



Wall Bracing 2009

R602.10 and R602.12

Presenters

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 Professional Engineer
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Logistics

Exits



Restrooms



Cell phones



No Smoking

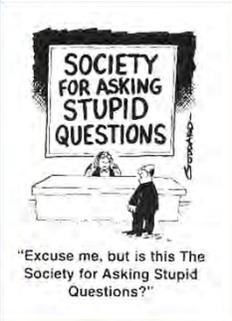


Questions?

SURE- Go ahead and ask your question!

This class is interactive!

There are no stupid questions!



"Excuse me, but is this The Society for Asking Stupid Questions?"

VBCOA



ORGANIZATION DOCUMENTS

- 2009 VBCOA Directory
- Association By-Laws
- Strategic Plan
- Officer Job Descriptions
- Canon of Ethics
- VBCOA Brand Manual

MISCELLANEOUS DOCUMENTS

- Wall Bracing Presentation

Introductions

- Identify yourself
- Name
- Jurisdiction
- Position
- How long?
- Have you attended a wall bracing class before?

Engineer Worship




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Background

Applicability and Horizontal Loads



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Background Topics

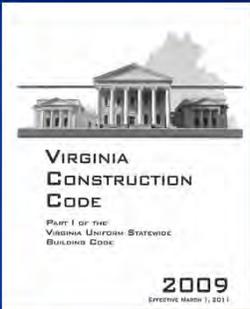
- Wall bracing in Virginia
- Applicability
- Wind speed
- Seismic design category
- Loads and load path
- Design trends
- Failure modes
- Wall bracing options



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Wall Bracing in the USBC

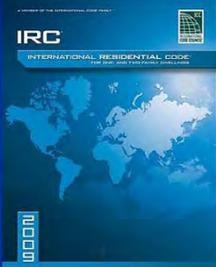
- Delete R602.10 thru R602.12 of 2009 IRC
- Insert Virginia amendment.
- Based on 2012 IRC provisions
- Differences from 2006 noted with **NEW**




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IRC - Prescriptive Code

- “Cookbook” approach
- Recipes based on:
 - Historical performance
 - Typical materials
 - Conservative
 - Nationwide application
- No RDP design required



It is the worst house you can build by law!



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Applicability

- Light-weight wood framed structures
- New houses & townhouses
- Additions
- Deck conversions
- Sunrooms




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Horizontal Loads

Wind Load

Seismic Load

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Virginia Wind Speed

- Wind speeds 90 - 120 mph
- 3 second gust
- 50 year storm
- 30' above grade

Wind speeds ≥ 110 mph require engineered design

2009

Special wind region

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Virginia Wind Speed - 2012

Virginia in 90 or 100 mph zones

- Verify with the jurisdiction's building official
- Code modification may be required

2012

■ 90 mph

■ 100 mph

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Wind Speed Comparison

Comparison of Various Wind Speed Measurements
From ASCE 7-05 Table C6.2 and Figure C6-4

Saffir/Simpson Hurricane Category	Category 1	Category 2	Category 3	Category 4	Category 5
NOAA Sustained Wind Speed (1 minute over water)	74 - 95 mph	96 - 110 mph	111 - 130 mph	131 - 155 mph	> 155 mph
IBC 3-Second Gust	80 - 100 mph	100 - 120 mph	120 - 140 mph	140 - 160 mph	160 - 200 mph
BOCA/UBC Fastest Mile	70 - 90 mph	90 - 110 mph	110 - 130 mph	130 - 150 mph	150 - 180 mph

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Seismic Design Category

- Most of Virginia in SDC A or B.
- Southwest corner in SDC C.

