text{ plf (w/ blocked gypsum)} \]
\[ v = 336 \text{ plf (w/o gypsum)} \]

\[ \%FHS = \frac{L_i}{L_{tot}} \]
\[ L_i = 16' + 2[2(2.5)/8]2.5' = 19.1' \]
\[ L_{tot} = 36' \]
\[ \%FHS = 19.1' / 36' = 53\% \]
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
**WFCM ENGINEERED – WIND**

2015 WFCM Engineered - Perforated

19.1' Effective Full-height sheathing > 15.1' OK

**WFCM ENGINEERED – WIND**

2015 WFCM Engineered – Hold-downs

\[ T = v \times h \]

- \( v = 436 \text{ plf (w/ blocked gypsum)} \)
- \( v = 336 \text{ plf (w/o gypsum)} \)
- \( h = 8' \)

\[ T = 436(8') = 3,488 \text{ lbs} \]

\[ T = 336(8') = 2,688 \text{ lbs} \]

- 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

OUTLINE

• 2018 IBC/IRC Recognition
• Background and Assumptions
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  • 2015 WFCM Engineered
  • 2015 SDPWS
### 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>B WIND (plf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Structural Panels - Structural</td>
<td>1-1/4</td>
<td>10d</td>
<td>6s</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Wood Structural Panels - Sheathing</td>
<td>1-1/4</td>
<td>10d</td>
<td>6s</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

ASD Capacity = 670/2 = 335 plf

---

#### 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>Min. Stab Spacing (in.)</th>
<th>B WIND (plf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum and Portland Cement Plaster</td>
<td>5/8&quot;</td>
<td>2</td>
<td>24</td>
<td></td>
<td>200</td>
</tr>
</tbody>
</table>

ASD Capacity = 200/2 = 100 plf
### 2015 SDPWS

#### Table 4.3.4 Maximum Shear Wall Aspect Ratios

<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>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>

Notes:
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, $\delta_{max}$, 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 20/h, the nominal shear capacities need not be reduced by the adjustment in 4.3.4.2.

---

### 2015 SDPWS - WIND

#### 4.3.4 Shear Wall Aspect Ratios and Capacity Adjustments

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 - 0.125b/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 - WIND**

**2015 SDPWS**

Required Capacity = 2,985 lbs
WSP = 335 plf
Gypsum = 100 plf
Total = 435 plf

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

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

![Table 4.3.4 Maximum Shear Wall Aspect Ratios](image)

1. Walls having aspect ratios exceeding 1:5:1 shall be blocked shear walls.

**SDPWS - WIND**

2015 SDPWS – Segmented Shear Wall

2,985 lbs

\[
4' + 4' = 8' > 6.9' \text{ OK}
\]

assuming interior blocked gypsum
**SDPWS - WIND**

2015 SDPWS – Segmented Shear Wall

4' + 2.5'(0.625) + 2.5'(0.625) + 4' = 11.1' > 8.9' 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

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

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

- **h** = 8’
- **Li** = 16’ + 2[2(2.5)/8]2.5’ = 19.1’
- **L_{tot}** = 36’
- **A_o** = 4(4’)(2.5’) + 5’(6.67’) = 73.4 ft²
- **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 = \( 2b_s/h \)

Note: **Li** 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
  - \( \frac{2,985}{335} = 8.9' \)

- **w/o gypsum**
  - 335 (0.77) = 258
  - \( \frac{2,985}{258} = 11.6' \)

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

## 2015 SDPWS – Perforated Shear Wall

![Perforated Shear Wall Diagram](image)

- **2,985 lbs**
- **19.1' Effective Full-height sheathing > 11.6'** OK

## SDPWS - WIND

### 2015 SDPWS – Hold-downs (Segmented)

\[ T = v \times h \]

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

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

\[ h = 8' \]

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

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

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

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

where:

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

\[ T = \frac{C_o V h}{\sum L_i} \] (4.3.8)

\[ \text{where:} \]

- \( C_o = \) shear capacity adjustment factor from Table 4.3.3.5
- \( V = \) induced shear force in perforated shear wall, lbs
- \( \sum L_i = \) sum of perforated shear wall segment lengths \( L_i \). Lengths of perforated shear wall segments with aspect ratio greater than 2:1 shall be adjusted in accordance with 4.3.4.3.

