WFCM

WOOD FRAME CONSTRUCTION MANUAL

WORKBOOK

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

INTERNATIONAL CODE COUNCIL®

AF&PA®

American Forest & Paper Association
American Wood Council

In Cooperation with the
International Code Council®

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FOREWORD

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.

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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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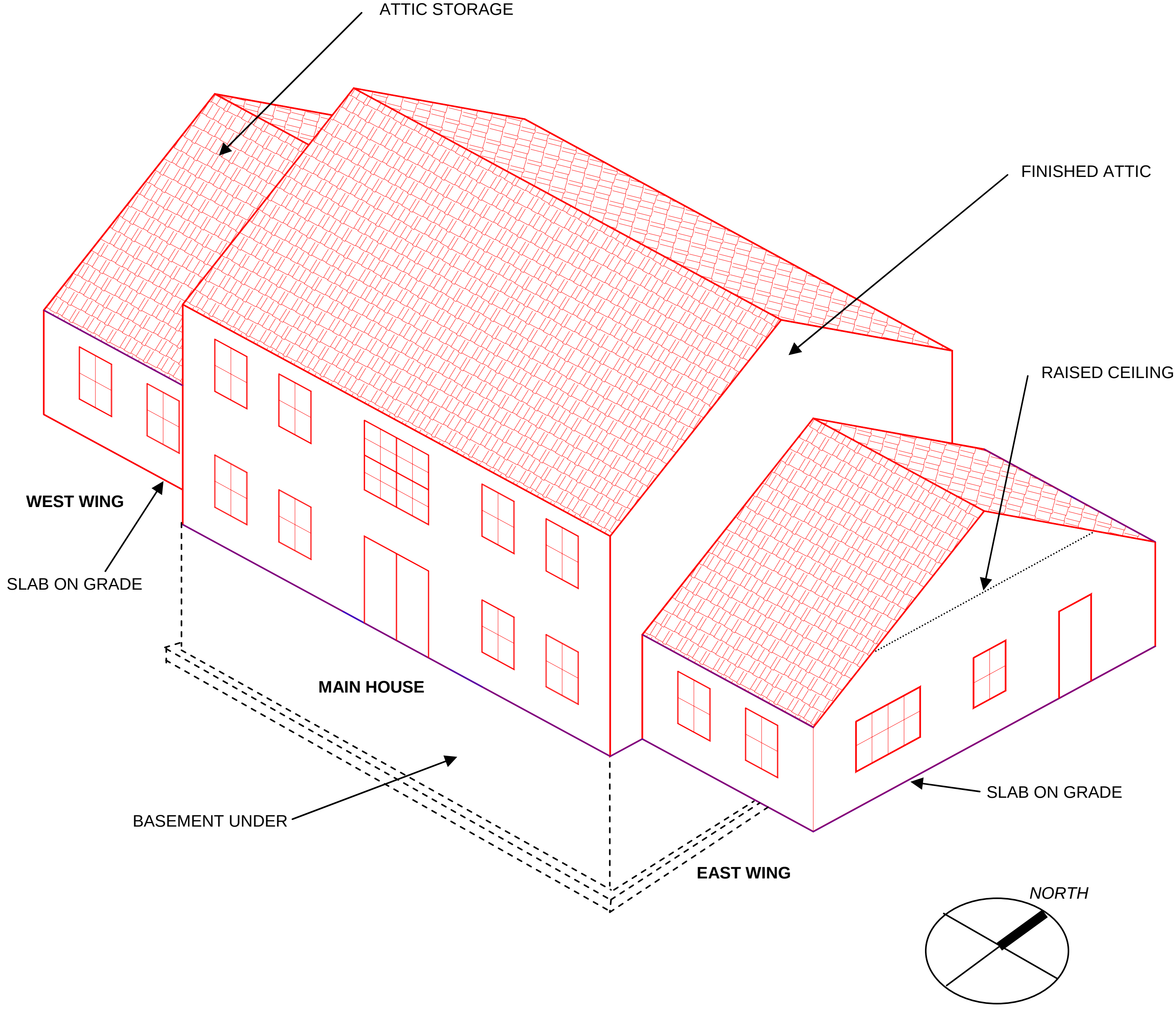
Job: WFCM Workbook Description: General Information

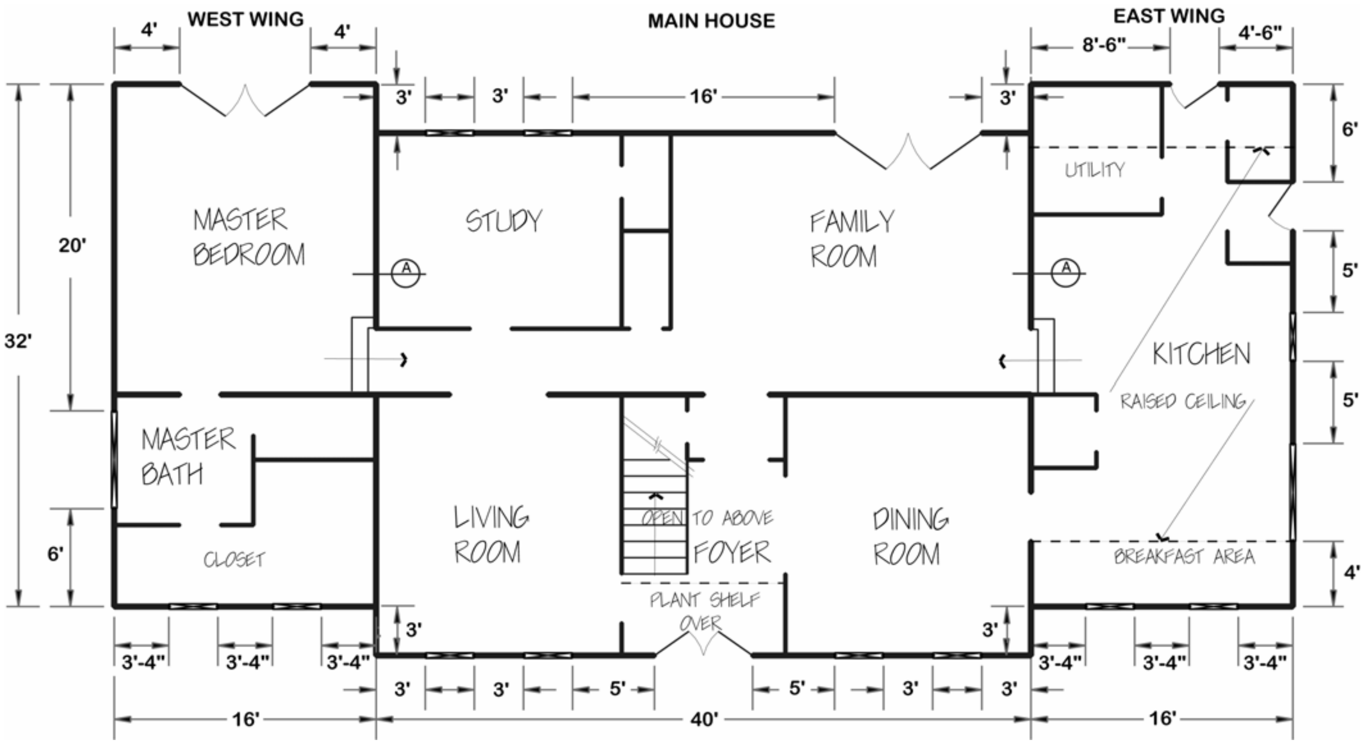
BUILDING DESCRIPTION



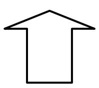
Option 1: Design as Separate Structures

Job: WFCM Workbook **Description:** General Information

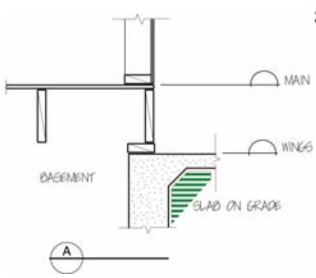
BUILDING DESCRIPTION

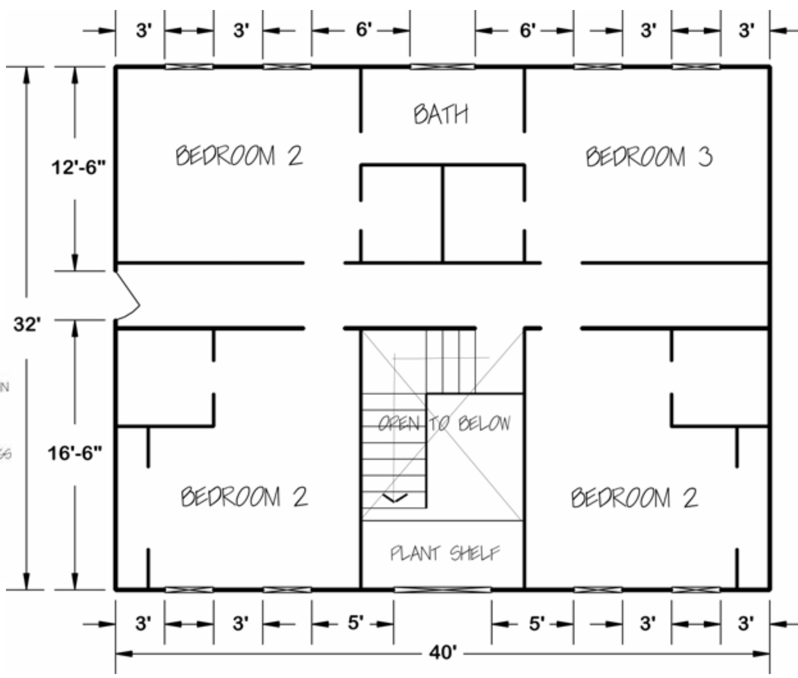


Bottom Floor Plan



North





Top Floor Plan

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"

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

Job: WFCM Workbook **Description: General Information**

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 B = 120 mph

Seismic:

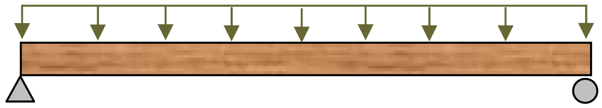
Seismic Design Category (SDC) = D1

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

$= 1.5(0.7)P_g\ C_e\ C_t\ I$

$= (1.5)(0.7)(30)(1.0)(1.1)(1.0)$

= 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/Δ = 240

Roof Rafters with no Ceiling Attached L/Δ = 180

Floor Joists L/Δ = 360

Job: WFCM Workbook **Description:** General Information

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).

Attribute		Limitation	Design Case	✓
BUILDING DIMENSIONS				
Number of Stories	maximum	3	3[1]	✓
Roof Slope	minimum	Flat	12:12	✓
	maximum	12:12	12:12	✓
Mean Roof Height (MRH)	maximum	33'	29'	✓
Building Dimension (L or W)	minimum		16'[2]	✓
	maximum	80'	32'[2]	✓
Building Aspect Ratio (L/W)	minimum	1:4	1:2	✓
	maximum	4:1	2:1	✓

[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).

Job: WFCM Workbook **Description:** General Information

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).

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

[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.

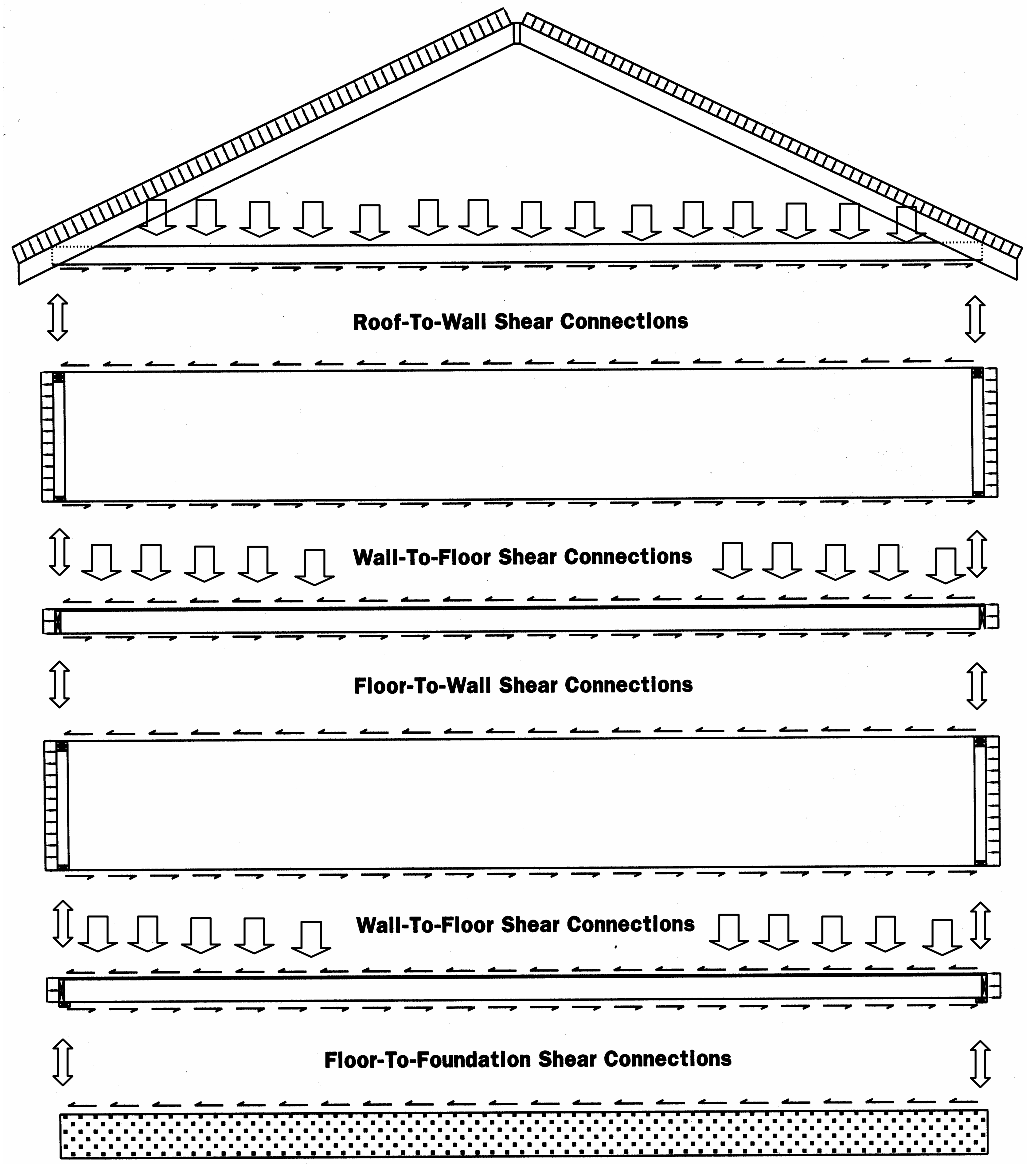
Job: WFCM Workbook **Description: General Information**

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



Job: WFCM Workbook **Description:** General Information

CHECKLIST

The following checklist is used to assist with the evaluation of a structure in accordance with *WFCM* Chapter 3 prescriptive provisions. Items are keyed to sections of the *WFCM* Chapter 3 to allow a systematic evaluation of the structure. Blank checklists are reproduced in the Appendix of the workbook.

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 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? ✓

Job: WFCM Workbook **Description:** General Information

WFCM 3.3 FLOOR SYSTEMS CHECKLIST

3.3.1 Wood Joist Systems

3.3.1.1 Floor Joists .... Ok? ✓

3.3.1.1.1 Notching and Boring .... Ok? ✓

3.3.1.2 Bearing .... Ok? ✓

3.3.1.3 End Restraint .... Ok? ✓

3.3.1.4 Lateral Stability .... Ok? ✓

3.3.1.5 Single or Continuous Floor Joists

3.3.1.5.1 Supporting Loadbearing Walls .... Ok? ✓

3.3.1.5.2 Supporting Non-Loadbearing Walls .... Ok? ✓

3.3.1.5.3 Supporting Concentrated Loads .... Ok? ✓

3.3.1.6 Cantilevered Floor Joists

3.3.1.6.1 Supporting Loadbearing Walls .... Ok? ✓

3.3.1.6.2 Supporting Non-Loadbearing Walls .... Ok? ✓

3.3.1.7 Floor Diaphragm Openings .... Ok? ✓

3.3.2 Wood I-Joist Systems .... Ok? ✓

3.3.3 Wood Floor Truss Systems .... Ok? ✓

3.3.4 Floor Sheathing

3.3.4.1 Sheathing Spans .... Ok? ✓

3.3.4.2 Sheathing Edge Support .... Ok? ✓

3.3.5 Floor Diaphragm Bracing .... Ok? ✓

Job: WFCM Workbook Description: General Information

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? ✓

Job: WFCM Workbook **Description: General Information**

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? ✓

Job: WFCM Workbook Description: General Information

Notes

ROOF STORY DESIGN

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Ceiling Framing 23

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Connections 24

East Wing 25

Roof Framing 26

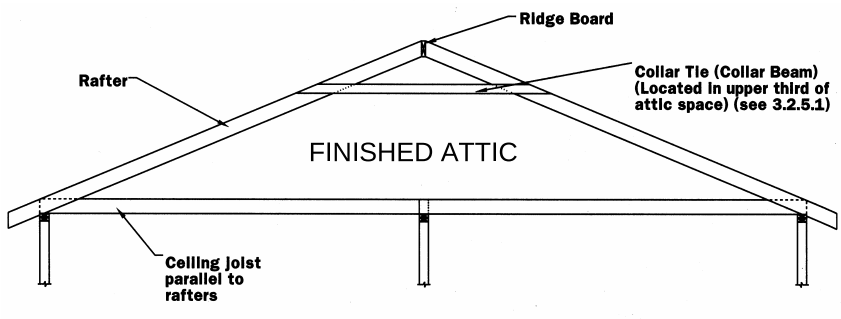
Ceiling Framing 27

Roof and Ceiling Sheathing.....................28

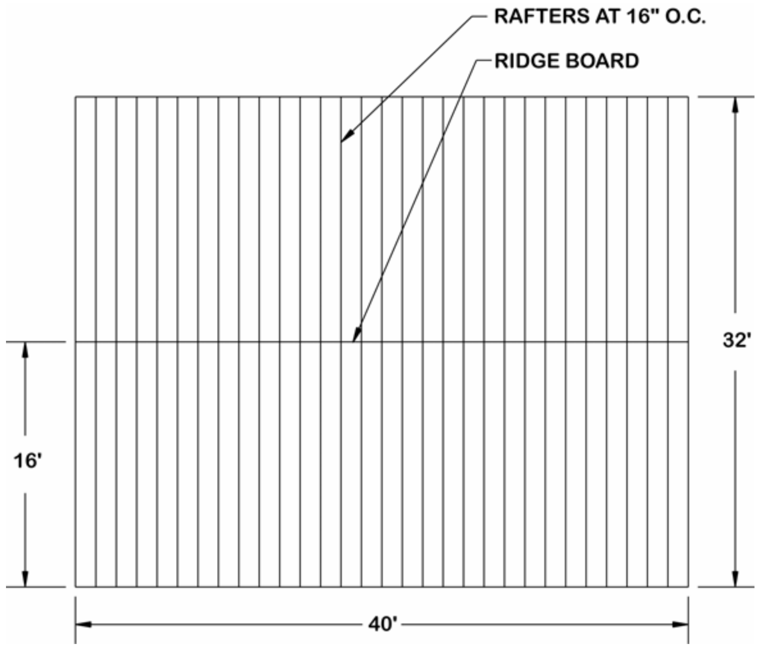
Connections 28

Job: WFCM Workbook Description: Main House

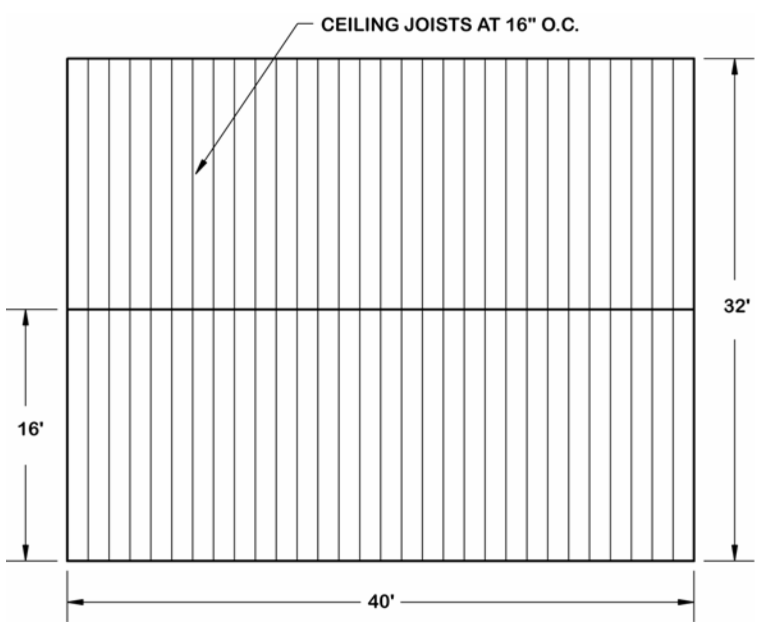
Roof and Ceiling Framing Details



Cross Section

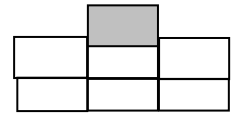


Roof Framing



Ceiling Framing

Job: **WFCM Workbook** **Description:** **Main House**



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 (1)
Wind Factor (Footnote 2): 0.71 (2)
Sloped Roof Adjustment (Footnote 3): .... 1.17 (3) ASCE LIVE LOAD REDUCTION
Selection of Species, Grade, Size, and Spacing: (Table 3.26B & C)

Species	Douglas Fir-Larch		Hem-Fir		Southern Pine		Spruce-Pine-Fir		
Spacing	16"		16"		16"		16"		
Grade	#2		#2		#2		#2		
(4) Table 3.26B Span	2x6	14'-1"	2x8	17'-3"	2x6	14'-1"	2x8	17'-9"	
Live Load Span (4)x(1)x(3)	14.1(1.0)(1.17)= 16'-6" ok		17.3(1.0)(1.17)= 20'-2" ok		14.1(1.0)(1.17)= 16'-6" ok		17.75(1.0)(1.17)= 20'-9" ok		TRIAL AND ERROR
(5) Table 3.26B Span	2x10	22'-6"	2x10	21'-11"	2x10	23'-2"	2x10	22'-3"	
Wind Load Span (5)x(2)x(3)	22.5(0.71)(1.17)= 18'-8" ok		21.9(0.71)(1.17)= 18'-2" ok		23.17(0.71)(1.17)= 19'-3" ok		22.25(0.71)(1.17)= 18'-6" ok		TRIAL AND ERROR
(6) Table 3.26D Span	**2x10**	17'-9"	**2x10**	17'-3"	**2x10**	18'-3"	**2x10**	17'-6"	
Snow Load Span (6)x(1)	17.75(1.0)= **17'-9" ok**		17.25(1.0)= **17'-3" ok**		18.25(1.0)= **18'-3" ok**		17.5(1.0)= **17'-6" ok**		TRIAL AND ERROR

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

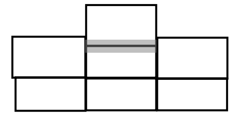
Ridge Beams (WFCM 3.5.1.4)

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

Job: WFCM Workbook **Description:** Main House



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.

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

Specie	**Douglas Fir-Larch**	**Hem-Fir**	**Southern Pine**	**Spruce-Pine-Fir**
Spacing	**16**	**16**	**16**	**16**
Grade	**#2**	**#2**	**#2**	**#2**
Size	**2x10**	**2x10**	**2x10**	**2x10**
Maximum Span	17'-5"	16'-10"	18'-0"	17'-2"

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.

Job: WFCM Workbook **Description:** Main House

Roof and Ceiling Sheathing

Sheathing (WFCM 3.5.4.1)

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

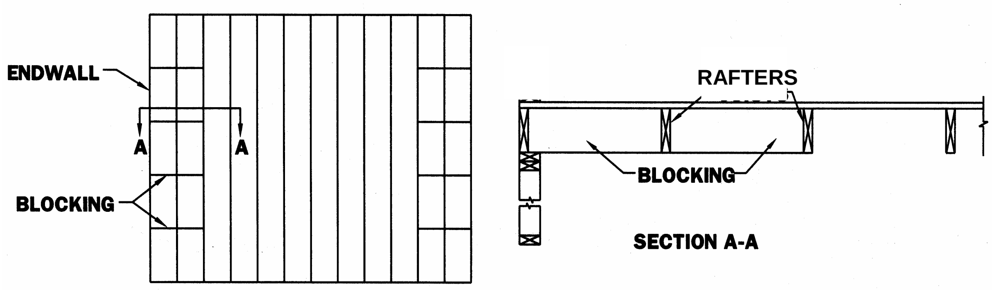
Ground Snow Load .... 30 psf
Live Load .... 20 psf
Dead Load .... 10 psf
Three second gust windspeed: .... 120 mph Exp. B

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



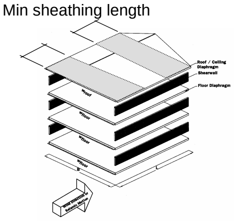
OR

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

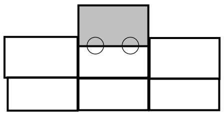
Tabulated Minimum Length of Attic Floor/Ceiling Diaphragm: .... 10.67 ft. interpolated
Bracing One Gable End Adjustment (Table 3.15 Footnote 1): 1.0
Wall Height Adjustment (Table 3.15 Footnote 3): 1.125
Ceiling Framing Spacing Adjustment (Table 3.15 Footnote 5): .... 1.0 WSP USED. NOT GYPSUM

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.

Job: WFCM Workbook **Description:** Main House



Connections

Lateral Framing and Shear Connections (WFCM 3.2.1)

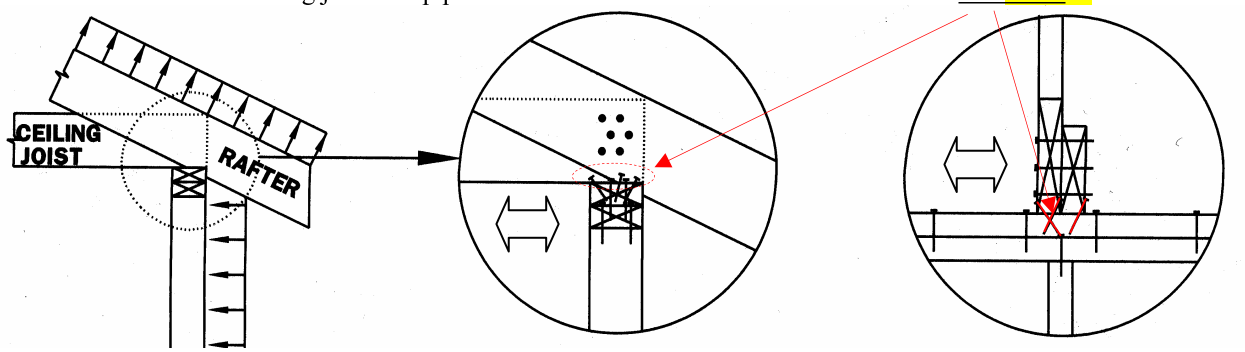
Roof Assembly to Wall Assembly (WFCM 3.2.1.2)

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** *



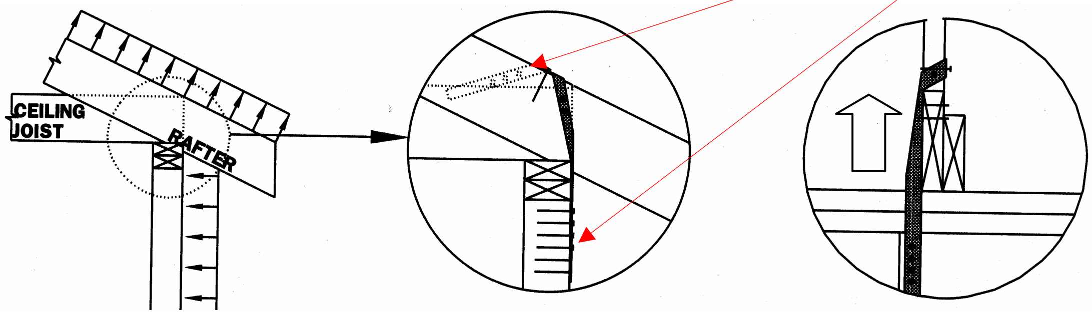
Uplift Connections (WFCM 3.2.2)

Roof Assembly to Wall Assembly (WFCM 3.2.2.1)

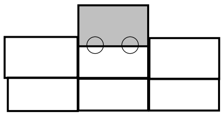
Choose Roof to Wall Uplift Strap Connection from Table 3.4B (p. 151)

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

[1] calculated using 416 lbs uplift (below) divided by 127 lb/nail per *WFCM Supplement* Table 6A.