Explanation

Seismic Design Category

%g

E 117

D₅ 83

D₄ 83

D₃ 83

D₂ 60

C 50

B 33

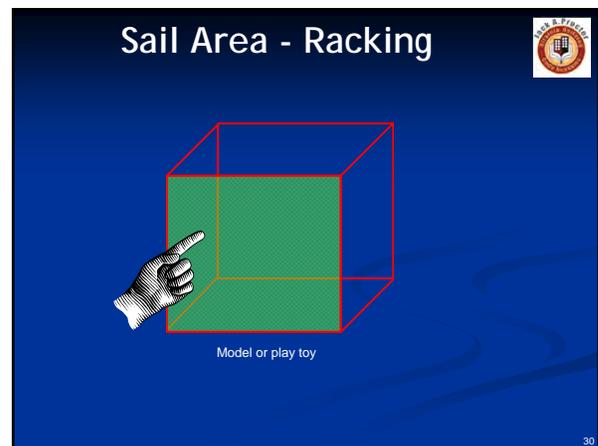
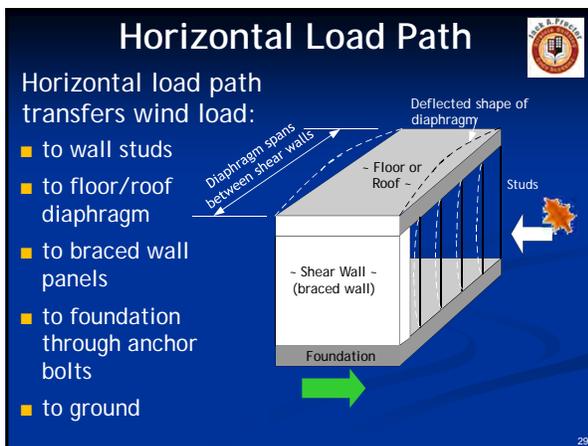
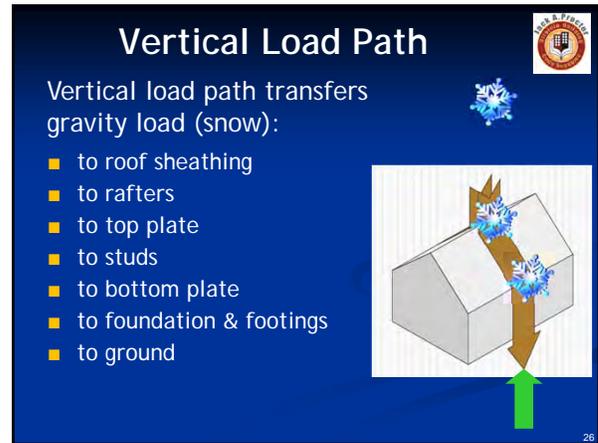
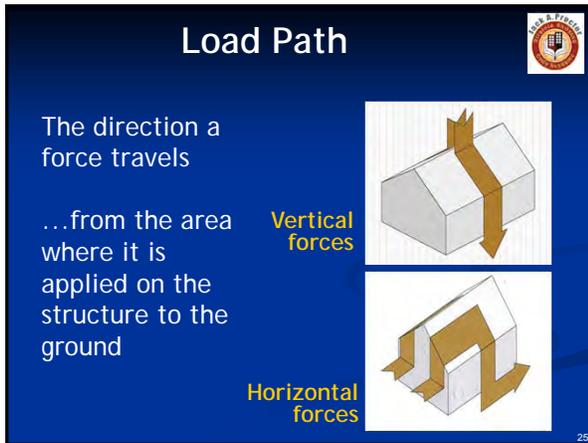
A 17

A 0

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Magnitude 8.9 Damage

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Multi-story House

Accumulative process:

- Upper stories transfer loads to diaphragms below
- More bracing required on lower floors

Most openings on bottom floor

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Design Trends

- Open floor plans
- Open rooms
- Two-story walls
- More windows

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Failure Modes

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Failure Mode: Sliding

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Failure Mode: Sliding

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Resisting Sliding

Sliding is resisted by:

- The connection of the bracing material to the bottom plate
- The anchor bolts into the foundation

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Failure Mode: Overturning



Sometimes called "UPLIFT FAILURE"

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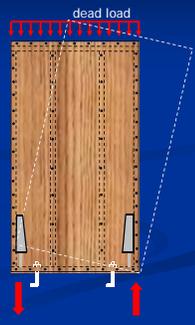
Failure Mode: Overturning



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Resisting Overturning

Overturning creates the need for a restraint force at bottom of panel.

