

Earthquakes and Single Family Homes

2021 International Residential Code® (IRC®)



Description

- Mid-career residential inspectors and plans examiners will find this seminar insightful as will designers looking for a review of seismic requirements for single family homes.
- With a focus on wood construction, this seminar dives into the details for designing and inspecting a home built to resist large earthquakes.
- Minimum requirements for foundations, walls, roofs and floors are covered as well as a discussion of beyond code minimum options.



Objectives

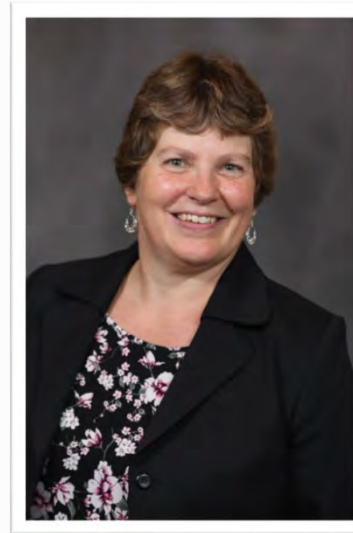
- Understand how seismic resistance is developed using the IRC to build a structurally safe dwelling.
- Explain how framing and nailing are different in high seismic regions.
- Describe which structural members should be considered when designing for earthquakes.
- Identify structural members requiring additional detailing for earthquakes in a residential example.



About Me

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About You

What is your primary job function?

- Plans Reviewer
- Inspector
- Building or Fire Official
- Permit Tech
- Designer/Engineer
- Contractor/Builder



About You

Where in the United States do you work?

- East coast
- West coast
- Mid-west
- Central
- South
- Alaska
- Hawaii, US Territories
- Canada
- Other country



About You

How many years have you worked in the construction industry?

- 0-5
- 6-10
- 11-20
- 21-30
- 30+



Outline

- Overview
- Building Planning and Construction
 - Loads and Load Path
 - Walls and Wall Coverings
 - Roof-Ceilings and Assemblies
- Two-story Residential Examples
 - 115 mph Winds, Exposure B
 - 160 mph Winds, Exposure B



Overview



IRC – International Residential Code

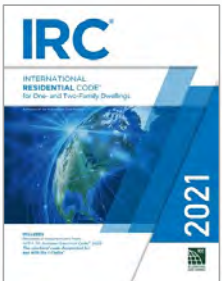
- Regulates 1- and 2-family dwellings and townhouse structures, existing structures and accessory buildings
- Combines all regulations for building, energy, mechanical, fuel gas, plumbing and electrical into one document



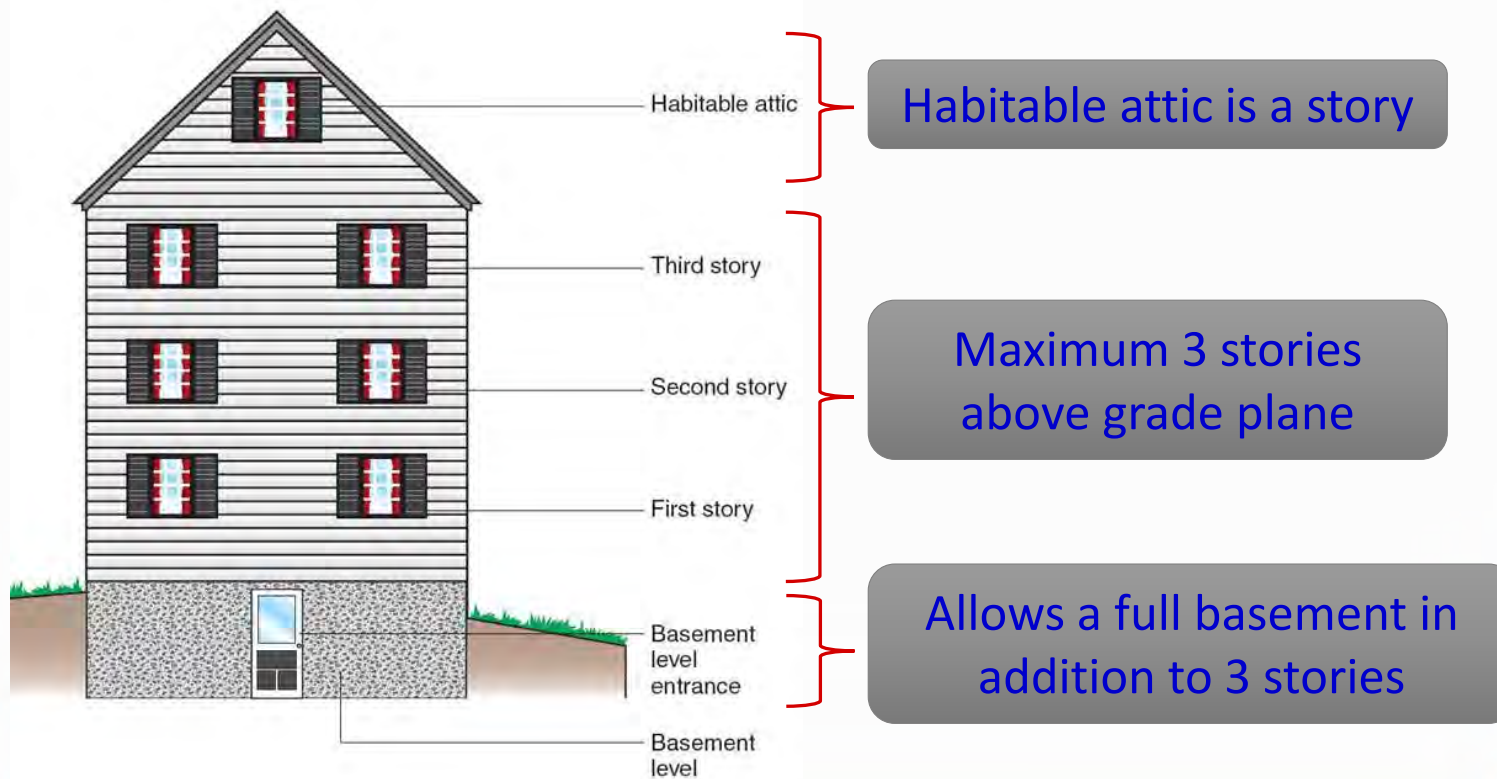
Single-family dwelling



Townhouses



Dwellings and Townhouses



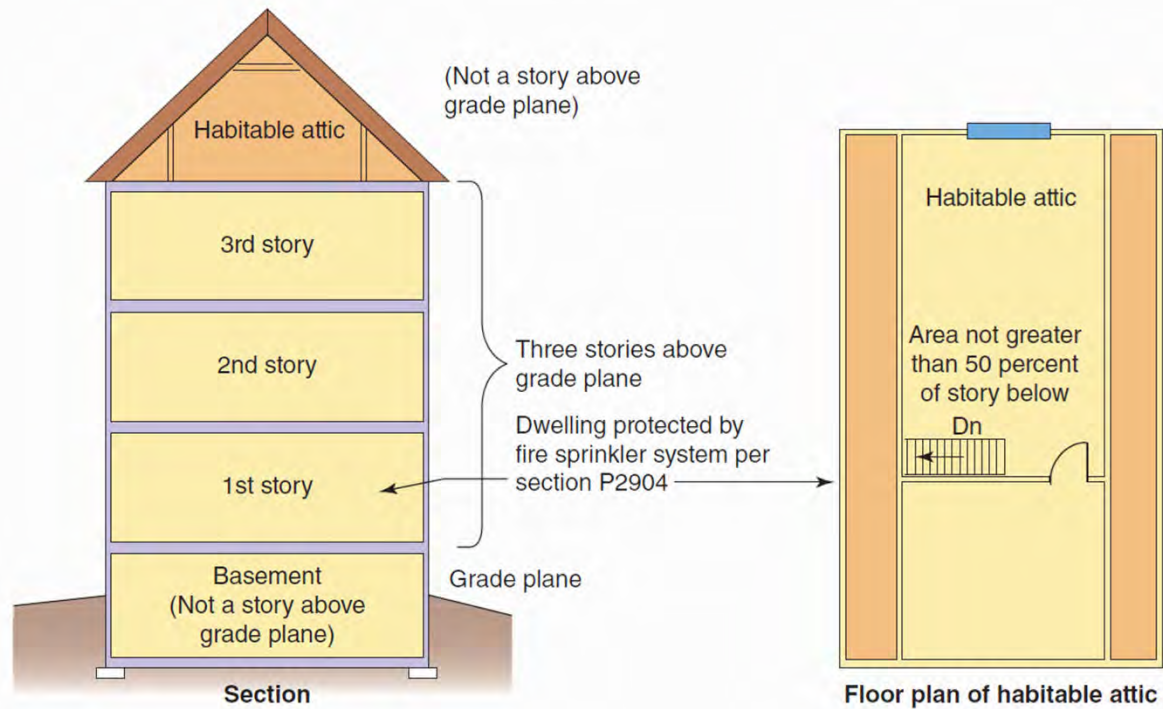
Habitable Attics

- Floor area per Section R304
- Ceiling height per Section R305
- Considered a story above grade plane
- Not a story above grade plane if all the following are met:
 - Total area $< \frac{1}{3}$ floor area of the story below, or $< \frac{1}{2}$ floor area of the story below with fire sprinkler system
 - Occupiable space enclosed by roof assembly, knee walls, and floor-ceiling assembly
 - Floor does not extend beyond exterior walls of story below
 - Where located above a 3rd story, the unit must have a fire sprinkler system

R326



Habitable Attics



R326



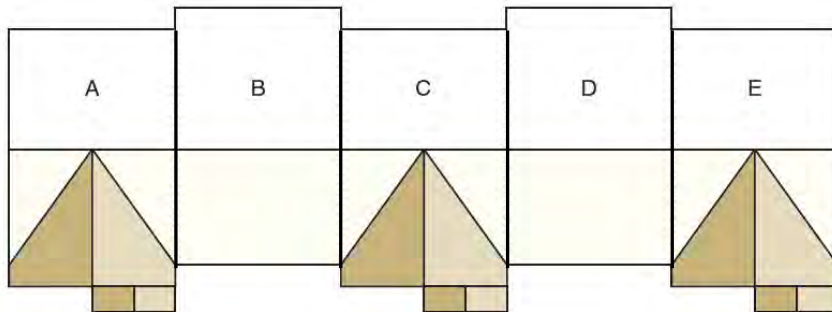
Dwellings

- Separate means of egress for each dwelling unit
 - 1 exterior exit door
 - Egress travel distance not regulated
- No size limit
- 2-family dwellings require fire-resistant separations

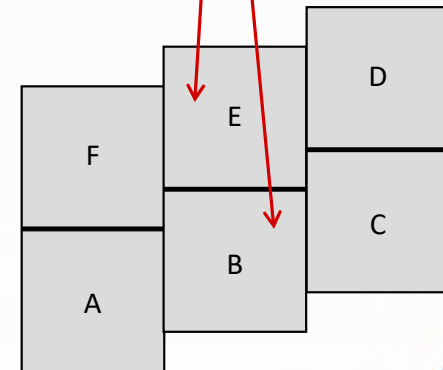


Townhouses

- Minimum of 3 units
- No maximum number of units
- Fire-resistant separations between units
- Open on at least 2 sides



Units not open on 2
sides cannot be
constructed under
IRC



Accessory Buildings

- IRC regulates accessory buildings
 - Use incidental and accessory to dwelling
 - On same lot as dwelling
 - Unlimited area
 - ≤ 3 stories AGP



Existing Buildings



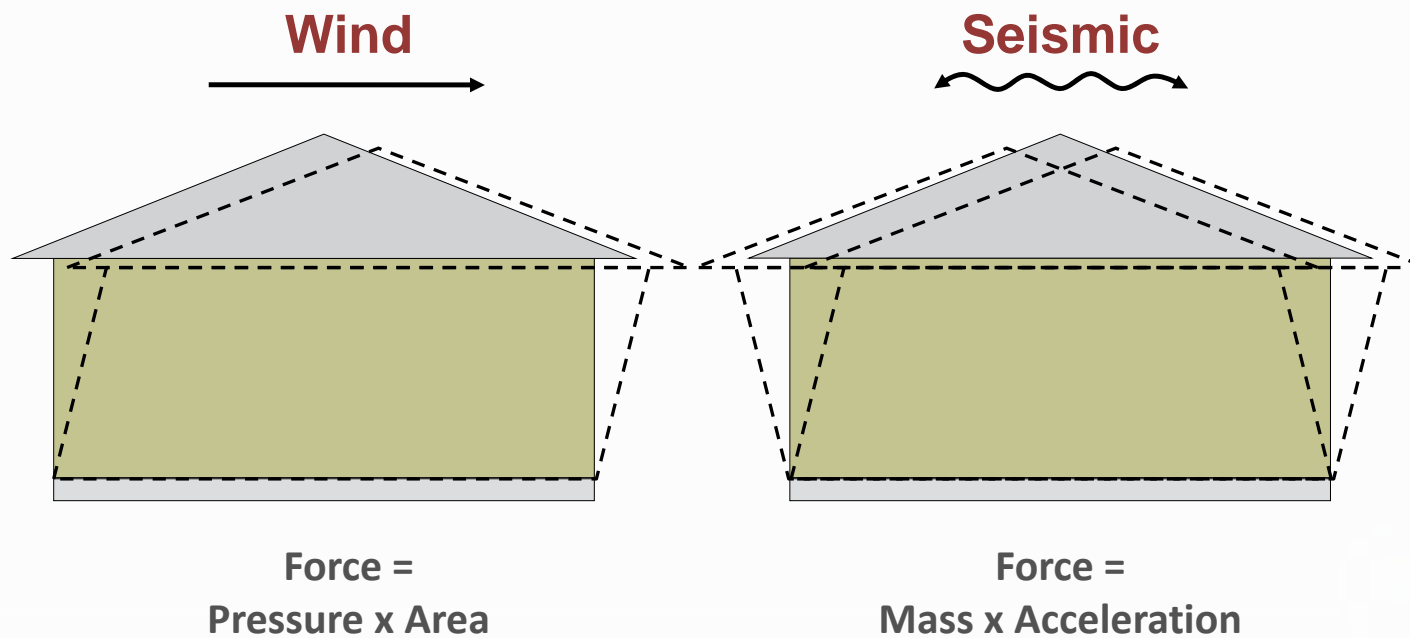
- Existing buildings may continue without change
 - Maintained per code under which constructed
- IRC regulates additions, alterations and repairs to an existing building
- Appendix J offers construction compliance alternatives for existing buildings
 - Work categorized as repair, renovation, alteration or reconstruction



Seismic Loads



Lateral Forces



Climatic and Geographic Design Criteria

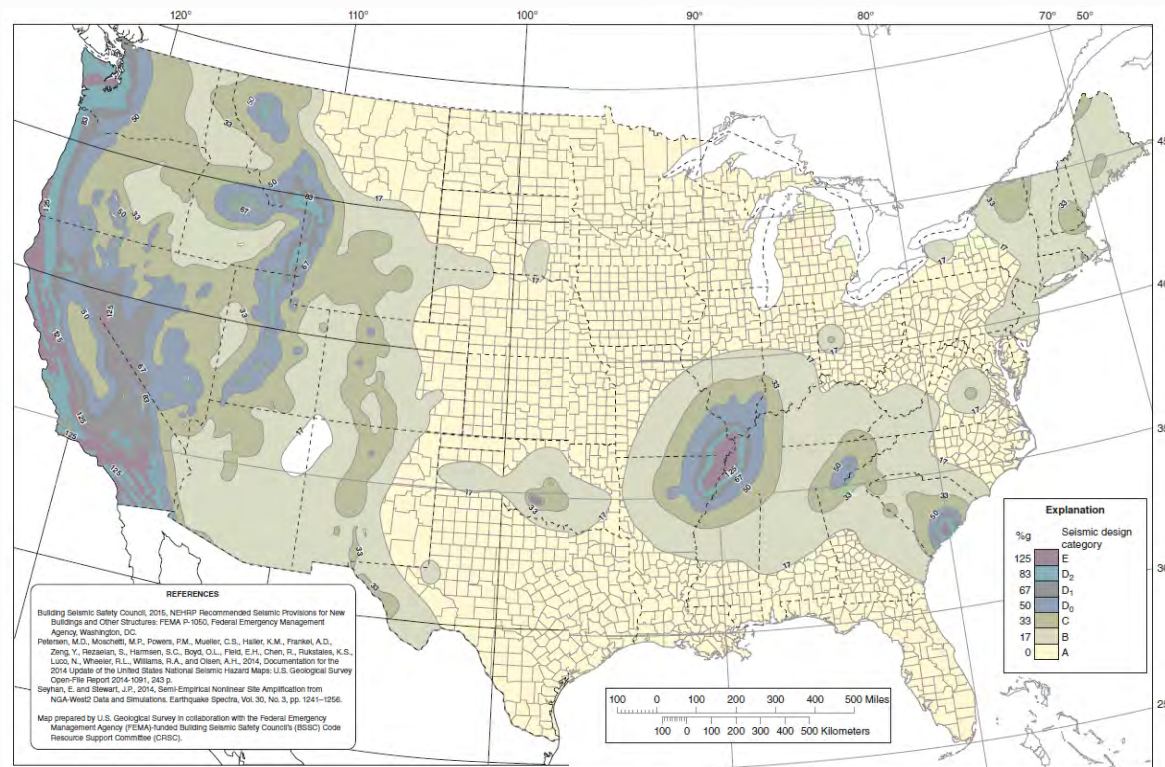
IRC adoption: jurisdiction completes table with data applicable to the jurisdiction – for example:

Ground Snow Load	Wind Design				Seismic Design Category
	Speed (mph) V	Topographic Effects	Special Wind Region	Wind-borne Debris Zone	
30 psf	115 mph		No	No	B

Table
R301.2(1)



Lateral Forces - Earthquakes



ATC Hazards Tool

hazards.atcouncil.org

S_{DS} value
Site Class D
0.462g = SDC C
per Table R301.2.2.1.1



ATC Hazards by Location

Search by Address Search by Coordinate

Las Vegas Strip, NV, USA Search

Coordinates: 36.1147065, -115.1728484

Wind Snow Tornado **Seismic**

Reference Document: ASCE7-16

Risk Category: II

Site Class: D - Stiff Soil

Print these results Save these results

Basic Parameters

Name	Value	Description
S_s	0.493	MCE _R ground motion (period=0.2s)
S_1	0.171	MCE _R ground motion (period=1.0s)
S_{MS}	0.693	Site-modified spectral acceleration value
S_{M1}	0.386	Site-modified spectral acceleration value
S_{DS}	0.462	Numeric seismic design value at 0.2s SA

Map **Satellite**

Desert Nat'l Wildlife Range Moapa Moapa Lake Nat'l Recreation Area Henderson Enterprise Boulder City Jean Primm Searchlight

2104 ft

Google

MCE_R Horizontal Response Spectrum

$S_a(g)$

0.60
0.50
0.40
0.30

Table R301.2.2.1.1

Seismic Design Category Determination

Las Vegas Strip
0.462g

S_{DS}	Seismic Design Category
	II
$S_{DS} < 0.167g$	A
$0.167g \leq S_{DS} < 0.33g$	B
$0.33g \leq S_{DS} < 0.50g$	C
$0.50g \leq S_{DS} < 0.67g$	D ₀
$0.67g \leq S_{DS} < 0.83g$	D ₁
$0.83g \leq S_{DS} < 1.25g$	D ₂
$1.25g \geq S_{DS}$	E



ATC Hazards Tool hazards.atcouncil.org

S_{DS} value
Site Class E
 $0.462g = SDC D_0$
per Table R301.2.2.1.1



ATC Hazards by Location

Search by Address Search by Coordinate

Las Vegas Strip, NV, USA

Coordinates: 36.1147065, -115.1728484

Wind Snow Tornado Seismic

Reference Document ASCE7-16

Risk Category II

Site Class E - Soft Clay Soil

Print these results Save these results

Basic Parameters

Name	Value	Description
S_S	0.493	MCE_R ground motion (period=0.2s)
S_1	0.171	MCE_R ground motion (period=1.0s)
S_{MS}	0.848	Site-modified spectral acceleration value
S_{M1}	0.718	Site-modified spectral acceleration value
S_{DS}	0.565	Numeric seismic design value at 0.2s SA

Map Satellite

Desert Nat'l Wildlife Range

Moapa

2104 ft

Las Vegas

Henderson

Enterprise

Boulder City

Jean

Primm

Searchlight

Google

MCER Horizontal Response Spectrum

$S_a(g)$

0.80

0.60

0.40

Lateral Forces - Earthquakes

ASCE HAZARD TOOL

Location
Las Vegas Strip, Nevada, .

Elevation
0 ft with respect to North American Vertical Datum of 1988 (NAVD 88)

Lat: 36.11479

Long: -115.17281

Standard: ASCE/SEI 7-16

Risk Category: II

Soil Class: D - Stiff Soil

Seismic Overlay ☐

Risk Category II DETAILS

REPORT SUMMARY

Seismic

S_s	0.493
S_1	0.171
F_a	1.405
F_v	2.258
S_{MS}	0.693
S_{M1}	0.386
S_{DS}	0.462
S_{N1}	0.257

S_{DS} value
0.462g = SDC C
per Table R301.2.2.1.1



Oregon Residential Code

TABLE R301.2(1) CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA^{f, g}

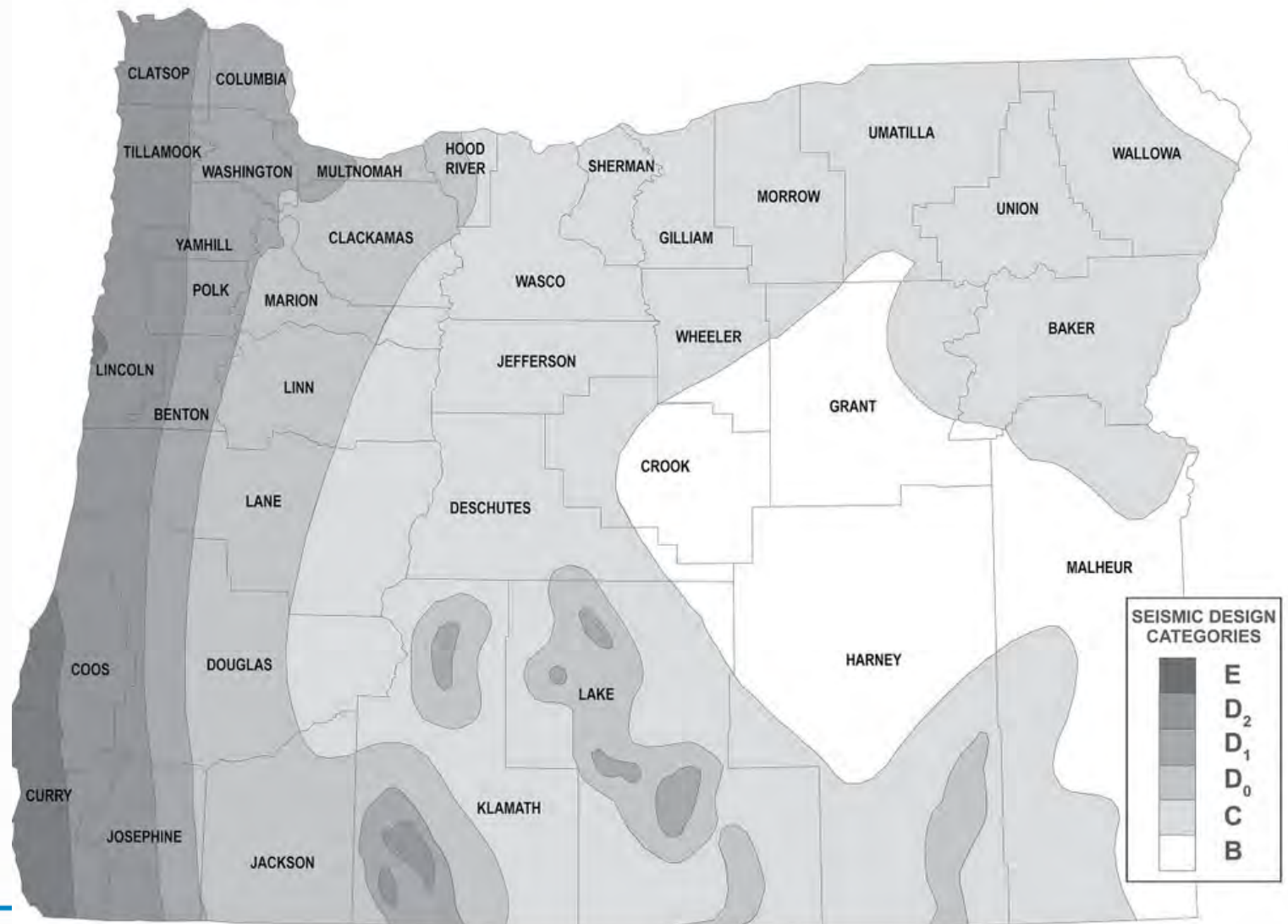
COUNTY	GROUND SNOW LOAD, p_g	BASIC DESIGN WIND SPEED, V (mph) ^b	SPECIAL WIND REGION BASIC DESIGN WIND SPEED, V (mph) ^b	SEISMIC DESIGN CATEGORY	SUBJECT TO DAMAGE			AIR FREEZING INDEX
					Weathering ^d	Frost line depth (inches)	Decay	
Baker	Note a	103	—	Note c	Severe	24	Slight	2000
Benton	Note a	96	—	Note c	Moderate	12	Moderate	≤ 1,500
Clackamas	Note a	98	120	Note c	Moderate	12	Moderate	≤ 1,500
Clatsop	Note a	97	135	Note c	Moderate	12	Moderate	≤ 1,500
Columbia	Note a	97	120	Note c	Moderate	12	Moderate	≤ 1,500
Coos	Note a	95	120 ^h	Note c	Moderate	12	Moderate	≤ 1,500
Crook	Note a	98	110	Note c	Severe	18	Slight	2,000
Curry	Note a	95	135	Note c	Moderate	12	Moderate	≤ 1,500

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

- a. The ground snow load, p_g shall be determined in accordance with Section R301.2.3.1.
- b. Sites located within a special wind region as determined from Figure R301.2.1 shall use the special criteria herein.
- c. The seismic design category shall be determined in accordance with Section R301.2.2.1.



Oregon Residential Code



Earthquakes and Single Family Homes

Building Department Website

mc CHAPTER 33 - BUILDING CODE | x +

library.municode.com/ia/cedar_rapids/codes/code_of_ordinances?nodeId=CH33BUCO_33.23R31CLGEDECR

mc Cedar Rapids, IA Search or jump to

Cedar Rapids, Iowa - Code of O... / CHAPTER 33 - BUILDING CO... / 33.23 - R301.2(1) CLIMATIC A...

VERSION: JUL 16, 2020 (CURRENT) ▾

- 33.21 - 202 Definitions
- 33.22 - R302.1 Exterior Walls
- 33.23 - R301.2(1) CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA.**
- 33.24 - R302.1(1) EXTERIOR WALL PROJECTIONS
- 33.25 - R302.5.1 OPENING PROTECTION.
- 33.26 - R302.13 FIRE PROTECTION OF FLOORS.

33.23 - R301.2(1) CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA.

Table R301.2(1) Climatic and Geographic Design Criteria is hereby amended by modifying Table R301.2(1) as follows:

GROUND SNOW LOAD	WIND SPEED MPH	Topo. Special wind Debris	SEISMIC DESIGN CATEGORY	SUBJECT TO DAMAGE FROM			
				Weathering	Frost Line Depth	Termite	Decay
30 PSF	115	NO	A	Severe	42"	Moderate Heavy	Slight-Moderate

https://library.municode.com/ia/cedar_rapids/codes/code_of_ordinances?nodeId=CH33BUCO_33.18R1NOOWOWAUAG

Seismic Forces

- Seismic (earthquake) forces are:
 - Dynamic; loading direction changes during an earthquake with forces reversing rapidly.
 - Able to shake or slide buildings off their foundations, overturn the entire structure, or force walls out of vertical similar to wind forces.



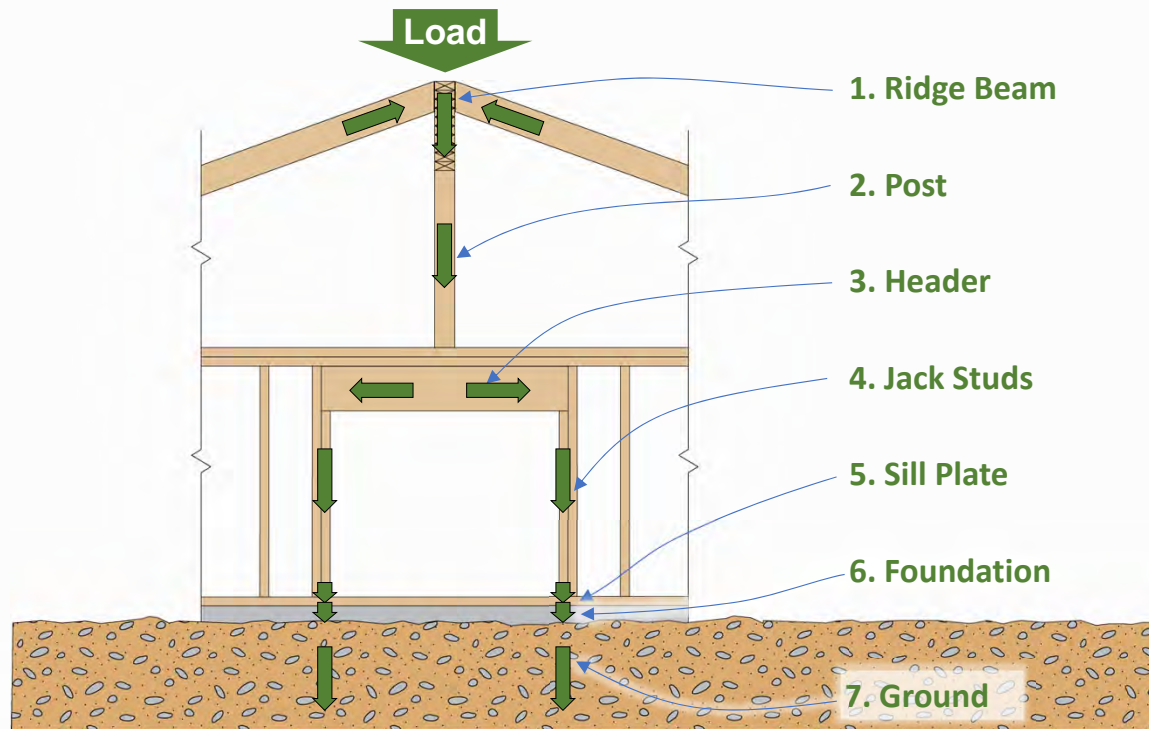
Seismic Forces

- Seismic forces vary due to:
 - Geometry of the building (regular/irregular).
 - Strength and stiffness distribution (soft/weak story).
 - Weight (mass) and height of the building.
 - Location (SDC and proximity to faults).
 - Construction materials (type/strength/ductility)



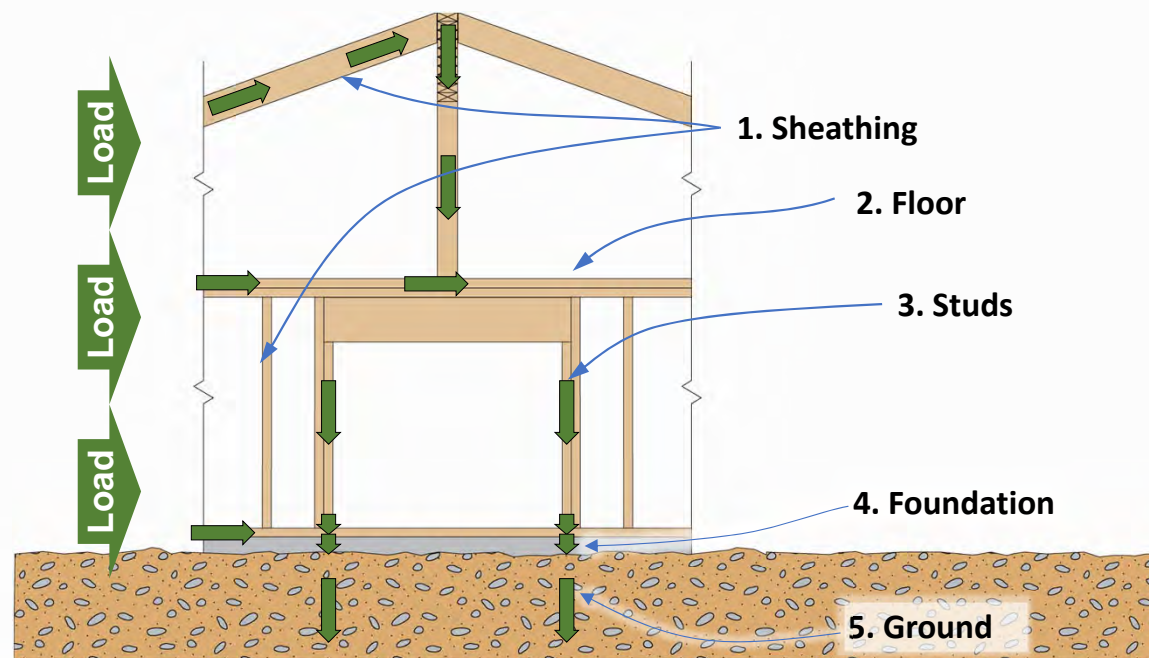
Vertical Loads

Vertical (Gravity) Load Path



Load Path

Lateral (Sideways) Load Path



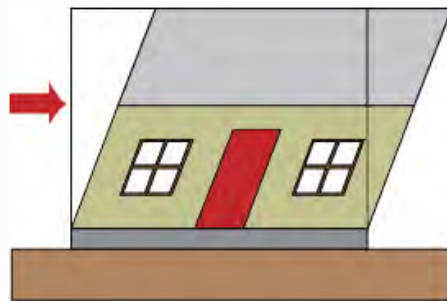
Lateral Forces



Lateral Forces

Effects of Forces

Racking



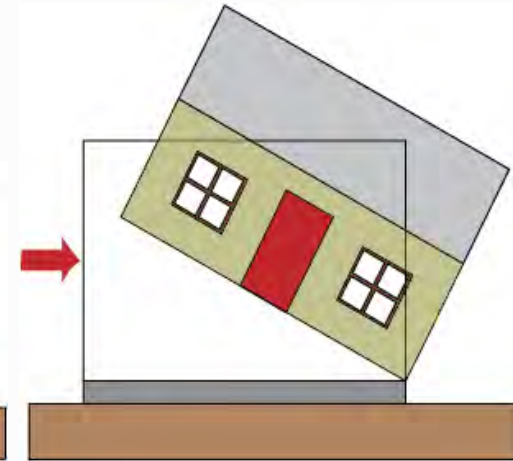
Resisted by Bracing

Base Shear



Resisted by Anchors

Overtuning

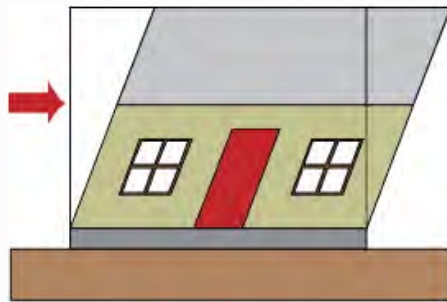


Resisted by hold-downs & Dead Load



Lateral Forces – Effects of Forces

Racking



Resisted by Bracing

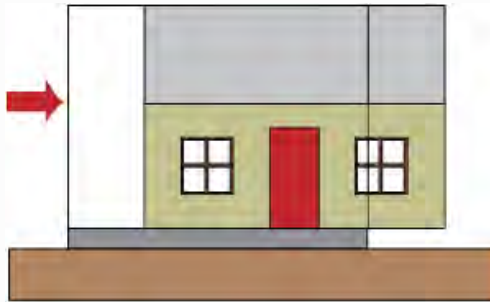


Lateral Forces – Effects of Forces

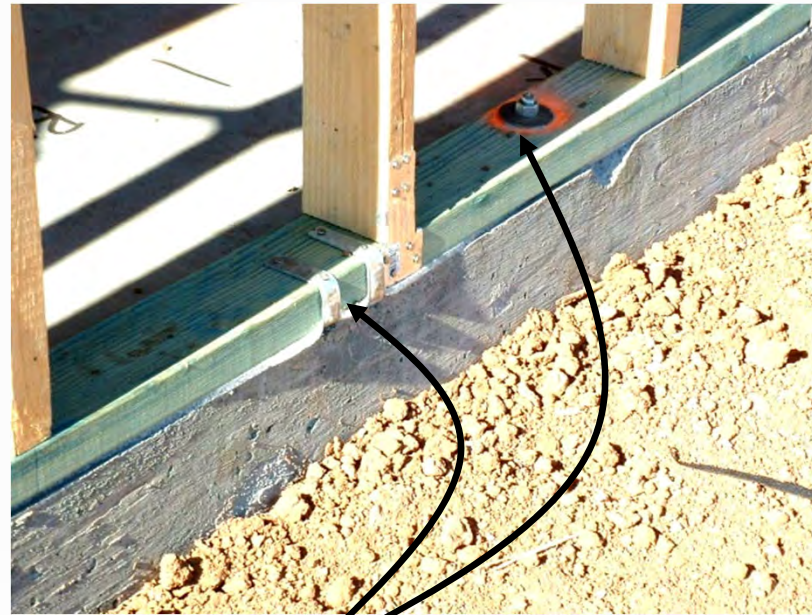


Lateral Forces – Effects of Forces

Base Shear



Resisted by Anchors



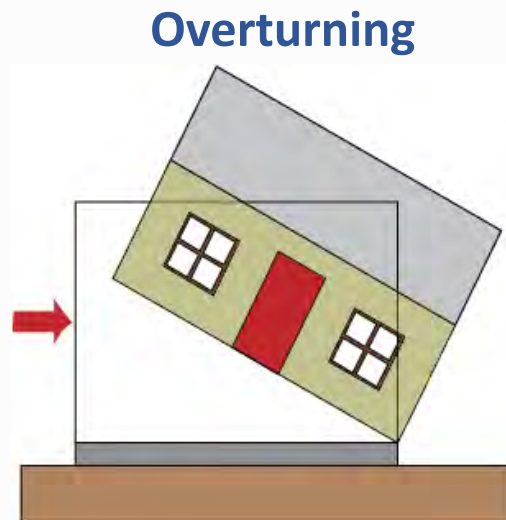
Anchors



Lateral Forces – Effects of Forces



Lateral Forces – Effects of Forces



Resisted by hold-downs &
Dead Load



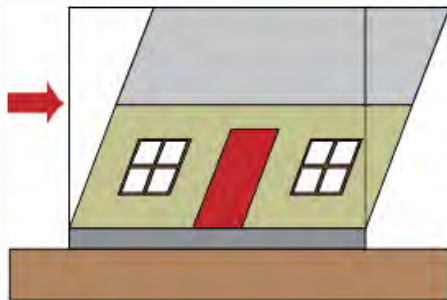
Lateral Forces – Effects of Forces

Overtuning



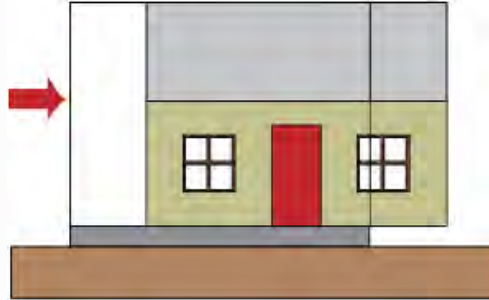
Lateral Forces – Effects of Forces

Racking



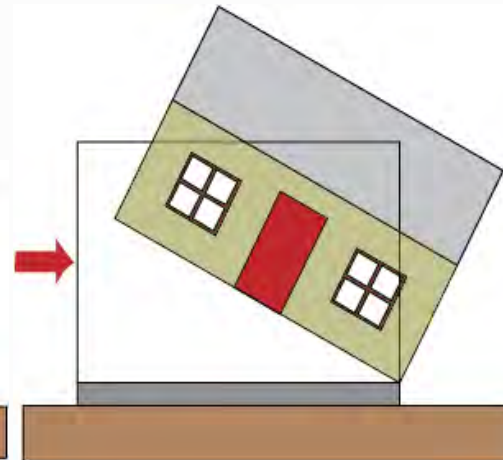
Resisted by Bracing

Base Shear



Resisted by Anchors

Overtuning



Resisted by hold-downs & Dead Load



Stiffened Walls

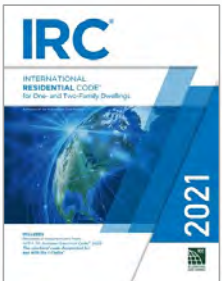
BWP (Prescriptive)

- Limitations
 - 3-Stories Maximum
 - Wind : $V_{ult} < 140\text{mph}^1$
 - SDC A-D₂
 - Others (see IRC Chap. 3)
- Typically without hold-downs

VS.