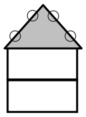


Job: WFCM Workbook **Description:** Main House

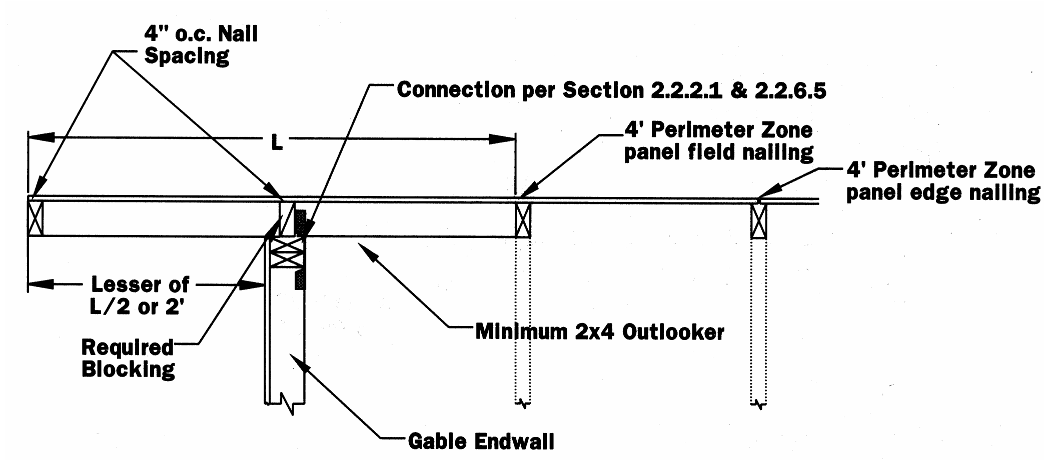


Connections (cont'd)

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



Wind	**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 psf – 15 psf) x 8' x 16" /12" / ' = 32 lbs]	-32 lbs	
	Non-Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4C, page 152)		496 lbs
	Overhang Multiplier (Table 3.4C, Footnote 2) [(2' + OH) / 4']^2 OH = 2 '	1.0	1.0
	Zone 2 Multiplier (Table 3.4C, Footnote 3)		1.0
	Required Minimum **Uplift** Capacity of proprietary connector = Tabulated minimum capacity x Adjustments - Reduction	**409 lbs**	**496 lbs**
	Required Minimum **Lateral** Capacity	**210 lbs**	**210 lbs**
	Required Minimum **Shear Parallel to Ridge** Capacity	**74 lbs**	**74 lbs**
	Required Minimum **Shear Perpendicular to Ridge** Capacity	**116 lbs**	**116 lbs**



Job: WFCM Workbook **Description:** Main House

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

	Nail Spacing 8d Common Nails	
Location	Edges	Field
4' Perimeter Edge Zone	6	6
Interior Zones	6	12
Gable Endwall Rake with Overhang	4*	4*

* 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)

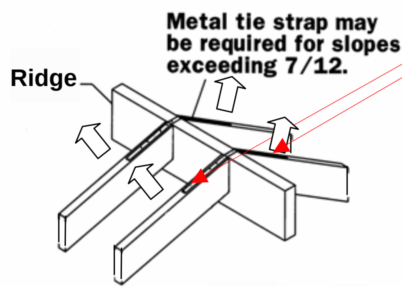
For a clean finished ceiling line, rather than using collar ties to resist upward ridge separation, choose Ridge Tension Strap Connection from Table 3.6A (p. 156)

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

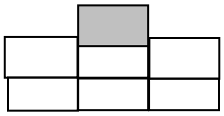
Roof Pitch: 12:12
Roof Span:........ 32 ft.

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**:
Tabulated number of nails x Applicable adjustment factors: .... **4** *



Job: WFCM Workbook **Description:** Main House



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

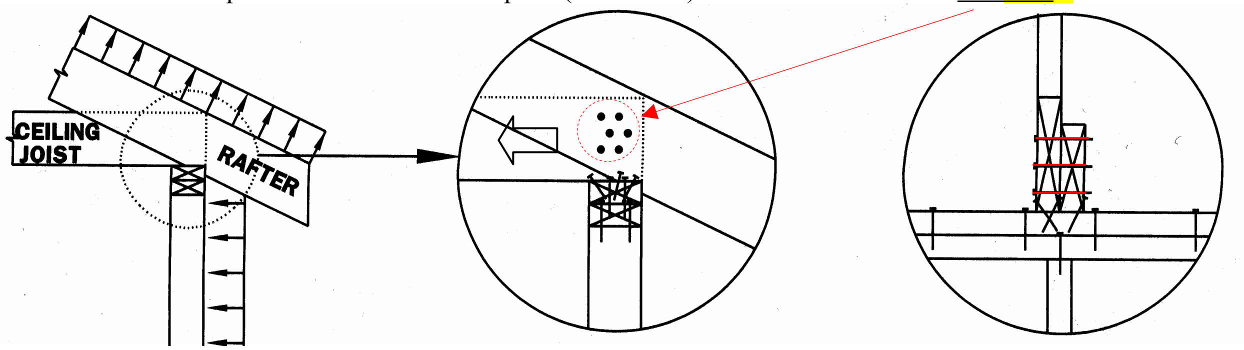
Table 3.1 Nailing Schedule

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

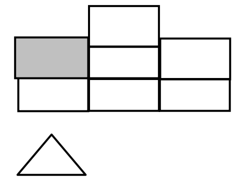
Required minimum capacity of proprietary connector:
Tabulated minimum capacity x Applicable adjustment factors: .... **353** lbs

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

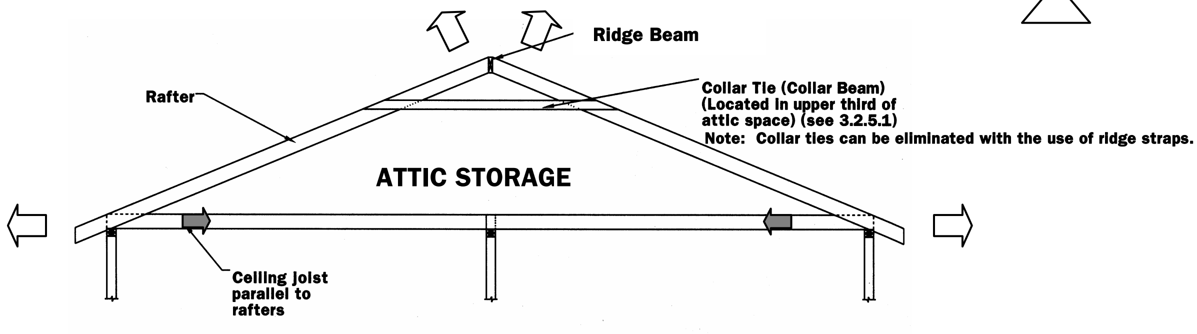
OR

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

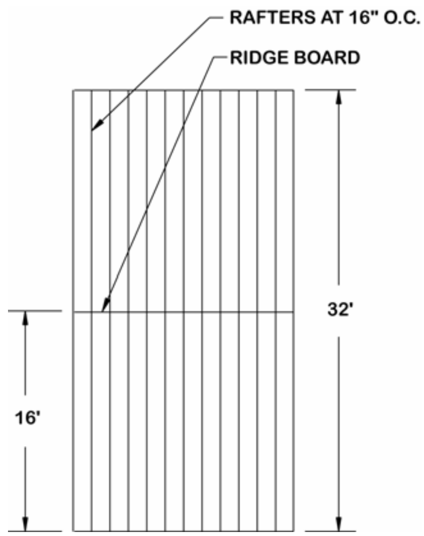
Job: WFCM Workbook **Description:** West Wing



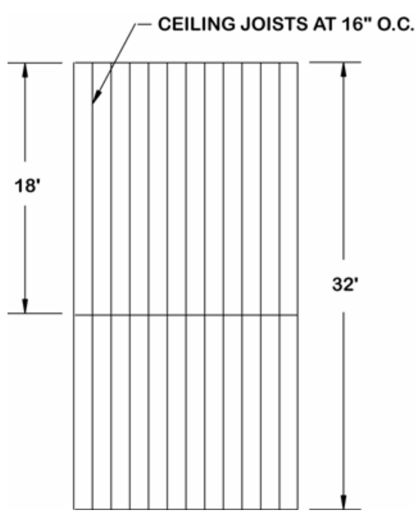
Roof and Ceiling Framing Details



Cross Section

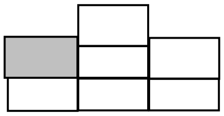


Gable Roof Framing



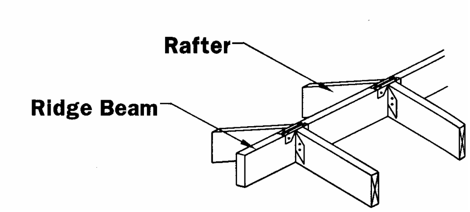
Ceiling Framing

Job: WFCM Workbook **Description:** West Wing



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)

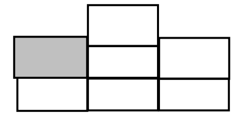
Live Load: .... 30 psf
Dead Load: .... 10 psf
Joist Vertical Displacement L/Δ: 360

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

Selection of Specie, Grade, Size, and Spacing:

Specie	**Douglas Fir-Larch**	**Hem-Fir**	**Southern Pine**	**Spruce-Pine-Fir**
Spacing	**16**	**16**	**16**	**16**
Grade	**#1**	**SS**	**#2**	**#2**
Size	**2x10**	**2x10**	**2x10**	**2x12**
Tabulated Spans	18'-5"	18'-0"	18'-0"	19'-11"

Job: WFCM Workbook **Description:** West Wing



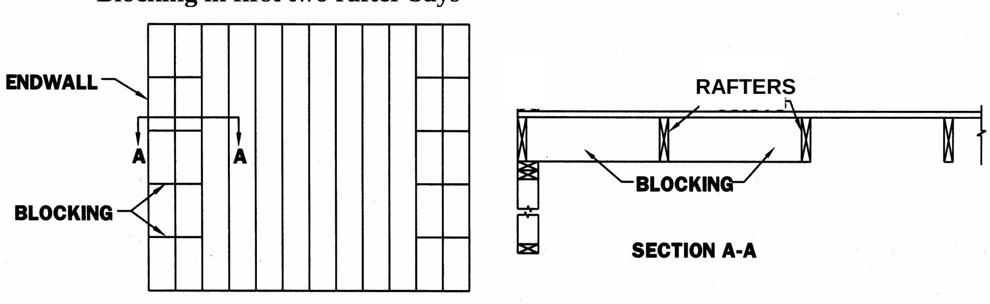
Roof/Ceiling Sheathing and Connections

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

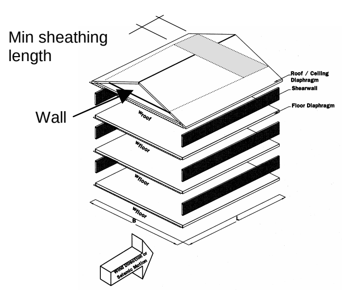


OR

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

Three second gust windspeed:	120 mph Exp.B	
Roof Pitch:	12:12	
Diaphragm Span:	32 ft.	
Building Length:	16 ft.	
Sheathing Type (wood structural panels or gypsum):	**WSP**	GYP
Tabulated Minimum Length of Attic Floor/Ceiling Diaphragm (interpolated):	10.7 ft.	30.7 ft.
Bracing One Gable End Adjustment (Footnote 1):	0.84	0.84
Wall Height Adjustment (Footnote 3): (9'/8')	1.125	1.125
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:	**10.1** ft.	22.6 ft.

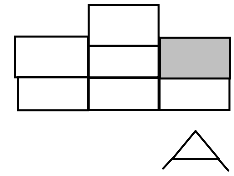
Structural sheathing is required for the ceiling diaphragm, since 22.6' required length of gypsum diaphragm is greater than the 16' length of ceiling on the west wing. If full height studs to the roof planes are used, a ceiling diaphragm will not be needed.



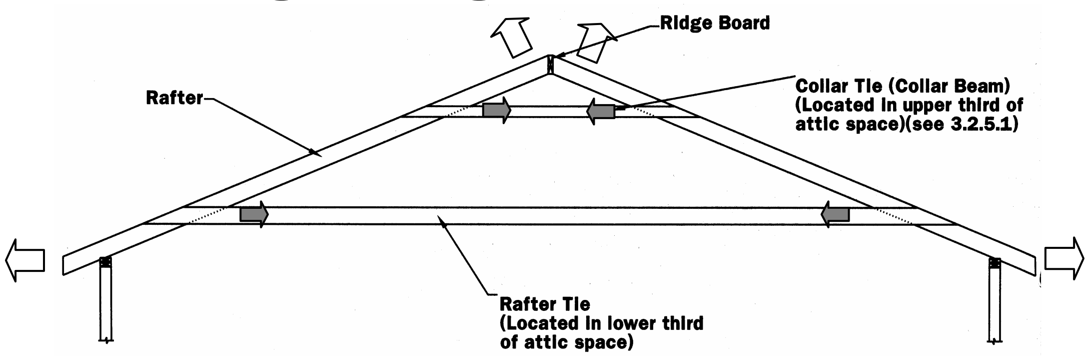
Connections

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

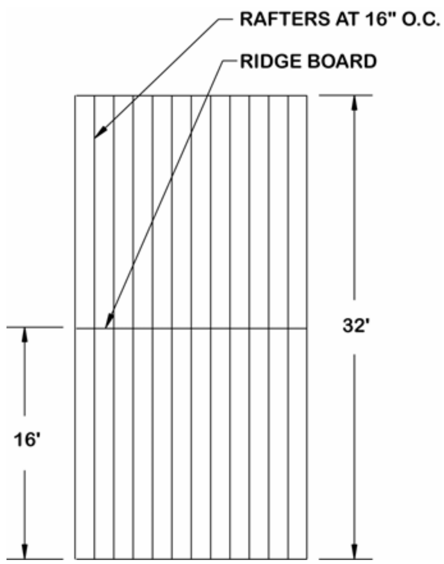
Job: WFCM Workbook **Description:** East Wing



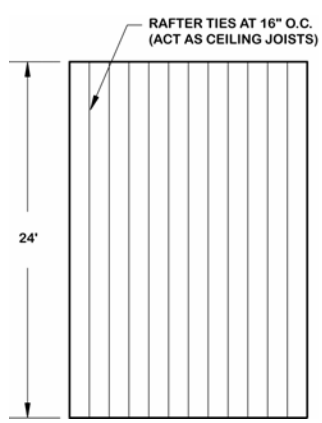
Roof and Ceiling Framing Details



Cross Section

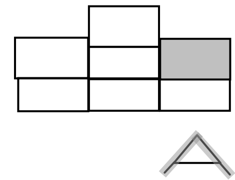


Gable Roof Framing



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 ①
Wind Factor (Footnote 2): .... 0.71 ②
Sloped Roof Adjustment (Footnote 3): .... 1.17 ③ ASCE LIVE LOAD REDUCTION

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

Species	Douglas Fir-Larch		Hem-Fir		Southern Pine		Spruce-Pine-Fir		
Spacing	16"		16"		16"		16"		
Grade	#2		#2		#2		#2		
④ Table 3.26B Span	2x8	18'-5"	2x10	21'-11"	2x8	18'-6"	2x10	22'-3"	
Live Load Span ④X①X③	18.4(0.76)(1.17)= 16'-4" ok		21.9(0.76)(1.17)= 19'-5" ok		18.5(0.76)(1.17)= 16'-5" ok		22.25(0.76)(1.17)= 19'-9" ok		TRIAL AND ERROR
⑤ Table 3.26B Span	2x10	22'-6"	2x10	21'-11"	2x10	23'-2"	2x10	22'-3"	
Wind Load Span ⑤X②X③	22.5(0.71)(1.17)= 18'-8" ok		21.9(0.71)(1.17)= 18'-2" ok		23.2(0.71)(1.17)= 19'-3" ok		22.25(0.71)(1.17)= 18'-6" ok		TRIAL AND ERROR
⑥ WoodWorks® Span*	**2x12 #1**	21'-6"	**2x12 SS**	23'-4"	**2x12 #2**	21'-4"	**2x12 SS**	22'-10"	
Snow Load Span ⑥X①	21.5(0.76)= **16'-4" ok**		23.33(0.76)= **17'-9" ok**		21.33(0.76)= **16'-2" ok**		22.8(0.76)= **17'-4" ok**		TRIAL AND ERROR

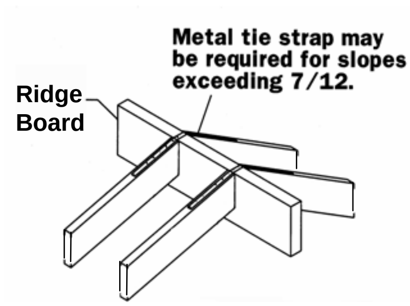
*Spans from WoodWorks Sizer since tabulated values are not given in the WFCM for spans greater than 20 feet.
Note: as an energy consideration, 2x10 rafters might be a minimum requirement for batt insulation.

Ridge Boards (WFCM 3.5.1.4)

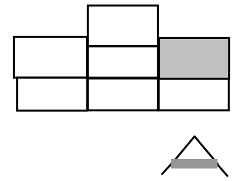
Since thrust is accounted for in rafter selection, per 3.5.1.4 exception use: 15¾” deep Ridge Board

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:

Size	2x8	2x10	
Required E	1,800,000	900,000	psi
Required F_b	1,344	847	psi

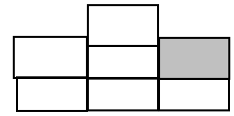
Select Grade from *WFCM* Table 4A and 4B based on required E and F_b above:

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

* 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.

Job: WFCM Workbook **Description:** East Wing



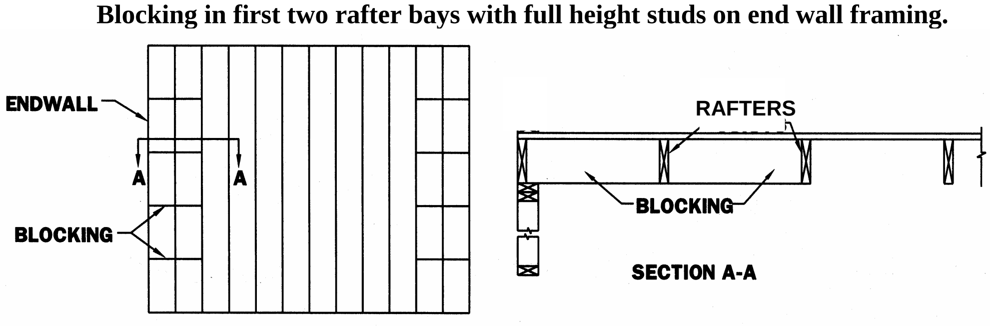
Roof and Ceiling Sheathing

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

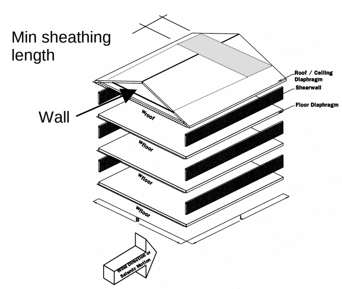
Bracing Gable Endwall with Attic Floor/Ceiling Sheathing Length from Table 3.15 (p. 165) with Gable Brace Figure 3.7a.

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

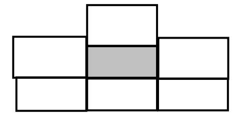
Wall Sheathing 32

Floor Framing 36

Floor Sheathing 36

Connections 37

Job: WFCM Workbook **Description:** Main House



Wall Framing

Wall Studs (WFCM 3.4.1.1)

....**Loadbearing**

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)

Specie	Douglas Fir-Larch	Hem-Fir	Southern Pine	Spruce-Pine-Fir
Spacing, in. o.c.	**16**	**16**	**16**	**16**
Grade	**Stud**	**Stud**	**Stud**	**Stud**
Size	**2x4**	**2x4**	**2x4**	**2x4**
Maximum Length (Wind)	10'-5" *	10'-2" *	10'-10" *	10'-2" *
Maximum Length (Dead and Live Loads)	10'-0"	10'-0"	10'-0"	10'-0"

* 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.

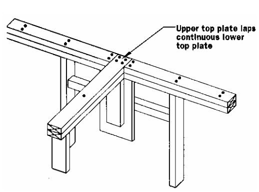
....**Non-Loadbearing**

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)

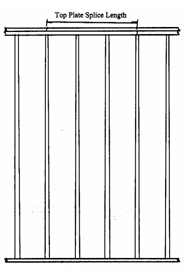


Building Dimension: .... 32 ft.

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)

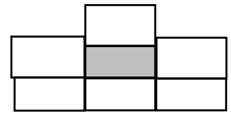


Building Dimension: .... 40 ft.

Tabulated Minimum Splice Length:.. **8** ft.

Connection: top plate – to – top plate:.. **2-16d** nails per ft.

Job: WFCM Workbook **Description: Main House**



Wall Framing (cont'd)

.... Foyer Window

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

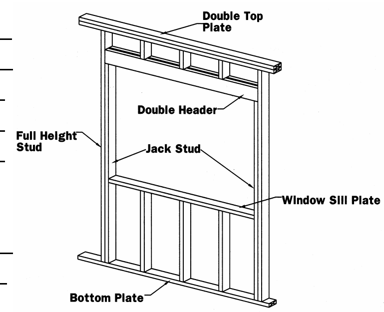


Table 3.23A (p. 192)

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:
Gravity loads control: **2-Southern Pine #2 2x12's**
Number of **Jack Studs** Required (gravity controlled): **3***
Number of **Full Height (King) Studs** Required (gravity controlled):..... **3**

(same species / grade as Loadbearing Studs (WFCM 3.4.1.4.2))

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

Job: WFCM Workbook **Description:** Main House

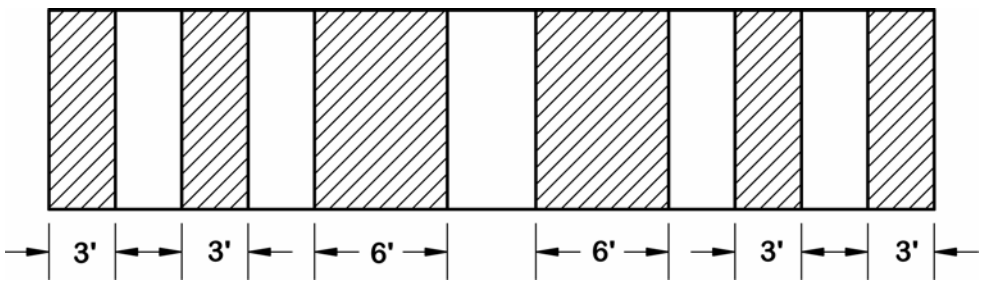
Wall Sheathing

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

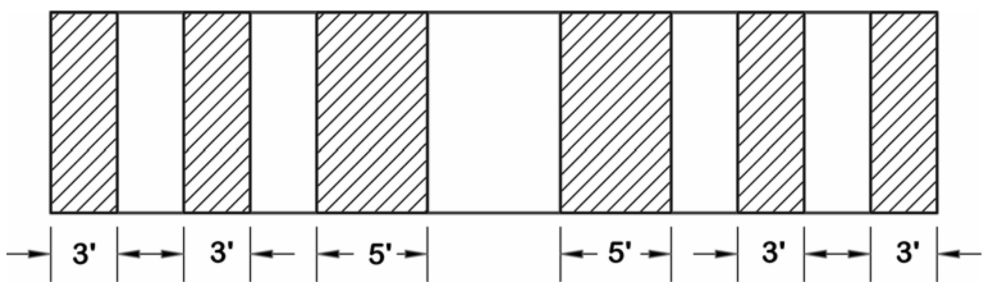
Sheathing Type (wood structural panels, fiberboard, board, hardboard): .... WSP
Direction Across Studs (Short or Long):.. Short
Stud Spacing: .... 16 in.
Minimum Panel Thickness:... 3/8 in.
Shear wall minimum panel thickness (WFCM 3.4.4.2): .... 7/16 in.



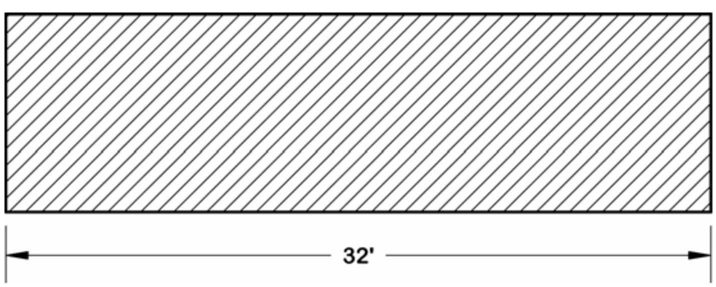
= 24 ft. long = L_{FH}

North Elevation

= 22 ft. long = L_{FH}



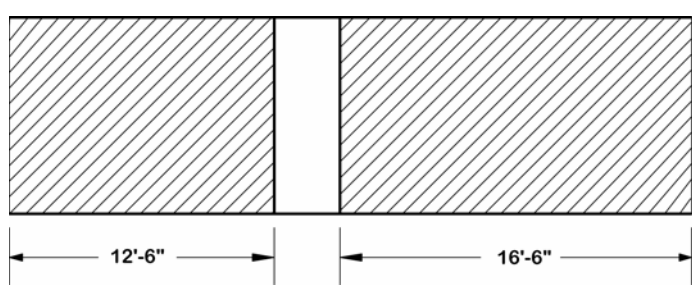
South Elevation



= 32 ft. long = L_{FH}

East Elevation

= 29 ft. long = L_{FH}



West Elevation

Job: WFCM Workbook Description: Main House

Wall Sheathing (cont'd)

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

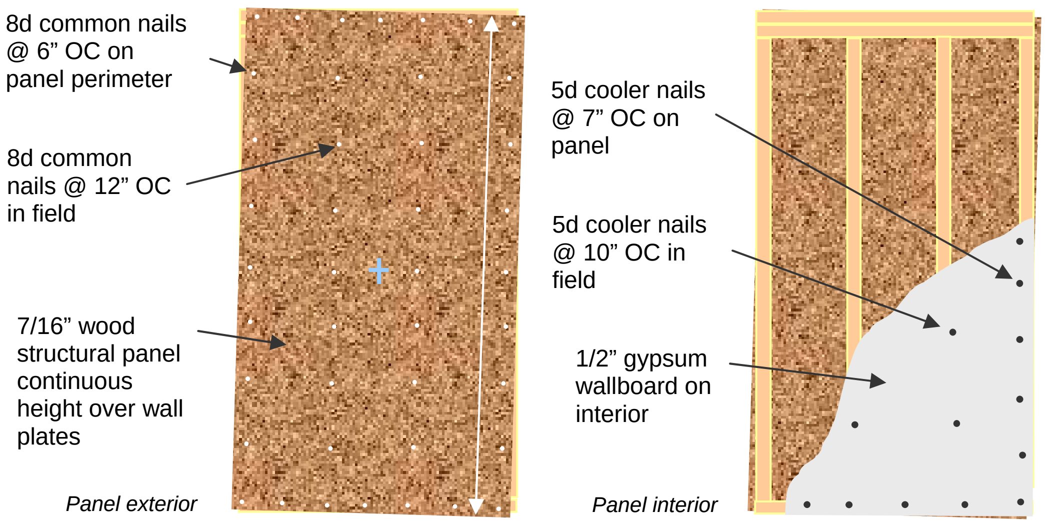
Choose Exterior Segmented (Type I) Shear Wall Length from Table 3.17A-D (pp. 169-174)

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.

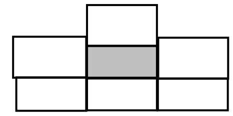
Seismic Design Category: D1
Maximum shear wall aspect ratio for seismic (Table 3.17D Footnote 3): 2:1
Minimum shear wall segment length (Wall height/aspect ratio): .... 4.5 ft.

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.