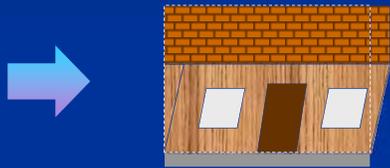


Overturning is resisted by:

- Anchor bolts
- Hold downs devices, and/or
- Dead load above

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Failure Mode: Racking



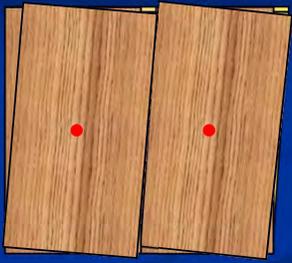
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Failure Mode: Racking



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Resisting Racking



Studs try to move with the diaphragm above

Panels rotate about their centroid

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Resisting Racking

Racking is resisted by:

- Connection of bracing material to studs with edge nails
- Field nails resist buckling

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Wall Bracing Options

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Wall Bracing Options

1. **Shear Walls**
 - Engineered solution
 - Per IBC
2. **Proprietary Products**
 - Tested solution by manufacturer
 - Per ICC-ES acceptance criteria
3. **Braced Wall Panels**
 - Prescriptive solution
 - Per IRC, Section R602.10, "classic wall bracing"
4. **Bracing Units**
 - Simpler prescriptive solution
 - Per IRC, Section R602.12, Simplified Wall Bracing

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Engineered Shear Walls

RDP should include:

- Stud size, spacing
- Sheathing type & thickness
- Nailing size, spacing
- Hold-down, anchor bolt size, capacity
- RDP seal

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First Male Engineer

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Engineered Shear Walls

Design per IBC Section 2306.3, SDPWS-08

SDPWS-08, Table 4.3.4 requires 3½:1 aspect ratio

$$\frac{\text{Height}}{\text{Length}} = 3\frac{1}{2}:1$$

8'	9'	10'	11'	12'
27"	31"	34"	38"	41"

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Tips for Reviewing Engineering Calculations

- Look for wind load computations
 - Per current ASCE—7
 - In 90 mph zone, expect 13-18 psf load
- Ensure aspect ratio meets minimum
- No reference to the IRC provisions (no backward engineering)



ASCE

Proprietary Products

Two types of proprietary products:

- Equivalents:** products that fit into IRC prescriptive solutions
- Pre-engineered:** products designed by engineers for a specific load



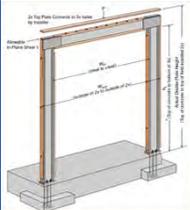
Equivalent Products

Install per manufacturer's requirements & ICC—ES evaluation report

		
Simpson Steel Strong Wall®	i-Level Shear Brace®	Hardy Frame HFX-Series Panels
12" solution 48" equivalent	12" solution 48" equivalent	12" solution 48" equivalent

Pre-engineered Products

Engineering may be necessary to determine actual load.

	
Simpson Strong-Tie Strong Frame	Hardy Frame Moment Frame

Quiz Question

Which of the following wind speeds requires an engineered design:

- 99 mph
- 101 mph
- 109 mph
- 111 mph



Quiz Question

Match the failure mode to the resisting element of a braced wall panel:

Overtuning	Fasteners-to-studs
Racking	Hold-down device
Sliding	Anchor bolts

Quiz Question



The walls of which floor have the least amount of horizontal load?

- Top floor
- Middle floor
- Bottom floor
- Cripple walls



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Quiz Question



For a wall height of 12', what is the minimum compliant *shear wall* width?

- 27"
- 41"
- 48"
- 54"



144" @ 3.5:1 height / width
 $144" / 3.5 = 41"$

41" ?

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2009 Wall Bracing

Braced wall methodology - 2 options



"Classic"
Wall Bracing
(Braced Wall Lines)

R602.10

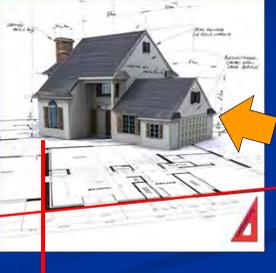


Simplified
Wall Bracing
(Circumscribed Rectangle)

R602.12

Classic Wall Bracing R602.10

- Braced wall lines (BWLs)
- Braced wall panels (BWPs)



Braced Wall Lines (BWLs)

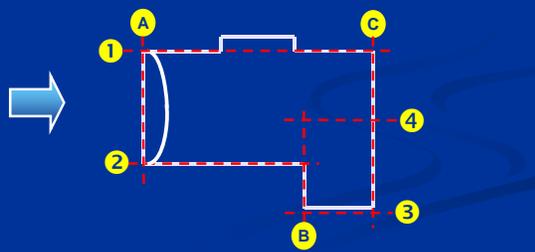
Determining Spacing and Length of Braced Wall Lines