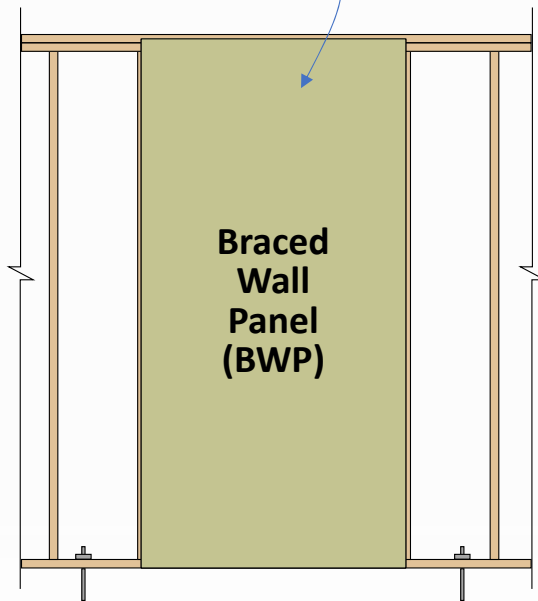
Shear Walls (Engineered)

- Applications
 - Any building size/shape
 - Wind – no limit
 - SDC – no limit
 - Calculations required
- Typically with hold-downs



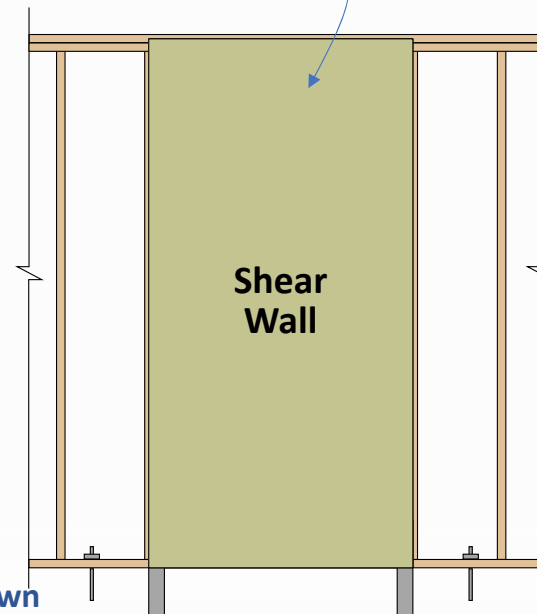
Stiffened Walls

Prescribed
material & nailing



VS.

Calculated load,
material & nailing

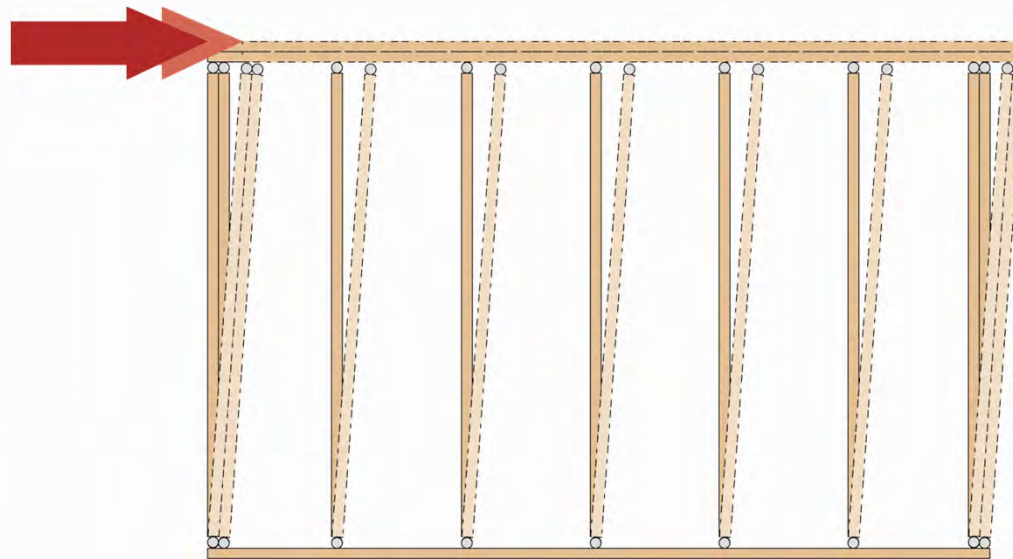


Hold-down
capacity calculated



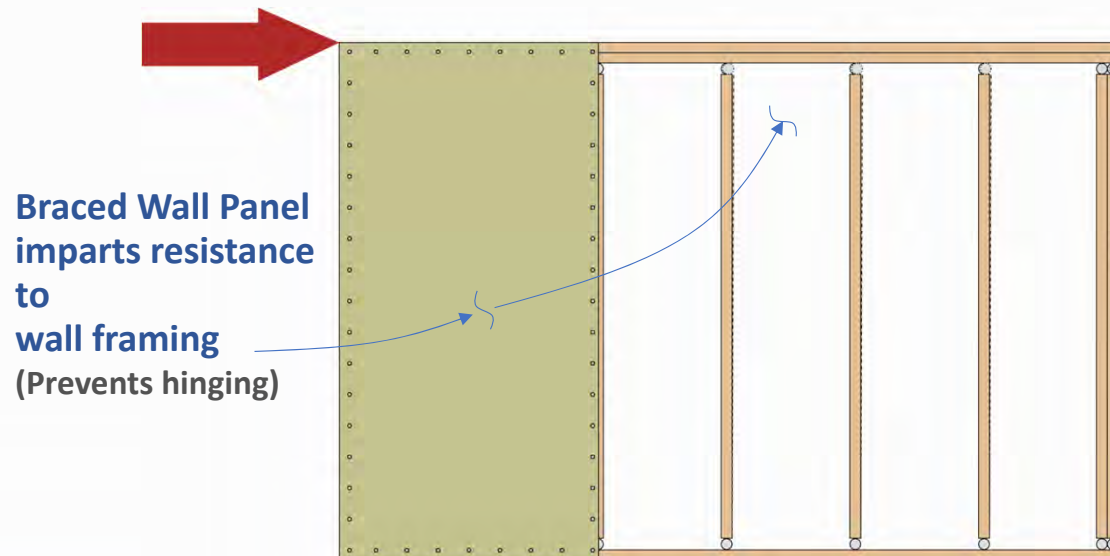
Stiffened Walls

Wall Framing



Stiffened Walls

Wall Framing



Limits



Limits - Seismic

R301.2.2 Seismic provisions.

The seismic provisions of this code shall apply to...

- Townhouses in SDC C, D₀, D₁ and D₂
- Detached one- and two-family dwellings in SDC D₀, D₁ and D₂



Limits - Seismic

Seismic Design Category C



One- & two-family
Seismic requirements
don't apply



Townhouse
Seismic requirements
apply

R301.2.2



Limits – Weight

R301.2.2.2 Weight of Materials

Average dead loads shall not exceed:

- 15 psf for roofs/ceiling assemblies, (exception for up to 25 psf)
- 10 psf for floor assemblies
- 15 psf for exterior wall assemblies

R301.2.2.2



Limits – Irregular Buildings

Irregular building definitions

1

2

3

4

5

6

7

8

R301.2.2.6 Irregular buildings

Seismic Requirements

Irregular building provisions
apply



Limits – Irregular Buildings

Irregular building definitions

1

2

3

4

5

6

7

8

R301.2.2.6 Irregular buildings

"The seismic provisions of this code shall not be used for structures... located in Seismic Design Categories C, D₀, D₁, and D₂ and considered to be irregular... Irregular structures, or irregular portions...shall be designed ... with accepted engineering practice... design of the remainder of the building shall be permitted to use the provisions of this code."

Wind Requirements

Irregular building provisions do not apply

Seismic Requirements

Irregular building provisions apply

Additional building shape and structural requirements apply



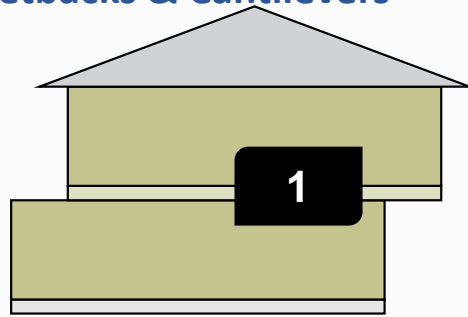
Limits – Irregular Buildings

Seismic Requirements Irregular Buildings, R301.2.2.6		
	Structural Requirements for Irregular Shape	If Irregular Shape Limit Exceeded
1	① ② ③ ④ ⑤	Engineering
2	Ex	Engineering
3	① ② ③ ④ ⑤	Engineering
4	N/A (Eng. Req.)	Engineering
5	① ②	Engineering
6	N/A (Eng. Req.)	Engineering
7	Ex	Engineering
8	N/A (Eng. Req.)	Engineering

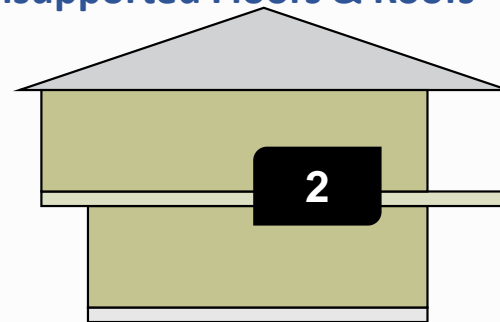


Limits – Irregular Buildings

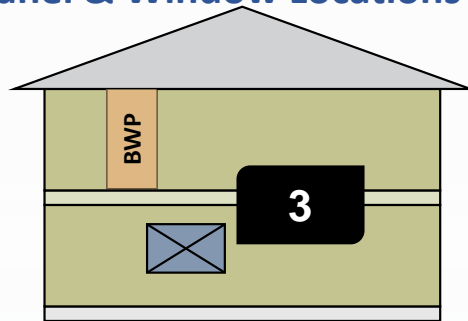
Setbacks & Cantilevers



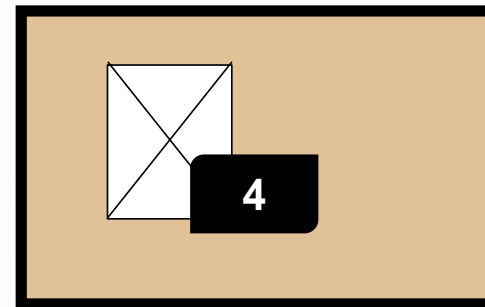
Unsupported Floors & Roofs



Panel & Window Locations



Floor or Roof Opening

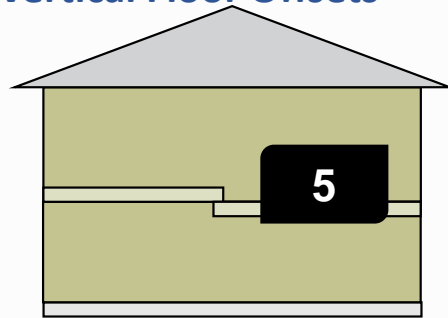


R301.2.2.6

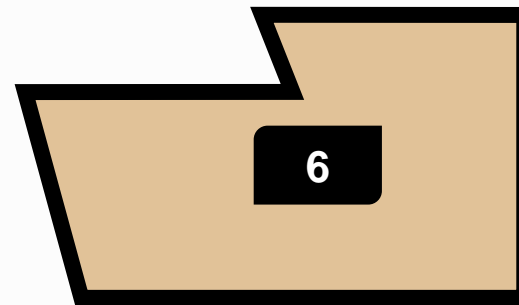


Limits – Irregular Buildings

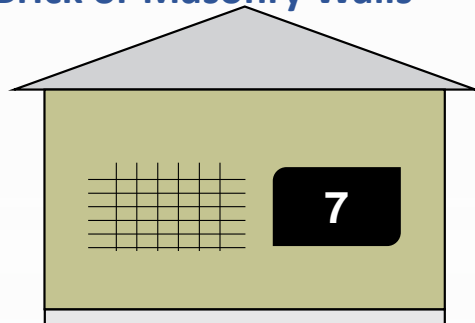
Vertical Floor Offsets



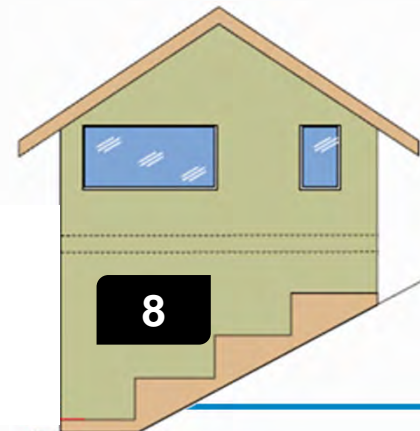
Non-perpendicular Walls



Brick or Masonry Walls



Hillside Structures



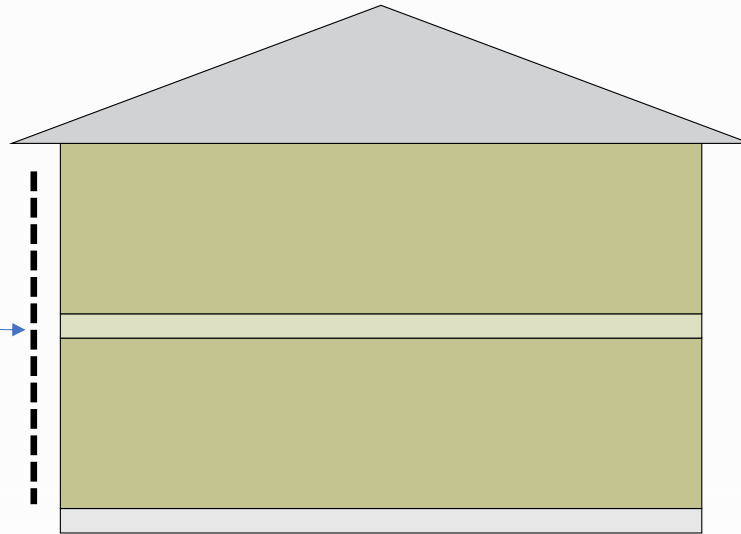
R301.2.2.6



Limits – Irregular Buildings

1

Vertically
in plane

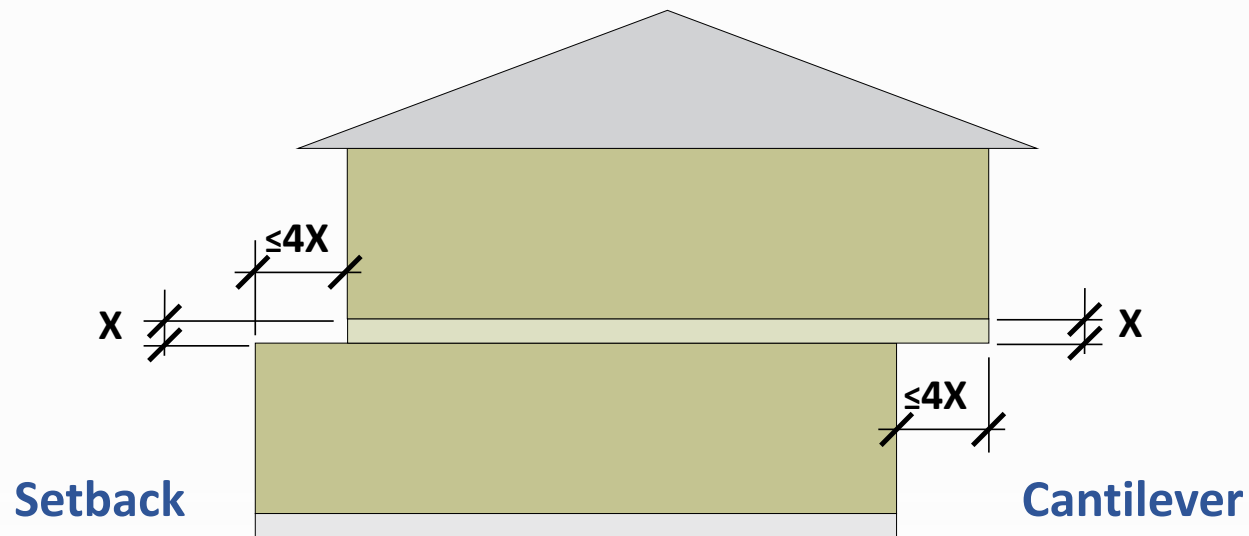


R301.2.2.6



Limits – Irregular Buildings

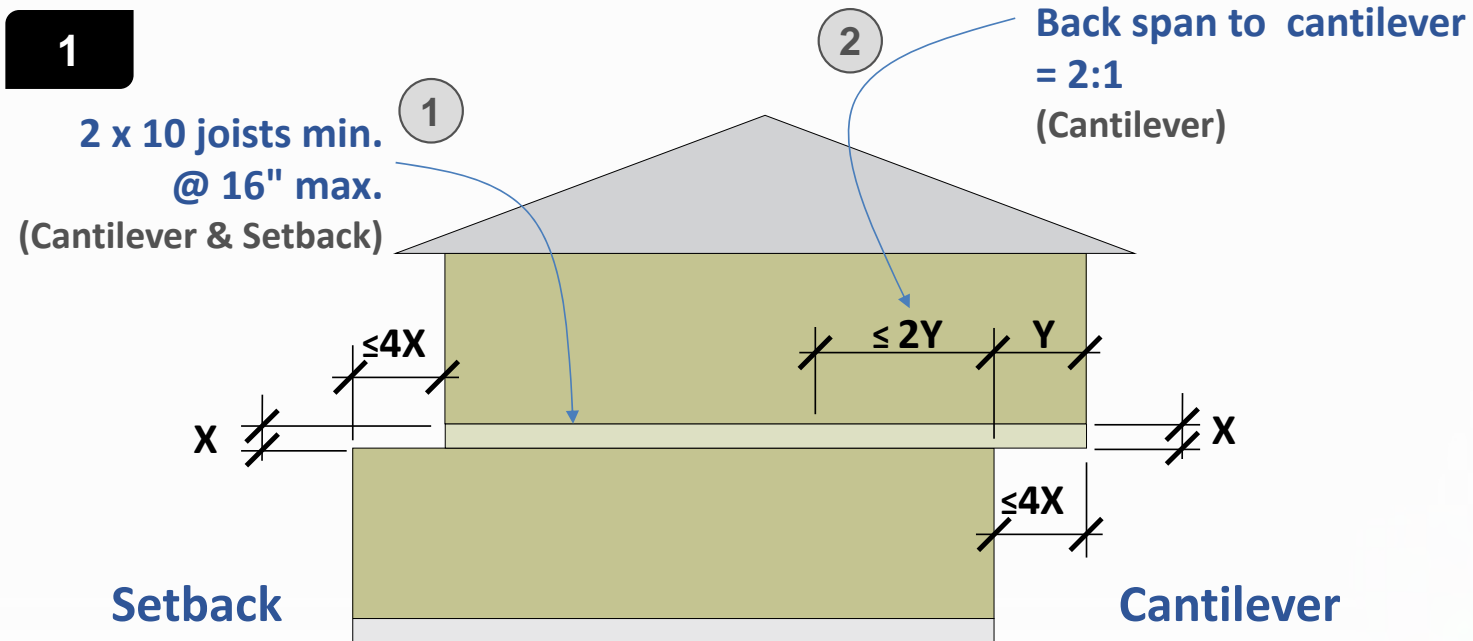
1



R301.2.2.6



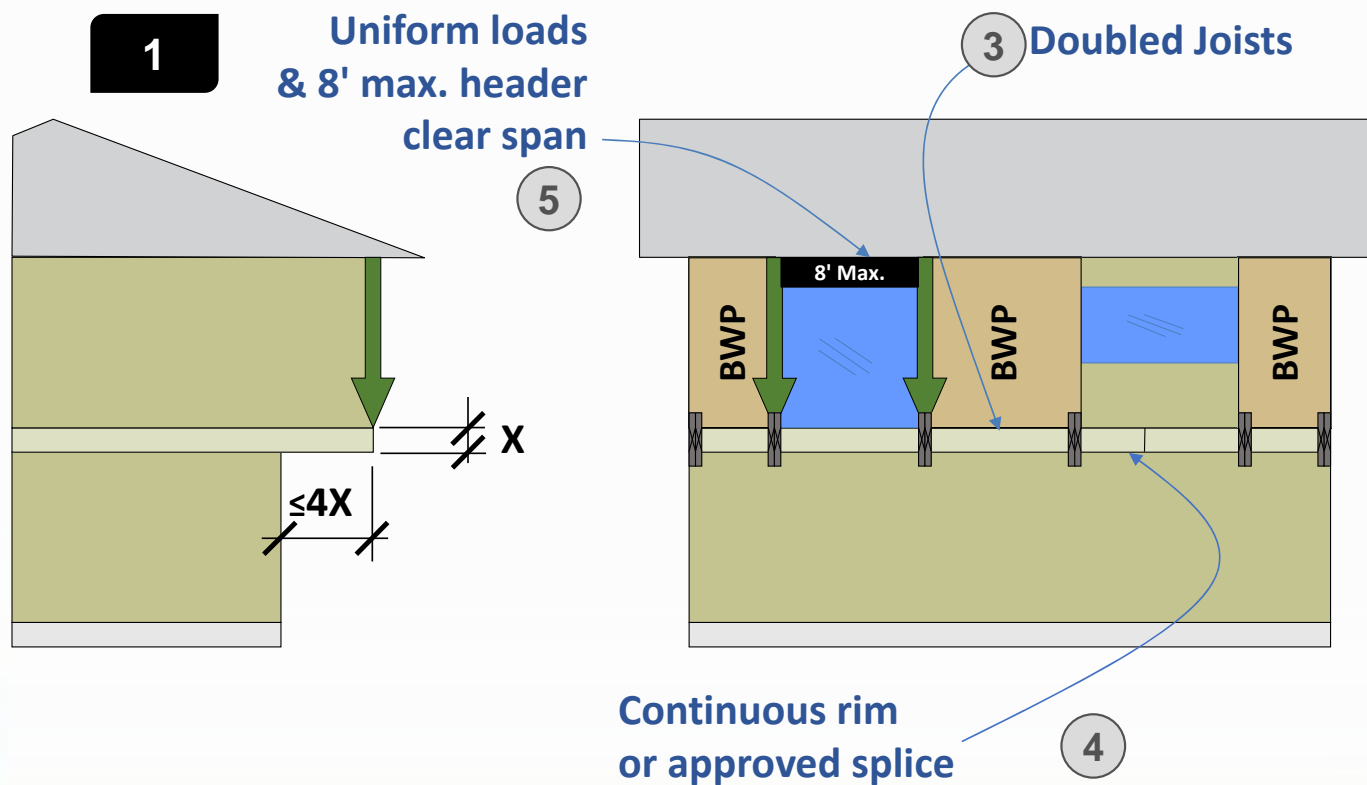
Limits – Irregular Buildings



R301.2.2.6



Limits – Irregular Buildings



R301.2.2.6



Limits – Irregular Buildings

1 Summary

Setback or Cantilever

1. 2" x 10" Joists @ 16" Max.
2. Back span to cantilever = 2:1
3. Doubled joists at BWP ends
4. Continuous rim or approved splice
5. Uniform load & 8' max header



R301.2.2.6



Limits – Irregular Buildings

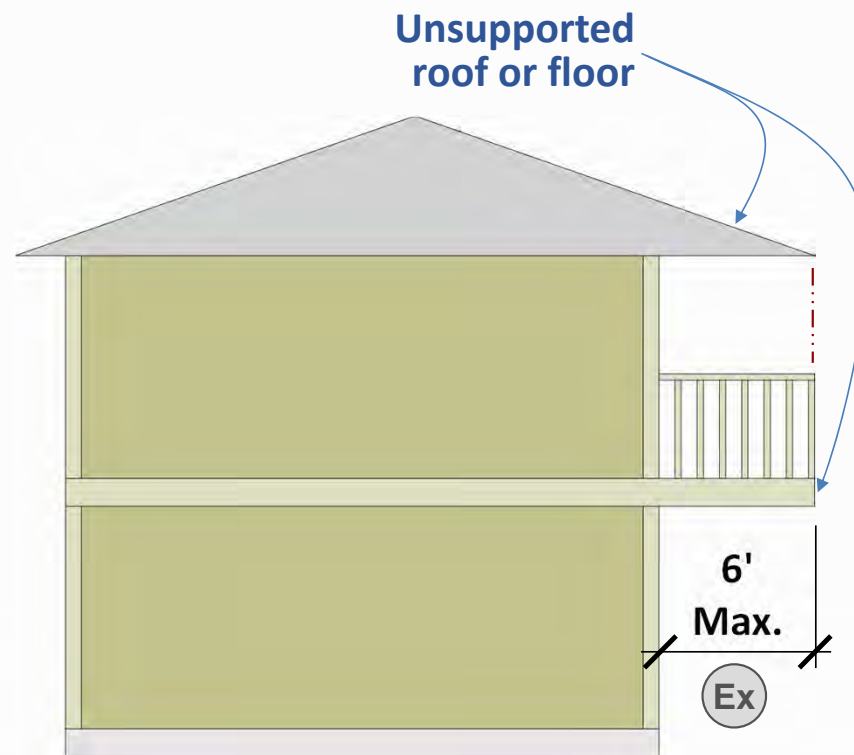


R301.2.2.6



Limits – Irregular Buildings

2



R301.2.2.6



Limits – Irregular Buildings

2

Lateral Support:

When a section of floor or roof is not laterally supported by shear walls or braced wall lines on all edges.

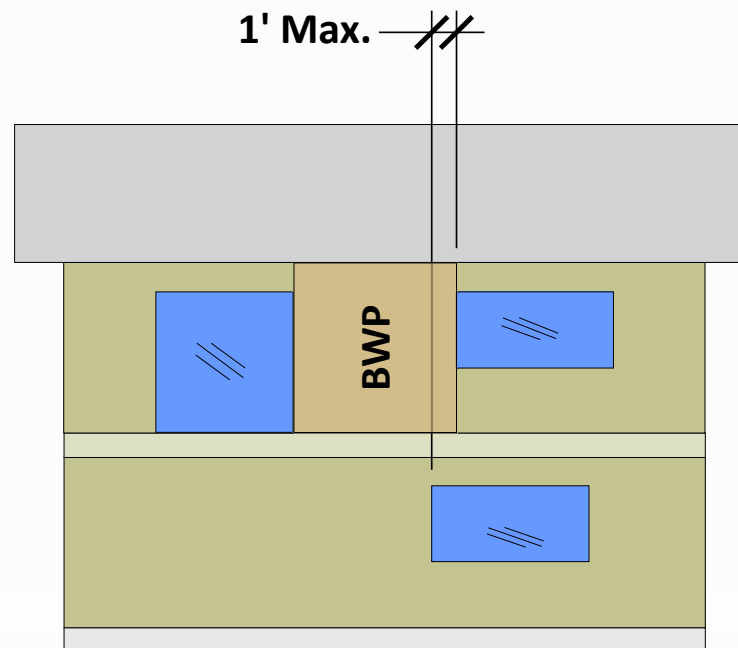


R301.2.2.6



Limits – Irregular Buildings

3



R301.2.2.6



Limits – Irregular Buildings

3

Entire BWP length shall not occur over opening below

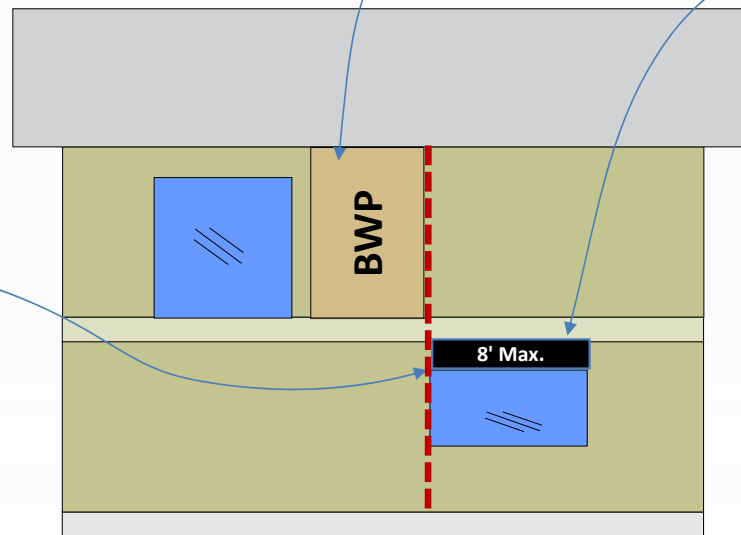
5

Header requirement

1 2 3 4

BWP & window not in line

5



R301.2.2.6



Limits – Irregular Buildings

3

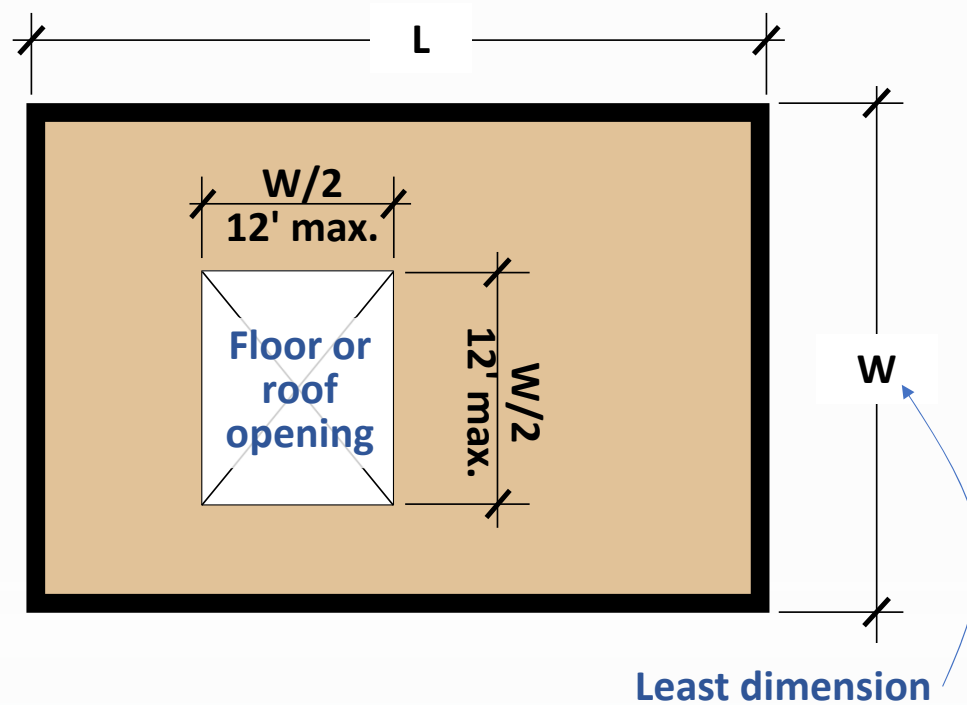
Header Requirements Per Table R502.5(1) ¹		
Maximum Opening length		Minimum Header Requirements
4' ²		Qty 1 – 2" x 12" Qty 2 – 2" x 10"
6' ³		Qty 2 – 2" x 12" Qty 3 – 2" x 10"
8' ⁴		Qty 3 – 2" x 12" Qty 4 – 2" x 10"

R301.2.2.6



Limits – Irregular Buildings

4



R301.2.2.6



Limits – Irregular Buildings

4

Floor or Roof Opening:

When an opening in a floor or roof exceeds the lesser of 12 feet or 50% of the least floor dimension it must be engineered in high seismic regions.