- 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**

1st of 2-story; \( W = 30' \); \( L = 36' \); GSL = 30psf; 130 mph Exposure B

<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>2018 WFCM Engineered</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 [1,624] [PSW]</td>
</tr>
</tbody>
</table>
OUTLINE

- 2018 IBC/IRC Recognition
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  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Shear Wall Detailing (time permitting)

DESIGN EXAMPLE - SEISMIC

Assumptions
Seismic Design Category D1
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

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  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Shear Wall Detailing (time permitting)
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>23</td>
<td>1.1.3.1a</td>
<td>1.2</td>
</tr>
<tr>
<td>Number of Stories</td>
<td>3</td>
<td>1.1.3.1b</td>
<td>-</td>
</tr>
<tr>
<td>Building Length and Width</td>
<td>80'</td>
<td>1.1.3.1b</td>
<td>-</td>
</tr>
<tr>
<td>LOAD ASSUMPTIONS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(See Chapter 3 or Chapter 3 tables for load assumptions applicable to the specific tabulated requirement)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Type</td>
<td>Load Assumption</td>
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<tr>
<td>Partition Dead Load</td>
<td>0.8 psf of floor area</td>
<td></td>
<td></td>
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<tr>
<td>Wall Assembly Dead Load</td>
<td>11-18 psf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Dead Load</td>
<td>10-20 psf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof/Ceiling Assembly Dead Load</td>
<td>0-25 psf</td>
<td></td>
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</tr>
<tr>
<td>Floor Live Load</td>
<td>30-40 psf</td>
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</tr>
<tr>
<td>Roof Live Load</td>
<td>20 psf</td>
<td></td>
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</tr>
<tr>
<td>Ceiling Live Load</td>
<td>10-20 psf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Snow Load</td>
<td>0-20 psf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Load</td>
<td>90-135 mph wind speed (15-second gust)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seismic Load</td>
<td>Seismic Design Category (SDC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SDC A, B, C, D, E, and F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wood Shear Wall Seismic and Wind Design
### 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>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>
<tr>
<td><strong>FLOOR SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Joists</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joist Span</td>
<td>26'</td>
<td>3.1.3.2a</td>
<td>-</td>
</tr>
<tr>
<td>Joist Spacing</td>
<td>24&quot; o.c.</td>
<td>3.1.3.2b</td>
<td>-</td>
</tr>
<tr>
<td>Cantilevers - Supporting loadbearing walls¹</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>
</tr>
<tr>
<td>Floor Diaphragm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Floor Offset</td>
<td>d_v</td>
<td>3.1.3.2e</td>
<td>2.1i</td>
</tr>
<tr>
<td>Floor Diaphragm Aspect Ratio</td>
<td></td>
<td>Tables 3.16B and 3.16C</td>
<td>3.1.3.2f</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** Sectioned 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 trimmed. For other sheathing materials or sheathing configurations see 3.4.4.2.1.
### WFCM PRESCRIPTIVE - SEISMIC

2018 WFCM Prescriptive – Segmented Shear Wall

#### Table 3.17C1

<table>
<thead>
<tr>
<th>Shear Wall Line Beneath</th>
<th>SDC $D_1$</th>
<th>SDC $D_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L/W</td>
<td>L/W</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>1.5</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Minimum Building Dimension, $W$ (ft)

- Roof, Ceiling, & 1 Floor
  - 12
  - 15
  - 20
  - 25
  - 30
  - 35


GSL = 30

Interpolate = 15.8'

Required length of full height sheathing (FHS)

---

### WFCM PRESCRIPTIVE - SEISMIC

2018 WFCM Prescriptive – Segmented

Footnotes to Table 3.17C

1. Full-height sheathing lengths can be determined for either dead load cases by multiplying by 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 = 75 psf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Full height sheathing length (ft)</td>
<td>Full height sheathing length (ft)</td>
</tr>
<tr>
<td>12</td>
<td>1.34</td>
<td>1.09</td>
<td>1.26</td>
</tr>
<tr>
<td>15</td>
<td>1.42</td>
<td>1.11</td>
<td>1.29</td>
</tr>
<tr>
<td>20</td>
<td>1.40</td>
<td>1.12</td>
<td>1.33</td>
</tr>
<tr>
<td>25</td>
<td>1.36</td>
<td>1.12</td>
<td>1.33</td>
</tr>
<tr>
<td>30</td>
<td>1.35</td>
<td>1.12</td>
<td>1.33</td>
</tr>
<tr>
<td>35</td>
<td>1.35</td>
<td>1.12</td>
<td>1.33</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 30 psf. $S_{gw}$ used for SDC A, B, C, D1, D2 and D2 are as follows: $S_{gw} = 0.17$ for SDC A; $S_{gw} = 0.33$ for SDC B; $S_{gw} = 0.50$ for SDC C; $S_{gw} = 0.67$ for SDC D1; $S_{gw} = 0.83$ for SDC D2.