WFCM 3.4.4.2 "Standard" Shear Wall

Job: WFCM Workbook **Description:** Main House



Wall Sheathing (cont'd)

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

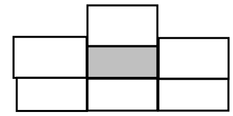
STEPS			Load Parallel to Ridge		Load Perpendicular to Ridge		
	Building Wall Elevation		**North**	**South**	**East**	**West**	
	Length of Main Building		40'	40'	32'	32'	
1	**Seismic**	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	20'[1]	18'[1]	32'	29'	HAVE
2		Tabulated Minimum Length Full Height Sheathing for **Seismic** Loads per Table 3.17C (L_s) C_1 = 57 C_2 = 15 L_{max} = 40' L_{min} = 32'	19.5'[2]	19.5'[2]	19.5'[2]	19.5'[2]	
3		WSP Perimeter Edge Nail Spacing – **Seismic** (WFCM 3.4.4.2 + 3.4.4.2.1)	4"	4"	6"	6"	PICK
4		Shear wall Adjustment per Table 3.17D (C_{swa})	0.69	0.69	1.0	1.0	
5		Min. Length Full Ht. Sheathing–Segmented **Seismic** ($L_{TypeI\text{-}S} = L_s(C_{swa})$)	**13.5'**	**13.5'**	19.5'	19.5'	NEED
	$L_{TypeI\text{-}S} < L_{FHS}$		**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**	
1	**Wind**	Effective Length of Full Height Sheathing (L_{FH})	24'	22'	32'	29'	HAVE
2		Tabulated Minimum Length Full Height Sheathing for **Wind** Loads per Table 3.17B and 3.17A (L_w)	10.6'	10.6'	17.5'	17.5'	
3		WSP Perimeter Edge Nail Spacing – **Wind** (WFCM 3.4.4.2)	6"	6"	6"	6"	PICK
4		Shear wall Adjustment per Table 3.17D (C_{swa})	1.3[3]	1.3[3]	1.3[3]	1.3[3]	
5		Wall Height Adjustment (Table 3.17A&B Footnote 2) (C_{WH}=9'/8')	1.125	1.125	1.125	1.125	
6		Min. Length Full Ht. Sheathing–Segmented **Wind** ($L_{TypeI\text{-}W}=L_w(C_{WH})(C_{swa})$)	15.5'	15.5'	**25.6'**	**25.6'**	NEED
	$L_{TypeI\text{-}W} < L_{FH}$		**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**	

[1]Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic.
There are four 3' segments in the south wall, so 12' (0.67) = 8' of additional full height sheathing (L_{FHS}) can be added for shear wall capacity for the south wall (L_{FHS} = 18'). Similarly, an additional 8' can be added to the North wall (L_{FHS} = 20').
[2]From Table 3.17C: C_1=57, C_2=15, L_{max}=40', L_{min}=32' so req'd sheathing = [57+(0.25)15]32/100=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

Job: WFCM Workbook **Description:** Main House



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)

			Parallel to Ridge		Perpendicular to Ridge	
		Building Wall Elevation	**North**	**South**	**East**	**West**
		Wall Height	9'	9'	9'	9'
		Max. Unrestrained Opening Height	6'-0"	4'-6"	0	7'-6"
		Actual Length of Full Height Sheathing (L_{FH})	24'	22'	32'	29'
HAVE	**Seismic**	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	16'[1]	14.7'[1]	32'	29'
		Length of Wall (L_{Wall})	40'	40'	32'	32'
		Percent Full Height Sheathing (L_{FH} / L_{Wall})	60%	55%	100%	91%
		Tabulated Min. Length Full Ht. Sheathing - Segmented **Seismic** ($L_{TypeI-S}$)	13.5'	13.5'	19.5'	19.5'
		Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.25	1.18	1.00	1.06
NEED		Min. Length Full Ht. Sheathing - Perforated Seismic ($L_{TypeII-S} = L_{TypeI-S} (C_L)$)	**16.9'**	**15.9'**	19.5'	20.7'
		$L_{Type II} < L_{FHS}$	**NG**	**NG**	**Ok?✓**	**Ok?✓**
HAVE	**Wind**	Actual Length of Full Height Sheathing (L_{FH})	24'	22'	32'	29'
		Length of Wall (L_{Wall})	40'	40'	32'	32'
		Percent Full Height Sheathing (L_{FH} / L_{Wall})	60%	55%	100%	91%
		Tabulated Min. Length Full Height Sheathing - Segmented **Wind** ($L_{TypeI-W}$)	15.5'	15.5'	25.6'	25.6'
		Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.25	1.18	1.00	1.06
NEED		Min. Length Full Ht. Sheathing - Perforated **Wind** ($L_{TypeII-W} = L_{TypeI-W} (C_L)$)	19.4'	18.3'	**25.6'**	**27.1'**
		$L_{TypeII-W} < L_{FH}$	**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**

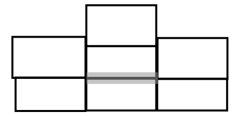
[1]Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic applied to the entire length of full height sheathing. See Top Story Segmented (Type I) wall sheathing design for explanation.

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.

Top Story Main House Shear Wall Details Summary

Building Elevation	**North**	**South**	**East**	**West**
Shear Wall Type	Perf	Perf	Perf	Perf
WSP Perimeter Nail Spacing	3"	3"	6"	6"
Governing Load	Seismic	Seismic	Wind	Wind
Shear wall Adjustment per Table 3.17D (C_{swa})	0.53	0.53	1.3	1.3

Job: WFCM Workbook **Description:** Main House



Floor Framing

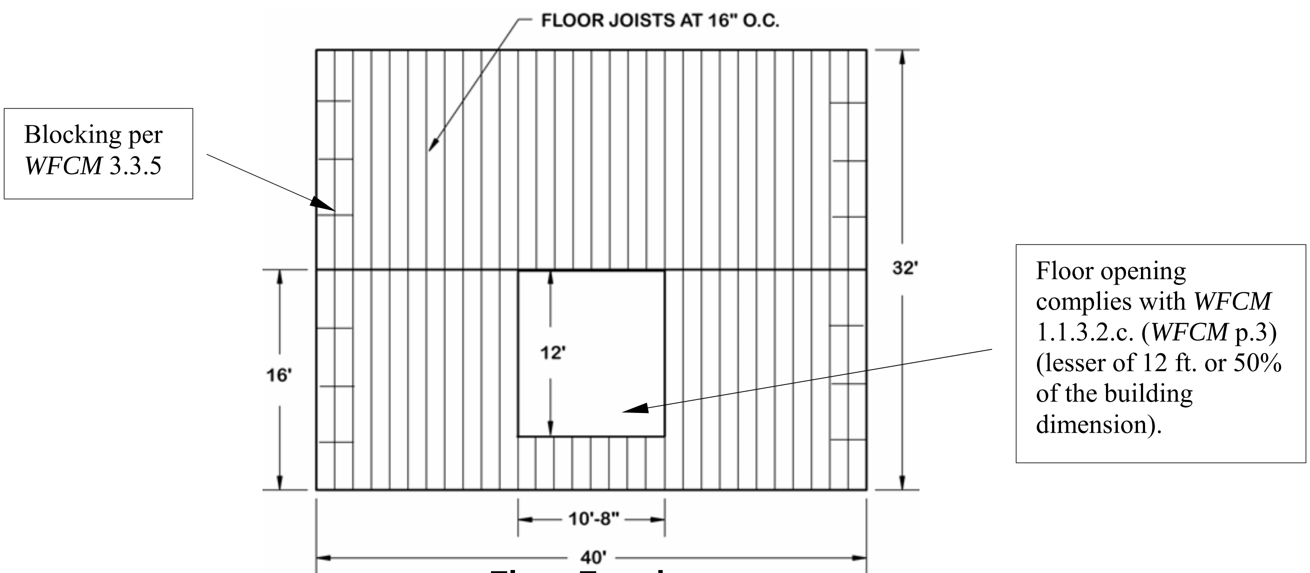
Floor Joists (WFCM 3.3.1.1)

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

Live Load: .... 30 psf
Dead Load: .... 10 psf
Joist Vertical Displacement L/Δ: 360
Required Span: .... 16 ft.

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

Specie	**Douglas Fir-Larch**	**Hem-Fir**	**Southern Pine**	**Spruce-Pine-Fir**
Spacing	**16**	**16**	**16**	**16**
Grade	**#2**	**#2**	**#2**	**#2**
Size	**2x10**	**2x10**	**2x10**	**2x10**
Maximum Span	17'-5"	16'-10"	18'-0"	17'-2"



Floor Framing

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.

Job: WFCM Workbook **Description: Main House**

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) .... 2-16d Commons per foot
Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6" (North / South walls)
(4" nail spacing: 1.67 x 2 nails) .... 4-16d Commons per foot
(3" nail spacing: 2.0 x 2 nails) .... 4-16d Commons per foot

Top Plate Intersection Connection from Table 3.1: .... 4-16d Commons each side joint

Stud to Stud Connection from Table 3.1: .... 2-16d Commons 24" o.c.

Header to Header Connection from Table 3.1: .... 16d Commons 16" o.c. -edges

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) .... 2-16d Commons per foot
Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
(4" nail spacing: 1.67 x 2 nails) .... 4-16d Commons per foot
(3" nail spacing: 2.0 x 2 nails) .... 4-16d Commons per foot

Floor Assembly (WFCM 3.2.1.5)

Bridging to Floor Joist Connection from Table 3.1: .... 2-8d Commons each end

Blocking to Floor Joist Connection from Table 3.1: .... 2-8d Commons each end

Band Joist to Floor Joist Connection from Table 3.1: .... 3-16d Commons per joist

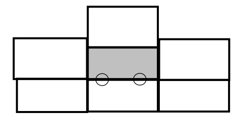
Floor Assembly to Wall Assembly (WFCM 3.2.1.6)

Floor Joist to Top Plate Connection from Table 3.1: .... 4-8d Commons per joist

Blocking to Sill or Top Plate Connection from Table 3.1: .... 3-16d Commons each block

Band Joist to Sill or Top Plate Connection from Table 3.1: (6" nail spacing) 2-16d Commons per foot
Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
(4" nail spacing: 1.67 x 2 nails) .... 4-16d Commons per foot
(3" nail spacing: 2.0 x 2 nails) .... 4-16d Commons per foot

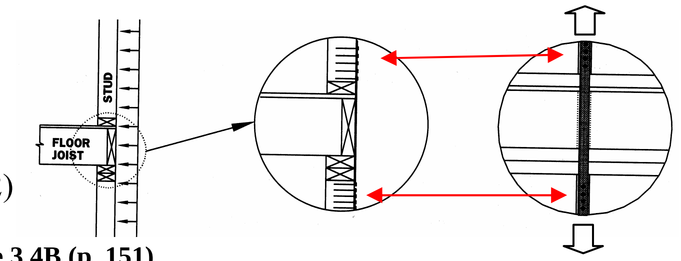
Job: WFCM Workbook **Description: Main House**



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)

	Building Wall Elevation	North	South	East	West
Wind	Three second gust wind speed	120 mph Exp. B		120 mph Exp. B	
	Framing Spacing	16 in.		16 in.	
	Roof Span	32 ft.		32 ft.	
	Minimum tabulated number of 8d Common Nails required in each end of 1-1/4" x 20 gage strap *every stud*	4		4[1]	
	No Ceiling Assembly nail increase (Footnote 3)	0			
	Minimum required number of 8d Common Nails in each end of strap *every stud* = Tabulated number of nails - Reductions + Increases	4 *		4 *	

[1] calculated using 416 lbs uplift (below) divided by 127 lb/nail per *WFCM Supplement* Table 6A.

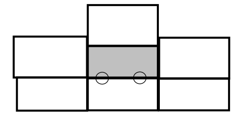
***Alternatively, use proprietary connectors every stud with the following minimum capacities**

		North / South	East / West
Wind	**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 psf – 15 psf) x 8' x 16"/12"/ ' = 32 lbs]	-32 lbs	
	Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4) = [60 plf x (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 plf x (16" / 12"/ ') = 80 lbs]		-80 lbs
	Required minimum capacity of proprietary connector = Tabulated minimum capacity x Adjustments - Reduction	**329 lbs**	**416 lbs**

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.

Job: WFCM Workbook **Description:** Main House



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)

	Building Wall Elevation	**North**	**South**	**East**	**West**
	Wall Height	9	9	9	9
Wind	WSP Perimeter Edge Nail Spacing - **wind**	6"	6"	6"	6"
	Tabulated hold down connection capacity required – **wind** (T_w)	3924 lbs	3924 lbs	3924 lbs	3924 lbs
	Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) (C_{swa})	1.3	1.3	1.3	1.3
	Adjusted hold down capacity ($T_{aw} = (T_w) / (C_{swa})$)	3019 lbs	3019 lbs	**3019 lbs**	**3019 lbs**
Seismic	WSP Perimeter Edge Nail Spacing - **seismic**	3"	3"	6"	6"
	Tabulated hold down connection capacity required – **seismic** (T_s)	2160 lbs	2160 lbs	2160 lbs	2160 lbs
	Hold down adjustment per Table 3.17F footnotes (Table 3.17D) (C_{swa})	0.53	0.53	1.0	1.0
	Adjusted hold down capacity ($T_{as} = (T_s) / (C_{swa})$)	**4075 lbs[1]**	**4075 lbs[1]**	2160 lbs	2160 lbs

[1]Three inch nail spacing controls.

Figure 3.8a Corner Stud Holddown Detail - 3 Studs With Blocking

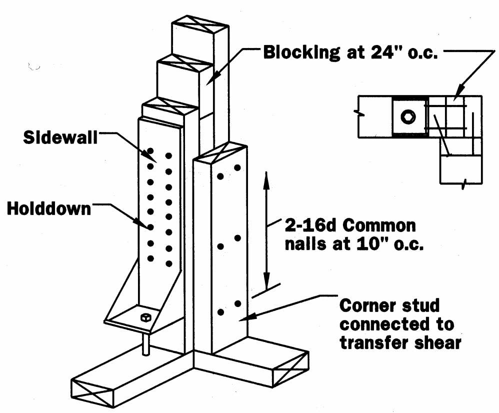
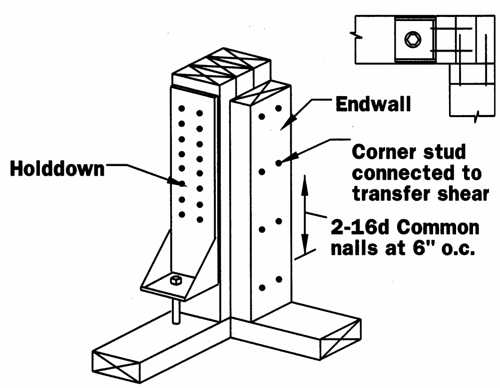


Figure 3.8b Corner Stud Holddown Detail - 4 Studs



Job: WFCM Workbook **Description: Main House**

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

Location	Edges	Field
4' Edge Zone	6	12
Interior Zones	6	12

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

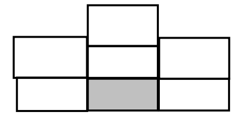
West Wing

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

Job: WFCM Workbook **Description:** Main House



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)

Specie	**Douglas Fir-Larch**	**Hem-Fir**	**Southern Pine**	**Spruce-Pine-Fir**
Spacing	**16**	**16**	**16**	**16**
Grade	**Stud**	**Stud**	**Stud**	**Stud**
Size	**2x6**	**2x6**	**2x6**	**2x6**
Maximum Length (Wind)	14'-10"	14'-5"	15'-7"	14'-5"
Maximum Length (Dead and Live Loads)	10'-0"	10'-0"	10'-0"	10'-0"

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.

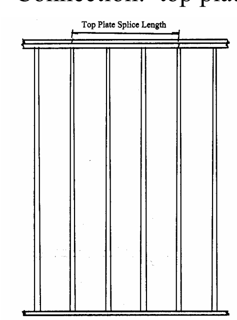
Connection: top plate – to – top plate: .... **2-16d** nails per ft.

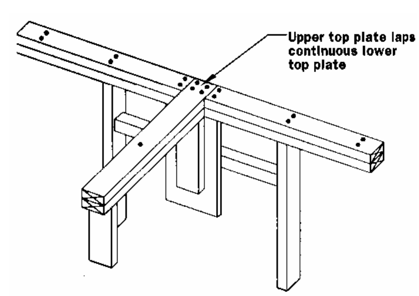
Choose Building Side Wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

Building Dimension: .... 40 ft.

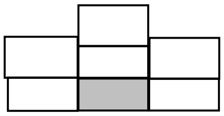
Tabulated Minimum Splice Length: .... **8** ft.

Connection: top plate – to – top plate: .... **2-16d** nails per ft.





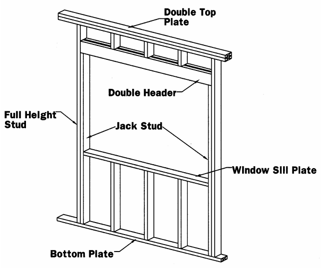
Job: WFCM Workbook **Description:** Main House



Wall Framing (cont'd)

....Family Room 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:.. 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

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 .... >13'-1" >12' OK
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)

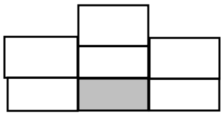
Three second gust wind speed:.. 120 mph Exp. B
Required Span:.. 3 ft.

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 – $(H/10)^{1/2}$):.. 0.95

Adjusted Maximum Sill Plate Length:

Tabulated maximum sill plate Length ÷ wall Height Adjustment:.......... **7'-10"** >3' OK

Job: WFCM Workbook **Description:** Main House



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: 3-Southern Pine #2 2x12's
Maximum Header/Girder Span (interpolated): .... 6'-1" ft. >6' OK
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)

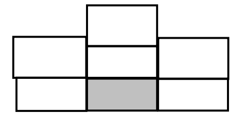
Selection of Header Specie, Grade, and Size: 2-Southern Pine #2 2x10's
Maximum Header/Girder Span (interpolated): .... 4'-2" ft. >4' OK
Number of Jack Studs Required (Table 3.24C): 3

.... 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.

Job: WFCM Workbook **Description:** Main House



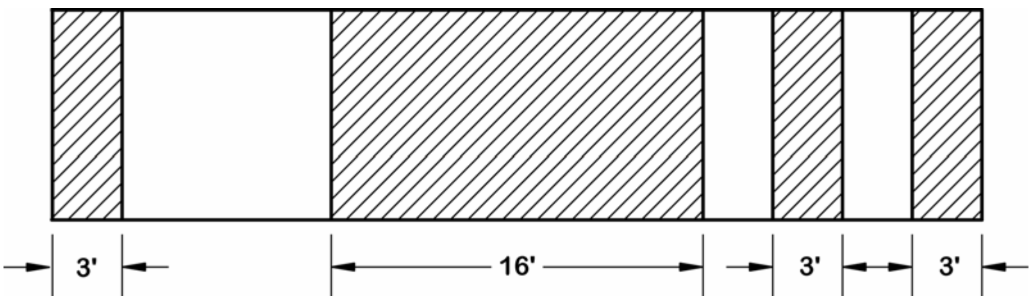
Wall Sheathing

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

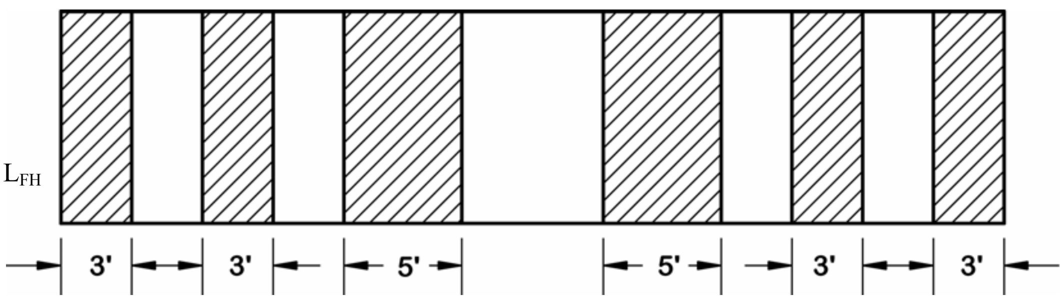
Sheathing Type (wood structural panels, fiberboard, board, hardboard): .... WSP
Direction Across Studs (Short or Long):............ Short
Stud Spacing: .... 16 in.
Minimum Panel Thickness:............ 3/8 in.
Shearwall minimum panel thickness (WFCM 3.4.4.2): .... 7/16 in.



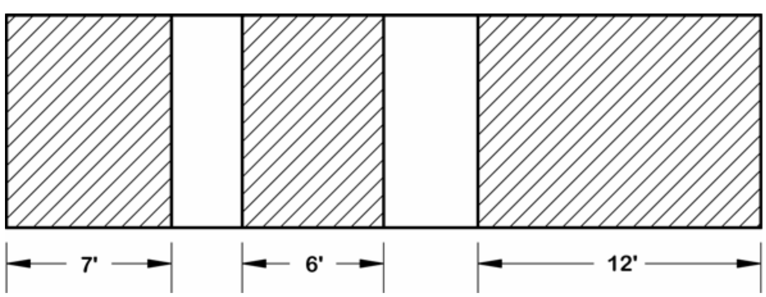
= 25 ft. long = L_{FH}

North Elevation

= 22 ft. long = L_{FH}



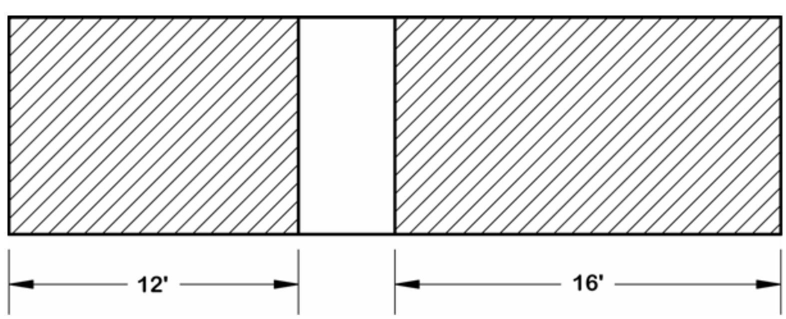
South Elevation



= 25 ft. long = L_{FH}

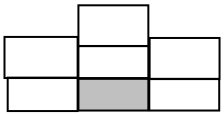
East Elevation

= 28 ft. long = L_{FH}



West Elevation

Job: WFCM Workbook **Description:** Main House



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.

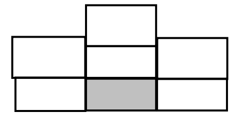
Note: The main house is designed as a three story structure and the wings are designed as 2 story structures. Therefore, shear walls will be designed as 3 separate structures.

STEPS			Load Parallel to Ridge		Load Perpendicular to Ridge		
		Building Wall Elevation	**North**	**South**	**East**	**West**	
		Actual Length of Wall – Main House	40'	40'	32'	32'	
1	**Seismic**	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	22'[1]	18'[1]	25'	28'	HAVE
2		Tabulated Minimum Length Full Height Sheathing for **Seismic** Loads per Table 3.17C (L_s) C_1 = 87 C_2 = 22 L_{max} = 40' L_{min} = 32'	29.6'	29.6'	29.6'	29.6'	
3		WSP Perimeter Edge Nail Spacing – **Seismic** (WFCM 3.4.4.2 + 3.4.4.2.1)	3"	3"	4"	4"	PICK
4		Shear wall Adjustment per Table 3.17D (C_{swa})	0.53	0.53	0.69	0.69	
5		Min. Length Full Ht. Sheathing - Segmented **Seismic** ($L_{TypeI\text{-}S} = L_s \times C_{swa}$)	**15.7'**	**15.7'**	20.4'	20.4'	NEED
		$L_{TypeI\text{-}S} < L_{FHS}$	**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**	
1	**Wind**	Effective Length of Full Height Sheathing (L_{FH})	25'	22'	25'	28'	HAVE
2		Tabulated Minimum Length Full Height Sheathing for **Wind** Loads per Table 3.17B and 3.17A (L_w)	16'[2]	16'[2]	27.6'	27.6'	
3		WSP Perimeter Edge Nail Spacing- **Wind** (WFCM 3.4.4.2)	6"	4"	3"	4"	PICK
4		Shear wall Adjustment per Table 3.17D (C_{swa})	1.0	0.74	0.60	0.74	
5		Wall Height Adjustment (Table 3.17A&B Footnote 2) (C_{WH} =9'/8')	1.125	1.125	1.125	1.125	
6		Min. Length Full Ht. Sheathing - Segmented **Wind** ($L_{TypeI\text{-}W}=L_w(C_{WH})(C_{swa})$)	18'	13.3'	**18.6'**	**23'**	NEED
		$L_{TypeI\text{-}W} < L_{FH}$	**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**	

[1] Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See Top Story wall design for explanation.
[2] This 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).

Job: WFCM Workbook **Description:** Main House



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)

			Load Parallel to Ridge		Load Perpendicular to Ridge		
		Building Wall Elevation	**North**	**South**	**East**	**West**	**South Split?**
		Wall Height	9'	9'	9'	9'	
		Max. Unrestrained Opening Height	7'-6"	7'-6"	7'-6"	7'-6"	
HAVE		Actual Length of Full Height Sheathing (L_{FH})	25'	22'	25'	28'	11'
	Seismic	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	16.7'[1]	14.7'[1]	25'	28'	7.3'
		Length of Wall (L_{Wall})	40'	40'	32'	32'	17'
		Percent Full Height Sheathing (L_{FH} / L_{Wall})	63%	55%	78%	88%	65%
		Minimum Length Full Ht. Sheathing - Segmented **Seismic** ($L_{TypeI\text{-}S}$)	15.7'	15.7'	20.4'	20.4'	15.7/2 =7.85'
		Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.29	1.37	1.16	1.08	1.13
NEED		Min. Length Full Ht. Sheathing-Perforated **Seismic** ($L_{TypeII\text{-}S}=L_{TypeI\text{-}S}(C_L)$)	**20.3'**	**21.3'**	23.7'	22'	8.9'
		$L_{TypeII\text{-}S} < L_{FHS}$	**NG**	**NG**	**Ok?✓**	**Ok?✓**	> 7.3' NG
HAVE	Wind	Actual Length of Full Height Sheathing (L_{FH})	25'	22'	25'	28'	
		Length of Wall (L_{Wall})	40'	40'	32'	32'	
		Percent Full Height Sheathing (L_{FH} / L_{Wall})	63%	55%	78%	88%	
		Tabulated Min. Length Full Height Sheathing - Segmented **Wind** ($L_{TypeI\text{-}W}$)	18'	13.3'	18.6'	23'	
		Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.29	1.37	1.16	1.08	
NEED		Min. Length Full Ht. Sheathing - Perforated **Wind** ($L_{TypeII\text{-}W} = L_{TypeI\text{-}W}(C_L)$)	23.2'	18.2'	**21.6'**	**24.8'**	
		$L_{Type\ II\text{-}W} < L_{FH}$	**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**	

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

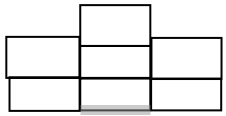
North and South walls require design as Segmented (Type I) shear walls. Wind controls for east wall because of 3" nail spacing requirement.

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).

