WORKBOOK
Design of Wood Frame Buildings for High Wind, Snow and Seismic Loadings

American Forest & Paper Association
American Wood Council
In Cooperation with the International Code Council®
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American Wood Council
Engineered and Traditional Wood Products

AWC Mission Statement
To increase the use of wood by assuring the broad regulatory acceptance of wood products, developing design tools and guidelines for wood construction, and influencing the development of public policies affecting the use of wood products.

The American Wood Council (AWC) is the wood products division of the American Forest & Paper Association (AF&PA). AF&PA is the national trade association of the forest, paper, and wood products industry, representing member companies engaged in growing, harvesting, and processing wood and wood fiber; manufacturing pulp, paper, and paperboard products from both virgin and recycled fiber; and producing engineered and traditional wood products. For more information see www.afandpa.org.
WOOD FRAME CONSTRUCTION MANUAL

WORKBOOK

Design of Wood Frame Buildings for High Wind, Snow and Seismic Loadings

American Forest & Paper Association
American Wood Council

In Cooperation with the International Code Council®
Wood Frame Construction Manual Workbook

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AMERICAN WOOD COUNCIL
This Wood Frame Construction Manual Workbook (WFCM Workbook) provides a design example, typical checklist, and background information related to design of a wood-frame structure in accordance with AF&PA’s Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings, 2001 Edition. The design example uses plans from a 2-story residence designed to resist wind, seismic and snow loads. Typically, these load conditions do not all apply to the same structure (e.g., usually only 2 of these conditions are evaluated depending on the geographic location and local building code requirements). However, all three load conditions are evaluated in this example to show the broader range of applicability of the WFCM. The authority having jurisdiction should be consulted for applicable load conditions.

The design example is based primarily on prescriptive provisions found in Chapter 3 of the WFCM. References to page numbers, tables and section numbers are for those found in the 2001 WFCM, unless noted otherwise. Additional engineering provisions or alternate solutions are provided where necessary. See the American Wood Council website (www.awc.org) for an in-depth overview of the WFCM.

While building codes (and the WFCM) are organized based on the construction sequence (foundation to roof), this design example is organized based on the typical design sequence (roof to foundation).

The Association invites and welcomes comments, inquiries and suggestions relative to the provisions of this document.

American Forest & Paper Association
American Wood Council

The design example herein is based on AWC’s Colonial Homes Idea House in Williamsburg, VA designed by nationally acclaimed architect William E. Poole. The house was opened to the public in June 1995, and was featured in the October 1995 issue of Colonial Homes magazine.

The 47,000 square foot colonial style mansion featured both traditional and modern wood applications. The façade replicates a historical home in Connecticut. Clad in southern pine siding, the house had glulam door headers, oak floors, and antiqued wood kitchen cabinets. But what caught visitors’ attention most were the intricate wood moldings throughout the house and the inlaid wood design bordering the foyer floor.
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<th>Page</th>
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**WFCM Workbook**  
**General Information**

**BUILDING DESCRIPTION**

**Bottom Floor Plan**

- Master Bedroom
- Study
- Family Room
- Dining Room
- Breakfast Area
- Kitchen
- Master Bath
- Living Room
- Closet
- Foyer

**Top Floor Plan**

- Bedroom 2
- Bath
- Bedroom 3
- Plant Shelf

**Openings**

**Windows**
- Typical 3’x4'-6"
- Master Bath 6’x4'-6"
- Foyer 6’x4'-6"
- Kitchen 6’x6'
- North Bath 4’x6'

**Doors**
- Typical 3’x7'-6"
- Master Bedroom 8’x8'-4"
- Foyer 6’x7'-6"
- Family Room 9’x7'-6"
- Kitchen 3’x8'-4"

**Dimensions**

- First Floor Wall Height = 9’ (Main) 10’ (Wings)
- Second Floor Wall Height = 9’
- Finished Grade to Foundation Top = 1’
- Floor Assembly Height = 1’
- Overall Building Dimension = 35’ x 72’
- Basement under Main House, Slab on Grade under Wings
- Roof Pitch = 12:12
- House Mean Roof Height = 29’
- (1’+9’+½(32’))
- Wing Mean Roof Height = 18’
- (1’+9’+½(32’))
- Roof Overhangs = 2’

**Notes**

- North Bath 4’x6’
- Raised Ceiling
- Roof Overhangs = 2’

**American Forest & Paper Association**
LOADS ON THE BUILDING

Structural systems in the *WFCM 2001 Edition* have been sized using dead, live, snow, seismic and wind loads in accordance with the 2000 *International Building Code*.

**Lateral Loads:**

**Wind:**

3-second gust wind speed in Exposure Category B = 120 mph

**Seismic:**

Seismic Design Category (SDC) = D1

Short period design spectral response acceleration ($S_{D0}$) = 0.83

One second period design spectral response acceleration ($S_{D1}$) = 0.48

Seismic response coefficient ($C_s$) = 0.1383

**Gravity Loads:**

**Roof:**

- Roof Dead Load = 10 psf
- Roof Snow Load
  - Ground Snow Load, $P_g$ = 30 psf
  - Flat Roof Snow Load (calculated from *ASCE 7-98* – see *WFCM Commentary* Table 2.14B)
    - $= 1.5(0.7)P_g C_e C_I$
    - $= (1.5)(0.7)(30)(1.0)(1.1)(1.0)$
    - $= 34.65$ psf
    - $= 35$ psf

**Floors:**

- First Floor Live Load = 40 psf
- Second Floor Live Load = 30 psf
- Attic Floor Live Load = 20 psf
- Floor Dead Load = 10 psf

**Walls:**

- Wall Dead Load = 11 psf

**Displacements:**

- Roof Rafters with Ceiling Attached $L/\Delta = 240$
- Roof Rafters with no Ceiling Attached $L/\Delta = 180$
- Floor Joists $L/\Delta = 360$
### WFCM APPLICABILITY LIMITATIONS (p. 2)

The following table is used to determine whether the building geometry is within the applicability limitations of the *WFCM*. Conditions not complying with the limitations shall be designed in accordance with accepted engineer practice (see *WFCM* 1.1.3).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Limitation</th>
<th>Design Case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BUILDING DIMENSIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Stories</td>
<td>maximum 3</td>
<td>3' &lt; 3'</td>
</tr>
<tr>
<td></td>
<td>minimum Flat</td>
<td>12:12</td>
</tr>
<tr>
<td>Roof Slope</td>
<td>maximum 12:12</td>
<td></td>
</tr>
<tr>
<td>Mean Roof Height (MRH)</td>
<td>maximum 33'</td>
<td>29'</td>
</tr>
<tr>
<td>Building Dimension (L or W)</td>
<td>minimum 80'</td>
<td>32&quot;</td>
</tr>
<tr>
<td></td>
<td>maximum 1:4</td>
<td>1:2</td>
</tr>
<tr>
<td>Building Aspect Ratio (L/W)</td>
<td>minimum 4:1</td>
<td>2:1</td>
</tr>
</tbody>
</table>

1. Building designed as a 3-story structure since the roof slope exceeds 6:12 (see WFCM 3.1.3.1).
2. Building dimensions based on design as separate structures (Option 1).
# PRESCRIPTIVE DESIGN LIMITATIONS (p. 106)

The following table is used to determine whether the building geometry is within the applicability limitations of the WFCM Chapter 3 prescriptive provisions. Conditions not complying with the limitations shall be designed in accordance with WFCM Chapter 2 (see WFCM 3.1.3).

<table>
<thead>
<tr>
<th>Element</th>
<th>Attribute</th>
<th>Limitation</th>
<th>Design Case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FLOOR SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Joists</td>
<td>Joist Span</td>
<td>26' maximum</td>
<td>16'</td>
</tr>
<tr>
<td></td>
<td>Joist Spacing</td>
<td>24&quot; maximum</td>
<td>16&quot;</td>
</tr>
<tr>
<td></td>
<td>Cantilevers/Setback - Supporting loadbearing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>walls or shearwalls</td>
<td>d maximum</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Cantilevers - Supporting non-loadbearing wall</td>
<td>L/4 maximum</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>non-shearwall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Diaphragms</td>
<td>Vertical Floor Offset</td>
<td>d_f maximum</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Floor Diaphragm Aspect Ratio</td>
<td>3:1 maximum</td>
<td>2:1</td>
</tr>
<tr>
<td></td>
<td>Floor Diaphragm Openings</td>
<td>Lesser of 12' or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>50% of Diaphragm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dimension</td>
<td></td>
</tr>
<tr>
<td><strong>WALL SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall Studs</td>
<td>Loadbearing Wall Height</td>
<td>10' maximum</td>
<td>10'</td>
</tr>
<tr>
<td></td>
<td>Non-Loadbearing Wall Height</td>
<td>20' maximum</td>
<td>16'</td>
</tr>
<tr>
<td></td>
<td>Wall Stud Spacing</td>
<td>24&quot; maximum</td>
<td>16&quot;</td>
</tr>
<tr>
<td>Shearwalls</td>
<td>Shearwall Line Offset</td>
<td>4&quot; maximum</td>
<td>3'</td>
</tr>
<tr>
<td></td>
<td>Shearwall Story Offset</td>
<td>d maximum</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Shearwall Segment Aspect Ratio</td>
<td>3½:1 maximum</td>
<td>3:1</td>
</tr>
<tr>
<td><strong>ROOF SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Rafters</td>
<td>Rafter Span (Horizontal Projection)</td>
<td>26&quot;³ maximum</td>
<td>16'</td>
</tr>
<tr>
<td></td>
<td>Rafter Spacing</td>
<td>24&quot; maximum</td>
<td>16&quot;</td>
</tr>
<tr>
<td></td>
<td>Eave Overhang Length</td>
<td>Lesser of 2' or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>rafter length/3</td>
<td>2'</td>
</tr>
<tr>
<td></td>
<td>Rake Overhang Length</td>
<td>Lesser of 2' or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>purlin span/2</td>
<td>24&quot;</td>
</tr>
<tr>
<td></td>
<td>Roof Slope</td>
<td>12:12 maximum</td>
<td>12:12</td>
</tr>
<tr>
<td>Roof Diaphragms</td>
<td>Roof Diaphragm Aspect Ratio</td>
<td>3:1 maximum</td>
<td>2:1</td>
</tr>
</tbody>
</table>

1 Exception: For roof live loads and ground snow loads less than or equal to 20 psf and 30 psf, respectively, lumber floor joist cantilevers supporting load-bearing walls shall not exceed one-eighth of the backspan when supporting only a roof load where the roof clear span does not exceed 28 feet.

2 Shear wall segments aspect ratios are limited to a maximum of 2:1 for seismic loads (Table 3.17D Footnote 3). 2003 International Building Code (IBC) Table 2305.3.3 footnote a., permits a 2w/h reduction for shear walls not meeting maximum shear wall aspect ratio of 2:1 for seismic loads.

3 For roof snow loads, tabulated spans are limited to 20 ft, to account for unbalanced snow loading in the table.
LOAD PATHS

A continuous load path shall be provided to transfer all lateral and vertical loads from the roof, wall, and floor systems to the foundation.

Continuous Load Path: The interconnection of framing elements of the lateral and vertical force resisting systems, which transfer *lateral* and *vertical* forces to the foundation.

See 2001 WFCM Figures 2.2a-c
WFCM 3.2 CONNECTIONS CHECKLIST

3.2.1 Lateral Framing and Shear Connections

3.2.1.1 Roof Assembly ................................................................. Ok? ✓
3.2.1.2 Roof Assembly to Wall Assembly ........................................ Ok? ✓
3.2.1.3 Wall Assembly ................................................................. Ok? ✓
3.2.1.4 Wall Assembly to Floor Assembly .................................... Ok? ✓
3.2.1.5 Floor Assembly ................................................................. Ok? ✓
3.2.1.6 Floor Assembly to Wall Assembly or Sill Plate ................ Ok? ✓
3.2.1.7 Wall Assembly or Sill Plate to Foundation ....................... Ok? ✓

3.2.2 Uplift Connections

3.2.2.1 Roof Assembly to Wall Assembly ........................................ Ok? ✓
3.2.2.2 Wall Assembly to Wall Assembly ........................................ Ok? ✓
3.2.2.3 Wall Assembly to Foundation ........................................... Ok? ✓

3.2.3 Overturning Resistance

3.2.3.1 Hold downs ................................................................. Ok? ✓

3.2.4 Sheathing and Cladding Attachment

3.2.4.1 Roof Sheathing ................................................................. Ok? ✓
3.2.4.2 Wall Sheathing ................................................................. Ok? ✓
3.2.4.3 Floor Sheathing ................................................................. Ok? ✓
3.2.4.4 Roof Cladding ................................................................. Ok? ✓
3.2.4.5 Wall Cladding ................................................................. Ok? ✓

3.2.5 Special Connections

3.2.5.1 Ridge Straps ................................................................. Ok? ✓
3.2.5.2 Jack Rafters ................................................................. Ok? ✓
3.2.5.3 Non-Loadbearing Wall Assemblies ................................ Ok? ✓
3.2.5.4 Connections around Wall Openings ................................ Ok? ✓
3.3.1 Wood Joist Systems

3.3.1.1 Floor Joists

3.3.1.1.1 Notching and Boring

3.3.1.2 Bearing

3.3.1.3 End Restraint

3.3.1.4 Lateral Stability

3.3.1.5 Single or Continuous Floor Joists

3.3.1.5.1 Supporting Loadbearing Walls

3.3.1.5.2 Supporting Non-Loadbearing Walls

3.3.1.5.3 Supporting Concentrated Loads

3.3.1.6 Cantilevered Floor Joists

3.3.1.6.1 Supporting Loadbearing Walls

3.3.1.6.2 Supporting Non-Loadbearing Walls

3.3.1.7 Floor Diaphragm Openings

3.3.2 Wood I-Joist Systems

3.3.3 Wood Floor Truss Systems

3.3.4 Floor Sheathing

3.3.4.1 Sheathing Spans

3.3.4.2 Sheathing Edge Support

3.3.5 Floor Diaphragm Bracing
3.4.1 Exterior Walls

3.4.1.1 Wood Studs ................................................................. Ok? ✓
  3.4.1.1.1 Notching and Boring ........................................... Ok? ✓
  3.4.1.1.2 Stud Continuity .................................................. Ok? ✓
  3.4.1.1.3 Corners ............................................................. Ok? ✓
3.4.1.2 Top Plates ................................................................. Ok? ✓
3.4.1.3 Bottom Plates .......................................................... Ok? ✓
3.4.1.4 Wall Openings
  3.4.1.4.1 Headers ............................................................. Ok? ✓
  3.4.1.4.2 Full Height Studs ................................................ Ok? ✓
  3.4.1.4.3 Jack Studs ........................................................ Ok? ✓
  3.4.1.4.4 Window Sill Plates ............................................ Ok? ✓

3.4.2 Interior Loadbearing Partitions

3.4.2.1 Wood Studs ................................................................. Ok? ✓
  3.4.2.1.1 Notching and Boring ........................................... Ok? ✓
  3.4.2.1.2 Stud Continuity .................................................. Ok? ✓
3.4.2.2 Top Plates ................................................................. Ok? ✓
3.4.2.3 Bottom Plates .......................................................... Ok? ✓
3.4.2.4 Wall Openings
  3.4.2.4.1 Headers ............................................................. Ok? ✓
  3.4.2.4.2 Studs Supporting Header Beams ......................... Ok? ✓

3.4.3 Interior Non-Loadbearing Partitions

3.4.3.1 Wood Studs ................................................................. Ok? ✓
  3.4.3.1.1 Notching and Boring ........................................... Ok? ✓
3.4.3.2 Top Plates ................................................................. Ok? ✓
3.4.3.3 Bottom Plates .......................................................... Ok? ✓

3.4.4 Wall Sheathing

3.4.4.1 Sheathing and Cladding ............................................. Ok? ✓
3.4.4.2 Exterior Shearwalls .................................................. Ok? ✓
  3.4.4.2.1 Sheathing Type Adjustments .............................. Ok? ✓
  3.4.4.2.2 Perforated Shearwall Adjustments ..................... Ok? ✓
  3.4.4.2.3 Holddowns ....................................................... Ok? ✓
3.5.1 Wood Rafter Systems

3.5.1.1 Rafters
3.5.1.1.1 Jack Rafters
3.5.1.1.2 Rafter Overhangs
3.5.1.1.3 Rake Overhangs
3.5.1.1.4 Notching and Boring
3.5.1.2 Bearing
3.5.1.3 End Restraint
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3.5.2 Wood I-Joist Roof Systems

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  Roof Framing ..........................................................26
  Ceiling Framing ......................................................27
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  Connections .............................................................28
Roof Story Design

Job:_________ WFCM Workbook  Description:__Main House

Roof and Ceiling Framing Details

Cross Section

RAFTERS AT 16" O.C.
RIDGEBORD

Roof Framing

CEILING JOISTS AT 16" O.C.

Ceiling Framing

AMERICAN WOOD COUNCIL
Roof Framing

Rafters (WFCM 3.5.1.1) (page 115)

Assuming ceiling attached to rafters, choose rafters from Table 3.26B and 3.26D (pp. 201 and 203)

| Ground Snow Load: | 30 psf |
| Live Load: | 20 psf |
| Dead Load: | 10 psf |
| Three second gust windspeed: | 120 mph Exp. B |
| Rafter Vertical Displacement L/Δ: | 240 |

Required Span (Horizontal Projection): 16 ft.

Thrust Factor (Footnote 1): 1.0
Wind Factor (Footnote 2): 0.71
Sloped Roof Adjustment (Footnote 3): 1.17

Selection of Species, Grade, Size, and Spacing: (Table 3.26B & C)

<table>
<thead>
<tr>
<th>Species</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16&quot;</td>
<td>16&quot;</td>
<td>16&quot;</td>
<td>16&quot;</td>
</tr>
<tr>
<td>Grade</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
</tr>
</tbody>
</table>

| Table 3.26B Span | 2x6 | 14'-1" | 2x8 | 17'-3" | 2x6 | 14'-1" | 2x8 | 17'-9" |
| Live Load Span   | 16'-6" ok | 20'-2" ok | 16'-6" ok | 20'-9" ok |

| Table 3.26B Span | 2x10 | 22'-6" | 2x10 | 21'-11" | 2x10 | 23'-2" | 2x10 | 22'-3" |
| Wind Load Span   | 18'-8" ok | 18'-2" ok | 19'-3" ok | 18'-6" ok |

| Table 3.26D Span | 2x10 | 17'-9" | 2x10 | 17'-3" | 2x10 | 18'-3" | 2x10 | 17'-6" |
| Snow Load Span   | 17.75(1.0)= | 17.25(1.0)= | 18.25(1.0)= | 17.5(1.0)= |

Note: as an energy consideration, 2x10 rafters might be a minimum requirement for batt insulation.

Ridge Beams (WFCM 3.5.1.4)

Since thrust is accounted for in rafter selection, per 3.5.1.4 exception use: 1x14 Ridge Board
Alternatively, use 3/4"x14" plywood or OSB.

* Alternatively, a Ridge Beam could be designed per Table 2.16 (p. 103) since the span exceeds values shown in Table 3.29A and B (pp. 211-212). Additional columns at beam ends would be required to establish load path to the foundation. Also, fasteners will need to be designed to resist uplift from the rafters at each end of the ridge beam.

| Ground Snow Load: | 30 psf |
| Live Load: | 20 psf |
| Dead Load: | 10 psf |
| Required Span: | 40 ft. |
| Building Width: | 32 ft. |
| Tabulated Load: | 530 plf interpolated |

From the 2001 ASD Manual Glulam Supplement Table 7.2 choose: 5-1/2" x 25-1/2" Western Glulam or 5-1/2"x24-3/4" Southern Pine Glulam


Ceiling Framing

Floor Joists (WFCM 3.3.1.1)

For habitable attics use residential sleeping area with 30psf live load, choose floor joists from Table 3.18A (p. 177):

- Live Load: ................................................................. 30 psf
- Dead Load: ............................................................... 10 psf
- Joist Vertical Displacement L/Δ: ........................................ 360

Required Span: ............................................................. 16 ft.

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
</tr>
<tr>
<td>Size</td>
<td>2x10</td>
<td>2x10</td>
<td>2x10</td>
<td>2x10</td>
</tr>
<tr>
<td>Maximum Span</td>
<td>17'-5&quot;</td>
<td>16'-10&quot;</td>
<td>18'-0&quot;</td>
<td>17'-2&quot;</td>
</tr>
</tbody>
</table>

Floor Sheathing (WFCM 3.3.4.1)

Choose floor sheathing from Table 3.14 (p. 164):

- Floor Joist Spacing: ................................................. 16 in.
- Sheathing Type (Wood Structural Panel or Board Sheathing): ............... WSP
- Span Rating or Grade: ................................................... 24/16

Tabulated Minimum Panel Thickness: ...................................................... 7/16 in.
Roof and Ceiling Sheathing

Sheathing (WFCM 3.5.4.1)

Choose Roof Sheathing from Tables 3.12A and 3.12B (p. 162)

Ground Snow Load ................................................................. 30 psf
Live Load .................................................................................. 20 psf
Dead Load ............................................................................. 10 psf
Three second gust windspeed.................................................. 120 mph Exp. B
Rafter/Truss Spacing: ................................................................. 16 in.
Sheathing Type: ...................................................................... WSP

Tabulated Minimum Panel Thickness:
From Table 3.12A: ................................................................. 3/8 in.
From Table 3.12B: ................................................................. 3/8 in.

Roof Diaphragm Bracing (WFCM 3.5.5)

Blocking in first two rafter bays per Figure 3.7b (p. 127) and Table 3.1 (p. 139) fastener schedule.
Blocking to Joist (toe-nailed): .................................................. 2-8d Common

OR

Bracing Gable Endwall with Attic Floor/Ceiling Sheathing Length from Table 3.15 (p. 165)
(assumes windward and leeward loads and sheathing length from gable end to gable end)

Three second gust windspeed: .................................................. 120 mph Exp. B
Roof Pitch: .................................................................................. 12:12
Diaphragm Span: ........................................................................ 32 ft.
Sheathing Type: ...................................................................... WSP

Tabulated Minimum Length of Attic Floor/Ceiling Diaphragm: .............. 10.67 ft. interpolated
Bracing One Gable End Adjustment (Table 3.15 Footnote 1): ..................... 1.0
Wall Height Adjustment (Table 3.15 Footnote 3): ..................................... 1.125
Ceiling Framing Spacing Adjustment (Table 3.15 Footnote 5): .................... 1.0

Required Minimum Length of Attic Floor/Ceiling Diaphragm:
Tabulated Minimum Length x Applicable Adjustment Factors:............... 12.00 ft.
Tabulated minimum length ≥ 1/3 distance between bracing endwalls.... 10.67 ft.
(per Table 3.15 Footnote 1)

Use Table 3.1 (p.139) fastener schedule for floor sheathing.
Connections

Lateral Framing and Shear Connections (WFCM 3.2.1)

Roof Assembly to Wall Assembly (WFCM 3.2.1.2)

Choose Rafter/Ceiling Joist to Top Plate Lateral and Shear Connection from Table 3.4A (p. 150)

Three second gust windspeed: 120 mph Exp. B
Rafter/Ceiling Joist Spacing: 16 in.
Wall Height: 9 ft.

Required number of 8d Common Nails in each rafter/ceiling joist to top plate connection: 3

Uplift Connections (WFCM 3.2.2)

Roof Assembly to Wall Assembly (WFCM 3.2.2.1)

Choose Roof to Wall Uplift Strap Connection from Table 3.4B (p. 151)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three second gust wind speed</td>
<td>120 mph Exp. B</td>
<td>120 mph Exp. B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing Spacing</td>
<td>16 in.</td>
<td>16 in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Span</td>
<td>32 ft.</td>
<td>32 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum tabulated number of 8d Common Nails required in each end of 1-1/4&quot; x 20 gage strap every rafter / stud</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Ceiling Assembly nail increase (Footnote 3)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum required number of 8d Common Nails in each end of strap every rafter / stud = Tabulated number of nails - Reductions + Increases</td>
<td>4 *</td>
<td>4 *</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 calculated using 416 lbs uplift (below) divided by 127 lb/nail per WFCM Supplément Table 6A.
Connections (cont’d)

*Alternatively, use proprietary connectors every rafter with the following minimum capacities from Table 3.4 (pp. 148-149)

<table>
<thead>
<tr>
<th></th>
<th>Loadbearing Walls</th>
<th>Non-Loadbearing Walls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tabulated min. uplift connection capacity (Table 3.4, page 149)</td>
<td>Tabulated min. uplift connection capacity (Table 3.4C, page 152)</td>
</tr>
<tr>
<td>Interior framing adjustment (Footnote 1)</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Roof dead load reduction (Table 3.4, Footnote 3)</td>
<td>-32 lbs</td>
<td>-32 lbs</td>
</tr>
<tr>
<td>[0.60(20 \text{ psf} – 15 \text{ psf}) \times 8' \times 16&quot; /12&quot; /' = 32 \text{ lbs}]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhang Multiplier (Table 3.4C, Footnote 2) [(2' + \text{OH}) / 4']</td>
<td>[2]</td>
<td>[2]</td>
</tr>
<tr>
<td>Zone 2 Multiplier (Table 3.4C, Footnote 3)</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Required Minimum Uplift Capacity of proprietary connector</td>
<td>409 lbs</td>
<td>496 lbs</td>
</tr>
<tr>
<td>= Tabulated minimum capacity x Adjustments - Reduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required Minimum Lateral Capacity</td>
<td>210 lbs</td>
<td>210 lbs</td>
</tr>
<tr>
<td>Required Minimum Shear Parallel to Ridge Capacity</td>
<td>74 lbs</td>
<td>74 lbs</td>
</tr>
<tr>
<td>Required Minimum Shear Perpendicular to Ridge Capacity</td>
<td>116 lbs</td>
<td>116 lbs</td>
</tr>
</tbody>
</table>
Connections (cont’d)

Sheathing and Cladding Attachment (WFCM 3.2.4)

Roof Sheathing (WFCM 3.2.4.1)

Choose Roof Sheathing Nail Spacing from Table 3.10 (p. 160)

Three second gust windspeed: ................................................................. 120 mph Exp. B

Rafter/Truss Spacing: ................................................................. 16 in.

Sheathing Type: ................................................................. WSP

<table>
<thead>
<tr>
<th>Location</th>
<th>Edges</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>4’ Perimeter Edge Zone</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Interior Zones</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Gable Endwall Rake with Overhang</td>
<td>4*</td>
<td>4*</td>
</tr>
</tbody>
</table>

* see 2001 WFCM Figure 2.1 p. 34 for nailing details. Perimeter edge zone nailing of 6” permitted for edges and field per Figure 2.1g.

Special Connections (WFCM 3.2.5)

Ridge Straps (WFCM 3.2.5.1)

For a clean finished ceiling line, rather than using collar ties to resist upward ridge separation, choose Ridge Tension Strap Connection from Table 3.6A (p. 156)

Three second gust windspeed: ................................................................. 120 mph Exp. B

Roof Pitch: ................................................................. 12:12

Roof Span: ................................................................. 32 ft.

Tabulated number of 8d Common Nails required in each end of 1-1/4” x 20 gage strap: ................................................................. 3

Ridge Strap Spacing Adjustment (Footnote 4): ................................................................. 1.33

Required number of 8d Common Nails in each end of 1-1/4” x 20 gage strap: 4

Tabulated number of nails x Applicable adjustment factors: 4*
Connections (cont’d)

* Alternatively, use proprietary connectors with the following minimum capacity from Table 3.6 (p. 155)
  Tabulated minimum connection capacity: .......................................................... 324
  Ridge Strap Spacing Adjustment (Footnote 4): .............................................. 1.33
  Required minimum capacity of proprietary connector:
    Tabulated minimum capacity x Applicable adjustment factors: ................. 431 lbs

Table 3.1 Nailing Schedule

Choose Ceiling Joist to Parallel Rafter and Ceiling Joist Lap Connection from Table 3.9A (p. 159)

- Ground Snow Load: .......................................................... 30 psf
- Roof Span: .......................................................... 32 ft.
- Rafter Slope: .......................................................... 12:12
- Rafter Spacing: .......................................................... 16 in.

  Tabulated number of 16d Common Nails required per heel joint splice: ........ 4
  Clinched Nails Adjustment (Footnote 1): ................................................. 1.0
  Ceiling Height/Roof Ridge Height Adjustment (Footnote 6): .................... 1.0

  Required number of 16d Common Nails per heel joint splice:
    Tabulated number of nails x Applicable adjustment factors: ................. 4 *
    Required number of nails at splice (Footnote 4): ...................................... 4 *

*Alternatively, use proprietary connectors with the following minimum capacity from Table 3.9 (p. 158)
  Tabulated minimum connection capacity: .......................................................... 353 interpolated
  Ceiling Height/Roof Ridge Height Adjustment (Footnote 5): .................... 1.0

  Required minimum capacity of proprietary connector:
    Tabulated minimum capacity x Applicable adjustment factors: ................. 353 lbs

Blocking to Rafter Connection from Table 3.1 (p. 139): ................... 2-8d common nails toe-nailed at each end

OR

Rim Board to Rafter Connection from Table 3.1 (p. 139): 2-16d common nails end-nailed at each end
Roof and Ceiling Framing Details

Ridge Beam

Collar Tie (Collar Beam) (Located in upper third of attic space) (see 3.2.6.1)

Note: Collar ties can be eliminated with the use of ridge straps.

Cross Section

Gable Roof Framing

Ceiling Framing
**Roof Framing**

**Rafters (WFCM 3.5.1.1)**

Design same as Main House rafters. See *WFCM Workbook* p.15.

**Ridge Beams (WFCM 3.5.1.4)**

The ridge beam could be designed per Tables 3.29A and 3.29B (pp. 211 & 212). Additional columns and/or framing would be required to establish load path to the foundation. Fasteners to resist uplift at ridge beam ends will also need to be designed.

- Ground Snow Load: ................................................................. 30 psf
- Live Load: ........................................................................... 20 psf
- Dead Load: ........................................................................ 10 psf
- Beam Vertical Displacement L/Δ: ...................................... 240

Required Span: ........................................................................... 16 ft.

Building Width: ........................................................................... 32 ft.

- Per Table 3.29A (interpolated): ........................................... 3x12-3/8 Glulam
- Per Table 3.29B (interpolated): ........................................... 3x13-3/4 Glulam (controls)

**Ceiling Framing**

**Ceiling Joists (WFCM 3.5.1.6)**

For attics used as residential sleeping areas, choose floor joists from Table 3.18A (p. 177)

- Live Load: ........................................................................... 30 psf
- Dead Load: ........................................................................... 10 psf
- Joist Vertical Displacement L/Δ: ........................................ 360

Required Span: ........................................................................... 18(max) ft.