BWL Topics

- Basic engineering
- Length
- Offsets
- Spacing between BWLs
- Angled walls

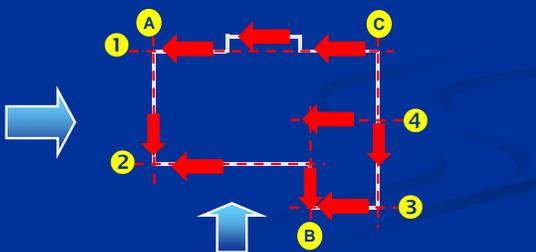
Basic Engineering

Walls perpendicular to the wind resist "out-of-plane" loading



Basic Engineering

Walls parallel to the wind resist "in-plane" loading



BWL Requirements R602.10.1

- Straight
- Run in each plan direction
- Required on each floor

BWL Length R602.10.1.1

BWL Length = Distance between ends (aka "start/stop" points)

BWLs start/stop at:

- Intersections with perpendicular BWLs
- Diagonal BWLs
- The end of the building **New**

BWL Length R602.10.1.1

Where there is no perpendicular BWL, BWLs can stop at the end of the farthest exterior wall. **New**

BWL Offsets R602.10.1.2

The walls of the house are permitted to offset from the BWL:

- $\leq 4'$ on either side of the BWL
- BWL is not required to align with actual wall(s)

BWL Length and Offsets

The length of a BWL is measured between the points where it intersects perpendicularly with other BWLs.

BWL Spacing R602.10.1.3

BWL spacing is equivalent to its "sail area."

- Sail area is perpendicular to wind load
- BWLs resist parallel wind load

BWL Spacing R602.10.1.3

Bigger "sails" require more bracing

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BWL Spacing R602.10.1.3

New

TABLE R602.10.1.3 BRACED WALL LINE SPACING				
APPLICATION	CONDITION	BUILDING TYPE	BRACED WALL LINE SPACING CRITERIA	
			Maximum Spacing	Exception to Maximum Spacing
Wind bracing	85 mph to <110 mph	Detached, townhouse	60 feet	None
		SDC A - C	Detached	Use wind bracing
Seismic bracing	SDC A - B	Townhouse	Use wind bracing	
		SDC C	Townhouse	35 feet

- 4 wind zones: ≤85, ≤90, ≤100, <110
- 60' max spacing between BWLs

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BWL Spacing R602.10.1.3

BWL 1 spacing: "where is my help?"
Use average spacing = $(30 + 16) \div 2 = 23'$

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BWL Spacing R602.10.1.3

BWL 2 spacing: "where is my help?"
Use average spacing = $(30+10+14) \div 3 = 18'$

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BWL Spacing R602.10.1.3

BWL 4 spacing: "where is my help?"
Use average spacing = $(24+16+14+16) \div 4 = 17.5'$

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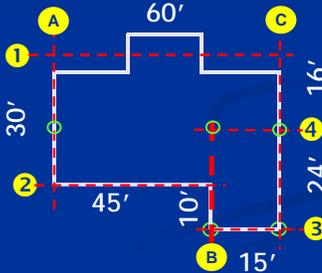
BWL Spacing R602.10.1.3

BWL A spacing: "where is my help?"
Use average spacing = $(60+45) \div 2 = 52.5'$

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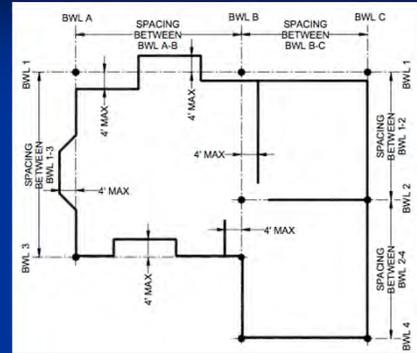
BWL Spacing R602.10.1.3

BWL B spacing: "where is my help?"
 Use average length = $(15+45+15) \div 3 = 25'$



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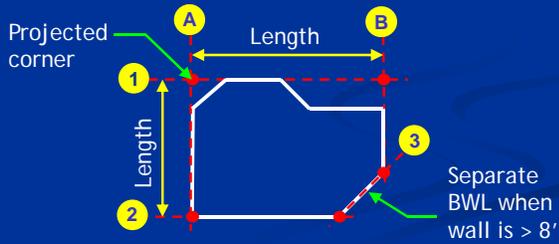
BWL Figure R602.10.1.1



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Angled Walls R602.10.1.4

- Angled walls $\leq 8'$ use projected corner
- Angled walls $> 8'$ create new BWL



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Quiz Question

Which walls resist the wind load shown?