Bottom Story Main House Shear Wall Details Summary

Building Elevation	**North**	**South**	**East**	**West**
Shear Wall Type	Segmented	Segmented	Perf	Perf
WSP Perimeter Nail Spacing	3"	3"	3"	4"
Governing Load	Seismic	Seismic	Wind	Wind
Shear wall Adjustment per Table 3.17D (C_{swa})	0.53	0.53	0.60	0.74

Job: WFCM Workbook **Description:** Main House



Floor Framing

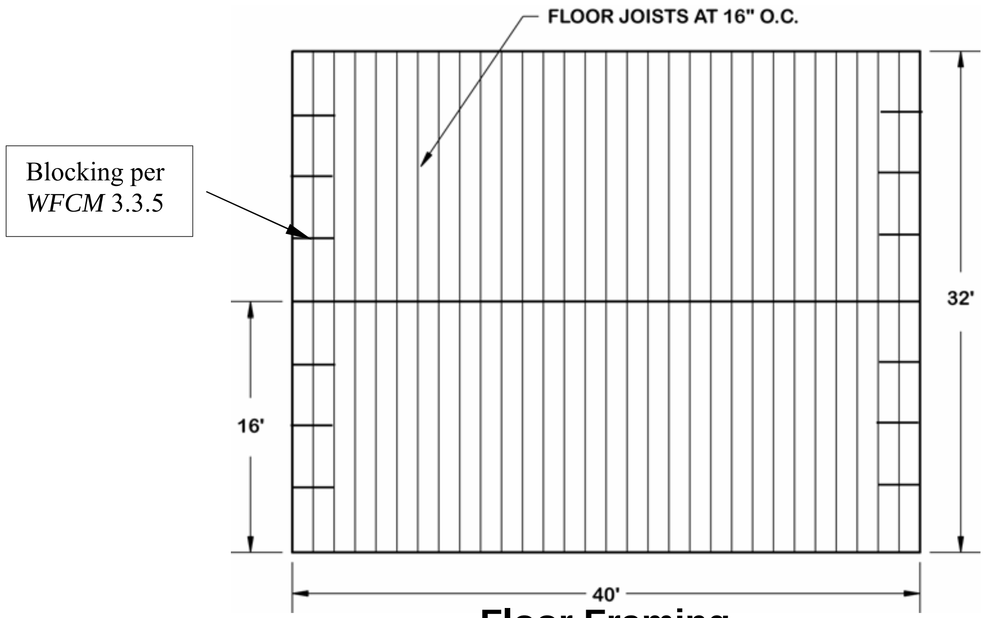
Floor Joists (WFCM 3.3.1.1)

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)

Specie	Douglas Fir-Larch	Hem-Fir	Southern Pine	Spruce-Pine-Fir
Spacing	16	16	16	16
Grade	#1	#1	#2	SS
Size	2x10	2x10	2x10	2x10
Maximum Span	16'-5"	16'-0"	16'-1"	16'-0"



Floor Framing

Floor Sheathing

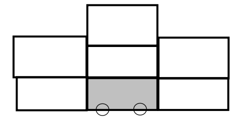
Sheathing Spans (WFCM 3.3.4.1)

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.

Job: WFCM Workbook **Description:** Main House



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)
.... 2-16d Commons per foot
Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6" (North / South walls)
(4" nail spacing: 1.67 x 2 nails) .... 4-16d Commons per foot
(3" nail spacing: 2.0 x 2 nails) .... 4-16d Commons per foot

Top Plate Intersection Connection from Table 3.1: .... 4-16d Commons each side joint

Stud to Stud Connection from Table 3.1: .... 2-16d Commons 24" o.c.

Header to Header Connection from Table 3.1: .... 16d Commons 16" o.c. -edges

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) .... 2-16d Commons per foot
Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
(4" nail spacing: 1.67 x 2 nails) .... 4-16d Commons per foot
(3" nail spacing: 2.0 x 2 nails) .... 4-16d Commons per foot

Floor Assembly (WFCM 3.2.1.5)

Bridging to Floor Joist Connection from Table 3.1: .... 2-8d Commons each end

Blocking to Floor Joist Connection from Table 3.1: .... 2-8d Commons each end

Band Joist to Floor Joist Connection from Table 3.1: .... 3-16d Commons per joist

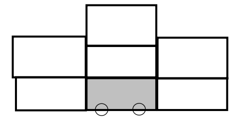
Floor Assembly to Wall Assembly (WFCM 3.2.1.6)

Floor Joist to Top Plate Connection from Table 3.1: .... 4-8d Commons per joist

Blocking to Sill or Top Plate Connection from Table 3.1: .... 3-16d Commons each block

Band Joist to Sill or Top Plate Connection from Table 3.1: (6" nail spacing) 2-16d Commons per foot
Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
(4" nail spacing: 1.67 x 2 nails) .... 4-16d Commons per foot
(3" nail spacing: 2.0 x 2 nails) .... 4-16d Commons per foot

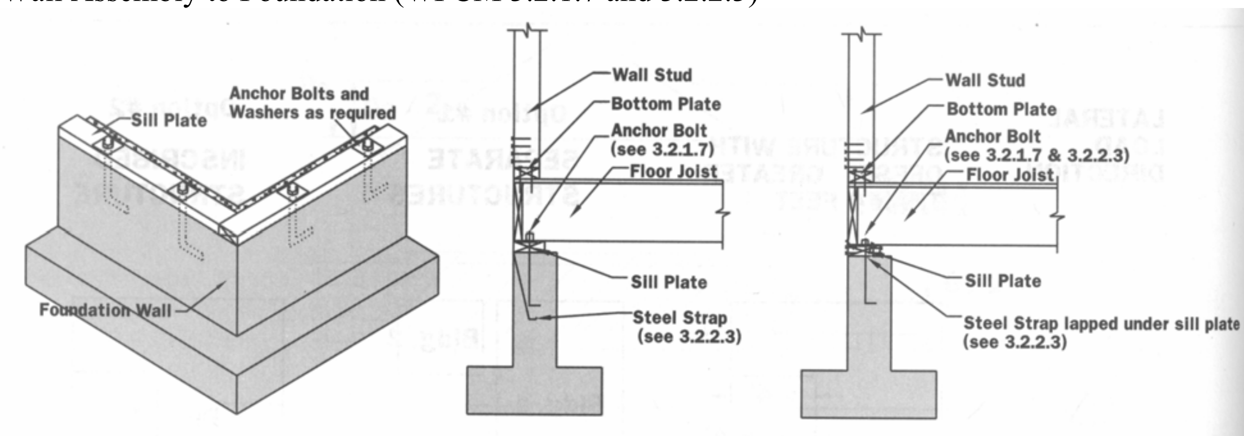
Job: WFCM Workbook **Description:** Main House



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)

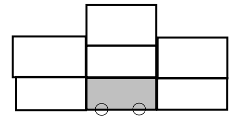
Three second gust wind speed:.......... 120 mph Exp. B
Stories supported by Foundation:.......... 3
Anchor Bolt Diameter: .... 5/8 in.

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

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

[1]Calculated 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.
Table 3.4C = 496 lbs x 12"/' / 16" – 120 plf (walls) = 372 plf – 120 plf = 252 plf
252 plf (32ft) / 1488 lbs = 5.4bolts, so spacing = 72" maximum.
[2]Anchor bolt spacing shall not exceed 6' (72") on center per Table 3.2A Footnote 2.
[3]These will be added to anchor bolts required by West and East wing common walls respectively.

Job: WFCM Workbook **Description:** Main House



Connections (cont'd)

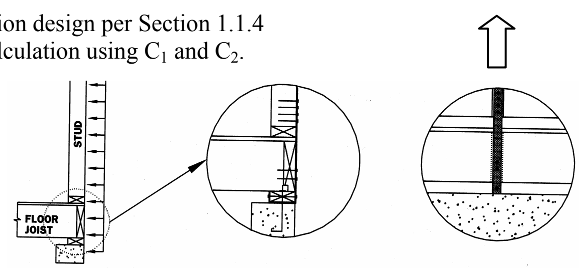
Alternatively, use proprietary connectors with the following minimum capacities from Table 3.2 (pp. 140-141), Table 3.3 (pp. 145-146) and Table 3.4C (p. 152).

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

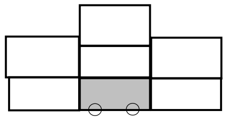
Assuming Crawl Space or Basement, determine required loads for proprietary connectors:

	Building Wall Elevation	North	South	East	West
	Building dimension W or L	40'	40'	32'	32'
	R=L/W or W/L for Table 3.2	0.8	0.8	1.25	1.25
Wind	Number of stories receiving lateral wind load (Table 3.2A)	3	3	3	3
Wind	Wind uplift (Table 3.4C)			496 lbs	496lbs
Wind	Uplift force Spacing			16"	16"
Wind	Wind uplift plf basis			372 plf	372 plf
Wind	Overhang Reduction (Table 3.4C Footnote 2) $[(2' - OH / 4')]^2$			1.0	1.0
Wind	Wall Dead Load Reduction[1] (2 walls (0.6)(99plf))			-119	-119
Wind	**Adjusted Wind uplift** (Table 3.4C)			**253 plf**	**253 plf**
Wind	**Wind uplift** (Table 3.2(U))	**151 plf**	**151 plf**		
Wind	**Wind lateral load** (Table 3.2(L))	*	*	*	*
Wind	**Wind shear load** (Table 3.2(S)) 411 R	**329 plf**	**329 plf**	**514 plf**	**514 plf**
Seismic	Seismic shear load (Table 3.3)[2] C_1 = 208 C_2 = 53 L_{max} = 40' L_{min} = 32' or, ❑ slab on grade	7080 lbs	7080 lbs	7080 lbs	7080 lbs
Seismic	Wall Dead Load w_w	11 psf	11 psf	11 psf	11 psf
Seismic	Footnote 4 Wall Dead Load Reduction $R_w = (w_w + 70.65) / 85.65$	0.95	0.95	0.95	0.95
Seismic	Footnote 5 Sheathing Adjustment Factor for wall (Table 3.17D) (C_{swa})	0.53	0.53	0.69	0.69
Seismic	Adjusted seismic shear load = seismic shear load x R_w / C_{swa}	12690 lbs	12690 lbs	9748 lbs	9748 lbs
Seismic	Wall length	40'	40'	32'	32'
Seismic	**Seismic shear load** = adjusted seismic shear load / wall length	**317 plf**	**317 plf**	**305 plf**	**305 plf**

[1]Refer to *WFCM Commentary* 1.1.2.
*Table 3.2 Footnote: Determine anchorage for Lateral Loads in foundation design per Section 1.1.4
[2]See top story main segmented shearwall design for example seismic calculation using C_1 and C_2.



Job: WFCM Workbook Description: Main House



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)

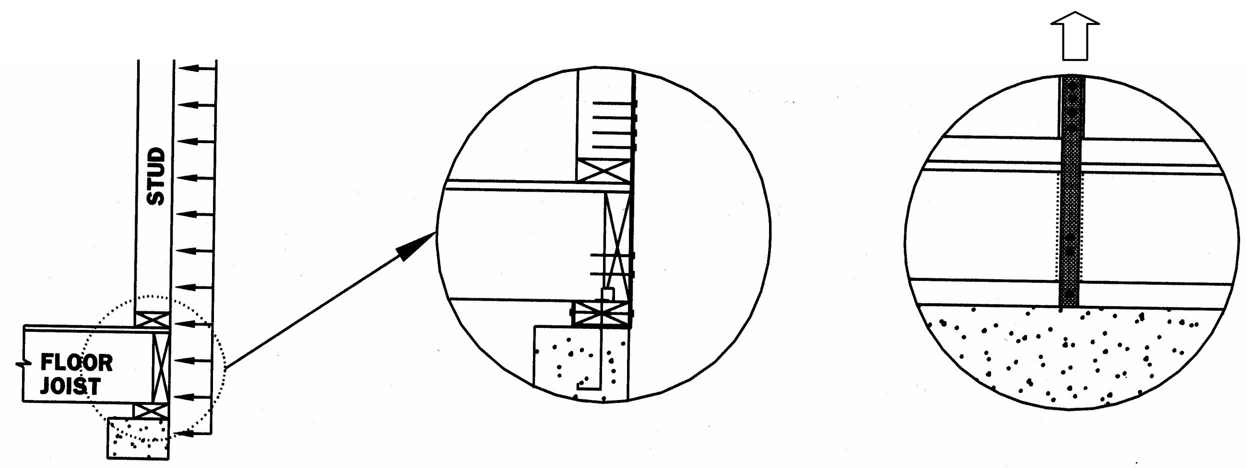
Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

	Building Wall Elevation	**North**	**South**	**East**	**West**
Wind	Three second gust wind speed	120 mph Exp. B		120 mph Exp. B	
	Framing Spacing	16 in.		16 in.	
	Roof Span	32 ft.		32 ft.	
	Tabulated number of 8d Common Nails required in each end of 1-1/4" x 20 gage strap *every stud*	4		3[1]	
	No Ceiling Assembly nail increase (Footnote 3)	0			
	Required number of **8d Common Nails in each end of strap** *every stud* = Tabulated number of nails - Reductions + Increases	**4 ***		3 *	

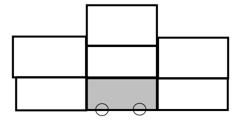
[1] calculated using 336 lbs uplift (below) divided by 127 lb/nail per *WFCM Supplement* Table 6A.

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

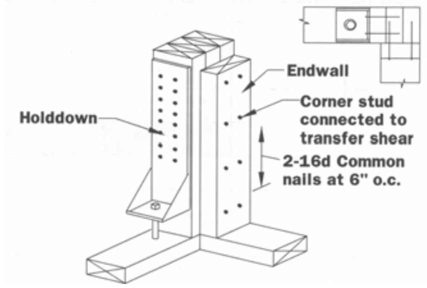
		North / South	East / West
Wind	**Loadbearing Walls** - Tabulated minimum uplift connection capacity (Table 3.4, page 149)	441 lbs	
	Interior framing adjustment (Footnote 1)	1.0	
	Roof dead load reduction (Table 3.4, Footnote 3) = [0.60(20 psf – 15 psf) x 8'-0" x 16"/12"/ ' = 32 lbs]	-32 lbs	
	Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4) = [60 plf x 2 walls (16" / 12"/ ') = 160 lbs]	-160 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 plf x 2 walls (16" / 12"/ ') = 160 lbs]		-160 lbs
	Required minimum capacity of proprietary connector = Tabulated minimum capacity x Adjustments - Reduction	**249 lbs**	**336 lbs**



Job: WFCM Workbook **Description:** Main House



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)

	Building Wall Elevation	**North**	**South**	**East**	**West**
	Wall Height	9'	9'	9'	9'
Wind	Tabulated hold down connection capacity required – **wind** (T_w)	3924 lbs	3924 lbs	3924 lbs	3924 lbs
	WSP Perimeter Edge Nail Spacing - **wind**	3"	3"	3"	4"
	Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) (C_{swa})	0.6	0.6	0.6	0.74
	Adjusted hold down capacity ($T_{wa} = (T_w) / (C_{swa})$) - **wind**	6540 lbs	6540 lbs	6540 lbs	5303 lbs
	Additional story hold down requirements – **wind** (see Workbook p.39)	3019 lbs	3019 lbs	3019 lbs	3019 lbs
	Total hold down requirement for floor to foundation – **wind** (ΣT_{wa})	**9559 lbs**	**9559 lbs**	**9559 lbs**	**8322 lbs**
Seismic	Tabulated hold down connection capacity required – **seismic** (T_s)	2160 lbs	2160 lbs	2160 lbs	2160 lbs
	WSP Perimeter Edge Nail Spacing - **seismic**	3"	3"	3"	4"
	Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) (C_{swa})	0.53	0.53	0.53	0.69
	Adjusted hold down capacity ($T_{sa} = (T_s) / (C_{swa})$) - **seismic**	4075 lbs	4075 lbs	4075 lbs	3130 lbs
	Additional story hold down req'ments – **seismic** (see Workbook p.39)	4075 lbs	4075 lbs	2160 lbs	2160 lbs
	Total hold down requirement for floor to foundation (ΣT_{sa}) - **seismic**	**8150 lbs**	**8150 lbs**	**6235 lbs**	**5290 lbs**

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)

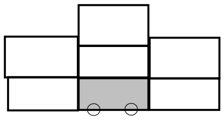
Three second gust wind speed:.. 120 mph Exp. B

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

Location	Edges	Field
4' Edge Zone	6	12
Interior Zones	6	12

Shear wall sheathing nail spacing requirements control.

Job: WFCM Workbook **Description:** Main House



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.

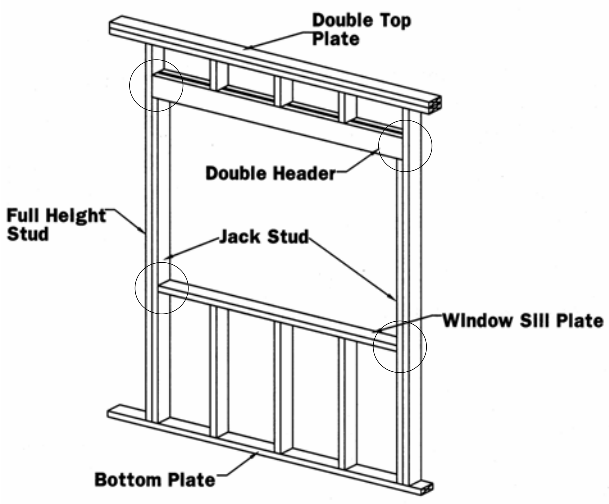
Using identical procedures:
Family Room Door (9' header) Tabulated Uplift Capacity (interpolated):............ 1219 lbs.
Family Room Door (9' header) Tabulated Lateral Capacity: .... 708 lbs.

Foyer Door (12' header) Tabulated Uplift Capacity (interpolated): .... 1625 lbs.
Foyer Door (12' header) Tabulated Lateral Capacity (interpolated):............ 944 lbs.

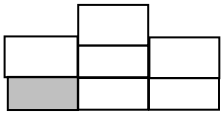
Choose Window Sill Plate Connections based on loads from Table 3.8 (p. 157)

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.



Job: WFCM Workbook **Description:** West 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 (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)

Specie	Douglas Fir-Larch	Hem-Fir	Southern Pine	Spruce-Pine-Fir
Spacing	**16**	**16**	**16**	**16**
Grade	**Stud**	**Stud**	**Stud**	**Stud**
Size	**2x4[1]**	**2x4[1]**	**2x4[1]**	**2x4[1]**
Maximum Length (Wind)	10'-5"	10'-2"	10'-10"	10'-2"
Maximum Length (Dead and Live Loads)	10'-0"	10'-0"	10'-0"	10'-0"

[1]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)

Specie	Douglas Fir-Larch	Hem-Fir	Southern Pine	Spruce-Pine-Fir
Spacing	**16**	**16**	**16**	**16**
Grade	**#2**	**#2**	**#2**	**#2**
Size	**2x6**	**2x6**	**2x6**	**2x6**
Maximum Length (Wind)	18'-7"	17'-4"	18'-7"	17'-9"
Maximum Length (Dead and Live Loads)	20'-0"	20'-0"	20'-0"	20'-0"

Job: WFCM Workbook **Description:** West Wing

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.

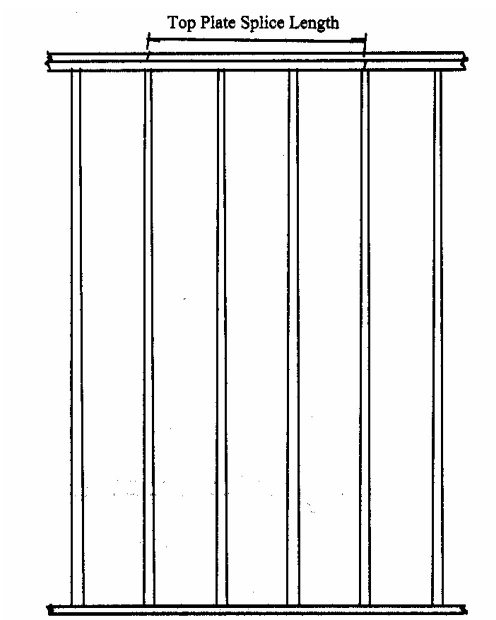
Connection: top plate – to – top plate:.......... **2-16d** nails per ft.

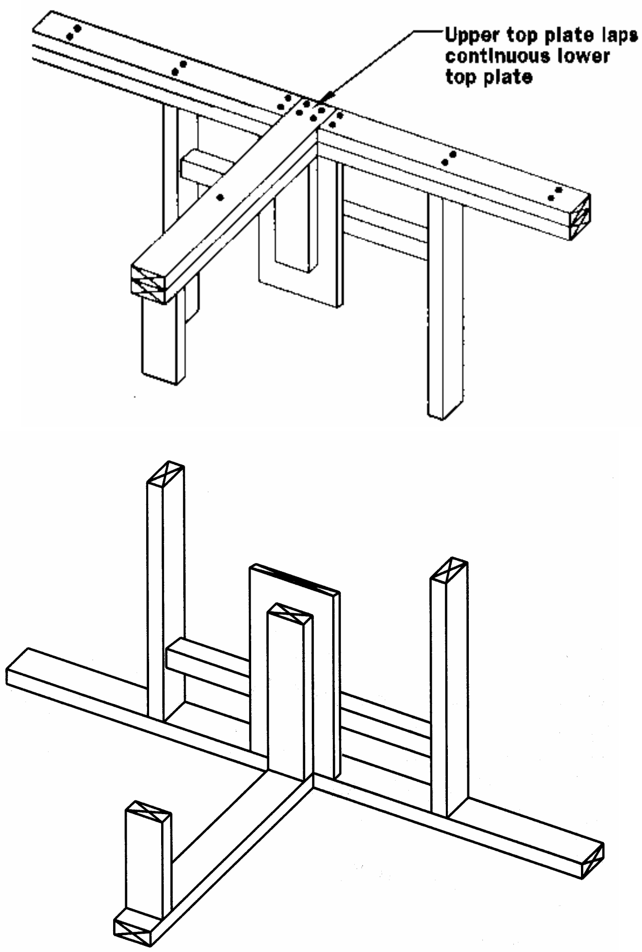
Choose Building Side wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

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

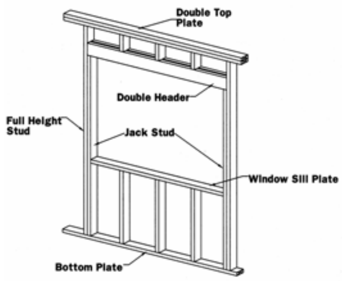
Exterior Loadbearing Wall Headers (WFCM 3.4.1.4.1)

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): 3-Southern Pine #2 2x12's



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): 3-Southern Pine #2 2x8's

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: **3-Southern Pine #2 2x12's**
> 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 – $(H/10)^{1/2}$): 1.0

Adjusted Maximum Sill Plate Length:
Tabulated maximum sill plate Length ÷ wall Height Adjustment: .... **7'-6"** >3' OK

Job: WFCM Workbook Description: West Wing

Wall Framing (cont'd)

....Master Bath

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))

....Master Bath Door

Interior Loadbearing Wall Headers (WFCM 3.4.2.4.1)

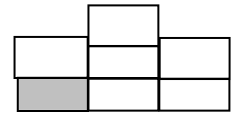
Choose Header Table 3.24A (p. 195)

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

Job: WFCM Workbook **Description:** West Wing



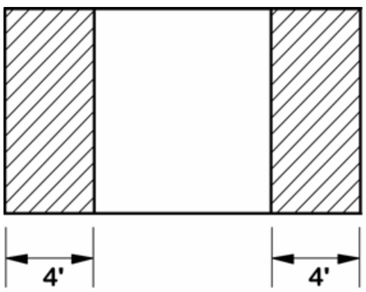
Wall Sheathing

Sheathing and Cladding (WFCM 3.4.4.1)

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

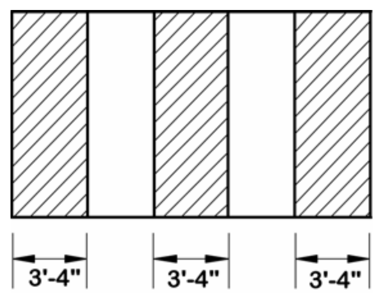
Three second gust wind speed:.. 120 mph Exp. B

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.



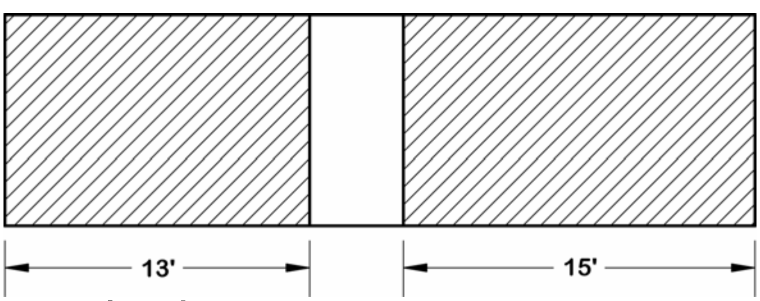
= 8 ft. long = L_{FH}

North Elevation



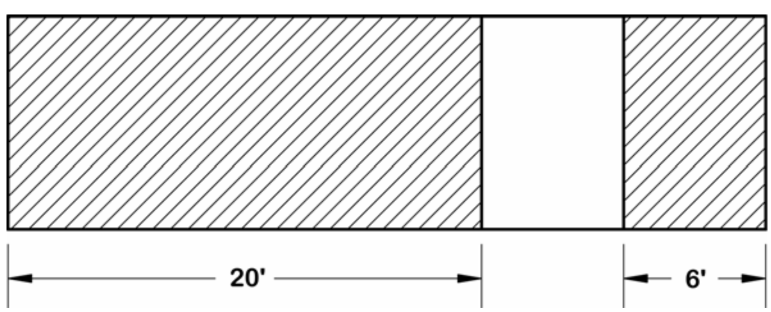
= 10 ft. long = L_{FH}

South Elevation



= 28 ft. long = L_{FH}

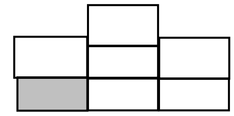
East Elevation



= 26 ft. long = L_{FH}

West Elevation

Job: WFCM Workbook **Description:** West Wing



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: .... 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.

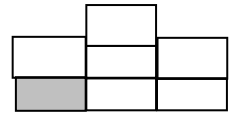
Minimum WSP sheathing thickness (per WFCM 3.4.4.2): .... 7/16 in.
Minimum gypsum thickness (per WFCM 3.4.4.2): .... 1/2 in.

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).

STEPS			Load Parallel to Ridge		Load Perpendicular to Ridge		
	Building Wall Elevation		**North**	**South**	**East (h = 9')**	**West**	
1	Length of Wall – West Wing		16'	16'	32'	32'	HAVE
2	**Seismic**	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	6.4'[1]	6.7'[1]	28'	26'	
3		Tabulated Minimum Length Full Height Sheathing for **Seismic** Loads per Table 3.17C (L_s) C_1 = 51 C_2 = 15 L_{max} = 32' L_{min} = 16'	10.6'	10.6'	10.6'	10.6'	PICK
4		WSP Perimeter Edge Nail Spacing – **Seismic** (WFCM 3.4.4.2 + 3.4.4.2.1)	3"	3"	6"	6"	
5		Shear wall Adjustment per Table 3.17D (C_{swa})	0.53	0.53	1.0	1.0	NEED
		Min. Length Full Ht. Sheathing - Segmented **Seismic** ($L_{TypeI\text{-}S} = L_s \times C_{swa}$)	5.6'	**5.6'**	**10.6'**	**10.6'**	
1	$L_{TypeI\text{-}S} < L_{FHS}$		**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**	
2	**Wind**	Effective Length of Full Height Sheathing (L_{FH})	8'	10'	28'	26'	HAVE
3		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]	PICK
4		WSP Perimeter Edge Nail Spacing – **Wind** (WFCM 3.4.4.2)	3"	4"	6"	6"	
5		Shear wall Adjustment per Table 3.17D (C_{swa})	0.6	0.74	1.0	1.0	
6		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** ($L_{TypeI\text{-}W}=L_w(C_{WH})(C_{swa})$)	**7.9'**	9.8'	8.0'	8.9'	NEED
	$L_{TypeI\text{-}W} < L_{FH}$		**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, except h = 10' for North, South & West walls. (w = 4' North) (w = 3'-4" South).
[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]Extrapolated from Table 3.17A

Job: WFCM Workbook **Description:** West Wing



Wall Sheathing (cont'd)

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)

			Load Parallel to Ridge		Load Perpendicular to Ridge	
		Building Wall Elevation	**North**	**South**	**East**	**West**
		Wall Height	10'	10'	9'	10'
		Max. Unrestrained Opening Height	8'-4"	4'-6"	7'-6"	4'-6"
HAVE		Actual Length of Full Height Sheathing (L_{FH})	8'	10'	28'	26'
	Seismic	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	6.4'[1]	6.7'[1]	28'	26'
	Seismic	Length of Wall (L_{Wall})	16'	16'	32'	32'
	Seismic	Percent Full Height Sheathing (L_{FH} / L_{Wall})	50%	63%	88%	81%
	Seismic	Tabulated Min. Length Full Ht. Sheathing-Segmented **Seismic** ($L_{TypeI-S}$)	5.6'	5.6'	10.6'	10.6'
	Seismic	Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.43	1.11	1.08	1.05
NEED	**Seismic**	Min. Length Full Ht. Sheathing-Perforated **Seismic** ($L_{TypeII-S}=L_{TypeI-S}(C_L)$)	8.0'	**6.2'**	**11.4'**	**11.1'**
		$L_{TypeII-S} < L_{FHS}$	**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**
HAVE	**Wind**	Actual Length of Full Height Sheathing (L_{FH})	8'	10'	28'	26'
	Wind	Length of Wall (L_{Wall})	16'	16'	32'	32'
	Wind	Percent Full Height Sheathing (L_{FH} / L_{Wall})	50%	63%	88%	81%
	Wind	Tabulated Min. Length Full Ht. Sheathing-Segmented **Wind** ($L_{TypeI-W}$)	7.9'	9.8'	8'	8.9'
	Wind	Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.43	1.11	1.08	1.05
NEED	**Wind**	Min. Length Full Ht. Sheathing-Perforated **Wind** ($L_{TypeII-W} = L_{TypeI-W}(C_L)$)	**11.3'**	10.9'	8.6'	9.4'
		$L_{TypeII-W} < L_{FH}$	**NG**	**NG**	**Ok?✓**	**Ok?✓**

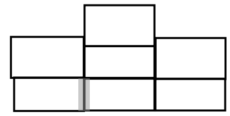
[1]Includes a 2w/h reduction for exceeding 2:1 aspect ratio for seismic. See shear wall calculations for bottom story main structure.