Selection of Specie, Grade, Size, and Spacing:

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>#1</td>
<td>SS</td>
<td>#2</td>
<td>#2</td>
</tr>
<tr>
<td>Size</td>
<td>2x10</td>
<td>2x10</td>
<td>2x10</td>
<td>2x12</td>
</tr>
<tr>
<td>Tabulated Spans</td>
<td>18'-5&quot;</td>
<td>18'-0&quot;</td>
<td>18'-0&quot;</td>
<td>19'-11&quot;</td>
</tr>
</tbody>
</table>
Roof/Ceiling Sheathing and Connections

Sheathing (WFCM 3.5.4.1)

Roof sheathing design same as main house roof sheathing. See WFCM Workbook p.17.

Roof Diaphragm Bracing (WFCM 3.5.5)

Blocking in first two rafter bays

OR

Bracing Gable Endwall with Attic Floor/Ceiling Sheathing Length from Table 3.15 (p. 165)

<table>
<thead>
<tr>
<th>Three second gust windspeed:</th>
<th>120 mph Exp.B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Pitch:</td>
<td>12:12</td>
</tr>
<tr>
<td>Diaphragm Span:</td>
<td>32 ft.</td>
</tr>
<tr>
<td>Building Length:</td>
<td>16 ft.</td>
</tr>
<tr>
<td>Sheathing Type (wood structural panels or gypsum):</td>
<td>WSP  GYP</td>
</tr>
<tr>
<td>Tabulated Minimum Length of Attic Floor/Ceiling Diaphragm (interpolated):</td>
<td>10.7 30.7 ft.</td>
</tr>
<tr>
<td>Bracing One Gable End Adjustment (Footnote 1):</td>
<td>0.84 0.84</td>
</tr>
<tr>
<td>Wall Height Adjustment (Footnote 3): (9'/8')</td>
<td>1.125 1.125</td>
</tr>
<tr>
<td>Ceiling Framing Spacing Adjustment (Footnote 5):</td>
<td>1.0 0.78</td>
</tr>
</tbody>
</table>

Required Minimum Length of Attic Floor/Ceiling Diaphragm:
Tabulated Minimum Length x Applicable Adjustment Factors: 10.1 ft. 22.6 ft.

Structural sheathing is required for the ceiling diaphragm, since 22.6’ required length of gypsum diaphragm is greater than the 16’ length of ceiling on the west wing. If full height studs to the roof planes are used, a ceiling diaphragm will not be needed.

Connections

All connections are designed the same as the main house elements. See WFCM Workbook pp.17-21.
Job: WFCM Workbook  
Description: East Wing

Roof and Ceiling Framing Details

Cross Section

Gable Roof Framing

Ceiling Framing
Job: WFCM Workbook  
Description: East Wing

Roof Framing

Rafters (WFCM 3.5.1.1)

Assuming a finished ceiling attached to rafters (on lower rafter tails) and ceiling joists raised ¼ of the ridge height from the top plate, choose rafters from Table 3.26B and 3.26C (pp. 201 and 202)

- Ground Snow Load: ................................................................. 30 psf
- Live Load: .................................................................................. 20 psf
- Dead Load: .................................................................................. 10 psf
- Three second gust windspeed: .............................................. 120 mph Exp. B
- Rafter Vertical Displacement L/Δ: ........................................... 240
- Required Span (Horizontal Projection): ..................................... 16 ft.
- Thrust Factor (Footnote 1): ....................................................... 0.76
- Wind Factor (Footnote 2): ......................................................... 0.71
- Sloped Roof Adjustment (Footnote 3): .................................... 1.17

Selection of Species, Grade, Size, and Spacing: (Table 3.26B & C)

<table>
<thead>
<tr>
<th>Species</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16&quot;</td>
<td>16&quot;</td>
<td>16&quot;</td>
<td>16&quot;</td>
</tr>
<tr>
<td>Grade</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
</tr>
<tr>
<td>Table 3.26B Span</td>
<td>2x8 18'-5&quot;</td>
<td>2x10 21'-11&quot;</td>
<td>2x8 18'-6&quot;</td>
<td>2x10 22'-3&quot;</td>
</tr>
<tr>
<td>Live Load Span</td>
<td>18.4(0.76)(1.17)=</td>
<td>21.9(0.76)(1.17)=</td>
<td>18.5(0.76)(1.17)=</td>
<td>22.25(0.76)(1.17)=</td>
</tr>
<tr>
<td>Wind Load Span</td>
<td>22.5(0.71)(1.17)=</td>
<td>21.9(0.71)(1.17)=</td>
<td>23.2(0.71)(1.17)=</td>
<td>22.25(0.71)(1.17)=</td>
</tr>
<tr>
<td>WoodWorks® Span*</td>
<td>2x12 #1 21'-6&quot;</td>
<td>2x12 SS 23'-4&quot;</td>
<td>2x12 #2 21'-4&quot;</td>
<td>2x12 SS 22'-10&quot;</td>
</tr>
<tr>
<td>Snow Load Span</td>
<td>21.5(0.76)=</td>
<td>23.3(0.76)=</td>
<td>21.3(0.76)=</td>
<td>22.8(0.76)=</td>
</tr>
</tbody>
</table>

*Spans from WoodWorks Sizer since tabulated values are not given in the WFCM for spans greater than 20 feet.

Note: as an energy consideration, 2x10 rafters might be a minimum requirement for batt insulation.

Ridge Boards (WFCM 3.5.1.4)

Since thrust is accounted for in rafter selection, per 3.5.1.4 exception use: 15 3/4" deep Ridge Board

Use a 15.75" deep engineered wood product like glulam or LVL, or ¾" thick plywood.

Some building codes require that ridge boards be of continuous length. Long lengths are possible with engineered wood products, or one could be built up using two layers of ¾” wood structural panel material ripped to depth and end joints offset.
Job: WFCM Workbook

Description: East Wing

**Ceiling Framing**

**Ceiling Joists** (WFCM 2.5.1.6)

For uninhabitable attics without storage, choose ceiling joists from Table 2.12A (p. 88), as an alternative solution process.

- **Live Load**: ................................................................. 10 psf
- **Dead Load**: ................................................................. 5 psf
- **Joist Vertical Displacement L/Δ**: ........................................ 240
- **Required Span**: .......................................................... 24 ft.

Required E and $F_b$ at 16"o.c. joist spacing for 24' span from Table 2.12A:

<table>
<thead>
<tr>
<th>Size</th>
<th>2x8</th>
<th>2x10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required E</td>
<td>1,800,000</td>
<td>900,000</td>
</tr>
<tr>
<td>Required $F_b$</td>
<td>1,344</td>
<td>847</td>
</tr>
</tbody>
</table>

Select Grade from *WFCM* Table 4A and 4B based on required E and $F_b$ above:

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size &amp; Grade</td>
<td>2x8 No.1 &amp; Btr.*</td>
<td>2x10 #2</td>
<td>2x8 No.1 Dense*</td>
<td>2x10 #2</td>
</tr>
<tr>
<td>Tabulated E, psi</td>
<td>1,800,000</td>
<td>1,300,000</td>
<td>1,800,000</td>
<td>1,400,000</td>
</tr>
<tr>
<td>Tabulated $F_b$, psi</td>
<td>1200</td>
<td>850</td>
<td>1650</td>
<td>875</td>
</tr>
<tr>
<td>Size Factor, $C_F$</td>
<td>1.2</td>
<td>1.1</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Load Duration Factor, $C_D$</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Repetitive Member Factor, $C_r$</td>
<td>1.15</td>
<td>1.15</td>
<td>1.15</td>
<td>1.15</td>
</tr>
<tr>
<td>Allowable $F_b$, psi</td>
<td>1200(1.2)(1.0)(1.15)= 1,656 psi OK</td>
<td>850(1.1)(1.0)(1.15)= 1,075 psi OK</td>
<td>1650(1.0)(1.0)(1.15)= 1,900 psi OK</td>
<td>875(1.1)(1.0)(1.15)= 1,110 psi OK</td>
</tr>
</tbody>
</table>

* 2x10 #2 will also work for Douglas-Fir Larch and Southern Pine

Adjustment factors for Table 4A are found on *WFCM* p. 279-280.
Adjustment factors for Table 4B are found on *WFCM* p. 286-287.
Roof Story Design  
Job: WFCM Workbook

Description: East Wing

Roof and Ceiling Sheathing

Sheathing (WFCM 3.5.4.1)

Roof sheathing design same as main house roof sheathing. See *WFCM Workbook* p.17.

Roof Diaphragm Bracing (WFCM 3.5.5)

Blocking in first two rafter bays with full height studs on end wall framing.

OR

Bracing Gable Endwall with Attic Floor/Ceiling Sheathing Length from Table 3.15 (p. 165) with Gable Brace Figure 3.7a.

Three second gust windspeed: ................................................................. 120 mph Exp.B
Roof Pitch: .................................................................................. 12:12
Diaphragm Span: ............................................................................. 24 ft.
Building Length: ............................................................................. 16 ft.
Sheathing Type (wood structural panels or gypsum): .................. WSP GYP

Tabulated Minimum Length of Attic Floor/Ceiling Diaphragm (interpolated): 8 ft. 20 ft.
Bracing One Gable End Adjustment (Footnote 1): 0.84 0.84
Wall Height Adjustment (Footnote 3): (13'/8') 1.625 1.625
Ceiling Framing Spacing Adjustment (Footnote 5): 1.0 0.78

Required Minimum Length of Attic Floor/Ceiling Diaphragm:
Tabulated Minimum Length x Applicable Adjustment Factors: ........ 10.9 ft. 21.3 ft.

*Structural sheathing is required for the ceiling diaphragm, since 21.3’ required length of gypsum diaphragm is greater than the 16’ length of ceiling on the east wing.*

Connections

All connections are designed the same as the main house elements. See *WFCM Workbook* pp.17-21.
TOP STORY
DESIGN

Main House

Wall Framing ...........................................30
Wall Sheathing .........................................32
Floor Framing ..........................................36
Floor Sheathing ........................................36
Connections ..............................................37
Wall Framing

Wall Studs (WFCM 3.4.1.1)

Choose Studs from Table 3.20A or 3.20B and Footnotes (pp. 182-184)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Wall Height: ........................................................................................................ 9 ft.
Studs supporting (Roof, Ceiling, Floor): ......................................................... Roof, Ceiling and 1 Floor
Sheathing Type (wood structural panel or minimum sheathing): ...................... WSP

Selection of Specie, Grade, Size, and Spacing: (Table 3.20A and 3.20B and Footnotes)

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing, in. O.C.</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
</tr>
<tr>
<td>Size</td>
<td>2x4</td>
<td>2x4</td>
<td>2x4</td>
<td>2x4</td>
</tr>
<tr>
<td>Maximum Length (Wind)</td>
<td>10'-5&quot; *</td>
<td>10'-2&quot; *</td>
<td>10'-10&quot; *</td>
<td>10'-2&quot; *</td>
</tr>
<tr>
<td>Maximum Length (Dead and Live Loads)</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
</tbody>
</table>

* Footnote “a” would require that stud spacing shall be multiplied by 0.85 for framing within 4 ft. of the corners. Since Table 3.20A shows spans of 9'-0" and 9'-5" for Douglas Fir-Larch and Southern Pine studs, no spacing adjustment is required for those species.

Choose Studs from Table 3.20A or 3.20B and Footnotes (pp. 182-183)

Same as West Wing Design, except h = 9'. (see WFCM Workbook p.55)

Top Plates (WFCM 3.4.1.2)

Choose Building End Wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185) (all other cases)

Building Dimension: ................................................................. 32 ft.
Tabulated Minimum Splice Length: .............................................................. 6 ft.
Connection: top plate – to – top plate: ...................................................... 2-16d nails per ft.

Choose Building Side wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185) (all other cases)

Building Dimension: ................................................................. 40 ft.
Tabulated Minimum Splice Length: .............................................................. 8 ft.
Connection: top plate – to – top plate: ...................................................... 2-16d nails per ft.
**Wall Framing (cont’d)**

**Exterior Loadbearing Wall Headers** (WFCM 3.4.1.4.1)

Choose Headers in Loadbearing Walls from Tables 3.22A-E and Table 3.22F (pp. 186-193)

Building Width: ............................................................... 32 ft.
Required Span (Foyer Window): ........................................... 6 ft.
Ground Snow Load: ........................................................... 30 psf
Three second gust wind speed: ......................................... 120 mph Exp. B

Header supporting roof, ceiling and attic floor – use Table 3.22B (p. 187)

Preliminary Header Selection (Gravity Loads):
2-Southern Pine #2 2x12's

Maximum Header/Girder Span (interpolated): ........ 6'-5"
Tabulated Number of Jack Studs (Table 3.22F): ........... 3
Roof Span Adjustment (Footnote 1 – (W+12)/48): ........ 0.92
Adjusted number of jack studs required = tabulated x roof span adjustment: .... 3

Table 3.23A (p. 192)

Preliminary Header Selection (Wind Loads):
2-Southern Pine #2 2x6's

Maximum Header/Girder Span ........................................ 6'-0"
Tabulated Number of Full Height (King) Studs (Table 3.23C): .......... 3
Reduced Full Height Stud Requirements (Table 3.23D): ................ 2

Final Selection of Header Specie, Grade, and Size:

<table>
<thead>
<tr>
<th>Specie</th>
<th>Grade</th>
<th>Size</th>
<th>Number of Jack Studs Required</th>
<th>Number of Full Height (King) Studs Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Pine</td>
<td>#2</td>
<td>2x12's</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Using identical procedures:

North bathroom headers: 2-Southern Pine #2 2x8's 4'-6" >4' OK
Number of Jack Studs Required: ........................................ 2
Number of Full Height (King) Studs Required: 2

Typical bedroom headers: 2-Southern Pine #2 2x6's 3'-6" >3' OK
Number of Jack Studs Required: ........................................ 2
Number of Full Height (King) Studs Required: 2

*Note: WFCM 3.4.1.4.3 allows jack studs to be replaced with an equivalent number of full height (king) studs if adequate gravity connections are provided.

**Exterior Loadbearing Wall Window Sill Plates** (WFCM 3.4.1.4.4)

Choose Window Sill Plates from Table 3.23B (p. 193)

Three second gust wind speed: ........................................ 120 mph Exp. B
Required Span (Foyer Sill Plate): ...................................... 6 ft.

Selection of Window Sill Plate Specie, Grade, and Size:
2-Southern Pine #2 2x4's (flat)
Tabulated Window Sill Plate Span: .................................... 7'-8"
Wall Height Adjustment (Footnote 3 – (H/10)\(1/2\)): ........... 0.95

Adjusted Maximum Sill Plate Length:
Tabulated maximum Sill Plate Length ÷ wall Height Adjustment: .... 8'-0"

Using identical procedures:

North bathroom sill plates: 1-Southern Pine #2 2x4 (flat) 4'-11" >4' OK
Typical bedroom sill plates: 1-Southern Pine #2 2x4 (flat) 4'-11" >3' OK

AMERICAN FOREST & PAPER ASSOCIATION
**Job: WFCM Workbook**

**Description: Main House**

**Wall Sheathing**

**Sheathing and Cladding** *(WFCM 3.4.4.1)*

Choose Exterior Wall Sheathing or Cladding from Tables 3.13A and 3.13B, respectively (p. 163)

- Three second gust wind speed: ................................................................. 120 mph Exp. B
- Sheathing Type (wood structural panels, fiberboard, board, hardboard): ........ WSP
- Direction Across Studs (Short or Long): ...................................................... Short
- Stud Spacing: ............................................................................................ 16 in.
- Shear wall minimum panel thickness (WFCM 3.4.4.2): .................................. 7/16 in.

---

**North Elevation**

- 3' 3' 6' 6' 3' 3'

**South Elevation**

- 3' 3' 5' 5' 3' 3'

**East Elevation**

- 32'

**West Elevation**

- 12'-8" 16'-6"
Wall Sheathing (cont’d)

Exterior Segmented (Type I) Shear Walls (WFCM 3.4.4.2)

Choose Exterior Segmented (Type I) Shear Wall Length from Table 3.17A-D (pp. 169-174)

- Wall Height: ................................................................. 9 ft.
- Number of Stories Braced (per 3.1.3.1): .............................................. 2
- Three second gust wind speed: ..................................................... 120 mph Exp. B
- Maximum shear wall aspect ratio for wind (Table 3.17D): .............. 3.5:1
- Minimum shear wall segment length (Wall height/aspect ratio): ........ 2.6 ft.
- Seismic Design Category: .......................................................... D1
- Maximum shear wall aspect ratio for seismic (Table 3.17D Footnote 3): 2:1
- Minimum shear wall segment length (Wall height/aspect ratio): ......... 4.5 ft.
- Minimum WSP sheathing thickness (per WFCM 3.4.4.2): ............... 7/16 in.
- Minimum gypsum thickness (per WFCM 3.4.4.2): ......................... 1/2 in.

8d common nails @ 6" OC on panel perimeter

8d common nails @ 12" OC in field

7/16" wood structural panel continuous height over wall plates

5d cooler nails @ 7" OC on panel

5d cooler nails @ 10" OC in field

1/2" gypsum wallboard on interior

WFCM 3.4.4.2 “Standard” Shear Wall
**Exterior Segmented (Type I) Shear Walls** (WFCM 3.4.4.2)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>Load Parallel to Ridge</th>
<th>Load Perpendicular to Ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Main Building</td>
<td>North 40' South 40' East 32' West 32'</td>
<td>HAVE</td>
</tr>
<tr>
<td><strong>Seismic</strong></td>
<td><strong>Seismic</strong></td>
<td><strong>Seismic</strong></td>
</tr>
<tr>
<td>Effective Length of Full Height Sheathing for <strong>Seismic</strong> (L\textsubscript{FHS})</td>
<td>20' 18'</td>
<td>32' 29'</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing – <strong>Seismic</strong> (WFCM 3.4.4.2)</td>
<td>6&quot; 6&quot;</td>
<td>6&quot; 6&quot;</td>
</tr>
<tr>
<td>Min. Length Full Ht. Sheathing – Segmented <strong>Seismic</strong> (L\textsubscript{Type-I-S} = L\textsubscript{FH}C\textsubscript{swa})</td>
<td>13.5' 13.5'</td>
<td>19.5' 19.5'</td>
</tr>
</tbody>
</table>

**Wind**

| Tabulated Minimum Length Full Height Sheathing for **Wind** Loads per Table 3.14 | 10.6' 10.6' | 17.5' 17.5' | HAVE |
| WSP Perimeter Edge Nail Spacing – **Wind** (WFCM 3.4.4.2) | 6" 6" | 6" 6" | PICK |
| Min. Length Full Ht. Sheathing – Segmented **Wind** (L\textsubscript{Type-I-W} = L\textsubscript{FH}C\textsubscript{WH}C\textsubscript{swa}) | 15.5' 15.5' | 25.6' 25.6' | NEED |

1. Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic.
2. From Table 3.17C: C\textsubscript{1}=57, C\textsubscript{2}=15, L\textsubscript{max}=40', L\textsubscript{min}=32' so req'd sheathing = \([57+(0.25)15]\times32\times100=19.5' on a 6:12 perimeter:field nailing pattern. See Table 3.17C Footnote 5 for other assemblies and nail spacings.
3. Assumes 7/16" WSP exterior sheathing and non-rated interior sheathing (i.e., doesn't include gypsum as shear element).

---

North and south walls are seismic controlled (4" nail spacing). East and west walls are wind controlled.

Note: Since the North and South walls have shear wall segments with aspect ratios greater than the required 2:1 for seismic loads (Table 3.17D Footnote 3), use 2003 International Building Code (IBC) Table 2305.3.3 footnote a., which allows a 2w/h reduction for shear walls not meeting maximum shear wall aspect ratio of 2:1. Therefore, the 3' segments are added to the south wall as follows: 2w/h = 2(3)/9 = 0.67
Exterior Perforated (Type II) Shear Walls (WFCM 3.4.4.2)

Choose Exterior Perforated (Type II) Shear Wall Length from Table 3.17E (p. 175)

- **Parallel to Ridge**: 24' 22' 32' 29'
- **Perpendicular to Ridge**: 40' 40' 32' 32'

### Wall Sheathing (cont’d)

#### Exterior Perforated (Type II) Shear Walls

**Tabulated Min. Length Full Ht. Sheathing - Segmented Seismic** ($L_{TypeI-S}$)

- East: 13.5'  13.5'  19.5'  19.5'
- West: 12.5'  1.18  1.00  1.06

**Effective Length of Full Height Sheathing for Seismic** ($L_{FHS}$)

- East: 16.9'  14.7'  32'  29'
- West: 16.9'  14.7'  32'  29'

**Length of Wall** ($L_{Wall}$)

- East: 40'  32'  32'  32'
- West: 40'  32'  32'  32'

**Percent Full Height Sheathing** ($L_{FH} / L_{Wall}$)

- East: 60%  100%  91%
- West: 55%  100%  91%

**Perforated (Type II) Length Increase Factor from Table 3.17E ($C_L$)**

- East: 1.25  1.18  1.00  1.06
- West: 1.25  1.18  1.00  1.06

**Min. Length Full Ht. Sheathing - Perforated Seismic** ($L_{TypeII-S} = L_{TypeI-S} (C_L)$)

- East: 16.9'  16.9'  19.5'  20.7'
- West: 16.9'  16.9'  19.5'  20.7'

---

### Top Story Main House Shear Wall Details Summary

- **Governing Load**
  - Seismic
  - Wind

- **WSP Perimeter Nail Spacing**
  - 3"  3"  6"  6"

- **Shear wall Adjustment per Table 3.17D ($C_{swa}$)**
  - North: 0.53
  - South: 0.53
  - East: 1.3
  - West: 1.3

---

**Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic applied to the entire length of full height sheathing. See Top Story Segmented (Type I) wall sheathing design for explanation.**

**East and West walls are wind controlled. Since North and South walls do not have enough capacity, they can either be designed as two Segmented (Type I) walls with hold downs around interior wall openings, or sheathing edge nail spacing on the Perforated Type II wall can be reduced to 3" o.c. In the latter case, the respective shear wall adjustment factor from Table 3.17D is 0.53 (seismic controlling). Multiplying each of the North and South seismic wall lengths by 0.53 / 0.69 gives 12.98 ft and 12.2 ft respectively, each satisfactorily below the effective length of full height sheathing $L_{FHS}$ for each wall. The 3” spacing will be chosen here.**
Floor Framing

**Floor Joists** (WFCM 3.3.1.1)

Choose Floor Joists from Tables 3.18A-B (pp. 177-178)

- Live Load: .......................................................... 30 psf
- Dead Load: .......................................................... 10 psf
- Joist Vertical Displacement \( L/\Delta \): ........................................... 360
- Required Span: .................................................... 16 ft.

Selection of Specie, Grade, Size, and Spacing: (Table 3.18A)

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
</tr>
<tr>
<td>Size</td>
<td>2x10</td>
<td>2x10</td>
<td>2x10</td>
<td>2x10</td>
</tr>
<tr>
<td>Maximum Span</td>
<td>17'-5&quot;</td>
<td>16'-10&quot;</td>
<td>18'-0&quot;</td>
<td>17'-2&quot;</td>
</tr>
</tbody>
</table>

Floor opening complies with WFCM 1.1.3.2.c. (WFCM p.3) (lesser of 12 ft. or 50% of the building dimension).

Floor Sheathing

**Sheathing Spans** (WFCM 3.3.4.1)

Choose Floor Sheathing from Table 3.14 (p. 164)

- Floor Joist Spacing: ....................................................... 16 in.
- Sheathing Type: .......................................................... WSP
- Span Rating: .............................................................. 24/16
- Tabulated Minimum Panel Thickness: .................................. 7/16 in.
Connections

Lateral Framing and Shear Connections (WFCM 3.2.1)

Wall Assembly (WFCM 3.2.1.3)

**Top Plate to Top Plate Connection from Table 3.1 (p. 139):** (6” nail spacing on East / West Walls)

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>2-16d Commons per foot</td>
</tr>
<tr>
<td>3”</td>
<td>4-16d Commons per foot</td>
</tr>
</tbody>
</table>

Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6” (North / South walls)

- (4” nail spacing: 1.67 x 2 nails)
- (3” nail spacing: 2.0 x 2 nails)

**Top Plate Intersection Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>4-16d Commons each side joint</td>
</tr>
</tbody>
</table>

**Stud to Stud Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>24” o.c.</td>
<td>2-16d Commons</td>
</tr>
</tbody>
</table>

**Header to Header Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>16” o.c., edges</td>
<td>16d Commons</td>
</tr>
</tbody>
</table>

Choose Top or Bottom Plate to Stud Connection from Table 3.1 & 3.5A:

- (2x4 stud) 2-16d Commons per 2x4 stud
- (2x6 stud) 3-16d Commons per 2x6 stud
- (2x8 stud) 4-16d Commons per 2x8 stud

Wall Assembly to Floor Assembly (WFCM 3.2.1.4)

**Bottom Plate to Floor Joist, Bandjoist, Endjoist or Blocking Connection from Table 3.1:** (6” nail spacing)

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>2-16d Commons per foot</td>
</tr>
</tbody>
</table>

Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6”

- (4” nail spacing: 1.67 x 2 nails)
- (3” nail spacing: 2.0 x 2 nails)

Floor Assembly (WFCM 3.2.1.5)

**Bridging to Floor Joist Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>2-8d Commons each end</td>
</tr>
</tbody>
</table>

**Blocking to Floor Joist Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>2-8d Commons each end</td>
</tr>
</tbody>
</table>

**Band Joist to Floor Joist Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td>3-16d Commons per joist</td>
</tr>
</tbody>
</table>

Floor Assembly to Wall Assembly (WFCM 3.2.1.6)

**Floor Joist to Top Plate Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>4-8d Commons per joist</td>
</tr>
</tbody>
</table>

**Blocking to Sill or Top Plate Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td>3-16d Commons each block</td>
</tr>
</tbody>
</table>

**Band Joist to Sill or Top Plate Connection from Table 3.1:** (6” nail spacing)

<table>
<thead>
<tr>
<th>Nailing Spacing</th>
<th>Number of Nails</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>2-16d Commons per foot</td>
</tr>
</tbody>
</table>

Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6”

- (4” nail spacing: 1.67 x 2 nails)
- (3” nail spacing: 2.0 x 2 nails)
Connections (cont’d)

Uplift Connections (WFCM 3.2.2)

Wall Assembly to Wall Assembly (WFCM 3.2.2.2)

Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three second gust wind speed</td>
<td>120 mph Exp. B</td>
<td>120 mph Exp. B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing Spacing</td>
<td>16 in.</td>
<td>16 in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Span</td>
<td>32 ft.</td>
<td>32 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum tabulated number of 8d Common Nails required in each end of 1-1/4&quot; x 20 gage strap <em>every stud</em></td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Ceiling Assembly nail increase (Footnote 3)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum required number of 8d Common Nails in each end of strap <em>every stud</em> = Tabulated number of nails - Reductions + Increases</td>
<td>4*</td>
<td>4*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Alternatively, use proprietary connectors every stud with the following minimum capacities*

<table>
<thead>
<tr>
<th>Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4, page 149)</th>
<th>441 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior framing adjustment (Footnote 1)</td>
<td>1.0</td>
</tr>
<tr>
<td>Roof dead load reduction (Table 3.4, Footnote 3)</td>
<td>-32 lbs</td>
</tr>
<tr>
<td>Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4)</td>
<td>-80 lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4C, page 152)</th>
<th>496 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-to-Wall and Wall-to-Foundation reduction (WFCM 3.2.5.3)</td>
<td>-80 lbs</td>
</tr>
<tr>
<td>Required minimum capacity of proprietary connector = Tabulated minimum capacity x Adjustments - Reduction</td>
<td>329 lbs</td>
</tr>
</tbody>
</table>

Check Perforated Shearwall plate anchorage between wall ends

The assumption is that the wall plate nailing to the floor frame (*WFCM* 3.2.1.6 Table 3.1, see previous page), in addition to the wind uplift straps (determined above), are sufficient to resist uplift requirements on the plate using the Perforated Shearwall Method.
Connections (cont’d)

Overturning Resistance (WFCM 3.2.3)

Hold downs (WFCM 3.2.3.1)

Choose Hold downs from Table 3.17F for Type I & II Wall (p. 176)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Height</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - wind</td>
<td>6”</td>
<td>6”</td>
<td>6”</td>
<td>6”</td>
</tr>
<tr>
<td>Tabulated hold down connection capacity required – wind ($T_w$)</td>
<td>3924 lbs</td>
<td>3924 lbs</td>
<td>3924 lbs</td>
<td>3924 lbs</td>
</tr>
<tr>
<td>Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) ($C_{swa}$)</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Adjusted hold down capacity ($T_{aw} = (T_w) / (C_{swa})$)</td>
<td>3019 lbs</td>
<td>3019 lbs</td>
<td>3019 lbs</td>
<td>3019 lbs</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - seismic</td>
<td>3”</td>
<td>3”</td>
<td>6”</td>
<td>6”</td>
</tr>
<tr>
<td>Tabulated hold down connection capacity required – seismic ($T_s$)</td>
<td>2160 lbs</td>
<td>2160 lbs</td>
<td>2160 lbs</td>
<td>2160 lbs</td>
</tr>
<tr>
<td>Hold down adjustment per Table 3.17F footnotes (Table 3.17D) ($C_{swa}$)</td>
<td>0.53</td>
<td>0.53</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Adjusted hold down capacity ($T_{as} = (T_s) / (C_{swa})$)</td>
<td>4075 lbs$^1$</td>
<td>4075 lbs$^1$</td>
<td>2160 lbs</td>
<td>2160 lbs</td>
</tr>
</tbody>
</table>

$^1$Three inch nail spacing controls.
Connections (cont’d)

Sheathing and Cladding Attachment (WFCM 3.2.4)

Wall Sheathing (WFCM 3.2.4.2)

Choose Wall Sheathing Nail Spacing from Table 3.11 (p. 161)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Stud Spacing: ................................................................................................. 16 in.
Sheathing Type: .............................................................................................. WSP

<table>
<thead>
<tr>
<th>Location</th>
<th>Edges</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>4' Edge Zone</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Interior Zones</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Shear wall sheathing nail spacing requirements control.

Special Connections (WFCM 3.2.5)

Connections around Wall Openings (WFCM 3.2.5.4)

................................................................. Foyer Window

Choose Header/Girder Connections based on loads from Table 3.7 (p. 157)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Roof Span: ................................................................................................. 32 ft.
Header Span (Foyer Window): ........................................................................ 6 ft.

Required Connection Capacity at Each End of Header:
Tabulated Uplift Capacity (interpolated): ....................................................... 992 lbs.
Tabulated Lateral Capacity: ............................................................................ 472 lbs.