R301.2.2.6

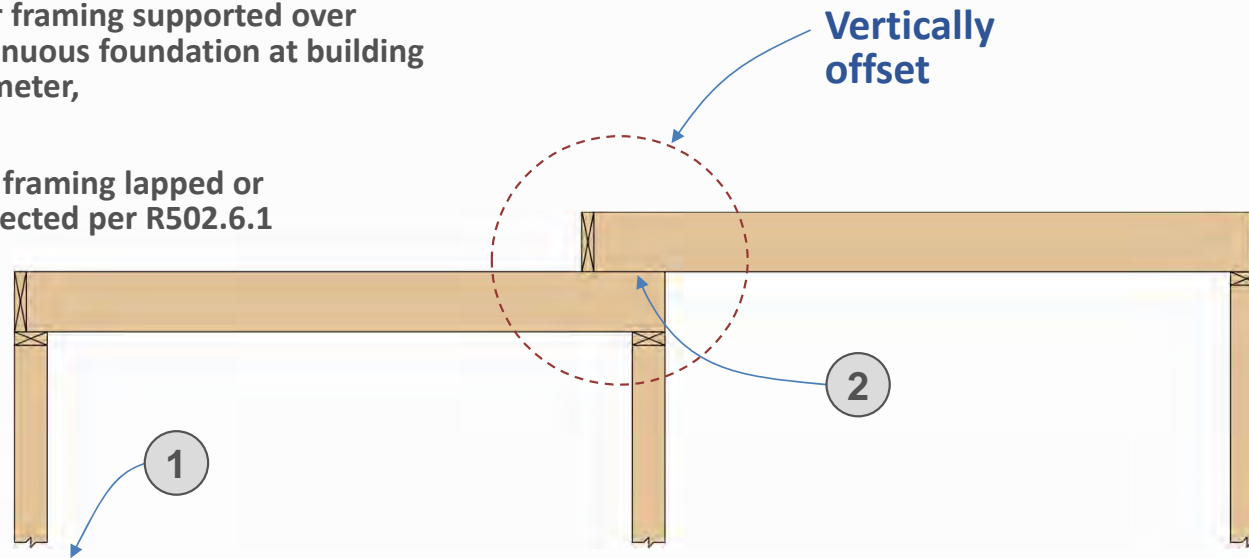


Limits – Irregular Buildings

5

Vertical offset permitted if:

- 1 Floor framing supported over continuous foundation at building perimeter,
or
- 2 Floor framing lapped or connected per R502.6.1



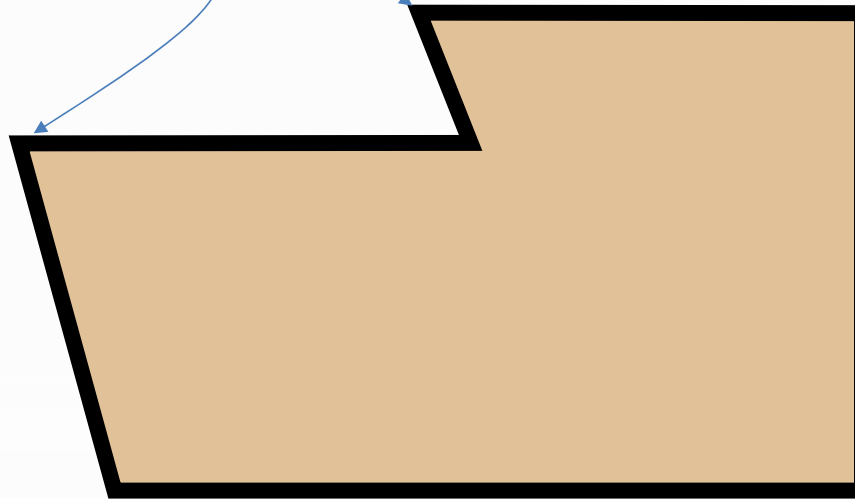
R301.2.2.6



Limits – Irregular Buildings

6

Not perpendicular



R301.2.2.6



Limits – Irregular Buildings

7

Masonry or Concrete:

When stories above-grade...include masonry or concrete construction.

Entire story must be designed by engineer.

Exception:

Fireplaces, chimneys, and masonry veneer are permitted by this code.



R301.2.2.6



Limits – Irregular Buildings

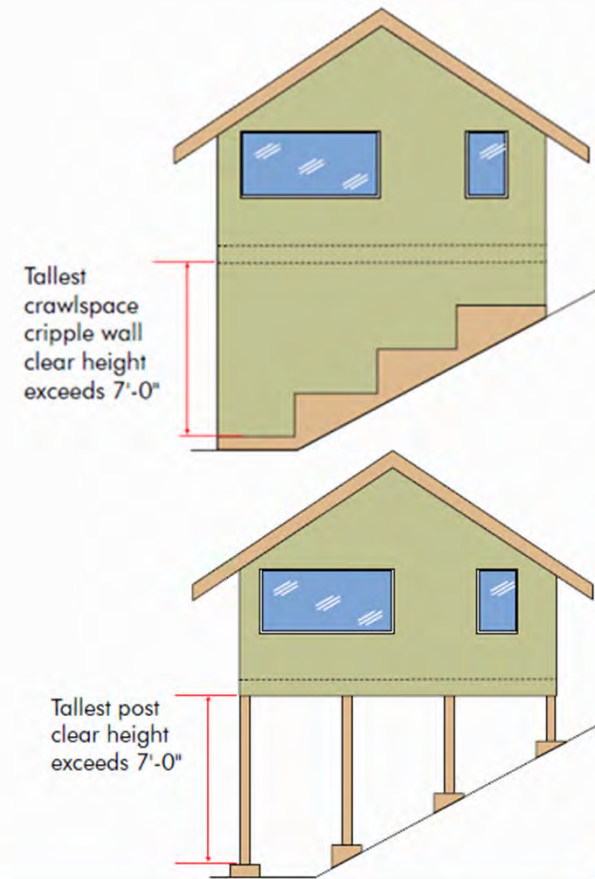
8

Hillside Construction:

Grade slope $> 1:5$; Engineering required for cripple walls or posts and beams, floor above and foundation.

Exception:

Basement with concrete or masonry walls on three sides



R301.2.2.6



Limits – Irregular Buildings

Irregular building definitions

1

2

3

4

5

6

7

8

R301.2.2.6 Irregular buildings review

Irregular portions of structures shall be designed in accordance with accepted engineering practice unless specific exceptions are met.



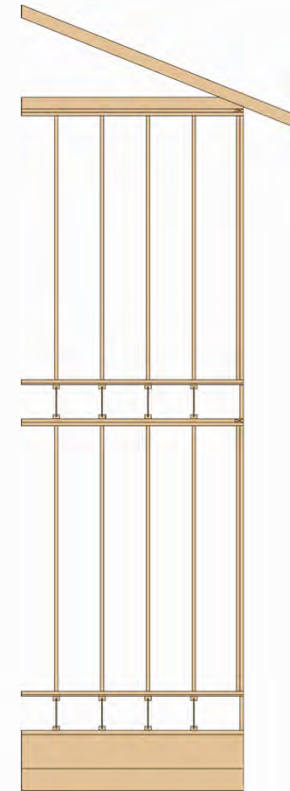
Story Heights



Limits – Story Height

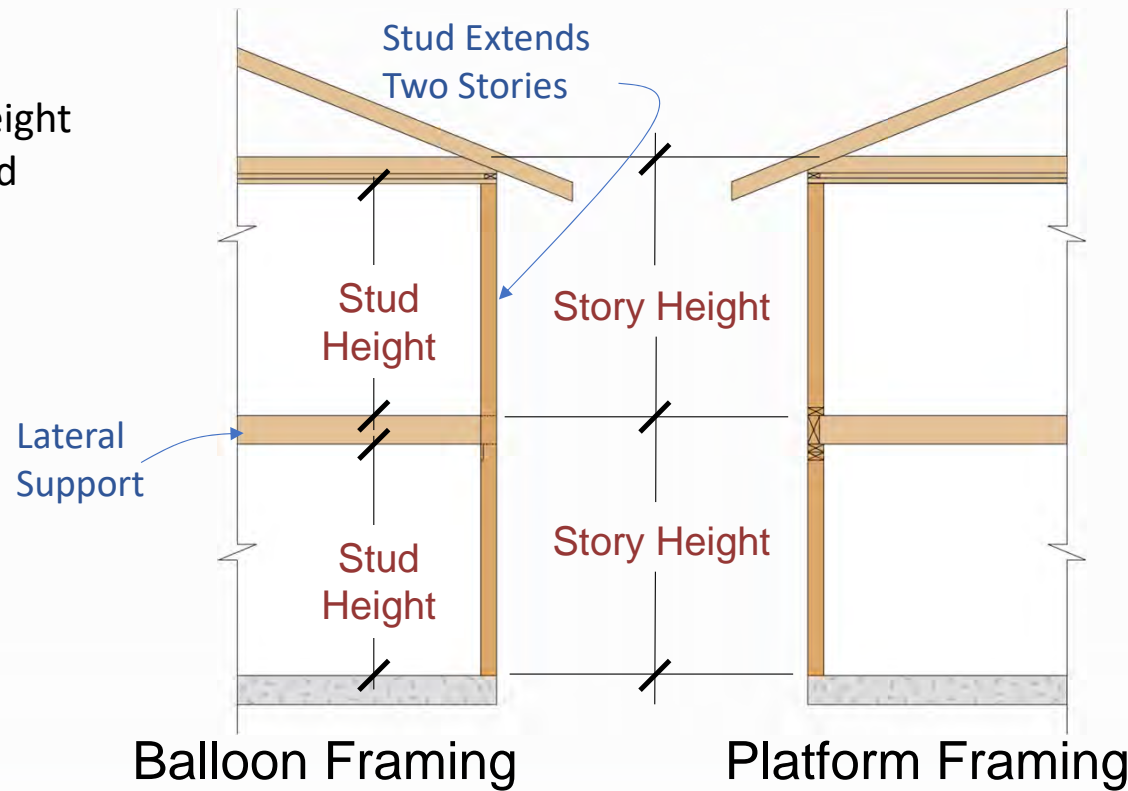
In-plane lateral forces

- Requirements for story height exist to limit the wind and seismic provisions
- In-plane forces (lateral forces along a wall line)
 - Story height limit – 11 ft. 7 in.
 - Exception: 13 ft. 7 in. with limits (R602.3.1)
 - Bearing stud height – 10 ft.
 - Exception: 12 ft with limits (Table R602.3(5) footnote a)
- When wall heights do exceed the limit, the walls are designed using the IBC



Limits – Story vs Stud Height

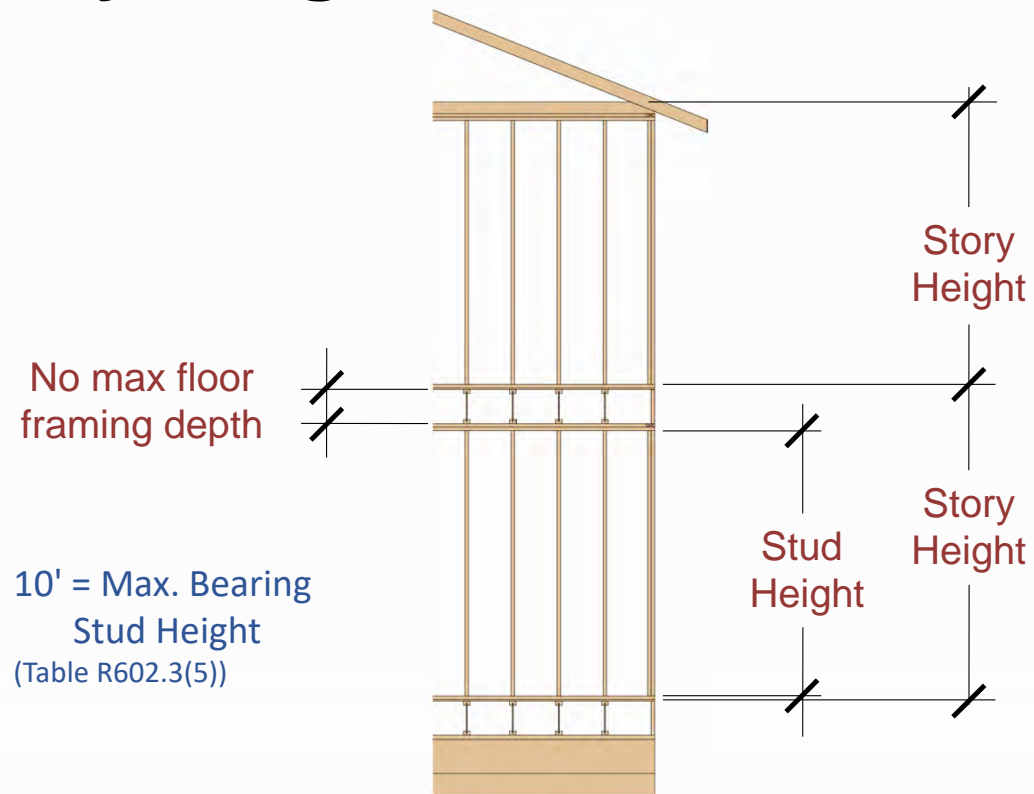
10' = Max. Bearing Stud Height
20' = Max. Nonbearing Stud Height
(Table R602.3(5))



R301.1.2



Limits – Story Height



R301.3



Limits – Story Height

Out-of-plane lateral forces

Requirements for story height exist to limit the wind forces pressing against a wall

Out-of-plane forces (wind on sail area):

- Stud height limit – 10 ft (bearing wall)
- 20 ft (nonbearing wall)

Stud height may be increased to 20 ft. for bearing walls, if the building and wall line meet the requirements of Section R602.3.1



R602.3.1



Limits – Stud Height

Size, Height and Spacing of Wood Studs - Table R602.3(5)^a

Stud Size (Inches)	BEARING WALLS					NONBEARING WALLS	
	Laterally unsupported stud height (feet) ^a	Maximum spacing when supporting roof-ceiling assembly or habitable attic, only (inches)	Maximum spacing when supporting one floor, plus a roof-ceiling assembly or habitable attic (inches)	Maximum spacing when supporting two floors, a roof-ceiling assembly or habitable attic (inches)	Maximum spacing when supporting one floor height (inches) ^a	Laterally unsupported stud height (feet) ^a	Maximum spacing (inches)
2 x 3^b	--	--	--	--	--	10	16
2 x 4	10	24	16	--	24	14	24
3 x 4	10	24	24	16	24	14	24
2 x 5	10	24	24	--	24	16	24
2 x 6	10	24	24	16	24	20	24

Table
R602.3(5)



Limits – Stud Height

Table R602.3(5) footnote a

1. **Listed heights are distances between points of lateral support** placed perpendicular to the plane of the wall.
2. **Bearing walls shall be sheathed on not less than one side** or bridging shall be installed not greater than 4 feet apart measured vertically from either end of the stud.
3. **Increases in unsupported height** are permitted where in compliance with **Exception 2 of Section R602.3.1** or designed in accordance with accepted engineering practice.

Table
R602.3(5)



Limits – Stud Height

Table R602.3(5) footnotes b and c

- b. [2x3 studs] shall not be used in exterior walls.
- c. A habitable attic assembly supported by 2 × 4 studs is limited to a roof span of 32 feet. **Where the roof span exceeds 32 feet, the wall studs shall be increased to 2 × 6** or the studs shall be designed in accordance with accepted engineering practice.

Table
R602.3(5)



Limits – Stud Height

Stud Size, Height and Spacing - Section R602.3.1 footnote b

An exception in Section R602.3.1 allows stud heights greater than 10 feet tall for very limited circumstances in bearing walls.

- Snow loads ≤ 25 psf
- $V_{ult} \leq 130$ mph
- 2-inch by 6-inch studs
- Roof load ≤ 6 feet of tributary length
- Min. No. 2 grade studs

Maximum height

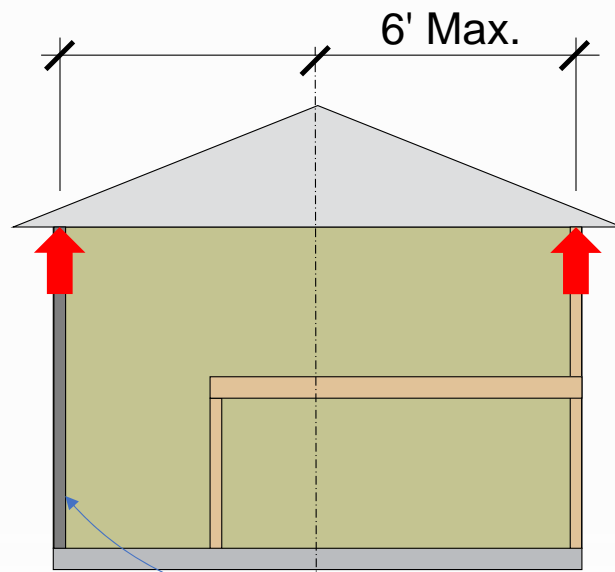
- 18 feet @ 16 inches o.c.
- 20 feet @ 12 inches o.c.

R602.3.1

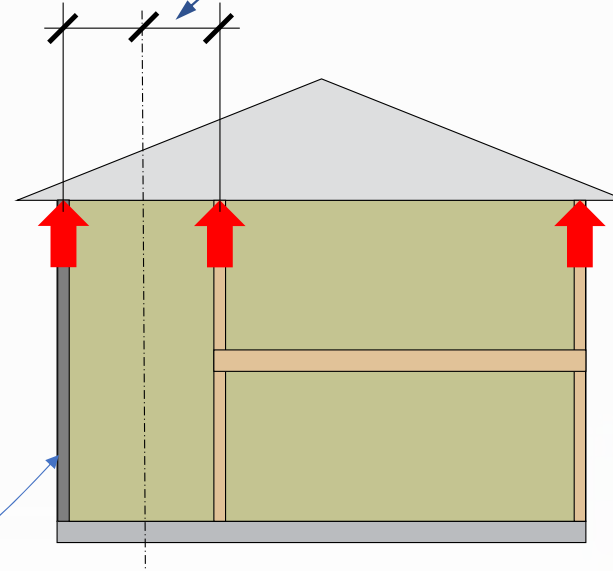


Limits – Stud Height

Two Point Truss



Three Point Truss
6' Max.



Tall walls

R602.3.1



Limits – Stud Height

Stud Size, Height and Spacing - Section R602.3.1 footnote c

- An exception in Section R602.3.1 allows stud heights to 12 feet tall in bearing walls.
- Studs must meet the requirements of Table R602.3(6).

R602.3.1



Limits

- Snow loads \leq 30 psf
- Wind Exposure B
- Min. No. 2 grade studs and plates

Maximum height

- 12 feet

Limits – Stud Height

Alternate Wood Bearing Wall Stud Size, Height and Spacing –
Table R602.3(6) excerpt

Stud Height	Supporting	Stud Spacing ^a	Ultimate Design Wind Speed			
			115 mph		130 mph ^b	
			Maximum roof/floor span ^c		Maximum roof/floor span ^c	
			12 ft.	24 ft.	12 ft.	24 ft.
11 ft.	Roof Only	12 in.	2 × 4	2 × 4	2 × 4	2 × 4
		16 in.	2 × 4	2 × 4	2 × 4	2 × 6
		24 in.	2 × 6	2 × 6	2 × 6	2 × 6
	Roof and One Floor	12 in.	2 × 4	2 × 6	2 × 4	2 × 6
		16 in.	2 × 6	2 × 6	2 × 6	2 × 6
		24 in.	2 × 6	2 × 6	2 × 6	2 × 6
12 ft.	Roof Only	12 in.	2 × 4	2 × 4	2 × 4	2 × 6
		16 in.	2 × 4	2 × 6	2 × 6	2 × 6
		24 in.	2 × 6	2 × 6	2 × 6	2 × 6

Table
R602.3(6)



Limits – Stud Height

Alternate Wood Bearing Wall Stud Size, Height and Spacing – Table R602.3(6)

DR = Design Required

- a. Wall studs ≤ 16 in. o.c. shall be sheathed with minimum $\frac{1}{2}$ -inch GB on the interior and $\frac{3}{8}$ -inch WSP sheathing on the exterior. WSP sheathing shall be attached with 8d (2.5" x 0.131") nails ≤ 6 in. o.c. along panel edges and 12 in. o.c. at intermediate supports, and all panel joints shall occur over studs or blocking.
- b. Where $V_{ult} > 115$ mph, studs shall be attached to top and bottom plates with connectors having a min. 300-pound lateral capacity.
- c. The max. span is applicable to both single- and multiple-span roof and floor conditions. The roof assembly shall not contain a habitable attic.

Table
R602.3(6)



Foundations



Earthquakes and Single Family Homes

Foundation styles

Basement



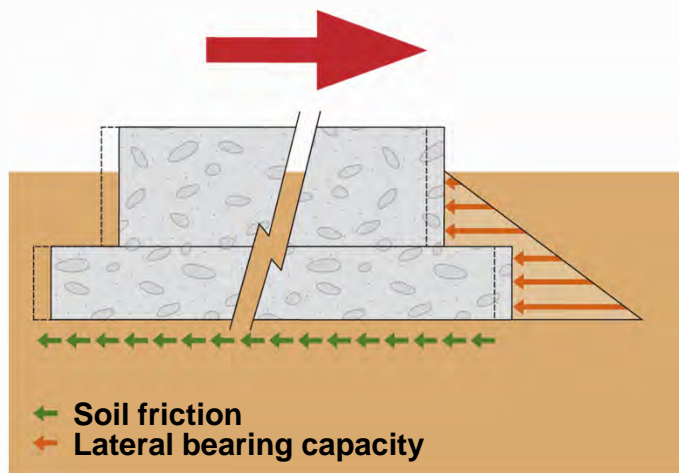
Crawl Space



Slab on Grade

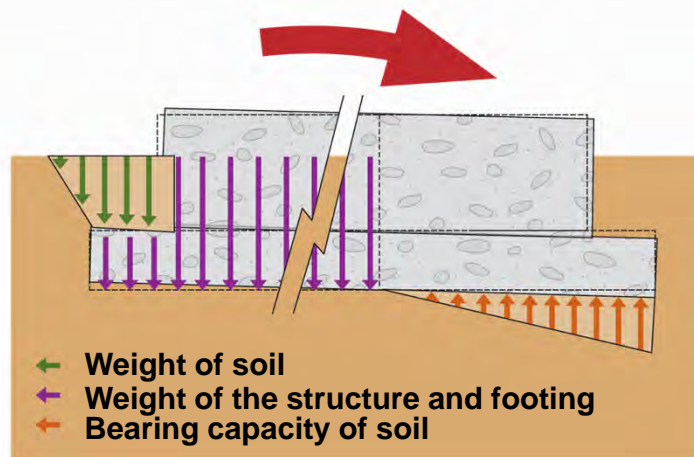


Wall Anchorage to Foundations



Sliding

Resisted by soil friction and lateral bearing capacity of soil.



Overturning

Resisted by weight of structure and footing, weight of soil on footing, and bearing capacity of soil.

Footings

Table R403.1 Concrete Footings

TABLE R403.1(1)
MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME CONSTRUCTION (inches)^{a, b}

GROUND SNOW LOAD OR ROOF LIVE LOAD	STORY AND TYPE OF STRUCTURE WITH LIGHT FRAME	LOAD-BEARING VALUE OF SOIL (psf)				
		1,500	2,000	2,500	3,000	3,500
20 psf roof live load or 25 psf ground snow load	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	22 × 7	16 × 6	13 × 6	12 × 6	12 × 6
	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6



Footings and Foundations

Concrete Reinforced Footing Requirements (R403)

Code Section	Provision	SDC A-C	High Seismic Regions SDC D ₀ -D ₂
R403.1.3.1	Concrete stem wall	No reinforcement requirements, unless required by other sections of code	1-#4 horizontal within 12" of the top of wall
	Construction Joint		1-#4 horizontal located 3" to 4" from bottom of footing
R403.1.3.2	Masonry stem wall	No reinforcement requirements, unless required by other sections of code	1-#4 vertical at 48" o.c. with standard hook at bottom bars with minimum 14" into stem wall
			1-#4 horizontal within 12" of the top of wall and 1-#4 at 3" to 4" from bottom of footing
R403.1.3.3	Slab with turned down footing	No reinforcement requirements, unless required by other sections of code	1-#4 horizontal at top and bottom or 2-#4 or 1-#5 in middle third
			1-#3 vertical at 48" o.c. with standard hook to top and bottom bars when slab and footing cast separately



Footings and Foundations

Construction Joint Reinforcement



Footings and Foundations

Continuous Footings in SDC D₀, D₁, D₂ (R403.1.2)

Braced Wall Panel	Number of Stories	Plan Dimension ≤ 50 ft.	Plan Dimension > 50 ft.
Exterior	All Stories	Supported by continuous footings	Supported by continuous footings
Interior	Single Story	No requirement for continuous footing	Continuous footings below all required interior BWPs
	Two Story	No requirement for continuous footing	Continuous footings below all required interior BWPs
	Two Story Exception		Exception – allows interior BWP support every 50 feet or less with additional requirements

R403.1.2



Footings and Foundations

SDC D_0 and D_1

Two-story exception to allow 50' interval between continuous foundation segments

1. Cripple walls not more than 4' in height
2. First floor BWP's are supported on double floor joists, continuous blocking or floor beams
3. The distance between BWL's does not exceed twice the building width measure parallel to the BWL

R403.1.2



Footings and Foundations

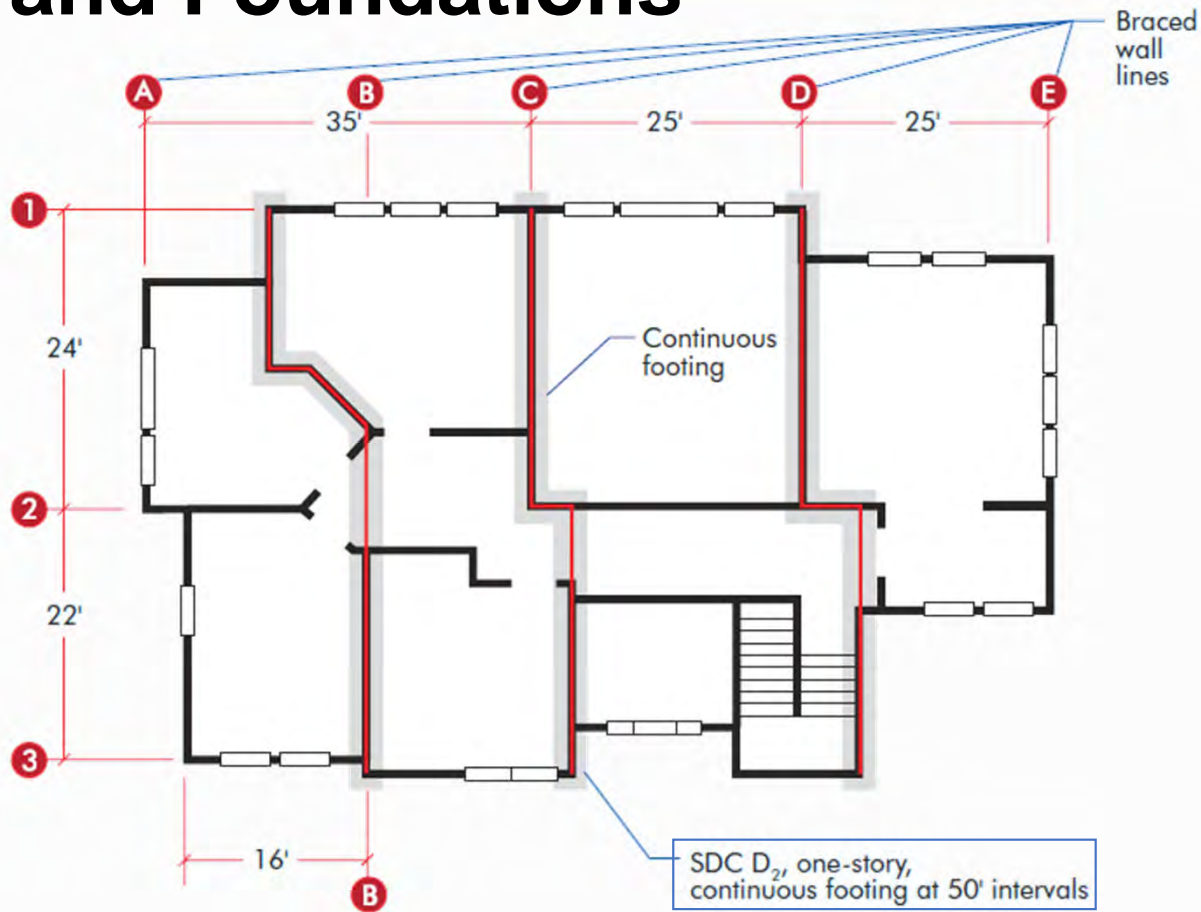
Continuous Footings SDC D₂

Braced Wall Panel	Number of Stories	Plan Dimension ≤ 50 ft.	Plan Dimension > 50 ft.
Exterior	All Stories	Supported by continuous footings	Supported by continuous footings
Interior	Single Story	No requirement for continuous footing	Continuous footings below all interior BWPs
	Two Story	Requires continuous foundation below all interior BWPs	Requires continuous foundation below all interior BWPs

R403.1.2



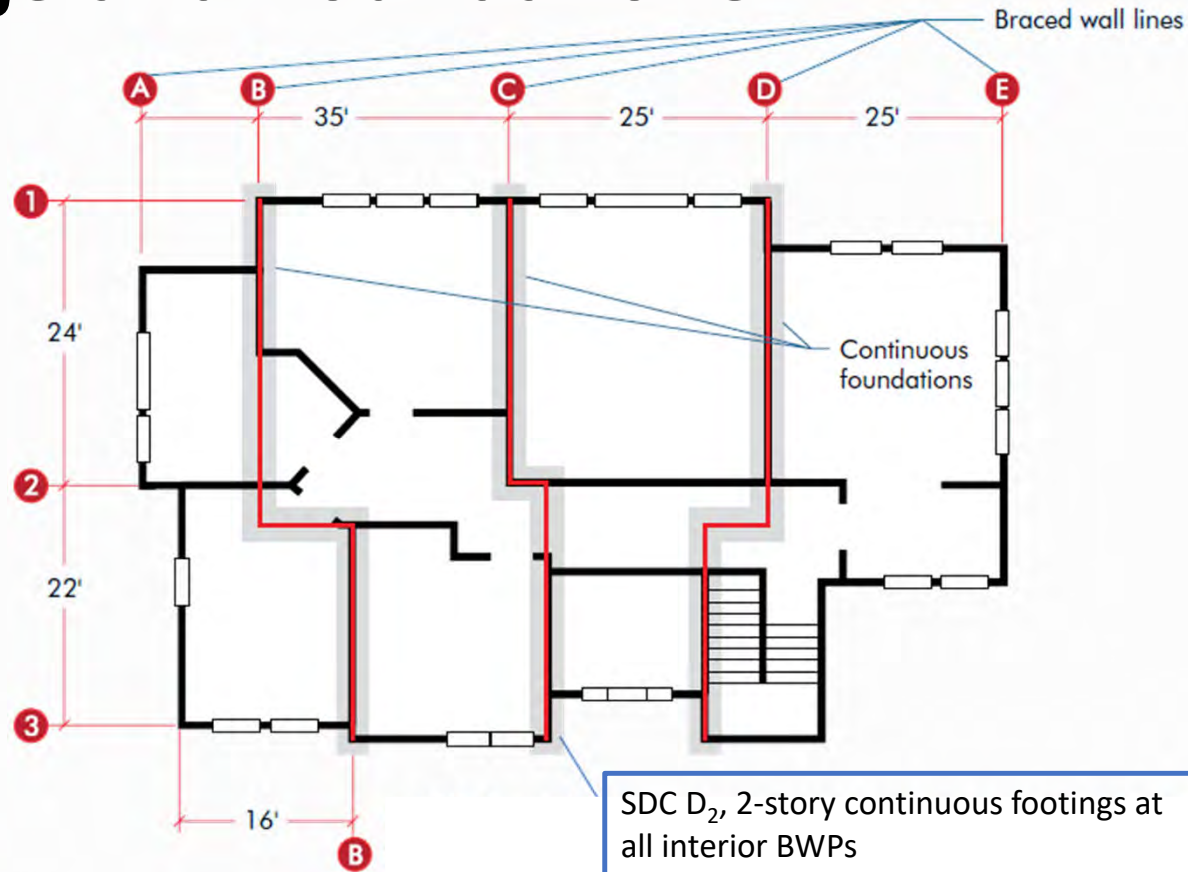
Footings and Foundations



R403.1.2



Footings and Foundations



R403.1.2



Footings and Foundations

Footings

Anchor bolt placement

- Bolts embedded 7 inches
- Total length = 7" + plate(s) depth + threaded end
- Placed at 6 feet on center
- Bolts shall be located in the middle third of the width of the plate
- Bolts can be wet-set

Footing depth

- Minimum 12 inches (R403.1.4)
- Frost depth controls in many areas

R403.1.6

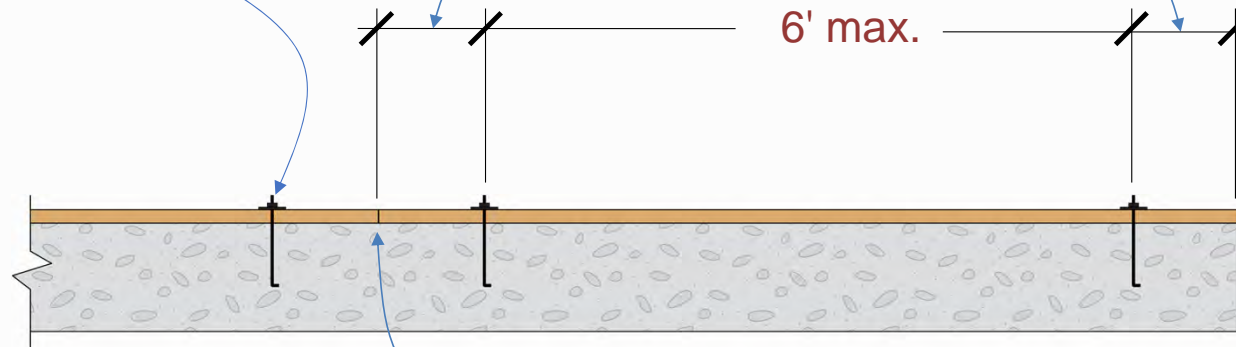


Footings and Foundations

1/2" bolt with 7" min.
embedment in concrete or
masonry

7 bolt dia. min.
to 12" max.

6' max.



R403.1.6



Footings and Foundations

Anchor bolt spacing



Footings and Foundations

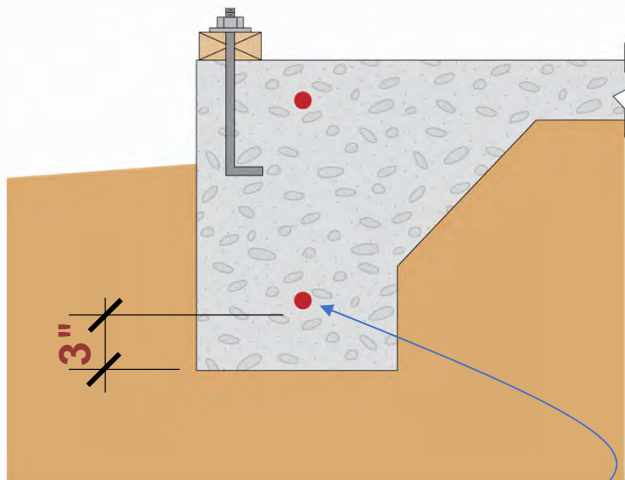
Wall Bracing – Foundation Requirements (R602.10)

Code Section	Provision	SDC A-C	SDC D ₀ -D ₂
R602.10.6, Figures R602.10.6.1 and R602.10.6.2	Alternate wall bracing (ABW, PFH)	Methods ABW and PFH required 1-#4 horizontal top and bottom of footing	Methods ABW and PFH required 1-#4 horizontal at top and bottom of footing
R602.10.9, Figure R602.10.9	Short concrete or masonry walls below BWP	Rebar required complying with Figure R602.10.9 if wall length, height, and thickness are $L \leq 48"$ AND $H > 12"$ AND $T < 6"$	Rebar required complying with Figure R602.10.9 if wall length, height, and thickness are $L \leq 48"$ AND $H > 12"$ AND $T < 6"$



Wall Anchorage to Foundations

Wall Bracing Section Requirements



For footings supporting an
ABW or PFH panel

#4 bars at top & bottom

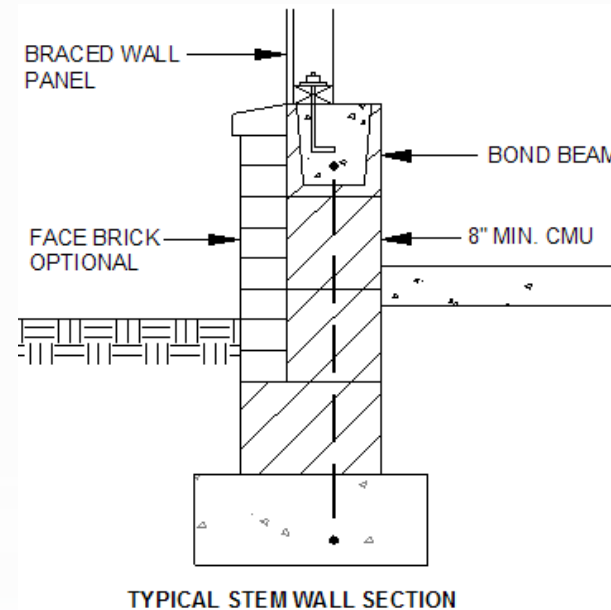
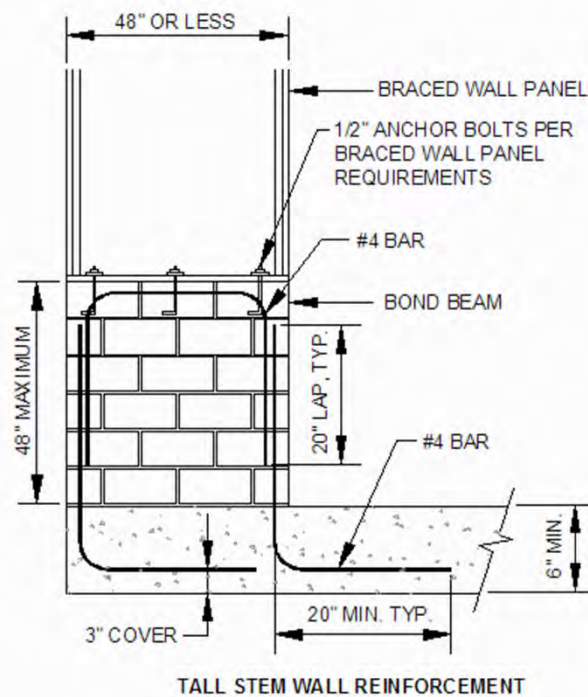
R602.10.6.1 and
R602.10.6.2



Footings and Foundations

Narrow Masonry Wall Requirements

Only required for walls less than 48" long.