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_{swa}, 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

Building Elevation	**North**	**South**	**East**	**West**
Shear Wall Type	Perf	Perf	Perf	Perf
WSP Perimeter Nail Spacing (North wall WSP on both sides)	3"	3"	6"	6"
Governing Load	Wind	Seismic	Seismic	Seismic

Job: WFCM Workbook **Description:** West Wing



Wall Sheathing (cont'd)

Combine Shear Wall Requirements for Main Building and West Wing

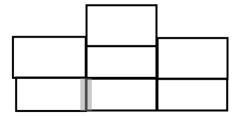
Adjust Shear Wall Requirements to Common Nailing Pattern

	Building Wall Elevation	Wind	Seismic
	Segmented (Type I) Shear Wall Requirements – Sheathing Thickness	7/16"	7/16"
REQ'D FROM	Main Building – West Elevation (WSP perimeter edge nail spacing) (L_{FH1})	23.0'(4")	20.4'(4")
	Length adjustment factor, C_{swa1} (Table 3.17D)	0.74	0.69
	Revised Length Adjustment Factor ($C_{swa1revised}$) (Table 3.17D)	no change	no change
	Length adjustment factor ratio $C_{swa1\ ratio} = C_{swa1revised} / C_{swa1}$	no change	no change
	Adjusted Shared wall length = $L_{FH1} * C_{swa1\ ratio} = L_{FHadj1}$	23.0'(4")	20.4'(4")
REQ'D FROM	West Wing – East Elevation (WSP perimeter edge nail spacing) (L_{FH2})	8.9'(6")	10.6'(6")
CHANGE	Length adjustment factor, C_{swa2} (Table 3.17D)	1.0	1.0
REVISED	Revised Length Adjustment Factor ($C_{swa2revised}$) (Table 3.17D)	**0.74**	**0.69**
	Length adjustment factor ratio $C_{swa2\ ratio} = C_{swa2revised} / C_{swa2}$	0.74	0.69
	Adjusted Shared wall length = $L_{FH2} * C_{swa2\ ratio} = L_{FHadj2}$	**6.6'(4")**	**7.9'(4")**
NEED	Adjusted Shared Wall – Total Requirement ($L_{TypeIadjusted}$) = $L_{FHadj1} + L_{FHadj2}$	29.6'	27.7'
HAVE	Actual Length of Full Height Sheathing (L_{FH})	31.0'[1]	31.0'[1]
	$L_{TypeIadjusted} < L_{FH}$	**Ok? ✓**	**Ok? ✓**
	Perforated (Type II) Shear Wall Requirements		
	Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.08	1.08
NEED	Min. Length Full Ht. Sheathing-Perforated ($L_{TypeIIadjusted} = L_{TypeIadjusted} (C_L)$)	31.9'	29.9'
HAVE	Actual Length of Full Height Sheathing (L_{FH})	31.0'[1]	31.0'[1]
	$L_{TypeIIadjusted} < L_{FH}$	**Ok? ~**	**Ok? ✓**

Use Table 3.17D (p.174) to increase sheathing capacity. Changing the WSP sheathing edge nail spacing to 4"o.c. on West Wing – East Elevation, gives a length adjustment factor, C_{swa}, of 0.74 for wind loads and 0.69 for seismic (previous value of C_{swa} for 6"o.c. nail spacing was 1.0 for wind and seismic). (29.6' OK based on conservatism due to progressive rounding. – see Footnote 2 on p.60.)

[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.

Job: WFCM Workbook **Description:** West Wing

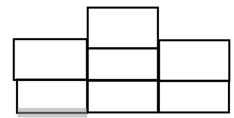


Wall Sheathing (cont'd)

Combine Shear Wall Requirements for Main Building and West Wing

Bottom Story West Wing Shear Wall Details Summary - Final

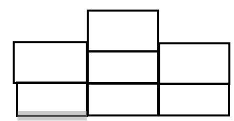
Building Elevation	North	South	East	West
Shear Wall Type	Perf	Perf	Perf	Perf
WSP Perimeter Nail Spacing (North wall WSP on both sides)	3"	3"	4"	6"
Governing Load	Wind	Seismic	Wind	Seismic
Shear wall Adjustment per Table 3.17D (C_{swa})	0.35	0.53	0.74	1.0



Floor Framing

Floor Joists (WFCM 3.3.1.1)

Slab on Grade – not applicable

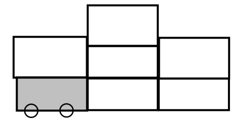


Floor Sheathing

Sheathing Spans (WFCM 3.3.4.1)

Slab on Grade – not applicable

Job: WFCM Workbook **Description:** West Wing



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)

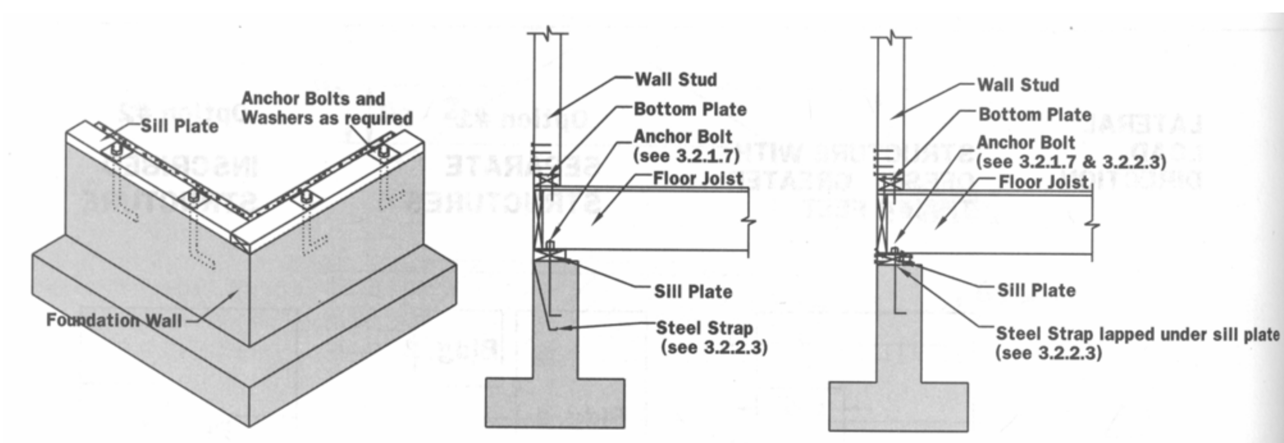
Choose Sill or Bottom Plate to Foundation Connection Requirements for Anchor Bolts Resisting Lateral, Shear, and Uplift Loads from Table 3.2A & B (pp. 142-144) and Table 3.3A (p. 147).

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

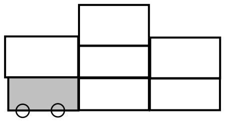
Assuming <u>Crawl Space or Basement</u>, determine maximum Anchor Bolt Spacing for common wall portion :

	Building Wall Elevation	**North**	**South**	**East**	**West**
	Shear wall line dimension (L_{sw})			32'	
	Building dimension perpendicular to shear wall line (Table 3.2A)			16'	
Wind	Number of stories receiving **wind** load (Table 3.2A)			2	
Wind	Tabulated number of bolts to resist shear loads from wind (Table 3.2A)			5	
Wind	Bolt spacing for wind **shear** loads $s_{ws} = (L_{sw}-2) / (\text{number of bolts}-1)$			**72"**[1, 2, 3]	
Wind	Max. bolt spacing to resist wind **uplift** loads (s_{wu}) (Table 3.2C & 3.4C)			**N/A**[4]	

[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:

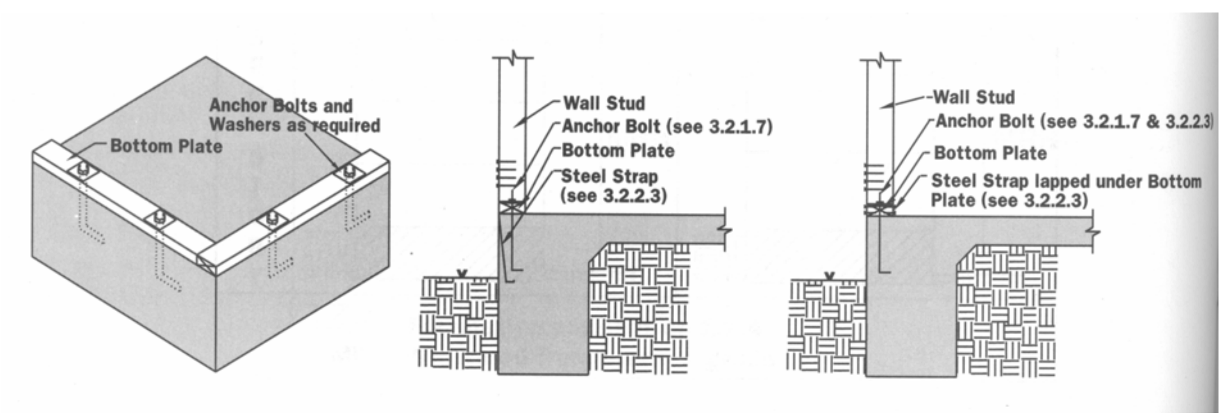
	Building Wall Elevation	**North**	**South**	**East**	**West**
	Shear wall line dimension (L_{sw})	16'	16'	36'	32'
Wind	Number of stories receiving **wind** load (Table 3.2B)	2	2	2	2
	Bolt spacing for wind **lateral** and **shear** loads (Table 3.2B)	45"	45"	45"	45"
	Wall sheathing type adjustment factor per Table 3.17D (Table 3.2B Footnote 3) (assumes perforated shear wall capacities) C_{swa}	0.35	0.74	0.74	1.0
	Adjusted bolt spacing for wind **lateral** and **shear** loads (s_{ws})	15"	33"	33"	45"
	Max. anchor bolt spacing to resist wind **uplift** loads (s_{wu}) (Table 3.2C)	60"[1]	60"[1]	33"	33"
Seismic	Tabulated anchor bolt spacing to resist **seismic** loads (s_s) (Table 3.3A)	72"	72"	72"	72"
	WSP Perimeter Edge Nail Spacing - **Seismic**	3"	3"	4"	6"
	Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) (C_{swa})	0.53	0.53	0.69	1.0
	Adjusted bolt spacing for seismic loads $s_{sa} = (s_s)(C_{swa})$	38"	38"	49"	72"[2]
	Max. anchor bolt spacing (lesser of s_{ws}, s_{wu}, and s_{sa})	**15"**	**33"**	**33"**	**33"**

[1]Calculated from *WFCM* Table 3.4C based on 16" o.c. (horizontal projection) outlooker spacing with 1 wall dead load subtracted (0.6x99plf) and anchor bolt capacity of 1488 lbs from *WFCM Commentary* Table 3.2B.

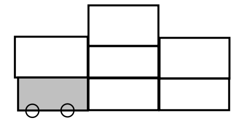
Table 3.4C 496 lbs x 12"/' / 16" = 372 plf

(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.



Job: WFCM Workbook **Description:** West Wing



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)

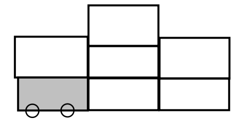
Three second gust wind speed:.. 120 mph Exp. B
Stories supported by Foundation:.. 2

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

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

[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. 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.

Job: WFCM Workbook **Description:** West Wing



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)

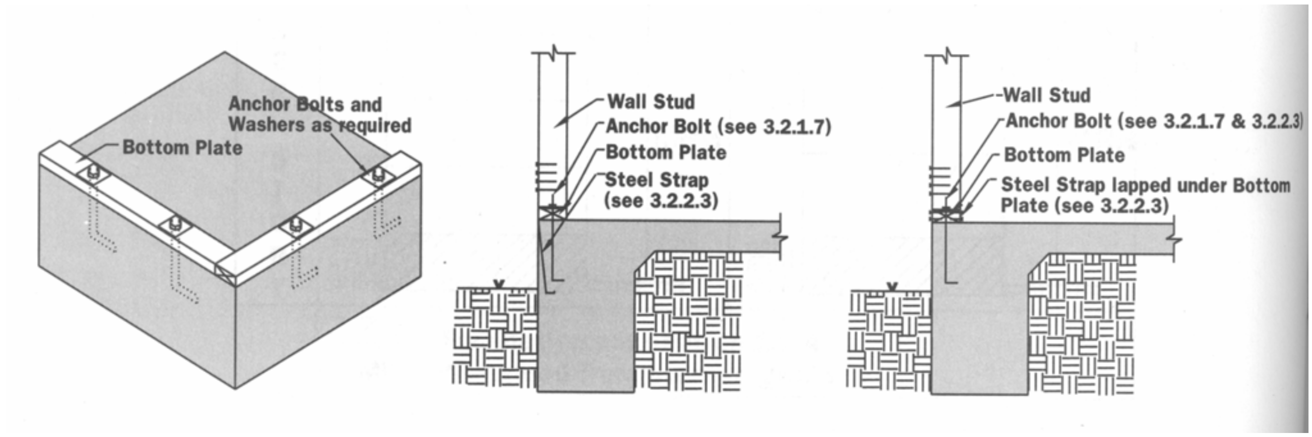
Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

Building Wall Elevation		**North**	**South**	**East**	**West**
Wind	Three second gust wind speed	120 mph Exp. B		120 mph Exp. B	
	Framing Spacing	16 in.		16 in.	
	Roof Span	32 ft.		32 ft.	
	Tabulated number of 8d Common Nails required in each end of 1-1/4" x 20 gage strap *every stud*	4		4[1]	
	No Ceiling Assembly nail increase (Footnote 3)	0			
	Required number of **8d Common Nails in each end of strap** *every stud* = Tabulated number of nails - Reductions + Increases	**4 ***		3 *	

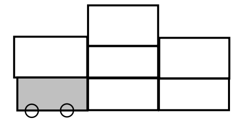
[1] calculated using 416 lbs uplift (below) divided by 127 lb/nail per *WFCM Supplement* Table 6A.

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

Wind	**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 psf – 15 psf) x 8'-0" x 16"/12"/' = 32 lbs]	-32 lbs	
	Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4) = [60 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 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**



Job: WFCM Workbook **Description:** West Wing



Connections (cont'd)

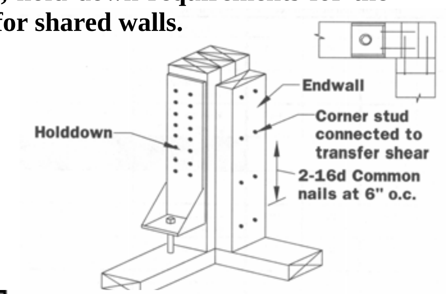
Overturning Resistance (WFCM 3.2.3)

Hold downs (WFCM 3.2.3.1)

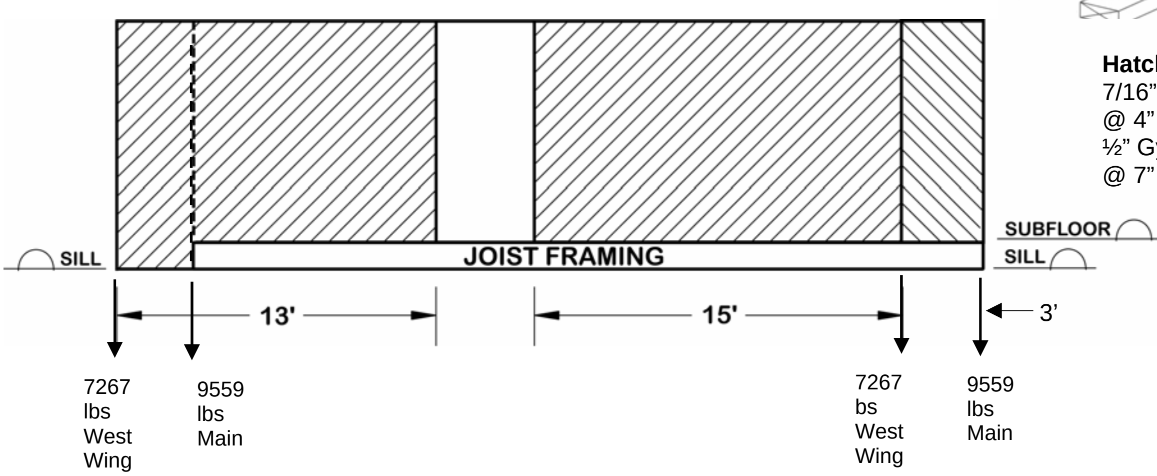
Choose Hold downs from Table 3.17F for Segmented (Type I) and Perforated (Type II) Walls (p. 176)

	Building Wall Elevation	North	South	East	West
	Wall Height	10'	10'	10'	10'
Wind	WSP Perimeter Edge Nail Spacing - **wind**	3"	3"	4"	6"
	Tabulated hold down connection capacity required – **wind** (T_w)	4360 lbs	4360 lbs	4360 lbs	4360 lbs
	Hold down adj. per Table 3.17F Footnotes (Table 3.17D) (C_{swa})	0.60	0.60	0.74	1.0
	Adjusted hold down capacity ($T_{wa} = (T_w) / (C_{swa})$)	**7267 lbs**	**7267 lbs**	**5892 lbs**	**4360 lbs**
Seismic	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.

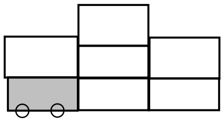


Hatched Wall Area (31 ft):
7/16" WSP 8d Common
@ 4" edge spacing +
½" Gyp (Unblocked) 5d Cooler
@ 7" edge spacing



East Wall Elevation

Job: WFCM Workbook Description: West Wing



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

Location	Edges	Field
4' Edge Zone	6	12
Interior Zones	6	12

Shear wall sheathing nail spacing requirements control.

Special Connections (WFCM 3.2.5)

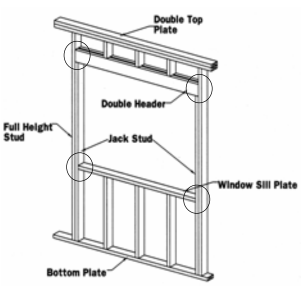
Connections around Wall Openings (WFCM 3.2.5.4)
.... Typical Window

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.

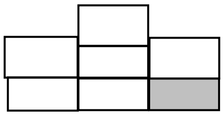
Master Bath (6' header) Tabulated Uplift Capacity (interpolated): .... 992 lbs.
Master Bath (6' header) Tabulated Lateral Capacity:.................... 472 lbs.

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)

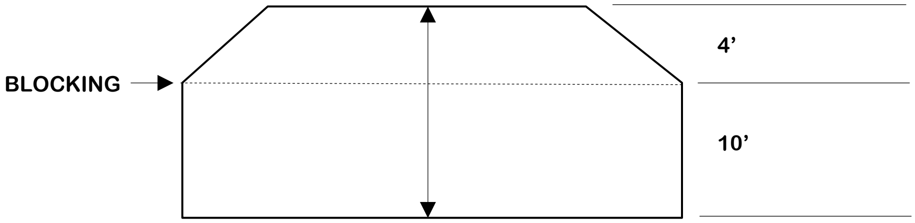
Specie	**Douglas Fir-Larch**	**Hem-Fir**	**Southern Pine**	**Spruce-Pine-Fir**
Spacing	**16**	**16**	**16**	**16**
Grade	**Stud**	**Stud**	**Stud**	**Stud**
Size	**2x4**[1]	**2x4**[1]	**2x4**[1]	**2x4**[1]
Maximum Length (Wind)	10'-5"	10'-2"	10'-10"	10'-2"
Maximum Length (Dead and Live Loads)	10'-0"	10'-0"	10'-0"	10'-0"

[1]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)

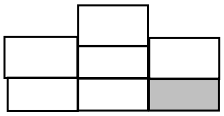
Same as West Wing Design (see *WFCM* Workbook p.55) except wall will balloon to raised ceiling to avoid formation of hinges.



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

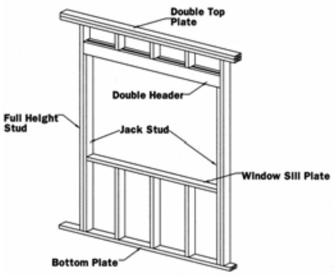
Exterior Loadbearing Wall Headers (WFCM 3.4.1.4.1)

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)

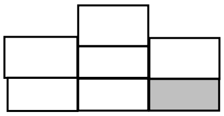
Choose Window Sill Plates from Table 3.23B (p. 193)

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"** >3' OK

Job: WFCM Workbook **Description:** East Wing



Wall Framing (cont'd)

....Master Bath

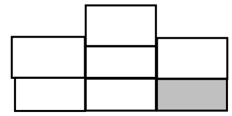
Exterior Non-Loadbearing Wall Headers (WFCM 3.4.1.4.1)

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)

Job: WFCM Workbook **Description:** East Wing



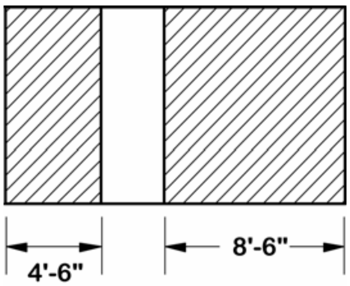
Wall Sheathing

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

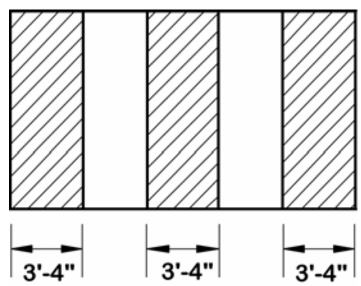
Sheathing Type (wood structural panels, fiberboard, board, hardboard): .... WSP
Direction Across Studs (Short or Long):.. Short
Stud Spacing: .... 16 in.
Minimum Panel Thickness:.. 3/8 in.
Shear wall minimum panel thickness (WFCM 3.4.4.2): .... 7/16 in.



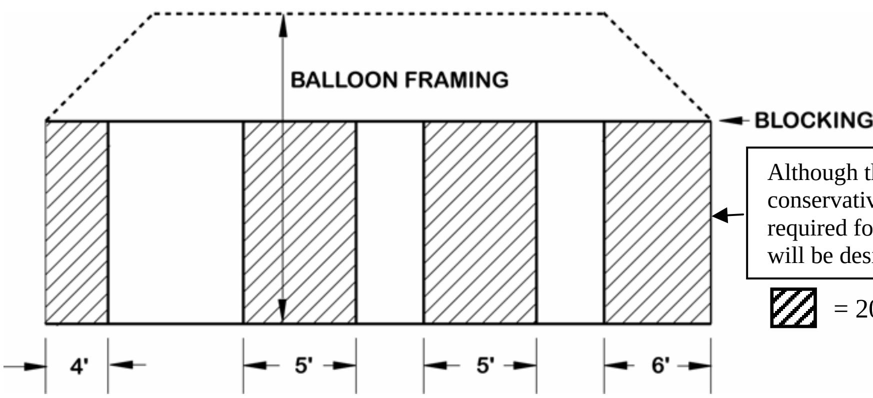
= 13 ft. long = L_{FH}

North Elevation

= 16 ft. long = L_{FH}



South Elevation

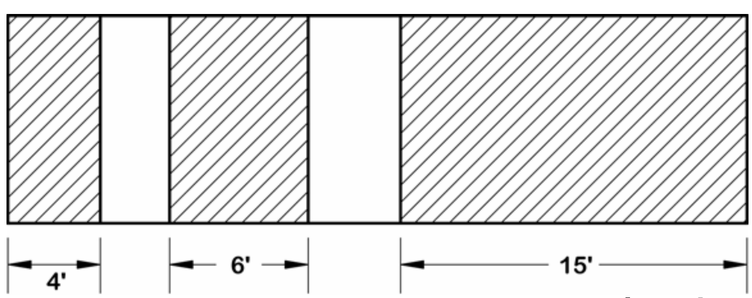


Although this wall is balloon framed to avoid hinges, conservatively the lower 10 ft below the blocking required for panel perimeter nailing (shown hatched) will be designed as a shear wall to resist lateral loads.

= 20 ft. long = L_{FH}

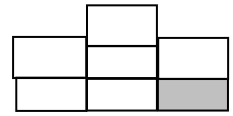
East Elevation

= 25 ft. long = L_{FH}



West Elevation

Job: WFCM Workbook **Description:** East Wing



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: .... 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.

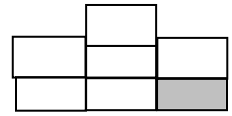
* Although the space above the kitchen ceiling is considered an Attic, Uninhabitable without Storage (see definition *WFCM* p. 6), the number of stories can be driven by the roof slope exceeding 6:12 (see *WFCM* 3.1.3.1 and Figure 3.1a), as in this case.

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).

STEPS			Load Parallel to Ridge		Load Perpendicular to Ridge		
		Building Wall Elevation	**North**	**South**	**East**	**West (h = 9')**	
		Length of Wall – East Wing	16'	16'	32'	32'	
1	**Seismic**	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	12.6'[1]	6.7'[1]	19.2'[1]	24.6'[1,2]	HAVE
2		Tabulated Minimum Length Full Height Sheathing for **Seismic** Loads per Table 3.17C (L_s) C_1 = 51 C_2 = 15 L_{max} = 32' L_{min} = 16'	10.6'	10.6'	10.6'	10.6'	
3		WSP Perimeter Edge Nail Spacing – **Seismic** (WFCM 3.4.4.2)	6"	3"	6"	6"	PICK
4		Shear wall Adjustment per Table 3.17D (C_{swa})	1.0	0.53	1.0	1.0	
5		Min. Length Full Ht. Sheathing - Segmented **Seismic** ($L_{TypeI\text{-}S} = L_s \times C_{swa}$)	10.6'	5.6'	**10.6'**	**10.6'**	NEED
1		$L_{TypeI\text{-}S} < L_{FHS}$	**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**	
2	**Wind**	Effective Length of Full Height Sheathing (L_{FH})	13'	10'	20'	25'	HAVE
3		Tabulated Minimum Length Full Height Sheathing for **Wind** Loads per Table 3.17B and 3.17A (L_w)	10.6'[3]	10.6'[3]	7.1'[4]	7.1'[4]	
4		WSP Perimeter Edge Nail Spacing – **Wind** (WFCM 3.4.4.2)	4"	3"	6"	6"	PICK
5		Shear wall Adjustment per Table 3.17D (C_{swa})	0.74	0.6	1.0	1.0	
		Wall Height Adjustment (Table 3.17A&B Footnote 2) (C_{WH} =10' / 8')	1.25	1.25	1.25	1.125	
6		Min. Length Full Ht. Sheathing-Segmented **Wind** ($L_{TypeI\text{-}W}=L_w(C_{WH})(C_{swa})$)	**9.8'**	**8.0'**	8.9'	8.0'	NEED
		$L_{TypeI\text{-}W} < L_{FH}$	**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 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.