- Red
- White
- Green
- Green and Yellow
- Red and White

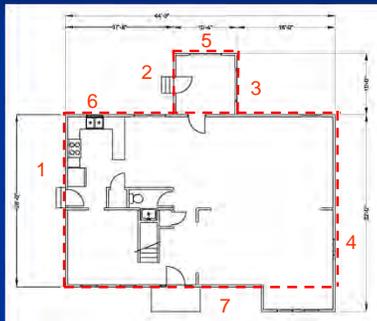


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Quiz Question

What are fewest number of BWLs for this house?

- 5
- 6
- 7
- 8

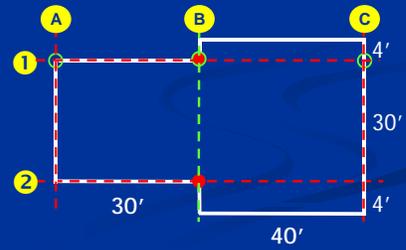


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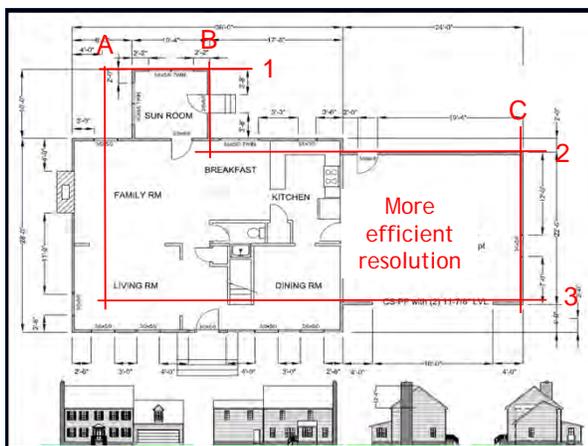
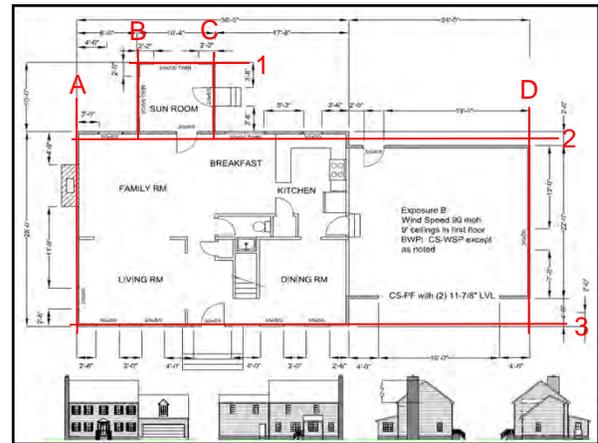
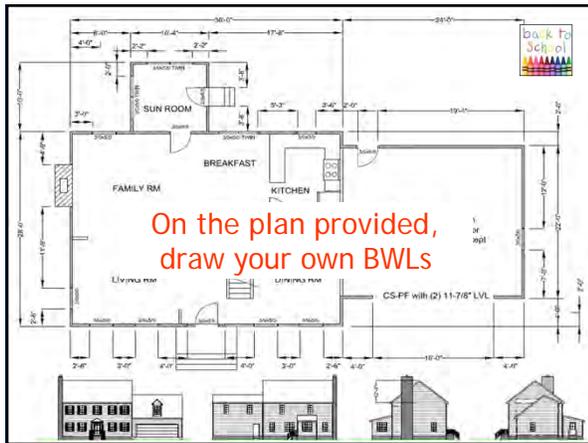
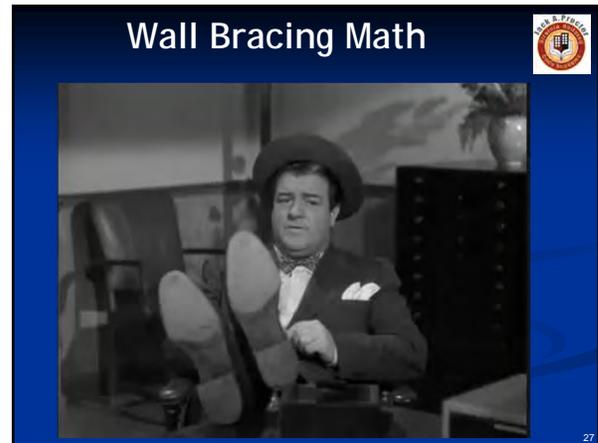
Quiz Question

What is the length of BWL B?
 What is the spacing for BWL B?