602.10.9



Footings and Foundations

Anchorage Requirements (R403.1.6, R403.1.6.1, R602.11)

Section	Provision	SDC A-C	SDC D ₀ -D ₂ , SDC C (townhouses)
R403.1.6, R403.1.6.1	Foundation anchorage	<ul style="list-style-type: none"> • Wood sole and sill plates attached to foundation with anchor bolts 6' o.c. • ½" bolt w/ min. 7" embedment • 2 bolts per plate with bolts located 7 bolt diameters to 12" from each end 	<ul style="list-style-type: none"> • Wood sole and sill plates attached to foundation with anchor bolts 4' o.c. for 3-stories • Interior and exterior BWLs require plate washers • Wall lines without BWPs may use cut washers in lieu of plate washers • ½" bolt w/ min. 7" embedment and 3" by 3" plate washers • 2 bolts per plate with bolts located 7 bolt diameters to 12" from each end
		Exception: <ul style="list-style-type: none"> • 24" and shorter walls require 1 anchor bolt • 12" and shorter walls do not require anchor bolts 	



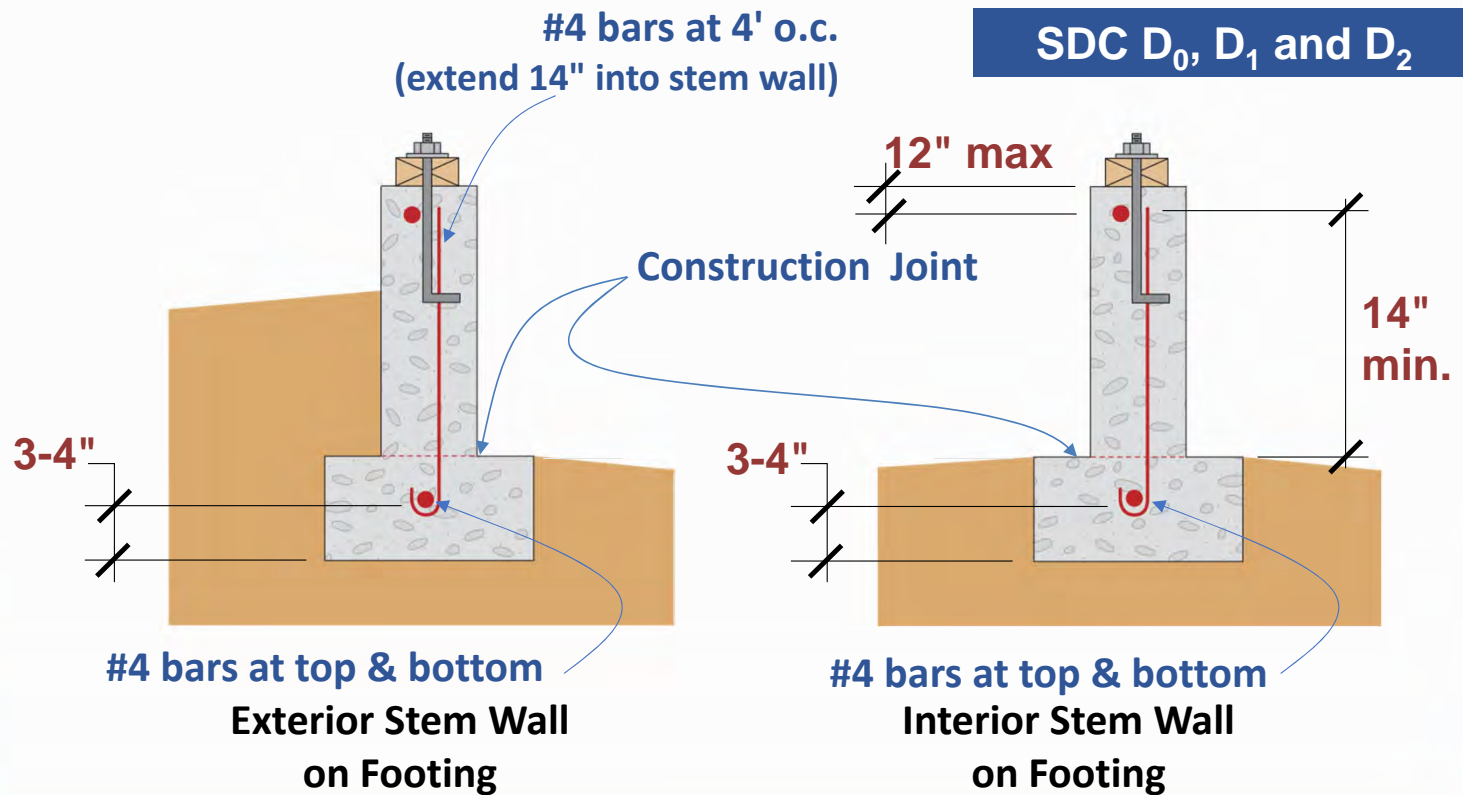
Footings and Foundations

Anchorage Requirements (R602.11)

Code Section	Provision	SDC A-C	SDC D ₀ -D ₂ , SDC C (townhouses)
R602.11	Wall anchorage	No additional requirements, use Section R403.1.6	Plate washers 0.229" by 3" by 3" minimum between sill plate and nut on braced wall lines



Wall Anchorage to Foundations

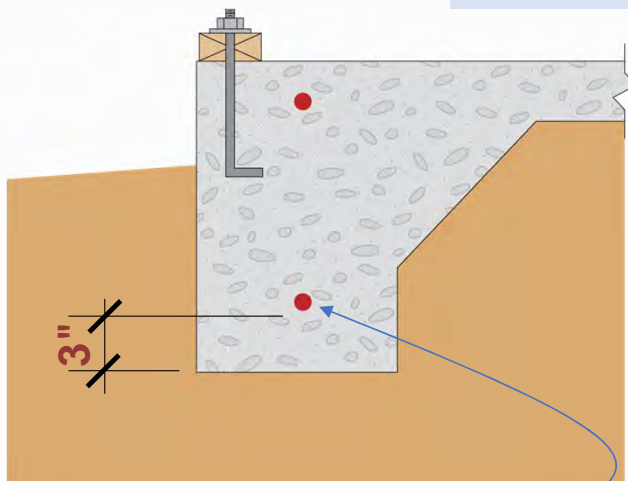


R403.1.3,
R403.1.3.1

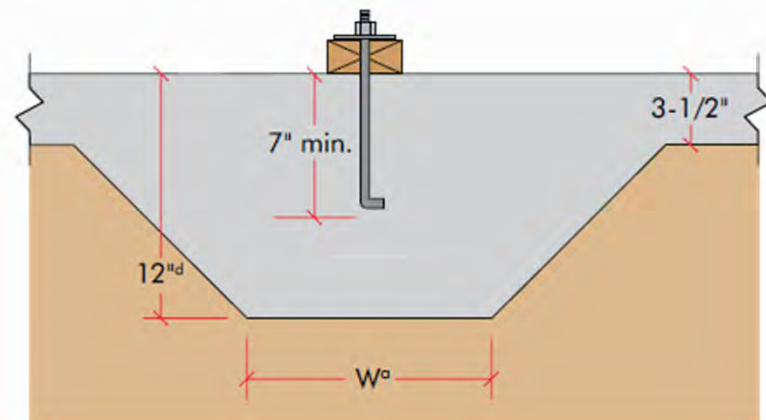


Wall Anchorage to Foundations

SDC D₀, D₁ and D₂
Seismic reinforcing



#4 bars at top & bottom
Exterior Turned-down Slab
Footing

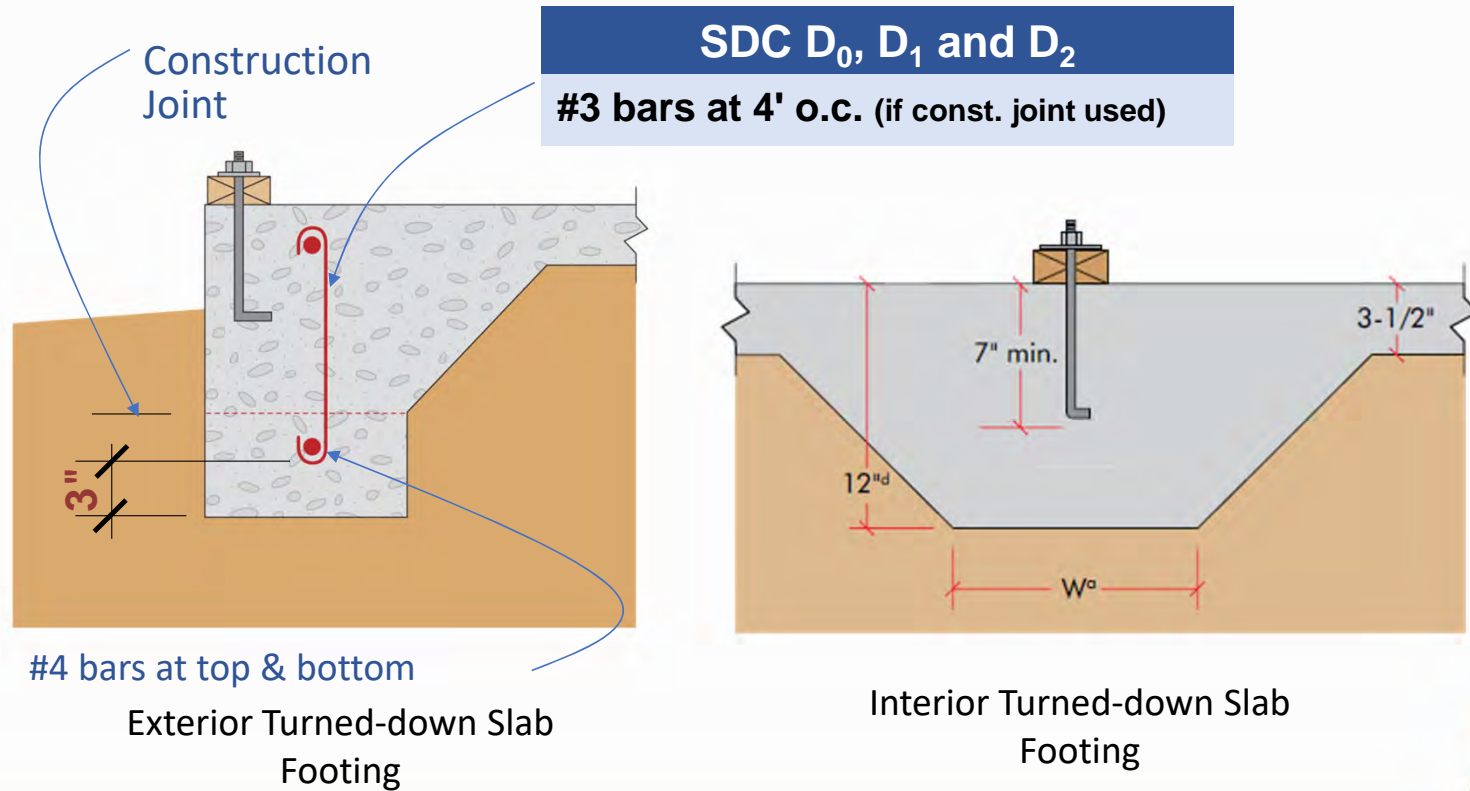


Interior Turned-down Slab
Footing

R403.1.3.3



Wall Anchorage to Foundations



R403.1.3.3,
R403.1.3.4



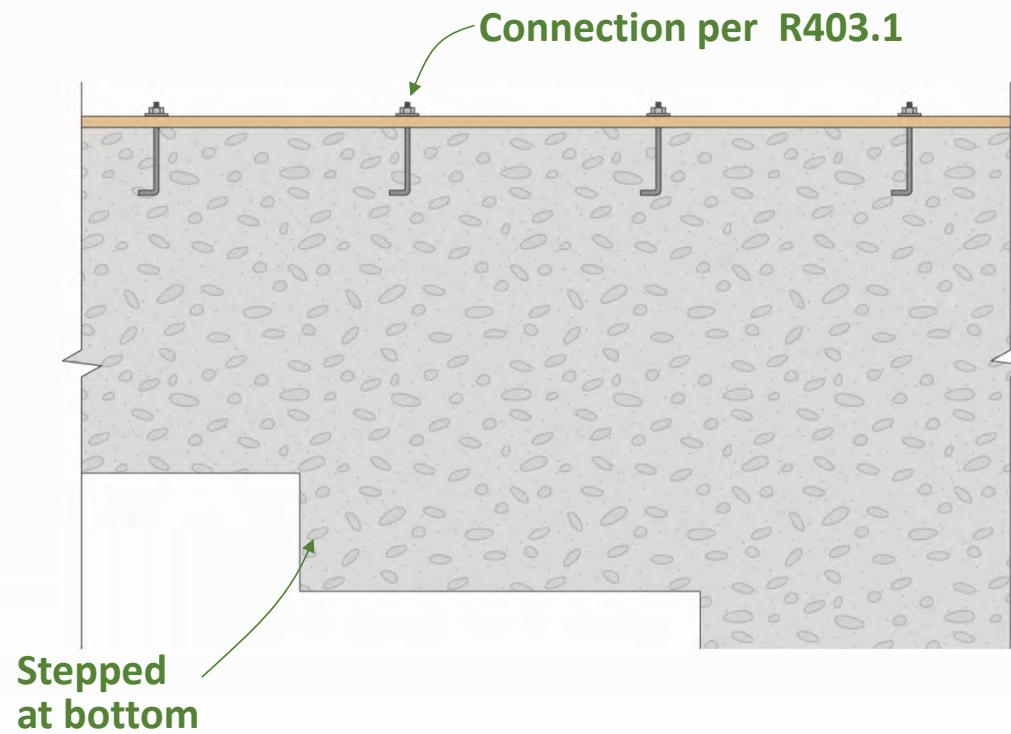
Footings and Foundations

Concrete Foundation Walls (Basement Walls) R404

Code Section	Provision	SDC A-C	High Seismic Regions SDC D ₀ -D ₂
Table R404.1.2(1)	Horizontal Reinforcement	1-#4 required at top and mid-height (or third points)	1-#4 horizontal required within 12 inches of top and near mid-height
Tables R404.1.2(2) thru R404.1.2(9)	Vertical Reinforcement	Rebar required according to table used, read footnotes for additional requirements	Rebar required according to table used, read footnotes for additional requirements
R404.1.4.2	Concrete foundation walls in SDC D ₀ -D ₂	No additional reinforcement requirements	Walls less than or equal to 7.5" thick require 1-#4 vertical bar at 48" o.c.



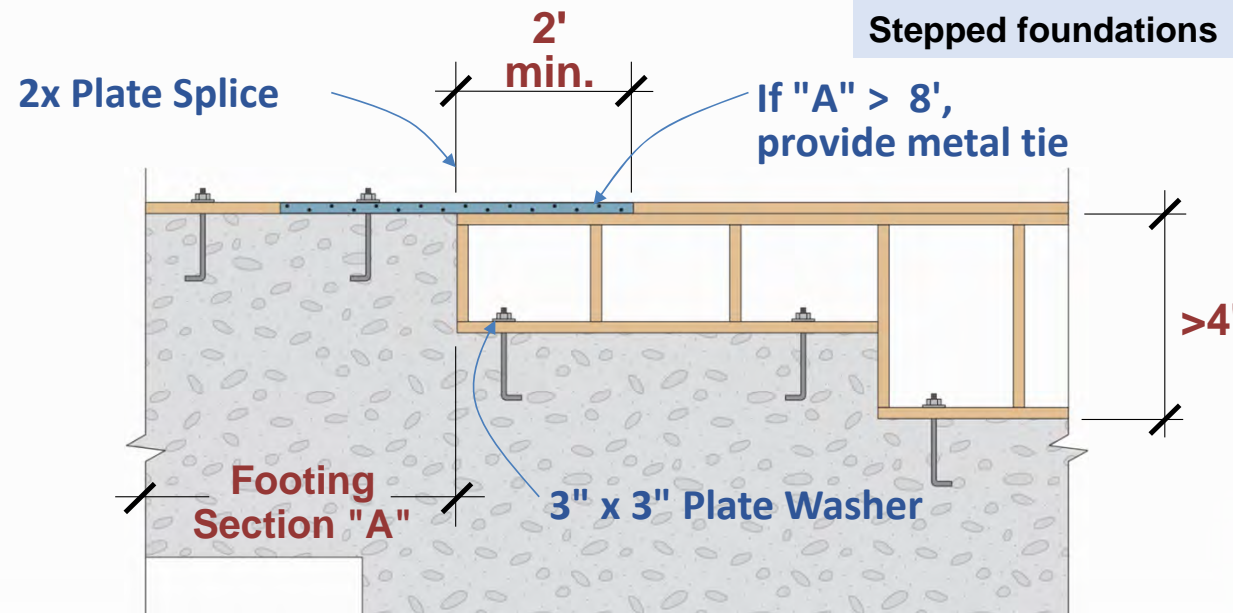
Stepped Foundation Base



Intermittent Cripple Walls

SDC D₀, D₁ and D₂

Stepped foundations



R602.11.2

- If "A" \geq 8', wall line considered braced
- If "A" < 8', not considered braced, bracing required



Walls



Earthquakes and Single Family Homes

Connections – Wall

Item	Description of Building Elements	Number and Type of Fastener	Spacing of Fasteners
Wall			
8	Stud to Stud (not at braced wall panels)	16d common (3½" x 0.162")	24" o.c. face nail
		10d box (3" x 0.128"); or 3" x 0.131" nails	16" o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3½" x 0.135"); or 3" x 0.131" nails	12" o.c. face nail
		16d common (3½" x 0.162")	16" o.c. face nail

NOTE:

16d common (3½" x 0.162")
 16d sinker (3¼" x 0.148");
 16d box (3½" x 0.135")
 Pneumatic nails (3½" x 0.12" - 0.131")

Table
R602.3(1)



Connections – Wall

Studs at corners



Abutting studs = Built-up column



Table
R602.3(1)



Connections – Wall

Item	Description of Building Elements	Number and Type of Fastener	Spacing of Fasteners
Wall			
10	Built-up header (2" to 2" header with ½" spacer)	16d common (3½" x 0.162")	16" o.c. along each edge face nail
		16d box (3½" x 0.135")	12" o.c. along each edge face nail
11	Continuous header to stud	5-8d box (2½" x 0.113"); or 4-8d common (2½" x 0.131"); or 4-10d box (3" x 0.128")	Toe nail

Table
R602.3(1)



Connections – Wall

Item	Description of Building Elements	Number and Type of Fastener	Spacing of Fasteners
Wall			
12	Adjacent full-height stud to end of header	4-16d box (3-1/2" x 0.135"); or 3-16d common (3-1/2" x 0.162"); or 4-10d box (3" x 0.128"); or 4-3" x 0.131" nails	End nail
13	Top plate to top plate	16d common (3½" x 0.162")	16" o.c. face nail
		10d box (3" x 0.128"); or 3" x 0.131" nails	12" o.c. face nail

Table
R602.3(1)



Earthquakes and Single-Family Homes

Connections – Wall

Item	Description of Building Elements	Number and Type of Fastener	Spacing of Fasteners
Wall			
14	Double top plate splice for SDCs A-D ₂ with seismic braced wall line spacing < 25'	8-16d common (3½" x 0.162"); or 12-16d box (3½" x 0.135"); or 12-10d box (3" x 0.128"); or 12-3" x 0.131" nails	Face nail on each side of end joint (minimum 24" lap splice length each side of end joint)
	Double top plate splice SDCs D ₀ , D ₁ , or D ₂ ; and braced wall line spacing ≥ 25'	12-16d (3½" x 0.135")	

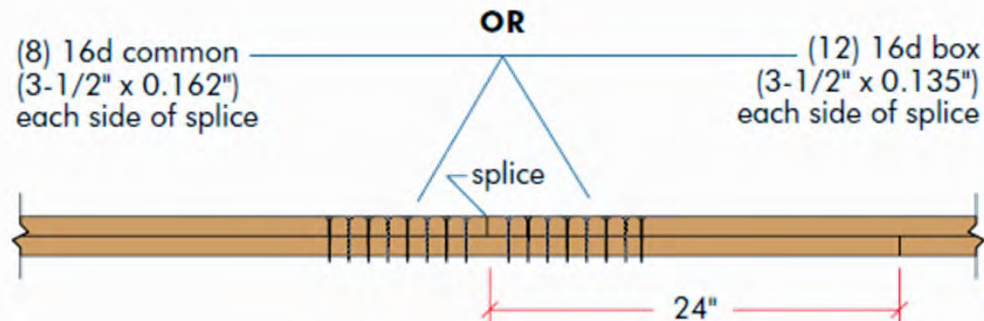


Table
R602.3(1)



Connections – Wall

Item	Description of Building Elements	Number and Type of Fastener	Spacing of Fasteners
Wall			
15	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3½" x 0.162")	16" o.c. face nail
		16d box (3½" x 0.135"); or 3" x 0.131" nails	12" o.c. face nail
16	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3½" x 0.135"); or 2-16d common (3½" x 0.162"); or 4-3" x 0.131" nails	16" o.c. face nail

Table
R602.3(1)



Connections – Wall

Blocking for interior BWP
placed between 2 joists



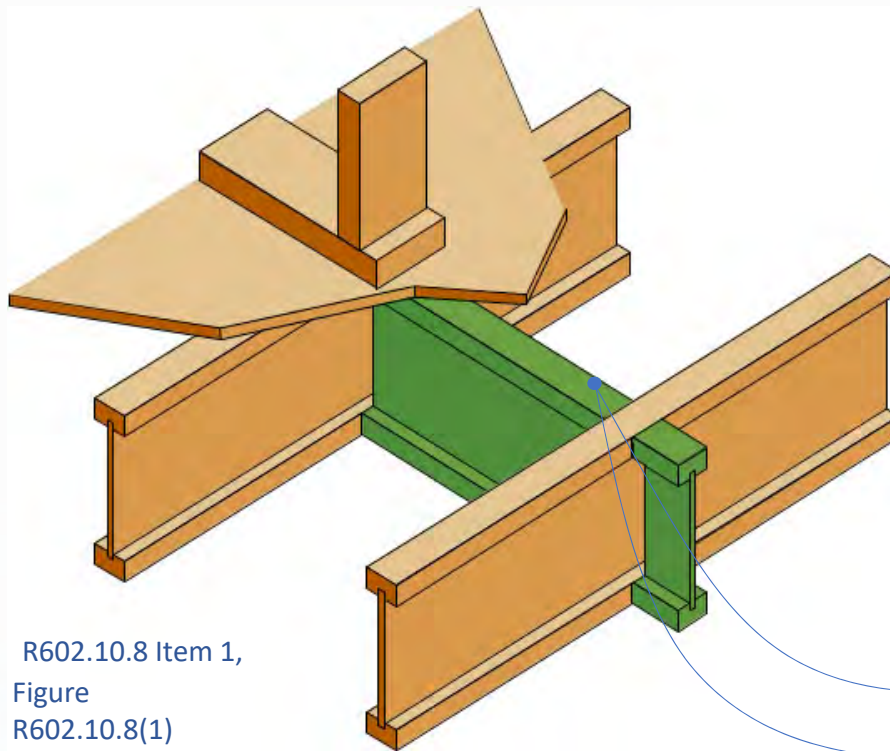
Blocking for interior BWL



Table R602.3(1)

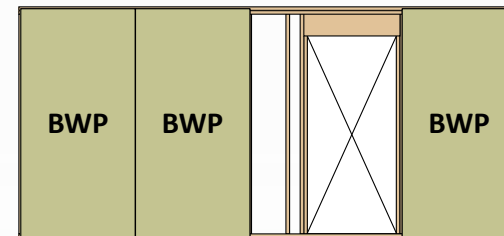


Connections



R602.10.8 Item 1,
Figure
R602.10.8(1)

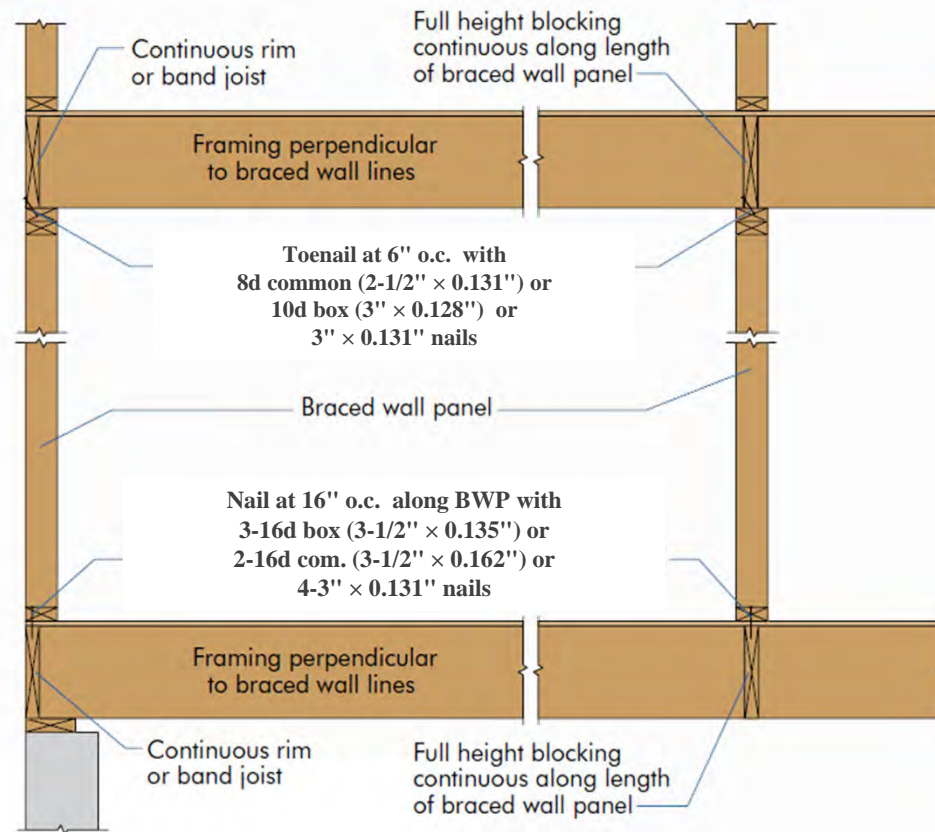
When braced wall panels are perpendicular to joists above or below, blocking shall be provided in line with the BWP...



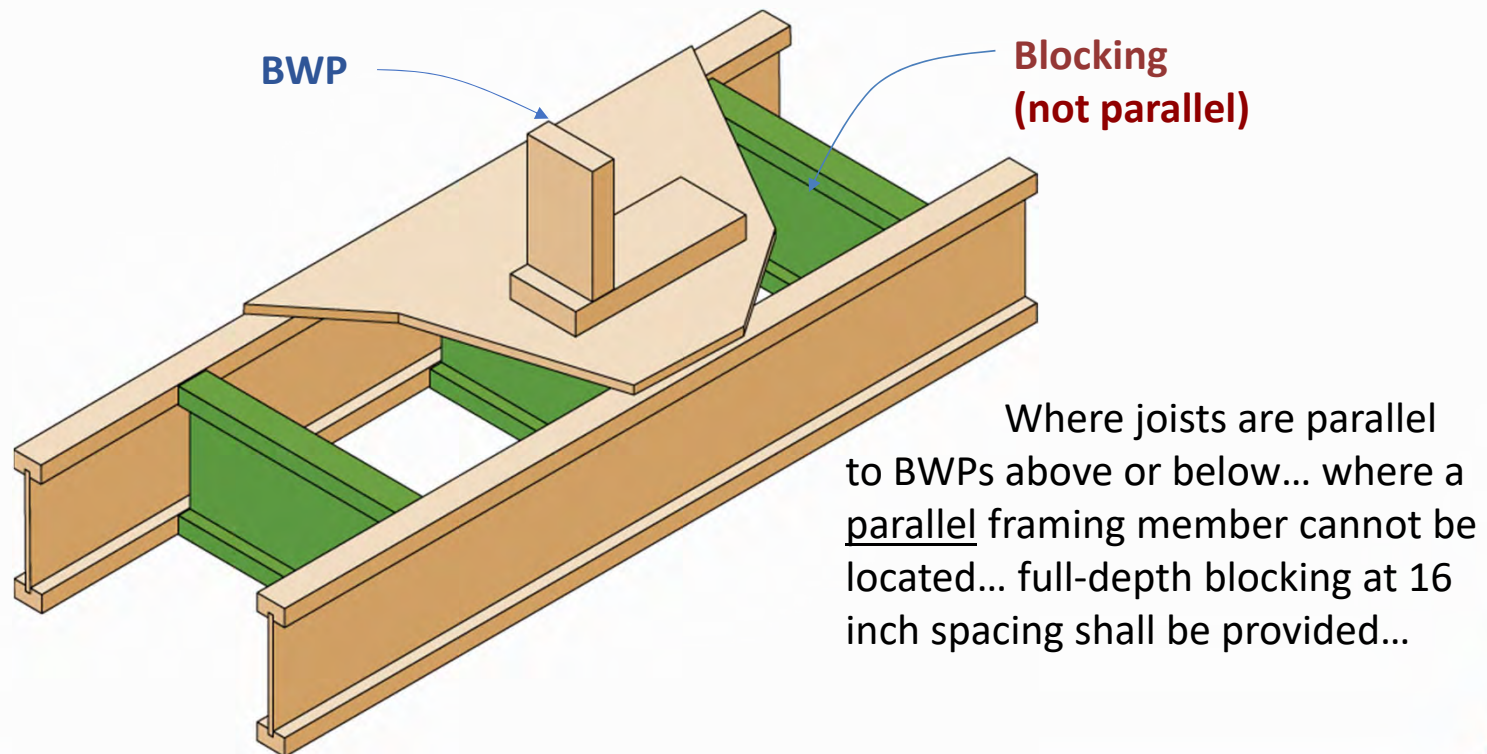
Connections

BWP Perpendicular to Framing

Figure R602.10.8(1) &
Table R602.3(1) Items 16, 23



Connections



Where joists are parallel to BWPs above or below... where a parallel framing member cannot be located... full-depth blocking at 16 inch spacing shall be provided...

R602.10.8 Item 2, Figure R602.10.8(2)



Connections

BWP Parallel to Framing

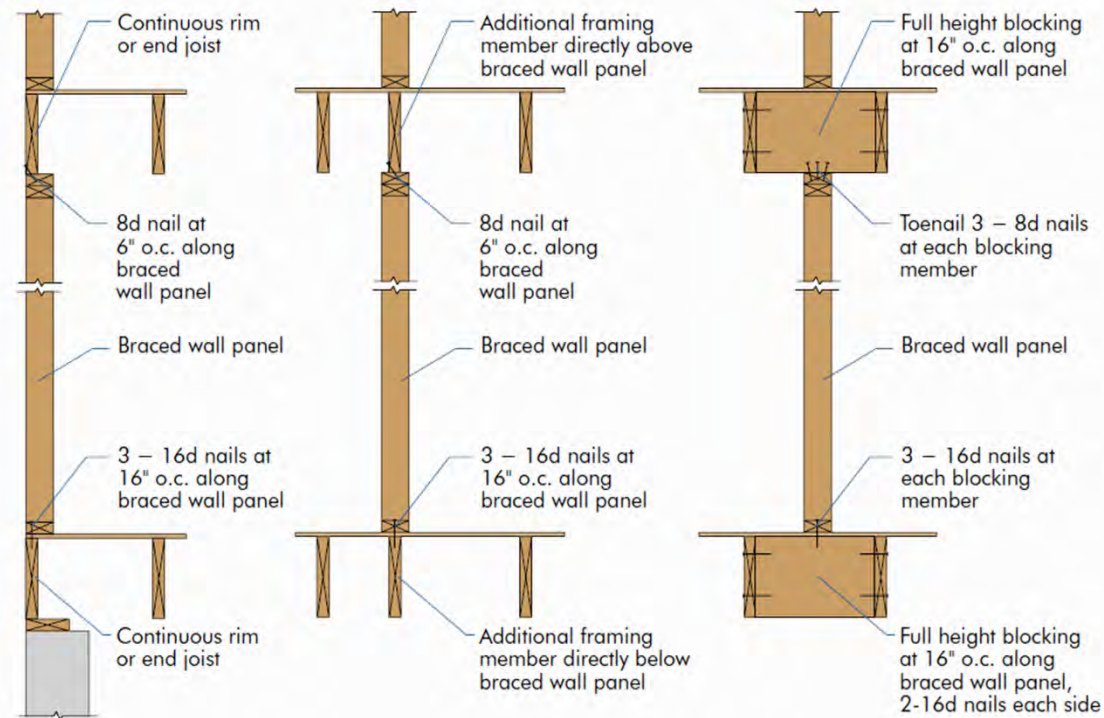


Figure
R602.10.8(2) &
Table R602.3(1)



Bracing Topics

Forces &
History

Related
Provisions

Bracing

Examples

Locate BWL

BWL Spacing

Locate BWPs

Required Length

Sufficient Length

Panel Material &
Ends

Connections

Simplified Wall
Bracing



Wall Bracing

R602.10 Wall Bracing

"... Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1."



R301 Design Criteria

Engineered design

- Where a building of otherwise conventional construction contains structural elements not conforming to the IRC, these elements shall be designed in accordance with accepted engineering practice.
- The extent of design must show equal or better capacity to requirements of the IRC and be compatible with the performance of the conventional system.
- Engineered design in accordance with the *International Building Code* is permitted.

R301.1.3

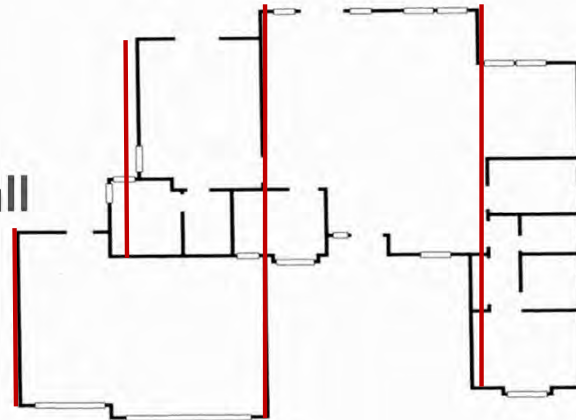


Definitions

Definitions from the IRC have been copied into the wall bracing guide, including

BRACED WALL LINE

A straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing.