Job: WFCM Workbook **Description:** East Wing



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)

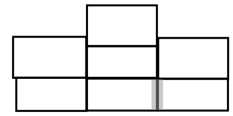
			Load Parallel to Ridge		Load Perpendicular to Ridge	
		Building Wall Elevation	**North**	**South**	**East**	**West**
		Wall Height	10'	10'	10'	9'
		Max. Unrestrained Opening Height	8'-4"	4'-6"	8'-4"	7'-6"
HAVE		Actual Length of Full Height Sheathing (L_{FH})	13'	10'	20'	25'
	Seismic	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})	12.6'[1]	6.7'[1]	19.2'[1]	24.6'[1,2]
	Seismic	Length of Wall (L_{Wall})	16'	16'	32'	32'
	Seismic	Percent Full Height Sheathing (L_{FH} / L_{Wall})	81%	63%	63%	78%
	Seismic	Minimum Length Full Height Sheathing - Segmented **Seismic** ($L_{TypeI-S}$)	10.6'	5.6'	10.6'	10.6'
	Seismic	Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.13	1.11	1.29	1.15
NEED	Seismic	Min. Length Full Ht. Sheathing-Perforated **Seismic** ($L_{TypeII-S}=L_{TypeI-S}(C_L)$)	12.0'	6.2'	**13.7'**	**12.2'**
		$L_{TypeII-S} < L_{FHS}$	**Ok?✓**	**Ok?✓**	**Ok?✓**	**Ok?✓**
HAVE		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%
	Wind	Minimum Length Full Height Sheathing - Segmented **Wind** ($L_{TypeI-W}$)	9.8'	8.0'	8.9'	8.0'
	Wind	Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.13	1.11	1.29	1.15
NEED	Wind	Min. Length Full Ht. Sheathing-Perforated **Wind** ($L_{TypeII-W} = L_{TypeI-W}(C_L)$)	**11.1'**	**8.9'**	11.5'	9.2'
		$L_{TypeII-W} < L_{FH}$	**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

Building Elevation	**North**	**South**	**East**	**West**
Shear Wall Type	Perf	Perf	Perf	Perf
WSP Perimeter Nail Spacing	4"	3"	6"	6"
Governing Load	Wind	Wind	Seismic	Seismic

Job: WFCM Workbook Description: East Wing



Wall Sheathing (cont'd)

Combine Shear Wall Requirements for Main Building and East Wing

Adjust Shear Wall Requirements to Common Nailing Pattern

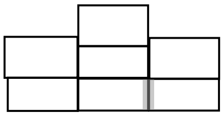
	Building Wall Elevation	**Wind**	**Seismic**
	Segmented (Type I) Shear Wall Requirements – Sheathing Thickness	7/16"	7/16"
REQ'D FROM	Main Building – East Elevation (WSP perimeter edge nail spacing) (L_{FH1})	18.6'(3")	20.4'(4")
	Length adjustment factor, C_{swa1} (Table 3.17D)	0.60	0.69
	Revised Length Adjustment Factor ($C_{swa1revised}$) (Table 3.17D)	no change	**0.53**
	Length adjustment factor ratio $C_{swa1\ ratio} = C_{swa1revised} / C_{swa1}$	no change	0.77
	Adjusted Shared wall length = $L_{FH1} * C_{swa1\ ratio} = L_{FHadj1}$	18.6'(3")	**15.7'(3")**
REQ'D FROM	East Wing – West Elevation (WSP perimeter edge nail spacing) (L_{FH2})	8.0'(6")	10.6'(6")
CHANGE	Length adjustment factor, C_{swa2} (Table 3.17D)	1.0	1.0
REVISED	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")**
NEED	Adjusted Shared Wall – Total Requirement ($L_{TypeIadjusted}$) = $L_{FHadj1} + L_{FHadj2}$	23.4'	21.3'
HAVE	Actual Length of Full Height Sheathing (L_{FH})	28.0'[1]	28.0'[1]
	$L_{TypeIadjusted} < L_{FH}$	**Ok? ✓**	**Ok? ✓**
	Perforated (Type II) Shear Wall Requirements		
	Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)	1.15	1.15
NEED	Min. Length Full Ht. Sheathing-Perforated ($L_{TypeIIadjusted} = L_{TypeIadjusted} (C_L)$)	26.9'	24.5'
HAVE	Actual Length of Full Height Sheathing (L_{FH})	28.0'[1]	28.0'[1]
	$L_{TypeIIadjusted} < L_{FH}$	**Ok? ✓**	**Ok? ✓**

Use Table 3.17D (p.174) to increase sheathing capacity for Main Building and East Wing wall elevations. Changing the WSP sheathing edge nail spacing to 3"o.c., gives a length adjustment factor, C_{swa}, of 0.53 for seismic loads and 0.60 for wind loads. (the previous values of C_{swa} was 1.0 for 6" nail spacing for wind and seismic loads, and 0.69 for seismic load for 4" nail spacing).

[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.

Job: WFCM Workbook **Description:** East Wing

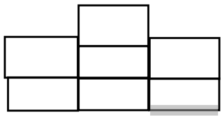


Wall Sheathing (cont'd)

Combine Shear Wall Requirements for Main Building and East Wing

Bottom Story East Wing Shear Wall Details Summary - Final

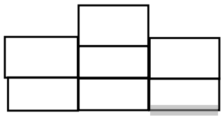
Building Elevation	**North**	**South**	**East**	**West**
Shear Wall Type	Perf	Perf	Perf	Perf
WSP Perimeter Nail Spacing	4"	3"	6"	3"
Governing Load	Wind	Wind	Seismic	Wind
Shear wall Adjustment per Table 3.17D (C_{swa})	0.74	0.6	1.0	0.60



Floor Framing

Floor Joists (WFCM 3.3.1.1)

Slab on Grade – not applicable

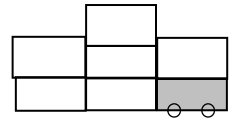


Floor Sheathing

Sheathing Spans (WFCM 3.3.4.1)

Slab on Grade – not applicable

Job: WFCM Workbook **Description:** East Wing



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)

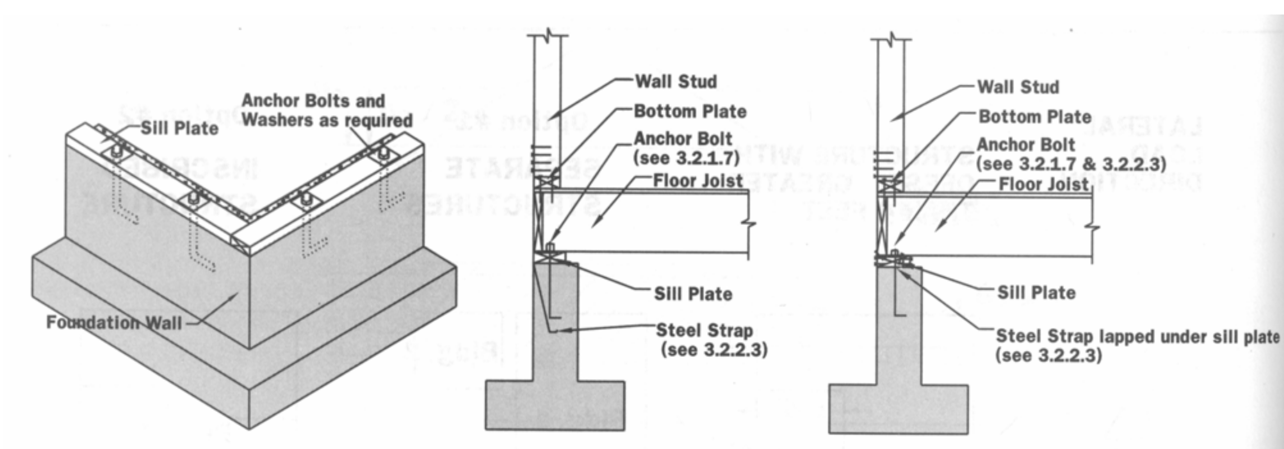
Choose Sill or Bottom Plate to Foundation Connection Requirements for Anchor Bolts Resisting Lateral, Shear, and Uplift Loads from Table 3.2A & B (pp. 142-144) and Table 3.3A (p. 147).

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

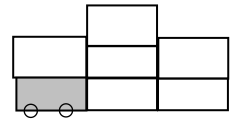
Assuming Crawl Space or Basement, determine maximum Anchor Bolt Spacing for common wall portion :

	Building Wall Elevation	**North**	**South**	**East**	**West**
	Shear wall line dimension (L_{sw})				32'
	Building dimension perpendicular to shear wall line (Table 3.2A)				16'
Wind	Number of stories receiving **wind** load (Table 3.2A)				2
Wind	Tabulated number of bolts to resist shear loads from wind (Table 3.2A)				5
Wind	Bolt spacing for wind **shear** loads $s_{ws} = (L_{sw}-2) / (\text{number of bolts}-1)$				**72"**[1, 2, 3]
Wind	Max. bolt spacing to resist wind **uplift** loads (s_{wu}) (Table 3.2C & 3.4C)				**N/A**[4]

[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:** East Wing



Connections (cont'd)

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

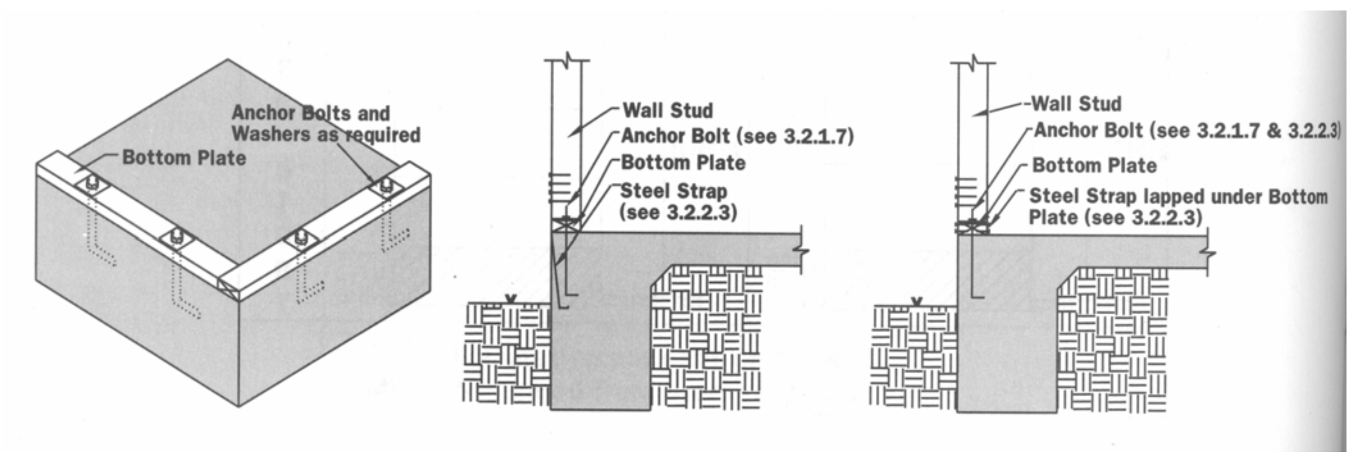
	Building Wall Elevation	North	South	East	West
	Shear wall line dimension (L_{sw})	16'	16'	32'	36'
Wind	Number of stories receiving **wind** load (Table 3.2B)	2	2	2	2
Wind	Bolt spacing for wind **lateral** and **shear** loads (Table 3.2B)	45"	45"	45"	45"
Wind	Wall sheathing type adjustment factor per Table 3.17D (Table 3.2B Footnote 3) (assumes perforated shear wall capacities) C_{swa}	0.74	0.60	1.0	0.60
Wind	Adjusted bolt spacing for wind **lateral** and **shear** loads (s_{ws})	33"	27"	45"	27"
Wind	Max. anchor bolt spacing to resist wind **uplift** loads (s_{wu}) (Table 3.2C)	60"[1]	60"[1]	33"	33"
Seismic	Tabulated anchor bolt spacing to resist **seismic** loads (s_s) (Table 3.3A)	72"	72"	72"	72"
Seismic	WSP Perimeter Edge Nail Spacing - **Seismic**	4"	3"	6"	3"
Seismic	Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) (C_{swa})	0.69	0.53	1.0	0.53
Seismic	Adjusted bolt spacing for seismic loads $s_{sa} = (s_s)(C_{swa})$	49"	38"	72"[2]	38"
	Max. anchor bolt spacing (lesser of s_{ws}, s_{wu}, and s_{sa})	**33"**	**27"**	**33"**	**27"**

[1]Calculated from *WFCM* Table 3.4C based on 16" o.c. (horizontal projection) outlooker spacing with 1 wall dead load subtracted (0.6x99plf) and anchor bolt capacity of 1488 lbs from *WFCM Commentary* Table 3.2B.

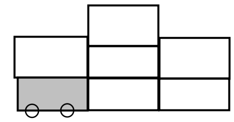
Table 3.4C 496 lbs x 12"/' / 16" = 372 plf

(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.



Job: WFCM Workbook **Description:** East Wing



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)

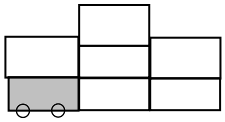
Three second gust wind speed:.. 120 mph Exp. B
Stories supported by Foundation:... 2

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

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

[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. 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.

Job: WFCM Workbook **Description:** East Wing



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)

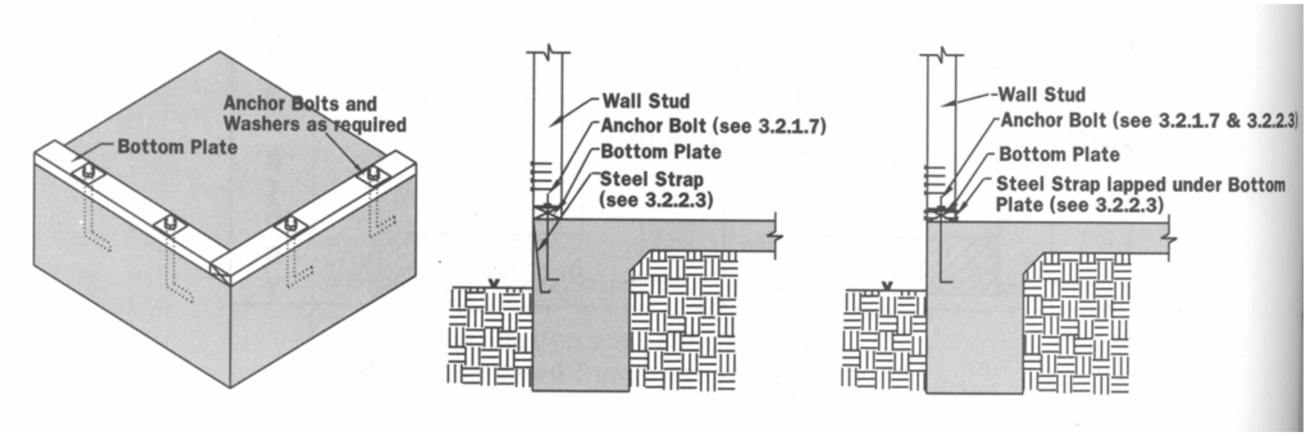
Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

	Building Wall Elevation	**North**	**South**	**East**	**West**
Wind	Three second gust wind speed	120 mph Exp. B		120 mph Exp. B	
	Framing Spacing	16 in.		16 in.	
	Roof Span	32 ft.		32 ft.	
	Tabulated number of 8d Common Nails required in each end of 1-1/4" x 20 gage strap *every stud*	4		4[1]	
	No Ceiling Assembly nail increase (Footnote 3)	0			
	Required number of **8d Common Nails in each end of strap** *every stud* = Tabulated number of nails - Reductions + Increases	**4 ***		3 *	

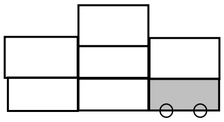
[1] calculated using 416 lbs uplift (below) divided by 127 lb/nail per *WFCM Supplement* Table 6A.

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

Wind	**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 psf – 15 psf) x 8'-0" x 16"/12"/' = 32 lbs]	-32 lbs	
	Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4) = [60 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 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**



Job: WFCM Workbook **Description:** East Wing



Connections (cont'd)

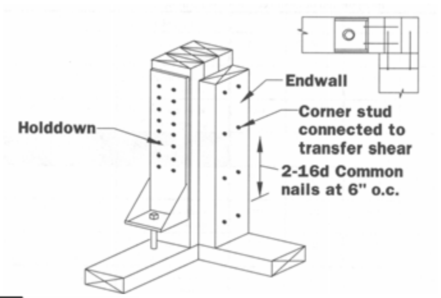
Overturning Resistance (WFCM 3.2.3)

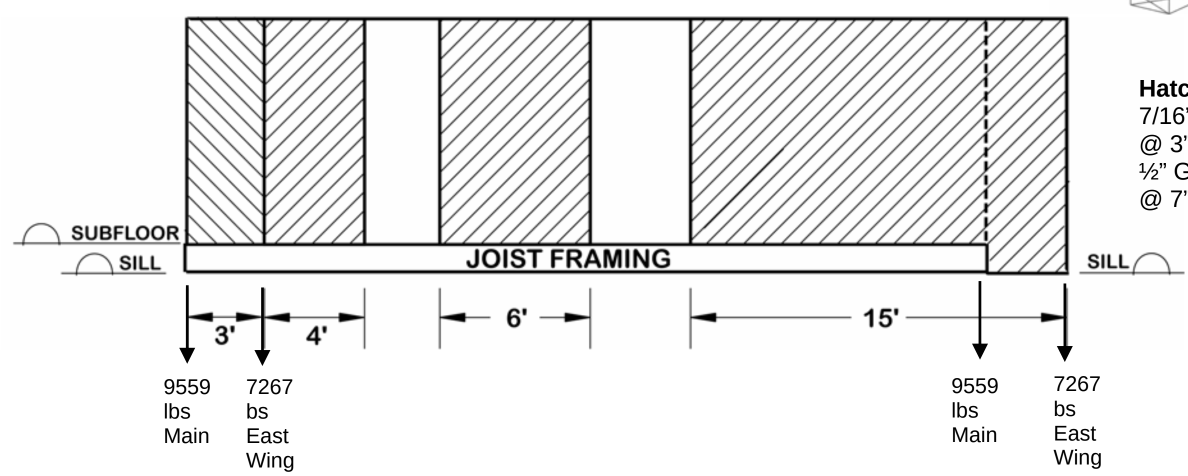
Hold downs (WFCM 3.2.3.1)

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

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

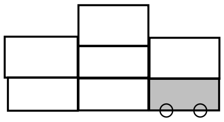




Hatched Wall Area (28 ft):
7/16" WSP 8d Common
@ 3" edge spacing +
½" Gyp (Unblocked) 5d Cooler
@ 7" edge spacing

West Wall Elevation

Job: WFCM Workbook **Description: East Wing**



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).

Job: WFCM Workbook **Description:** East Wing

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

<u>Windows</u>
Typical
Master Bath
Foyer
Kitchen
North Bath

<u>Doors</u>
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	= __________		
Floor Assembly Height	= __________	Wing Mean Roof Height	= ____________
Overall Building Dimension	= __________		
Foundation Type	= __________	Roof Overhang Distance	= ____________

Job:______________________________ **Description:**____________________

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:

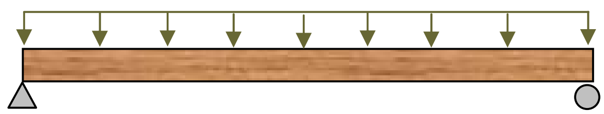
Seismic Design Category (SDC) = ________

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/Δ = ______

Roof Rafters with no Ceiling Attached L/Δ = ______

Floor Joists L/Δ = ______

Job:________________________________ **Description:**__________________________

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).

Attribute		Limitation	Design Case	✓
BUILDING DIMENSIONS				
Number of Stories	maximum	3		
Roof Slope	minimum	Flat		
	maximum	12:12		
Mean Roof Height (MRH)	maximum	33'		
Building Dimension (L or W)	minimum			
	maximum	80'		
Building Aspect Ratio (L/W)	minimum	1:4		
	maximum	4:1		

Job:________________________________ **Description:**__________________________

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).

Element	Attribute	Limitation	Design Case	✓
FLOOR SYSTEMS				
Lumber Joists	Joist Span	26' maximum		
	Joist Spacing	24" maximum		
	Cantilevers/Setback - Supporting loadbearing walls or shearwalls	d[1] maximum		
	Cantilevers - Supporting non-loadbearing wall non-shearwall	L/4 maximum		
Floor Diaphragms	Vertical Floor Offset	d_f maximum		
	Floor Diaphragm Aspect Ratio	3:1 maximum		
	Floor Diaphragm Openings	Lesser of 12' or 50% of Dia. Dimension		
WALL SYSTEMS				
Wall Studs	Loadbearing Wall Height	10' maximum		
	Non-Loadbearing Wall Height	20' maximum		
	Wall Stud Spacing	24" maximum		
Shearwalls	Shearwall Line Offset	4' maximum		
	Shearwall Story Offset	d maximum		
	Shearwall Segment Aspect Ratio	3½:1 maximum[2]		
ROOF SYSTEMS				
Lumber Rafters	Rafter Span (Horizontal Projection)	26'[2] maximum		
	Rafter Spacing	24" maximum		
	Eave Overhang Length	Lesser of 2' or rafter length/3		
	Rake Overhang Length	Lesser of 2' or purlin span/2		
	Roof Slope	12:12 maximum		
Roof Diaphragms	Roof Diaphragm Aspect Ratio	3:1 maximum		

[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.

Job:________________________________ Description:__________________________

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 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? ❑

Job:________________________________ **Description:**____________________________

WFCM 3.3 FLOOR SYSTEMS CHECKLIST

3.3.1 WOOD JOIST SYSTEMS

3.3.1.1 Floor Joists .... Ok? ❑

3.3.1.1.1 Notching and Boring .... Ok? ❑

3.3.1.2 Bearing .... Ok? ❑

3.3.1.3 End Restraint .... Ok? ❑

3.3.1.4 Lateral Stability .... Ok? ❑

3.3.1.5 Single or Continuous Floor Joists

3.3.1.5.1 Supporting Loadbearing Walls .... Ok? ❑

3.3.1.5.2 Supporting Non-Loadbearing Walls .... Ok? ❑

3.3.1.5.3 Supporting Concentrated Loads .... Ok? ❑

3.3.1.6 Cantilevered Floor Joists

3.3.1.6.1 Supporting Loadbearing Walls .... Ok? ❑

3.3.1.6.2 Supporting Non-Loadbearing Walls .... Ok? ❑

3.3.1.7 Floor Diaphragm Openings .... Ok? ❑

3.3.2 WOOD I-JOIST SYSTEMS .... Ok? ❑

3.3.3 WOOD FLOOR TRUSS SYSTEMS .... Ok? ❑

3.3.4 FLOOR SHEATHING

3.3.4.1 Sheathing Spans .... Ok? ❑

3.3.4.2 Sheathing Edge Support .... Ok? ❑

3.3.5 FLOOR DIAPHRAGM BRACING .... Ok? ❑

Job:________________________________ Description:___________________________

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? ❑

Job:________________________________ **Description:**______________________________

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? ❑

Job:_________________________________ Description:___________________________

Roof and Ceiling Framing Details

Cross Section

Roof Framing

Ceiling Framing

Job:________________________________ **Description:**__________________________

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/Δ: .... ________
Required Span (Horizontal Projection): .... ________ ft.

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

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

	Species								
	Spacing								
	Grade								
④	Table 3.26A Span								
	Live Load Span ④X①X③								
⑤	Table 3.26A Span								
	Wind Load Span ⑤X②X③								
⑥	Table 3.26C Span								
	Snow Load Span ⑥X①								

Job:________________________________ **Description:**__________________________

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:

____

Job:_______________________________ Description:__________________________

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)

Specie				
Spacing				
Grade				
Size				
Maximum Span				

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)

Specie				
Spacing				
Grade				
Size				
Maximum Span				

Job:________________________________ Description:___________________________

Ceiling Framing

Ceiling Joists (WFCM 2.5.1.6)

For <u>uninhabitable attics without storage</u>, 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:

Size			
Required E			psi
Required F_b			psi

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

TRIAL AND ERROR

Specie				
Size & Grade				
Tabulated E, psi				
Tabulated F_b, psi				
Size Factor, C_F				
Load Duration Factor, C_D				
Repetitive Member Factor, C_r				
Allowable F_b, psi				

Adjustment factors for Table 4A are found on *WFCM* p. 279-280.
Adjustment factors for Table 4B are found on *WFCM* p. 286-287.

Job:______________________________ Description:___________________________

Roof and Ceiling Sheathing

Sheathing (WFCM 3.5.4.1)

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

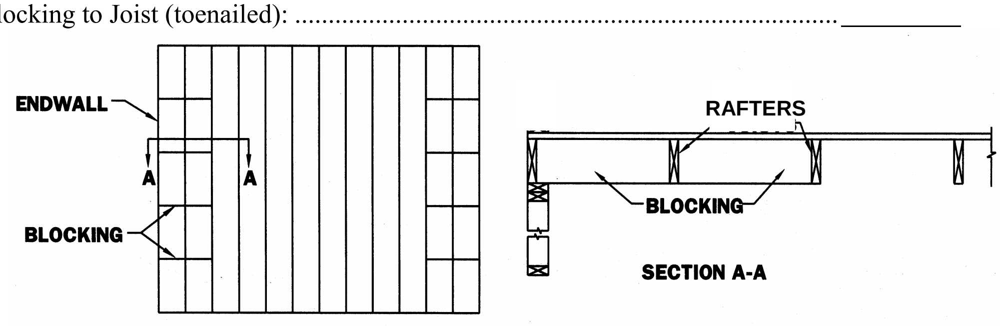
Ground Snow Load .... ______ psf
Live Load .... ______ psf
Dead Load .... ______ psf
Three second gust windspeed: .... ______ mph Exp. ____

Rafter/Truss Spacing: .... _______ in.
Sheathing Type: .... _______

Tabulated Minimum Panel Thickness:
From Table 3.12A: .... ______ in.
From Table 3.12B: .... ______ 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 (toenailed): .... _________

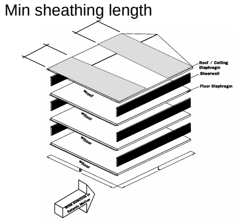


OR

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: .... _________ mph Exp. ___
Roof Pitch: .... _________
Diaphragm Span: .... _________ft.
Sheathing Type: .... _________

Tabulated Minimum Length of Attic Floor/Ceiling Diaphragm: .... _________ 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: .... _________ ft.
Tabulated minimum length ≥ 1/3 distance between bracing endwalls..... _________ ft.
(per Table 3.15 Footnote 1)

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

Job:________________________________ Description:___________________________

Connections – Roof Lateral, Shear, Uplift

Lateral Framing and Shear Connections (WFCM 3.2.1)

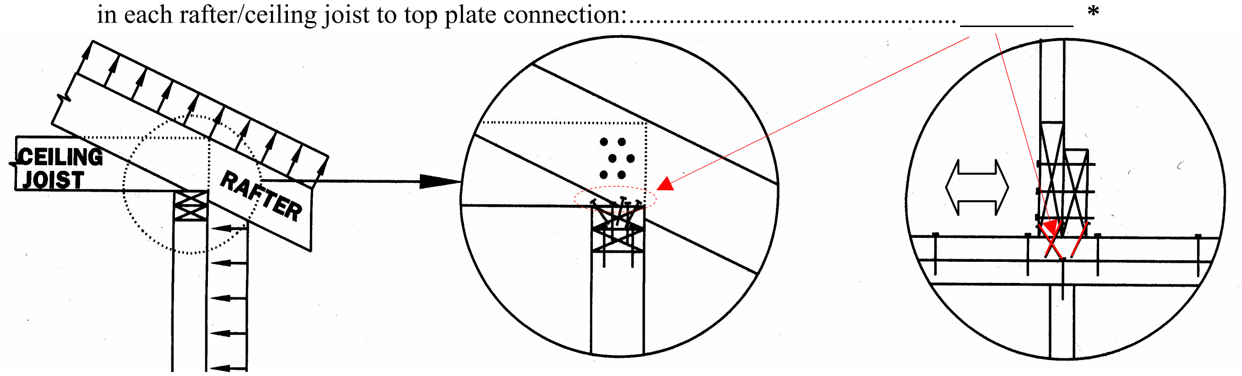
Roof Assembly to Wall Assembly (WFCM 3.2.1.2)

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:.. ________ *



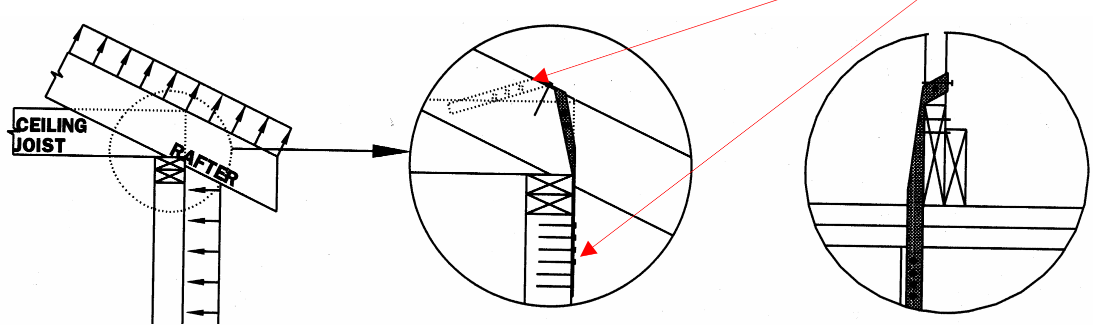
Uplift Connections (WFCM 3.2.2)

Roof Assembly to Wall Assembly (WFCM 3.2.2.1)

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

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

[1] calculated using _______ lbs uplift (below) divided by _______ lb/nail per *WFCM Supplement* Table 6A.