Adjusted = 15.8' (1.2) = 19'

Required length of FHS
### WFCM PRESCRIPTIVE - SEISMIC

#### 2018 WFCM Prescriptive – Segmented

<p>| Table 3.17D Shear Wall Assembly Allowable Unit Shear Capacities, Maximum Shear Wall Segment Aspect Ratios, and Sheathing Type Adjustments |
|---|---|---|---|---|---|
| Exterior Wall Sheathing | Nails and Spacing Requirements | ASD Unit Shear Capacity of Wall Assembly (psf) | Maximum Shear Wall Segment Aspect Ratio | Sheathing Type Adjustment Factor |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Wind</th>
<th>Seismic</th>
<th>Wind</th>
<th>Seismic</th>
<th>Wind</th>
<th>Seismic</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>8d common nails - 6&quot; edge spacing</td>
<td>336</td>
<td>239</td>
<td>2:1</td>
<td>2:1</td>
<td>1.30</td>
<td>1.00</td>
</tr>
<tr>
<td>No Sheathing or Non-Rated Sheathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2&quot; Gypsum Wallboard (unblocked)</td>
<td>6d common nails - 7&quot; edge spacing</td>
<td>436</td>
<td>239</td>
<td>2:1</td>
<td>2:1</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>3/8&quot;, 7/16&quot;, and 15/32&quot; Wood Structural Panels (blocked)</td>
<td>8d common nails - 6&quot; edge spacing</td>
<td>572</td>
<td>478</td>
<td>2:1</td>
<td>2:1</td>
<td>0.85</td>
<td>0.50</td>
</tr>
</tbody>
</table>

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 = \( c_{\delta_{\text{shear}}} = \frac{2b_s}{h} \) (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, \( \delta_{\text{shear}} \), in each shear wall.

**Exceptions:**
1. Where nominal shear capacities of all wood structural panel shear walls with aspect ratios \( \left( \frac{h}{b_s} \right) \) greater than 2:1 are multiplied by 2\( b_s / h \) 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 2\( b_s / h \), the nominal shear capacities need not be reduced by the adjustment in 4.3.4.2.
2018 WFCM Prescriptive – Segmented – required = 19'

\[ 4(4') + 2(2.5') = 21' \text{ actual length} \]
\[ 4(4')+ 2(2.5')(2(2.5)/8) = 19.1' \text{ effective length} \]

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

**WFCM PRESCRIPTIVE - SEISMIC**

2018 WFCM Prescriptive – Segmented – Hold-downs

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

19'(1.40) = 26.6'
Req'd length of FHS

26.6' req'd FHS > 19.1' effective FHS NG

SDPWS adjustment = 2b/h
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

---

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

Hold-downs
- \( \frac{1,912}{0.53} = 3,608 \text{ lbs} \)

For segmented wall @ 6/12 nailing

- 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 16” oc max.
   b) 3/8” wood structural panels on the exterior
   c) 8d common nails at 6” oc panel edges
   d) All of the above

OUTLINE

• 2018 IBC/IRC Recognition
• Background and Assumptions
• Wind Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
• Seismic Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
• Shear Wall Detailing (time permitting)
### WFCM ENGINEERED - SEISMIC

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

<table>
<thead>
<tr>
<th>Diaphragm level</th>
<th>Calculating diaphragm unit shear capacity requirements (psi)</th>
<th>Calculating total shear at each level (lb) for shear capacity requirements for shear walls and connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof/ Ceiling (RD)</td>
<td>$W_{FD2} + W_{FD1} + W_{FD} + W_{FD} + W_{FD} + W_{FD}$</td>
<td>$V_F = \frac{1.1}{2.5} W_{FD2}$</td>
</tr>
<tr>
<td>1st Floor (FD2)</td>
<td>$W_{FD2} + W_{FD2} + W_{FD2} + W_{FD2}$</td>
<td>$V_F = \frac{1.1}{2.5} W_{FD2}$</td>
</tr>
<tr>
<td>2nd Floor (FD1)</td>
<td>$W_{FD2} + W_{FD2} + W_{FD2}$</td>
<td>$V_F = \frac{1.1}{2.5} W_{FD2}$</td>
</tr>
</tbody>
</table>