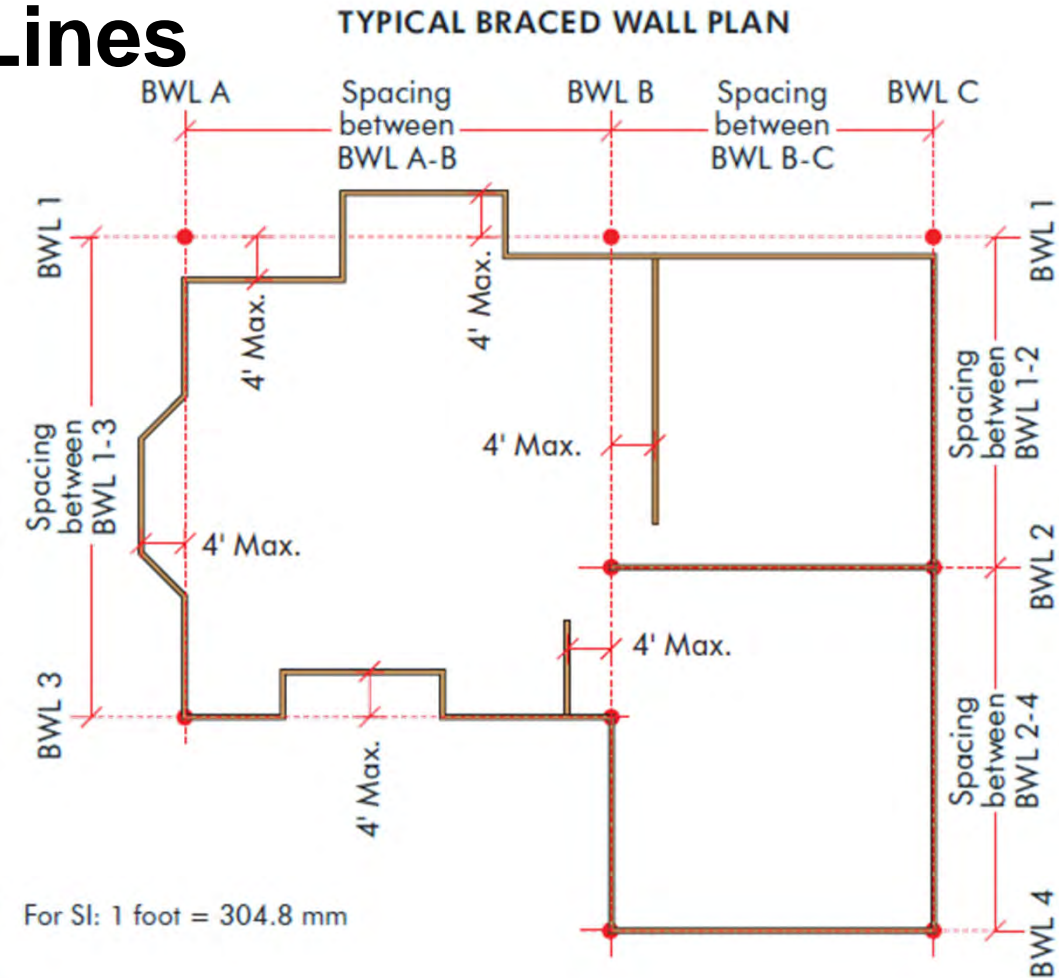
R202



Locating Braced Wall Lines

Braced Wall Lines (BWL)

- Braced wall lines are straight lines drawn on a building plan



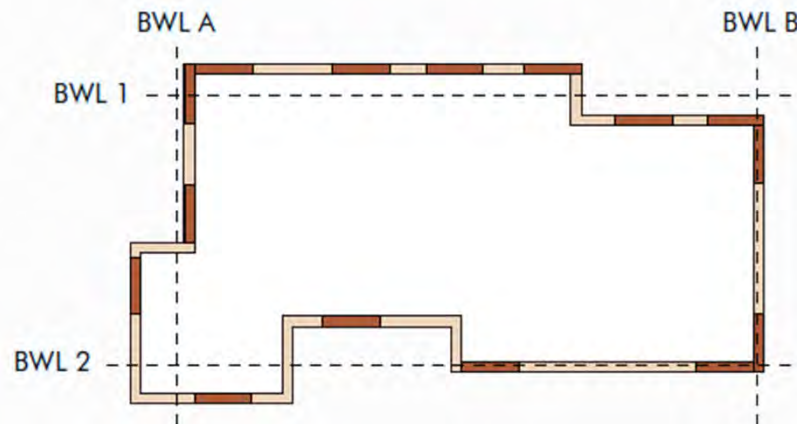
R602.10.1
Figure
R602.10.1.1



Locating Braced Wall Lines

Braced Wall Lines (BWL)

- Each BWL shall be located such that no more than 2/3 of the required braced wall panel length is located to one side of the BWL
- Bracing on walls within 4 feet of the designated BWL may be counted as bracing for that BWL



R602.10.1.2



Locating Braced Wall Lines



R602.10.1



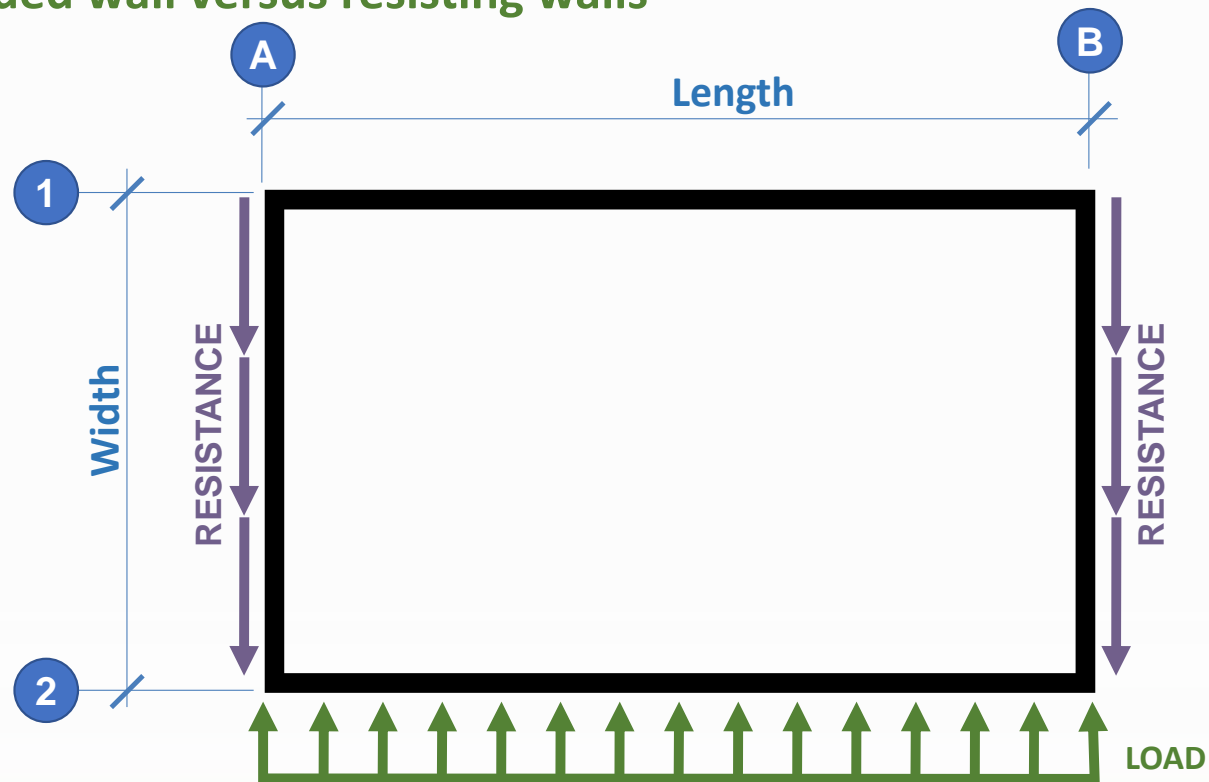
Braced Wall Line Spacing

How many BWL's?



Braced Wall Line Spacing

Loaded wall versus resisting walls

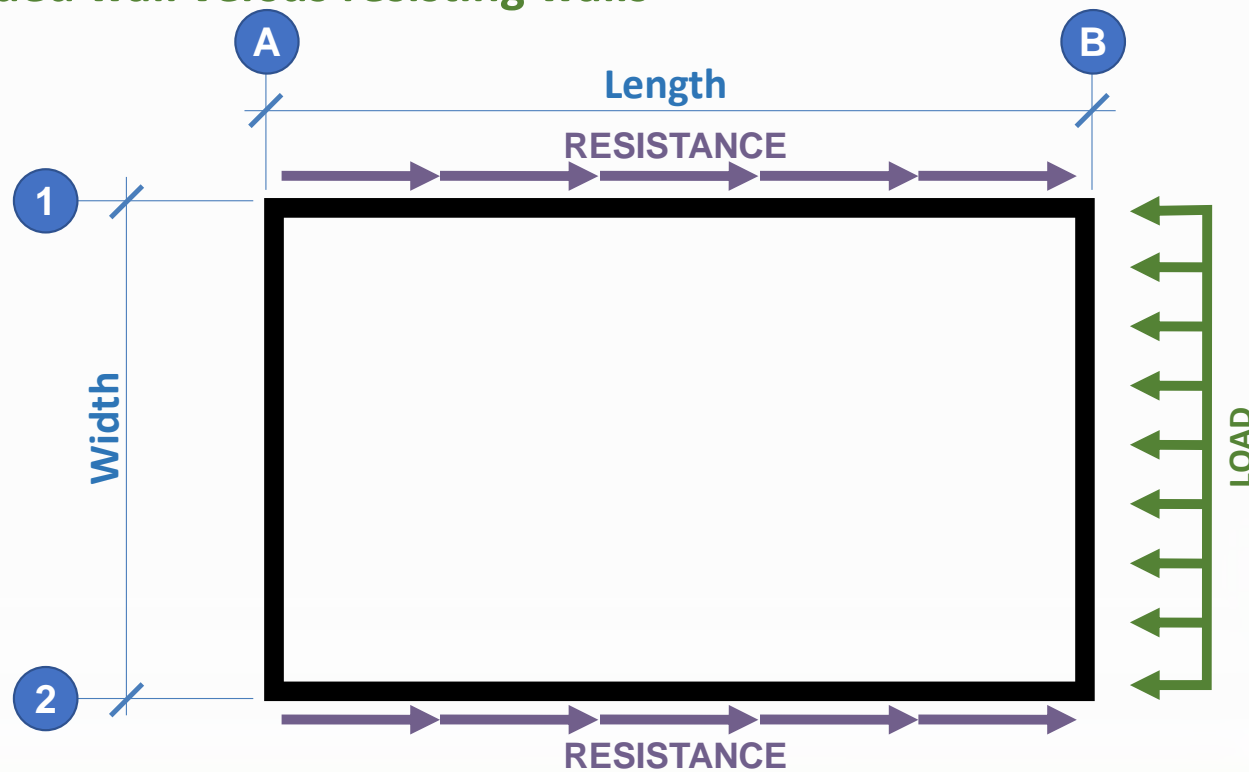


R602.10.1



Braced Wall Line Spacing

Loaded wall versus resisting walls



R602.10.1



Braced Wall Line Spacing

Wall lines with BWP offset limitations

- Wall lines with BWP that are counted as part of a BWL must be parallel to the BWL
- Offsets out-of-plane up to 4' are permitted for any wall line
- There is an angle wall exception which will be discussed later

R602.10.1.2

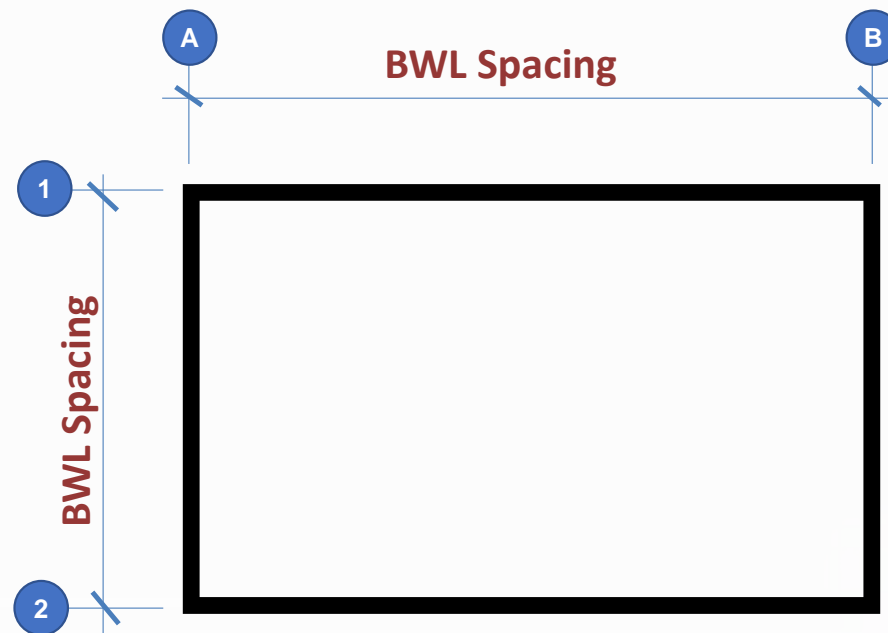


Braced Wall Line Spacing

Table R602.10.1.3

Wind

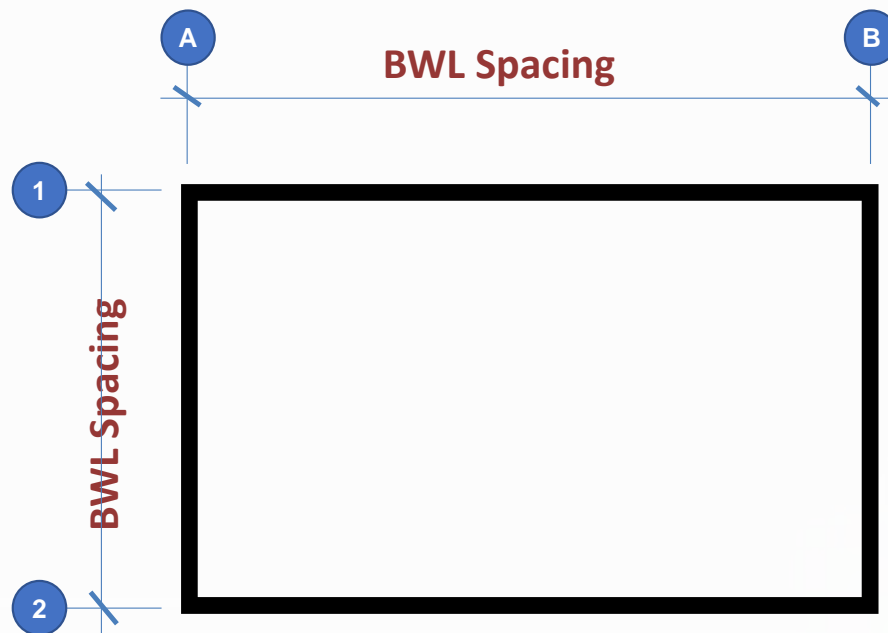
BWL Spacing = 60' max.



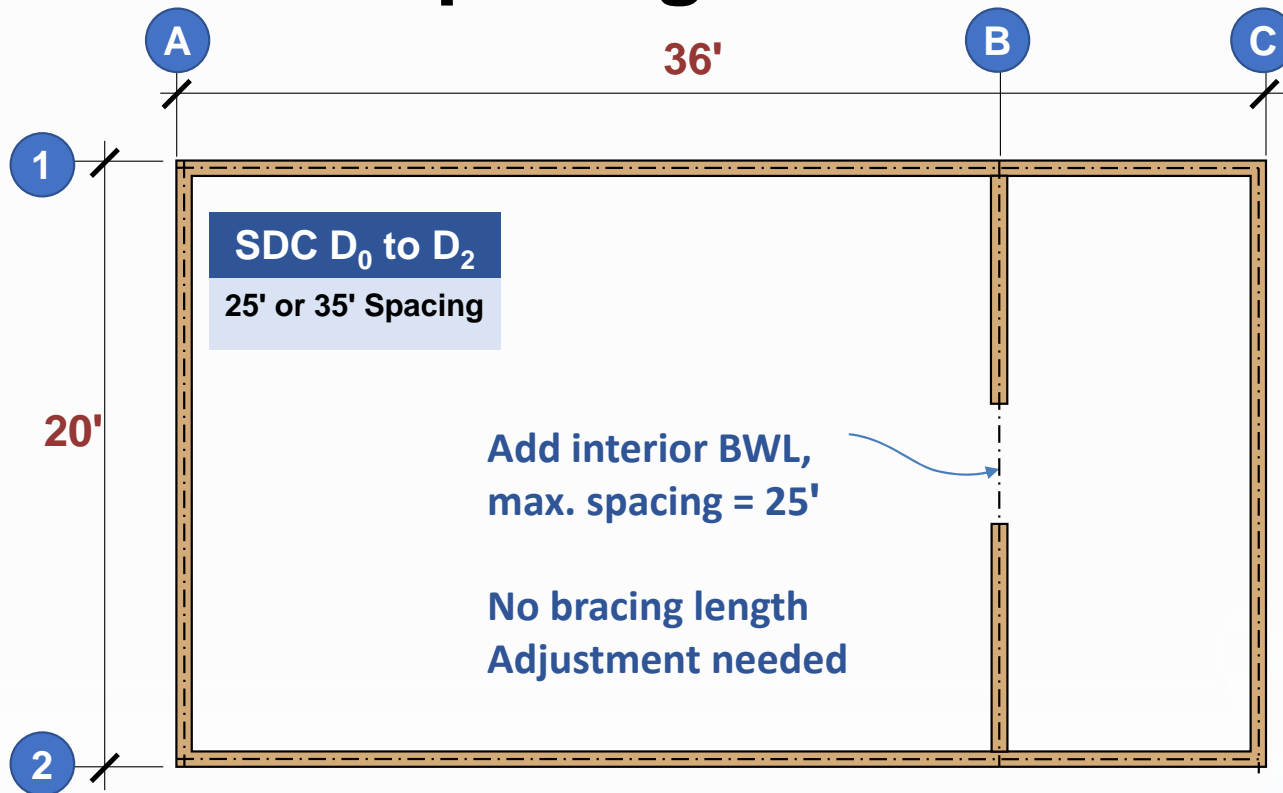
Braced Wall Line Spacing

Table R602.10.1.3

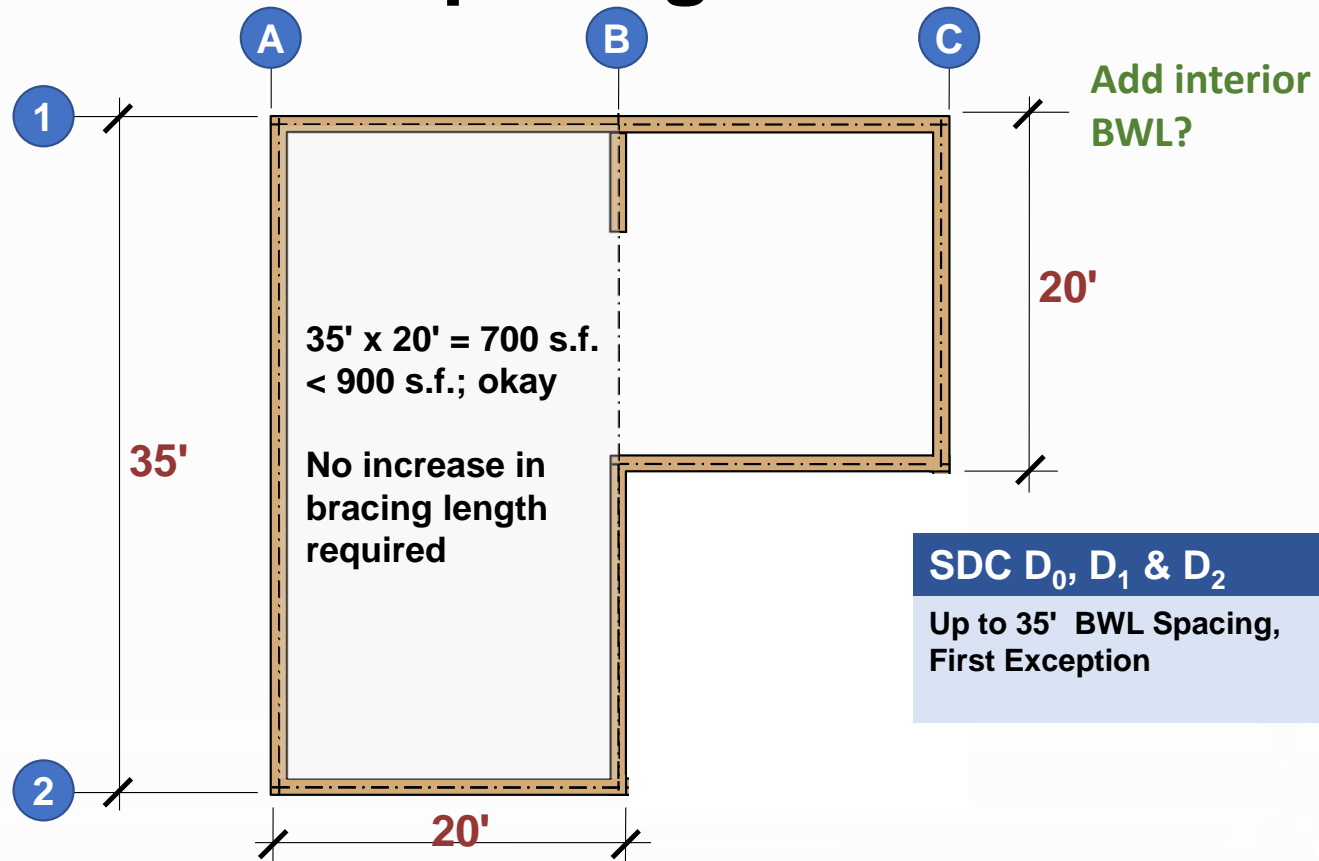
Seismic
SDC D ₀ , D ₁ , & D ₂ (all dwellings) BWL Spacing = 25' max. Permitted to be = 35' max. 1. To accommodate one room not exceeding 900 ft ² 2. For all BWLs when bracing length is increased and $L/W < 3:1$



Braced Wall Line Spacing



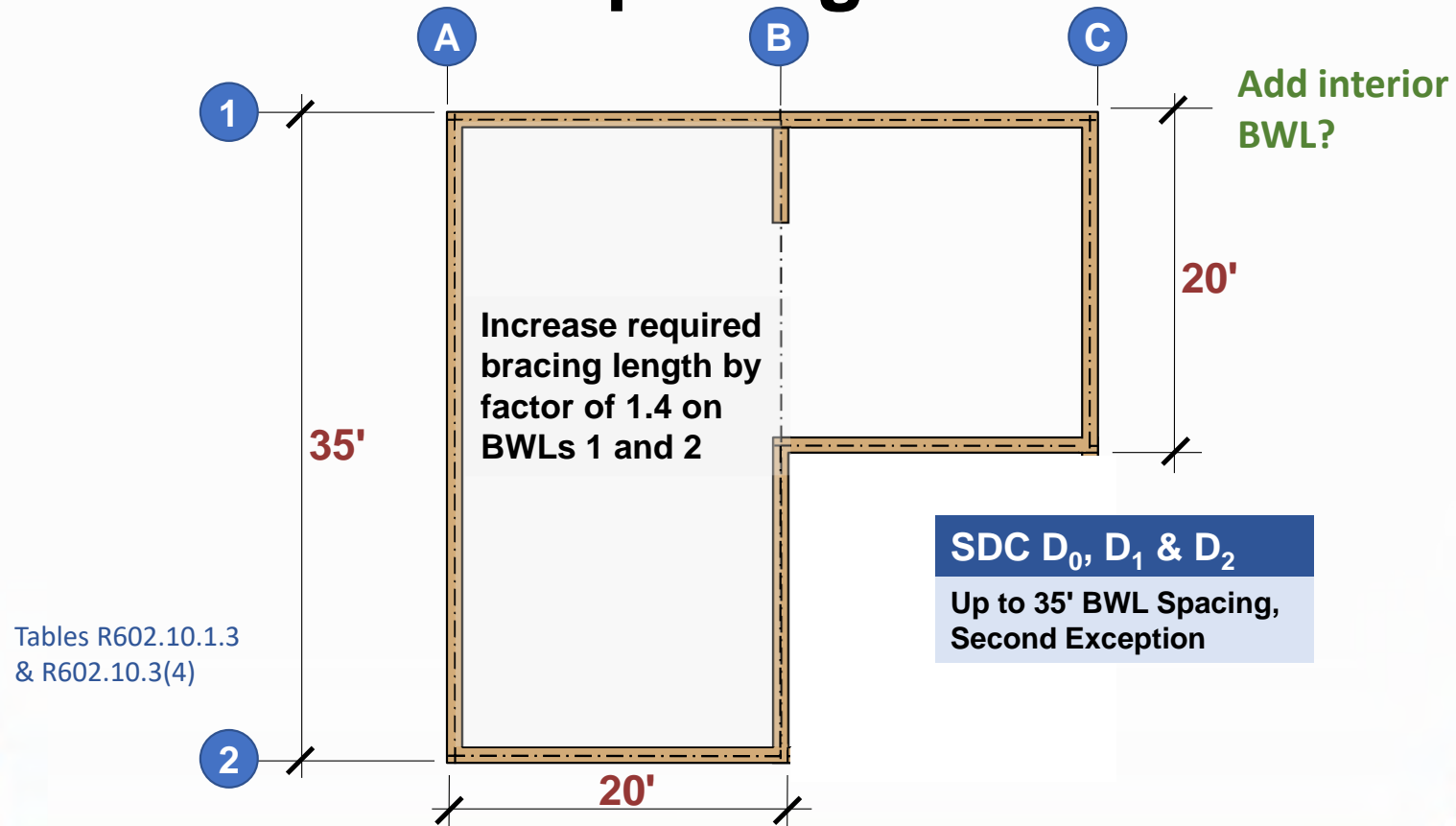
Braced Wall Line Spacing



R602.10.1.3



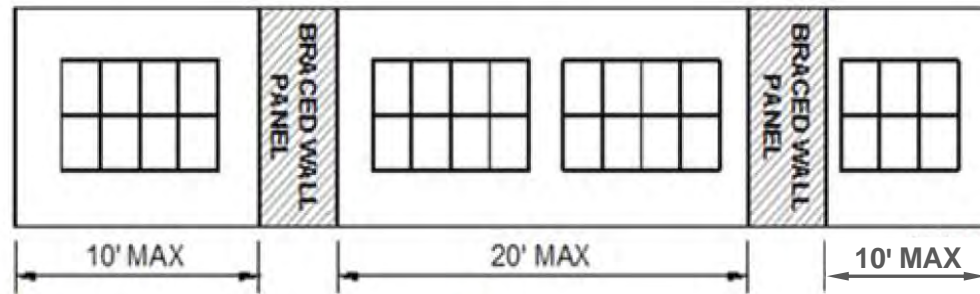
Braced Wall Line Spacing



Locate Braced Wall Panels

R602.10.2.2 Location of Braced Wall Panels Placement Requirements

- BWP begins no more than 10' feet from the end of a BWL.
- BWP located not more than 20' o.c. from edge to edge



R602.10.2.2

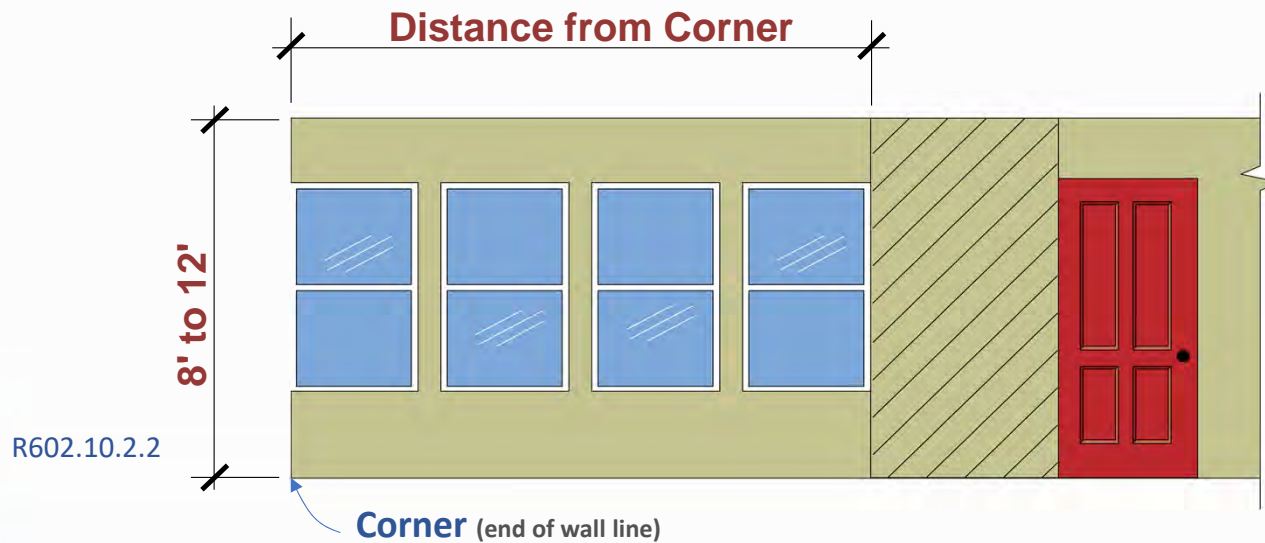


Locate Braced Wall Panels

Braced Panel Starting Location

Wind

Panel begins up to 10 ft. from the corner

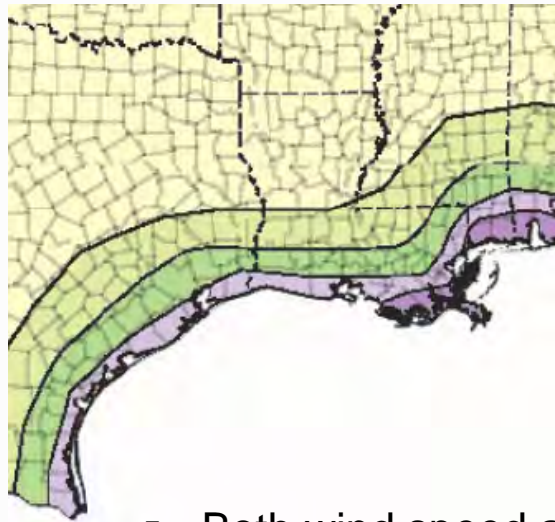


Walls – Required Bracing Length

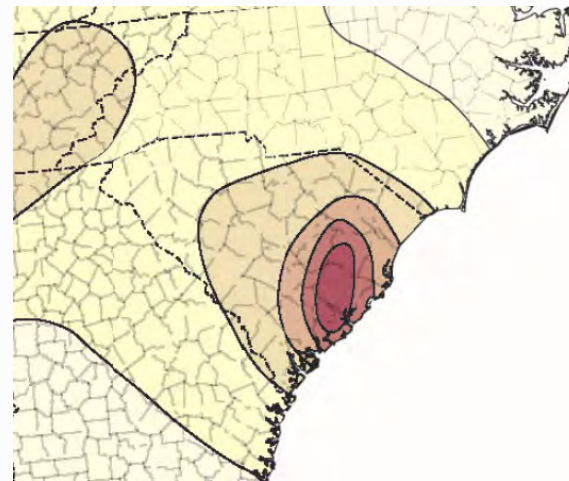


Required Length

Wind Speed



Seismic Risk



- Both wind speed and seismic risk must be considered when defining required wall bracing.
- The required bracing length is the greater of the two bracing lengths.



Required Length

When considering whether wind or seismic requirements control, a number of factors must be considered.

- Wall bracing length - either wind or seismic requirements may control. Use the longest required length.
- Hold-downs, Roof Ties, Limits – if wind or seismic requirements require additional connections or limits, they must be applied regardless of which bracing length controls.

Seismic Requirements

- Wall length
- Braced wall line spacing
- Hold-downs
- Material weight limits

R602.10.3



Required Length

Bracing Length Tables

Two bracing length tables

- Wind Table R602.10.3(1)
- Seismic Table R602.10.3(3)

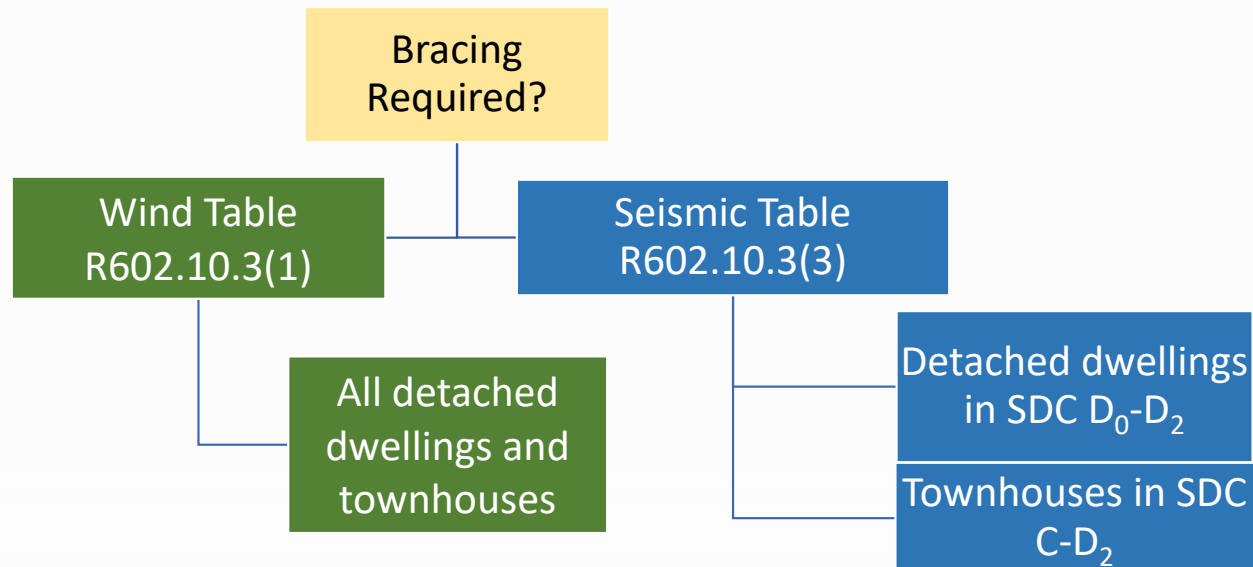
Required bracing length is the maximum of the two tables' bracing length x all adjustment factors

R602.10.3



Required Length

Decision Tree for Determining Required Bracing Length



Required Length

Bracing Requirements Based on Seismic Design Category

Seismic Bracing Table based on:

- Soil Class D
- Wall height of 10 ft.
- Floor dead load of 10 psf
- Roof/ceiling dead load of 15 psf
- Braced wall line spacing \leq 25 ft.