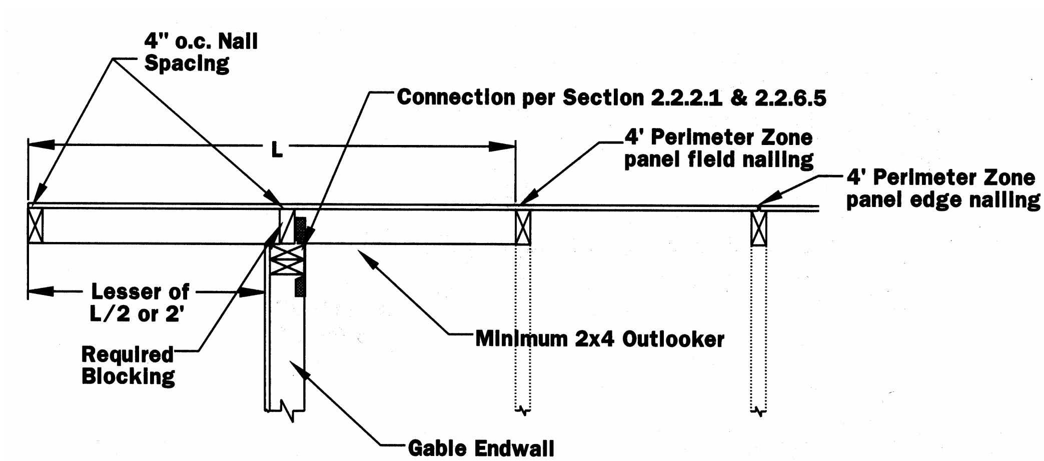


Job:________________________________ Description:__________________________

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) = [0.60(___ psf – 15 psf) x ______' x _____" / 12 "/ ' = _______ lbs]		
Wind	**Non-Loadbearing Walls** - Tabulated minimum uplift connection capacity (Table 3.4C, page 152)		
	Overhang Multiplier (Table 3.4C, Footnote 2) $[(2' + OH) / 4']^2$ OH = _____'		
	Zone 2 Multiplier (Table 3.4C, Footnote 3)		
	Required Minimum **Uplift** Capacity of proprietary connector = Tabulated minimum capacity x Adjustments - Reduction		
	Required Minimum **Lateral** Capacity		
	Required Minimum **Shear Parallel to Ridge** Capacity		
	Required Minimum **Shear Perpendicular to Ridge** Capacity		



Job:________________________________ **Description:**__________________________

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:.. ________

	Nail Spacing 8d Common Nails	
Location	Edges	Field
4' Perimeter Edge Zone		
Interior Zones		
Gable Endwall Rake with Lookout Block		

* 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)

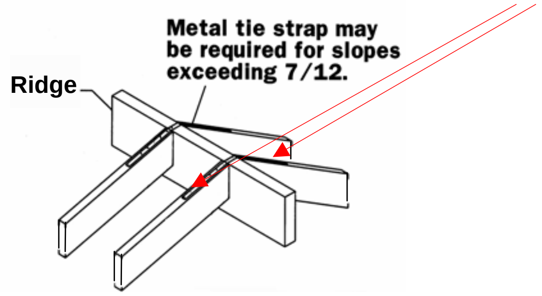
For a clean finished ceiling line, rather than using collar ties to resist upward ridge separation, choose Ridge Tension Strap Connection from Table 3.6A (p. 156)

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: .... ________ *



Job:_______________________________ **Description:**_________________________

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

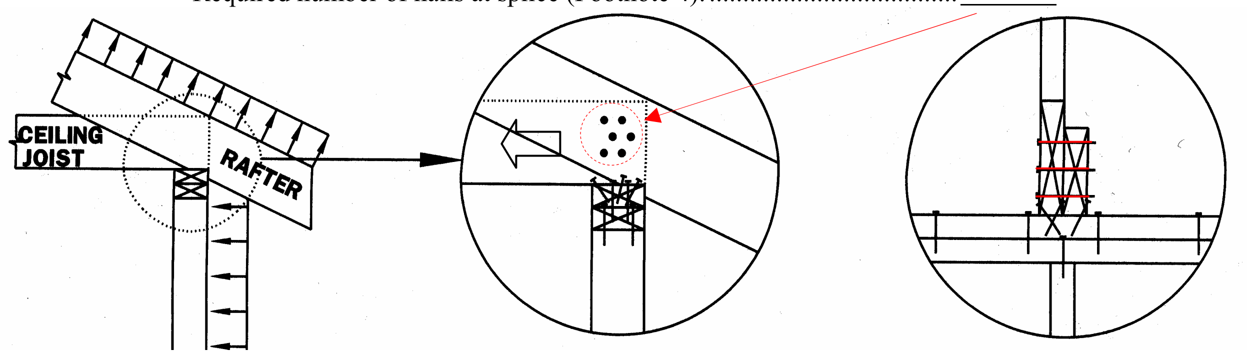
Table 3.1 Nailing Schedule

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:.. ________ in.

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): ...... ______________________________

<u>OR</u>

Rim Board to Rafter Connection from Table 3.1 (p. 139): . ______________________________

Job:________________________________ Description:___________________________

Wall Framing - Studs

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:.. ________ 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)

Specie				
Spacing				
Grade				
Size				
Maximum Length (Wind)				
Maximum Length (Dead and Live Loads)				

.... **Non-Loadbearing**

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

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

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

Specie				
Spacing				
Grade				
Size				
Maximum Length (Wind)				
Maximum Length (Dead and Live Loads)				

Job:______________________________ Description:_________________________

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.

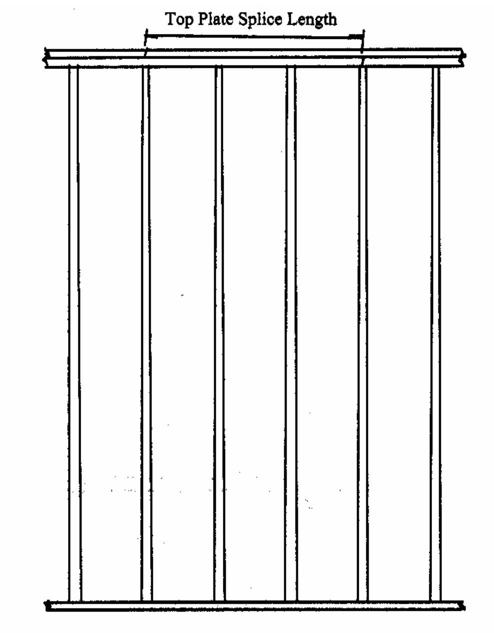
Connection: top plate – to – top plate:.. _______ nails per ft.

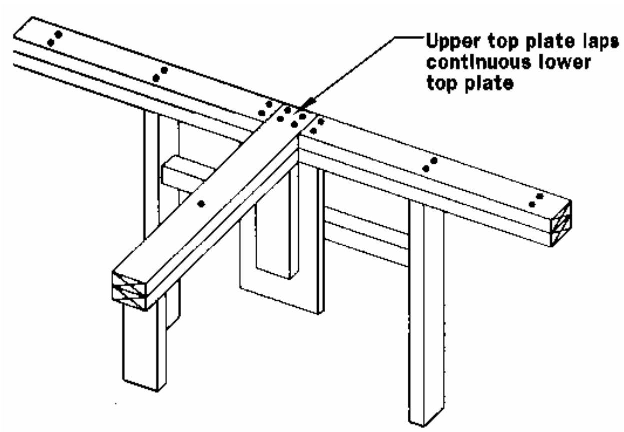
Choose Building Side wall Double Top Plate Lap Splice Length from Table 3.21 (p. 185)

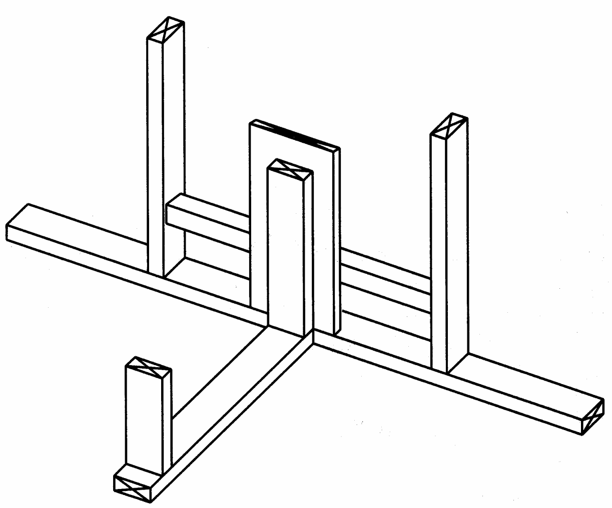
Building Dimension: .... _______ ft.

Tabulated Minimum Splice Length:... _______ ft.

Connection: top plate – to – top plate:.. ________ nails per ft.







Job:________________________________ **Description:**___________________________

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:........________

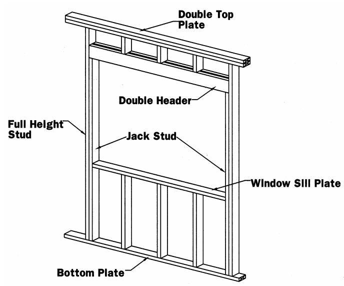


Table 3.23A (p. 192)
Preliminary Header Selection (Wind Loads): __________________ ____ ________
Maximum Header/Girder Span ....________ ft.
Tabulated Number of Full Height (King) Studs (Table 3.23C):.............________
Reduced Full Height Stud Requirements (Table 3.23D):......................________
(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 – $(H/10)^{1/2}$):..________

Adjusted Maximum Sill Plate Length:
Tabulated maximum Sill Plate Length ÷ wall Height Adjustment: ....________

Job:________________________________ **Description:**__________________________

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 – $(H/10)^{1/2}$): ...._______
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 – $(H/10)^{1/2}$): ...._______
Adjusted Header Span:..._______
Number of Full Height (King) Studs Required: ...._______
(same species / grade as Non-Loadbearing Studs (WFCM 3.4.1.4.2))

Job:________________________________ **Description:**____________________________

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:.. ________

Job:________________________________ **Description:**__________________________

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: .... _______ in.
Minimum Panel Thickness:.. _______ in.
Shear wall minimum panel thickness (WFCM 3.4.4.2): .... _______ in.

= ____ ft. long = L_{FH}

North Elevation

= ____ ft. long = L_{FH}

South Elevation

= ____ ft. long = L_{FH}

East Elevation

= ____ ft. long = L_{FH}

West Elevation

Job:________________________________ **Description:**__________________________

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.

Seismic Design Category: .... ________
Maximum shear wall aspect ratio for seismic (Table 3.17D Footnote 3):............. ________
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.

STEPS		**Building Wall Elevation**	**Load Parallel to Ridge** North		**Load Perpendicular to Ridge** East		
			North	**South**	**East**	**West**	
		Length of Building ____________					
1	**Seismic**	Effective Length of Full Height Sheathing for **Seismic** (L_{FHS})					HAVE
2	**Seismic**	Tabulated Minimum Length Full Height Sheathing for **Seismic** Loads per Table 3.17C (L_s) C_1 = ___ C_2 = ____ L_{max} = _____ L_{min} = _______					
3	**Seismic**	WSP Perimeter Edge Nail Spacing – **Seismic** (WFCM 3.4.4.2 + 3.4.4.2.1)					PICK
4	**Seismic**	Shear wall Adjustment per Table 3.17D (C_{swa})					
5	**Seismic**	Min. Length Full Ht. Sheathing–Segmented **Seismic** ($L_{TypeI\text{-}S} = L_s(C_{swa})$)					NEED
		$L_{TypeI\text{-}S} < L_{FHS}$	**Ok?**	**Ok?**	**Ok?**	**Ok?**	
1	**Wind**	Effective Length of Full Height Sheathing (L_{FH})					HAVE
2	**Wind**	Tabulated Minimum Length Full Height Sheathing for **Wind** Loads per Table 3.17B and 3.17A (L_w)					
3	**Wind**	WSP Perimeter Edge Nail Spacing – **Wind** (WFCM 3.4.4.2)					PICK
4	**Wind**	Shear wall Adjustment per Table 3.17D (C_{swa})					
5	**Wind**	Wall Height Adjustment (Table 3.17A&B Footnote 2) (C_{WH} = ___'/8')					
6	**Wind**	Min. Length Full Ht. Sheathing–Segmented **Wind** ($L_{TypeI\text{-}W}=L_w(C_{WH})(C_{swa})$)					NEED
		$L_{TypeI\text{-}W} < L_{FH}$	**Ok?**	**Ok?**	**Ok?**	**Ok?**	

Job:________________________________ **Description:**___________________________

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)

			Parallel to Ridge		Perpendicular to Ridge	
	Building Wall Elevation		**North**	**South**	**East**	**West**
	Wall Height					
	Max. Unrestrained Opening Height					
	Actual Length of Full Height Sheathing (L_{FH})					
HAVE	**Seismic**	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** ($L_{TypeI\text{-}S}$)				
		Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)				
NEED		Min. Length Full Ht. Sheathing - Perforated Seismic ($L_{TypeII\text{-}S} = L_{TypeI\text{-}S}$ (C_L))				
	$L_{Type\ II}$ < L_{FHS}		**Ok?**	**Ok?**	**Ok?**	**Ok?**
HAVE	**Wind**	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** ($L_{TypeI\text{-}W}$)				
		Perforated (Type II) Length Increase Factor from Table 3.17E (C_L)				
NEED		Min. Length Full Ht. Sheathing - Perforated **Wind** ($L_{TypeII\text{-}W} = L_{TypeI\text{-}W}$ (C_L))				
	$L_{TypeII\text{-}W}$ < L_{FH}		**Ok?**	**Ok?**	**Ok?**	**Ok?**

Remarks:

Shear Wall Details Summary ____

Building Elevation	**North**	**South**	**East**	**West**
Shear Wall Type				
WSP Perimeter Nail Spacing				
Governing Load				
Shear wall Adjustment per Table 3.17D (C_{swa})				

Job:_______________________________ **Description:**__________________________

Wall Sheathing - Combined Shear Walls

Combine Shear Wall Requirements at Interface of Two Buildings ________

	Building Wall Elevation	Wind	Seismic
	Segmented (Type I) Shear Wall Requirements – Sheathing Thickness		
REQ'D FROM	Building 1 – __________ Elevation (WSP perimeter edge nail spacing) (L_{FH1})		
	Length adjustment factor, C_{swa1} (Table 3.17D)		
	Revised Length Adjustment Factor ($C_{swa1revised}$) (Table 3.17D)		
	Length adjustment factor ratio $C_{swa1\ ratio} = C_{swa1revised} / C_{swa1}$		
	Adjusted Shared wall length = $L_{FH1} * C_{swa1\ ratio} = L_{FHadj1}$		
REQ'D FROM	Building 2 – __________ Elevation (WSP perimeter edge nail spacing) (L_{FH2})		
CHANGE	Length adjustment factor, C_{swa2} (Table 3.17D)		
REVISED	Revised Length Adjustment Factor ($C_{swa2revised}$) (Table 3.17D)		
	Length adjustment factor ratio $C_{swa2\ ratio} = C_{swa2revised} / C_{swa2}$		
	Adjusted Shared wall length = $L_{FH2} * C_{swa2\ ratio} = L_{FHadj2}$		
NEED	Adjusted Shared Wall – Total Requirement ($L_{TypeIadjusted}$) = $L_{FHadj1} + L_{FHadj2}$		
HAVE	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)		
NEED	Min. Length Full Ht. Sheathing-Perforated ($L_{TypeIIadjusted} = L_{TypeIadjusted} (C_L)$)		
HAVE	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

Building Elevation	**North**	**South**	**East**	**West**
Shear Wall Type				
WSP Perimeter Nail Spacing				
Governing Load				
Shear wall Adjustment per Table 3.17D (C_{swa})				

Job:________________________________ **Description:**___________________________

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)

Specie				
Spacing				
Grade				
Size				
Maximum Span				

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.

Job:_______________________________ Description:_________________________

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: (6" nail spacing)............. ________________________
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: .... ________________________

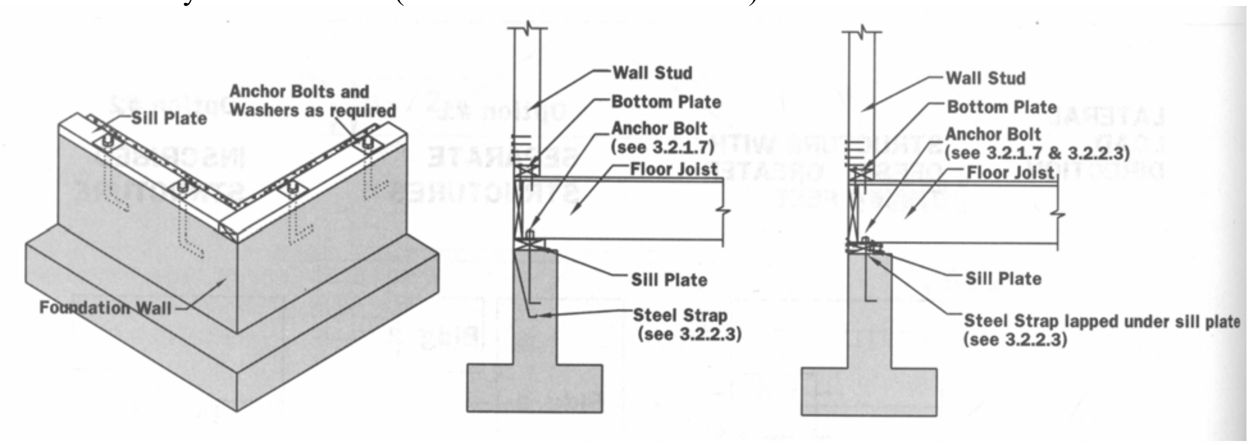
Band Joist to Sill or Top Plate Connection from Table 3.1: .... ________________________
Table 3.1 Footnote 1 for wall sheathing perimeter nailing spacings < 6"
(4" nail spacing: 1.67 x _____ nails) .... ________________________
(3" nail spacing: 2.0 x _____ nails) .... ________________________

Job:________________________________ **Description:**__________________________

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:

	Building Wall Elevation	**North**	**South**	**East**	**West**
	Shear wall line dimension (L_{sw})				
	Building dimension perpendicular to shear wall line (Table 3.2A)				
Wind	Number of stories receiving wind load (Table 3.2A)				
	Tabulated number of bolts to resist shear loads from wind (Table 3.2A)				
	Bolt spacing for wind **shear** loads $s_{ws} = (L_{sw}-2) / (\text{number of bolts}-1)$				
	Max. bolt spacing to resist wind **uplift** loads (s_{wu}) (Table 3.2C & 3.4C)				
Seismic	Tabulated anchor bolt spacing to resist **seismic** loads (s_s) (Table 3.3A)				
	WSP Perimeter Edge Nail Spacing - **Seismic**				
	Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) (C_{swa})				
	Adjusted bolt spacing for seismic loads $s_{sa} = (s_s)(C_{swa})$				
	Max. anchor bolt spacing (lesser of s_{ws}, s_{wu}, and s_{sa})				

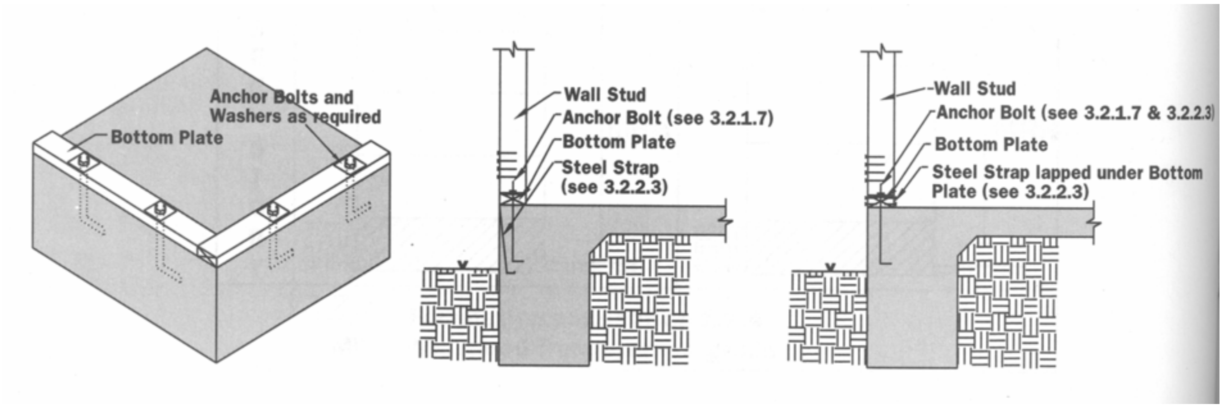
Notes:

Job:________________________________ **Description:**__________________________

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).

Three second gust wind speed:.. _______ mph Exp. ___
Stories supported by Foundation:... _______
Anchor Bolt Diameter: .... _______ in.

Assuming Slab on Grade, determine maximum Anchor Bolt Spacing:

	Building Wall Elevation	**North**	**South**	**East**	**West**
	Shear wall line dimension (L_{sw})				
Wind	Number of stories receiving **wind** load (Table 3.2B)				
Wind	Bolt spacing for wind **lateral** and **shear** loads (Table 3.2B)				
Wind	Wall sheathing type adjustment factor per Table 3.17D (Table 3.2B Footnote 3) (assumes perforated shear wall capacities) C_{swa}				
Wind	Adjusted bolt spacing for wind **lateral** and **shear** loads (s_{ws})				
Wind	Max. anchor bolt spacing to resist wind **uplift** loads (s_{wu}) (Table 3.2C)				
Seismic	Tabulated anchor bolt spacing to resist **seismic** loads (s_s) (Table 3.3A)				
Seismic	WSP Perimeter Edge Nail Spacing - **Seismic**				
Seismic	Bolt spacing adjustment per Table 3.3A Footnotes (Table 3.17D) (C_{swa})				
Seismic	Adjusted bolt spacing for seismic loads $s_{sa} = (s_s)(C_{swa})$				
	Max. anchor bolt spacing (lesser of s_{ws}, s_{wu}, and s_{sa})				

Notes:

Job:________________________________ **Description:**__________________________

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:

	Building Wall Elevation	North	South	East	West
	Building dimension W or L				
	R=L/W or W/L for Table 3.2				
Wind	Number of stories receiving lateral wind load (Table 3.2A)				
Wind	Wind uplift (Table 3.4C)				
Wind	Uplift force Spacing				
Wind	Wind uplift plf basis				
Wind	Overhang Reduction (Table 3.4C Footnote 2) $[(2' - OH / 4')]^2$				
Wind	Wall Dead Load Reduction[1] (____ walls (0.6) (____ plf))				
Wind	**Adjusted Wind uplift** (Table 3.4C)				
Wind	**Wind uplift** (Table 3.2(U))				
Wind	**Wind lateral load** (Table 3.2(L))				
Wind	**Wind shear load** (Table 3.2(S)) ________				
Seismic	Seismic shear load (Table 3.3) C_1 = ______ C_2 = ____ L_{max} = _______ L_{min} = ________ or, ❏ slab on grade				
Seismic	Wall Dead Load w_w				
Seismic	Footnote 4 Wall Dead Load Reduction $R_w = (w_w + 70.65) / 85.65$				
Seismic	Footnote 5 Sheathing Adjustment Factor for wall (Table 3.17D) (C_{swa})				
Seismic	Adjusted seismic shear load = seismic shear load x R_w / C_{swa}				
Seismic	Wall length				
Seismic	**Seismic shear load** = adjusted seismic shear load / wall length				

[1]Refer to *WFCM Commentary* 1.1.2.
*Table 3.2 Footnote: Determine anchorage for Lateral Loads in foundation design per Section 1.1.4

Job:________________________________ **Description:**__________________________

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)

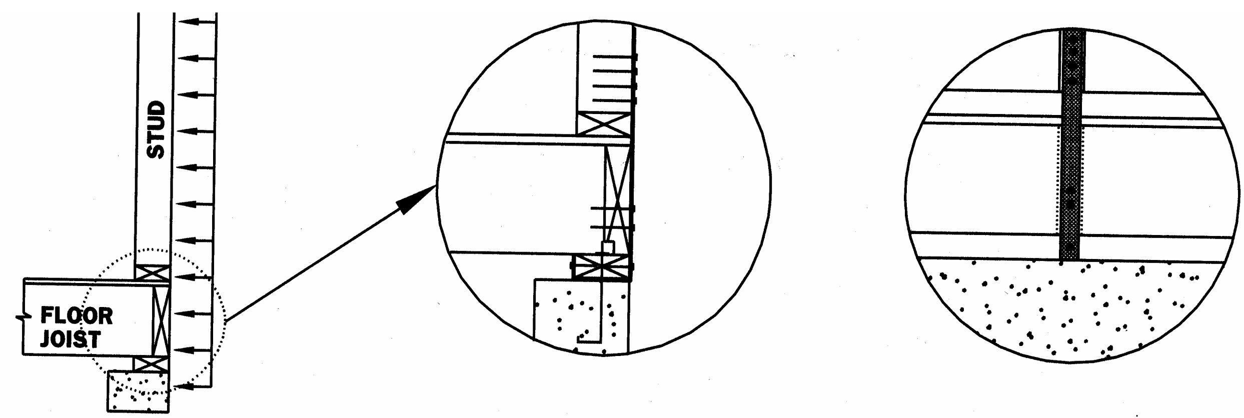
Choose Wall to Wall Uplift Strap Connection from Table 3.4B (p. 151)

Building Wall Elevation		North	South	East	West
Wind	Three second gust wind speed				
	Framing Spacing				
	Roof Span				
	Tabulated number of 8d Common Nails required in each end of 1-1/4" x 20 gage strap *every stud*				
	No Ceiling Assembly nail increase (Footnote 3)				
	Required number of **8d Common Nails in each end of strap** *every stud* = 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**

Wind	**Loadbearing Walls** - Tabulated minimum uplift connection capacity (Table 3.4, page 149)		
	Interior framing adjustment (Footnote 1)		
	Roof dead load reduction (Table 3.4, Footnote 3) = [0.60(____ psf – 15 psf) x _____ x _____"/12"/ ' = ________ lbs]		
	Wall-to-Wall and Wall-to-Foundation reduction (Table 3.4, Footnote 4) = [____ plf x ____ walls (______" / 12"/ ') = ______ lbs]		
	Non-Loadbearing Walls - Tabulated minimum uplift connection capacity (Table 3.4C, page 152)		
	Wall-to-Wall and Wall-to-Foundation reduction (WFCM 3.2.5.3) = [_____ plf x ____ walls (______" / 12"/ ') = ______ lbs]		
	Required minimum capacity of proprietary connector = Tabulated minimum capacity x Adjustments - Reduction		

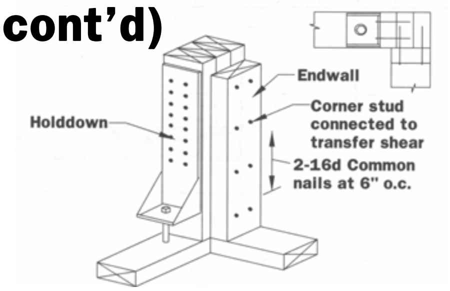


Check Perforated Shear Wall plate anchorage between wall ends

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.