Using identical procedures:
North Bathroom (4' header) Tabulated Uplift Capacity (interpolated): .......... 661 lbs.
North Bathroom (4' header) Tabulated Lateral Capacity: ............................... 315 lbs.

Typical Bedroom (3' header) Tabulated Uplift Capacity (interpolated): .......... 496 lbs.
Typical Bedroom (3' header) Tabulated Lateral Capacity (interpolated): ......... 236 lbs.

Choose Window Sill Plate Connections based on loads from Table 3.8 (p. 157)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Window Sill Plate Span: .............................................................................. 6 ft.

Tabulated Lateral Connection Capacity at Each End of Window Sill Plate: .... 472 lbs.

Using identical procedures:
North Bathroom (4' sill) Tabulated Lateral Connection Capacity at Each End: 315 lbs.
Typical Bedroom (3' sill) Tabulated Lateral Connection Capacity at Each End: 236 lbs.
BOTTOM STORY DESIGN

Main House
Wall Framing ...........................................42
Wall Sheathing ........................................45
Floor Framing ..........................................48
Floor Sheathing ........................................48
Connections ............................................49

West Wing
Wall Framing ...........................................55
Wall Sheathing ........................................59
Floor Framing ..........................................63
Floor Sheathing ........................................63
Connections ............................................64

East Wing
Wall Framing ...........................................70
Wall Sheathing ........................................73
Floor Framing ..........................................77
Floor Sheathing ........................................77
Connections ............................................78
Wall Framing

Wall Studs (WFCM 3.4.1.1)

Choose Studs from Table 3.20A or 3.20B and Footnotes (pp. 182-184)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Wall Height: ............................................................................................... 9 ft.
Sheathing Type (wood structural panel or minimum sheathing): .................. WSP
Studs supporting (Roof, Ceiling, Floors): ..................................................... Roof, Ceiling, 2 Floors

Selection of Specie, Grade, Size, and Spacing: (Table 3.20B and Footnotes)

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
</tr>
<tr>
<td>Size</td>
<td>2x6</td>
<td>2x6</td>
<td>2x6</td>
<td>2x6</td>
</tr>
<tr>
<td>Maximum Length (Wind)</td>
<td>14'-10&quot;</td>
<td>14'-5&quot;</td>
<td>15'-7&quot;</td>
<td>14'-5&quot;</td>
</tr>
<tr>
<td>Maximum Length (Dead and Live Loads)</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
</tbody>
</table>

Top Plates (WFCM 3.4.1.2)

Choose Building End Wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

Building Dimension: .................................................................................. 32 ft.
Tabulated Minimum Splice Length: ............................................................. 6 ft.
Connection: top plate – to – top plate: ...................................................... 2-16d nails per ft.

Choose Building Side Wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

Building Dimension: .................................................................................. 40 ft.
Tabulated Minimum Splice Length: ............................................................. 8 ft.
Connection: top plate – to – top plate: ...................................................... 2-16d nails per ft.
Wall Framing (cont’d)

Exterior Loadbearing Wall Headers (WFCM 3.4.1.4.1)

Choose Headers in Loadbearing Walls from Tables 3.22A-E and Table 3.22F (pp. 186-193)

Building Width: ................................................................. 32 ft.
Required Span: ................................................................. 9 ft.
Ground Snow Load: ........................................................... 30 psf
Three second gust wind speed: ........................................... 120 mph Exp. B

Headers supporting roof, ceiling and two center bearing floors, use Table 3.22D (p. 189)

Preliminary Header Selection (Gravity Loads): ........................................ 24F Glulam 5x11
Maximum Header/Girder Span (interpolated): .................................. 10'-6"
Tabulated Number of Jack Studs Required (Table 3.22F): .................... 3
Roof Span Adjustment (Footnote 1 – (W+12)/48): ................................. 0.92
Adjusted number of jack studs required = tabulated x roof span adjustment: 3

Preliminary Header Selection (Wind Loads): ........................................ 3-Southern Pine #2 2x12's
Maximum Header/Girder Span .................................................... 9'-4"
Tabulated Number of Full Height (King) Studs (Table 3.23C): ............... 4

Table 3.23A (p. 192)

Preliminary Header Selection (Wind Loads): ........................................ 3-Southern Pine #2 2x12's
Maximum Header/Girder Span .................................................... 9'-4"
Tabulated Number of Full Height (King) Studs (Table 3.23C): ............... 4

Final Selection of Header Specie, Grade, and Size:

Gravity Loads Control: .......................................................... 24F Glulam 5x11
Number of Jack Studs Required (gravity controlled): ......................... 3*
Number of Full Height (King) Studs Required (wind controlled): .......... 4 (same species / grade as Loadbearing Studs, WFCM Workbook p. 42 (WFCM 3.4.1.4.2))

Using identical procedures:

Foyer headers (12' required): .................................................. 24F Glulam 5x15.125
Number of Jack Studs Required: ............................................. 4*
Number of Full Height (King) Studs Required: ................................ 5

Typical Window headers (3' required): 2-Southern Pine #2 2x6's ....... 3'-1" >3' OK
Number of Jack Studs Required: ............................................. 2*
Number of Full Height (King) Studs Required: ................................ 2

*Note: WFCM 3.4.1.4.3 allows jack studs to be replaced with an equivalent number of full height (king) studs if adequate gravity connections are provided.

Exterior Loadbearing Wall Window Sill Plates (WFCM 3.4.1.4.4)

Choose Window Sill Plates from Table 3.23B (p. 193)

Three second gust wind speed: .................................................. 120 mph Exp. B
Required Span: ................................................................. 3 ft.

Selection of Window Sill Plate Specie, Grade, and Size: 1-Southern Pine #2 2x6 (flat) (to match wall stud size)
Tabulated Window Sill Plate Span: .......................................... 7'-6"
Wall Height Adjustment (Footnote 3 – (H/10)^2): .......................... 0.95

Adjusted Maximum Sill Plate Length:
Tabulated maximum sill plate Length ÷ wall Height Adjustment: ........ 7'-10" >3' OK
Wall Framing (cont’d)

Living Room Door

Interior Loadbearing Wall Headers (WFCM 3.4.2.4.1)

Choose Headers for Interior Loadbearing Walls from Tables 3.24A-C (pp. 195-197)

Building Width: ................................................................. 32 ft.
Required Span: ............................................................... 6 ft.

Table 3.24B (p.196)
Selection of Header Specie, Grade, and Size:

<table>
<thead>
<tr>
<th>Specie</th>
<th>Grade</th>
<th>Size</th>
<th>Span</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Southern Pine</td>
<td>#2</td>
<td>2x12's</td>
<td>6'-1&quot;</td>
<td>&gt;6' OK</td>
</tr>
</tbody>
</table>

Number of Jack Studs Required (Table 3.24C): 3

Foyer Hall

Interior Loadbearing Wall Headers (WFCM 3.4.2.4.1)

Choose Headers for Interior Loadbearing Walls from Tables 3.24A-C (pp. 195-197)

Building Width: ................................................................. 32 ft.
Required Span: ............................................................... 4 ft.

Table 3.24B (p.196)
Selection of Header Specie, Grade, and Size:

<table>
<thead>
<tr>
<th>Specie</th>
<th>Grade</th>
<th>Size</th>
<th>Span</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Southern Pine</td>
<td>#2</td>
<td>2x10's</td>
<td>4'-2&quot;</td>
<td>&gt;4' OK</td>
</tr>
</tbody>
</table>

Number of Jack Studs Required (Table 3.24C): 3

Ends of Hallway

Interior Non-Loadbearing Wall Headers (WFCM 3.4.1.4.1)

The 2000 International Residential Code (IRC) section R602.7.2 allows a single flat 2x4 for interior non-loadbearing walls up to 8’ spans.
Wall Sheathing

Sheathing and Cladding (WFCM 3.4.4.1)

Choose Exterior Wall Sheathing or Cladding from Tables 3.13A and 3.13B respectively (p. 163)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Sheathing Type (wood structural panels, fiberboard, board, hardboard): ............ WSP
Direction Across Studs (Short or Long): ............................................... Short
Stud Spacing: ........................................................................... 16 in.
Minimum Panel Thickness: .............................................................. 3/8 in.
Shearwall minimum panel thickness (WFCM 3.4.4.2): ........................................ 7/16 in.

North Elevation

= 25 ft. long = L_{FH}

South Elevation

= 25 ft. long = L_{FH}

East Elevation

= 28 ft. long = L_{FH}

West Elevation

= 25 ft. long = L_{FH}
**Wall Sheathing (cont’d)**

**Exterior Segmented (Type I) Shear Walls (WFCM 3.4.4.2)**

Choose Exterior Segmented (Type I) Shear Wall Length from Table 3.17A-D (pp. 169-174)

- **Wall Height:** ................................................................. 9 ft.
- **Number of Stories Braced (per 3.1.3.1):** ................................................................. 3
- **Three second gust wind speed:** ................................................................. 120 mph Exp. B
- **Maximum shear wall aspect ratio for wind (Table 3.17D):** .......................... 3.5:1
- **Minimum shear wall segment length (Wall height/aspect ratio):** .................. 2.6 ft.
- **Seismic Design Category:** ................................................................. D1
- **Maximum shear wall aspect ratio for seismic (Table 3.17D Footnote 3):** .... 2:1
- **Minimum shear wall segment length (Wall height/aspect ratio):** .................. 4.5 ft.
- **Minimum WSP sheathing thickness (per WFCM 3.4.4.2):** ......................... 7/16 in.
- **Minimum gypsum thickness (per WFCM 3.4.4.2):** ............................... 1/2 in.

Note: The main house is designed as a three story structure and the wings are designed as 2 story structures. Therefore, shear walls will be designed as 3 separate structures.

<table>
<thead>
<tr>
<th>Load Parallel to Ridge</th>
<th>Load Perpendicular to Ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building Wall Elevation</strong></td>
<td>North</td>
</tr>
<tr>
<td>Actual Length of Wall – Main House</td>
<td>40'</td>
</tr>
<tr>
<td>Effective Length of Full Height Sheathing for Seismic (L_{FHs})</td>
<td>22'</td>
</tr>
<tr>
<td>Tabulated Minimum Length Full Height Sheathing for Seismic Loads per Table 3.17C (L_s)</td>
<td>29.6'</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing – Seismic (WFCM 3.4.4.2 + 3.4.4.2.1)</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Shear wall Adjustment per Table 3.17D (C_{swa})</td>
<td>0.53</td>
</tr>
<tr>
<td>Min. Length Full Ht. Sheathing - Segmented Seismic (L_{Typ,Seismic} = L_s x C_{swa})</td>
<td>15.7'</td>
</tr>
</tbody>
</table>

\[ L_{Typ-S} < L_{FHs} \]

- **ok?**
- **ok?**
- **ok?**
- **ok?**

1Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See Top Story wall design for explanation.
2This is a conservative based on design as separate structures (see note on East Wing Segmented shear walls regarding inscribed method). Shielding from the wings is not accounted for in selection of tabulated values.

North and south walls are seismic controlled (3" nail spacing). East and west walls are wind controlled (3" nail spacing for the east wall and required length for the west wall).
### Wall Sheathing (cont’d)

#### Exterior Perforated (Type II) Shear Walls (WFCM 3.4.4.2)

Choose Exterior Perforated (Type II) Shear Wall Length from Table 3.17E (p. 175)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
<th>South Split?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Height</td>
<td>9'</td>
<td>9'</td>
<td>9'</td>
<td>9'</td>
<td></td>
</tr>
<tr>
<td>Max. Unrestrained Opening Height</td>
<td>7'-6&quot;</td>
<td>7'-6&quot;</td>
<td>7'-6&quot;</td>
<td>7'-6&quot;</td>
<td></td>
</tr>
<tr>
<td>Actual Length of Full Height Sheathing (L&lt;sub&gt;FH&lt;/sub&gt;)</td>
<td>25'</td>
<td>22'</td>
<td>25'</td>
<td>28'</td>
<td></td>
</tr>
<tr>
<td>Effective Length of Full Height Sheathing for Seismic (L&lt;sub&gt;FHS&lt;/sub&gt;)</td>
<td>16.7&lt;sup&gt;i&lt;/sup&gt;</td>
<td>14.7&lt;sup&gt;i&lt;/sup&gt;</td>
<td>25'</td>
<td>28'</td>
<td></td>
</tr>
<tr>
<td>Length of Wall (L&lt;sub&gt;Wall&lt;/sub&gt;)</td>
<td>40'</td>
<td>40'</td>
<td>32'</td>
<td>32'</td>
<td></td>
</tr>
<tr>
<td>Percent Full Height Sheathing (L&lt;sub&gt;FH&lt;/sub&gt; / L&lt;sub&gt;Wall&lt;/sub&gt;)</td>
<td>63%</td>
<td>55%</td>
<td>78%</td>
<td>88%</td>
<td></td>
</tr>
<tr>
<td>Minimum Length Full Ht. Sheathing - Segmented Seismic (L&lt;sub&gt;TypeI-S&lt;/sub&gt;)</td>
<td>15.7'</td>
<td>15.7'</td>
<td>20.4'</td>
<td>20.4'</td>
<td></td>
</tr>
<tr>
<td>Perforated (Type II) Length Increase Factor from Table 3.17E (C&lt;sub&gt;L&lt;/sub&gt;)</td>
<td>1.29</td>
<td>1.37</td>
<td>1.16</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>Min. Length Full Ht. Sheathing-Perforated Seismic (L&lt;sub&gt;TypeII-S&lt;/sub&gt;=L&lt;sub&gt;TypeI-S&lt;/sub&gt;(C&lt;sub&gt;L&lt;/sub&gt;))</td>
<td>20.3'</td>
<td>21.3'</td>
<td>23.7'</td>
<td>22'</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HAVE</th>
<th>NG</th>
<th>NG</th>
<th>Ok? ✓</th>
<th>Ok? ✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>L&lt;sub&gt;TypeII-S&lt;/sub&gt; &lt; L&lt;sub&gt;FHS&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| NEED | | | | |
|---|---|---|---|
| L<sub>TypeI-S</sub> < L<sub>FHS</sub> | | | | |

<sup>i</sup>Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See Segmented (Type I) shear wall calculations.

North and South walls require design as Segmented (Type I) shear walls. Wind controls for east wall because of 3" nail spacing requirement.

Shear wall requirements for the building wings will be added to the requirements here for the main building for shared walls (see East and West wing wall sheathing sections).
Floor Framing

Floor Joists (WFCM 3.3.1.1)

Choose Floor Joists from Tables 3.18A-B (pp. 177-178)

Live Load: ................................................................. 40 psf
Dead Load: ................................................................. 10 psf
Joist Vertical Displacement L/Δ: .................................. 360
Required Span: .......................................................... 16 ft.

Selection of Specie, Grade, Size, and Spacing: (Table 3.18B)

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>#1</td>
<td>#1</td>
<td>#2</td>
<td>SS</td>
</tr>
<tr>
<td>Size</td>
<td>2x10</td>
<td>2x10</td>
<td>2x10</td>
<td>2x10</td>
</tr>
<tr>
<td>Maximum Span</td>
<td>16'-5&quot;</td>
<td>16'-0&quot;</td>
<td>16'-1&quot;</td>
<td>16'-0&quot;</td>
</tr>
</tbody>
</table>

Floor Sheathing

Sheathing Spans (WFCM 3.3.4.1)

Choose Floor Sheathing from Table 3.14 (p. 164)

Floor Joist Spacing: ......................................................... 16 in.
Sheathing Type (wood structural panels or boards): .................. WSP
Span Rating ................................................................. 24/16
Tabulated Minimum Panel Thickness: ..................................... 7/16 in.
Connections

Lateral Framing and Shear Connections (WFCM 3.2.1)

Wall Assembly (WFCM 3.2.1.3)

**Top Plate to Top Plate Connection from Table 3.1 (p. 139):** (6” nail spacing on East / West Walls)

<table>
<thead>
<tr>
<th>Nail Spacing</th>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>1.67 x 2</td>
<td>16d</td>
</tr>
<tr>
<td>3”</td>
<td>2.0 x 2</td>
<td>16d</td>
</tr>
</tbody>
</table>

Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6” (North / South walls)

<table>
<thead>
<tr>
<th>Nail Spacing</th>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>1.67 x 2</td>
<td>16d</td>
</tr>
<tr>
<td>3”</td>
<td>2.0 x 2</td>
<td>16d</td>
</tr>
</tbody>
</table>

**Top Plate Intersection Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-16d Commons</td>
<td>each side joint</td>
</tr>
</tbody>
</table>

**Stud to Stud Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-16d</td>
<td>Commons 24” o.c.</td>
</tr>
</tbody>
</table>

**Header to Header Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>16d Commons</td>
<td>16” o.c. -edges</td>
</tr>
</tbody>
</table>

**Choose Top or Bottom Plate to Stud Connection from Table 3.1 & 3.5A:**

- 2-16d Commons per 2x4 stud
- 3-16d Commons per 2x6 stud
- 4-16d Commons per 2x8 stud

Wall Assembly to Floor Assembly (WFCM 3.2.1.4)

**Bottom Plate to Floor Joist, Bandjoist, Endjoist or Blocking Connection from Table 3.1:** (6” nail spacing)

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-16d Commons</td>
<td>per foot</td>
</tr>
</tbody>
</table>

Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6”

<table>
<thead>
<tr>
<th>Nail Spacing</th>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>1.67 x 2</td>
<td>16d</td>
</tr>
<tr>
<td>3”</td>
<td>2.0 x 2</td>
<td>16d</td>
</tr>
</tbody>
</table>

**Bridging to Floor Joist Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-8d</td>
<td>Commons each end</td>
</tr>
</tbody>
</table>

**Blocking to Floor Joist Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-8d</td>
<td>Commons each end</td>
</tr>
</tbody>
</table>

**Band Joist to Floor Joist Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-16d Commons</td>
<td>per joist</td>
</tr>
</tbody>
</table>

Floor Assembly (WFCM 3.2.1.5)

**Floor Joist to Top Plate Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-8d Commons</td>
<td>per joist</td>
</tr>
</tbody>
</table>

Floor Assembly to Wall Assembly (WFCM 3.2.1.6)

**Floor Joist to Top Plate Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-8d Commons</td>
<td>per joist</td>
</tr>
</tbody>
</table>

**Blocking to Sill or Top Plate Connection from Table 3.1:**

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-16d Commons</td>
<td>each block</td>
</tr>
</tbody>
</table>

**Band Joist to Sill or Top Plate Connection from Table 3.1:** (6” nail spacing)

<table>
<thead>
<tr>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-16d Commons</td>
<td>per foot</td>
</tr>
</tbody>
</table>

Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6”

<table>
<thead>
<tr>
<th>Nail Spacing</th>
<th>Number of Nails</th>
<th>Type of Nail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>1.67 x 2</td>
<td>16d</td>
</tr>
<tr>
<td>3”</td>
<td>2.0 x 2</td>
<td>16d</td>
</tr>
</tbody>
</table>
Connections (cont’d)

Lateral, Shear, and Uplift Connections (WFCM 3.2.1 and 3.2.2)

Wall Assembly to Foundation (WFCM 3.2.1.7 and 3.2.2.3)

Choose Sill Plate to Foundation Connection Requirements for Anchor Bolts Resisting Lateral, Shear, and Uplift Loads from Table 3.2A & B (pp. 142-144)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Stories supported by Foundation: .............................................................. 3
Anchor Bolt Diameter: ........................................................................... 5/8 in.

Assuming Crawl Space or Basement, determine maximum Anchor Bolt Spacing:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear wall line dimension (L_{sw})</td>
<td>40'</td>
<td>40'</td>
<td>32'</td>
<td>32'</td>
</tr>
<tr>
<td>Building dimension perpendicular to shear wall line (Table 3.2A)</td>
<td>32'</td>
<td>32'</td>
<td>40'</td>
<td>40'</td>
</tr>
<tr>
<td>Number of stories receiving wind load (Table 3.2A)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Tabulated number of bolts to resist shear loads from wind (Table 3.2A)</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Bolt spacing for wind shear loads $s_{sw} = (L_{sw}-2) / (#bolts-1)$</td>
<td>57&quot;</td>
<td>57&quot;</td>
<td>32&quot;</td>
<td>32&quot;</td>
</tr>
<tr>
<td>Max. bolt spacing to resist wind uplift loads ($s_{wu}$) (Table 3.2C &amp; 3.4C)</td>
<td>33&quot;</td>
<td>33&quot;</td>
<td>72^{n,2}</td>
<td>72^{n,2}</td>
</tr>
<tr>
<td>Tabulated anchor bolt spacing to resist seismic loads ($s_{s}$) (Table 3.3A)</td>
<td>47&quot;</td>
<td>47&quot;</td>
<td>47&quot;</td>
<td>47&quot;</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - Seismic</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>4&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) ($C_{swa}$)</td>
<td>0.53</td>
<td>0.53</td>
<td>0.69</td>
<td>0.69</td>
</tr>
<tr>
<td>Adjusted bolt spacing for seismic loads $s_{sa} = (s_{s})(C_{swa})$</td>
<td>24&quot;</td>
<td>24&quot;</td>
<td>32&quot;</td>
<td>32&quot;</td>
</tr>
<tr>
<td>Max. anchor bolt spacing (lesser of $s_{sw}$, $s_{wu}$, and $s_{sa}$)</td>
<td>24&quot;</td>
<td>24&quot;</td>
<td>32^{n,3}</td>
<td>32^{n,3}</td>
</tr>
</tbody>
</table>

1Calculated from WFCM Table 3.4C based on 16” o.c. outlooker spacing (horizontal projection) with 2 wall dead loads subtracted (0.6x99plf) and anchor bolt capacity of 1488 lbs from WFCM Commentary Table 3.2B.
2Table 3.4C = 496 lbs x 12’’/ 16” – 120 plf (walls) = 372 plf – 120 plf = 252 plf $252 \text{ plf} (32\text{ft}) / 1488 \text{ lbs} = 1.64 \text{ bolts}$, so spacing = 72" maximum.
3Anchor bolt spacing shall not exceed 6' (72") on center per Table 3.2A Footnote 2.
4These will be added to anchor bolts required by West and East wing common walls respectively.
Connections (cont’d)

Alternatively, use proprietary connectors with the following minimum capacities from Table 3.2 (pp. 140-141), Table 3.3 (pp. 145-146) and Table 3.4C (p. 152).

Three second gust wind speed: 120 mph Exp. B
Stories supported by Foundation: 3

Assuming Crawl Space or Basement, determine required loads for proprietary connectors:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building dimension W or L</td>
<td>40'</td>
<td>40'</td>
<td>32'</td>
<td>32'</td>
</tr>
<tr>
<td>R=W/L for Table 3.2</td>
<td>0.8</td>
<td>0.8</td>
<td>1.25</td>
<td>1.25</td>
</tr>
</tbody>
</table>

| Wind | 
| Number of stories receiving lateral wind load (Table 3.2A) | 3 | 3 | 3 | 3 |
| Wind uplift (Table 3.4C) | 496 lbs | 496 lbs |
| Uplift force Spacing | 16" | 16" |
| Wind uplift plf basis | 372 plf | 372 plf |
| Overhang Reduction (Table 3.4C Footnote 2) | 1.0 | 1.0 |
| Wall Dead Load Reduction (Table 3.17D) | -119 | -119 |
| Adjusted Wind uplift (Table 3.4C) | 253 plf | 253 plf |
| Wind uplift (Table 3.2(U)) | 151 plf | 151 plf |
| Wind lateral load (Table 3.2(L)) | * | * | * | * |
| Wind shear load (Table 3.2(S)) | 329 plf | 329 plf | 514 plf | 514 plf |

Seismic shear load (Table 3.3) $C_1 = 208$, $C_2 = 53$, $I_{max} = 40'$

Seismic shear load $= \frac{7080 \text{ lbs}}{40'} = 177 \text{ plf}$

Wall Dead Load $w_w = 11 \text{ psf}$

Footnote 4 Wall Dead Load Reduction

$R_w = \frac{(w_w + 70.65)}{85.65} = 0.95$

Footnote 5 Sheathing Adjustment Factor for wall (Table 3.17D)

$C_{swa} = 0.53$

Adjusted seismic shear load $= \frac{12690 \text{ lbs}}{0.53} = 23500 \text{ lbs}$

Wall length

$40' \times 317 \text{ plf} = 12690 \text{ lbs}$

1 Refer to WFCM Commentary 1.1.2.

2 See top story main segmented shearwall design for example seismic calculation using $C_1$ and $C_2$. 
Connections (cont’d)

Uplift Connections (WFCM 3.2.2)

Wall Assembly to Wall Assembly or Wall Assembly to Foundation (WFCM 3.2.2.2 and 3.2.2.3)

Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three second gust wind speed</td>
<td>120 mph Exp. B</td>
<td>120 mph Exp. B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing Spacing</td>
<td>16 in.</td>
<td>16 in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Span</td>
<td>32 ft.</td>
<td>32 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated number of 8d Common Nails required in each end of 1-1/4&quot; x 20 gage strap every stud</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Ceiling Assembly nail increase (Footnote 3)</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required number of 8d Common Nails in each end of strap every stud</td>
<td>4 *</td>
<td>3 *</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Alternatively, use proprietary connectors with the following minimum capacities

| Wind | Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4, page 149) | 441 lbs |
| Wind | Interior framing adjustment (Footnote 1) | 1.0 |
| Wind | Roof dead load reduction (Table 3.4, Footnote 3) | -32 lbs |
| Wind | Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4) | -160 lbs |

Non-Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4C, page 152)

| Wind | Wall-to-Wall and Wall-to-Foundation reduction (WFCM 3.2.5.3) | -160 lbs |
| Wind | Required minimum capacity of proprietary connector | 249 lbs |

calculated using 336 lbs uplift (below) divided by 127 lbs/nail per WFCM Supplement Table 6A.
Connections (cont’d)

Overturning Resistance (WFCM 3.2.3)

Hold downs (WFCM 3.2.3.1)

Choose Hold downs from Table 3.17F for Segmented (Type I) and Perforated (Type II) Walls (p. 176)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tabulated hold down connection capacity required – wind ( (T_w) )</td>
<td>3924 lbs</td>
<td>3924 lbs</td>
<td>3924 lbs</td>
<td>3924 lbs</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - wind</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) ( (C_{swa}) )</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.74</td>
</tr>
<tr>
<td>Adjusted hold down capacity ( (T_{wa} = (T_w) / (C_{swa})) - wind )</td>
<td>6540 lbs</td>
<td>6540 lbs</td>
<td>6540 lbs</td>
<td>5303 lbs</td>
</tr>
<tr>
<td>Additional story hold down requirements – wind (see Workbook p.39)</td>
<td>3019 lbs</td>
<td>3019 lbs</td>
<td>3019 lbs</td>
<td>3019 lbs</td>
</tr>
<tr>
<td>Total hold down requirement for floor to foundation – wind ( (\Sigma T_{wa}) )</td>
<td>9559 lbs</td>
<td>9559 lbs</td>
<td>9559 lbs</td>
<td>8322 lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seismic</th>
<th>Tabulated hold down connection capacity required – seismic ( (T_s) )</th>
<th>2160 lbs</th>
<th>2160 lbs</th>
<th>2160 lbs</th>
<th>2160 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSP Perimeter Edge Nail Spacing - seismic</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>4&quot;</td>
<td></td>
</tr>
<tr>
<td>Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) ( (C_{swa}) )</td>
<td>0.53</td>
<td>0.53</td>
<td>0.53</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>Adjusted hold down capacity ( (T_{sa} = (T_s) / (C_{swa})) - seismic )</td>
<td>4075 lbs</td>
<td>4075 lbs</td>
<td>4075 lbs</td>
<td>3130 lbs</td>
<td></td>
</tr>
<tr>
<td>Additional story hold down req’ments – seismic (see Workbook p.39)</td>
<td>4075 lbs</td>
<td>4075 lbs</td>
<td>2160 lbs</td>
<td>2160 lbs</td>
<td></td>
</tr>
<tr>
<td>Total hold down requirement for floor to foundation ( (\Sigma T_{sa}) - seismic )</td>
<td>8150 lbs</td>
<td>8150 lbs</td>
<td>6235 lbs</td>
<td>5290 lbs</td>
<td></td>
</tr>
</tbody>
</table>

Sheathing and Cladding Attachment (WFCM 3.2.4)

Wall Sheathing (WFCM 3.2.4.2)

Choose Wall Sheathing Nail Spacing from Table 3.11 (p. 161)

Three second gust wind speed: .................................................... 120 mph Exp. B

Stud Spacing: ................................................................................. 16 in.
Sheathing Type (wood structural panels, board or lap siding): ..................... WSP

<table>
<thead>
<tr>
<th>Location</th>
<th>Edges</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>4’ Edge Zone</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Interior Zones</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Shear wall sheathing nail spacing requirements control.
Connections (cont’d)

Special Connections (WFCM 3.2.5)

Connections around Wall Openings (WFCM 3.2.5.4)

................................................................. Typical Window

Choose Header/Girder Connections based on loads from Table 3.7 (p. 157)

Three second gust wind speed: ................................................................. 120 mph Exp. B

Roof Span: ........................................................................................................... 32 ft.
Header Span (Typical Window): ........................................................................... 3 ft.

Required Connection Capacity at Each End of Header:
Tabulated Uplift Capacity (interpolated): ................................................................. 496 lbs.
Floor load adjustment (per footnote 4): ................................................................. -90 lbs.
Adjusted Uplift Capacity ................................................................................ 406 lbs.
Tabulated Lateral Capacity: .................................................................................. 236 lbs.

Using identical procedures:
Family Room Door (9’ header) Tabulated Uplift Capacity (interpolated): ............ 1219 lbs.
Family Room Door (9’ header) Tabulated Lateral Capacity: .................. 708 lbs.
Foyer Door (12’ header) Tabulated Uplift Capacity (interpolated): ...................... 1625 lbs.
Foyer Door (12’ header) Tabulated Lateral Capacity (interpolated): ................. 944 lbs.

Choose Window Sill Plate Connections based on loads from Table 3.8 (p. 157)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Window Sill Plate Span: ................................................................................... 3 ft.
Tabulated Lateral Connection Capacity at Each End of Window Sill Plate: ........ 236 lbs.
# Wall Framing

## Wall Studs (WFCM 3.4.1.1)

### Loadbearing

Choose Studs from Table 3.20A or 3.20B and Footnotes (pp. 180-184)

- Three second gust wind speed: ................................................................. 120 mph Exp. B
- Wall Height: ............................................................................................. 10 ft.
- Sheathing Type (wood structural panel or minimum sheathing): .............. WSP
- Studs supporting: ..................................................................................... Roof, Ceiling, 1 Floor

Selection of Specie, Grade, Size, and Spacing: (Table 3.20B and Footnotes)

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
</tr>
<tr>
<td>Size</td>
<td>2x4&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2x4&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2x4&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2x4&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Maximum Length (Wind)</td>
<td>10'-5&quot;</td>
<td>10'-2&quot;</td>
<td>10'-10&quot;</td>
<td>10'-2&quot;</td>
</tr>
<tr>
<td>Maximum Length (Dead and Live Loads)</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
</tbody>
</table>

<sup>1</sup>While 2x4s will work, 2x6s will frame consistently with end walls and main building.

