Combined Shear and Uplift in the 2008 Special Design Provisions for Wind and Seismic
Outline

• Loads – What Causes Uplift?
• Combined Shear and Uplift in SDPWS
• Connections for Combined Loading
Lateral Loads

- Wind Load Path
- Diaphragm SUPPORTS out-of-plane walls
- In-plane walls SUPPORT diaphragm
Wind Basics

Reactions

- UPLIFT
- OVERTURNING
- SLIDING
- SHEAR


4.4 Wood Structural Panels Designed to Resist Combined Shear and Uplift from Wind

4.4.1 Application

Wood structural panel sheathing or siding shall be permitted to be used for simultaneously resisting shear and uplift from wind forces. The ASD allowable unit uplift capacity shall be determined by dividing the tabulated nominal uplift capacity in Table 4.4.1, modified by applicable footnotes, by the ASD reduction factor of 2.0. The LRFD factored unit uplift resistance shall be determined by multiplying the tabulated nominal uplift capacity in Table 4.4.1 modified by applicable footnotes, by a resistance factor, \( \phi \), of 0.65.

- Combined Wind Uplift & Shear - WSP
- Wood structural panels (WSP)
- Resist combined wind uplift and shear
- Resist tension only from wind uplift
- Alternate to metal straps
**Table 4.4.1 Shear & Uplift**

- **Amount of available uplift capacity beyond shear capacity**

| Table 4.4.1 Nominal Uplift Capacity of 7/16" Minimum Wood Structural Panel Sheathing or Siding When Used for Both Shear Walls and Wind Uplift Simultaneously over Framing with a Specific Gravity of 0.42 or Greater ¹ |

<table>
<thead>
<tr>
<th>Nail Spacing Required for Shearwall Design</th>
<th>6d Common Nail 6&quot; panel edge spacing 12&quot; field spacing</th>
<th>8d Common Nail 6&quot; panel edge spacing 12&quot; field spacing</th>
<th>8d Common Nail 4&quot; panel edge spacing 12&quot; field spacing</th>
<th>10d Common Nail 6&quot; panel edge spacing 12&quot; field spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Nail Spacing at Top and Bottom Plate Edges</td>
<td>6&quot;</td>
<td>4&quot;</td>
<td>3&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Nails- Single Row ²</td>
<td>0</td>
<td>168</td>
<td>336</td>
<td>0</td>
</tr>
<tr>
<td>Nails- Double Row ³</td>
<td>336</td>
<td>672</td>
<td>1008</td>
<td>432</td>
</tr>
</tbody>
</table>
Combined Wind Uplift & Shear - WSP

- Minimum panel thickness = 7/16"
- Vertical sheathing
- Minimum spacing of fasteners in a row = 3"
- Horizontal blocking
- All shear wall types
  - Individual full-height
  - Perforated
  - Force-transfer
• **Critical details**
  
  • *Note minimum edge distance is 1/2"*
Combined Wind Uplift & Shear - WSP

- Sheathing tension splice vs. shear blocking
# Combined Wind Uplift & Shear - WSP

## Sheathing Splices per 4.4.1.7

<table>
<thead>
<tr>
<th>Number of Stories</th>
<th>No Horizontal Sheathing Joint over Studs</th>
<th>Horizontal Sheathing Joint over Studs</th>
<th>Sheathing Tension Splice over Studs</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Story</td>
<td>No splice required</td>
<td>• Blocking to resist shear (4.4.1.3)</td>
<td>Resists both shear and uplift (4.4.1.7 Exception)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Stud nailing to resist uplift (4.4.1.7(2))</td>
<td></td>
</tr>
<tr>
<td>Multi-Story</td>
<td>Nail spacing at common horizontal framing ≥ 3” single row or ≥ 6” double row (4.4.1.7 (1) and Fig. 4H)</td>
<td>• Blocking to resist shear (4.4.1.3)</td>
<td>Resists both shear and uplift (4.4.1.7 Exception)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Stud nailing to resist uplift (4.4.1.7(2))</td>
<td></td>
</tr>
</tbody>
</table>
Combined Wind Uplift & Shear - WSP