Required bracing length is determined by:

- Seismic design category
- Story location
- Braced wall line length
- Bracing method

Table
R602.10.3(3)



Required Length

Adjustments to the required bracing length for seismic forces:

Only required when adjustment is greater than 1.0

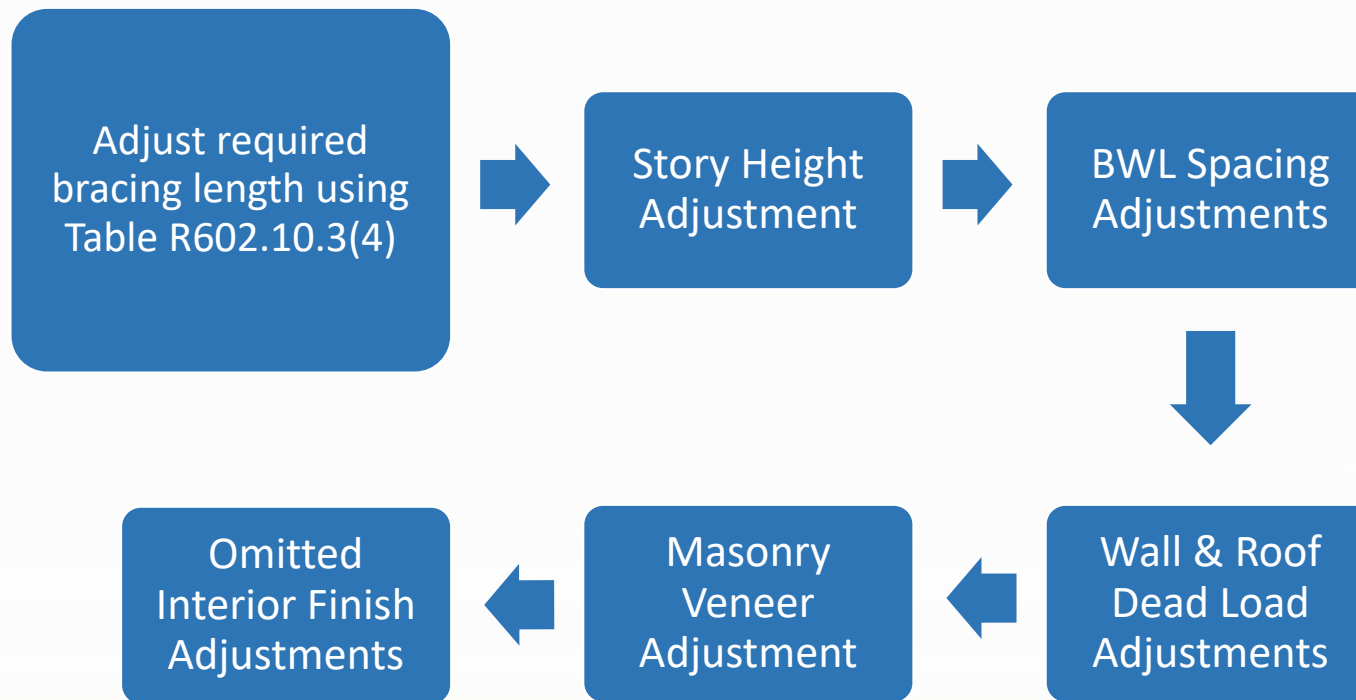


Table
R602.10.3(4)



Required Length

Bracing adjustment based on seismic bracing length

Adjustment based on	Story	Condition	Adjustment Factor	Applies To
Story Height (R301.3)	Any story	≤ 10 ft.	1.0	All bracing methods
		> 10 ft. and ≤ 12 ft.	1.2	
Braced wall line spacing – townhouses in SDC C	Any story	≤ 35 ft.	1.0	
		> 35 ft. and ≤ 50 ft.	1.43	
Braced wall line spacing – SDC D ₀ , D ₁ or D ₂	Any story	> 25 ft. and ≤ 30 ft.	1.2	
		> 30 ft. and ≤ 35 ft.	1.4	
Wall dead load	Any story	≤ 8 lb	0.85	
		> 8 lb and ≤ 15 lb	1.0	
Roof /Ceiling dead load for wall supporting	1-, 2- or 3-story	≤ 15 psf	1.0	
	2- or 3-story	> 15 psf and ≤ 25 psf	1.1	
	1-story or top story	> 15 psf and ≤ 25 psf	1.2	

Table
R602.10.3(4)



Required Length

Bracing adjustment based on seismic bracing length




Adjustment based on		Adjustment Factor	Applies To
Walls with stone or masonry veneer, townhouses in SDC C		1.0	All methods, excluding BV-WSP
		1.5	
		1.5	
Walls with stone or masonry veneer, detached dwellings in SDC D ₀ -D ₂	See R602.10.6.5	NA	BV-WSP
		1.2	WSP, CS-WSP
Interior finish omitted	Any story	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, and CS-SFB
Horizontal blocking omitted	Any story	2.0	WSP, PBS, CS-WSP

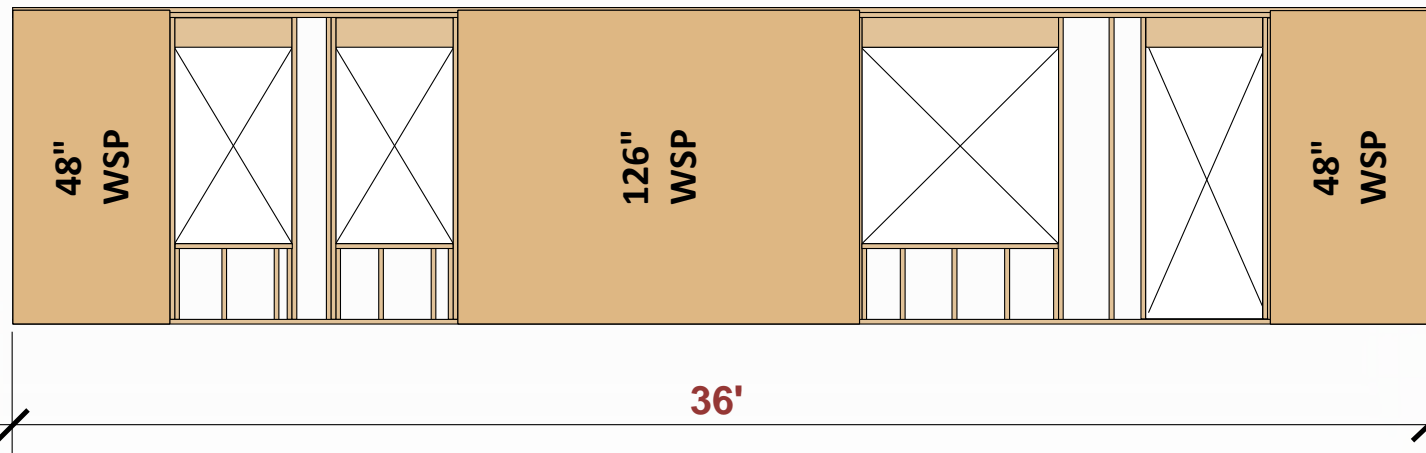
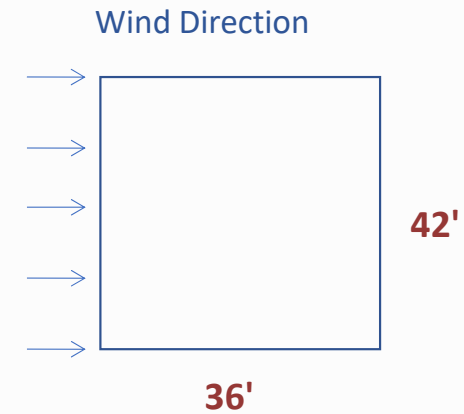
Table
R602.10.3(4)



Sufficient Length

Method WSP

WSP	130 mph	SDC D ₁
Bottom of Two Stories		



Tables R602.10.3(1)-(4), R602.10.4, R602.10.5



Sufficient Length


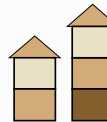
<ul style="list-style-type: none"> Exposure Category B 30-Foot Mean Roof Height 10-Foot Wall Height 2 Braced Wall Lines 						
Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line						
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB	Method GB	Methods WSP, SFB, ABW, BV-WSP, PFH, PFG, CS-SFB	Methods CS-WSP, CS-G, CS-PF
≤ 130		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.5	19.5	11.0	9.5
		60	23.0	23.0	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.5	8.0
		30	23.0	23.0	13.5	11.5
		40	30.0	30.0	17.5	15.0
		50	37.0	37.0	21.5	18.0
		60	44.0	44.0	25.0	21.5

Table R602.10.3(1)



Sufficient Length

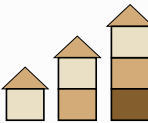
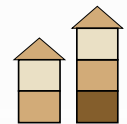
<ul style="list-style-type: none"> Wall height = 10 feet 10 psf floor dead load 15 psf roof/ceiling dead load Braced wall line spacing ≤ 25 feet 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line				
Seismic Design Category	Story Location	Braced Wall Line Length (feet)	Method LIB	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB	Method WSP	Methods CS-WSP, CS-G, CS-PF
D ₁		10	NP	3.0	3.0	2.0	1.7
		20	NP	6.0	6.0	4.0	3.4
		30	NP	9.0	9.0	6.0	5.1
		40	NP	12.0	12.0	8.0	6.8
		50	NP	15.0	15.0	10.0	8.5
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1

Table R602.10.3(3)



Sufficient Length

Method WSP

WSP Bottom of Two Stories	130 mph	SDC D ₁
	21.5	18

Placement Requirement

$$4' + 4' + 4' = 12'$$

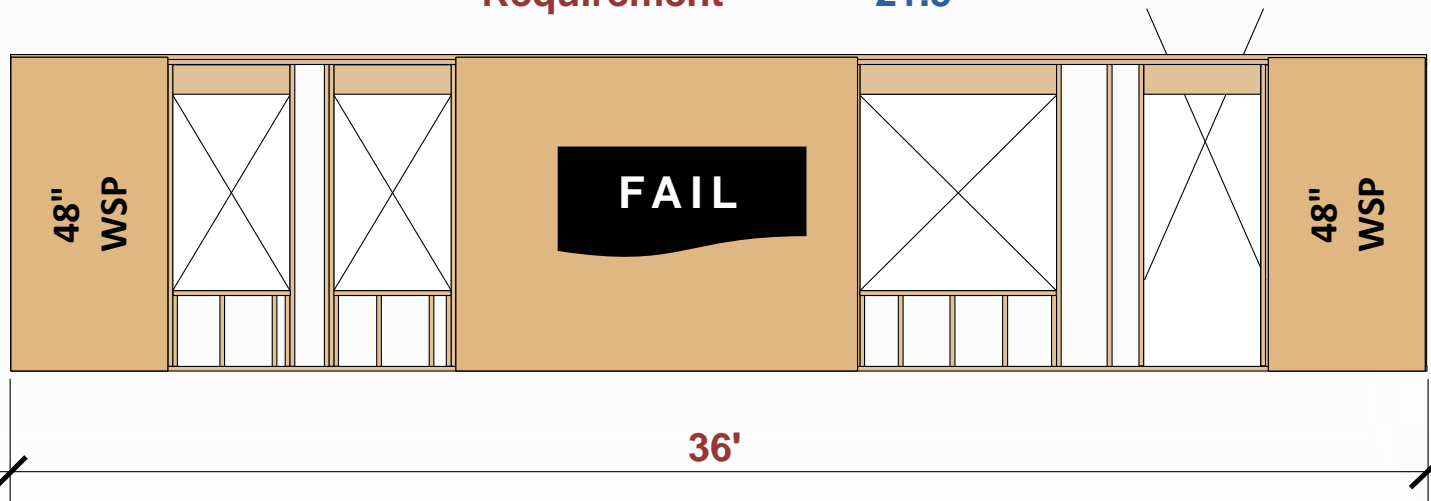
Max Wind or Seismic

Requirement

21.5'

Braced Length = 18.5'

$$4' + 10.5' + 4' = 18.5'$$



Tables R602.10.3(1)-(4), R602.10.4, R602.10.5



Sufficient Length


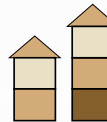
• Exposure Category B • 30-Foot Mean Roof Height • 10-Foot Wall Height • 2 Braced Wall Lines						
Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line						
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB	Method GB	Methods WSP, SFB, ABW, PFH, PFG, CS-SFB	Methods CS-WSP, CS-G, CS-PF
≤ 130		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.5	19.5	11.0	9.5
		60	23.0	23.0	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.5	8.0
		30	23.0	23.0	13.5	11.5
		40	30.0	30.0	17.5	15.0
		50	37.0	37.0	21.5	18.0
		60	44.0	44.0	25.0	21.5

Table R602.10.3(1)



Sufficient Length

Method WSP

WSP	130 mph	SDC D ₁
Bottom of Two Stories	18.3	18

Braced Length = 18.5'
4' + 10.5' + 4' = 18.5'

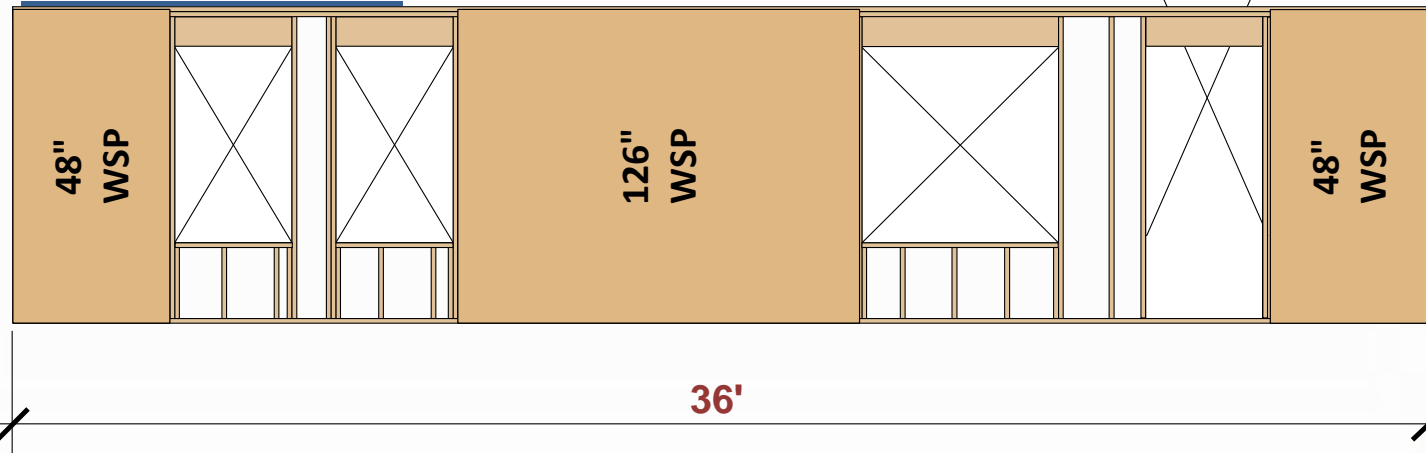
Interpolate for 42 ft BWL length:

30 ft: 17.5 ft required

40 ft: 21.5 ft required

$(21.5 - 17.5) / 10 \times 2 + 17.5 = 18.3$ ft required

Bracing is sufficient



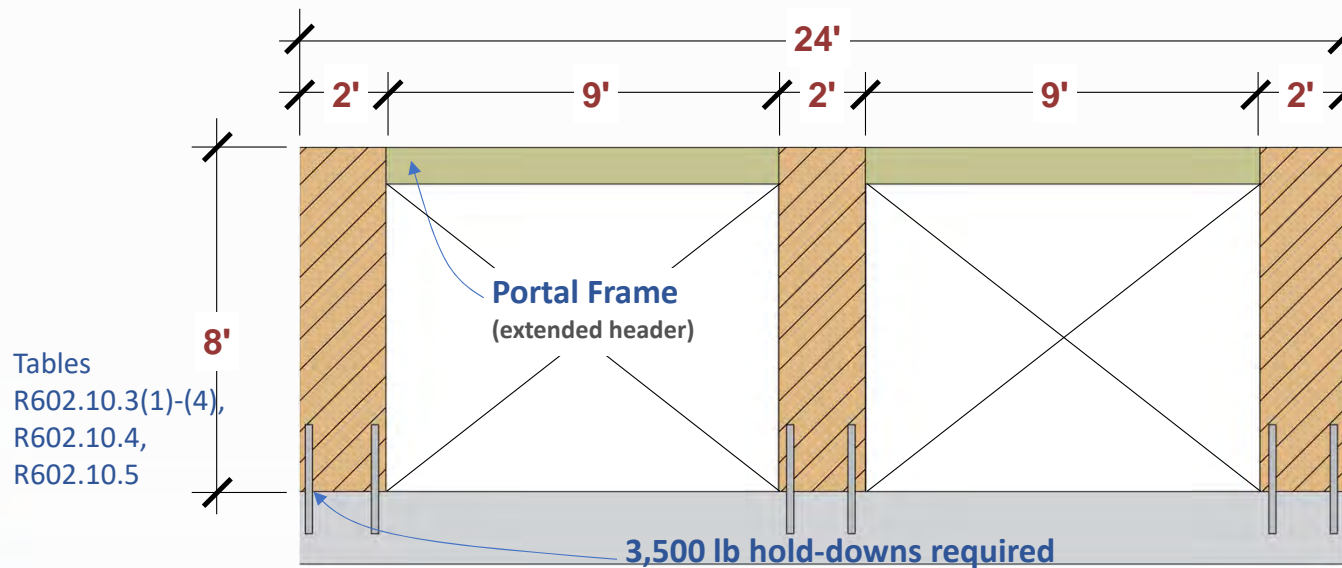
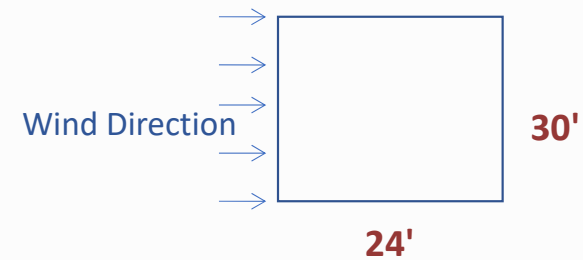
Tables R602.10.3(1)-(4), R602.10.4, R602.10.5



Sufficient Length

Method PFH

PFH	115 mph	SDC D ₀
Bottom of Two Stories	?	?



Sufficient Length

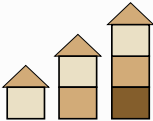
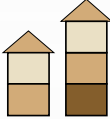
<ul style="list-style-type: none"> Exposure Category B 30-Foot Mean Roof Height 10-Foot Wall Height 2 Braced Wall Lines 						
Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line						
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB	Method GB	Methods WSP, SFB, ABW, PFH, PFG, CS-SFB	Method CS-WSP, CS-G, CS-PF
≤ 115		10	3.5	3.5	2.0	2.0
		20	6.5	6.5	3.5	3.5
		30	9.5	9.5	5.5	4.5
		40	12.5	12.5	7.0	6.0
		50	15.0	15.0	9.0	7.5
		60	18.0	18.0	10.5	9.0
		10	7.0	7.0	4.0	3.5
		20	12.5	12.5	7.5	6.5
		30	18.0	18.0	10.5	9.0
		40	23.5	23.5	13.5	11.5
		50	29.0	29.0	16.5	14.0
		60	34.5	34.5	20.0	17.0

Table
R602.10.3(1)



Sufficient Length

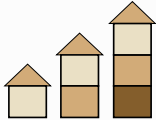
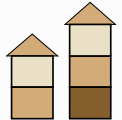
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length (ft.)	Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line				
			Method LIB	Method GB	Methods DWB, SFB, PBS, PCP, HPS	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₀		10	NP	2.8	2.8	1.8	1.6
		20	NP	5.5	5.5	3.6	3.1
		30	NP	8.3	8.3	5.4	4.6
		40	NP	11.0	11.0	7.2	6.1
		50	NP	13.8	13.8	9.0	7.7
		10	NP	5.3	5.3	3.8	3.2
		20	NP	10.5	10.5	7.5	6.4
		30	NP	15.8	15.8	11.3	9.6
		40	NP	21.0	21.0	15.0	12.8
		50	NP	26.3	26.3	18.8	16.0

Table R602.10.3(3)



Sufficient Length

Method PFH

PFH Bottom of Two Stories	115 mph	SDC D ₀
	10.5'	11.3'

Placement Requirement

$$4' + 4' = 8'$$

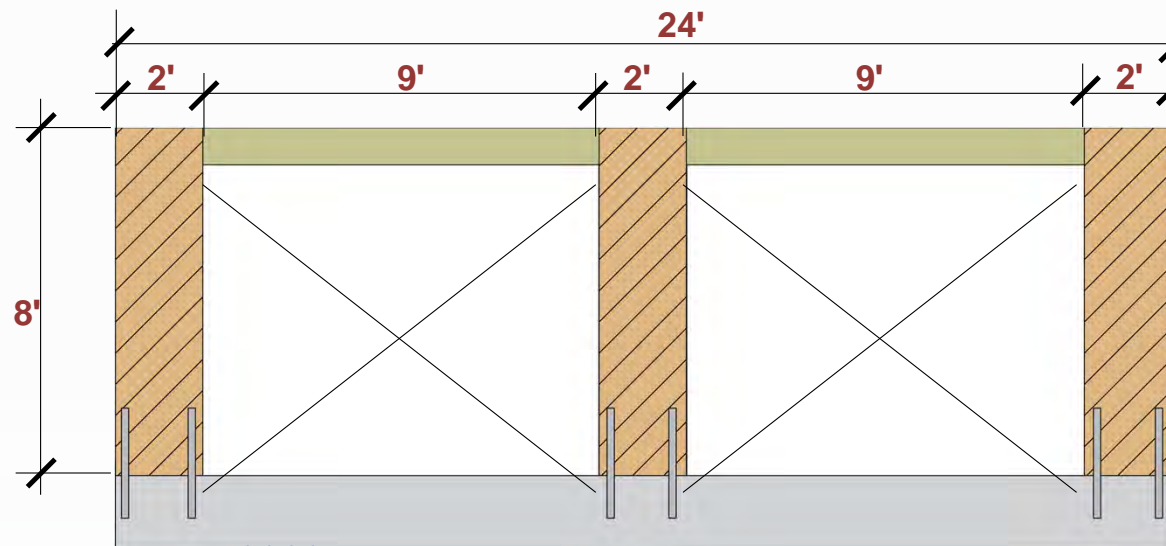
Max Wind or Seismic Requirement

$$11.3'$$

Braced Length = 12'

$$4' + 4' + 4' = 12'$$

Bracing is sufficient



Tables R602.10.3(1)-(4), R602.10.4, R602.10.5



Roof-Ceilings and Assemblies



Earthquakes and Single Family Homes

Connections – Roof

Roof Uplift Load Path vs BWP Uplift Load Path

Section R602.3.5 and R802.11 both address uplift of the roof

- Section R802.11 requires hurricane clips, toe-nails or other connector to tie the rafters or trusses to the wall below
- Section R602.3.5 requires exterior wall BWPs to be connected to the rafters or trusses when in the upper story and for the connections to continue through the stories below to the foundation

In some cases, the same strap or clip may be used to meet both code provisions



Connections

BWP Connection Requirements to Roof Framing

SDC	Distance (bottom of roof sheathing to top of plate)	Blocking
SDC A, B, C	9.25" or less	Not required, attach per R602.3(1)
	9.25" to 15.25"	Per R602.10.8.2.2 Item 1 and Figure R602.10.8.2(1)
SDC D ₀ , D ₁ , D ₂	15.25" or less	Per R602.10.8.2 Item 2 and Figure R602.10.8.2(1)
All SDCs	15.25" to 48"	Per R602.10.8.2 Item 3 and Figure R602.10.8.2(2) or R602.10.8.2(3) or engineered design

R602.10.8.2



Connections

BWP Perpendicular to Rafters or Roof Trusses

For SDC D₀, D₁ and D₂,

- Where distance from top of rafters or roof trusses to perpendicular top plates is $\leq 15.25"$
- Connect rafters to the top plates of braced wall panels with blocking [Figure R602.10.8.2(1) and Table R602.3(1)]

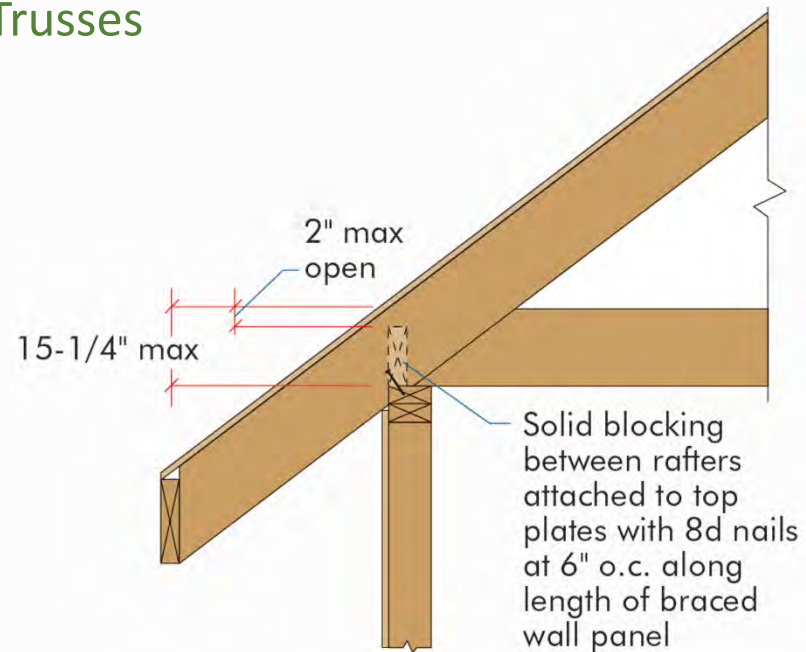


Figure
R602.10.8.2(1)



Connections

BWP Perpendicular to Rafters or Roof Trusses

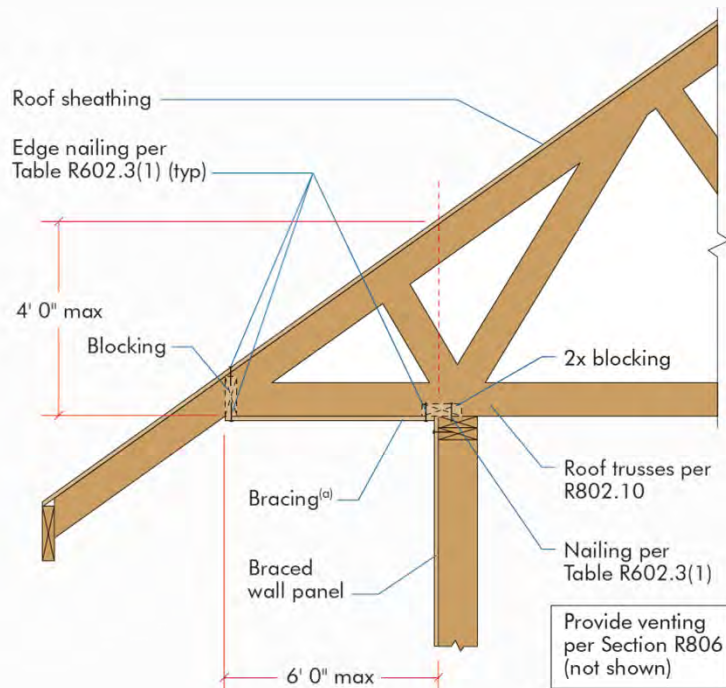


Figure
R602.10.8.2(2)



Energy Trusses

- Where distance from top of rafters or roof trusses to perpendicular top plates is $> 15.25"$
- Connect rafters to the top plates of braced wall panels [Figure R602.10.8.2(2) or Figure R602.10.8.2(3)]

Connections

BWP Perpendicular to Rafters or Roof Trusses

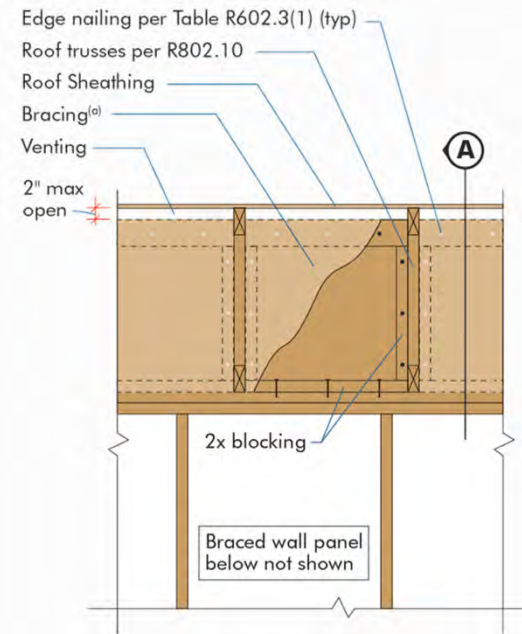
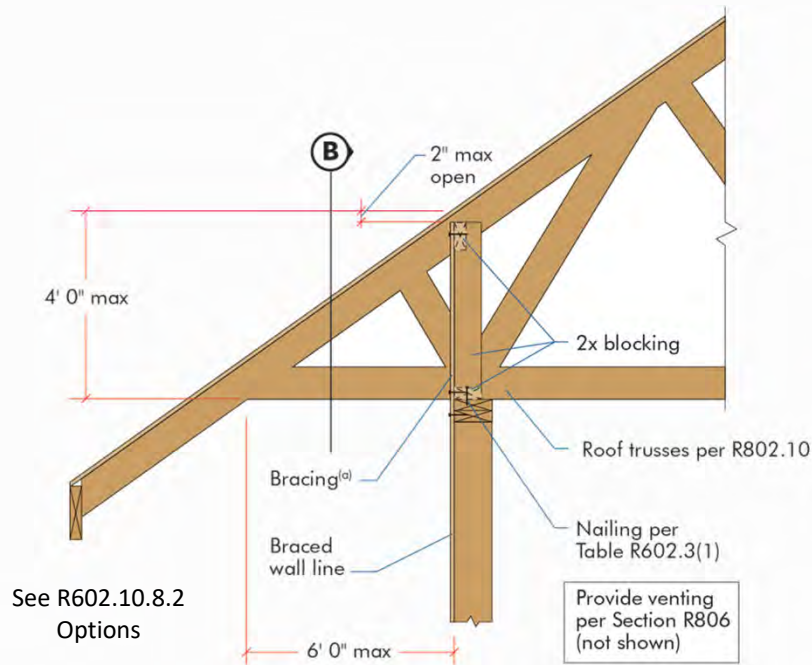


Figure
R602.10.8.2(3)



Whole House Example 1



Earthquakes and Single Family Homes

Example: SDC D₂, Wind 110 mph, Exp C

Example Attributes:

- SDC D₂
- Wind 110 mph, Wind Exposure C
- Method WSP & GB
- 1 Story
- Walls 9 ft. tall
- Eave to ridge height 8 ft. tall

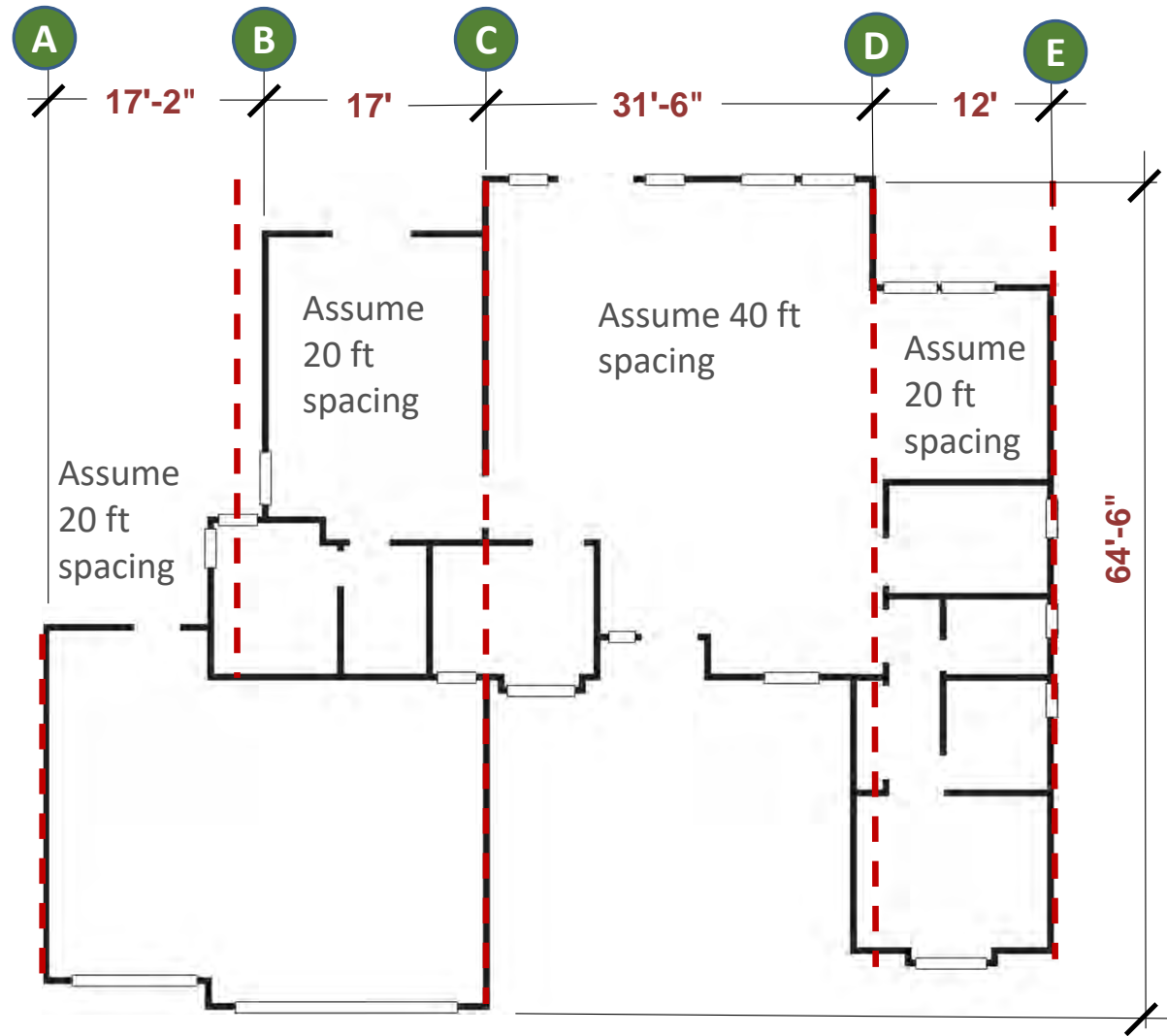
WSP or GB	110 mph	SDC D ₂
One Story		

Example Highlights:

- Wind Exposure C adjustment
- Use of different bracing methods in one BWL
- Application of WSP, GB and PFH

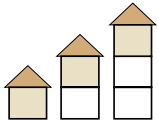
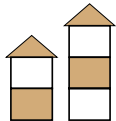


North-South Braced Wall Lines



Minimum Required Length of Bracing

Table R602.10.3(1)

<ul style="list-style-type: none"> Exposure Category B 30 ft. Mean Roof Height 10 ft. Eave to Ridge Height 10 ft. Wall Height 2 Braced Wall Lines 		Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line				
Basic Wind Speed	Story Location	Braced Wall Line Spacing (feet)	Method LIB	Method GB (double sided)	Methods WSP, SFB, ABW, PFH, PFG	Methods CS-WSP, CS-G, CS-PF
≤ 110 (mph)		10	3.5	3.5	2	1.5
		20	6	6	3.5	3
		30	8.5	8.5	5	4.5
		40	11.5	11.5	6.5	5.5
		50	14	14	8	7
		60	16.5	16.5	9.5	8
		10	6.5	6.5	3.5	3
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.5	13
		60	31.5	31.5	18	15.5



One Story	Wall Line	110 mph	SDC D ₂
WSP	A, E	5.6 ft.	
GB	B C, D	9.6 ft. 18.4 ft.	

Adjustment Factors:

- Wind Exposure C, 1 story building = 1.2
 - 5 braced wall lines = 1.6
 - Walls - 9 feet tall = 0.95
 - Eave to ridge height - 8 feet tall = 0.88
- Total Adjustment = 1.6

Braced Wall Lines A, B & E Assume spacing of 20 ft.

Required bracing length

Method WSP: 3.5 ft. x 1.6 = 5.6 feet

Method GB: 6 ft. x 1.6 = 9.6 feet


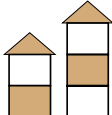
Braced Wall Lines C & D Assume spacing of 40 ft.

Required bracing length

Method GB: 11.5 ft. x 1.6 = 18.4 feet



Minimum Required Length of Bracing Table R602.10.3(3)

<ul style="list-style-type: none"> Soil Class D Wall Height = 10 ft. 10 psf Floor Dead Load 15 psf Roof/Ceiling Dead Load Braced Wall Line Spacing \leq 25 ft. 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line			
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length	Method LIB	Method GB	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₂		10	NP	4	2.5	2.1
		20	NP	8	5	4.3
		30	NP	12	7.5	6.4
		40	NP	16	10	8.5
		50	NP	20	12.5	10.6
		10	NP	7.5	5.5	4.7
		20	NP	15	11	9.4
		30	NP	22.5	16.5	14
		40	NP	30	22	18.7
		50	NP	37.5	27.5	23.4



One Story	Wall Line	110 mph	SDC D ₂
WSP	A, E	5.6 ft.	17.5 ft.
GB	B C, D	9.6 ft. 18.4 ft.	28 ft. 39.2 ft.

Adjustment Factors:

- BWL spacing of 35 ft = 1.4
- Story height - 10 feet tall = 1.0
- Total Adjustment = 1.4

Braced Wall Lines A, B & E

BWL spacing less than 25 ft.

BWL Length is 64.5 ft.