### Non-Loadbearing

Choose Studs from Table 3.20A or 3.20B and Footnotes (pp. 180-184)

- Three second gust wind speed: ................................................................. 120 mph Exp. B
- Wall Height: ............................................................................................. 16 (max) ft.
- Sheathing Type (wood structural panel or minimum sheathing): .............. WSP

Selection of Specie, Grade, Size, and Spacing: (Table 3.20B and Footnotes)

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
<td>#2</td>
</tr>
<tr>
<td>Size</td>
<td>2x6</td>
<td>2x6</td>
<td>2x6</td>
<td>2x6</td>
</tr>
<tr>
<td>Maximum Length (Wind)</td>
<td>18'-7&quot;</td>
<td>17'-4&quot;</td>
<td>18'-7&quot;</td>
<td>17'-9&quot;</td>
</tr>
<tr>
<td>Maximum Length (Dead and Live Loads)</td>
<td>20'-0&quot;</td>
<td>20'-0&quot;</td>
<td>20'-0&quot;</td>
<td>20'-0&quot;</td>
</tr>
</tbody>
</table>
Wall Framing (cont’d)

Top Plates (WFCM 3.4.1.2)

Choose Building End Wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

Building Dimension: ................................................................. 32 ft.
Tabulated Minimum Splice Length: ........................................... 6 ft.
Connection: top plate – to – top plate: ................................... 2-16d nails per ft.

Choose Building Side wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

Building Dimension: ................................................................. 16 ft.
Tabulated Minimum Splice Length: ........................................... 3 ft.
Connection: top plate – to – top plate: ................................... 2-16d nails per ft.
Job: WFCM Workbook

Description: West Wing

Wall Framing (cont’d)

Bedroom Patio Door

Exterior Loadbearing Wall Headers (WFCM 3.4.1.4.1)

Choose Headers in Loadbearing Walls from Tables 3.22A-E and Table 3.22F (pp. 186-193)

Building Width: .......................................................... 32 ft.
Required Span (Foyer Window): .......................................................... 8 ft.
Ground Snow Load: .......................................................... 30 psf
Three second gust wind speed: .......................................................... 120 mph Exp. B

Header supporting roof, ceiling and attic floor – use Table 3.22B (p. 187)

Preliminary Header Selection (Gravity Loads):

Maximum Header/Girder Span (interpolated): .......................................................... 8'-0"
Tabulated Number of Jack Studs (Table 3.22F): .......................................................... 2
Roof Span Adjustment (Footnote 1 – (W+12)/48): .......................................................... 0.92
Adjusted number of jack studs required = tabulated x roof span adjustment: ........ 2

Table 3.23A (p. 192)

Preliminary Header Selection (Wind Loads):

Maximum Header/Girder Span .......................................................... 8'-1" ft.
Tabulated Number of Full Height (King) Studs (Table 3.23C): .......................................................... 3
(same species / grade as Loadbearing Studs, WFCM Workbook p. 55 (WFCM 3.4.1.4.2))

Final Selection of Header Specie, Grade, and Size:

Gravity loads control:

Number of Jack Studs Required (gravity controlled): .......................................................... 2*
Number of Full Height (King) Studs Required (wind controlled): .......................................................... 3
(same species / grade as Loadbearing Studs, WFCM Workbook p. 55 (WFCM 3.4.1.4.2))

Using identical procedures:

Typical bedroom headers (3’): 2-Southern Pine #2 2x6's ............................................. 3'-8" >3’ OK
Number of Jack Studs Required: .......................................................... 2*
Number of Full Height (King) Studs Required: .......................................................... 2
(same species / grade as Loadbearing Studs, WFCM Workbook p. 55 (WFCM 3.4.1.4.2))

*Note: WFCM 3.4.1.4.3 allows Jack Studs to be replaced with an equivalent number of Full Height (King) Studs of same species / grade as Loadbearing Studs on WFCM Workbook p. 55 (WFCM 3.4.1.4.2) if adequate gravity connections are provided.

Exterior Loadbearing Wall Window Sill Plates (WFCM 3.4.1.4.4)

Choose Window Sill Plates from Table 3.23B (p. 193)

Three second gust wind speed: .......................................................... 120 mph Exp. B
Required Span (Foyer Sill Plate): .......................................................... 3 ft.

Selection of Window Sill Plate Specie, Grade, and Size: 1-Southern Pine #2 2x6 (flat) (to match wall stud size)
Tabulated Window Sill Plate Span: .......................................................... 7'-6"
Wall Height Adjustment (Footnote 3 – (H/10)²): .......................................................... 1.0

Adjusted Maximum Sill Plate Length: Tabulated maximum sill plate Length ÷ wall Height Adjustment: ........ 7'-6" >3’ OK
**Wall Framing (cont’d)**

**Exterior Non-Loadbearing Wall Headers** (WFCM 3.4.1.4.1)

Choose Headers in Non-Loadbearing Walls from Table 3.23B and 3.23C (p. 193)

Three second gust wind speed: ................................................................. 120 mph Exp. B

Required Span: ........................................................................................................ 6 ft.

Selection of Header Specie, Grade, and Size: 1-Southern Pine #2 2x6 (flat)

Tabulated Header Span: ................................................................. 7'-6"

Wall Height Adjustment (Footnote 3 – (H/10) 1/2): ........................................ 1.0

Adjusted Header Span: ............................................................................ 7'-8"

Number of Full Height (King) Studs Required: ........................................... 3

(same species / grade as Non-Loadbearing Studs on WFCM Workbook p. 55 (WFCM 3.4.1.4.2))

**Exterior Non-Loadbearing Wall Window Sill Plates** (WFCM 3.4.1.4.3)

Choose Window Sill Plates from Table 3.23B (p. 193)

Three second gust wind speed: ................................................................. 120 mph Exp. B

Required Span: ........................................................................................................ 6 ft.

Selection of Window Sill Plate Specie, Grade, and Size: 1-Southern Pine #2 2x6 (flat)

Tabulated Window Sill Plate Span: ................................................................. 7'-6"

Wall Height Adjustment (Footnote 3 – (H/10) 1/2): ........................................ 1.0

Adjusted Header Span: ............................................................................ 7'-8"

Number of Full Height (King) Studs Required: ........................................... 3

(same species / grade as Non-Loadbearing Studs on WFCM Workbook p. 55 (WFCM 3.4.1.4.2))

**Interior Loadbearing Wall Headers** (WFCM 3.4.2.4.1)

Choose Header Table 3.24A (p. 195)

Building Width: ........................................................................................................ 32 ft.

Required Span: ........................................................................................................ 3 ft.

Selection of Header Specie, Grade, and Size: 2-Southern Pine #2 2x6's

Maximum Header/Girder Span: ........................................................................... 3'-11" ft.

Number of Jack Studs Required: ........................................................................... 1
**Wall Sheathing**

**Sheathing and Cladding** *(WFCM 3.4.4.1)*

Choose Exterior Wall Sheathing or Cladding from Tables 3.13A and 3.13B respectively (p. 163)

- Three second gust wind speed: ................................................................. 120 mph Exp. B
- Sheathing Type (wood structural panels, fiberboard, board, hardboard): .............. WSP
- Direction Across Studs (Short or Long): ....................................................... Short
- Stud Spacing: ............................................................................................... 16 in.
- Shear wall minimum panel thickness (WFCM 3.4.4.2): .............................. 7/16 in.

*North Elevation*

---

*South Elevation*

---

*East Elevation*

---

*West Elevation*
### Exterior Segmented (Type I) Shear walls (WFCM 3.4.4.2)

Choose Exterior Segmented (Type I) Shear Wall Length from Table 3.17A-D (pp. 169-174)

- **Wall Height:** .......................................................... 10 ft.
- **Number of Stories Braced (per 3.1.3.1):** ...................................... 2
- **Three second gust wind speed:** .............................................. 120 mph Exp. B
- **Maximum shear wall aspect ratio for wind (Table 3.17D):** .......... 3.5:1
- **Minimum shear wall segment length (Wall height/aspect ratio):** ... 2.9 ft.
- **Seismic Design Category:** ................................................. D1
- **Maximum shear wall aspect ratio for seismic (Table 3.17D Footnote 3):** 2:1
- **Minimum shear wall segment length (Wall height/aspect ratio):** ... 5.0 ft.
- **Minimum WSP sheathing thickness (per WFCM 3.4.4.2):** .......... 7/16 in.
- **Minimum gypsum thickness (per WFCM 3.4.4.2):** .................. 1/2 in.

Note: Since the main house is designed as a three story structure and the wings are designed as 2 story structures, the shear walls will be designed as 3 separate structures (see 3.1.3.3c Exception).

#### Building Wall Elevation

<table>
<thead>
<tr>
<th>STEPS</th>
<th>Description</th>
<th>North</th>
<th>South</th>
<th>East (h = 9')</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Length of Wall – West Wing</td>
<td>16'</td>
<td>16'</td>
<td>32'</td>
<td>32'</td>
</tr>
<tr>
<td>2</td>
<td>Effective Length of Full Height Sheathing for Seismic ($L_{FH}$)</td>
<td>6.4(^1)</td>
<td>6.7(^1)</td>
<td>28'</td>
<td>26'</td>
</tr>
<tr>
<td>3</td>
<td>Tabulated Minimum Length Full Height Sheathing for Seismic Loads per Table 3.17C ($L_2$): $C_1 = \frac{51}{L_{max}}$, $C_2 = \frac{15}{L_{min}}$</td>
<td>10.6'</td>
<td>10.6'</td>
<td>10.6'</td>
<td>10.6'</td>
</tr>
<tr>
<td>4</td>
<td>WSP Perimeter Edge Nail Spacing – Seismic (WFCM 3.4.4.2 + 3.4.4.2.1)</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>6&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>5</td>
<td>Shear wall Adjustment per Table 3.17D ($C_{swa}$)</td>
<td>0.53</td>
<td>0.53</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
<td>Min. Length Full Ht. Sheathing - Segmented Seismic ($L_{Type-I-S} = L_2 \times C_{swa}$)</td>
<td>5.6'</td>
<td>5.6'</td>
<td>10.6'</td>
<td>10.6'</td>
</tr>
</tbody>
</table>

#### Load Parallel to Ridge

1. **$L_{Type-S} < L_{FH}$**
   - Effective Length of Full Height Sheathing ($L_{FH}$) | 8' | 10' | 28' | 26' |
   - Tabulated Minimum Length Full Height Sheathing for Wind Loads per Table 3.17B and 3.17A ($L_{w}$) | 10.6\(^2\) | 10.6\(^2\) | 7.1\(^3\) | 7.1\(^3\) |
   - WSP Perimeter Edge Nail Spacing – Wind (WFCM 3.4.4.2) | 3" | 4" | 6" | 6" |
   - Shear wall Adjustment per Table 3.17D ($C_{swa}$) | 0.6 | 0.74 | 1.0 | 1.0 |
   - Wall Height Adjustment (Table 3.17A&B Footnote 2) ($C_{WH} = 10'/8'$) | 1.25 | 1.25 | 1.125 | 1.25 |
   - Min. Length Full Ht. Sheathing - Segmented Wind ($L_{Type-W}=L_{w} (C_{WH}) (C_{swa})$) | 7.9' | 9.8' | 8.0' | 8.9' |

1\(^{1}\)Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See shear wall calculations for bottom story main structure, except h = 10' for North, South & West walls. (w = 4' North) (w = 3'-4" South).

2\(^{2}\)This is conservative based on design as separate structures (see note on East Wing Segmented shear walls regarding inscribed method). Shielding from the main building is not accounted for in selection of tabulated values.

3\(^{3}\)Extrapolated from Table 3.17A
North wall is wind controlled. East and west walls are seismic controlled (required length), while the south wall is seismic controlled due to the 3" perimeter edge nail spacing.

**Exterior Perforated (Type II) Shear Walls** (WFCM 3.4.4.2)

Choose Exterior Perforated (Type II) Shear Wall Length from Table 3.17E (p. 175)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>Load Parallel to Ridge</th>
<th>Load Perpendicular to Ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>North</td>
<td>South</td>
</tr>
<tr>
<td>Wall Height</td>
<td>10'</td>
<td>10'</td>
</tr>
<tr>
<td>Max. Unrestrained Opening Height</td>
<td>8'-4&quot;</td>
<td>4'-6&quot;</td>
</tr>
<tr>
<td>Actual Length of Full Height Sheathing (L_{FHS})</td>
<td>8'</td>
<td>10'</td>
</tr>
<tr>
<td>Effective Length of Full Height Sheathing for Seismic (L_{FHS})</td>
<td>6.4'</td>
<td>6.7'</td>
</tr>
<tr>
<td>Length of Wall (L_{Wall})</td>
<td>16'</td>
<td>16'</td>
</tr>
<tr>
<td>Percent Full Height Sheathing (L_{FHS} / L_{Wall})</td>
<td>50%</td>
<td>63%</td>
</tr>
<tr>
<td>Tabulated Min. Length Full Ht. Sheathing-Segmented Seismic (L_{TypeI-S})</td>
<td>5.6'</td>
<td>5.6'</td>
</tr>
<tr>
<td>Perforated (Type II) Length Increase Factor from Table 3.17E (C_{L})</td>
<td>1.43</td>
<td>1.11</td>
</tr>
<tr>
<td>Min. Length Full Ht. Sheathing-Perforated Seismic (L_{TypeII-S} = L_{TypeI-S} * C_{L})</td>
<td>8.0'</td>
<td>6.2'</td>
</tr>
</tbody>
</table>

\[ L_{TypeII-S} < L_{FHS} \]

**Wind**

| Actual Length of Full Height Sheathing (L_{FHS}) | 8'   | 10'  | 28'  | 26'  |
| Length of Wall (L_{Wall}) | 16'  | 16'  | 32'  | 32'  |
| Percent Full Height Sheathing (L_{FHS} / L_{Wall}) | 50%  | 63%  | 88%  | 81%  |
| Tabulated Min. Length Full Ht. Sheathing-Segmented Wind (L_{TypeI-W}) | 7.9'  | 9.8'  | 8'   | 8.9'  |
| Perforated (Type II) Length Increase Factor from Table 3.17E (C_{L}) | 1.43  | 1.11  | 1.08  | 1.05  |
| Min. Length Full Ht. Sheathing-Perforated Wind (L_{TypeII-W} = L_{TypeI-W} * C_{L}) | 11.3' | 10.9' | 8.6'  | 9.4'  |

\[ L_{TypeII-W} < L_{FHS} \]

Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See shear wall calculations for bottom story main structure.

North and South walls require design as Segmented (Type I) wall with hold downs around the interior opening. Alternatively, use Table 3.17D (p.174) to increase capacity by changing the interior sheathing from gypsum to 7/16" wood structural panels with an edge nail spacing of 3" o.c., giving a length adjustment factor, C_{max} of 0.35 for wind loads. Since an adjustment factor was used in the Segmented (Type I) shear wall calculations, it will be divided out:  North wall (wind controlled): 11.3' / (0.6)*(0.35) = 6.6' < 8' OK;  South wall (wind controlled): 10.9' / (0.74)*(0.35) = 5.2' < 10' OK

**Bottom Story West Wing Shear Wall Details Summary**

<table>
<thead>
<tr>
<th>Building Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Wall Type</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
</tr>
<tr>
<td>WSP Perimeter Nail Spacing (North wall WSP on both sides)</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>6&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Governing Load</td>
<td>Wind</td>
<td>Seismic</td>
<td>Seismic</td>
<td>Seismic</td>
</tr>
</tbody>
</table>
**Wall Sheathing (cont’d)**

**Combine Shear Wall Requirements for Main Building and West Wing**

### Adjust Shear Wall Requirements to Common Nailing Pattern

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>Wind</th>
<th>Seismic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Segmented (Type I) Shear Wall Requirements</strong> – Sheathing Thickness</td>
<td>7/16&quot;</td>
<td>7/16&quot;</td>
</tr>
<tr>
<td><strong>Main Building – West Elevation (WSP perimeter edge nail spacing) (L_{FH1})</strong></td>
<td>23.0'(4&quot;)</td>
<td>20.4'(4&quot;)</td>
</tr>
<tr>
<td>Length adjustment factor, C_{sw1} (Table 3.17D)</td>
<td>0.74</td>
<td>0.69</td>
</tr>
<tr>
<td>Revised Length Adjustment Factor (C_{sw1revised}) (Table 3.17D)</td>
<td>no change</td>
<td>no change</td>
</tr>
<tr>
<td>Length adjustment factor ratio C_{sw1 ratio} = C_{sw1revised} / C_{sw1}</td>
<td>no change</td>
<td>no change</td>
</tr>
<tr>
<td>Adjusted Shared wall length = L_{FH1} * C_{sw1 ratio} = L_{FHadj1}</td>
<td>23.0'(4&quot;)</td>
<td>20.4'(4&quot;)</td>
</tr>
</tbody>
</table>

**West Wing – East Elevation (WSP perimeter edge nail spacing) (L_{FH2})**

| Length adjustment factor, C_{sw2} (Table 3.17D) | 1.0 | 1.0 |
| Revised Length Adjustment Factor (C_{sw2revised}) (Table 3.17D) | 0.74 | 0.69 |
| Length adjustment factor ratio C_{sw2 ratio} = C_{sw2revised} / C_{sw2} | 0.74 | 0.69 |
| Adjusted Shared wall length = L_{FH2} * C_{sw2 ratio} = L_{FHadj2} | 6.6'(4") | 7.9'(4") |

**Adjusted Shared Wall – Total Requirement (L_{TypeIadjusted}) = L_{FHadj1} + L_{FHadj2}**

| 29.6' | 27.7' |

**Actual Length of Full Height Sheathing (L_{FH})**

| 31.0' | 31.0' |

L_{TypeIadjusted} < L_{FH}\[\text{Ok?} \checkmark\]  

**Perforated (Type II) Shear Wall Requirements**

| Perforated (Type II) Length Increase Factor from Table 3.17E (C_{L}) | 1.08 | 1.08 |
| Min. Length Full Ht. Sheathing-Perforated (L_{TypeIIadjusted} = L_{TypeIadjusted} (C_{L})) | 31.9' | 29.9' |
| Actual Length of Full Height Sheathing (L_{FH}) | 31.0' | 31.0' |

L_{TypeIIadjusted} < L_{FH}\[\text{Ok?} ~ \checkmark\]

---

1. Actual length including the 3’ offset of the wings. Decreased nail spacing should be considered first to increase Perforated (Type II) shear wall capacity, otherwise try increasing WSP thickness.
Wall Sheathing (cont’d)

Combine Shear Wall Requirements for Main Building and West Wing

<table>
<thead>
<tr>
<th>Building Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Wall Type</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
</tr>
<tr>
<td>WSP Perimeter Nail Spacing (North wall WSP on both sides)</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>4&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Governing Load</td>
<td>Wind</td>
<td>Seismic</td>
<td>Wind</td>
<td>Seismic</td>
</tr>
<tr>
<td>Shear wall Adjustment per Table 3.17D (Cswa)</td>
<td>0.35</td>
<td>0.53</td>
<td>0.74</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Floor Framing

Floor Joists (WFCM 3.3.1.1)

Slab on Grade – not applicable

Floor Sheathing

Sheathing Spans (WFCM 3.3.4.1)

Slab on Grade – not applicable
Connections

Lateral Framing and Shear Connections (WFCM 3.2.1)

See Top Story design for wall and roof assembly connection requirements (Workbook p.37).

Lateral, Shear, and Uplift Connections (WFCM 3.2.1 and 3.2.2)

Wall Assembly to Foundation (WFCM 3.2.1.7 and 3.2.2.3)

Choose Sill or Bottom Plate to Foundation Connection Requirements for Anchor Bolts Resisting Lateral, Shear, and Uplift Loads from Table 3.2A & B (pp. 142-144) and Table 3.3A (p. 147).

Three second gust wind speed: ............................................................................ 120 mph Exp. B
Stories supported by Foundation: .......................................................................... 2
Anchor Bolt Diameter: ........................................................................................... 5/8 in.

Assuming Crawl Space or Basement, determine maximum Anchor Bolt Spacing for common wall portion:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear wall line dimension ($L_{sw}$)</td>
<td>32'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building dimension perpendicular to shear wall line (Table 3.2A)</td>
<td>16'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>Number of stories receiving wind load (Table 3.2A)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tabulated number of bolts to resist shear loads from wind (Table 3.2A)</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bolt spacing for wind shear loads $s_{sw} = (L_{sw} - 2) / (number of bolts - 1)$</td>
<td>$72^1, 2, 3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. bolt spacing to resist wind uplift loads ($s_{wu}$) (Table 3.2C &amp; 3.4C)</td>
<td>N/A$^4$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$Calculated per WFCM Commentary for Table 3.2A
$^2$Anchor bolt spacing shall not exceed 6' on center per Table 3.2A Footnote 2.
$^3$These anchor bolts will be added to anchor bolt requirements for Main house west wall.
$^4$WFCM 3.2.5.3 provision for walls that do not support the roof assembly and are attached according to 3.2.1 need no additional uplift connections.
Job: WFCM Workbook  
Description: West Wing

Connections (cont’d)

Assuming Slab on Grade, determine maximum Anchor Bolt Spacing for non-common wall portions:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear wall line dimension (L_{sw})</td>
<td>16'</td>
<td>16'</td>
<td>36'</td>
<td>32'</td>
</tr>
<tr>
<td>Number of stories receiving wind load (Table 3.2B)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bolt spacing for wind lateral and shear loads (Table 3.2B)</td>
<td>45&quot;</td>
<td>45&quot;</td>
<td>45&quot;</td>
<td>45&quot;</td>
</tr>
<tr>
<td>Wall sheathing type adjustment factor per Table 3.17D (Table 3.2B Footnote 3) (assumes perforated shear wall capacities) C_{swa}</td>
<td>0.35</td>
<td>0.74</td>
<td>0.74</td>
<td>1.0</td>
</tr>
<tr>
<td>Adjusted bolt spacing for wind lateral and shear loads (s_{sw})</td>
<td>15&quot;</td>
<td>33&quot;</td>
<td>33&quot;</td>
<td>45&quot;</td>
</tr>
<tr>
<td>Max. anchor bolt spacing to resist wind uplift loads (s_{wu}) (Table 3.2C)</td>
<td>60&quot;</td>
<td>60&quot;</td>
<td>33&quot;</td>
<td>33&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seismic</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSP Perimeter Edge Nail Spacing - Seismic</td>
</tr>
<tr>
<td>Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) (C_{swa})</td>
</tr>
<tr>
<td>Adjusted bolt spacing for seismic loads s_{sa} = (s_{sw})(C_{swa})</td>
</tr>
<tr>
<td>Max. anchor bolt spacing (lesser of s_{sw}, s_{wu}, and s_{sa})</td>
</tr>
</tbody>
</table>

1 Calculated from WFCM Table 3.4C based on 16" o.c. (horizontal projection) lookouter spacing with 1 wall dead load subtracted (0.6x99plf) and anchor bolt capacity of 1488 lbs from WFCM Commentary Table 3.2B.  
   Table 3.4C: 496 lbs x 12 / 16 = 372 plf  
   (372 plf - 60 plf)(32ft) / 1488lbs = 6.7 bolts, so spacing =60" maximum  
2 Anchor bolt spacing shall not exceed 6' on center per Table 3.3A Footnote 5.
Connections (cont’d)

Alternatively, use proprietary connectors with the following minimum capacities from Table 3.2 (pp. 140-141) and Table 3.3 (pp. 145-146)

- Three second gust wind speed: ........................................ 120 mph Exp. B
- Stories supported by Foundation: ........................................ 2

Assuming Slab on Grade, determine required loads for proprietary connectors:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building dimension W or L</td>
<td>16’</td>
<td>16’</td>
<td>32’</td>
<td>32’</td>
</tr>
<tr>
<td>R=L/W or W/L for Table 3.2</td>
<td>0.5</td>
<td>0.5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Number of stories receiving lateral wind load (Table 3.2A)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wind uplift (Table 3.4C)</td>
<td></td>
<td>496 lbs</td>
<td>496 lbs</td>
<td></td>
</tr>
<tr>
<td>Uplift force Spacing</td>
<td></td>
<td>16&quot;</td>
<td>16&quot;</td>
<td></td>
</tr>
<tr>
<td>Wind uplift plf basis</td>
<td></td>
<td>372 plf</td>
<td>372 plf</td>
<td></td>
</tr>
<tr>
<td>Overhang Reduction (Table 3.4C Footnote 2)</td>
<td></td>
<td>(2’ - OH / 4’)^2</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Wall Dead Load Reduction¹ (1 walls (0.6)(99plf))</td>
<td></td>
<td>-60</td>
<td>-60</td>
<td></td>
</tr>
<tr>
<td>Adjusted Wind uplift (Table 3.4C)</td>
<td></td>
<td></td>
<td>312 plf</td>
<td>312 plf</td>
</tr>
<tr>
<td>Wind uplift (Table 3.2(U))</td>
<td>211 plf</td>
<td>211 plf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind lateral load (Table 3.2(L))</td>
<td></td>
<td>157 plf</td>
<td>157 plf</td>
<td>157 plf</td>
</tr>
<tr>
<td>Wind shear load (Table 3.2(S))</td>
<td>329 plf</td>
<td>329 plf</td>
<td>514 plf</td>
<td>514 plf</td>
</tr>
</tbody>
</table>

¹Refer to WFCM Commentary 1.1.2.

Seismic shear load = adjusted seismic shear load / wall length

| Wall Dead Load w_w | 11 psf | 11 psf | 11 psf | 11 psf |
| Footnote 4 Wall Dead Load Reduction | 0.95 | 0.95 | 0.95 | 0.95 |
| Footnote 5 Sheathing Adjustment Factor for wall (Table 3.17D) (Cswa) | 0.53 | 0.53 | 0.69 | 1.0 |
| Adjusted seismic shear load = seismic shear load x R_w / Cswa | 430 plf | 430 plf | 330 plf | 228 plf |
| Wall length | 16’ | 16’ | 32’ | 32’ |

²See top story main segmented shearwall design for example seismic calculation using C_1 and C_2. Here, the determination is based on slab-on-grade condition. Note that Table 3.3 limits spacing of exterior shear wall lines to 20 – 80 feet for two stories.
**Connections (cont’d)**

**Uplift Connections** *(WFCM 3.2.2)*

Wall Assembly to Wall Assembly or Wall Assembly to Foundation *(WFCM 3.2.2.2 and 3.2.2.3)*

**Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)**

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three second gust wind speed</td>
<td>120 mph Exp. B</td>
<td>120 mph Exp. B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing Spacing</td>
<td>16 in.</td>
<td>16 in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Span</td>
<td>32 ft.</td>
<td>32 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated number of 8d Common Nails required in each end of</td>
<td>4</td>
<td>4(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-1/4&quot; x 20 gage strap every stud</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Ceiling Assembly nail increase (Footnote 3)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Required number of 8d Common Nails in each end of strap</strong></td>
<td><strong>4 (^*)</strong></td>
<td></td>
<td><strong>3 (^*)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>every stud</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{1}\) calculated using 416 lbs uplift (below) divided by 127 lb/nail per *WFCM Supplement* Table 6A.

**Loadbearing Walls** - Tabulated minimum uplift connection capacity *(Table 3.4, page 149)*

- 441 lbs
- Interior framing adjustment (Footnote 1)
  - 1.0
- Roof dead load reduction *(Table 3.4, Footnote 3)*
  - \[0.60(20 \text{ psf} - 15 \text{ psf}) \times 8'\times 16''/12'' = 32 \text{ lbs}\]
  - -32 lbs
- Wall-to-Wall and Wall-to-Foundation reduction *(Table 3.4, Footnote 4)*
  - \[60 \text{ plf x 1 walls (16''/12'') = 80 lbs}\]
  - -80 lbs

**Non-Loadbearing Walls** - Tabulated minimum uplift connection capacity *(Table 3.4C, page 152)*

- 496 lbs
- Wall-to-Wall and Wall-to-Foundation reduction *(WFCM 3.2.5.3)*
  - \[60 \text{ plf x 1 walls (16''/12'') = 160 lbs}\]
  - -80 lbs
- Required minimum capacity of proprietary connector
  - = Tabulated minimum capacity x Adjustments - Reduction
  - 361 lbs
  - 416 lbs

*Alternatively, use proprietary connectors with the following minimum capacities*
Connections (cont’d)

Overturning Resistance (WFCM 3.2.3)

Hold downs (WFCM 3.2.3.1)

Choose Hold downs from Table 3.17F for Segmented (Type I) and Perforated (Type II) Walls (p. 176)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Height</td>
<td>10’</td>
<td>10’</td>
<td>10’</td>
<td>10’</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - wind</td>
<td>3”</td>
<td>3”</td>
<td>4”</td>
<td>6”</td>
</tr>
<tr>
<td>Tabulated hold down connection capacity required – wind ( T_w )</td>
<td>4360 lbs</td>
<td>4360 lbs</td>
<td>4360 lbs</td>
<td>4360 lbs</td>
</tr>
<tr>
<td>Hold down adj. per Table 3.17F Footnotes (Table 3.17D) ( C_{swa} )</td>
<td>0.60</td>
<td>0.60</td>
<td>0.74</td>
<td>1.0</td>
</tr>
<tr>
<td>Adjusted hold down capacity ( T_{wa} = (T_w) / (C_{swa}) )</td>
<td>7267 lbs</td>
<td>7267 lbs</td>
<td>5892 lbs</td>
<td>4360 lbs</td>
</tr>
</tbody>
</table>

| WSP Perimeter Edge Nail Spacing - seismic | 3”     | 3”     | 4”   | 6”   |
| Tabulated hold down connection capacity required – seismic \( T_s \) | 2400 lbs | 2400 lbs | 2400 lbs | 2400 lbs |
| Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) \( C_{swa} \) | 0.53   | 0.53   | 0.69  | 1.0  |
| Adjusted hold down capacity \( T_{sa} = (T_s) / (C_{swa}) \) | 4528 lbs | 4528 lbs | 3478 lbs | 2400 lbs |

Since there are 3’ offsets at the junction of the main building to the wings, hold down requirements for the building wings will not be added to the requirements for the main building for shared walls.