- Multi-story – sheets splice at band joist

**Figure 4H  Panel Splice Occurring over Horizontal Framing Member**

Nail spacing limited to address tension perp

- 6” o.c. minimum
- 3” o.c. minimum
Combined Wind Uplift & Shear - WSP

- Multi-story – sheets splice at stud mid-height

**Figure 4I  Panel Splice Occurring across Studs**

- Double top plates
- Panel attachment to upper top plate (see Figure 4G)
- Increase stud nailing for uplift (each side of horizontal joint)
- Nailing provided in studs on each side of horizontal joint
- Panel edge
- 3/4" Spacing (for shear wall design)
- Blocking, same species as top and bottom plates (2x flatwise shown)
- Panel attachment to bottom plate (see Figure 4G)
- Increase stud nailing for uplift (each side of horizontal joint)

Combined

Uplift

Shear
Example: Splice over studs

- **110 MPH Exposure B**
- **Uplift to resist: 277 plf**
- Use \(2.0 \times 277 = 554\) plf and Table 4.4.1 below

### Table 4.4.1 Nominal Uplift Capacity of 7/16" Minimum Wood Structural Panel Sheathing or Siding When Used for Both Shear Walls and Wind Uplift Simultaneously over Framing with a Specific Gravity of 0.42 or Greater

<table>
<thead>
<tr>
<th>Nail Spacing Required for Shearwall Design</th>
<th>6d Common Nail</th>
<th>8d Common Nail</th>
<th>8d Common Nail</th>
<th>10d Common Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot; panel edge spacing</td>
<td>6&quot; field spacing</td>
<td>12&quot; field spacing</td>
<td>12&quot; field spacing</td>
<td>12&quot; field spacing</td>
</tr>
<tr>
<td>12&quot; field spacing</td>
<td>8&quot; field spacing</td>
<td>3&quot; field spacing</td>
<td>3&quot; field spacing</td>
<td>3&quot; field spacing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternate Nail Spacing at Top and Bottom Plate Edges</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Uplift Capacity (plf) of Wood Structural Panel Sheathing or Siding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nails-Single Row 4</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>Nails-Double Row 5</td>
</tr>
<tr>
<td>336</td>
</tr>
</tbody>
</table>
Combined Wind Uplift & Shear - WSP

- Example: Splice over studs
  - Uplift too high to allow multi-story splice to occur over band joist, so design splice over studs

4.4.1.7 Sheathing Splices

1. In multi-story applications where the upper story and lower story sheathing adjoin over a common horizontal framing member, the nail spacing shall not be less than 3" o.c. for a single row nor 6" o.c. for a double row in Table 4.4.1 (see Figure 4H).

Table 4.4.1 Nominal Uplift Capacity of 7/16" Minimum Wood Structural Panel Sheathing or Siding When Used for Both Shear Walls and Wind Uplift Simultaneously over Framing with a Specific Gravity of 0.42 or Greater

<table>
<thead>
<tr>
<th>Nail Spacing Required for Shearwall Design</th>
<th>6d Common Nail 6&quot; panel edge spacing 12&quot; field spacing</th>
<th>6d Common Nail 6&quot; panel edge spacing 12&quot; field spacing</th>
<th>8d Common Nail 4&quot; panel edge spacing 10&quot; field spacing</th>
<th>8d Common Nail 6&quot; panel edge spacing 12&quot; field spacing</th>
<th>10d Common Nail 6&quot; panel edge spacing 12&quot; field spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nails-Single Row</td>
<td>0</td>
<td>168</td>
<td>336</td>
<td>0</td>
<td>216</td>
</tr>
<tr>
<td>Nails-Double Row 5</td>
<td>336</td>
<td>672</td>
<td>1008</td>
<td>432</td>
<td>864</td>
</tr>
</tbody>
</table>
Combined Wind Uplift & Shear - WSP

- Example: Splice over studs

Double row
8d nails @ 4” o.c.
Example: Splice over studs

Single row 8d nails @ 4” o.c.