| WFD2 = 83,680 lbs |
| VFD2 = 1.1 (83,680) 0.83 / 6.5 = 8,228 lbs |

---

**Table 2. Engineered Design Limitations**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Limitation</th>
<th>Reference Section</th>
<th>Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Height (MH)</td>
<td>23”</td>
<td>2.1.1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Number of Stories</td>
<td>3</td>
<td>2.1.3.1</td>
<td>-</td>
</tr>
<tr>
<td>Building Length and Width</td>
<td>80’</td>
<td>2.1.3.1b</td>
<td>-</td>
</tr>
<tr>
<td>Floor Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Joists</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint Span</td>
<td>26”</td>
<td>2.1.3.2a</td>
<td>-</td>
</tr>
<tr>
<td>Joint Spacing</td>
<td>24” o.c.</td>
<td>2.1.5.2b</td>
<td>-</td>
</tr>
<tr>
<td>Cantilevers - Supporting loadbearing walls</td>
<td>d</td>
<td>2.1.3.2d</td>
<td>2.1d</td>
</tr>
<tr>
<td>Setbacks - Loadbearing walls</td>
<td>d</td>
<td>2.1.3.2d</td>
<td>2.1d</td>
</tr>
<tr>
<td>Wood I-Joists</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint Span</td>
<td>26”</td>
<td>2.1.3.2a</td>
<td>-</td>
</tr>
<tr>
<td>Joint Spacing</td>
<td>24” o.c.</td>
<td>2.1.5.2b</td>
<td>-</td>
</tr>
<tr>
<td>Cantilevers</td>
<td>(see manufacturer)</td>
<td>2.3.2.6</td>
<td>2.4a, 2.9a, 2.9b</td>
</tr>
<tr>
<td>Setbacks</td>
<td>(see manufacturer)</td>
<td>2.3.2.5</td>
<td>2.4d</td>
</tr>
<tr>
<td>Wood Floor Trusses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trans Spans</td>
<td>26”</td>
<td>2.1.3.1b</td>
<td>-</td>
</tr>
<tr>
<td>Cantilevers (see truss plans)</td>
<td>2.3.1.6</td>
<td>2.13a, 2.13b</td>
<td></td>
</tr>
<tr>
<td>Setbacks (see truss plans)</td>
<td>2.3.1.5</td>
<td>2.4d</td>
<td></td>
</tr>
</tbody>
</table>

---

**SDS for D1 = 0.83**

**R = 6.5**

**1.1 = vertical force distribution factor**
**Simplified Approach**

ASCE 7-16 Section 12.14.8

Shear at the roof diaphragm level, $V_{RO}$:

$$V_{RO} = 1.1 \times W_{W} \times S_{o}/R$$

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.
- $S_{o}$ - design frequency dependent spectral response acceleration parameter at short periods in accordance with ASCE 7-05.
- $R$ - seismic response modification factor in accordance with ASCE 7-05.

Shear at the second floor diaphragm level, $V_{SE}$:

$$V_{SE} = 1.1 \times W_{W} \times S_{o}/R$$

Shear at the first floor diaphragm level, $V_{SF}$:

$$V_{SF} = 1.1 \times W_{W} \times S_{o}/R$$

---

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

<table>
<thead>
<tr>
<th>Interior Wall Sheathing</th>
<th>Exterior Wall Sheathing</th>
<th>ASD Unit Shear Capacity of Wall Assembly (psi)</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 16&quot; on center</td>
<td>8d common nails - 6&quot; edge-spacing</td>
<td>936</td>
<td>239</td>
<td>2.1&quot;</td>
</tr>
<tr>
<td>No Sheathing or Non-Rated Sheathing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2&quot; Gypsum Wallboard (unblocked)</td>
<td>5d common nails - 7&quot; edge-spacing</td>
<td>436</td>
<td>239</td>
<td>2.1&quot;</td>
</tr>
</tbody>
</table>

* 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** = $2b_{h}$ (for stiffness)
**WFCM ENGINEERED - SEISMIC**

2018 WFCM Engineered – Segmented

Required Capacity = $\frac{8,228}{2} = 4,114$ lbs
7/16" WSP Capacity = 239 plf

\[ \frac{4,114 \text{ lbs}}{239 \text{ plf}} = 17.2' \]

Req’d length of FHS

---

**WFCM ENGINEERED - SEISMIC**

2018 WFCM Engineered – Segmented

\[ 4(4') + 2(2.5') = 21' \text{ actual length} \]
\[ 4(4') + 2(2.5')(2(2.5)/8) = 19.1' \]