Required bracing length

Method WSP: $(12.5 + 5) \text{ ft.} \times 1.0 = 17.5 \text{ feet}$

Method GB: $(20 + 8) \text{ ft.} \times 1.0 = 28 \text{ feet}$

Braced Wall Lines C & D

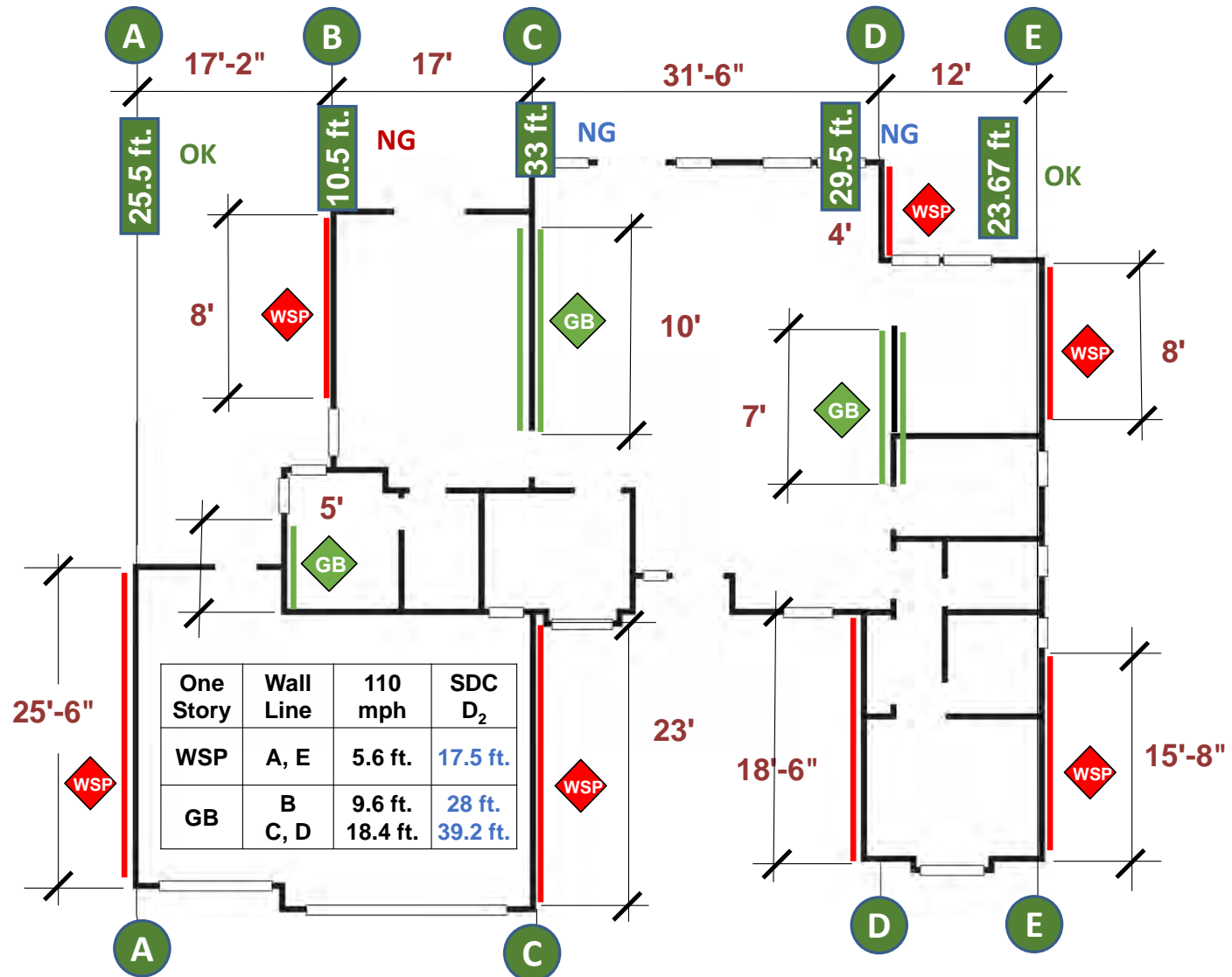
Assume BWL spacing of 35 ft.

BWL Length is 64.5 ft.

Required bracing length

Method GB: $(20 + 8) \text{ ft.} \times 1.4 = 39.2 \text{ ft.}$





Seismic lengths insufficient

- BWL B – bracing could be determined by actual wall length
- BWL C and D – Method GB doesn't work, use Method WSP

Braced Wall Line B

Use Method WSP

Actual length is 28 ft. 10 in., assume 30 ft. length

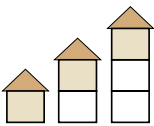
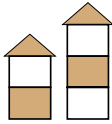
Braced Wall Lines C & D

Use Method WSP

Actual length is 64.5 ft., assume 70 ft.



Minimum Required Length of Bracing Table R602.10.3(3)

<ul style="list-style-type: none"> Soil Class D Wall Height = 10 ft. 10 psf Floor Dead Load 15 psf Roof/Ceiling Dead Load Braced Wall Line Spacing ≤ 25 ft. 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line			
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length	Method LIB	Method GB	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₂		10	NP	4	2.5	2.1
		20	NP	8	5	4.3
		30	NP	12	7.5	6.4
		40	NP	16	10	8.5
		50	NP	20	12.5	10.6
		10	NP	7.5	5.5	4.7
		20	NP	15	11	9.4
		30	NP	22.5	16.5	14
		40	NP	30	22	18.7
		50	NP	37.5	27.5	23.4



Seismic lengths

Braced Wall Line B

Use Method WSP

Actual length is 28 ft. 10 in., assume 30 ft. length

Required bracing length

Method WSP: $7.5 \text{ ft.} \times 1.0 = 7.5 \text{ ft.}$

Braced Wall Lines C & D

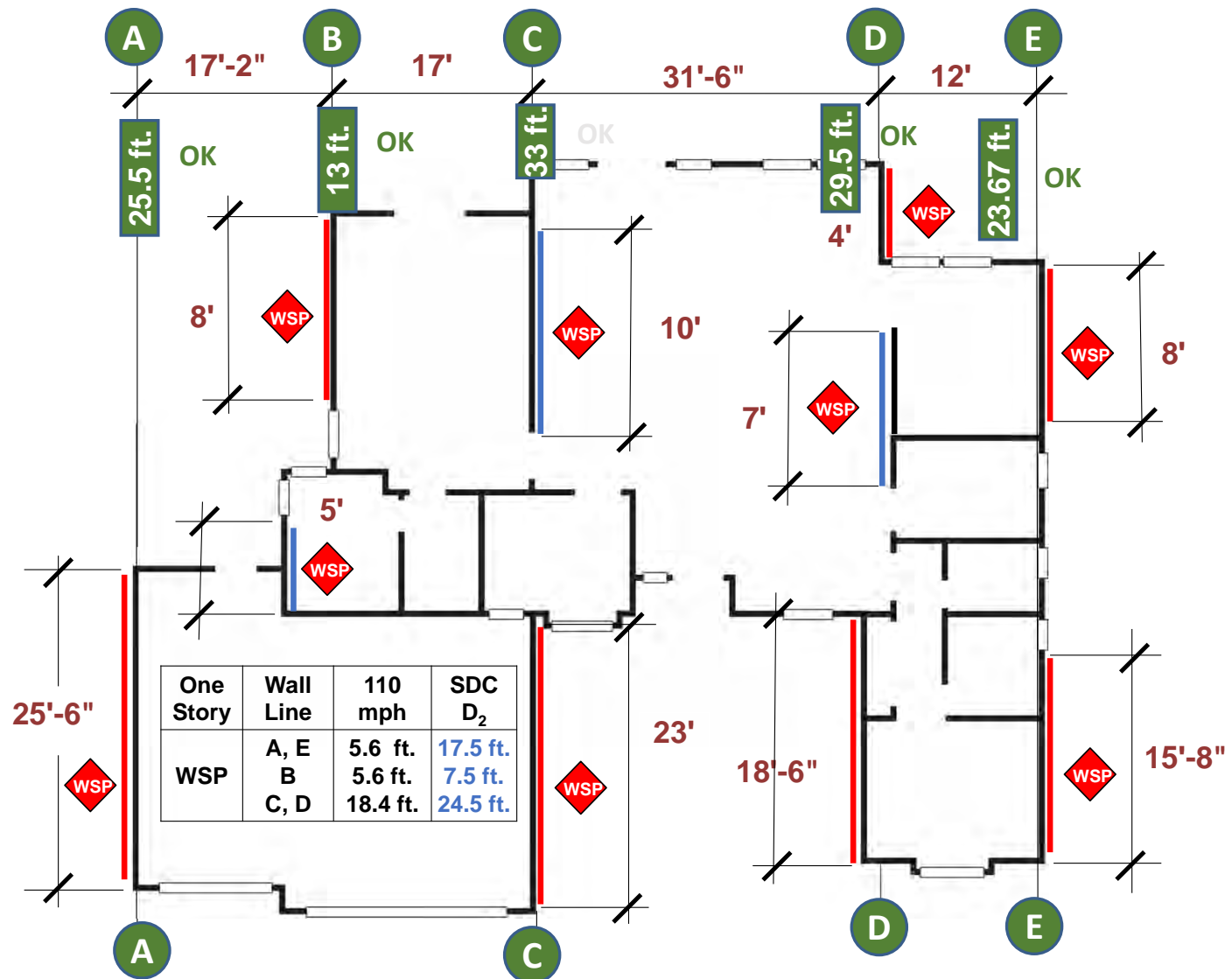
Use Method WSP

BWL Length is 64.5 ft., assume 70 ft. length

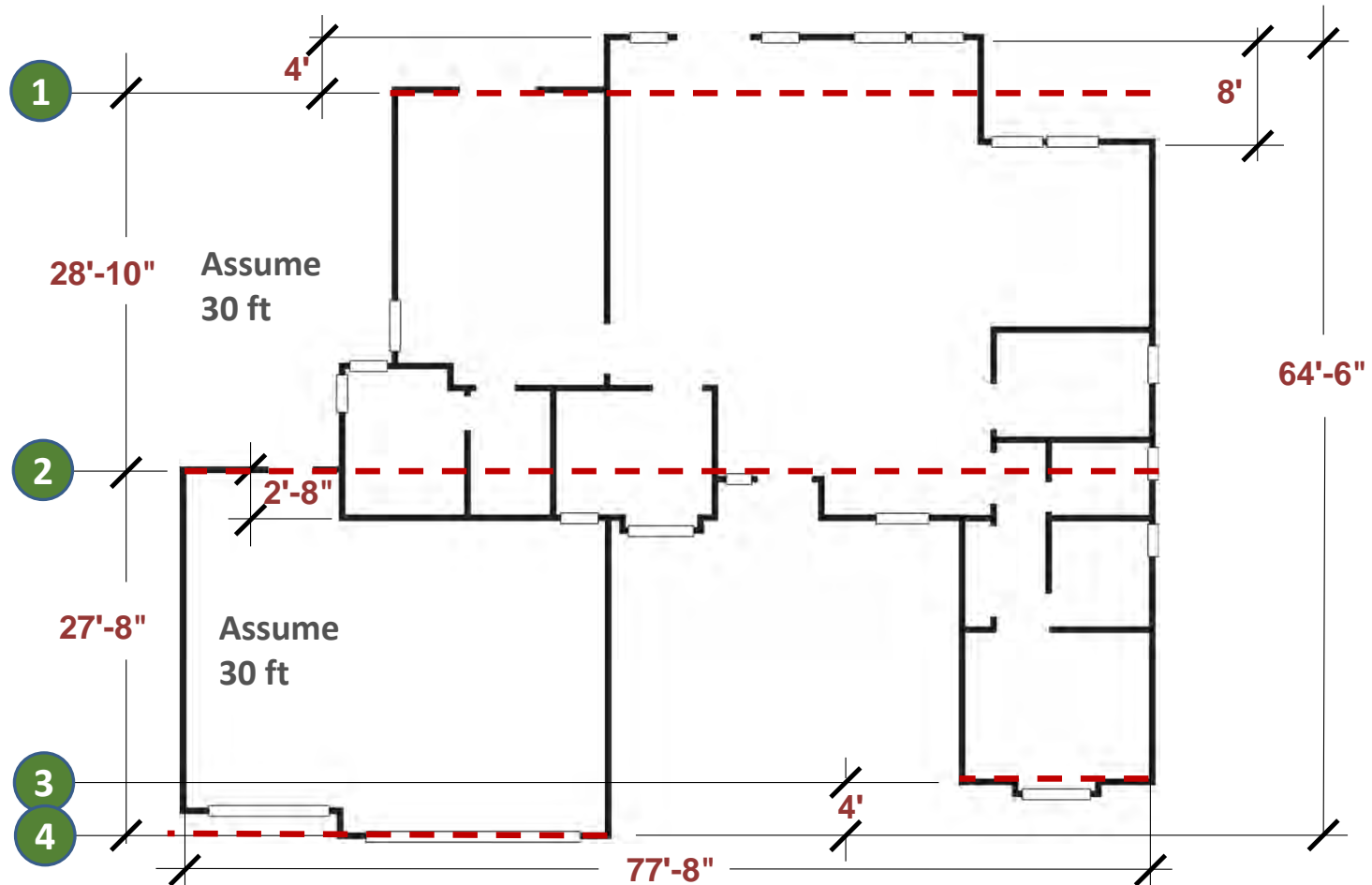
Required bracing length

Method WSP: $(12.5 + 5) \text{ ft.} \times 1.4 = 24.5 \text{ ft.}$



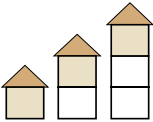
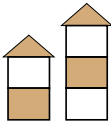


East-West Braced Wall Lines



Minimum Required Length of Bracing

Table R602.10.3(1)

<ul style="list-style-type: none"> Exposure Category B 30 ft. Mean Roof Height 10 ft. Eave to Ridge Height 10 ft. Wall Height 2 Braced Wall Lines 		Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line				
Basic Wind Speed	Story Location	Braced Wall Line Spacing (feet)	Method LIB	Method GB (double sided)	Methods WSP, SFB, ABW, PFH, PFG	Methods CS-WSP, CS-G, CS-PF
≤ 110 (mph)		10	3.5	3.5	2	1.5
		20	6	6	3.5	3
		30	8.5	8.5	5	4.5
		40	11.5	11.5	6.5	5.5
		50	14	14	8	7
		60	16.5	16.5	9.5	8
		10	6.5	6.5	3.5	3
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.5	13
		60	31.5	31.5	18	15.5



One Story	Wall Line	110 mph	SDC D ₂
WSP	1-4	7.25 ft.	
GB	1-4	12.3 ft.	

Adjustment Factors:

- Wind Exposure C, 1 story building = 1.2
 - 4 braced wall lines = 1.45
 - Walls - 9 feet tall = 0.95
 - Eave to ridge height - 8 feet tall = 0.88
- Total Adjustment = 1.45

Braced Wall Lines 1, 2, 3 and 4

BWLs 3 and 4 are close enough to combine into one wall line but there is a large gap between the actual wall lines. If BWPs can't be placed with 20 ft. edge to edge, there will need to be two separate wall lines.

Required bracing length (WSP)

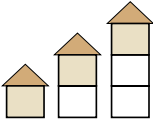
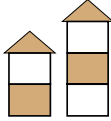
$$= 5 \text{ ft.} \times 1.45 = 7.25 \text{ feet}$$

Required bracing length (GB)

$$= 8.5 \text{ ft.} \times 1.45 = 12.3 \text{ feet}$$



Minimum Required Length of Bracing Table R602.10.3(3)

<ul style="list-style-type: none"> Soil Class D Wall Height = 10 ft. 10 psf Floor Dead Load 15 psf Roof/Ceiling Dead Load Braced Wall Line Spacing ≤ 25 ft. 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line			
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length	Method LIB	Method GB	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₂		10	NP	4	2.5	2.1
		20	NP	8	5	4.3
		30	NP	12	7.5	6.4
		40	NP	16	10	8.5
		50	NP	20	12.5	10.6
		10	NP	7.5	5.5	4.7
		20	NP	15	11	9.4
		30	NP	22.5	16.5	14
		40	NP	30	22	18.7
		50	NP	37.5	27.5	23.4



One Story	Wall Line	110 mph	SDC D ₂
WSP	1-4	7.25 ft.	24 ft.
GB	1-4	12.3 ft.	38.4 ft.

Seismic Adjustment Factors:

- BWL spacing of 30 ft = 1.2
 - Story height - 10 feet tall = 1.0
-
- Total Adjustment = 1.2

Braced Wall Lines 1, 2, 3 & 4

Assume BWL spacing of 30 ft.

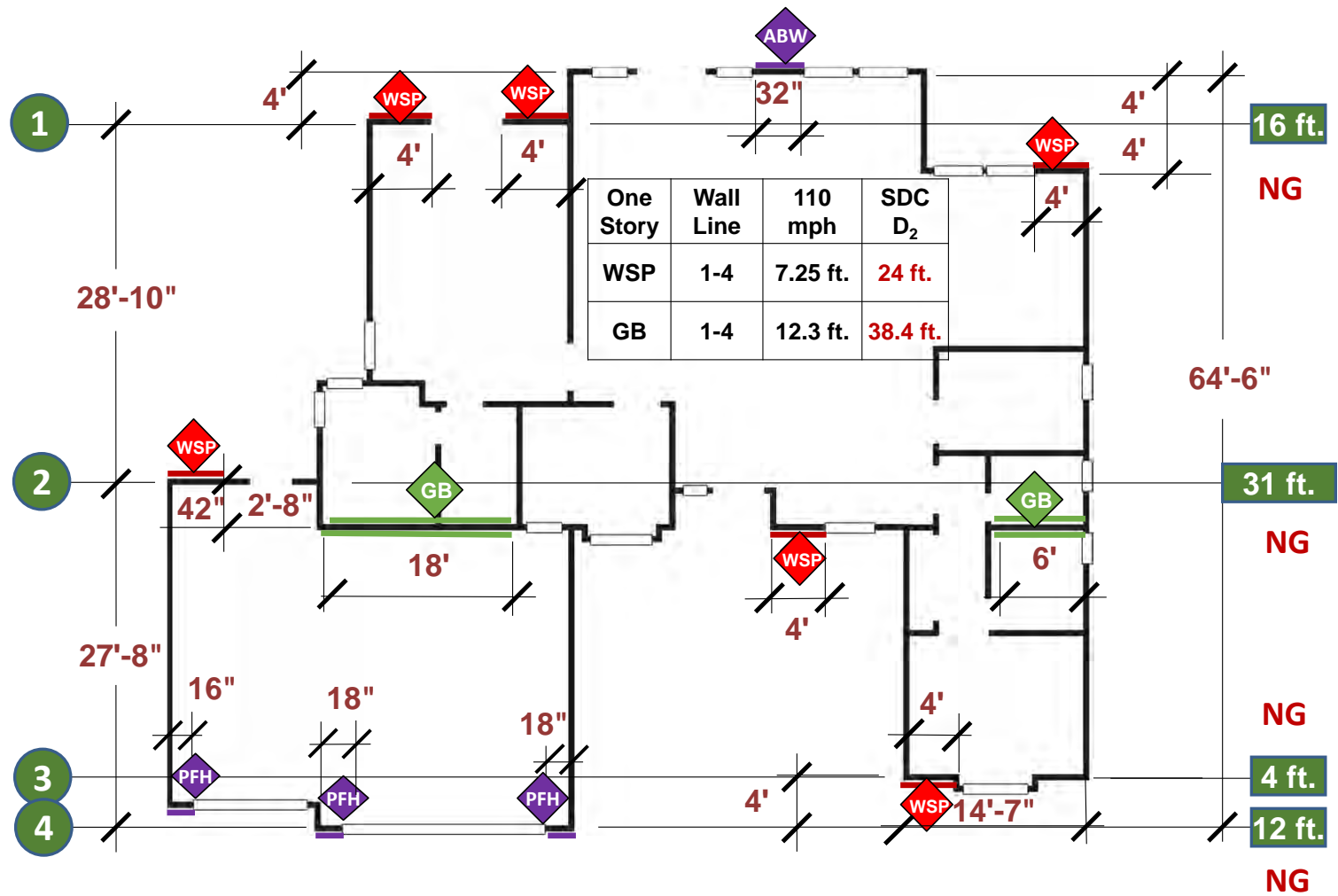
BWL Length is 77 ft. 8 in., assume 80 ft.

Required bracing length

Method WSP: $(12.5 + 7.5) \text{ ft.} \times 1.2 = 24 \text{ feet}$

Method GB: $(20 + 12) \text{ ft.} \times 1.2 = 38.4 \text{ feet}$





One Story	Wall Line	110 mph	SDC D ₂
WSP	1-4	7.25 ft.	
GB	1-4	12.3 ft.	

Seismic Adjustment Factors:

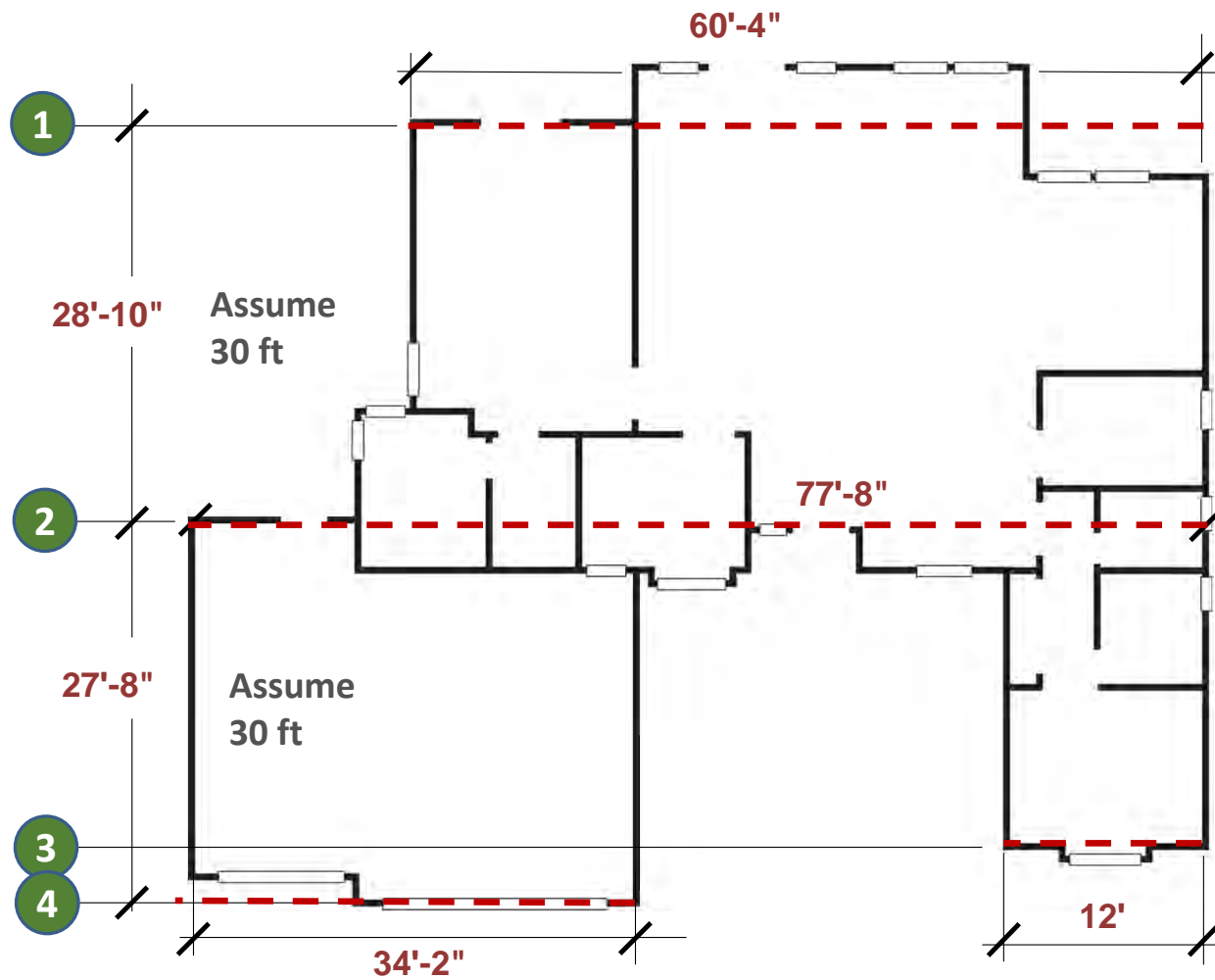
- BWL spacing of 30 ft = 1.2
 - Story height - 10 feet tall = 1.0
-
- Total Adjustment = 1.2

Braced Wall Lines 1, 2, 3 & 4

Determine actual braced wall line length.



East-West Braced Wall Lines



One Story	Wall Line	110 mph	SDC D ₂
WSP	1-4	7.25 ft.	

Seismic Adjustment Factors:

- BWL spacing of 30 ft = 1.2
- Story height - 10 feet tall = 1.0
- Total Adjustment = 1.2

Braced Wall Line 1

BWL Length is 60 ft. 4 in., assume 60 ft.

Braced Wall Line 2

BWL Length is 77 ft. 8 in., assume 80 ft.

Braced Wall Line 3

BWL Length is 34 ft. 2 in., assume 40 ft.

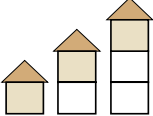
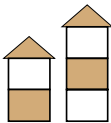
Braced Wall Line 4

BWL Length is 12 ft., interpolate for 12 ft. or use 20 ft.



Minimum Required Length of Bracing

Table R602.10.3(3)

<ul style="list-style-type: none"> Soil Class D Wall Height = 10 ft. 10 psf Floor Dead Load 15 psf Roof/Ceiling Dead Load Braced Wall Line Spacing ≤ 25 ft. 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line			
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length	Method LIB	Method GB	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₂		10	NP	4	2.5	2.1
		20	NP	8	5	4.3
		30	NP	12	7.5	6.4
		40	NP	16	10	8.5
		50	NP	20	12.5	10.6
		10	NP	7.5	5.5	4.7
		20	NP	15	11	9.4
		30	NP	22.5	16.5	14
		40	NP	30	22	18.7
		50	NP	37.5	27.5	23.4



One Story	Wall Line	110 mph	SDC D ₂
WSP	1		18 ft.
	2		24 ft.
	3		12 ft.
	4	7.25 ft.	6 ft.

Seismic Adjustment Factors:

- BWL spacing of 30 ft = 1.2
- Story height - 10 feet tall = 1.0
- Total Adjustment = 1.2

Braced Wall Line 1

BWL Length is 60 ft. 4 in., assume 60 ft.

Method WSP: $(12.5 + 2.5) \text{ ft.} \times 1.2 = 18 \text{ feet}$

Braced Wall Line 2

BWL Length is 77 ft. 8 in., assume 80 ft.

Method WSP: $(12.5 + 7.5) \text{ ft.} \times 1.2 = 24 \text{ feet}$

Braced Wall Line 3

BWL Length is 34 ft. 2 in., assume 40 ft.

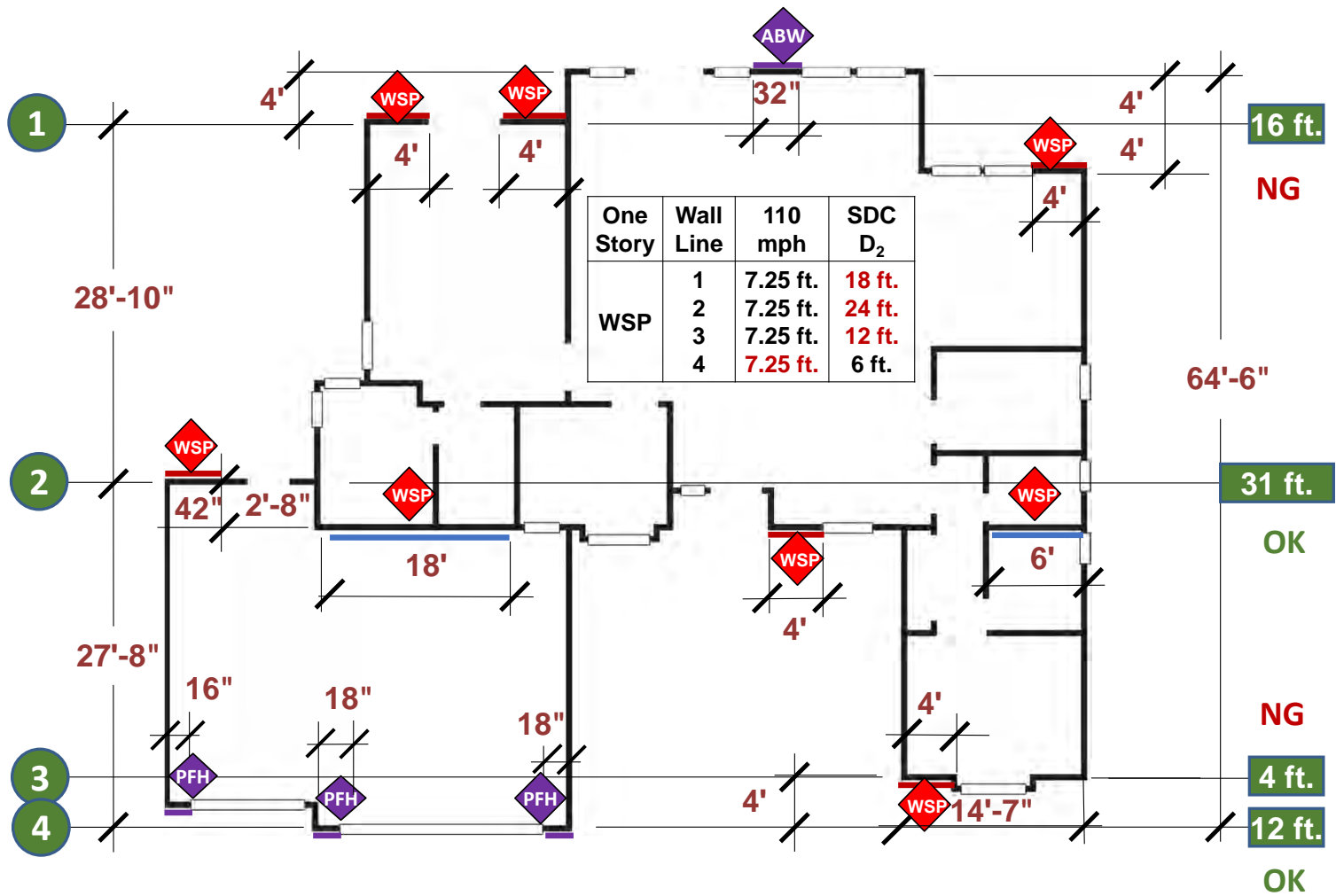
Method WSP: $10 \text{ ft.} \times 1.2 = 12 \text{ feet}$

Braced Wall Line 4

BWL Length is 12 ft., assume 20 ft.

Method WSP: $5 \text{ ft.} \times 1.2 = 6 \text{ feet}$





One Story	Wall Line	110 mph	SDC D ₂
WSP	1	7.25 ft.	18 ft.
	2	7.25 ft.	24 ft.
	3	7.25 ft.	12 ft.
	4	7.25 ft.	6 ft.

Braced Wall Line 1

BWL 1 has insufficient length.

There is no more space to add braced wall panels.

Options:

1. Remove a window and add a BWP.
2. Use proprietary panels in the narrow spaces.
3. Try CS-WSP.

Braced Wall Line 4

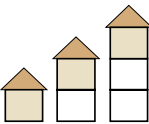
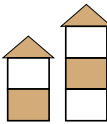
Minimum required BWL length is 7.25 ft.

There is extra space to the right of the window. If 48 inches, add WSP, if shorter add ABW or PFH.



Minimum Required Length of Bracing

Table R602.10.3(3)

<ul style="list-style-type: none"> Soil Class D Wall Height = 10 ft. 10 psf Floor Dead Load 15 psf Roof/Ceiling Dead Load Braced Wall Line Spacing ≤ 25 ft. 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line			
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length	Method LIB	Method GB	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₂		10	NP	4	2.5	2.1
		20	NP	8	5	4.3
		30	NP	12	7.5	6.4
		40	NP	16	10	8.5
		50	NP	20	12.5	10.6
		10	NP	7.5	5.5	4.7
		20	NP	15	11	9.4
		30	NP	22.5	16.5	14
		40	NP	30	22	18.7
		50	NP	37.5	27.5	23.4



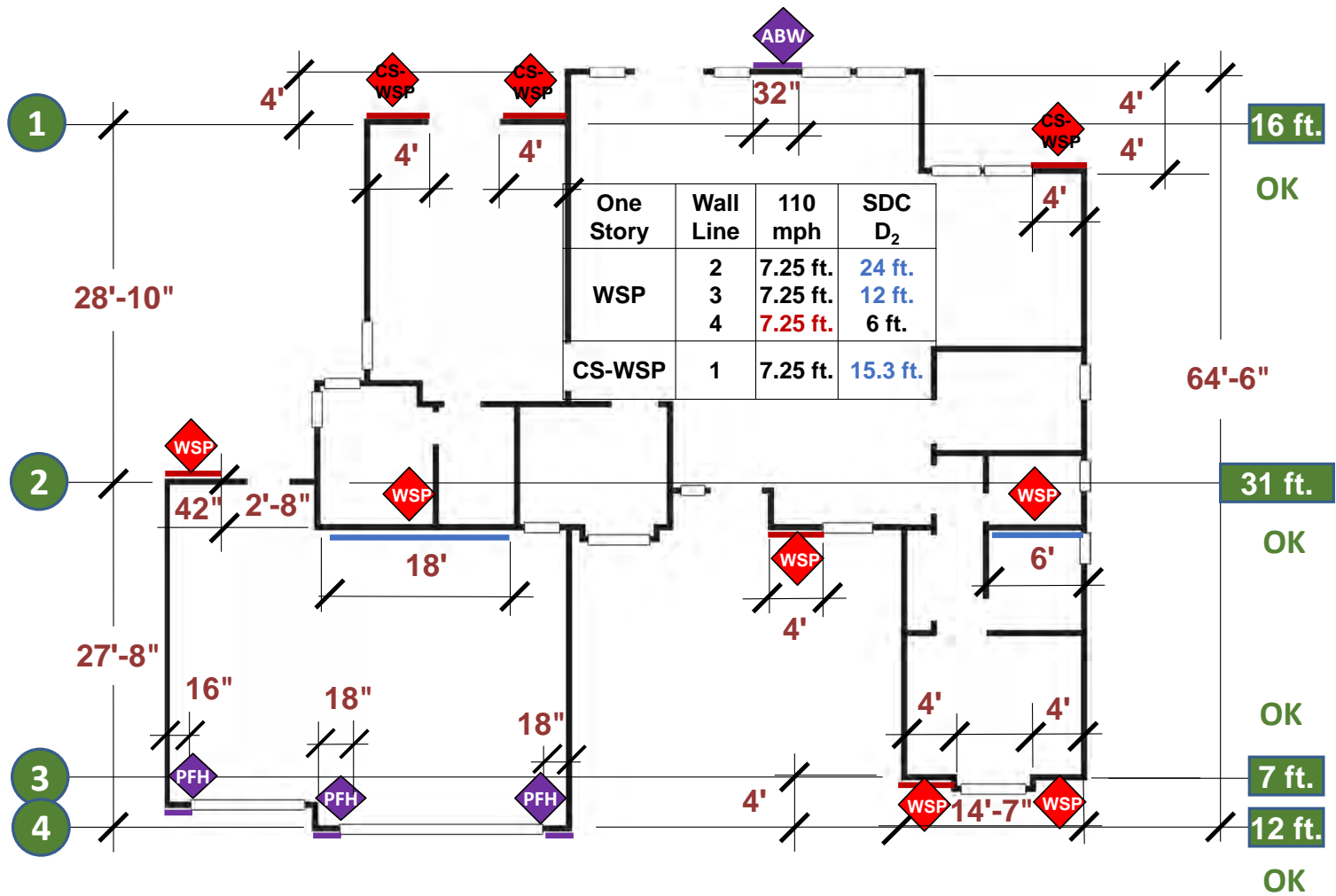
One Story	Wall Line	110 mph	SDC D ₂
WSP	2	7.25 ft.	24 ft.
	3	7.25 ft.	12 ft.
	4	7.25 ft.	6 ft.
CS-WSP	1	7.25 ft.	15.3 ft.