Job:_______________________________ **Description:**__________________________

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)

	Building Wall Elevation	North	South	East	West
	Wall Height				
Wind	Tabulated hold down connection capacity required – **wind** (T_w)				
	WSP Perimeter Edge Nail Spacing - **wind**				
	Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) (C_{swa})				
	Adjusted hold down capacity ($T_{wa} = (T_w) / (C_{swa})$) - **wind**				
	Additional story hold down requirements – **wind**				
	Total hold down requirement for floor to foundation – **wind** (ΣT_{wa})				
Seismic	Tabulated hold down connection capacity required – **seismic** (T_s)				
	WSP Perimeter Edge Nail Spacing - **seismic**				
	Hold down adjustment per Table 3.17F Footnotes (Table 3.17D) (C_{swa})				
	Adjusted hold down capacity ($T_{sa} = (T_s) / (C_{swa})$) - **seismic**				
	Additional story hold down requirements – **seismic**				
	Total hold down requirement for floor to foundation (ΣT_{sa}) - **seismic**				

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): .... ________

Location	Edges	Field
4' Edge Zone		
Interior Zones		

Job:________________________________ **Description:**__________________________

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. ____

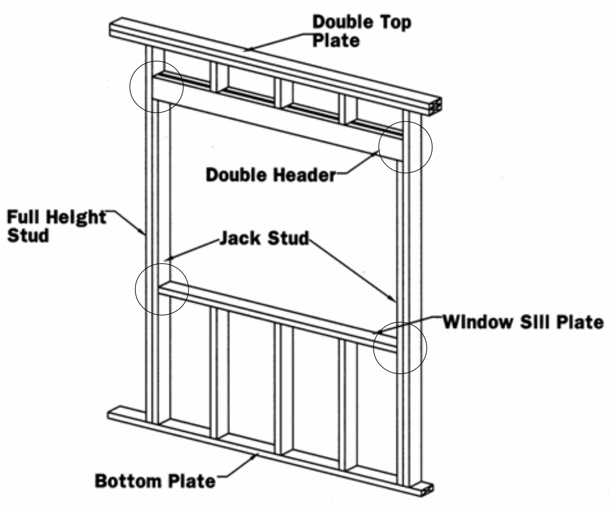
Roof Span:.. ________ ft.
Header Span (Typical Window):... ________ ft.

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 perforated shear wall method is included in the *2000 International Building Code* (IBC), AF&PA's *Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings*, *Standard Building Code* (SBC, 1994 revised), and the *2000 NEHRP Recommended Provisions for Seismic Regulations for New Buildings* (FEMA, 2000).

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, $V \leq V_{wall}$. The design shear capacity, V_{wall}, of a perforated shear wall is calculated as:

$$V_{wall} = (v\,C_O)\sum L_i \qquad [1]$$

where:

V_{wall} = design shear capacity of a perforated shear wall, lb.

v = 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.

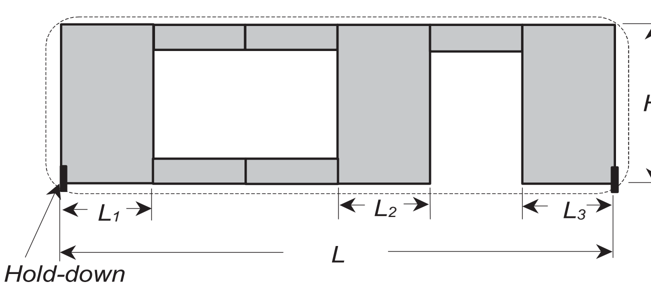


Figure 1.—Perforated shear wall.

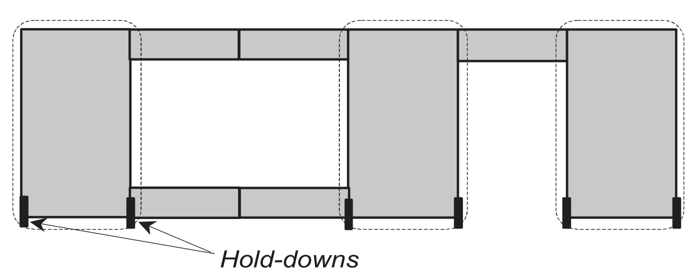


Figure 2.—Segmented shear wall.

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:

$$R = \frac{Vh}{C_O \sum L_i} \qquad [2]$$

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:

$$v_{max} = \frac{V}{C_O \sum L_i} \qquad [3]$$

where:

v_{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_{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.

Wall height (h)	Maximum opening height[a] h/3	h/2	2h/3	5h/6	h
8 ft. 0 in.	2 ft. 8 in.	4 ft. 0 in.	5 ft. 4 in.	6 ft. 8 in.	8 ft. 0 in.
10 ft. 0 in.	3 ft. 4 in.	5 ft. 0 in.	6 ft. 8 in.	8 ft. 4 in.	10 ft. 0 in.
Percent full-height sheathing[b]	Shear capacity adjustment factor				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.80	0.67	0.57	0.50
60%	1.00	0.83	0.71	0.63	0.56
70%	1.00	0.87	0.77	0.69	0.63
80%	1.00	0.91	0.83	0.77	0.71
90%	1.00	0.95	0.91	0.87	0.83
100%	1.00	1.00	1.00	1.00	1.00

[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.

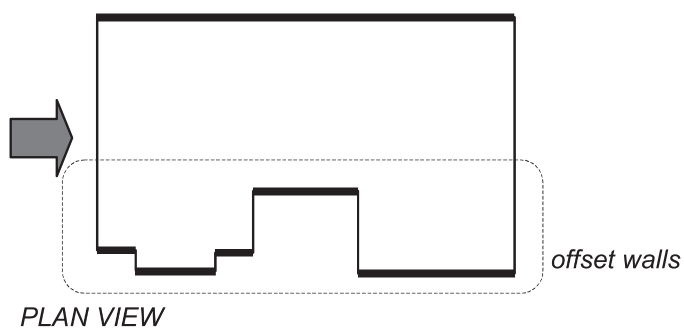


Figure 3.—In-plane versus offset walls.

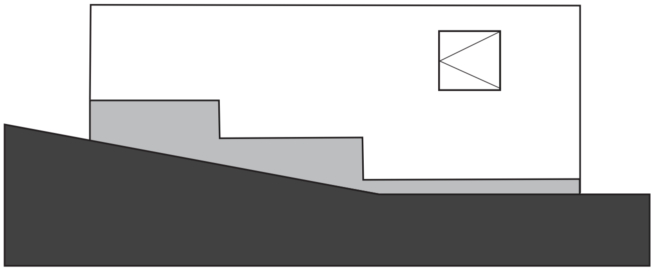


Figure 4.—Wall with non-uniform top and bottom of wall elevation (stepped wall).

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 dstributed 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

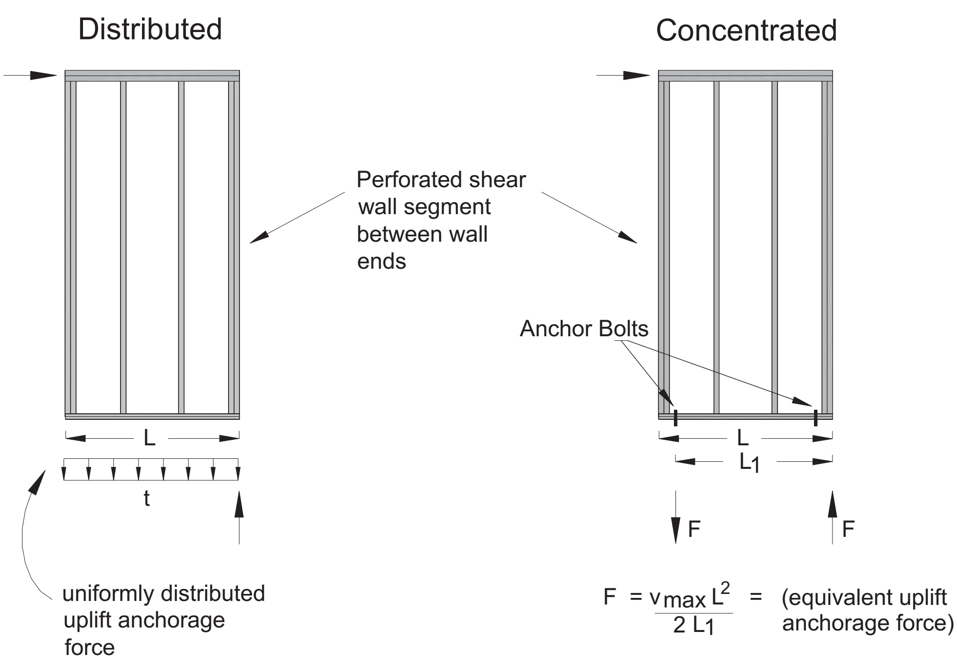
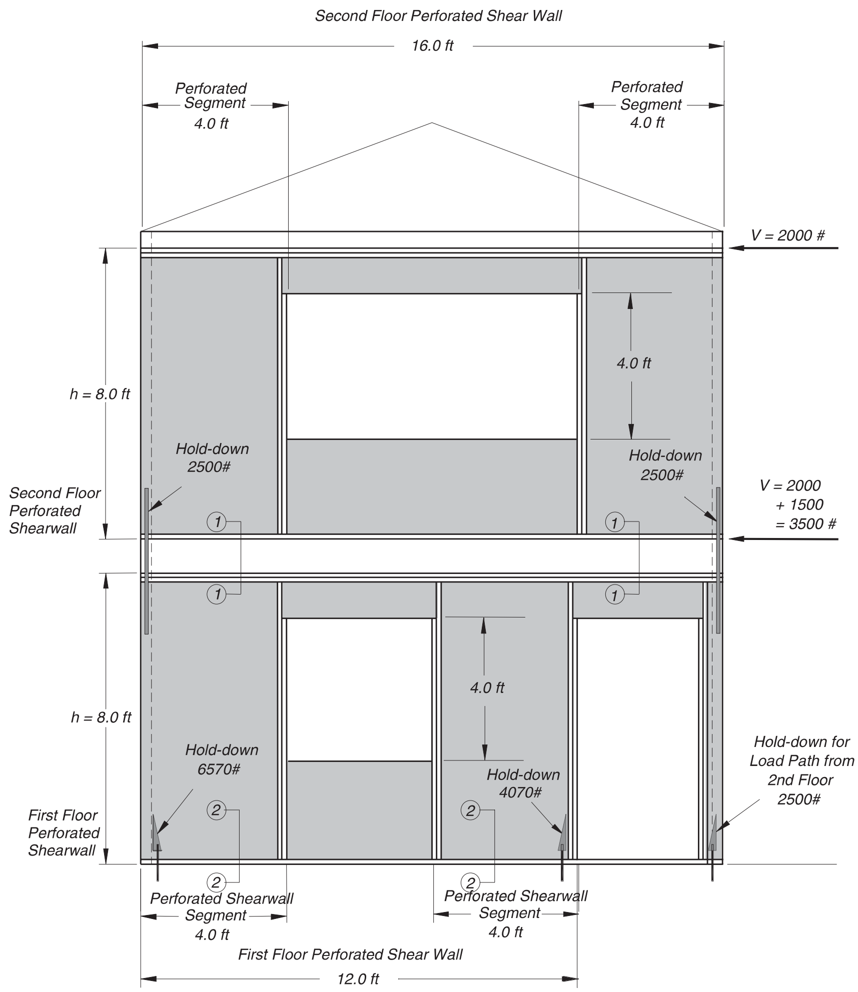


Figure 5.—Uplift anchorage force between wall ends.

Figure 6.—Two-story building with perforated shear walls.



that induced shear will not exceed v_{max}, it is acceptable to limit the concentrated uplift anchorage force at ends of perforated shear wall segments, due to story shear, to $v_{max}h$ 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

$= (4 \text{ ft.} + 4 \text{ ft.})/16 \text{ ft.} \times 100 = 50\%$

Maximum opening height ratio

$= 4 \text{ ft.}/8 \text{ ft.} = 0.50$

Shear capacity adjustment factor, C_o, from Table 1

$= 0.80$

$$V_{wall} = (v\, C_o) \sum L_i$$

$$= (365 \text{ plf})(0.80)(8 \text{ ft.}) = 2{,}336 \text{ lb.}$$

$2{,}336 \text{ lb.} > 2{,}000 \text{ lb.}$ OK

Note that $v = 365$ 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 × 1.4).

Uplift Anchorage Force at Shear Wall/Ends:

$$R = \frac{Vh}{C_O \sum L_i} = \frac{(2{,}000 \text{ lb.})(8 \text{ ft.})}{(0.80)(8 \text{ ft.})} = 2{,}500 \text{ lb.}$$

Anchorage Force for In-Plane Shear:

$$v_{max} = \frac{V}{C_O \sum L_i} = \frac{(2{,}000 \text{ lb.})}{(0.80)(8 \text{ ft.})} = 313 \text{ plf}$$

Anchorage Force for Uplift, t, Between Wall Ends:

$t = v_{max} = 313$ plf

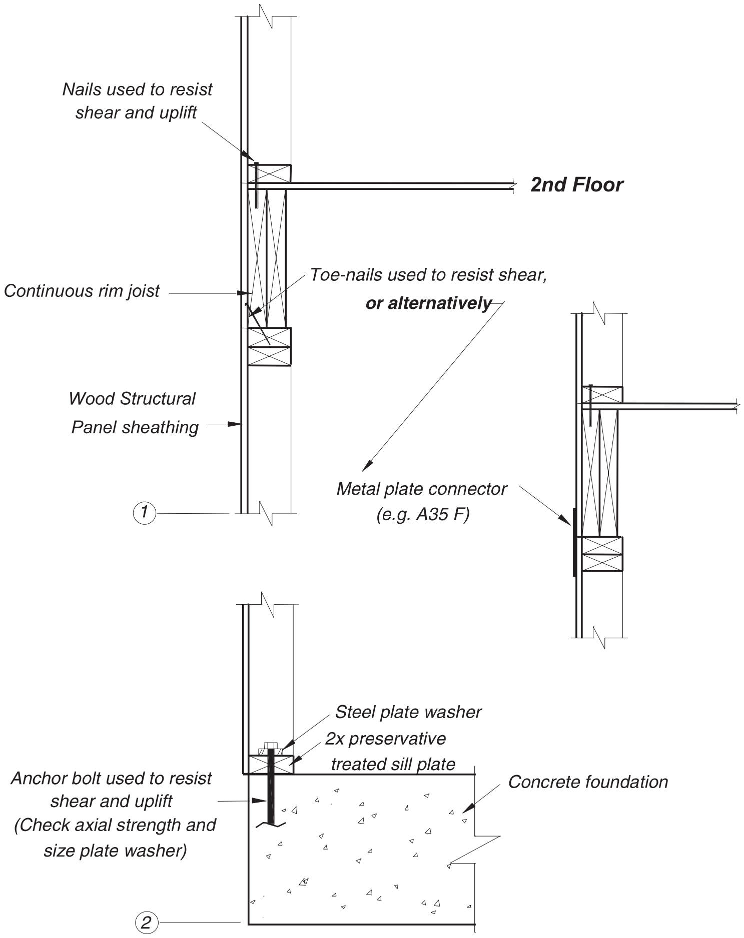


Figure 7.—Configuration A detail—continuous rim joist.

Tension Chord Force, T, and Compression Chord Force, C, at Each End of a Perforated Shear Wall Segment:

$C = T = R = 2{,}500$ lb.

First Floor Wall

Design Shear Capacity:

Percent full-height sheathing

$= (4 \text{ ft.} + 4 \text{ ft.})/12 \text{ ft.} \times 100 = 67\%$

Maximum opening height ratio

$= 4 \text{ ft.}/8 \text{ ft.} = 0.50$

Shear capacity adjustment factor, C_o, from Table 1

$= 0.86$

$V_{wall} = (v\,C_o)\sum L_i$

$= (530 \text{ plf})(0.86)(8 \text{ ft.}) = 3{,}646$ lb.

3,646 lb. > 3,500 lb. OK

Note that $v = 530$ 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 × 1.4).

Uplift Anchorage Force at Shear Wall/Ends:

$$R = \frac{Vh}{C_O \sum L_i} = \frac{(3{,}500 \text{ lb.})(8 \text{ ft.})}{(0.86)(8 \text{ ft.})} = 4{,}070 \text{ lb.}$$

When Maintaining Load Path from Story Above:

$R = R_{\text{from second floor}} + R_{\text{from first floor}}$

$= 2{,}500 \text{ lb.} + 4{,}070 \text{ lb.} = 6{,}570$ lb.

Anchorage Force Force for In-Plane Shear:

$$v_{max} = \frac{V}{C_O \sum L_i} = \frac{(3{,}500 \text{ lb.})}{(0.86)(8 \text{ ft.})} = 509 \text{ plf}$$

Anchorage Force for Uplift, t, Between Wall Ends:

$t = v_{max} = 509$ 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:

$C = T = R = 4{,}070$ lb.

When maintaining load path from story above,

$C = 4{,}070 \text{ lb.} + 2{,}500 \text{ lb.} = 6{,}570$ lb.

Load Path - Configuration A Detail

Configuration A detailing (Fig. 7) uses a continuous rim joist at the second floor.

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.

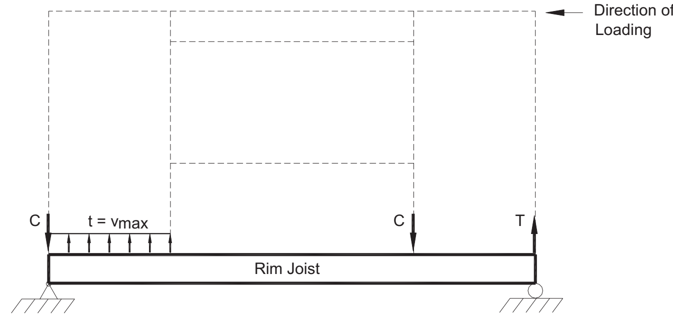


Figure 8.—Uplift and compression forces for rim joist design.

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

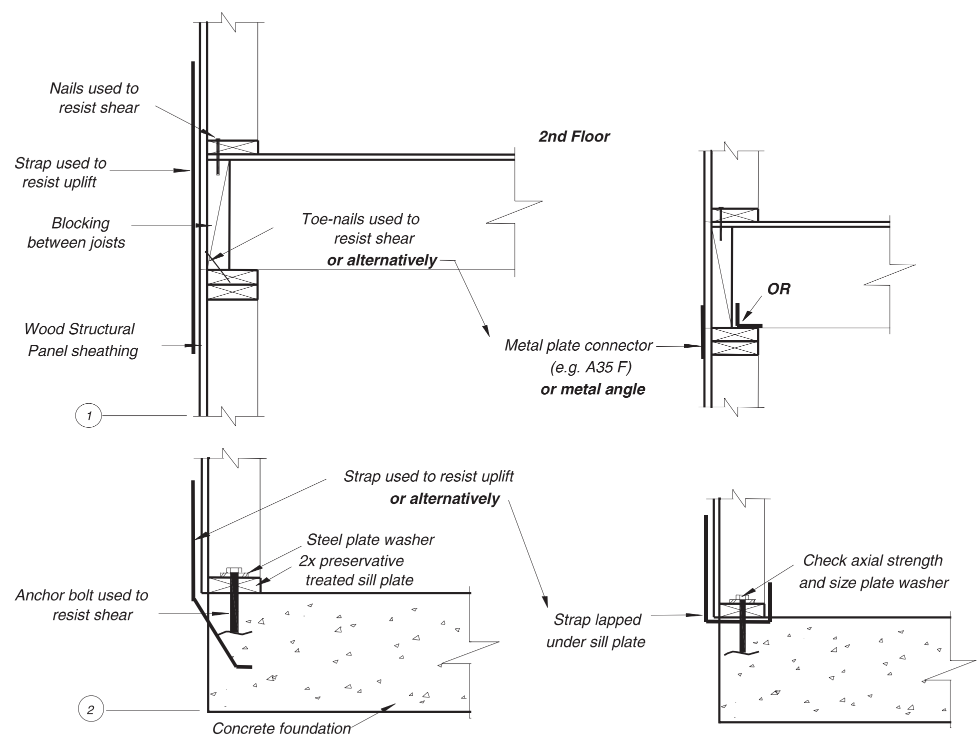


Figure 9.—Configuration B detail—blocking between joists.

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.

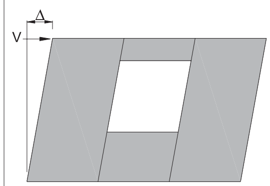
Shear Wall Deflection

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.

Example—Perforated Shear Wall Deflection



The deflection of a perforated shear wall can be calculated from standard equations for deflection of wood structural panel shear walls. Using *IBC* Equation 23-2, the deflection of a wood structural panel shear wall can be calculated as:

$$\Delta = \frac{8vh^3}{EAb} + \frac{vh}{Gt} + 0.75he_n + d_a$$

where:

- A = Area of boundary element cross section, in.^{2}
- b = Wall width, ft.
- d_a = Deflection due to anchorage details, in.
- E = Modulus of Elasticity of boundary element, psi
- e_n = Deformation of mechanically fastened connections, in.
- Gt = Rigidity through the thickness of wood structural panel, lb./in. of panel depth
- h = Wall height, ft.
- v = Maximum unit shear due to design loads at the top of the wall, lb./ft.

For the first floor perforated shear wall in Figure 5, standard inputs for variables of A, d_a, E, e_n, Gt, and h apply. Maximum unit shear, v, is taken as $v_{max} = V/[C_o \times \sum L_i] = 509$ *plf* and wall width, b, is taken as $b = \sum L_i = 8$ ft.

Assuming deflection due to anchorage is 0.125 in. and boundary elements (end posts) consisting of two 2x4 Douglas Fir, No. 2 grade lumber, deflection of the perforated shear wall is calculated as follows:

$$\Delta = \frac{8(509)8^3}{(1{,}6000{,}000)(10.5)(8)} + \frac{(509)8}{38{,}000} + 0.75(8)(0.049) + 0.125$$

$$\Delta = 0.016 + 0.107 + 0.294 + 0.125 = 0.54\ in.$$

Figure 10.—Perforated shear wall deflection.

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CONSIDERATIONS IN WIND DESIGN OF WOOD STRUCTURES

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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 ($F_{C\perp}$), 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:

$$q_h = 0.00256 K_z K_{zt} K_d V^2 I$$
$$= 21.93 \text{ psf}$$

Where:

q_h	=	Velocity pressure evaluated at height, h, above the ground, psf (Exposure B)
K_z	=	Exposure coefficient evaluated at height, h, above the ground (ASCE 7-98 Table 6-5)
	=	0.70 (Exposure B, 15' mean roof height)
K_{zt}	=	Topographic factor (ASCE 7-98 Figure 6-2)
	=	1.0
K_d	=	Wind directionality factor (ASCE 7-98 Table 6-6)
	=	0.85
I	=	Importance factor
	=	1.0 (Category II, ASCE 7-98 Table 6-1)
V	=	Three second gust wind speed, mph
	=	120 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:

$p_{3\text{-sec gust}}$	=	Design wind pressure, psf (MWFRS)
q_h	=	Velocity pressure, psf (120 mph, Exposure B)
	=	21.93 psf
GC_{pf}	=	External pressure coefficient
	=	0.80 (Edge Zone - Windward Wall)
	=	0.53 (Interior Zone - Windward Wall)
	=	-0.64 (Edge Zone - Leeward Wall)
	=	-0.43 (Interior Zone - Leeward Wall)
	=	-0.48 (Edge Zone - Side Walls)
	=	-0.45 (Interior Zone - Side Walls)
	=	-1.07 (Edge Zone - Windward Roof, 20° roof angle)
	=	-0.69 (Interior Zone - Windward Roof)
	=	-0.69 (Edge Zone - Leeward Roof, 20° roof angle)
	=	-0.48 (Interior Zone - Leeward Roof)
GC_{pi}	=	Internal pressure coefficient
	=	0.18 (internal pressurization)
	=	-0.18 (internal suction)
	=	0.68 (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, $A=L^2/3$. 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	
	Internal Pressurization	Internal Suction
Windward Walls		
Edge Zone	13.59	21.49
Interior Zone	7.68	15.57
Leeward Walls		
Edge Zone	-17.98	-10.09
Interior Zone	-13.38	-5.48
Side Walls		
End Zone	-14.47	-6.58
Interior Zone	-13.82	-5.92
Wind Perpendicular to Ridge		
Windward Roof		
Edge Zone	-27.41	-19.52
Interior Zone	-19.08	-11.18
Windward Roof Overhang		
Edge Zone	-38.38	-38.38
Interior Zone	-30.04	-30.04
Leeward Roof		
Edge Zone	-19.08	-11.18
Interior Zone	-14.47	-6.58
Leeward Roof Overhang		
Edge Zone	-19.08	-11.18
Interior Zone	-14.48	-6.58

	C&C Loads	
	Internal Pressurization	Internal Suction
Windward Walls	16.01	23.90
Leeward Walls (Edge)	-30.70	-22.81
Leeward Walls (Interior)	-25.88	-17.98

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 + $Live_f$ + Fluid + Earth + Self Straining + ($Live_r$ or Snow or Rain)
3) Dead + $Live_f$ + (Wind or 0.7*Seismic) + ($Live_r$ 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 + $Live_f$ + (Wind or 0.7*Seismic) + ($Live_r$ 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.

	Dead Load	Live Load
Roof	10 psf	20 psf
Ceiling	5 psf	10 psf
Wall	11 psf	---

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.

		MWFRS		C&C
Load Combination	C_D Adjustment	Axial Load	Lateral Moment	Lateral Moment
1) Dead	0.9	532 lbs. (C)	0 in-lbs.	0 in-lbs.
2) Dead + $Live_r$	1.25	1064 lbs. (C)	0 in-lbs.	0 in-lbs.
3) Dead + Wind	1.6			
Wind Perpendicular to Ridge				
Pressurization				
Windward Studs		-464 lbs. (T)	2711 in-lbs.	3194 in-lbs.
Leeward Studs		-324 lbs. (T)	3587 in-lbs.	6125 in-lbs.
Suction				
Windward Studs		-276 lbs. (T)	4287 in-lbs.	4768 in-lbs.
Leeward Studs		- 113 lbs. (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 psi
F_t = 525 psi
F_c = 1300 psi
MOE = 1,300,000 psi

Applying the appropriate adjustments and checking each load combination as follows:

1) Dead Loads

f_c = C/A
= 532/5.25 = 101 psi

F_c^* = $F_c*C_D*C_F$
= 1300*0.9*1.15 = 1346 psi

F_c' = $F_c^{*}*C_p$
= 1346*0.233 = 314 psi

f_c ≤ F_c'
101 psi ≤ 314 psi ✓

2) Dead + Live Loads

f_c = 1064/5.25 = 203 psi

F_c^* = $F_c*C_D*C_F$
= 1300*1.25*1.15 = 1869 psi

F_c' = $F_c^{*}*C_p$
= 1869*0.171 = 320 psi

f_c ≤ F_c'
203 psi ≤ 320 psi ✓

3) Dead + Wind Loads (Wind Perpendicular to Ridge - Windward Studs)

MWFRS Loads

f_t = T/A
= 464/5.25 = 88 psi

F_t' = $F_t*C_D*C_F$
= 525*1.6*1.5 = 1260 psi

f_b = M/S
= 2711/3.06 = 885 psi

F_b^* = $F_b*C_D*C_F*C_r$
= 850*1.6*1.5*1.5 = 3060 psi

F_b^{**} = $F_b*C_D*C_F*C_r$
= 850*1.6*1.5*1.5 = 3060 psi

$f_t/F_t' + f_b/F_b^*$ ≤ 1.0
88/1260 + 885/3060 = 0.36 ≤ 1.0 ✓

$(f_b - f_t)/F_b^{**}$ ≤ 1.0
(885-88)/3060 = 0.26 ≤ 1.0 ✓

C&C Loads

f_b = M/S
= 3194/3.06 = 1044 psi

F_b' = $F_b*C_D*C_F*C_r$
= 850*1.6*1.5*1.5 = 3060 psi

f_b ≤ F_b'
1044 psi ≤ 3060 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.

	MWFRS	C&C
Load Combination	Load/Resistance	Load/Resistance
1) Dead	0.32	---
2) Dead + Live$_r$	0.63	---
3) Dead + Wind		
Wind Perpendicular to Ridge		
Pressurization		
Windward Studs	0.36	0.34
Leeward Studs	0.43	0.65
Suction		
Windward Studs	0.50	0.51
Leeward Studs	0.23	0.49

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.

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