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

V = 4,114 lbs

%FHS = L_i / L_{tot}
L_i = 16’ + 2(2.5)/8 = 19.1’
L_{tot} = 36’
%FHS = 19.1’ / 36’ = 53%
Interpolated C_o Factor = 0.59

239(0.59) = 141 plf
4,114/141 = 29.2’ Req’d FHS

29.2’ > 19.1’ effective FHS NG

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

---

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 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>1/8”, 7/16”, and 15/32” Wood Structural Panels (Blocked), maximum stud spacing 16” on center</td>
<td>630</td>
<td>451</td>
<td>3.5:1</td>
</tr>
<tr>
<td>1/8” Gypsum Wallboard (Unblocked)</td>
<td>730</td>
<td>451</td>
<td>3.5:1</td>
</tr>
<tr>
<td>3/8”, 7/16”, and 15/32” Wood Structural Panels (Blocked)</td>
<td>1265</td>
<td>902</td>
<td>3.5:1</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 applied in accordance with SDPWS Section 3.3.4.4 Exception 1 for wood structural panel shear walls or Exception 2 for structural fiberboard shear walls.

SDPWS adjustment = 2b/h
Wood Shear Wall Seismic and Wind Design

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 \( C_o \) 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 = 2bs/h

---

WFCM ENGINEERED - SEISMIC

2018 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>1/3</td>
<td>1/2</td>
<td>2/3</td>
</tr>
<tr>
<td>3/4</td>
<td>4/5</td>
<td>5/6</td>
</tr>
<tr>
<td>5/8</td>
<td>6/8</td>
<td>7/8</td>
</tr>
<tr>
<td>8/10</td>
<td>9/10</td>
<td>10/11</td>
</tr>
</tbody>
</table>

\[ \text{Percent Full-Height Sheathing} \]

\[ \begin{array}{cccc}
0\% & 1.00 & 0.67 & 0.50 & 0.40 & 0.33 \\
10\% & 1.00 & 0.69 & 0.53 & 0.43 & 0.36 \\
20\% & 1.00 & 0.71 & 0.56 & 0.45 & 0.38 \\
30\% & 1.00 & 0.74 & 0.59 & 0.49 & 0.42 \\
40\% & 1.00 & 0.77 & 0.63 & 0.53 & 0.45 \\
50\% & 1.00 & 0.80 & 0.67 & 0.57 & 0.50 \\
60\% & 1.00 & 0.83 & 0.71 & 0.63 & 0.56 \\
70\% & 1.00 & 0.87 & 0.77 & 0.70 & 0.63 \\
80\% & 1.00 & 0.91 & 0.83 & 0.77 & 0.71 \\
90\% & 1.00 & 0.95 & 0.91 & 0.87 & 0.83 \\
100\% & 1.00 & 1.00 & 1.00 & 1.00 & 1.00 \\
\end{array} \]

19.1' effective FHS > 15.5' req'd FHS OK
**WFCM ENGINEERED - SEISMIC**

2018 WFCM Engineered – Hold-downs

\[ T = v \cdot h \]

\[ v = 239 \text{ plf} \text{ – segmented @ 6/12} \]
\[ v = 451 \text{ plf} \text{ – perforated @ 3/12} \]
\[ h = 8' \]
\[ T = 239(8') = 1,912 \text{ lbs} \text{ - segmented} \]
\[ T = 451(8') = 3,608 \text{ lbs} \text{ - perforated} \]

- 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)

---

**POLLING QUESTION**

5. The tabulated perforated shear wall shear capacity adjustment factor is based on the maximum unrestrained opening height.

True or False
OUTLINE

- 2018 IBC/IRC Recognition
- Background and Assumptions
- Wind Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Seismic Examples
  - 2018 WFCM Prescriptive
  - 2018 WFCM Engineered
  - 2015 SDPWS
- Shear Wall Detailing (time permitting)

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 7-16 Minimum Design Loads for Buildings and Other Structures

14.5 WOOD

Structures, including foundations, constructed of wood to resist seismic loads shall be designed and detailed in accordance with this standard including the references and additional requirements provided in this section.

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: AWC NDS and AWC SDPWS.

2015 SDPWS – SEISMIC WSP CAPACITY

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
### SDPWS - SEISMIC

#### 2015 SDPWS

#### Table 4.3.4 Maximum Shear Wall Aspect Ratios

<table>
<thead>
<tr>
<th>Shear Wall Sheathing Type</th>
<th>Maximum h/b_r 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>

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 $\delta_{\text{max}}$ in each shear wall.