Hatched Wall Area (31 ft):
7/16’ WSP 8d Common @ 4” edge spacing +
½’ Gyp (Unblocked) 5d Cooler @ 7” edge spacing

East Wall Elevation
Connections (cont’d)

Sheathing and Cladding Attachment (WFCM 3.2.4)

Wall Sheathing (WFCM 3.2.4.2)

Choose Wall Sheathing Nail Spacing from Table 3.11 (p. 161)

Three second gust wind speed: ................................................................. 120 mph Exp. B

Stud Spacing: .............................................................................................. 16 in.

Sheathing Type: .......................................................................................... WSP

<table>
<thead>
<tr>
<th>Location</th>
<th>Edges</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>4' Edge Zone</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Interior Zones</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Shear wall sheathing nail spacing requirements control.

Special Connections (WFCM 3.2.5)

Connections around Wall Openings (WFCM 3.2.5.4)

Typical Window

Choose Header/Girder Connections based on loads from Table 3.7 (p. 157)

Three second gust wind speed: ................................................................. 120 mph Exp. B

Roof Span: .................................................................................................. 32 ft.

Header Span (Typical Window): ................................................................. 3 ft.

Required Connection Capacity at Each End of Header:

Tabulated Uplift Capacity (interpolated): .................................................. 496 lbs.

Floor load adjustment (per footnote 4): .................................................... -90 lbs.

Adjusted Uplift Capacity ........................................................................ 406 lbs.

Tabulated Lateral Capacity: ..................................................................... 236 lbs.

Using identical procedures:

Bedroom Patio Door (8' header) Tabulated Uplift Capacity (interpolated): ....... 1323 lbs.

Bedroom Patio Door (8' header) Tabulated Lateral Capacity: .......................... 630 lbs.

Master Bath (6' header) Tabulated Uplift Capacity (interpolated): .................. 992 lbs.

Master Bath (6' header) Tabulated Lateral Capacity: ................................. 472 lbs.

Choose Window Sill Plate Connections based on loads from Table 3.8 (p. 157)

Three second gust wind speed: ................................................................. 120 mph Exp. B

Window Sill Plate Span: ............................................................................. 3 ft.

Tabulated Lateral Connection Capacity at Each End of Window Sill Plate: ...... 236 lbs.
Job: WFCM Workbook  
Description: East Wing

Wall Framing

Wall Studs (WFCM 3.4.1.1)

Loadbearing

Choose Studs from Table 3.20A or 3.20B and Footnotes (pp. 180-184)

Three second gust wind speed: ............................... 120 mph Exp. B
Wall Height: .............................................................. 10 ft.
Sheathing Type: ......................................................... WSP
Studs supporting: ...................................................... Roof & Ceiling Only

Selection of Specie, Grade, Size, and Spacing: (Table 3.20B and Footnotes)

<table>
<thead>
<tr>
<th>Specie</th>
<th>Douglas Fir-Larch</th>
<th>Hem-Fir</th>
<th>Southern Pine</th>
<th>Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Grade</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
<td>Stud</td>
</tr>
<tr>
<td>Size</td>
<td>2x4¹</td>
<td>2x4¹</td>
<td>2x4¹</td>
<td>2x4¹</td>
</tr>
<tr>
<td>Maximum Length (Wind)</td>
<td>10'-5&quot;</td>
<td>10'-2&quot;</td>
<td>10'-10&quot;</td>
<td>10'-2&quot;</td>
</tr>
<tr>
<td>Maximum Length (Dead and Live Loads)</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
</tbody>
</table>

¹While 2x4s will work, 2x6s will frame consistently with end walls and main building.

Non-Loadbearing

Choose Studs from Table 3.20A or 3.20B and Footnotes (pp. 180-184)

Same as West Wing Design (see WFCM Workbook p.55) except wall will balloon to raised ceiling to avoid formation of hinges.

Top Plates (WFCM 3.4.1.2)

Same as West Wing Design (see Workbook p.56).
Job: WFCM Workbook  Description: East Wing

Wall Framing (cont’d)

Door/Window Typical

Exterior Loadbearing Wall Headers (WFCM 3.4.1.4.1)

Choose Headers in Loadbearing Walls from Tables 3.22A-E and Table 3.22F (pp. 186-193)

Building Width: ................................................................. 32 ft.
Required Span (Typical Door/Window): ........................................ 3 ft.
Ground Snow Load: .............................................................. 30 psf
Three second gust wind speed: .............................................. 120 mph Exp. B

Header supporting roof and ceiling – use Table 3.22a (p. 186)

Preliminary Header Selection (Gravity Loads):       2-Southern Pine    #2    2x6's

Maximum Header/Girder Span (interpolated):............... 4'-1"
Tabulated Number of Jack Studs (Table 3.22F):.............. 2
Roof Span Adjustment (Footnote 1 – (W+12)/48):............ 0.92
Adjusted number of jack studs required = tabulated x roof span adjustment:........... 2

Table 3.23A (p. 192)

Preliminary Header Selection (Wind Loads):       2-Southern Pine    #2    2x4's

Maximum Header/Girder Span: ........................................ 5'-0" ft.
Tabulated Number of Full Height (King) Studs (Table 3.23C):.............. 2
(same species / grade as Loadbearing Studs, p. 68 (WFCM 3.4.1.4.2))

Final Selection of Header Specie, Grade, and Size:
Gravity loads control:       2-Southern Pine    #2    2x6's
Number of Jack Studs Required (gravity controlled):............... 2*
Number of Full Height (King) Studs Required (wind controlled):........ 2
(same species / grade as Loadbearing Studs, p. 68 (WFCM 3.4.1.4.2))

*Note: WFCM 3.4.1.4.3 allows Jack Studs to be replaced with an equivalent number of Full Height (King) studs of same species / grade as Loadbearing Studs on WFCM Workbook p. 68 (WFCM 3.4.1.4.2) if adequate gravity connections are provided.

Exterior Loadbearing Wall Window Sill Plates (WFCM 3.4.1.4.4)

Choose Window Sill Plates from Table 3.23B (p. 193)

Three second gust wind speed: .............................................. 120 mph Exp. B
Required Span (Typical Window): ........................................ 3 ft.

Selection of Window Sill Plate Specie, Grade, and Size: 1-Southern Pine    #2    2x6 (flat) (to match wall stud size)
Tabulated Window Sill Plate Span: ........................................ 7'-6"
Wall Height Adjustment (Footnote 3 – (H/10) 1/2):.................. 1.0

Adjusted Maximum Sill Plate Length:
Tabulated maximum sill plate Length ÷ wall Height Adjustment: .......... 7'-6" ÷ 1.0 = 7'-6" > 3’ OK
Wall Framing (cont’d)

Exterior Non-Loadbearing Wall Headers (WFCM 3.4.1.4.1)

Same as West Wing Design (see WFCM Workbook p.58)

Exterior Non-Loadbearing Wall Window Sill Plates (WFCM 3.4.1.4.3)

Same as West Wing Design (see WFCM Workbook p.58)
Wall Sheathing

Sheathing and Cladding (WFCM 3.4.4.1)

Choose Exterior Wall Sheathing or Cladding from Tables 3.13A and 3.13B respectively (p. 163)

Three second gust wind speed: ................................................................. 120 mph Exp. B

Sheathing Type (wood structural panels, fiberboard, board, hardboard): ............ WSP
Direction Across Studs (Short or Long): ...................................................... Short
Stud Spacing: ............................................................................................. 16 in.
Minimum Panel Thickness: ....................................................................... 3/8 in.
Shear wall minimum panel thickness (WFCM 3.4.4.2): ................................ 7/16 in.

North Elevation

South Elevation

Although this wall is balloon framed to avoid hinges, conservatively the lower 10 ft below the blocking required for panel perimeter nailing (shown hatched) will be designed as a shear wall to resist lateral loads.

East Elevation

West Elevation

= 13 ft. long = $L_{FH}$

= 16 ft. long = $L_{FH}$

= 20 ft. long = $L_{FH}$

= 25 ft. long = $L_{FH}$
### Exterior Segmented (Type I) Shear Walls (WFCM 3.4.4.2)

Choose Exterior Segmented (Type I) Shear Wall Length from Table 3.17A-D (pp. 169-174)

- **Wall Height**: 10 ft.
- **Number of Stories Braced (per 3.1.3.1)**: 2 *
- **Three second gust wind speed**: 120 mph Exp. B
- **Maximum shear wall aspect ratio for wind (Table 3.17D)**: 3.5:1
- **Minimum shear wall segment length (Wall height/aspect ratio)**: 2.9 ft.
- **Seismic Design Category**: D1
- **Maximum shear wall aspect ratio for seismic (Table 3.17D Footnote 3)**: 2:1
- **Minimum shear wall segment length (Wall height/aspect ratio)**: 5.0 ft.
- **Minimum WSP sheathing thickness (per WFCM 3.4.4.2)**: 7/16 in.
- **Minimum gypsum thickness (per WFCM 3.4.4.2)**: 1/2 in.

**Note**: Since the main house is designed as a three story structure and the wings are designed as 2 story structures, the shear walls will be designed as 3 separate structures (see 3.1.3.3c Exception).

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>Load Parallel to Ridge</th>
<th>Load Perpendicular to Ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Wall – East Wing</td>
<td>North</td>
<td>South</td>
</tr>
<tr>
<td><strong>Steps</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seismic</strong></td>
<td>Effective Length of Full Height Sheathing for Seismic ($L_{FHS}$)</td>
<td>12.6'</td>
</tr>
<tr>
<td></td>
<td>Tabulated Minimum Length Full Height Sheathing for Seismic Loads per Table 3.17C ($L_s$)</td>
<td>$C_1 = 51$</td>
</tr>
<tr>
<td></td>
<td>WSP Perimeter Edge Nail Spacing – Seismic (WFCM 3.4.4.2)</td>
<td>6'</td>
</tr>
<tr>
<td></td>
<td>Shear wall Adjustment per Table 3.17D ($C_{swa}$)</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Min. Length Full Ht. Sheathing - Segmented Seismic ($L_{TypeI-S} = L_s \times C_{swa}$)</td>
<td>10.6'</td>
</tr>
<tr>
<td><strong>Wind</strong></td>
<td>Effective Length of Full Height Sheathing ($L_{FHI}$)</td>
<td>13'</td>
</tr>
<tr>
<td></td>
<td>Tabulated Minimum Length Full Height Sheathing for Wind Loads per Table 3.17B and 3.17A ($L_{w}$)</td>
<td>10.6'</td>
</tr>
<tr>
<td></td>
<td>WSP Perimeter Edge Nail Spacing – Wind (WFCM 3.4.4.2)</td>
<td>4'</td>
</tr>
<tr>
<td></td>
<td>Shear wall Adjustment per Table 3.17D ($C_{swa}$)</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>Wall Height Adjustment (Table 3.17A&amp;B Footnote 2) ($C_{WH} = 10'/8'$)</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Min. Length Full Ht. Sheathing-Segmented Wind ($L_{TypeI-W} = L_w(C_{WH})(C_{swa})$)</td>
<td>9.8'</td>
</tr>
</tbody>
</table>

1. Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See shear wall calculations for bottom story west wing, where w’s are as follows: 4'-6" North, 3'-4" South, 4'-0" East, 4'-0" West.
2. The segment at the wall offset is part of a longer wall segment. Since the design is based on separate structures, it is considered a 4' segment for design of this wing. This is a conservative assumption and may be relaxed based on engineering judgment.
Wall Sheathing (cont’d)

3 This is a conservative based on design as separate structures. The total length (building and 2 wings) of the North and South walls assuming an inscribed 3-story structure would be 17'-6" with 6" perimeter edge nail spacing.
4 Extrapolated from Table 3.17A.
North and south walls are wind controlled. East and West walls are seismic controlled.

Exterior Perforated (Type II) Shear Walls (WFCM 3.4.4.2)

Choose Exterior Perforated (Type II) Shear Wall Length from Table 3.17E (p. 175)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Length of Full Height Sheathing (L_{FH})</td>
<td>13'</td>
<td>10'</td>
<td>20'</td>
<td>25'</td>
</tr>
<tr>
<td>Effective Length of Full Height Sheathing for Seismic (L_{FHS})</td>
<td>12.6'</td>
<td>6.7'</td>
<td>19.2'</td>
<td>24.6'</td>
</tr>
<tr>
<td>Length of Wall (L_{Wall})</td>
<td>16'</td>
<td>16'</td>
<td>32'</td>
<td>32'</td>
</tr>
<tr>
<td>Percent Full Height Sheathing (L_{FH} / L_{Wall})</td>
<td>81%</td>
<td>63%</td>
<td>63%</td>
<td>78%</td>
</tr>
<tr>
<td>Minimum Length Full Height Sheathing - Segmented Seismic (L_{Type I-S})</td>
<td>10.6'</td>
<td>5.6'</td>
<td>10.6'</td>
<td>10.6'</td>
</tr>
<tr>
<td>Perforated (Type II) Length Increase Factor from Table 3.17E (C_{L})</td>
<td>1.13</td>
<td>1.11</td>
<td>1.29</td>
<td>1.15</td>
</tr>
<tr>
<td>Min. Length Full Ht. Sheathing-Perforated Seismic (L_{Type II-S}=L_{Type I-S}(C_{L}))</td>
<td>12.0'</td>
<td>6.2'</td>
<td>13.7'</td>
<td>12.2'</td>
</tr>
</tbody>
</table>

L_{Type I-S} < L_{FHS}  
Ok?  Ok?  Ok?  Ok?

Actual Length of Full Height Sheathing (L_{FH}) | 13'   | 10'   | 20'  | 25'  |
| Length of Wall (L_{Wall}) | 16'  | 16'   | 32'  | 32'  |
| Percent Full Height Sheathing (L_{FH} / L_{Wall}) | 81%  | 63%   | 63%  | 78%  |
| Minimum Length Full Height Sheathing - Segmented Wind (L_{Type I-W}) | 9.8'  | 8.0'  | 8.9'  | 8.0'  |
| Perforated (Type II) Length Increase Factor from Table 3.17E (C_{L}) | 1.13  | 1.11  | 1.29  | 1.15  |
| Min. Length Full Ht. Sheathing-Perforated Wind (L_{Type II-W}=L_{Type I-W}(C_{L})) | 11.1' | 8.9'  | 11.5' | 9.2'  |

L_{Type I-W} < L_{FH}  
Ok?  Ok?  Ok?  Ok?

1 Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See shear wall calculations for bottom story main structure.
2 The segment at the wall offset is part of a longer wall segment. Since the design is based on separate structures, it is considered a 4' segment for design of this wing. This is a conservative assumption and may be relaxed based on engineering judgment.

East and West walls are seismic controlled. North and south walls are wind controlled (north wall due to 4" perimeter edge nail spacing).

Bottom Story East Wing Shear Wall Details Summary

<table>
<thead>
<tr>
<th>Building Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Wall Type</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
</tr>
<tr>
<td>WSP Perimeter Nail Spacing</td>
<td>4&quot;</td>
<td>3&quot;</td>
<td>6&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Governing Load</td>
<td>Wind</td>
<td>Wind</td>
<td>Seismic</td>
<td>Seismic</td>
</tr>
</tbody>
</table>

AMERICAN FOREST & PAPER ASSOCIATION
Wall Sheathing (cont’d)

Combine Shear Wall Requirements for Main Building and East Wing

Adjust Shear Wall Requirements to Common Nailing Pattern

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>Wind</th>
<th>Seismic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segmented (Type I) Shear Wall Requirements – Sheathing Thickness</td>
<td>7/16&quot;</td>
<td>7/16&quot;</td>
</tr>
<tr>
<td>Main Building – East Elevation (WSP perimeter edge nail spacing) (L_FHI)</td>
<td>18.6'(3&quot;)</td>
<td>20.4'(4&quot;)</td>
</tr>
<tr>
<td>Length adjustment factor, C_swa1 (Table 3.17D)</td>
<td>0.60</td>
<td>0.69</td>
</tr>
<tr>
<td>Revised Length Adjustment Factor (C_swa1revised) (Table 3.17D)</td>
<td>no change</td>
<td>0.53</td>
</tr>
<tr>
<td>Length adjustment factor ratio C_swa1 ratio = C_swa1revised / C_swa1</td>
<td>no change</td>
<td>0.77</td>
</tr>
<tr>
<td>Adjusted Shared wall length = L_FHI * C_swa1 ratio = L_FHadj1</td>
<td>18.6'(3&quot;)</td>
<td>15.7'(3&quot;)</td>
</tr>
</tbody>
</table>

East Wing – West Elevation (WSP perimeter edge nail spacing) (L_FH2)

| Length adjustment factor, C_swa2 (Table 3.17D) | 1.0 | 1.0 |
| Revised Length Adjustment Factor (C_swa2revised) (Table 3.17D) | 0.60 | 0.53 |
| Length adjustment factor ratio C_swa2 ratio = C_swa2revised / C_swa2 | 0.60 | 0.53 |
| Adjusted Shared wall length = L_FH2 * C_swa2 ratio = L_FHadj2 | 4.8'(3") | 5.6'(3") |

Adjusted Shared Wall – Total Requirement (L_TypeIadjusted) = L_FHadj1 + L_FHadj2

| Actual Length of Full Height Sheathing (L_FH) | 28.0' | 28.0' |
| L_TypeIadjusted < L_FH | Ok? ✓ | Ok? ✓ |

Perforated (Type II) Shear Wall Requirements

| Perforated (Type II) Length Increase Factor from Table 3.17E (C_L) | 1.15 | 1.15 |
| Min. Length Full Ht. Sheathing-Perforated (L_TypeIIadjusted = L_TypeIadjusted / C_L) | 26.9' | 24.5' |
| Actual Length of Full Height Sheathing (L_FH) | 28.0' | 28.0' |
| L_TypeIIadjusted < L_FH | Ok? ✓ | Ok? ✓ |

1 Actual length including the 3’ offset of the wings.
Decreased nail spacing should be considered first to increase Perforated (Type II) shear wall capacity, otherwise try increasing WSP thickness.

This shared wall is wind controlled.
Wall Sheathing (cont’d)

Combine Shear Wall Requirements for Main Building and East Wing

<table>
<thead>
<tr>
<th>Building Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Wall Type</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
<td>Perf</td>
</tr>
<tr>
<td>WSP Perimeter Nail Spacing</td>
<td>4&quot;</td>
<td>3&quot;</td>
<td>6&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Governing Load</td>
<td>Wind</td>
<td>Wind</td>
<td>Seismic</td>
<td>Wind</td>
</tr>
<tr>
<td>Shear wall Adjustment per Table 3.17D ($C_{swa}$)</td>
<td>0.74</td>
<td>0.6</td>
<td>1.0</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Floor Framing

Floor Joists (WFCM 3.3.1.1)

Slab on Grade – not applicable

Floor Sheathing

Sheathing Spans (WFCM 3.3.4.1)

Slab on Grade – not applicable
Connections

Lateral Framing and Shear Connections (WFCM 3.2.1)

See Top Story design for wall and roof assembly connection requirements (Workbook p.37).

Lateral, Shear, and Uplift Connections (WFCM 3.2.1 and 3.2.2)

Wall Assembly to Foundation (WFCM 3.2.1.7 and 3.2.2.3)

Choose Sill or Bottom Plate to Foundation Connection Requirements for Anchor Bolts Resisting Lateral, Shear, and Uplift Loads from Table 3.2A & B (pp. 142-144) and Table 3.3A (p. 147).

Three second gust wind speed: ................................................................. 120 mph Exp. B
Stories supported by Foundation: ............................................................. 2
Anchor Bolt Diameter: ........................................................................ 5/8 in.

Assuming Crawl Space or Basement, determine maximum Anchor Bolt Spacing for common wall portion:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear wall line dimension (L_w)</td>
<td></td>
<td></td>
<td></td>
<td>32'</td>
</tr>
<tr>
<td>Building dimension perpendicular to shear wall line (Table 3.2A)</td>
<td></td>
<td></td>
<td></td>
<td>16'</td>
</tr>
<tr>
<td>Number of stories receiving wind load (Table 3.2A)</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Tabulated number of bolts to resist shear loads from wind (Table 3.2A)</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Bolt spacing for wind shear loads s_ws = (L_w-2) / (number of bolts-1)</td>
<td></td>
<td></td>
<td>72&quot;</td>
<td></td>
</tr>
<tr>
<td>Max. bolt spacing to resist wind uplift loads (s_uw) (Table 3.2C &amp; 3.4C)</td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

1Calculated per WFCM Commentary for Table 3.2A
2Anchor bolt spacing shall not exceed 6' on center per Table 3.2A Footnote 2.
3These anchor bolts will be added to anchor bolt requirements for Main house west wall.
4WFCM 3.2.5.3 provision for walls that do not support the roof assembly and are attached according to 3.2.1 need no additional uplift connections.
Assuming **Slab on Grade**, determine maximum Anchor Bolt Spacing for non-common wall portions:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear wall line dimension (L&lt;sub&gt;sw&lt;/sub&gt;)</td>
<td>16'</td>
<td>16'</td>
<td>32'</td>
<td>36'</td>
</tr>
<tr>
<td>Number of stories receiving <strong>wind</strong> load (Table 3.2B)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bolt spacing for <strong>wind lateral</strong> and <strong>shear</strong> loads (Table 3.2B)</td>
<td>45&quot;</td>
<td>45&quot;</td>
<td>45&quot;</td>
<td>45&quot;</td>
</tr>
<tr>
<td>Wall sheathing type adjustment factor per Table 3.17D (Table 3.2B Footnote 3) (assumes perforated shear wall capacities) C&lt;sub&gt;swa&lt;/sub&gt;</td>
<td>0.74</td>
<td>0.60</td>
<td>1.0</td>
<td>0.60</td>
</tr>
<tr>
<td>Adjusted bolt spacing for <strong>wind lateral</strong> and <strong>shear</strong> loads (s&lt;sub&gt;sw&lt;/sub&gt;)</td>
<td>33&quot;</td>
<td>27&quot;</td>
<td>45&quot;</td>
<td>27&quot;</td>
</tr>
<tr>
<td>Max. anchor bolt spacing to resist <strong>wind uplift</strong> loads (s&lt;sub&gt;wu&lt;/sub&gt;) (Table 3.2C)</td>
<td>60&quot;&lt;sup&gt;1&lt;/sup&gt;</td>
<td>60&quot;&lt;sup&gt;1&lt;/sup&gt;</td>
<td>33&quot;</td>
<td>33&quot;</td>
</tr>
<tr>
<td>Tabulated anchor bolt spacing to resist <strong>seismic</strong> loads (s&lt;sub&gt;s&lt;/sub&gt;) (Table 3.3A)</td>
<td>72&quot;</td>
<td>72&quot;</td>
<td>72&quot;</td>
<td>72&quot;</td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - <strong>Seismic</strong></td>
<td>4&quot;</td>
<td>3&quot;</td>
<td>6&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) (C&lt;sub&gt;swa&lt;/sub&gt;)</td>
<td>0.69</td>
<td>0.53</td>
<td>1.0</td>
<td>0.53</td>
</tr>
<tr>
<td>Adjusted bolt spacing for seismic loads s&lt;sub&gt;sa&lt;/sub&gt; = (s&lt;sub&gt;s&lt;/sub&gt;)(C&lt;sub&gt;swa&lt;/sub&gt;)</td>
<td>49&quot;</td>
<td>38&quot;</td>
<td>72&quot;&lt;sup&gt;2&lt;/sup&gt;</td>
<td>38&quot;</td>
</tr>
<tr>
<td>Max. anchor bolt spacing (lesser of s&lt;sub&gt;sw&lt;/sub&gt;, s&lt;sub&gt;wu&lt;/sub&gt;, and s&lt;sub&gt;sa&lt;/sub&gt;)</td>
<td>33&quot;</td>
<td>27&quot;</td>
<td>33&quot;</td>
<td>27&quot;</td>
</tr>
</tbody>
</table>

<sup>1</sup>Calculated from WFCM Table 3.4C based on 16" o.c. (horizontal projection) outlooker spacing with 1 wall dead load subtracted (0.6×99plf) and anchor bolt capacity of 1488 lbs from WFCM Commentary Table 3.2B.

Table 3.4C 496 lbs × 12"/ft / 16" = 372 plf

(372 plf – 60 plf)(32ft) / 1488lbs = 6.7 bolts, so spacing =60” maximum

<sup>2</sup>Anchor bolt spacing shall not exceed 6’ on center per Table 3.3A Footnote 5.
Connections (cont’d)

Alternatively, use proprietary connectors with the following minimum capacities from Table 3.2 (pp. 140-141) and Table 3.3 (pp. 145-146)

Three second gust wind speed: ................................................................. 120 mph Exp. B
Stories supported by Foundation: ........................................................... 2

Assuming Slab on Grade, determine required loads for proprietary connectors:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building dimension W or L</td>
<td>16'</td>
<td>16'</td>
<td>32'</td>
<td>32'</td>
</tr>
<tr>
<td>R=L/W or W/L for Table 3.2</td>
<td>0.5</td>
<td>0.5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Number of stories receiving lateral wind load (Table 3.2A)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wind uplift (Table 3.4C)</td>
<td>496 lbs</td>
<td>496 lbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uplift force Spacing</td>
<td>16&quot;</td>
<td>16&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind uplift plf basis</td>
<td>372 plf</td>
<td>372 plf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhang Reduction (Table 3.4C Footnote 2) [ (2' - OH / 4')^2 ]</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall Dead Load Reduction (1 walls (0.6)(99plf))</td>
<td>-60</td>
<td>-60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Wind uplift (Table 3.4C)</td>
<td>312 plf</td>
<td>312 plf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind uplift (Table 3.2(U))</td>
<td>211 plf</td>
<td>211 plf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind lateral load (Table 3.2(L))</td>
<td>157 plf</td>
<td>157 plf</td>
<td>157 plf</td>
<td>157 plf</td>
</tr>
<tr>
<td>Wind shear load (Table 3.2(S)) [ 411 R ]</td>
<td>329 plf</td>
<td>329 plf</td>
<td>514 plf</td>
<td>514 plf</td>
</tr>
<tr>
<td>Seismic shear load (Table 3.3) [ C_1 = \ldots \ C_2 = ]</td>
<td>240 plf</td>
<td>240 plf</td>
<td>240 plf</td>
<td>240 plf</td>
</tr>
<tr>
<td>I_{max} = \ldots I_{min} = \ldots \quad \text{or, } \sqrt{\text{slab on grade}}</td>
<td>\quad \frac{w_w}{R_w} = \frac{(w_w + 70.65)}{85.65}</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>Footnote 4 Wall Dead Load Reduction</td>
<td>11 psf</td>
<td>11 psf</td>
<td>11 psf</td>
<td>11 psf</td>
</tr>
<tr>
<td>Footnote 5 Sheathing Adjustment Factor for wall (Table 3.17D) ( C_{swa} )</td>
<td>0.69</td>
<td>0.53</td>
<td>1.0</td>
<td>0.53</td>
</tr>
<tr>
<td>Adjusted seismic shear load = seismic shear load x ( R_w / C_{swa} )</td>
<td>330 plf</td>
<td>430 plf</td>
<td>228 plf</td>
<td>430 plf</td>
</tr>
<tr>
<td>Wall length</td>
<td>16'</td>
<td>16'</td>
<td>32'</td>
<td>32'</td>
</tr>
</tbody>
</table>

Seismic shear load = adjusted seismic shear load / wall length | 330 plf | 430 plf | 228 plf | 430 plf |

1Refer to WFCM Commentary 1.1.2.
2See top story main segmented shearwall design for example seismic calculation using \( C_1 \) and \( C_2 \). Here, the determination is based on slab-on-grade condition. Note that Table 3.3 limits spacing of exterior shear wall lines to 20 – 80 feet for two stories.
Connections (cont’d)

**Uplift Connections** (WFCM 3.2.2)

Wall Assembly to Wall Assembly or Wall Assembly to Foundation (WFCM 3.2.2.2 and 3.2.2.3)

Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three second gust wind speed</td>
<td>120 mph Exp. B</td>
<td>120 mph Exp. B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing Spacing</td>
<td>16 in.</td>
<td>16 in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Span</td>
<td>32 ft.</td>
<td>32 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated number of 8d Common Nails required in each end of 1-1/4&quot; x 20 gage strap every stud</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>No Ceiling Assembly nail increase (Footnote 3)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required number of 8d Common Nails in each end of strap every stud</td>
<td>4 *</td>
<td>3 *</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Alternatively, use proprietary connectors with the following minimum capacities*

<table>
<thead>
<tr>
<th>Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4, page 149)</th>
<th>441 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior framing adjustment (Footnote 1)</td>
<td>1.0</td>
</tr>
<tr>
<td>Roof dead load reduction (Table 3.4, Footnote 3)</td>
<td>-32 lbs</td>
</tr>
</tbody>
</table>
\[
= \left[0.60(20 \text{ psf} - 15 \text{ psf}) \times 8'\text{-}0'' \times 16''/12''/\text{r} = 32 \text{ lbs}\right]
\]
| Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4) | -80 lbs |
\[
= \left[60 \text{ plf} \times 1 \text{ walls} (16''/12''/\text{r} ) = 80 \text{ lbs}\right]
\]
<table>
<thead>
<tr>
<th>Non-Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4C, page 152)</th>
<th>496 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-to-Wall and Wall-to-Foundation reduction (WFCM 3.2.5.3)</td>
<td>-80 lbs</td>
</tr>
</tbody>
</table>
\[
= \left[60 \text{ plf} \times 1 \text{ walls} (16''/12''/\text{r} ) = 160 \text{ lbs}\right]
\]
| Required minimum capacity of proprietary connector | 361 lbs | 416 lbs |
\[
= \text{Tabulated minimum capacity x Adjustments - Reduction}
\]
**Connections (cont’d)**

**Overturning Resistance** *(WFCM 3.2.3)*

Hold downs *(WFCM 3.2.3.1)*

Choose Hold downs from Table 3.17F for Segmented (Type I) and Perforated (Type II) Walls (p. 176)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Height</td>
<td>10’</td>
<td>10’</td>
<td>10’</td>
<td>10’</td>
</tr>
<tr>
<td><strong>WSP Perimeter Edge Nail Spacing - wind</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>4”</td>
<td>3”</td>
<td>6”</td>
<td>3”</td>
</tr>
<tr>
<td>Tabulated hold down connection capacity required – wind ( (T_w) )</td>
<td>4360 lbs</td>
<td>4360 lbs</td>
<td>4360 lbs</td>
<td>4360 lbs</td>
</tr>
<tr>
<td>Hold down adj. per Table 3.17F Footnotes (Table 3.17D) ( (C_{swa}) )</td>
<td>0.74</td>
<td>0.60</td>
<td>1.0</td>
<td>0.60</td>
</tr>
<tr>
<td>Adjusted hold down capacity ( (T_{wa} = (T_w) / (C_{swa})) )</td>
<td><strong>5892 lbs</strong></td>
<td><strong>7267 lbs</strong></td>
<td><strong>4360 lbs</strong></td>
<td><strong>7267 lbs</strong></td>
</tr>
<tr>
<td><strong>WSP Perimeter Edge Nail Spacing - seismic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seismic</td>
<td>4”</td>
<td>3”</td>
<td>6”</td>
<td>3”</td>
</tr>
<tr>
<td>Tabulated hold down connection capacity required – seismic ( (T_s) )</td>
<td>2400 lbs</td>
<td>2400 lbs</td>
<td>2400 lbs</td>
<td>2400 lbs</td>
</tr>
<tr>
<td>Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) ( (C_{swa}) )</td>
<td>0.69</td>
<td>0.53</td>
<td>1.0</td>
<td>0.53</td>
</tr>
<tr>
<td>Adjusted hold down capacity ( (T_{sa} = (T_s) / (C_{swa})) )</td>
<td>3478 lbs</td>
<td>4528 lbs</td>
<td>2400 lbs</td>
<td>4528 lbs</td>
</tr>
</tbody>
</table>

Since there are 3’ offsets at the junction of the main building to the wings, hold down requirements for the building wings will not be added to the requirements for the main building for shared walls.