See 4.4.1.7 (1)
Additional nails (n) required above and below joint in studs to resist uplift capacity (4.4.1.7(2)):

For 8d @ 4” & 12” ASD Capacity = 324 plf > 277 plf OK

\[ n = \frac{[324 \times 16/12]}{Z \times C_D} \]

\[ = \frac{[324 \times 16/12]}{[67 \times 1.6]} \]

\[ = 4.03 \text{ use 4 nails per stud} \]

### Example: Splice over studs

![Diagram showing nail placement and stud dimensions](image)

**Combined Wind Uplift & Shear - WSP**

**Table: Nail Spacing Required for Shearwall Design**

<table>
<thead>
<tr>
<th>Nail Spacing Required for Shearwall Design</th>
<th>6d Common Nail 6” panel edge spacing</th>
<th>8d Common Nail 6” panel edge spacing</th>
<th>8d Common Nail 4” panel edge spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>12” field spacing</td>
<td>12” field spacing</td>
<td>12” field spacing</td>
<td></td>
</tr>
<tr>
<td><strong>Alternate Nail Spacing at Top and Bottom Plate Edges</strong></td>
<td>6”</td>
<td>4”</td>
<td>3”</td>
</tr>
<tr>
<td>Uplift Capacity (plf) of Wood Structural Panel Sheathing or Sid</td>
<td>0</td>
<td>168</td>
<td>336</td>
</tr>
<tr>
<td>Nails-Single Row *</td>
<td>336</td>
<td>672</td>
<td>1008</td>
</tr>
<tr>
<td>Nails-Double Row *</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Check field nailing requirements for stud supporting 4 x 12 panel below the rim joist:

Min. stud length on 4 x 12 panel below rim = 31.875”

#nails/stud = 31.875”/12” + 1 = 3.65 nails = 4 nails

Total # nails required/stud = 4 + 4 = 8 nails

Spacing: 31.875”/(8-1) = 4.55”

Specify 4” o.c. in field
Combined Wind Uplift & Shear - WSP

- **Uplift only case**
  - Single or double row of fasteners
  - Tension not shear
  - Test verified

---

**Table 4.4.2 Nominal Uplift Capacity of 3/8" Minimum Wood Structural Panel Sheathing or Siding When Used for Wind Uplift Only over Framing with a Specific Gravity of 0.42 or Greater**

<table>
<thead>
<tr>
<th>Nails</th>
<th>6d Common Nail</th>
<th>8d Common Nail</th>
<th>10d Common Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6&quot; panel edge spacing</td>
<td>12&quot; field spacing</td>
<td>6&quot; panel edge spacing</td>
</tr>
<tr>
<td></td>
<td>6&quot;</td>
<td>4&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Alternate Nail Spacing at Top and Bottom Panel Edges</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nails-Single Row</td>
<td>320</td>
<td>480</td>
<td>640</td>
</tr>
<tr>
<td>Nails-Double Row</td>
<td>640</td>
<td>960</td>
<td>1280</td>
</tr>
</tbody>
</table>
Combined Wind Uplift & Shear - WSP

- **Default anchorage (4.4.1.6)**
  - Anchor bolts at 16" o.c. with 3" x 3" x 0.229" steel plate washer
  - Plate washer within ½" of sheathing face that provides uplift
  - Resist cross grain bending of bottom plate
Connector Options

- Connector options
  - Manufacturer’s catalog (examples shown are Simpson StrongTie and USP) and product evaluation reports
  - WFCM Table A-3.4 (1-1/4” wide x 20 gage metal strap option)
Dead Load and Wind Loads

- Dead load can be used to reduce uplift forces
  - Reflected in load combinations

- Dead load should not be used to reduce both uplift AND overturning forces
  - If using DL to reduce straps, don’t use it for hold downs
Questions?

www.awc.org
info@awc.org