**Exceptions:**

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

---

#### SDPWS - SEISMIC

#### 2015 SDPWS

#### 4.3.4 Shear Wall Aspect Ratios and Capacity Adjustments

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

**Shear Distribution**

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

  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) **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(2.5)/8]2.5' = 19.1'
L_{tot} = 36'
A_o = 4(4')(2.5') + (5')(6.67') = 73.4 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_d/h
**SDPWS - SEISMIC**

2015 SDPWS – Perforated Shear Wall

\[ C_o = 0.77 \]

\[ 239 \text{ plf} \times 0.77 = 184 \text{ plf} \]

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

22.3’ > 21’ actual FHS \text{ NG}

6/12 nail spacing

---

**2015 SDPWS – SEISMIC WSP CAPACITY**

**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

\[ C_0 = 0.77 \]

350 plf (0.77) = 270 plf

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

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)**

\[ T = v \cdot h \]

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)**

\[ T = \frac{C \cdot v \cdot h}{C_0 \sum L_i} \]  \hspace{1cm} (4.3-8)

where:
- \( C_0 \) = shear capacity adjustment factor from Table 4.3.3.5
- \( C \) = compression force, lbs
- \( V \) = induced shear force in perforated shear wall, lbs
- \( L_i \) = sum of perforated shear wall segment lengths, ft

\[ V = 4,114 \text{ lbs} \]
\[ h = 8' \]
\[ L_i = 16' + 2[2(2.5)/8]2.5' \]
\[ L_i = 19.1' \]
\[ T = 2,238 \text{ lbs} \]

- 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

2018 WFCM/SDPWS Shear Wall Length Comparison
1st of 2-story; W=30'; L = 36'; GSL = 30psf; SDC D₁

<table>
<thead>
<tr>
<th>AWC Standard</th>
<th>Segmentated (SSW)</th>
<th>Perforated (PSW)</th>
<th>Hold-downs, lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 WFCM</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>17.2' (6/12)</td>
<td>15.5' (3/12)</td>
<td>1,912 [SSW]</td>
</tr>
<tr>
<td>Engineered</td>
<td></td>
<td></td>
<td>3,608 [PSW]</td>
</tr>
<tr>
<td>2015 SDPWS</td>
<td>17.0' (6/12)</td>
<td>15.2' (4/12)</td>
<td>1,723 [SSW]</td>
</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; SDC D₁

<table>
<thead>
<tr>
<th>AWC Standard</th>
<th>Wind</th>
<th>Seismic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2018 WFCM</td>
<td>2018 WFCM</td>
</tr>
<tr>
<td>Prescriptive</td>
<td>8.8' [11.4'] (6/12)</td>
<td>16.1' [19.3'] (6/12)</td>
</tr>
<tr>
<td>Engineered</td>
<td>6.8' [8.9'] (6/12)</td>
<td>11.6' [15.1'] (6/12)</td>
</tr>
<tr>
<td>2015 SDPWS</td>
<td>6.9' [8.9'] (6/12)</td>
<td>8.9' [11'] (6/12)</td>
</tr>
<tr>
<td></td>
<td>2018 WFCM</td>
<td>2018 WFCM</td>
</tr>
<tr>
<td>Prescriptive</td>
<td>19.0' (6/12)</td>
<td>17.8' (3/12)</td>
</tr>
<tr>
<td>Engineered</td>
<td>17.2' (6/12)</td>
<td>15.5' (3/12)</td>
</tr>
<tr>
<td>2015 SDPWS</td>
<td>17.0' (6/12)</td>
<td>15.2' (4/12)</td>
</tr>
</tbody>
</table>

Parenthetical values show nail spacing: (edge/field)
OUTLINE

• 2018 IBC/IRC Recognition
• Background and Assumptions
• Wind Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
• Seismic Examples
  • 2018 WFCM Prescriptive
  • 2018 WFCM Engineered
  • 2015 SDPWS
• Shear Wall Detailing (time permitting)

SHEAR WALL TEST

8 ft x 8 ft wood structural panel shear wall cyclic test
**SHEAR WALL TEST**

Typical failure of sheathing nailing

a) Nail yielding at adjoining panel edge

b) Nail yielding and head pull through at panel to bottom plate location

---

**SHEAR WALL 3X REQUIREMENTS**

At adjoining panel edges

---

Sill plate
CONNECTING WOOD - PHILOSOPHY

Splitting happens because wood is relatively weak perpendicular to grain.