**Hatched Wall Area (28 ft):**

- 7/16” WSP 8d Common
- @ 3” edge spacing +
- ½” Gyp (Unblocked) 5d Cooler
- @ 7” edge spacing

![Hatched Wall Area Diagram]
Connections (cont’d)

Sheathing and Cladding Attachment (WFCM 3.2.4)

Wall Sheathing (WFCM 3.2.4.2)

Same as West Wing design (see Workbook p.69).

Special Connections (WFCM 3.2.5)

Connections around Wall Openings (WFCM 3.2.5.4)

Same as West Wing design (see Workbook p.69).
Notes
APPENDIX A
SUPPLEMENTAL WORKSHEETS

Scoping
- WFCM Applicability Limitations
- Prescriptive Design Limitations

Checklists
- WFCM 3.2  Connections Checklist
- WFCM 3.3  Floor Systems Checklist
- WFCM 3.4  Wall Systems Checklist
- WFCM 3.5  Roof Systems Checklist

Worksheets
- Roof Systems Worksheets
- Roof Assembly Connections Worksheets
- Wall Systems Worksheets
- Floor Systems Worksheets
- Wall and Floor Assembly Connections Worksheets
Job:_________________________________________  Description:__________________________

BUILDING DESCRIPTION
Job: ___________________________  Description: ____________________

BUILDING DESCRIPTION

Bottom Floor Plan

North

Openings

Windows
  Typical
  Master Bath
  Foyer
  Kitchen
  North Bath

Doors
  Typical
  Master Bedroom
  Foyer
  Family Room

Top Floor Plan

First Floor Wall Height = ________  Roof Pitch = ________
Second Floor Wall Height = ________  House Mean Roof Height = ________
Finished Grade to Foundation Top = ________  Wing Mean Roof Height = ________
Floor Assembly Height = ________  Overall Building Dimension = ________
Foundation Type = ________  Roof Overhang Distance = ________

AMERICAN FOREST & PAPER ASSOCIATION
LOADS ON THE BUILDING

Structural systems in the WFCM 2001Edition have been sized using dead, live, snow, seismic and wind loads in accordance with the 2000 International Building Code.

Lateral Loads:

Wind:

3-second gust wind speed in Exposure Category ______ = ______

Seismic:

Seismic Design Category (SDC) = ______

Short period design spectral response acceleration ($S_{DS}$) = ______

One second period design spectral response acceleration ($S_{D1}$) = ______

Seismic response coefficient ($C_s$) = ______

Gravity Loads:

Roof:

Roof Dead Load = ______ psf

Roof Snow Load

Ground Snow Load, $P_g$ = ______ psf

Flat Roof Snow Load (calculated from ASCE 7-98 – see WFCM Commentary Table 2.14B)

$= 1.5(0.7)P_g C_e C_t I$

$= (1.5)(0.7)( )( )( )$

$= ______ psf$

Floors:

First Floor Live Load = ______ psf

Second Floor Live Load = ______ psf

Attic Floor Live Load = ______ psf

Floor Dead Load = ______ psf

Walls:

Wall Dead Load = ______ psf

Displacements:

Roof Rafters with Ceiling Attached

$L/\Delta =$ ______

Roof Rafters with no Ceiling Attached

$L/\Delta =$ ______

Floor Joists

$L/\Delta =$ ______
**WFCM APPLICABILITY LIMITATIONS (p. 2)**

The following table is used to determine whether the building geometry is within the applicability limitations of the WFCM. Conditions not complying with the limitations shall be designed in accordance with accepted engineer practice (see WFCM 1.1.3).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Limitation</th>
<th>Design Case</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BUILDING DIMENSIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Stories</td>
<td>maximum</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Roof Slope</td>
<td>minimum</td>
<td>Flat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>maximum</td>
<td>12:12</td>
<td></td>
</tr>
<tr>
<td>Mean Roof Height (MRH)</td>
<td>maximum</td>
<td>33'</td>
<td></td>
</tr>
<tr>
<td>Building Dimension (L or W)</td>
<td>minimum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>maximum</td>
<td>80'</td>
<td></td>
</tr>
<tr>
<td>Building Aspect Ratio (L/W)</td>
<td>minimum</td>
<td>1:4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>maximum</td>
<td>4:1</td>
<td></td>
</tr>
</tbody>
</table>
# PRESCRIPTIVE DESIGN LIMITATIONS (p. 106)

The following table is used to determine whether the building geometry is within the applicability limitations of the WFCM Chapter 3 prescriptive provisions. Conditions not complying with the limitations shall be designed in accordance with WFCM Chapter 2 (see WFCM 3.1.3).

<table>
<thead>
<tr>
<th>Element</th>
<th>Attribute</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FLOOR SYSTEMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Joists</td>
<td>Joist Span</td>
<td>26' maximum</td>
</tr>
<tr>
<td></td>
<td>Joist Spacing</td>
<td>24&quot; maximum</td>
</tr>
<tr>
<td></td>
<td>Cantilevers/Setback - Supporting loadbearing walls or shearwalls</td>
<td>$d_1$ maximum</td>
</tr>
<tr>
<td></td>
<td>Cantilevers - Supporting non-loadbearing wall non-shearwall</td>
<td>$L/4$ maximum</td>
</tr>
<tr>
<td>Lumber Joists</td>
<td>Vertical Floor Offset</td>
<td>$d_f$ maximum</td>
</tr>
<tr>
<td>Floor Diaphragms</td>
<td>Floor Diaphragm Aspect Ratio</td>
<td>3:1 maximum</td>
</tr>
<tr>
<td></td>
<td>Floor Diaphragm Openings</td>
<td>Lesser of 12' or 50% of Dia. Dimension</td>
</tr>
<tr>
<td><strong>WALL SYSTEMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall Studs</td>
<td>Loadbearing Wall Height</td>
<td>10' maximum</td>
</tr>
<tr>
<td></td>
<td>Non-Loadbearing Wall Height</td>
<td>20' maximum</td>
</tr>
<tr>
<td></td>
<td>Wall Stud Spacing</td>
<td>24&quot; maximum</td>
</tr>
<tr>
<td>Shearwalls</td>
<td>Shearwall Line Offset</td>
<td>4' maximum</td>
</tr>
<tr>
<td></td>
<td>Shearwall Story Offset</td>
<td>$d$ maximum</td>
</tr>
<tr>
<td></td>
<td>Shearwall Segment Aspect Ratio</td>
<td>3½:1 maximum³</td>
</tr>
<tr>
<td><strong>ROOF SYSTEMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber Rafters</td>
<td>Rafter Span (Horizontal Projection)</td>
<td>26&quot;² maximum</td>
</tr>
<tr>
<td></td>
<td>Rafter Spacing</td>
<td>24&quot; maximum</td>
</tr>
<tr>
<td></td>
<td>Eave Overhang Length</td>
<td>Lesser of 2' or rafter length/3</td>
</tr>
<tr>
<td></td>
<td>Rake Overhang Length</td>
<td>Lesser of 2' or purlin span/2</td>
</tr>
<tr>
<td></td>
<td>Roof Slope</td>
<td>12:12 maximum</td>
</tr>
<tr>
<td>Roof Diaphragms</td>
<td>Roof Diaphragm Aspect Ratio</td>
<td>3:1 maximum</td>
</tr>
</tbody>
</table>

¹ Exception: For roof live loads and ground snow loads less than or equal to 20 psf and 30 psf, respectively, lumber floor joist cantilevers supporting load-bearing walls shall not exceed one-eighth of the backspan when supporting only a roof load where the roof clear span does not exceed 28 feet.

² Shear wall segment aspect ratios are limited to 2:1 for seismic loads (Table 3.17D Footnote 3). 2003 International Building Code (IBC) Table 2305.3.3 footnote a., permits a 2w/h reduction for shear walls not meeting maximum shear wall aspect ratio of 2.1 for seismic loads.

³ For roof snow loads, tabulated spans are limited to 20 ft. to account for unbalanced snow loading in the table.
3.2.1 LATERAL FRAMING AND SHEAR CONNECTIONS

3.2.1.1 Roof Assembly ................................................................. Ok? □
3.2.1.2 Roof Assembly to Wall Assembly ........................................ Ok? □
3.2.1.3 Wall Assembly ................................................................ Ok? □
3.2.1.4 Wall Assembly to Floor Assembly ...................................... Ok? □
3.2.1.5 Floor Assembly ................................................................. Ok? □
3.2.1.6 Floor Assembly to Wall Assembly or Sill Plate ................ Ok? □
3.2.1.7 Wall Assembly or Sill Plate to Foundation ....................... Ok? □

3.2.2 UPLIFT CONNECTIONS

3.2.2.1 Roof Assembly to Wall Assembly ........................................ Ok? □
3.2.2.2 Wall Assembly to Wall Assembly ........................................ Ok? □
3.2.2.3 Wall Assembly to Foundation ........................................... Ok? □

3.2.3 OVERTURNING RESISTANCE

3.2.3.1 Holddowns ................................................................. Ok? □

3.2.4 SHEATHING AND CLADDING ATTACHMENT

3.2.4.1 Roof Sheathing ............................................................. Ok? □
3.2.4.2 Wall Sheathing ............................................................. Ok? □
3.2.4.3 Floor Sheathing ........................................................... Ok? □
3.2.4.4 Roof Cladding .............................................................. Ok? □
3.2.4.5 Wall Cladding .............................................................. Ok? □

3.2.5 SPECIAL CONNECTIONS

3.2.5.1 Ridge Straps ................................................................. Ok? □
3.2.5.2 Jack Rafters ................................................................. Ok? □
3.2.5.3 Non-Loadbearing Wall Assemblies ................................ Ok? □
3.2.5.4 Connections around Wall Openings ............................... Ok? □
## WFCM 3.3 FLOOR SYSTEMS CHECKLIST

### 3.3.1 WOOD JOIST SYSTEMS

<table>
<thead>
<tr>
<th>3.3.1.1 Floor Joists</th>
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</tr>
</thead>
<tbody>
<tr>
<td>3.3.1.1.1 Notching and Boring</td>
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<tr>
<td>3.3.1.2 Bearing</td>
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<tr>
<td>3.3.1.3 End Restraint</td>
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<tr>
<td>3.3.1.4 Lateral Stability</td>
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<tr>
<td>3.3.1.5 Single or Continuous Floor Joists</td>
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<tr>
<td>3.3.1.5.1 Supporting Loadbearing Walls</td>
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<tr>
<td>3.3.1.5.2 Supporting Non-Loadbearing Walls</td>
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</tr>
<tr>
<td>3.3.1.5.3 Supporting Concentrated Loads</td>
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<tr>
<td>3.3.1.6 Cantilevered Floor Joists</td>
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<tr>
<td>3.3.1.6.1 Supporting Loadbearing Walls</td>
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</tr>
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<td>3.3.1.6.2 Supporting Non-Loadbearing Walls</td>
<td>Ok?</td>
</tr>
<tr>
<td>3.3.1.7 Floor Diaphragm Openings</td>
<td>Ok?</td>
</tr>
</tbody>
</table>

### 3.3.2 WOOD I-JOIST SYSTEMS | Ok?  |

### 3.3.3 WOOD FLOOR TRUSS SYSTEMS | Ok?  |

### 3.3.4 FLOOR SHEATHING

<table>
<thead>
<tr>
<th>3.3.4.1 Sheathing Spans</th>
<th>Ok?</th>
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</thead>
<tbody>
<tr>
<td>3.3.4.2 Sheathing Edge Support</td>
<td>Ok?</td>
</tr>
</tbody>
</table>

### 3.3.5 FLOOR DIAPHRAGM BRACING | Ok?  |
WFCM 3.4 WALL SYSTEMS CHECKLIST

3.4.1 EXTERIOR WALLS

3.4.1.1 Wood Studs ................................................................. Ok? □
   3.4.1.1.1 Notching and Boring ................................................ Ok? □
   3.4.1.1.2 Stud Continuity ...................................................... Ok? □
   3.4.1.1.3 Corners ................................................................ Ok? □
3.4.1.2 Top Plates ................................................................ Ok? □
3.4.1.3 Bottom Plates ............................................................. Ok? □
3.4.1.4 Wall Openings
   3.4.1.4.1 Headers ................................................................ Ok? □
   3.4.1.4.2 Full Height Studs .................................................... Ok? □
   3.4.1.4.3 Jack Studs .............................................................. Ok? □
   3.4.1.4.4 Window Sill Plates ................................................. Ok? □

3.4.2 INTERIOR LOADBEARING PARTITIONS

3.4.2.1 Wood Studs ................................................................. Ok? □
   3.4.2.1.1 Notching and Boring ................................................ Ok? □
   3.4.2.1.2 Stud Continuity ...................................................... Ok? □
3.4.2.2 Top Plates ................................................................ Ok? □
3.4.2.3 Bottom Plates ............................................................. Ok? □
3.4.2.4 Wall Openings
   3.4.2.4.1 Headers ................................................................ Ok? □
   3.4.2.4.2 Studs Supporting Header Beams ................................ Ok? □

3.4.3 INTERIOR NON-LOADBEARING PARTITIONS

3.4.3.1 Wood Studs ................................................................. Ok? □
   3.4.3.1.1 Notching and Boring ................................................ Ok? □
3.4.3.2 Top Plates ................................................................ Ok? □
3.4.3.3 Bottom Plates ............................................................. Ok? □

3.4.4 WALL SHEATHING

3.4.4.1 Sheathing and Cladding................................................ Ok? □
3.4.4.2 Exterior Shearwalls ...................................................... Ok? □
   3.4.4.2.1 Sheathing Type Adjustments .................................. Ok? □
   3.4.4.2.2 Perforated Shearwall Adjustments ......................... Ok? □
   3.4.4.2.3 Holddowns ........................................................... Ok? □
WFCM 3.5 ROOF SYSTEMS CHECKLIST

3.5.1 Wood Rafter Systems

3.5.1.1 Rafters ................................................................. Ok? □

3.5.1.1.1 Jack Rafters ...................................................... Ok? □

3.5.1.1.2 Rafter Overhangs ......................................... Ok? □

3.5.1.1.3 Rake Overhangs ........................................... Ok? □

3.5.1.1.4 Notching and Boring ..................................... Ok? □

3.5.1.2 Bearing ................................................................ Ok? □

3.5.1.3 End Restraint ................................................... Ok? □

3.5.1.4 Ridge Beams .................................................... Ok? □

3.5.1.5 Hip and Valley Beams ........................................ Ok? □

3.5.1.6 Ceiling Joists .................................................... Ok? □

3.5.1.7 Open Ceilings .................................................. Ok? □

3.5.1.8 Roof Openings ................................................ Ok? □

3.5.2 Wood I-Joist Roof Systems ........................................ Ok? □

3.5.3 Wood Roof Truss Systems ....................................... Ok? □

3.5.4 Roof Sheathing

3.5.4.1 Sheathing .......................................................... Ok? □

3.5.4.2 Sheathing Edge Support .................................... Ok? □

3.5.5 Roof Diaphragm Bracing ........................................ Ok? □
Roof and Ceiling Framing Details

Cross Section

Roof Framing

Ceiling Framing

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Roof Framing

Rafters (WFCM 3.5.1.1)

Assuming ceiling not attached to rafters, choose rafters from Table 3.26A and 3.26C (pp. 200 and 202)

Ground Snow Load: ................................................................. ______ psf
Live Load: ................................................................................. ______ psf
Dead Load: ................................................................................. ______ psf
Three second gust windspeed: .............................................. ______ mph Exp. ___
Rafter Vertical Displacement \( L/\Delta \): ............................................ ______
Required Span (Horizontal Projection): ......................................... ______ ft.

Thrust Factor (Footnote 1): ..........................................................______
Wind Factor (Footnote 2): ............................................................______
Sloped Roof Adjustment (Footnote 3): .............................................______

Selection of Species, Grade, Size, and Spacing: (Table 3.26A & C)

<table>
<thead>
<tr>
<th>Species</th>
<th>Spacing</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 3.26A Span</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live Load Span</td>
<td>(4 \times 1 \times 3)</td>
<td></td>
</tr>
<tr>
<td>Table 3.26A Span</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Load Span</td>
<td>(5 \times 2 \times 3)</td>
<td></td>
</tr>
<tr>
<td>Table 3.26C Span</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snow Load Span</td>
<td>(6 \times 1)</td>
<td></td>
</tr>
</tbody>
</table>
Roof Framing - Ridge Members

Ridge Beams (WFCM 3.5.1.4)

Since thrust is accounted for in rafter selection, per 3.5.1.4 exception use: ____Ridge Board

Alternately, use ___ " x ___" plywood or OSB.

OR

A ridge beam could be designed per Tables 3.29A and B (pp. 211-212). Additional columns would be required to establish load path to the foundation.

Ground Snow Load: ................................................................. psf
Live Load: ................................................................. psf
Dead Load: ................................................................. psf
Required Span: ......................................................... ft.
Building Width: ......................................................... ft.

Per Table 3.29A (interpolated): ........................................ Glulam
Per Table 3.29B (interpolated): ........................................ Glulam

OR

A ridge beam could be designed per Table 2.16 (p. 103) since the span exceeds values shown in Table 3.29A and B (pp. 211-212). Additional columns would be required to establish load path to the foundation.

Ground Snow Load: ................................................................. psf
Live Load: ................................................................. psf
Dead Load: ................................................................. psf
Required Span: ......................................................... ft.
Building Width: ......................................................... ft.
Tabulated Load: ................................................................. plf

From the 2001 ASD Manual Glulam Supplement Table 7.2 choose:
Ceiling Framing

Ceiling Joists (WFCM 3.5.1.6)

For uninhabitable attics with limited storage live load, choose ceiling joists from Table 3.25A or B (pp. 198-199):

Live Load: .............................................................................................................. ____ psf
Dead Load: ............................................................................................................ ____ psf
Joist Vertical Displacement L/Δ: ........................................................................____
Required Span: ..................................................................................................... ____ ft.

Selection of Specie, Grade, Size, and Spacing: (Table 3.25A or B)

<table>
<thead>
<tr>
<th>Specie</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Span</td>
<td></td>
</tr>
</tbody>
</table>

Floor Joists (WFCM 3.3.1.1)

For habitable attics, use residential sleeping area with 30 psf live load, choose ceiling joists from Table 3.18A (p. 177):

Live Load: .............................................................................................................. ____ psf
Dead Load: ............................................................................................................ ____ psf
Joist Vertical Displacement L/Δ: ........................................................................____
Required Span: ..................................................................................................... ____ ft.

Selection of Specie, Grade, Size, and Spacing: (Table 3.18A)

<table>
<thead>
<tr>
<th>Specie</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Span</td>
<td></td>
</tr>
</tbody>
</table>
Job: ___________________________ Description: ___________________________

# Ceiling Framing

## Ceiling Joists (WFCM 2.5.1.6)

For uninhabitable attics without storage, choose ceiling joists from Table 2.12A (p. 88), as an alternative solution process.

Live Load: ................................................................. _____ psf
Dead Load: ................................................................. _____ psf
Joist Vertical Displacement L/Δ: .............................................

Required Span: ................................................................. _____ ft.

Required E and $F_b$ at ___ "o.c. joist spacing for ____' span from Table 2.12A:

<table>
<thead>
<tr>
<th>Size</th>
<th>Required E</th>
<th>Required $F_b$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>psi</td>
<td>psi</td>
</tr>
</tbody>
</table>

Select Grade from WFCM Table 4A and 4B based on required E and $F_b$ above:

<table>
<thead>
<tr>
<th>Specie</th>
<th>Size &amp; Grade</th>
<th>Tabulated E, psi</th>
<th>Tabulated $F_b$, psi</th>
<th>Size Factor, $C_F$</th>
<th>Load Duration Factor, $C_D$</th>
<th>Repetitive Member Factor, $C_r$</th>
<th>Allowable $F_b$, psi</th>
</tr>
</thead>
</table>

Adjustment factors for Table 4A are found on WFCM p. 279-280.
Adjustment factors for Table 4B are found on WFCM p. 286-287.
Roof and Ceiling Sheathing

Sheathing (WFCM 3.5.4.1)

Choose Roof Sheathing from Tables 3.12A and 3.12B (p. 162)

- Ground Snow Load ........................................................................................................... $$\text{psf}$$
- Live Load ......................................................................................................................... $$\text{psf}$$
- Dead Load ....................................................................................................................... $$\text{psf}$$
- Three second gust wind speed: ....................................................................................... $$\text{mph Exp. }$$
- Rafter/Truss Spacing: .......................................................................................................
- Sheathing Type: ..............................................................................................................

Tabulated Minimum Panel Thickness:
- From Table 3.12A: ...........................................................................................................
- From Table 3.12B: ...........................................................................................................

Roof Diaphragm Bracing (WFCM 3.5.5)

Blocking in first two rafter bays per Figure 3.7b (p. 127) and Table 3.1 (p. 139) fastener schedule.

Blocking to Joist (toenailed): ............................................................................................

OR

Bracing Gable Endwall with Attic Floor/Ceiling Sheathing Length from Table 3.15 (p. 165) (assumes windward and leeward loads and sheathing length from gable end to gable end)

- Fastest Mile Windspeed: ................................................................................................. $$\text{mph Exp. }$$
- Roof Pitch: ....................................................................................................................... 
- Diaphragm Span: .............................................................................................................. $$\text{ft.}$$
- Sheathing Type: ..............................................................................................................

Tabulated Minimum Length of Attic Floor/Ceiling Diaphragm: ........................................ $$\text{ft.}$$

Bracing One Gable End Adjustment (Footnote 1):

Wall Height Adjustment (Footnote 3):

Ceiling Framing Spacing Adjustment (Footnote 5):

Required Minimum Length of Attic Floor/Ceiling Diaphragm:

- Tabulated Minimum Length x Applicable Adjustment Factors: .................................... $$\text{ft.}$$
- Tabulated minimum length ≥ 1/3 distance between bracing endwalls: ................. $$\text{ft.}$$
  (per Table 3.15 Footnote 1)

Use Table 3.1 (p.139) fastener schedule for floor sheathing.
Connections – Roof Lateral, Shear, Uplift

Lateral Framing and Shear Connections (WFCM 3.2.1)

Roof Assembly to Wall Assembly (WFCM 3.2.1.2)

Choose Rafter/Ceiling Joist to Top Plate Lateral and Shear Connection from Table 3.4A (p. 150)

Three second gust windspeed: ........................................................................................................... _____ mph Exp. ___

Rafter/Ceiling Joist Spacing .............................................................................................................. _____ in.

Wall Height: .................................................................................................................................... _____ ft.

Required number of 8d Common Nails in each rafter/ceiling joist to top plate connection: .................. *

Uplift Connections (WFCM 3.2.2)

Roof Assembly to Wall Assembly (WFCM 3.2.2.1)

Choose Roof to Wall Uplift Strap Connection from Table 3.4B (p. 151)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
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<tbody>
<tr>
<td>Three second gust wind speed</td>
<td></td>
<td></td>
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<tr>
<td>Framing Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Span</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum tabulated number of 8d Common Nails required in each end of 1-1/4” x 20 gage strap every rafter / stud</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Ceiling Assembly nail increase (Footnote 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum required number of 8d Common Nails in each end of strap every rafter / stud = Tabulated number of nails - Reductions + Increases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* calculated using _____ lbs uplift (below) divided by _____ lb/nail per WFCM Supplement Table 6A.
Connections – Roof Lateral, Shear, Uplift (cont’d)

Alternatively, use proprietary connectors every rafter with the following minimum capacities from Table 3.4 (pp. 148-149)

### Loadbearing Walls
- Tabulated minimum uplift connection capacity (Table 3.4, page 149)
- Interior framing adjustment (Footnote 1)
- Roof-to-Wall reduction (Table 3.4, Footnote 3)
  \[ \text{Required Minimum Uplift Capacity of proprietary connector} = [0.60(\text{psf} - 15 \text{ psf}) \times \text{_____}' \times \text{_____}" / 12 "/" = \text{______ lbs}] \]

### Non-Loadbearing Walls
- Tabulated minimum uplift connection capacity (Table 3.4C, page 152)
- Overhang Multiplier (Table 3.4C, Footnote 2) \[ \left( \frac{2' + \text{OH}}{4'} \right)^2 \text{ OH} = \text{_____}' \]
- Zone 2 Multiplier (Table 3.4C, Footnote 3)

### Required Minimum
- Required Minimum Uplift Capacity of proprietary connector
- Required Minimum Lateral Capacity
- Required Minimum Shear Parallel to Ridge Capacity
- Required Minimum Shear Perpendicular to Ridge Capacity

---

![Diagram of 4" o.c. Nail Spacing and Connection per Section 2.2.2.1 & 2.2.6.5](image-url)
Connections – Roof Sheathing, Ridge

Sheathing and Cladding Attachment (WFCM 3.2.4)

Roof Sheathing (WFCM 3.2.4.1)

Choose Roof Sheathing Nail Spacing from Table 3.10 (p. 160)

Three second gust windspeed: ................................................................. _____ mph Exp. _____

Rafter/Truss Spacing: .................................................................................. in.

Sheathing Type: ........................................................................................... ____ in.

Sheathing Type: ........................................................................................... ____ in.

<table>
<thead>
<tr>
<th>Location</th>
<th>Edges</th>
<th>Field</th>
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</thead>
<tbody>
<tr>
<td>4' Perimeter Edge Zone</td>
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<tr>
<td>Interior Zones</td>
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<td></td>
</tr>
<tr>
<td>Gable Endwall Rake with Lookout Block</td>
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<td></td>
</tr>
</tbody>
</table>

* see 2001 WFCM Figure 2.1 p. 34 for nailing details. Perimeter edge zone nailing of 6” permitted for edges and field per Figure 2.1g.

Special Connections (WFCM 3.2.5)

Ridge Straps (WFCM 3.2.5.1)

For a clean finished ceiling line, rather than using collar ties to resist upward ridge separation, choose Ridge Tension Strap Connection from Table 3.6A (p. 156)

Three second gust windspeed: ................................................................. _____ mph Exp. _____

Roof Pitch: ............................................................................................... _____

Roof Span: ................................................................................................. _____ ft.

Tabulated number of 8d Common Nails required in each end of 1-1/4" x 20 gage strap: .................................................. ____

Ridge Strap Spacing Adjustment (Footnote 4): ............................................. ____

Required number of 8d Common Nails in each end of 1-1/4" x 20 gage strap:

Tabulated number of nails x Applicable adjustment factors: ...................... *
Connections – Roof Heels

* Alternatively, use proprietary connectors with the following minimum capacity from Table 3.6 (p. 155)
  Tabulated minimum connection capacity: ..............................................................
  Ridge Strap Spacing Adjustment (Footnote 4): ..............................................
  Required minimum capacity of proprietary connector:
  Tabulated minimum capacity x Applicable adjustment factors: .......... _____ lbs

Table 3.1 Nailing Schedule

Choose Ceiling Joist to Parallel Rafter and Ceiling Joist Lap Connection from Table 3.9A (p. 159)

Ground Snow Load: ................................................................. _____ psf
Roof Span: .................................................................................. _____ ft.
Rafter Slope: ..................................................................................
Rafter Spacing: ..................................................................................

Tabulated number of 16d Common Nails required per heel joint splice: ........
  Clinched Nails Adjustment (Footnote 1): ..............................................
  Ceiling Height/Roof Ridge Height Adjustment (Footnote 6): .................

Required number of 16d Common Nails per heel joint splice:
  Tabulated number of nails x Applicable adjustment factors: .............. *
  Required number of nails at splice (Footnote 4): .............. *

*Alternatively, use proprietary connectors with the following minimum capacity from Table 3.9 (p. 158)

Tabulated minimum connection capacity: ..............................................................
  Ceiling Height/Roof Ridge Height Adjustment (Footnote 5): ....................

Required minimum capacity of proprietary connector:
  Tabulated minimum capacity x Applicable adjustment factors: .......... _____ lbs

Blocking to Rafter Connection from Table 3.1 (p. 139): .................................................

OR

Rim Board to Rafter Connection from Table 3.1 (p. 139): .................................................
Job: ____________________________  Description: ____________________________

# Wall Framing - Studs

**Wall Studs** *(WFCM 3.4.1.1)*

Choose Studs from Table 3.20A or 3.20B and Footnotes *(pp. 180-184)*

<table>
<thead>
<tr>
<th>Specie</th>
<th>Spacing</th>
<th>Grade</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Loadbearing

Three second gust wind speed: .................................................................______ mph Exp. ____
Wall Height: ............................................................................................______ ft.
Sheathing Type (wood structural panel or minimum sheathing):..................______
Studs supporting: .......................................................................................______

Selection of Specie, Grade, Size, and Spacing: *(Table 3.20B and Footnotes)*

Non-Loadbearing

Choose Studs from Table 3.20A or 3.20B and Footnotes *(pp. 180-184)*

<table>
<thead>
<tr>
<th>Specie</th>
<th>Spacing</th>
<th>Grade</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Wall Framing – Top Plates

Top Plates (WFCM 3.4.1.2)

Choose Building End Wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

Building Dimension: .............................................................................. ____ ft.
Tabulated Minimum Splice Length: ................................................................____ ft.
Connection: top plate – to – top plate: ...................................................................... ____ nails per ft.