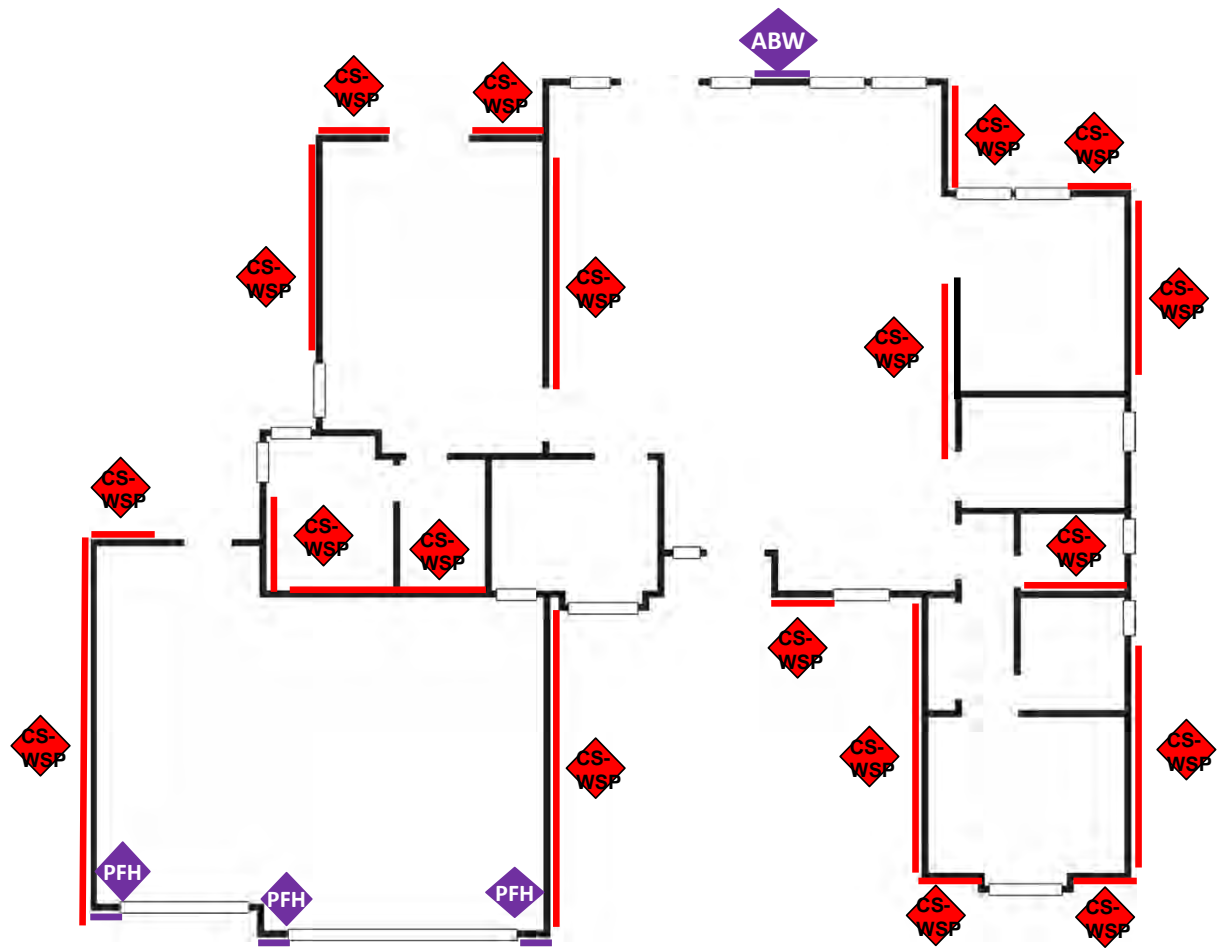
Braced Wall Line 1 BWL length of 60.33 ft., assume 60 ft.

Adjustment Factor: 1.2

Method CS-WSP: $(10.6 + 2.1) \times 1.2 = 15.3$ ft.







Whole House Example 2



Example 11: SDC D₂, Wind 129 mph, Exp C

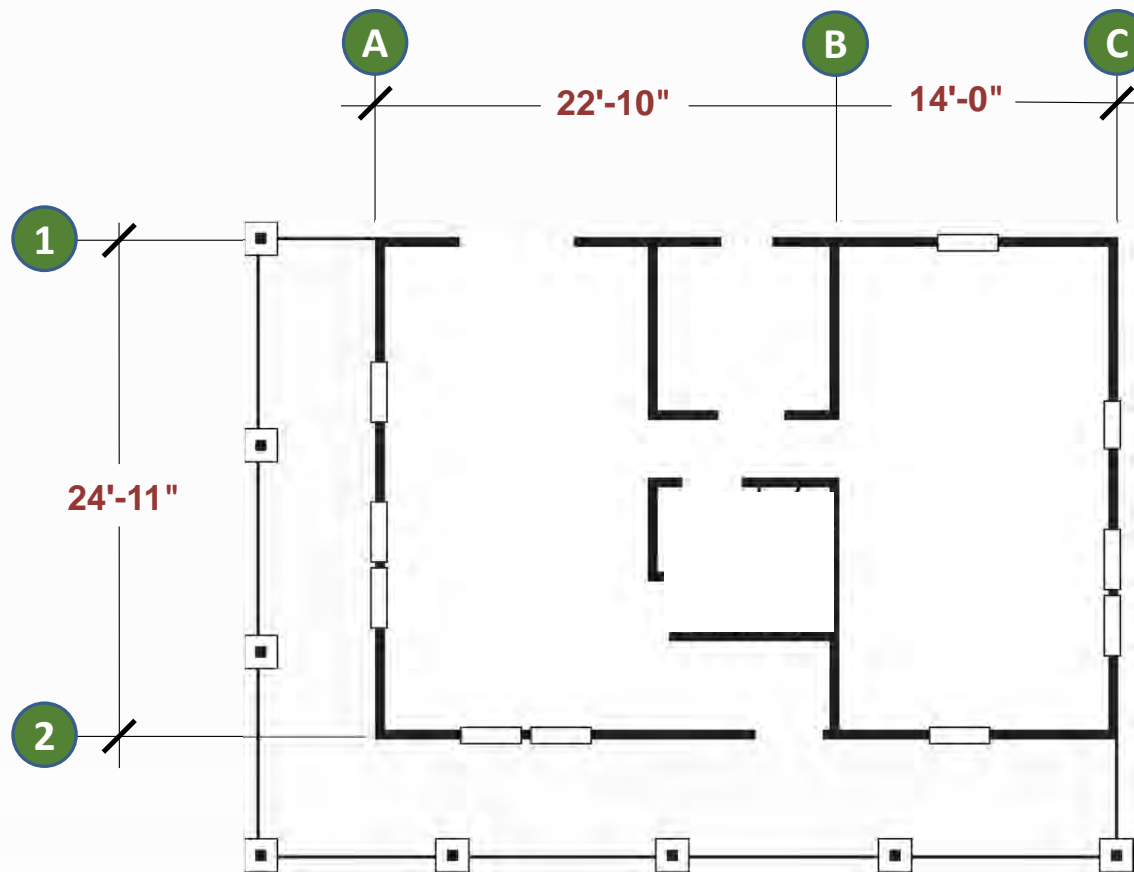
CS-WSP One Story	130 mph	SDC D ₂

Example Attributes:

- SDC D₂
- Wind 129 mph, Exposure Category C
- Method CS-WSP
- 1 Story
- Walls 9 ft. tall
- Eave to ridge height 8 ft. tall

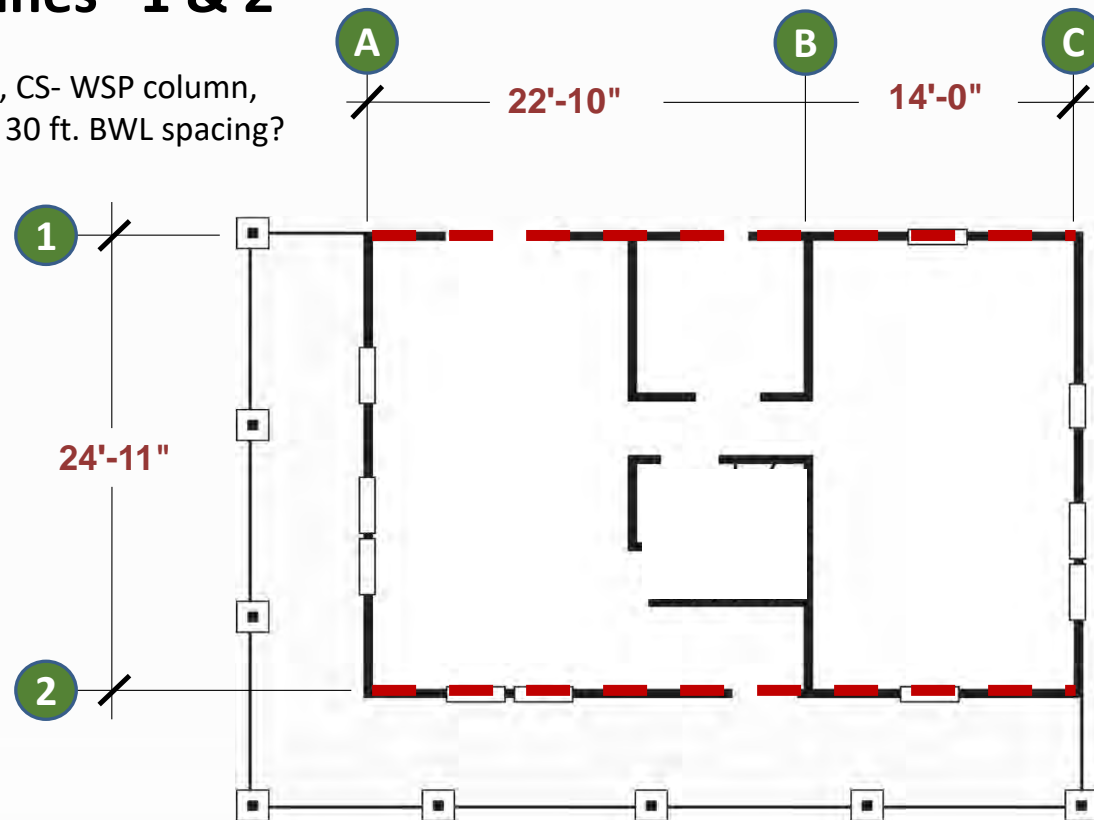


Use CS-WSP to brace walls.




Braced Wall Lines 1 & 2

From Table R602.10.3(1), CS- WSP column,
required bracing for the 30 ft. BWL spacing?



Minimum Required Length of Bracing Table R602.10.3(1)

<ul style="list-style-type: none"> Exposure Category B 30 ft. Mean Roof Height 10 ft. Eave to Ridge Height 10 ft. Wall Height 2 Braced Wall Lines 		Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line			
Basic Wind Speed	Story Location	Braced Wall Line Spacing (feet)	Method GB (double sided)	Methods WSP, SFB, ABW, PFH, PFG	Methods CS-WSP, CS-G, CS-PF
≤ 130 (mph)		10	4.5	2.5	2.5
		20	8.5	5	4
		30	12	7	6
		40	15.5	9	7.5
		50	19.5	11	9.5
		60	23	13	11



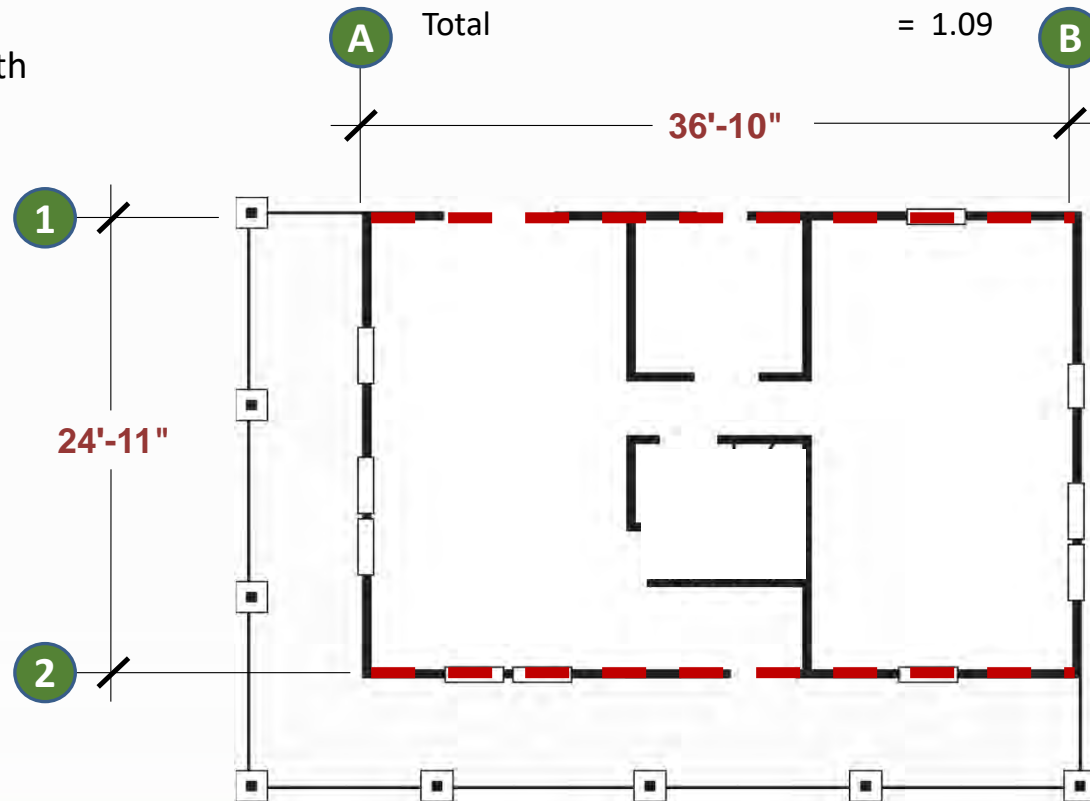
Single Story	Wall Line	130 mph	SDC D ₂
WSP	1 2	6 ft.	?

Required bracing length from table is 6 feet

Method WSP:
6 ft x 1.09 = 6.6 ft

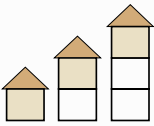
Wind Adjustment Factors:

- Wind Exposure C = 1.3
- 2 braced wall lines = 1.0
- Walls - 9 feet tall = 0.95
- Eave to ridge height - 8 feet tall = 0.88
- Total = 1.09



Minimum Required Length of Bracing

Table R602.10.3(3)

<ul style="list-style-type: none"> Soil Class D Wall Height = 10 ft. 10 psf Floor Dead Load 15 psf Roof/Ceiling Dead Load Braced Wall Line Spacing \leq 25 ft. 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line		
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length	Method GB	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₂		10	4	2.5	2.1
		20	8	5	4.3
		30	12	7.5	6.4
		40	16	10	8.5
		50	20	12.5	10.6



Seismic Adjustment Factors:

Bottom Story	Wall Line	130 mph	SDC D ₂
WSP	1 2	6.6 ft.	6.4 ft.

- Walls - 9 feet tall = 1.0
- BWL spacing < 25 ft. = 1.0
- Wall dead load of 12 psf = 1.0
- Roof dead load of 20 psf = 1.0

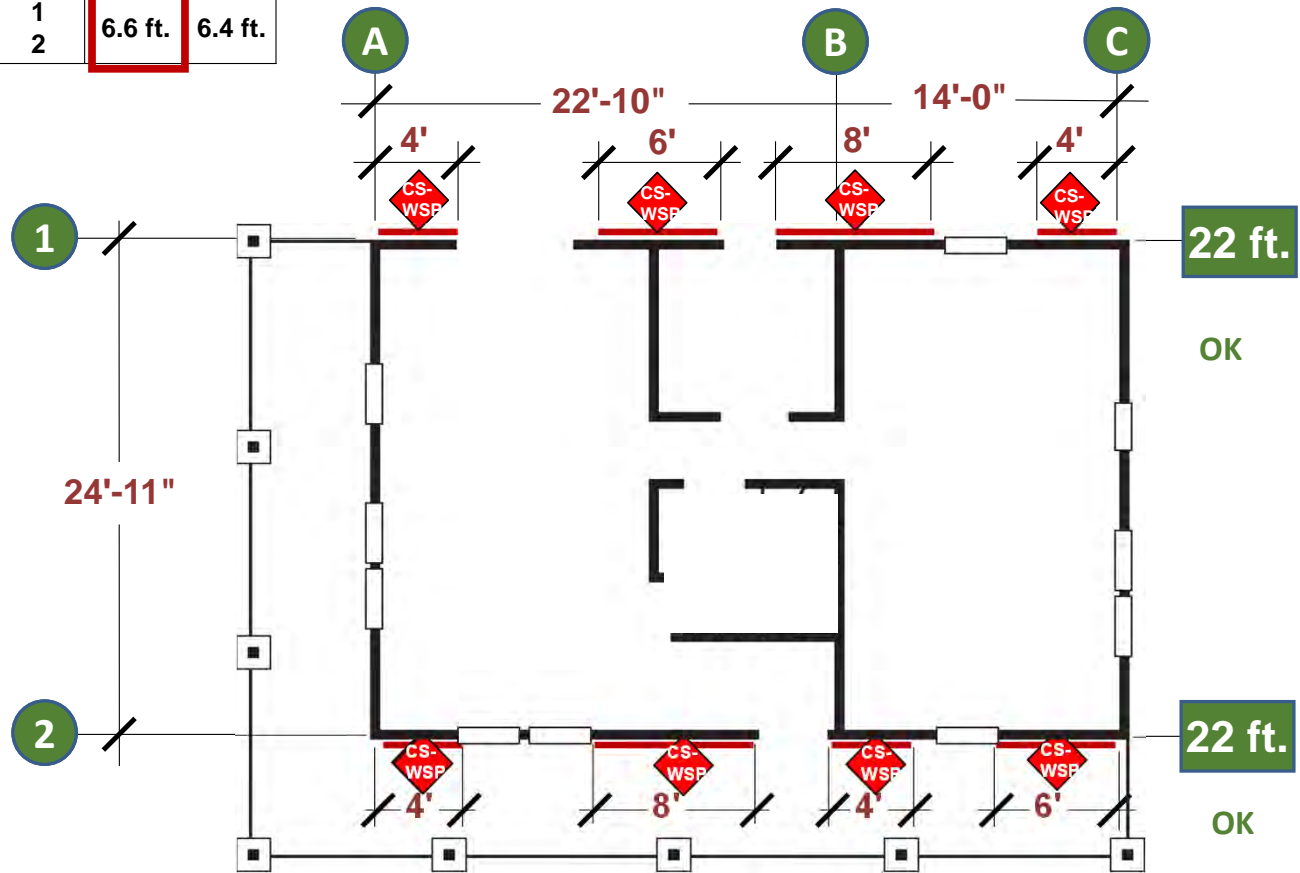
Total Adjustment = 1.0

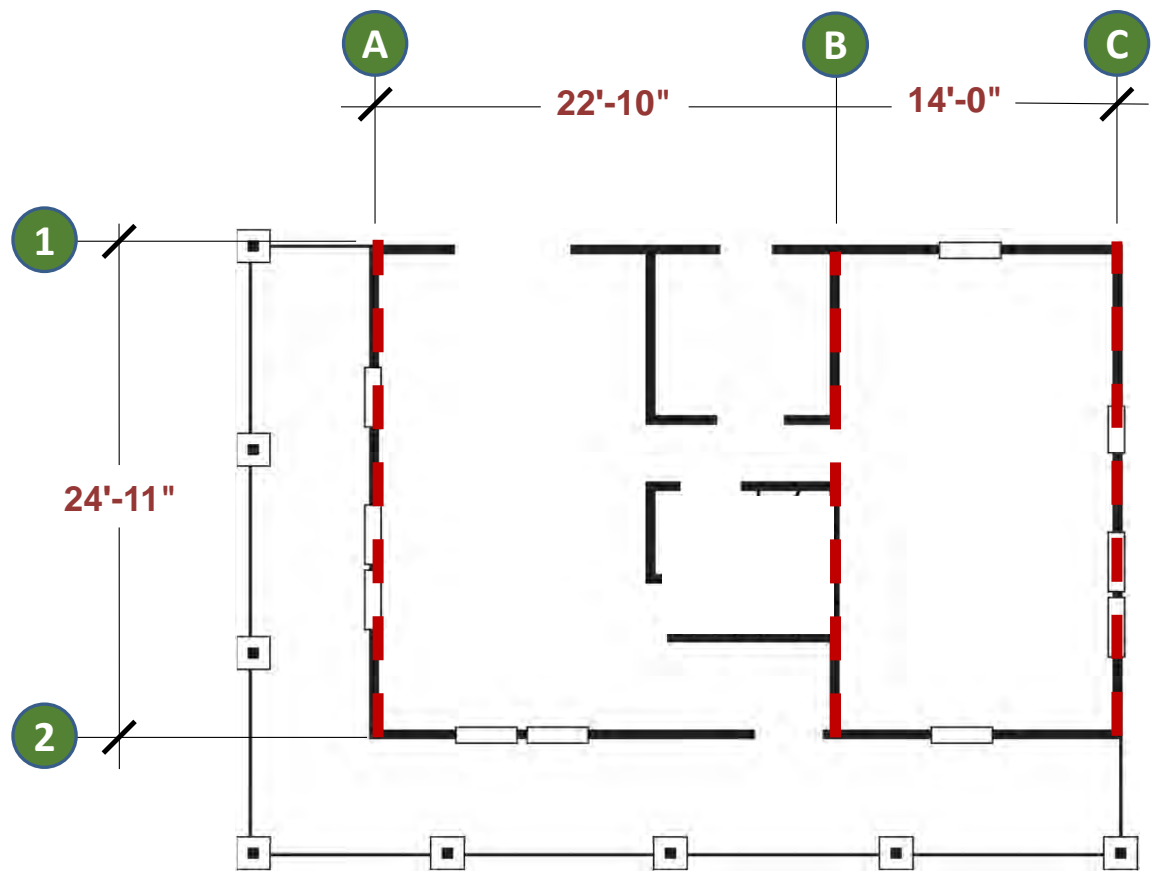
For an assumed 40 ft BWL length:

BWL 1 & 2 Method WSP $1.0 \times 6.4 \text{ ft} = 6.4 \text{ ft minimum}$



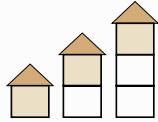
Bottom Story	Wall Line	130 mph	SDC D ₂
WSP	1 2	6.6 ft.	6.4 ft.





Minimum Required Length of Bracing

Table R602.10.3(1)

<ul style="list-style-type: none"> Exposure Category B 30 ft. Mean Roof Height 10 ft. Eave to Ridge Height 10 ft. Wall Height 2 Braced Wall Lines 		Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line			
Basic Wind Speed	Story Location	Braced Wall Line Spacing (feet)	Method GB (double sided)	Methods WSP, SFB, ABW, PFH, PFG	Methods CS-WSP, CS-G, CS-PF
≤ 130 (mph)		10	4.5	2.5	2.5
		20	8.5	5	4
		30	12	7	6
		40	15.5	9	7.5
		50	19.5	11	9.5
		60	23	13	11



Bottom Story	Wall Line	130 mph	SDC D ₂
WSP	A C	9.9 ft. 7.1 ft.	?
GB	B	17 ft.	?

Wind Adjustment Factors:

- Wind Exposure C = 1.3
 - 3 braced wall lines = 1.3
 - Walls - 9 feet tall = 0.95
 - Eave to ridge height - 8 feet tall = 0.88
- Total = 1.41

Braced Wall Lines A, B & C

From Table R602.10.3(1),
WSP and GB columns for
30 ft and 20 ft BWL
spacing

BWL A: Method WSP

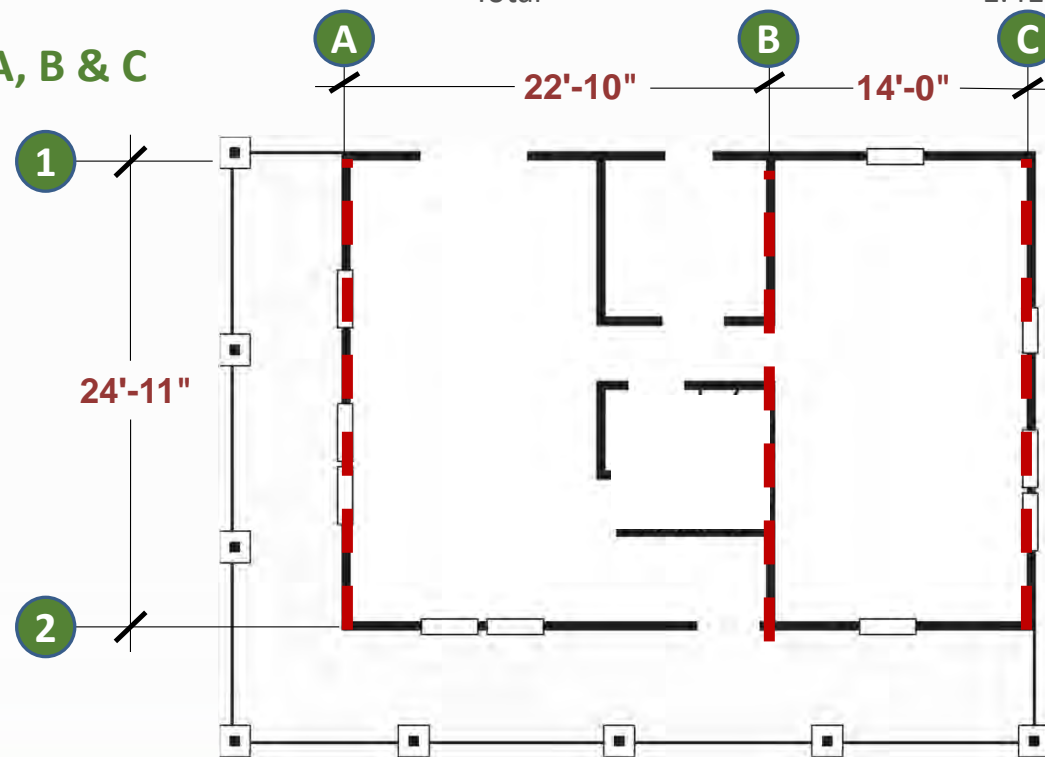
$$7 \times 1.41 = 9.9 \text{ ft.}$$

BWL B: Method GB

$$12 \times 1.41 = 17 \text{ ft.}$$

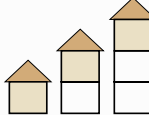
BWL C: Method WSP

$$5 \times 1.41 = 7.1 \text{ ft.}$$



Minimum Required Length of Bracing

Table R602.10.3(3)

<ul style="list-style-type: none"> Soil Class D Wall Height = 10 ft. 10 psf Floor Dead Load 15 psf Roof/Ceiling Dead Load Braced Wall Line Spacing \leq 25 ft. 			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line		
Seismic Design Category (SDC)	Story Location	Braced Wall Line Length	Method GB	Method WSP	Methods CS-WSP, CS-G, CS-PF
SDC D ₂		10	4	2.5	2.1
		20	8	5	4.3
		30	12	7.5	6.4
		40	16	10	8.5
		50	20	12.5	10.6



Bottom Story	Wall Line	130 mph	SDC D ₂
WSP	A C	9.9 ft. 7.1 ft.	7.5 ft.
GB	B	17 ft.	12 ft.

Seismic Adjustment Factors:

- Walls - 9 feet tall = 1.0
- BWL spacing < 25 ft. = 1.0
- Wall dead load of 12 psf = 1.0
- Roof dead load of 20 psf = 1.0

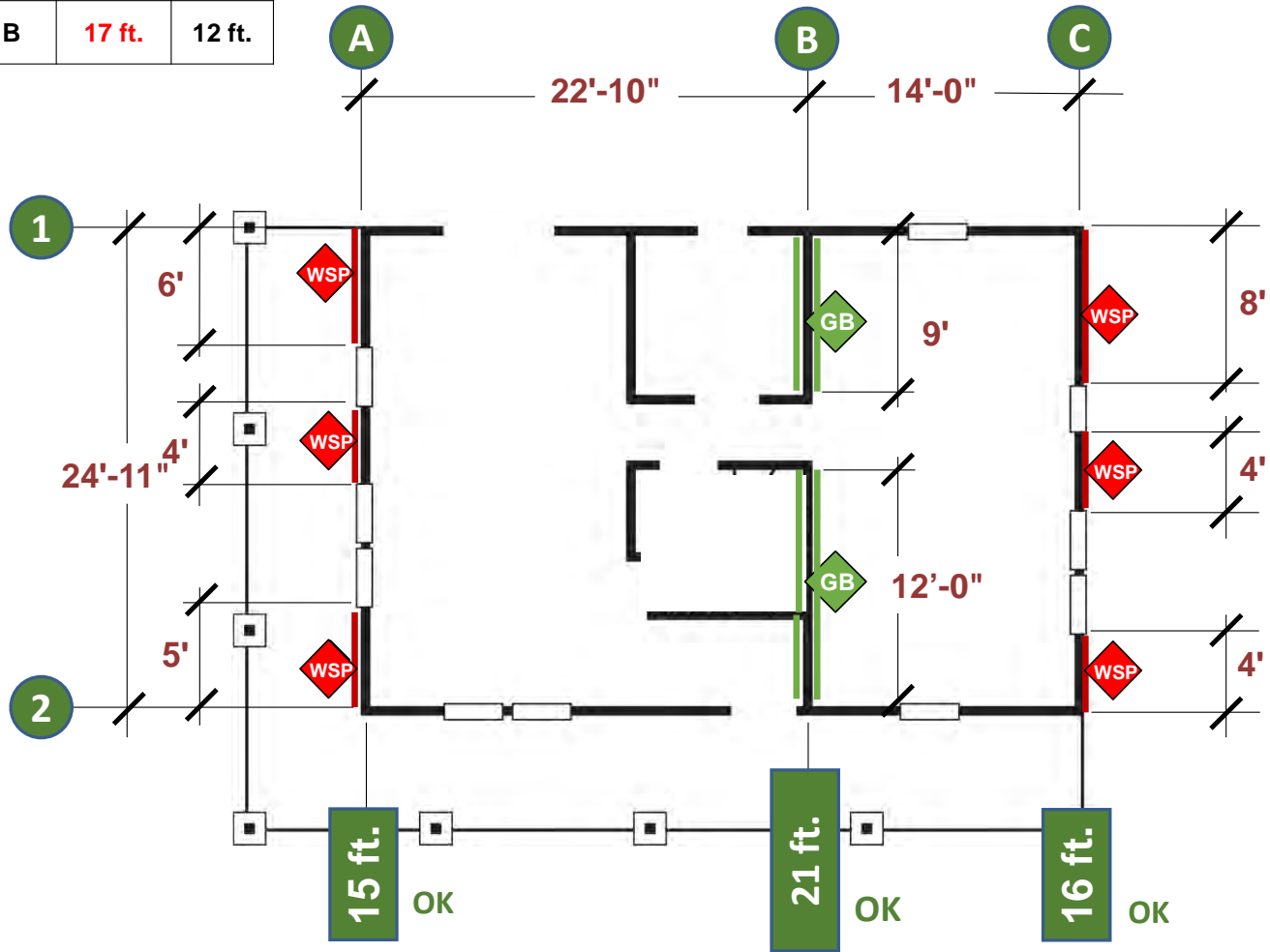
Total Adjustment = 1.0

For an assumed 30 ft BWL length:

BWL A and C	Method WSP	$1.0 \times 7.5 \text{ ft} = 7.5 \text{ ft minimum}$
BWL B	Method GB	$1.0 \times 12 \text{ ft} = 12 \text{ ft minimum}$



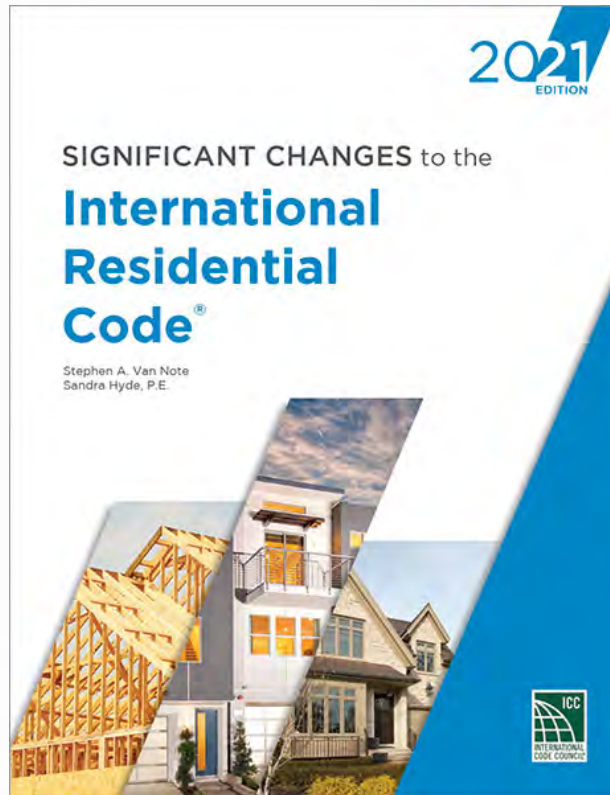
Bottom Story	Wall Line	130 mph	SDC D ₂
WSP	A C	9.9 ft. 7.1 ft.	7.5 ft.
GB	B	17 ft.	12 ft.



Resources



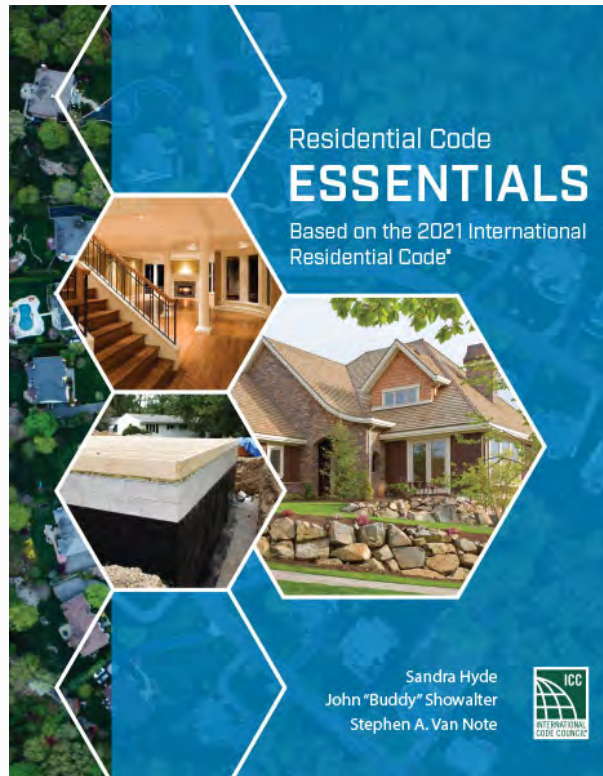
IRC Significant Changes



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IRC Essentials

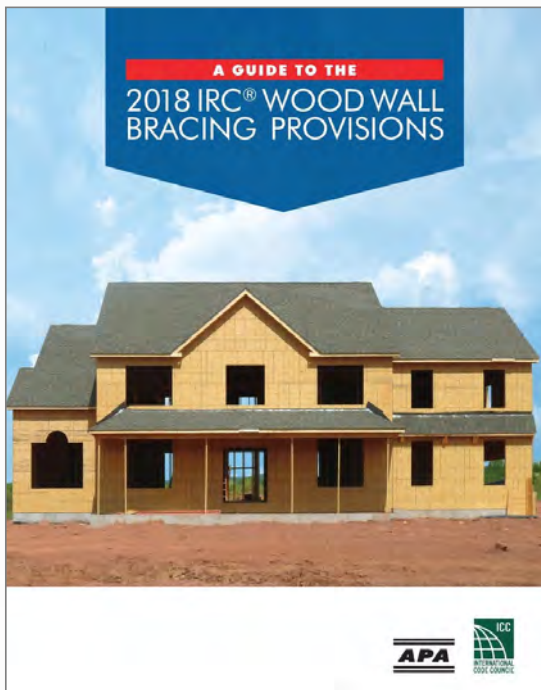


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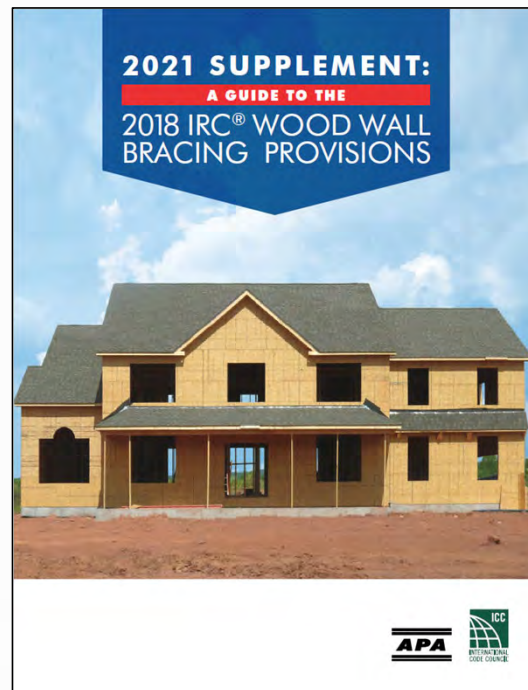
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Wall Bracing Guide



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