Nails too close (act like a wedge)

STAGGERED NAILING

Nailing not staggered

Nailing staggered
**CONNECTING WOOD - PHILOSOPHY**

Splitting occurs parallel to grain

Staggering a line of nails parallel to wood grain minimizes splitting

Splitting will not occur perpendicular to grain, no matter how close nails are

**CH. 4 - SHEAR WALLS SHEATHED ON 2 SIDES**

Provisions for shear walls sheathed on two sides

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

<table>
<thead>
<tr>
<th>Sheathing Material</th>
<th>Minimum Panel Thickness (in.)</th>
<th>Fastener Type &amp; Size</th>
<th>OGB</th>
<th>PLV</th>
<th>OGB</th>
<th>PLV</th>
<th>OGB</th>
<th>PLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plywood</td>
<td>0.50”</td>
<td>0.75</td>
<td>100</td>
<td>20</td>
<td>100</td>
<td>20</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>0.75”</td>
<td>0.75</td>
<td>125</td>
<td>25</td>
<td>125</td>
<td>25</td>
<td>125</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1.00”</td>
<td>0.75</td>
<td>150</td>
<td>30</td>
<td>150</td>
<td>30</td>
<td>150</td>
<td>30</td>
</tr>
</tbody>
</table>

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.
CH. 4 - SHEAR WALLS SHEATHED ON 2 SIDES

Adjoining Panel Edge Details

- Adjoining panel edge
- 3x framing or blocking
- Adjoining panel edge

a. Adjoining panel edges staggered
b. Adjoining panel edges not staggered

CHAPTER 4 – CONSTRUCTION REQUIREMENTS

4.3.6.1.1 Common Framing Members
- 2-2x permitted to replace 3x
  - Fastened together per NDS
  - Spacing <4” o.c. shall be staggered
  - Applies broadly to all framing

NEW

4.3.7 Shear Wall Systems
- 2-2x permitted to replace 3x
  - Wood Structural Panels (4.3.7.1(5))
  - Particleboard (4.3.7.3(5))
(2) 2X AT ADJOINING PANEL EDGES

Section 4.3.6.1.1 General framing requirements for shear walls permit the use of two 2x members in lieu of a single member provided they are adequately connected for transfer of induced shear forces. Cyclic tests of shear walls confirm that use of two 2x members nailed (22, 25, and 30) or screwed (33) together result in shear wall performance that is comparable to that obtained by use of a single 3x member at the adjoining panel edge. While introduced as a substitute for a 3x member at adjoining panel edges in shear wall construction, it is also permissible to use two 2x members to substitute for a single 2x member (e.g. for blocking, and top plates). Attachment of the two 2x members to each other is required to equal or exceed design unit shear forces in the shear wall. As an alternative, a capacity-based design approach can be used where the connection between the two 2x members equals or exceeds the capacity of the sheathing to framing attachment. Where fastener spacing used in the interconnection of the two 2x stud members is closer than 4" on center, staggered placement is required to limit potential for wood splitting.

3X AT ADJOINING PANEL EDGE

Section 4.3.7.1(4). 3x framing also required at adjoining panel edges where:

- Nail spacing of 2 in. o.c.
- 10d common nails having penetration of more than 1-1/2 in. at 3 in. o.c. or less
- Nominal unit shear capacity on either side exceeds 700 plf in SDC D, E, or F

Exception: (2) 2x framing permitted in lieu of (1) 3x where fastened in accordance with the NDS to transfer the induced shear between members.
(2) 2X AT ADJOINING PANEL EDGES

C4.3.7 1(5): A single 3x framing member is specified at adjoining panel edges for cases prone to splitting and where nominal unit shear capacity exceeds 700 plf in seismic design categories (SDC) D, E, and F. An alternative to single 3x framing, included in SDPWS, is the use of 2-2x “stitched” or interconnected two 2x members adequately fastened together (See C4.3.6.1.1 for additional information). For sheathing attachment to framing with closely spaced or larger diameter nails, staggered nail placement at each panel edge is intended to prevent splitting in the framing member (Figure C4.2.7).

Approximate stud to stud connection spacing for wood structural panel (WSP) walls sheathed on one side.