Choose Building Side wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

Building Dimension: .............................................................................. ____ ft.
Tabulated Minimum Splice Length: ................................................................____ ft.
Connection: top plate – to – top plate: ...................................................................... ____ nails per ft.
Wall Framing - Exterior Headers, Sills

Exterior Loadbearing Wall Headers (WFCM 3.4.1.4.1)

Choose Headers in Loadbearing Walls from Tables 3.22A-E and Table 3.22F (pp. 186-193)

Building Width: ................................................................. ft.
Required Span (Foyer Window): ............................................ ft.
Ground Snow Load: .......................................................... psf
Three second gust wind speed: ............................................. mph Exp. ___

Header supporting roof, ceiling and attic floor – use Table 3.22B (p. 187)

Preliminary Header Selection (Gravity Loads): ______________________ __________
Maximum Header/Girder Span (interpolated):................................. __________
Tabulated Number of Jack Studs (Table 3.22F):............................... __________
Roof Span Adjustment (Footnote 1 – (W+12)/48):.............................. __________
Adjusted number of jack studs required = tabulated x roof span adjustment: ...... __________

Table 3.23A (p. 192)

Preliminary Header Selection (Wind Loads):
Maximum Header/Girder Span .................................................. ft.
Tabulated Number of Full Height (King) Studs (Table 3.23C):................. __________
Reduced Full Height Stud Requirements (Table 3.23D):........................ __________
(same species / grade as Loadbearing Studs (WFCM 3.4.1.4.2))

Final Selection of Header Specie, Grade, and Size:
loads control:
Number of Jack Studs Required (_______ controlled): .................... __________
Number of Full Height (King) Studs Required (_______ controlled): ...
(same species / grade as Loadbearing Studs (WFCM 3.4.1.4.2))

Exterior Loadbearing Wall Window Sill Plates (WFCM 3.4.1.4.4)

Choose Window Sill Plates from Table 3.23B (p. 193)

Three second gust wind speed: ............................................ mph Exp. B
Required Span (Foyer Sill Plate): ............................................ ft.

Selection of Window Sill Plate Specie, Grade, and Size:
Tabulated Window Sill Plate Span: ............................................
Wall Height Adjustment (Footnote 3 – (H/10)^2): ....................................

Adjusted Maximum Sill Plate Length:
Tabulated maximum Sill Plate Length ÷ wall Height Adjustment: ...... __________
Wall Framing – Exterior Headers, Sills (cont’d)

Exterior Non-Loadbearing Wall Headers (WFCM 3.4.1.4.1)

Note: When headers support wall loads only, it is conservative to use the tabulated value for a header supporting a roof and ceiling with a 12’ roof span and 20psf live load.

Choose Headers in Non-Loadbearing Walls from Table 3.23B and 3.23C (p. 193)

- Three second gust wind speed: .............................................................. _____ mph Exp. B
- Required Span: .......................................................................................... _____ ft.
- Selection of Header Specie, Grade, and Size: ..............................................
- Tabulated Header Span: ............................................................................
- Wall Height Adjustment (Footnote 3 – (H/10)^2): .....................................
- Adjusted Header Span: .............................................................................
- Number of Full Height (King) Studs Required: ...........................................
  (same species / grade as Non-Loadbearing Studs (WFCM 3.4.1.4.2))

Exterior Non-Loadbearing Wall Window Sill Plates (WFCM 3.4.1.4.3)

Choose Window Sill Plates from Table 3.23B (p. 193)

- Three second gust wind speed: .............................................................. _____ mph Exp. B
- Required Span: .......................................................................................... _____ ft.
- Selection of Window Sill Plate Specie, Grade, and Size: .........................
- Tabulated Window Sill Plate Span: ............................................................
- Wall Height Adjustment (Footnote 3 – (H/10)^2): .....................................
- Adjusted Header Span: .............................................................................
- Number of Full Height (King) Studs Required: ...........................................
  (same species / grade as Non-Loadbearing Studs (WFCM 3.4.1.4.2))
Wall Framing – Interior Headers

Interior Loadbearing Wall Headers (WFCM 3.4.2.4.1)

Choose Header Table 3.24A (p. 195)

Building Width: ........................................................................................................... _____ ft.

Required Span: ............................................................................................................. _____ ft.

Selection of Header Specie, Grade, and Size: ............................................................... _____ ______

Maximum Header/Girder Span: ..................................................................................... _____ ft.

Number of Jack Studs Required: ................................................................................... _____
Wall Framing - Sheathing

Sheathing and Cladding (WFCM 3.4.4.1)

Choose Exterior Wall Sheathing or Cladding from Tables 3.13A and 3.13B respectively (p. 163)

Three second gust wind speed: .............................................................. ____ mph Exp. ____
Sheathing Type: ........................................................................................................
Direction Across Studs (Short or Long): ......................................................... ____
Stud Spacing: ...........................................................................................................
Minimum Panel Thickness: ...................................................................................
Shear wall minimum panel thickness (WFCM 3.4.4.2): ...................................... ____ in.

North Elevation

= ____ ft. long = \( L_{FH} \)

South Elevation

= ____ ft. long = \( L_{FH} \)

East Elevation

= ____ ft. long = \( L_{FH} \)

West Elevation

= ____ ft. long = \( L_{FH} \)
**Wall Sheathing – Segmented Shear Walls**

**Exterior Type I Shear walls (WFCM 3.4.4.2)**

Choose Exterior Type I Shear Wall Length from Table 3.17A-D (pp. 169-174)

- Wall Height: ................................................................. ______ ft.
- Number of Stories Braced (per 3.1.3.1): ...............................................................  
- Three second gust wind speed: ............................................................................ ______ mph Exp. ______
- Maximum shear wall aspect ratio for wind (Table 3.17D):.................................  
- Minimum shear wall segment length (Wall height/aspect ratio):.........................  ft.
- Minimum WSP sheathing thickness (per WFCM 3.4.4.2):.................................... ______ in.
- Minimum gypsum thickness (per WFCM 3.4.4.2):.............................................. ______ in.

---

<table>
<thead>
<tr>
<th>Steps</th>
<th>Task</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td>Tabulated Minimum Length Full Height Sheathing for Seismic (L_{FHS})</td>
</tr>
<tr>
<td>2</td>
<td>S</td>
<td>Effective Length of Full Height Sheathing for Seismic (L_{FS})</td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td>WSP Perimeter Edge Nail Spacing – Seismic (WFCM 3.4.4.2 + 3.4.4.2.1)</td>
</tr>
<tr>
<td>4</td>
<td>S</td>
<td>Min. Length Full Ht. Sheathing–Segmented Seismic (L_{TypeI-S} = L_s(C_{swa}))</td>
</tr>
<tr>
<td>5</td>
<td>W</td>
<td>Tabulated Minimum Length Full Height Sheathing for Wind Loads per Table 3.17B and 3.17A (L_w)</td>
</tr>
<tr>
<td>6</td>
<td>W</td>
<td>WSP Perimeter Edge Nail Spacing – Wind (WFCM 3.4.4.2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Load Parallel to Ridge | Load Perpendicular to Ridge**

# Wall Sheathing – Perforated Shear Walls

## Exterior Type II Shear Walls (WFCM 3.4.4.2)

Choose Exterior Type II Shear Wall Length from Table 3.17E (p. 175)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>Parallel to Ridge</th>
<th>Perpendicular to Ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Unrestrained Opening Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual Length of Full Height Sheathing (L_FH)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Effective Length of Full Height Sheathing for Seismic (L\_FHS)**

**Length of Wall (L\_Wall)**

**Percent Full Height Sheathing (L\_FH / L\_Wall)**

**Tabulated Min. Length Full Ht. Sheathing - Segmented Seismic (L\_TypeI-S)**

**Perforated (Type II) Length Increase Factor from Table 3.17E (C\_L)**

**Min. Length Full Ht. Sheathing - Perforated Seismic (L\_TypeII-S = L\_TypeI-S (C\_L))**

\[ L\_TypeII < L\_FHS \]

**Ok? Ok? Ok? Ok?**

**Actual Length of Full Height Sheathing (L\_FH)**

**Length of Wall (L\_Wall)**

**Percent Full Height Sheathing (L\_FH / L\_Wall)**

**Tabulated Min. Length Full Height Sheathing - Segmented Wind (L\_TypeI-W)**

**Perforated (Type II) Length Increase Factor from Table 3.17E (C\_L)**

**Min. Length Full Ht. Sheathing - Perforated Wind (L\_TypeII-W = L\_TypeI-W (C\_L))**

\[ L\_TypeII-W < L\_FH \]

**Ok? Ok? Ok? Ok?**

**Remarks:**

**Shear Wall Details Summary**

<table>
<thead>
<tr>
<th>Building Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Wall Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSP Perimeter Nail Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Governing Load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shear wall Adjustment per Table 3.17D (C_swa)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**AMERICAN FOREST & PAPER ASSOCIATION**
**Wall Sheathing - Combined Shear Walls**

Combine Shear Wall Requirements at Interface of Two Buildings

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>Wind</th>
<th>Seismic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Segmented (Type I) Shear Wall Requirements</strong> – Sheathing Thickness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building 1 – __________ Elevation (WSP perimeter edge nail spacing) (L_{FH1})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length adjustment factor, C_{swa1} (Table 3.17D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revised Length Adjustment Factor (C_{swa1revised}) (Table 3.17D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length adjustment factor ratio C_{swa1 ratio} = C_{swa1revised} / C_{swa1}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Shared wall length = L_{FH1} * C_{swa1 ratio} = L_{FHadj1}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Building 2 – __________ Elevation (WSP perimeter edge nail spacing) (L_{FH2}) |
| Length adjustment factor, C_{swa2} (Table 3.17D) |
| Revised Length Adjustment Factor (C_{swa2revised}) (Table 3.17D) |
| Length adjustment factor ratio C_{swa2 ratio} = C_{swa2revised} / C_{swa2} |
| Adjusted Shared wall length = L_{FH2} * C_{swa2 ratio} = L_{FHadj2} |

| Adjusted Shared Wall – Total Requirement (L_{TypeIadjusted}) = L_{FHadj1} + L_{FHadj2} |
| Actual Length of Full Height Sheathing (L_{FH}) |
| L_{TypeIadjusted} < L_{FH} | Ok? | Ok? |

**Perforated (Type II) Shear Wall Requirements**

| Perforated (Type II) Length Increase Factor from Table 3.17E (C_L) |
| Min. Length Full Ht. Sheathing-Perforated (L_{TypeIIadjusted} = L_{TypeIadjusted} (C_L)) |
| Actual Length of Full Height Sheathing (L_{FH}) |
| L_{TypeIIadjusted} < L_{FH} | Ok? | Ok? |

Decreased nail spacing should be considered first to increase Perforated (Type II) shear wall capacity, otherwise try increasing WSP thickness.

Shear Wall Details Summary - Final

<table>
<thead>
<tr>
<th>Building Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Wall Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSP Perimeter Nail Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Governing Load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shear wall Adjustment per Table 3.17D (C_{swa})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Floor Framing

Floor Joists (WFCM 3.3.1.1)

Choose Floor Joists from Tables 3.18A-B (pp. 177-178)

- Live Load: ................................................................. _____ psf
- Dead Load: ................................................................. _____ psf
- Joist Vertical Displacement L/Δ: ........................................______
- Required Span: ................................................................. ______ ft.

Selection of Specie, Grade, Size, and Spacing: (Table 3.18A)

<table>
<thead>
<tr>
<th>Specie</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Span</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Floor Framing

Floor Sheathing

Sheathing Spans (WFCM 3.3.4.1)

Choose Floor Sheathing from Table 3.14 (p. 164)

- Floor Joist Spacing: ................................................................. ______ in.
- Sheathing Type: .............................................................................
- Span Rating: ..................................................................................
- Tabulated Minimum Panel Thickness: ........................................______ in.
Connections – Wall / Floor Assemblies

Lateral Framing and Shear Connections (WFCM 3.2.1)

Wall Assembly (WFCM 3.2.1.3)

**Top Plate to Top Plate Connection from Table 3.1 (p. 139):**

- Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
  - (4” nail spacing: 1.67 x ____ nails)
  - (3” nail spacing: 2.0  x ____ nails)

**Top Plate Intersection Connection from Table 3.1:**

**Stud to Stud Connection from Table 3.1:**

**Header to Header Connection from Table 3.1:**

**Choose Top or Bottom Plate to Stud Connection from Table 3.1 & 3.5A:**

Wall Assembly to Floor Assembly (WFCM 3.2.1.4)

**Bottom Plate to Floor Joist, Bandjoist, Endjoist or Blocking Connection from Table 3.1:**

- Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
  - (4” nail spacing: 1.67 x ____ nails)
  - (3” nail spacing: 2.0  x ____ nails)

Floor Assembly (WFCM 3.2.1.5)

**Bridging to Floor Joist Connection from Table 3.1:**

**Blocking to Floor Joist Connection from Table 3.1:**

**Band Joist to Floor Joist Connection from Table 3.1:**

Floor Assembly to Wall Assembly (WFCM 3.2.1.6)

**Floor Joist to Top Plate Connection from Table 3.1:**

**Blocking to Sill or Top Plate Connection from Table 3.1:**

**Band Joist to Sill or Top Plate Connection from Table 3.1:**

- Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
  - (4” nail spacing: 1.67 x ____ nails)
  - (3” nail spacing: 2.0  x ____ nails)
Connections – Floor / Wall Assemblies (cont’d)

Lateral, Shear, and Uplift Connections (WFCM 3.2.1 and 3.2.2)

Wall Assembly to Foundation (WFCM 3.2.1.7 and 3.2.2.3)

Choose Sill Plate to Foundation Connection Requirements for Anchor Bolts Resisting Lateral, Shear, and Uplift Loads from Table 3.2A (pp. 142-143)

Three second gust wind speed: ................................................................. _____ mph Exp. _____
Stories supported by Foundation: .............................................................
Anchor Bolt Diameter: ............................................................................ in.

Assuming Crawl Space or Basement, determine maximum Anchor Bolt Spacing:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear wall line dimension ($L_{sw}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building dimension perpendicular to shear wall line (Table 3.2A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of stories receiving wind load (Table 3.2A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated number of bolts to resist shear loads from wind (Table 3.2A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolt spacing for wind shear loads $s_{sw} = (L_{sw} - 2) / (\text{number of bolts}-1)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. bolt spacing to resist wind uplift loads ($s_{wu}$) (Table 3.2C &amp; 3.4C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated anchor bolt spacing to resist seismic loads ($s_e$) (Table 3.3A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - Seismic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) ($C_{swa}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted bolt spacing for seismic loads $s_{sa} = (s_e)(C_{swa})$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. anchor bolt spacing (lesser of $s_{sw}$, $s_{wu}$, and $s_{sa}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Connections – Floor / Wall Assemblies (cont’d)

Lateral, Shear, and Uplift Connections (WFCM 3.2.1 and 3.2.2)

Wall Assembly to Foundation (WFCM 3.2.1.7 and 3.2.2.3)

Choose Bottom Plate to Foundation Connection Requirements for Anchor Bolts Resisting Lateral, Shear, and Uplift Loads from Table 3.2B (pp. 144) and Table 3.3A (p. 147).

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear wall line dimension (Lsw)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of stories receiving wind load (Table 3.2B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolt spacing for wind lateral and shear loads (Table 3.2B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall sheathing type adjustment factor per Table 3.17D (Table 3.2B Footnote 3) (assumes perforated shear wall capacities) Cswa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted bolt spacing for wind lateral and shear loads (swa)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. anchor bolt spacing to resist wind uplift loads (swu) (Table 3.2C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated anchor bolt spacing to resist seismic loads (sa) (Table 3.3A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - Seismic</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) (Cswa)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted bolt spacing for seismic loads sa = (sa)(Cswa)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Max. anchor bolt spacing (lesser of swa, swu, and sa)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Connections – Floor / Wall Assemblies (cont’d)

Lateral, Shear, and Uplift Connections (WFCM 3.2.1 and 3.2.2)

Wall Assembly to Foundation (WFCM 3.2.1.7 and 3.2.2.3)

Alternatively, use proprietary connectors with the following minimum capacities from Table 3.2 (pp. 140-141), Table 3.3 (pp. 145-146) and Table 3.4C (p. 152).

Three second gust wind speed: .............................................................................. ____ mph Exp. ____
Stories supported by Foundation: ........................................................................... ____

Determine required loads for proprietary connectors:

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building dimension W or L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R=L/W or W/L for Table 3.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of stories receiving lateral wind load (Table 3.2A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind uplift (Table 3.4C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uplift force Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind uplift plf basis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhang Reduction (Table 3.4C Footnote 2) [(2’ – OH / 4’)²]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall Dead Load Reduction¹ ( ____ walls (0.6) ( ____ plf))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Wind uplift (Table 3.4C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind uplift (Table 3.2(U))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind lateral load (Table 3.2(L))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind shear load (Table 3.2(S))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seismic shear load (Table 3.3) C₁ = _______ C₂ = _______</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L_max = _______ L_min = _______</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or, □ slab on grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall Dead Load  w_w</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Footnote 4 Wall Dead Load Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_w = (w_w + 70.65) / 85.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Footnote 5 Sheathing Adjustment Factor for wall (Table 3.17D) (C_sww)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted seismic shear load = seismic shear load x R_w / C_sww</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall length</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seismic shear load = adjusted seismic shear load / wall length</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Refer to WFCM Commentary 1.1.2.
*Table 3.2 Footnote: Determine anchorage for Lateral Loads in foundation design per Section 1.1.4
**Connections (cont’d)**

**Uplift Connections (WFCM 3.2.2)**

Wall Assembly to Wall Assembly or Wall Assembly to Foundation (WFCM 3.2.2.2 and 3.2.2.3)

Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three second gust wind speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Span</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated number of 8d Common Nails required in each end of 1-1/4&quot; x 20 gage strap every stud</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Ceiling Assembly nail increase (Footnote 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required number of 8d Common Nails in each end of strap every stud</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ = \text{Tabulated number of nails - Reductions + Increases} \]

1 calculated using _____ lbs uplift (below) divided by _____ lb/nail per WFCM Supplement Table 6A.

*Alternatively, use proprietary connectors with the following minimum capacities*

<table>
<thead>
<tr>
<th>Loadbearing Walls</th>
<th>Tabulated minimum uplift connection capacity (Table 3.4, page 149)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior framing adjustment (Footnote 1)</td>
<td></td>
</tr>
<tr>
<td>Roof dead load reduction (Table 3.4, Footnote 3)</td>
<td></td>
</tr>
<tr>
<td>[ = [0.60(____ psf – 15 psf) x ____ x ____&quot;/12'' = ____ lbs] ]</td>
<td></td>
</tr>
<tr>
<td>Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4)</td>
<td></td>
</tr>
<tr>
<td>[ = [____ plf x ____ walls (____&quot;/12'' ) = ____ lbs] ]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Loadbearing Walls</th>
<th>Tabulated minimum uplift connection capacity (Table 3.4C, page 152)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-to-Wall and Wall-to-Foundation reduction (WFCM 3.2.5.3)</td>
<td></td>
</tr>
<tr>
<td>[ = [____ plf x ____ walls (____&quot;/12'' ) = ____ lbs] ]</td>
<td></td>
</tr>
<tr>
<td>Required minimum capacity of proprietary connector</td>
<td></td>
</tr>
<tr>
<td>= Tabulated minimum capacity x Adjustments - Reduction</td>
<td></td>
</tr>
</tbody>
</table>

Check Perforated Shear Wall plate anchorage between wall ends

The assumption is that the wall plate nailing to the floor frame (WFCM 3.2.1.6 Table 3.1) in addition to the wind uplift straps are sufficient to resist uplift requirements on the plate using the Perforated Shear Wall Method.
Connections – Floor Wall Assemblies (cont’d)

Overturning Resistance (WFCM 3.2.3)

Hold downs (WFCM 3.2.3.1)

Choose Hold downs from Table 3.17F for Type I and Type II Walls (p. 176)

<table>
<thead>
<tr>
<th>Building Wall Elevation</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated hold down connection capacity required – wind ( T_w )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - wind</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) ( C_{swa} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted hold down capacity ( T_{wa} = (T_w) / (C_{swa}) ) - wind</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional story hold down requirements – wind</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total hold down requirement for floor to foundation – wind ( \Sigma T_{wa} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tabulated hold down connection capacity required – seismic ( T_s )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSP Perimeter Edge Nail Spacing - seismic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) ( C_{swa} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted hold down capacity ( T_{sa} = (T_s) / (C_{swa}) ) - seismic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional story hold down requirements – seismic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total hold down requirement for floor to foundation ( \Sigma T_{sa} ) - seismic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sheathing and Cladding Attachment (WFCM 3.2.4)

Wall Sheathing (WFCM 3.2.4.2)

Choose Wall Sheathing Nail Spacing from Table 3.11 (p. 161)

Three second gust wind speed: ................................................................. _______ mph Exp. _______

Stud Spacing: ........................................................................................................ _______ in.
Sheathing Type (wood structural panels, board or lap siding): ......................... _______

<table>
<thead>
<tr>
<th>Location</th>
<th>Edges</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>4' Edge Zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Zones</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Connections – Wall Opening Elements

Special Connections (WFCM 3.2.5)

Choose Header/Girder Connections based on loads from Table 3.7 (p. 157)

Three second gust wind speed: ...................................................... _____ mph Exp. _____

Roof Span: ........................................................................................................... _____ ft.
Header Span (Typical Window): ....................................................................... _____ ft.

Required Connection Capacity at Each End of Header:
Tabulated Uplift Capacity (interpolated): ......................................................... _____ lbs.
Floor load adjustment (per footnote 4): ............................................................ _____ lbs.
Adjusted Uplift Capacity ..................................................................................... _____ lbs.
Tabulated Lateral Capacity: ................................................................................... _____ lbs.

Choose Window Sill Plate Connections based on loads from Table 3.8 (p. 157)

Three second gust wind speed: ................................................................. _____ mph Exp. B
Window Sill Plate Span: ......................................................................................... _____ ft.

Tabulated Lateral Connection Capacity at Each End of Window Sill Plate: ...... _____ lbs.
APPENDIX B
RELATED PAPERS

Perforated Shearwall Design Method
Considerations in Wind Design of Wood Structures
Perforated Shear Wall Design

Philip Line, P.E.

Introduction
The perforated shear wall (Fig. 1) method is one of several options for the design of wood-frame shear walls in the 2000 International Building Code (IBC). Two other methods include: the segmented approach which utilizes full-height shear wall segments each with full end-restraint against overturning (Fig. 2), and the force transfer approach which utilizes strapping to transfer forces around openings. The perforated shear wall method provides one way to account for strength and stiffness of sheathed walls with openings while providing an alternative to strapping and anchors typically required by other methods.

A perforated shear wall design for a two-story building is described in this paper. The example is similar to one developed for the Commentary to the Recommended Provisions for Seismic Regulations for New Buildings and Other Structures (2000 NEHRP) but is modified to address wind loading using an allowable strength design approach.

A separate example is provided to demonstrate one approach for calculating deflection of a perforated shear wall.

Design Provisions

The basic method for determining design shear capacity of perforated shear walls is the same in each of these documents. However, application limits as well as requirements for shear and uplift forces between wall ends vary. For example, 2000 NEHRP provisions contain an equation format for determining shear and uplift forces between wall ends. This equation format provides a convenient means for calculating anchorage requirements based on shear forces resisted by perforated shear walls.

Design Equations
Basic equations for design shear capacity, and calculation of anchorage and chord forces based on story shear forces, are described below.

Design Shear Capacity
The design shear force must not exceed the design shear capacity of a perforated shear wall, \( V \leq V_{\text{wall}} \). The design shear capacity, \( V_{\text{wall}} \), of a perforated shear wall is calculated as:

\[
V_{\text{wall}} = (\nu C_o) \sum L_i
\]

where:
- \( V_{\text{wall}} \) = design shear capacity of a perforated shear wall, lb.
- \( \nu \) = design unit shear capacity of a segmented shear wall, plf
- \( C_o \) = shear capacity adjustment factor from Table 1 which accounts for the strength reducing effect of openings on shear wall capacity
- \( \sum L_i \) = sum of lengths of perforated shear wall segments. A perforated shear wall segment is a section of shear wall sheathed full height and which meets minimum aspect ratio requirements in the governing building code. In most cases, this ratio is 3-1/2:1 for shear walls resisting wind and low seismic forces, ft.

Figure 1.—Perforated shear wall.

Figure 2.—Segmented shear wall.
Uplift Anchorage Force at Perforated Shear Wall Ends
At each end of a perforated shear wall, end post anchors must be designed for an uplift force, \( R \), due to overturning:

\[
R = \frac{Vh}{C_o \sum L_i} \tag{2}
\]

where:
- \( R \) = uplift anchorage force at perforated shear wall ends, lb.
- \( V \) = shear force in perforated shear wall, lb.
- \( h \) = shear wall height, ft.

Anchorage Force for In-Plane Shear
The unit shear force, \( v \), transmitted into the top of a perforated shear wall, out of the base of the perforated shear wall at full height sheathing, and used to size collectors (drag struts) connecting perforated shear wall segments, is calculated as:

\[
v_{\text{max}} = \frac{V}{C_o \sum L_i} \tag{3}
\]

where:
- \( v_{\text{max}} \) = maximum induced unit shear force, plf

Uplift Anchorage Force Between Perforated Shear Wall Ends
Perforated shear wall bottom plates at full height sheathing must be anchored for a uniformly distributed uplift force, \( t \), equal to the unit shear force, \( v_{\text{max}} \), calculated in Equation 3.

Tension and Compression Chords
Each end of a perforated shear wall must be designed for a tension force, \( T \), and a compression force, \( C \), equal to the uplift anchorage force, \( R \), calculated in Equation 3. Each end of each perforated shear wall segment must be designed for a compression force, \( C \).

Load Path
Requirements for shear and uplift anchorage and chord forces are based on story shear forces. Elements resisting forces contributed by multiple stories should be designed for the sum of forces contributed by each story. A continuous load path to the foundation needs to be maintained and include effects of gravity and other forces.

Other Requirements
In addition to requirements for design shear capacity, anchorage forces, and chord forces, limitations outlined in 2000 NEHRP are also applicable:
- a. A perforated shear wall segment shall be located at each end of a perforated shear wall. Openings shall be permitted to occur beyond the ends of the perforated shear wall. However, the length of such openings shall not be included in the length of the perforated shear wall.
- b. Where out of plane offsets occur, portions of the wall on each side of the offset shall be considered as separate perforated shear walls. Offset walls are shown as heavy lines in Figure 3.
- c. Collectors for shear transfer shall be provided through the full length of the perforated shear wall.
- d. A perforated shear wall shall have uniform top of wall and bottom of wall elevations. Perforated shear walls not having uniform elevations shall be designed by other methods. One example of a wall with non-uniform top and bottom elevations is the stepped wall as shown in Figure 4.
- e. Perforated shear wall height, \( h \), shall not exceed 20 ft.
- f. The allowable tabulated capacity set forth in the 2000 IBC for wood structural panel shear walls should not ex-

### Table 1.—Shear capacity adjustment factor, \( C_o \).

<table>
<thead>
<tr>
<th>Wall height ( h )</th>
<th>Maximum opening heighta</th>
<th>Shear capacity adjustment factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 ft. 0 in.</td>
<td>2 ft. 8 in.</td>
<td>4 ft. 0 in.</td>
</tr>
<tr>
<td>10 ft. 0 in.</td>
<td>3 ft. 4 in.</td>
<td>5 ft. 0 in.</td>
</tr>
<tr>
<td>Percent full-height sheathingb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>1.00</td>
<td>0.69</td>
</tr>
<tr>
<td>20%</td>
<td>1.00</td>
<td>0.71</td>
</tr>
<tr>
<td>30%</td>
<td>1.00</td>
<td>0.74</td>
</tr>
<tr>
<td>40%</td>
<td>1.00</td>
<td>0.77</td>
</tr>
<tr>
<td>50%</td>
<td>1.00</td>
<td>0.80</td>
</tr>
<tr>
<td>60%</td>
<td>1.00</td>
<td>0.83</td>
</tr>
<tr>
<td>70%</td>
<td>1.00</td>
<td>0.87</td>
</tr>
<tr>
<td>80%</td>
<td>1.00</td>
<td>0.91</td>
</tr>
<tr>
<td>90%</td>
<td>1.00</td>
<td>0.95</td>
</tr>
<tr>
<td>100%</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

a The maximum opening height is taken as the maximum opening clear height in a perforated shear wall. Where areas above and below an opening remain unsheathed, the height of the opening shall be defined as the height of the wall.
b The percent of full height sheathing is calculated as the sum of lengths of perforated shear wall segments divided by the total length of the perforated shear wall including openings.

![Figure 3.—In-plane versus offset walls.](image-url)
ceed 490 plf. For wind design, the allowable capacity can be taken as 1.4 times 490 plf or 686 plf.

Discussion — Maximum Unit Shear

Shear is not distributed uniformly to perforated shear wall segments within the wall. Segments with greater end restraint develop greater shear than segments with less end restraint. Tests of shear wall segments with varying levels of end restraint (Chun and Karacabeyli 2000 and Salenikovich 2000) verify the influence of end restraint on shear capacity. Lower bound strengths are attributed to wall segments without end restraint and upper bound strengths are attributed to wall segments with full end-restraint.

The unit shear force determined by Equation 3 represents maximum unit shear force, $v_{max}$, developed in any perforated shear wall segment. The value of $v_{max}$ is associated with the shear force developed by any perforated shear wall segments having full end-restraint (such as those at the ends of the perforated shear wall). Use of $v_{max}$ to size shear and uplift anchorage between wall ends and collectors between perforated shear wall segments is required in lieu of a more complicated analysis of the actual distribution of shear within a perforated shear wall. This conservatism ensures that the capacity of each perforated shear wall segment can be developed without being limited by collector element capacity or bottom plate attachment for shear and uplift. One apparent result of the conservatism is that actual anchorage requirements for shear are in excess of the design shear force, $V$, resisted by the perforated shear wall.

Average unit shear in perforated shear wall segments equal to $V/\sum L_i$ is not used to size shear and uplift anchorage or collector elements because it underestimates forces that may develop in a particular perforated shear wall segment.

Discussion — Uplift Between Wall Ends

For perforated shear wall segments between wall ends, a uniform uplift anchorage force is specified for attachment of bottom plates to elements below. Designing distributed anchorage for $v_{max}$ provides resistance to overturning of perforated shear wall segments between wall ends. Alternatively, concentrated anchorage for uplift at ends of perforated shear wall segments, to provide equivalent moment resistance, satisfies the intended purpose: to keep the segment from overturning by holding the bottom plate to elements below (Fig. 5).

In tests of long shear walls with openings (Dolan and Johnson 1996), anchor bolts resisting overturning were located within 12 in. from ends of perforated shear wall segments. It is also acceptable to restrain studs by strapping since bottom plates in turn are held down.

The conservatism of the uplift anchorage requirement between wall ends is seen when evaluating longer perforated shear wall segments. In such cases, the concentrated force to restrain the bottom plate (based on moment resistance equivalent to that provided by specified uniformly distributed uplift anchorage force) at ends of the perforated shear wall segment exceeds the force required to develop the maximum induced unit shear force, $v_{max}$. Recognizing
that induced shear will not exceed \( v_{\text{max}} \), it is acceptable to limit the concentrated uplift anchorage force at ends of perforated shear wall segments, due to story shear, to \( v_{\text{max}}h \) where \( h \) is the wall height. This force will match the uplift anchorage force, \( R \), from Equation 2.