<table>
<thead>
<tr>
<th>Nail Size and Sheathing</th>
<th>Sheathing to frame lateral value per NDS</th>
<th>Fastener spacing (lb.) for 2x stud-to-2x stud connection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(G-0.5 framing)</td>
<td>Panel edge nail spacing (lb.)</td>
</tr>
<tr>
<td>6d common, 3/8&quot; WSP (6d=0.5)</td>
<td>56</td>
<td>12.0 8.0 6.0 4.0</td>
</tr>
<tr>
<td>6d common, 3/8&quot; WSP (6d=9.5)</td>
<td>71</td>
<td>9.1 6.1 4.5 3.0</td>
</tr>
<tr>
<td>6d common, 7/16&quot; WSP (6d=8.5)</td>
<td>73</td>
<td>8.6 5.9 4.4 2.9</td>
</tr>
<tr>
<td>10d common, 15/32&quot; WSP (6d=6.2)</td>
<td>95</td>
<td>6.8 4.5 3.4 2.3</td>
</tr>
</tbody>
</table>

* Spacing based on 8’ wall and assuming only 87.5” of stud height available for stud-to-stud fastening.
### NAILS - DIAPHRAGMS

**Table 4.2A Nominal Unit Shear Capacities for Wood-Frame Diaphragms**

<table>
<thead>
<tr>
<th>Sheathing</th>
<th>Common Nails</th>
<th>Minimum Nominal Panel Thickness (in.)</th>
<th>Minimum Required Panel Thickness (in.)</th>
<th>Minimum Spacing (in.) of Diaphragm Fasteners (all cases) at Conformance Panel Edges Parallel to Load (cases 1, 2, 3 &amp; 4)</th>
<th>Minimum Spacing (in.) of Diaphragm Fasteners (all cases) at Conformance Panel Edges Perpendicular to Load (cases 1, 2, 3 &amp; 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td>8d</td>
<td>1-1/4</td>
<td>5/16</td>
<td>11/32</td>
<td>3/16</td>
</tr>
<tr>
<td>Structural</td>
<td>8d</td>
<td>1-3/8</td>
<td>7/16</td>
<td>19/32</td>
<td>3/16</td>
</tr>
<tr>
<td>Structural</td>
<td>8d</td>
<td>1-1/2</td>
<td>7/16</td>
<td>19/32</td>
<td>3/16</td>
</tr>
</tbody>
</table>

---

### NAILS – SHEAR WALLS

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

<table>
<thead>
<tr>
<th>Wood-based Panels</th>
<th>Seismic</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---
FASTENERS NOT IN NDS/SDPWS

- Yield Mode Equations can be applied to any dowel-shaped fastener
- Fastener dimensions and yield strength come from manufacturer
- ICC-ES (www.icc-es.org) Evaluation Service Reports
- Searchable database
- ESR 1539 (ISANTA) Power-driven staples & nails

ISANTA WEBSITE – TECHNICAL BULLETINS

http://isanta.org/Technical-Resources
**FOUNDATION BOTTOM PLATE**

**Plate washer:**
Must extend to within ½ in. of sheathed edge of bottom plate

**Exceptions:**
- Lower capacity sheathing materials (nominal unit shear is 400 plf or less)
- Hold-downs are sized for full overturning – neglecting dead load

**FAILURE MODE**

**Small scale test specimen to induce cross grain bending**

---

*Wood Shear Wall Seismic and Wind Design*
**FOUNDATION BOTTOM PLATE – TESTING**

Mode A and Mode B observed in small specimen testing

Small scale test specimen to induce cross grain bending
Figure 2. Shear wall assembly in test fixture

View of bottom plate after test.
CHAPTER 4 - SHEAR WALL ANCHORAGE – 3”X3” DEFAULT

Shear wall anchorage provisions at foundation – Section 4.3.6.4.3

3” x 3” x 0.229” steel
slotted hole permitted
placed within ½” of sheathing material
automatically satisfied for 2x4 plate

CHAPTER 4 - SHEAR WALL ANCHORAGE – 3”X3” DEFAULT

Shear wall anchorage provisions at foundation – Section 4.3.6.4.3

Exception: Standard cut washers permitted
Anchor bolts designed to resist shear only
Hold downs designed for uplift neglecting DL
Aspect ratio < 2:1
Limited nominal shear wall capacities
< 980 plf seismic
< 1370 plf wind
MORE INFO???

https://awc.org/codes-standards/publications

Wood Shear Wall Seismic and Wind Design Example

MORE INFO???

WFCM

SDPWS

Wood Shear Wall Seismic and Wind Design Example
MORE INFO???


https://awc.org/codes-standards/publications/nds-2018

RESOURCES

www.apawood.org
This concludes the American Institute of Architects Continuing Education Systems Course.