**Example — Two-Story Building**

A design example involving a simple two-story building (Fig. 6) demonstrates application of the perforated shear wall method. Design shear capacity, shear and uplift between wall ends, and end post forces are calculated. Only lateral loads due to wind are considered. Building dead load and wind uplift forces are not included. Once forces are determined, two detailing options are considered. Configuration A uses a continuous rim joist at the second floor level sized to resist localized uplift and compression forces along the base of the wall due to story shear forces. Configuration B considers a condition where there is blocking between joists (e.g., floor framing runs perpendicular to the perforated shear wall).

**Second Floor Wall**

**Design Shear Capacity:**

Percent full-height sheathing

\[
= \frac{(4 \text{ ft.} + 4 \text{ ft.})}{16 \text{ ft.}} \times 100 = 50\%
\]

Maximum opening height ratio

\[
= \frac{4 \text{ ft.}}{8 \text{ ft.}} = 0.50
\]

Shear capacity adjustment factor, \( C_o \), from Table 1

\[
= 0.80
\]

\[
V_{\text{wall}} = (v \times C_o) \sum L_i = (365 \text{ plf})(0.80)(8 \text{ ft.}) = 2,336 \text{ lb.}
\]

\[
2,336 \text{ lb.} > 2,000 \text{ lb.} \quad \text{OK}
\]

Note that \( v = 365 \text{ plf} \) is for 15/32-in. rated sheathing with 8d common nails (0.131 by 2.5 in.) at 6-in. perimeter spacing resisting wind load (365 plf is obtained by multiplying the IBC Table 2306.4.1 value by the wind increase factor, or 260 plf \times 1.4).

**Uplift Anchorage Force at Shear Wall/Ends:**

\[
R = \frac{V h}{C_o \sum L_i} = \frac{(2,000 \text{ lb.})(8 \text{ ft.})}{(0.80)(8 \text{ ft.})} = 2,500 \text{ lb.}
\]

**Anchorage Force for In-Plane Shear:**

\[
V_{\text{max}} = \frac{V}{C_o \sum L_i} = \frac{(2,000 \text{ lb.})}{(0.80)(8 \text{ ft.})} = 313 \text{ plf}
\]

**Anchorage Force for Uplift, \( t \), Between Wall Ends:**

\[
t = v_{\text{max}} = 313 \text{ plf}
\]
Tension Chord Force, \( T \), and Compression Chord Force, \( C \), at Each End of a Perforated Shear Wall Segment:

\( C = T = R = 2,500 \text{ lb} \).

**First Floor Wall**

**Design Shear Capacity:**

Percent full-height sheathing

\[ \frac{4 \text{ ft.} + 4 \text{ ft.}}{12 \text{ ft.}} \times 100 = 67\% \]

Maximum opening height ratio

\[ = \frac{4 \text{ ft.}}{8 \text{ ft.}} = 0.50 \]

Shear capacity adjustment factor, \( C_o \), from Table 1

\[ = 0.86 \]

\[ V_{\text{wall}} = (v C_o) \sum L_i \]

\[ = (530 \text{ plf})(0.86)(8 \text{ ft.}) = 3,646 \text{ lb.} \]

\[ 3,646 \text{ lb.} > 3,500 \text{ lb.} \text{ OK} \]

Note that \( v = 530 \text{ plf} \) is for 15/32-in. rated sheathing with 8d common nails (0.131 by 2.5 in.) at 4-in. perimeter spacing resisting wind load (530 plf is obtained by multiplying the IBC Table 2306.4.1 value by the wind increase factor, or 390 plf \( \times 1.4 \)).

**Uplift Anchorage Force at Shear Wall/Ends:**

\[ R = \frac{V h}{C_o \sum L_i} = \frac{(3,500 \text{ lb})(8 \text{ ft.})}{(0.86)(8 \text{ ft.})} = 4,070 \text{ lb.} \]

When Maintaining Load Path from Story Above:

\[ R = R_{\text{from second floor}} + R_{\text{from first floor}} = 2,500 \text{ lb.} + 4,070 \text{ lb.} = 6,570 \text{ lb.} \]

**Anchorage Force for In-Plane Shear:**

\[ v_{\text{max}} = \frac{V}{C_o \sum L_i} = \frac{(3,500 \text{ lb.})}{(0.86)(8 \text{ ft.})} = 509 \text{ plf} \]

**Anchorage Force for Uplift, \( t \), Between Wall Ends:**

\[ t = v_{\text{max}} = 509 \text{ plf} \]

Uplift, \( t \), can be cumulative with 313 lb. from the story above to maintain load path. Whether this occurs depends on detailing for transfer of uplift forces between wall ends.

**Tension Chord Force, \( T \), and Compression Chord Force, \( C \), at Each End of a Perforated Shear Wall and Compression Chord Force, \( C \), at Each End of a Perforated Shear Wall Segment:**

\[ C = T = R = 4,070 \text{ lb.} \]

When maintaining load path from story above,

\[ C = 4,070 \text{ lb.} + 2,500 \text{ lb.} = 6,570 \text{ lb.} \]

**Load Path - Configuration A Detail**

Configuration A detailing (Fig. 7) uses a continuous rim joist at the second floor.

---

*Figure 7.*—Configuration A detail—continuous rim joist.
The rim joist is sized to resist forces from perforated shear wall segments between wall ends. For the second story perforated shear wall shown in Figure 8, a compression force, \( C \), and uplift force, \( t \), induce moment and shear in the rim joist. Continuity of load path for uplift and compression is maintained by adequate sizing of the rim joist for induced forces and adequate attachment at ends. For this example, dead load and additional compression reactions from wall studs below are ignored to simplify boundary conditions and assumed loading. Nails in the second story wall bottom plate to rim joist connection resist overturning of perforated shear wall segments between wall ends. Nails can be uniformly spaced to meet the specified uplift force (Equation 3) or alternatively, a concentrated nail schedule at ends of segments can be used to provide equivalent moment resistance to the specified uplift force. Other fasteners such as lag screws or bolts are an alternative to nails loaded in withdrawal.

Second story hold-downs at wall ends are sized for the force specified in Equation 2.

Transfer of shear from the second story to the first story is by nails in the wall bottom plate to rim joist connection and toe nails in the rim joist to wall top plate connection. First floor anchor bolts provide for transfer of shear and uplift forces between wall ends to the foundation. Plate washers and anchor bolts are sized to provide adequate bearing area and capacity to resist uplift forces. In this case, uplift between wall ends is not additive with second story uplift between wall ends due to design of the second story rim joist. First floor hold-downs are sized to resist uplift forces and include uplift forces from the story above, where applicable, to maintain a load path to the foundation. For simplicity, floor platform height is ignored in calculation of load path for overturning.

**Load Path - Configuration B Detail**

Configuration B detailing (Fig. 9) addresses a condition where a continuous rim joist is not provided. In Configuration B, floor framing runs perpendicular to the shear wall with blocking between floor framing members.

Nails in second story wall bottom plate-to-blocking connections and toe-nails in rim joist-to-wall top plate connections transfer in-plane shear forces. Transfer of shear to the foundation is by anchor bolts in the first story wall bottom plate-to-concrete connection. Transfer of uplift forces between wall ends, from the second story to the first story, is...
by metal strapping. Load path for uplift between wall ends is maintained by strapping into the foundation or lapping the strap around the first story bottom plate. When the strap is lapped around the bottom plate, the anchor bolt and plate washer must be sized to resist induced forces. First floor hold-downs are sized to resist uplift and include uplift forces from the story above, where applicable, to maintain a load path to the foundation. For simplicity, floor platform height is ignored in calculation of load path for overturning.

**Discussion - Configuration A and B Detail**

In Configuration A and B, fastening for shear and uplift between wall ends is provided over the length of full-height sheathed wall sections. Fastening between full-height segments will be controlled by minimum construction fastening requirements. For bottom plates on wood platforms this would typically require one 16-penny common nail at 16 in. on center. In some cases, it may be preferable for construction convenience to extend a single bottom plate fastening schedule across the entire length of the perforated shear wall rather than require multiple fastening schedules.

Load path for uplift between wall ends is simplified in Configuration A by design of the rim joist to resist induced forces. Detailing for shear and uplift between wall ends can be accomplished with standard connectors between the wall bottom plate and rim joist. In Configuration B, strapping is used to restrain bottom plate uplift between wall ends. Anchor bolts and plate washers sized for accumulated uplift forces maintain load path to the foundation for uplift forces between wall ends.

**Shear Wall Deflection**

One method for calculating deflection of a perforated shear wall is shown in Figure 10. The calculation procedure accounts for the presence of openings within the wall and is comparable to the process used to calculate deflection of a segmented shear wall.

**Summary**

A two-story example demonstrates one application for use of perforated shear walls. Methods for determining perforated shear wall design capacity and bottom plate anchorage requirements, based on story shear forces, are shown. In the example, sufficient strength to resist applied loads is provided by the perforated shear wall without the use of typical strapping and anchors required by other methods. Instead, anchorage requirements for bottom plates in a perforated shear wall provide an option to typical strapping and anchors that may be difficult to install.

**References**


CONSIDERATIONS IN WIND DESIGN OF WOOD STRUCTURES

Bradford K. Douglas, P.E.
Brian R. Weeks, P.E.

Proper design of wood structures to resist high wind loads requires the correct use of wind load provisions and member design properties. A thorough understanding of the interaction between wind loads and material properties is important in the design process.

There are varying wind load provisions in local, state and model building codes currently used in the United States. Most of these provisions are based on wind engineering research conducted over the last 50 years. Proposals to change current code provisions are the result of interpretations of new state-of-the-art wind engineering research.

The wind load provisions of the national load standard *ASCE 7-98 Minimum Design Loads for Buildings and Other Structures* include general wind load provisions which, in turn, are used as the basis for wind load requirements in most U.S. building codes. For the purposes of this paper, the references to wind loads in this article have been limited to the provisions found in *ASCE 7-98*.

Wind Load Provisions

Design wind load provisions in *ASCE 7-98* are based on wind speed data collected during severe wind events in the United States. The wind speed contours provided in *ASCE 7-98* are presented in terms of three second gust. Three second gust wind speed is based on the peak wind speed at a given height and exposure averaged over 3 seconds. The three second gust wind speed data has been statistically adjusted to a 50-year recurrence interval with an average annual probability of occurrence of 2 percent. The data has also been adjusted to a reference height of 33 feet and Exposure Category C, which assumes a flat, open terrain with scattered obstructions. The wind load provisions of *ASCE 7-98* provide adjustments for variations from reference conditions such as increased wind speeds during hurricane events, different exposure conditions, different elevations, and localized peak gusts.

*ASCE 7-98* contains separate provisions for the design of major structural elements using "Main Wind Force-Resisting System" (MWFRS) loads and secondary structural elements using "Component & Cladding" (C&C) loads. In building design, MWFRS loads have been developed to represent critical loads on the main structural elements from the two major orthogonal directions. These loads "envelope" the major structural actions induced on a building from various wind directions and for various building geometries, roof heights and roof slopes.

C&C loads have been developed to represent peak gusts which occur over small areas as a result of localized funneling and turbulence. Localized load increases can approach 300% at corners and ridges under certain configurations and require special considerations when designing for these loads. In wood structures, wind damage surveys have indicated that these localized loads can cause failures of connections in small areas which can effect the overall Main Wind Force Resisting System.

When designing a structural wood member, a decision must be made whether a member is a MWFRS element, a C&C element, or an element of both systems. *ASCE 7-98* defines the MWFRS as an assemblage of major structural elements assigned to provide support and stability for the overall structure. The system generally receives wind loading from more than one surface. Components and cladding are defined as elements of the building envelope that do not qualify as part of the MWFRS. Components and cladding are either directly loaded by the wind or receive wind loads originating at relatively close locations, and which transfer these loads to the MWFRS. However, some elements such as roof trusses, load-bearing studs, and structural
sheathing have been identified in both systems. One suggested interpretation is to design these elements for the MWFRS loads they would receive as part of the MWFRS and, separately, design these elements for the C&C loads they would receive if they were only a C&C element. In many cases this would require at least two checks; however, differences in the load cases and estimated stresses make it both necessary and beneficial to separately check both cases. Moreover, under certain common conditions, elements can be pre-engineered for C&C loads.

Allowable Design Stresses

Once the induced loads on a wood member or connection have been determined, that element can be designed. Structural wood members and connections should be designed using the appropriate provisions of the local building code. For the design of solid-sawn wood members and general connections, the codes normally reference or include provisions from the National Design Specification® for Wood Construction (NDS®). Included in NDS design provisions are various adjustments to design values. Among these adjustments is the duration of load (C_D) factor.

Wood strength properties have been observed to exhibit increased capacities under shorter durations of maximum load. This phenomenon has been analyzed extensively in the U.S. and in countries around the world. To account for this phenomenon in design, the U.S. Forest Service, Forest Products Laboratory in Madison, Wisconsin developed the "Madison Curve" which relates the maximum load-carrying capacity to a given load duration.

Most wood member design properties and connection capacities in the NDS are based on 10-minute test values which have been reduced for the effects of defects, stress concentrations, safety and duration of load. The duration of load adjustment reduces a 10-minute design value to a 10-year design value by dividing by a factor of 1.6 based on the "Madison Curve". During a severe wind event, maximum peak wind gusts on a structural member or connection have a cumulative duration of approximately 1-10 seconds. Worst case estimates by wind load experts have indicated that over the life of a structure the cumulative duration of these maximum loads would be less than 1 minute. NDS provisions specify an increase of 1.6 which returns the design capacities of the wood members or connections to the 10-minute test duration values.

While a duration of load increase is allowed for most design properties and connections, there are a few important exceptions. For lumber, a duration of load increase is not permitted for compression perpendicular-to-grain (F_{C_p}), and Modulus of Elasticity (E) design values. These properties are based on deformation and stiffness limits, which are not directly affected by the duration of load phenomenon. For panel product systems, published design capacities in the building codes for shear walls and diaphragms are expressed in terms of the test duration and need only be adjusted for long-term loading. In some codes the shear capacity of wood structural panel shearwalls and diaphragms, resisting wind loads, is permitted to be multiplied by a factor of 1.4. In addition, information on proprietary products and systems should be reviewed to determine if C_D adjustments of design capacities are permitted for those products.

Design Example

A 36’x60’ one-story wood-frame building is to be built on a site located in a 120 mph three second gust wind zone and on terrain representative of Exposure B. The walls will be constructed using 10-foot studs spaced 16 inches on center. The roof will be constructed using trusses spanning 36 feet spaced 24 inches on center and having 2 foot eave overhangs. The mean roof height will be approximately 15 feet and the roof angle will be approximately 20 degrees. The base velocity pressure can be calculated using the following equation:

\[
q_h = 0.00256K_xK_yK_dV^2I
\]

Where:

\[
q_h = 21.93 \text{ psf}
\]
\[ q_h = \text{Velocity pressure evaluated at height, } h, \text{ above the ground, psf (Exposure B)} \]

\[ K_z = \text{Exposure coefficient evaluated at height, } h, \text{ above the ground} \]
\[ = \text{(ASCE 7-98 Table 6-5)} \]
\[ = 0.70 \text{ (Exposure B, 15'} \text{ mean roof height)} \]

\[ K_{zt} = \text{Topographic factor (ASCE 7-98 Figure 6-2)} \]
\[ = 1.0 \]

\[ K_d = \text{Wind directionality factor (ASCE 7-98 Table 6-6)} \]
\[ = 0.85 \]

\[ I = \text{Importance factor} \]
\[ = 1.0 \text{ (Category II, ASCE 7-98 Table 6-1)} \]

\[ V = \text{Three second gust wind speed, mph} \]
\[ = 120 \text{ mph} \]

Using the calculated base velocity pressure, MWFRS design loads can be determined using the following equation:

\[ p_{3\text{-sec gust}} = q_h(GC_{pf})-q_h(GC_{pi}) \]

Where:

\[ p_{3\text{-sec gust}} = \text{Design wind pressure, psf (MWFRS)} \]

\[ q_h = \text{Velocity pressure, psf (120 mph, Exposure B)} \]
\[ = 21.93 \text{ psf} \]

\[ GC_{pf} = \text{External pressure coefficient} \]
\[ = 0.80 \text{ (Edge Zone - Windward Wall)} \]
\[ = 0.53 \text{ (Interior Zone - Windward Wall)} \]
\[ = -0.64 \text{ (Edge Zone - Leeward Wall)} \]
\[ = -0.43 \text{ (Interior Zone - Leeward Wall)} \]
\[ = -0.48 \text{ (Edge Zone - Side Walls)} \]
\[ = -0.45 \text{ (Interior Zone - Side Walls)} \]
\[ = -1.07 \text{ (Edge Zone - Windward Roof, 20° roof angle)} \]
\[ = -0.69 \text{ (Interior Zone - Windward Roof)} \]
\[ = -0.69 \text{ (Edge Zone - Leeward Roof, 20° roof angle)} \]
\[ = -0.48 \text{ (Interior Zone - Leeward Roof)} \]

\[ GC_{pi} = \text{Internal pressure coefficient} \]
\[ = 0.18 \text{ (internal pressurization)} \]
\[ = -0.18 \text{ (internal suction)} \]
\[ = 0.68 \text{ (underside overhang pressurization)} \]
For C&C design, the "effective" load area of the component must be determined to determine the external pressure coefficients. For rectangular load areas, ASCE 7-98 allows the area to be calculated as, $A = \frac{L^2}{3}$. For this example, the C&C design loads for studs can be calculated using the following equation and inputs:

\[ p_{C&C} = q_h(GC_p) - q_h(GC_{pi}) \]

Where;

- $p_{C&C}$ = Design wind pressure, psf (C&C)
- $q_h$ = Velocity pressure, psf (120 mph, Exposure B) = 21.93psf
- $GC_p$ = External pressure coefficient
  - 0.91 (windward wall, 33 ft$^2$)
  - -1.22 (leeward wall, 3’ edge, 33 ft$^2$)
  - -1.00 (leeward wall, interior, 33 ft$^2$)
- $GC_{pi}$ = Internal pressure coefficient
  - 0.18 (internal pressurization)
  - -0.18 (internal suction)
Using the equations and values given above, loads for design of the exterior load-bearing studs can be derived. Tabulated below are design loads for the MWFRS and C&C load cases:

### MWFRS Loads

<table>
<thead>
<tr>
<th>Component</th>
<th>Internal Pressurization</th>
<th>Internal Suction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Windward Walls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge Zone</td>
<td>13.59</td>
<td>21.49</td>
</tr>
<tr>
<td>Interior Zone</td>
<td>7.68</td>
<td>15.57</td>
</tr>
<tr>
<td><strong>Leeward Walls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge Zone</td>
<td>-17.98</td>
<td>-10.09</td>
</tr>
<tr>
<td>Interior Zone</td>
<td>-13.38</td>
<td>-5.48</td>
</tr>
<tr>
<td><strong>Side Walls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End Zone</td>
<td>-14.47</td>
<td>-6.58</td>
</tr>
<tr>
<td>Interior Zone</td>
<td>-13.82</td>
<td>-5.92</td>
</tr>
<tr>
<td><strong>Wind Perpendicular to Ridge</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windward Roof</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge Zone</td>
<td>-27.41</td>
<td>-19.52</td>
</tr>
<tr>
<td>Interior Zone</td>
<td>-19.08</td>
<td>-11.18</td>
</tr>
<tr>
<td>Windward Roof Overhang</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge Zone</td>
<td>-38.38</td>
<td>-38.38</td>
</tr>
<tr>
<td>Interior Zone</td>
<td>-30.04</td>
<td>-30.04</td>
</tr>
<tr>
<td>Leeward Roof</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge Zone</td>
<td>-19.08</td>
<td>-11.18</td>
</tr>
<tr>
<td>Interior Zone</td>
<td>-14.47</td>
<td>-6.58</td>
</tr>
<tr>
<td>Leeward Roof Overhang</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge Zone</td>
<td>-19.08</td>
<td>-11.18</td>
</tr>
<tr>
<td>Interior Zone</td>
<td>-14.48</td>
<td>-6.58</td>
</tr>
</tbody>
</table>

### C&C Loads

<table>
<thead>
<tr>
<th>Component</th>
<th>Internal Pressurization</th>
<th>Internal Suction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windward Walls</td>
<td>16.01</td>
<td>23.90</td>
</tr>
<tr>
<td>Leeward Walls (Edge)</td>
<td>-30.70</td>
<td>-22.81</td>
</tr>
<tr>
<td>Leeward Walls (Interior)</td>
<td>-25.88</td>
<td>-17.98</td>
</tr>
</tbody>
</table>
After determining the design wind loads on the structure, building components and assemblies can be designed. All pertinent load combinations should be considered. In *ASCE 7-98* the following load combinations should be considered for allowable stress design:

1) Dead
2) Dead + Live + Fluid + Earth + Self Straining + (Live, or Snow or Rain)
3) Dead + Live + (Wind or 0.7*Seismic) + (Live, or Snow or Rain)
4) 0.6*Dead + Wind + Earth
5) 0.6*Dead + 0.7*Seismic + Earth

When structural effects due to two or more loads in combination with dead load, but excluding earthquake load, are investigated in the load combinations of ASCE 7-98, the combined effects due to the two or more loads multiplied by 0.75 plus effects due to dead loads shall not be less than the effects from the load combination of dead load plus the load producing the largest effects.

Under most design conditions, many of these load combinations can be dismissed. For the design of load-bearing studs in the example case, it is assumed that the building will be located in an area that receives little or no snow, that rain can not pond on the roof, and that roof live loads will not be present during a high-wind event. In addition, the studs only support the roof and ceiling loads, therefore, a special case for floor live loads need not be considered. Given these assumptions, only the following load combinations need to be considered in this example:

1) Dead
2) Dead + Live + (Wind or 0.7*Seismic) + (Live, or Snow or Rain)
3) 0.6*Dead + Wind + Earth

For this example, live and dead loads in the structure must be determined. Tabulated below are the assumed roof and ceiling live and dead loads.

<table>
<thead>
<tr>
<th></th>
<th>Dead Load</th>
<th>Live Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>10 psf</td>
<td>20 psf</td>
</tr>
<tr>
<td>Ceiling</td>
<td>5 psf</td>
<td>10 psf</td>
</tr>
<tr>
<td>Wall</td>
<td>11 psf</td>
<td>---</td>
</tr>
</tbody>
</table>
The duration of load adjustment and induced loads exerted on the studs for each load case and combination are tabulated below. Note that the loads tabulated below are for End Zone pressures, as they represent the worst case design pressure.

<table>
<thead>
<tr>
<th>Load Combination</th>
<th>C&lt;sub&gt;n&lt;/sub&gt; Adjustment</th>
<th>MWFRS Axial Load (lbs)</th>
<th>MWFRS Lateral Moment (in-lbs)</th>
<th>MWFRS Lateral Moment (in-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Dead</td>
<td>0.9</td>
<td>532 (C)</td>
<td>0 in-lbs.</td>
<td>0 in-lbs.</td>
</tr>
<tr>
<td>2) Dead + Live,</td>
<td>1.25</td>
<td>1064 (C)</td>
<td>0 in-lbs.</td>
<td>0 in-lbs.</td>
</tr>
<tr>
<td>3) Dead + Wind</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wind Perpendicular to Ridge

<table>
<thead>
<tr>
<th>Pressurization</th>
<th>MWFRS Axial Load (lbs)</th>
<th>MWFRS Lateral Moment (in-lbs)</th>
<th>MWFRS Lateral Moment (in-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windward Studs</td>
<td>464 (T)</td>
<td>2711 in-lbs.</td>
<td>3194 in-lbs.</td>
</tr>
<tr>
<td>Leeward Studs</td>
<td>324 (T)</td>
<td>3587 in-lbs.</td>
<td>6125 in-lbs.</td>
</tr>
</tbody>
</table>

Windward Studs

| Leeward Studs                       | 276 (T)                | 4287 in-lbs.                  | 4768 in-lbs.                  |

| Windward Studs                      | 113 (T)                | 2013 in-lbs.                  | 4551 in-lbs.                  |

The final step in design of the studs is to choose a member which has sufficient design capacity to resist the induced loads tabulated above. Stud walls are a hybrid system in wind engineering terminology. Studs should be designed using MWFRS pressures when considering the combined interactions of axial and bending stresses; and designed using C&C pressures when considering axial or bending stresses individually. This interpretation was developed because only MWFRS pressures provide loads which have been temporally and spatially averaged for different surfaces (MWFRS loads are considered to be time-dependent loads). Since C&C loads attempt to address a “worst case” loading on a particular element during the wind event, these loads are not intended for use when considering the interaction of loads from multiple surfaces (C&C loads are not considered to be time-dependent loads). In the above example, stud design is limited by the C&C load case. This is not uncommon and in most cases can be considered the controlling limit in wind design of loadbearing and non-loadbearing exterior studs. However, until sufficient boundary conditions are placed on this simplification, both MWFRS and C&C load cases should be considered. These assumptions were also used in the development of the *Wood Frame Construction Manual for One- and Two-Family Dwellings, 1995 High Wind Edition* (WFCM-SBC).

For this example, Hem-Fir #2 - 2x4 was chosen. The following tabulated base design values were taken from the NDS Supplement:

\[
F_b = 850 \text{ psi} \\
F_t = 525 \text{ psi} \\
F_c = 1300 \text{ psi} \\
\text{MOE} = 1,300,000 \text{ psi}
\]
Applying the appropriate adjustments and checking each load combination as follows:

1) Dead Loads

\[ f_c = \frac{C}{A} = \frac{532}{5.25} = 101 \text{ psi} \]

\[ F_c^* = F_c \cdot C_D \cdot C_F = 1300 \cdot 0.9 \cdot 1.15 = 1346 \text{ psi} \]

\[ F_c' = F_c^* \cdot C_p = 1346 \cdot 0.233 = 314 \text{ psi} \]

\[ f_c < F_c' \leq 101 \text{ psi} \leq 314 \text{ psi} \]

2) Dead + Live Loads

\[ f_c = \frac{1064}{5.25} = 203 \text{ psi} \]

\[ F_c^* = F_c \cdot C_D \cdot C_F = 1300 \cdot 1.25 \cdot 1.15 = 1869 \text{ psi} \]

\[ F_c' = F_c^* \cdot C_p = 1869 \cdot 0.171 = 320 \text{ psi} \]

\[ f_c < F_c' \leq 203 \text{ psi} \leq 320 \text{ psi} \]

3) Dead + Wind Loads (Wind Perpendicular to Ridge - Windward Studs)

MWFRS Loads

\[ f_t = \frac{T}{A} = \frac{464}{5.25} = 88 \text{ psi} \]

\[ F_t' = F_t \cdot C_D \cdot C_F = 525 \cdot 1.6 \cdot 1.5 = 1260 \text{ psi} \]

\[ f_b = \frac{M}{S} = \frac{2711}{3.06} = 885 \text{ psi} \]

\[ F_b^* = F_b \cdot C_D \cdot C_F \cdot C_r = 850 \cdot 1.6 \cdot 1.5 \cdot 1.5 = 3060 \text{ psi} \]

\[ F_b'' = F_b \cdot C_D \cdot C_F \cdot C_r = 850 \cdot 1.6 \cdot 1.5 \cdot 1.5 = 3060 \text{ psi} \]

\[ \frac{f_t}{F_t'} + \frac{f_b}{F_b^*} \leq 1.0 \]

\[ 88/1260 + 885/3060 = 0.36 \leq 1.0 \]

\[ \frac{(f_b - f_t)}{F_b''} \leq 1.0 \]

\[ 885-88)/3060 = 0.26 \leq 1.0 \]

C&C Loads

\[ f_b = \frac{M}{S} = \frac{3194}{3.06} = 1044 \text{ psi} \]

\[ F_b' = F_b \cdot C_D \cdot C_F \cdot C_r = 850 \cdot 1.6 \cdot 1.5 \cdot 1.5 = 3060 \text{ psi} \]

\[ f_b \leq F_b' \leq 1044 \text{ psi} \leq 3060 \text{ psi} \]
The other cases considered under load combination 3, dead plus wind, can be calculated in a similar manner. Tabulated below are the load/resistance ratios for each load combination and load case.

<table>
<thead>
<tr>
<th>Load Combination</th>
<th>MWFRS Load/Resistance</th>
<th>C&amp;C Load/Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Dead</td>
<td>0.32</td>
<td>---</td>
</tr>
<tr>
<td>2) Dead + Live</td>
<td>0.63</td>
<td>---</td>
</tr>
<tr>
<td>3) Dead + Wind</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Perpendicular to Ridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressurization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windward Studs</td>
<td>0.36</td>
<td>0.34</td>
</tr>
<tr>
<td>Leeward Studs</td>
<td>0.43</td>
<td>0.65</td>
</tr>
<tr>
<td>Suction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windward Studs</td>
<td>0.50</td>
<td>0.51</td>
</tr>
<tr>
<td>Leeward Studs</td>
<td>0.23</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Summary
Determination of wind loads and material resistance must be considered together. Adjustments of reference wind conditions to extreme-value peak gusts require designers to make similar adjustments to design properties to ensure equivalent and economic designs.

Major structural elements should be designed for MWFRS loads and secondary cladding elements should be designed for C&C loads. Components and assemblies which receive loads both directly and as part of the MWFRS should be checked for MWFRS and C&C loads independently.

In cases where components and assemblies must be designed for lateral wind loads the controlling design case often will be wind acting alone. However, each load combination should be considered thoroughly before being dismissed.

As the wind load provisions in ASCE 7-98 and the Building Codes continue to change, the wood industry must keep abreast of these changes. Efforts must be made to improve engineering knowledge and procedures to ensure adequate design of structures in high wind areas.

REFERENCES


Updates and Errata
While every precaution has been taken to ensure the accuracy of this document, errors may have occurred during development. Updates or Errata are posted to the American Wood Council website at www.awc.org. Technical inquiries may be addressed to awcinfo@afandpa.org.

The American Wood Council (AWC) is the wood products division of the American Forest & Paper Association (AF&PA). AF&PA is the national trade association of the forest, paper, and wood products industry, representing member companies engaged in growing, harvesting, and processing wood and wood fiber; manufacturing pulp, paper, and paperboard products from both virgin and recycled fiber; and producing engineered and traditional wood products. For more information see www.afandpa.org.

American Wood Council
Engineered and Traditional Wood Products

AWC Mission Statement
To increase the use of wood by assuring the broad regulatory acceptance of wood products, developing design tools and guidelines for wood construction, and influencing the development of public policies affecting the use of wood products.