- 30' long - 30'spacing
- 30' long - 35'spacing
- 30' long - 40' spacing
- 40' long - 35' spacing



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Braced Wall Panels (BWPs)

Determining Location, Spacing, Number

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BWP Topics

- BWP minimum requirements
- Locations on a BWL
- Distance between BWPs
- Minimum number of BWPs



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BWPs R602.10.2

Braced wall panels:

- Full height, 12' max.
- Minimum length




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BWPs R602.10.2

Braced wall panels:

- Full height, 12' max.
- Minimum length
- No horizontal offsets



Cannot be considered as same BWP



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BWPs R602.10.2

Braced wall panels:

- Full height, 12' max.
- Minimum length
- No horizontal offsets
- No vertical offsets



Cannot be considered as same BWP



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BWPs R602.10.2

Braced wall panels:

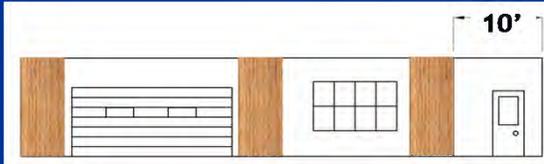
- Full height, 12' max.
- Minimum length
- No horizontal offsets
- No vertical offsets
- Vertical and horizontal joints permitted




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Location R602.10.2.2

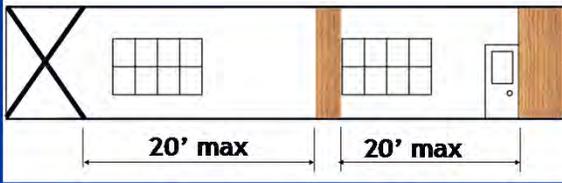
BWPs must begin at the end of a BWL, or begin within 10' of the end. **NEW!**




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Distance between BWPs R602.10.2.2

BWPs cannot be > 20' edge to edge. 



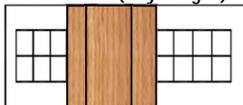
20' max 20' max

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Number of BWPs R602.10.2.3

Minimum 2 BWPs required per BWL. 

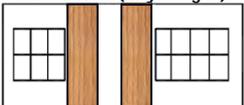
Two BWPs (any length)



...or one BWP 48" long

BWLs ≤ 16' long

Two BWPs (any length)



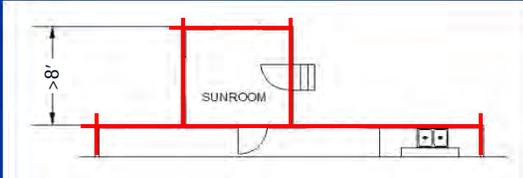
BWLs > 16' long

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BWL Placement Tip

When a wall is more than 8', BWL placement is strict. For instance:

- All sunroom walls must be on a BWL.
- All sunroom walls must have bracing.

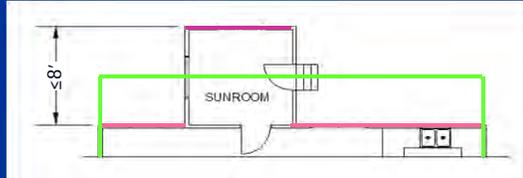


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BWL Placement Tip

When walls are ≤ 8', BWLs can be placed strategically to reduce bracing. For instance:

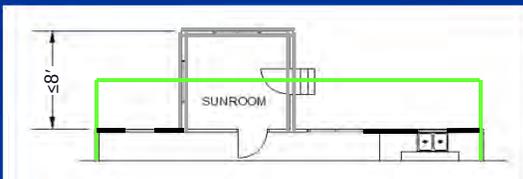
- Rear walls of house, and
- Rear wall of sunroom
- Share a BWL.



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BWL Placement Tip

- If the rear walls of the house have sufficient bracing,
- Then rear wall of the sunroom could also be all glass.



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Quiz Question

Assuming the most efficient BWL layout, what is the **minimum number** of 48" BWPs required on the long and short walls?

- 0 long, 0 short
- 1 long, 0 short
- 0 long, 1 short
- 1 long, 1 short



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Required Length of Bracing

How much bracing is required?



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Required Length of Bracing Topics

- Applicability
- Required length of bracing
 - Wind Tables
 - Wind Adjustment factor
 - Seismic Tables
 - Seismic Adjustment factor

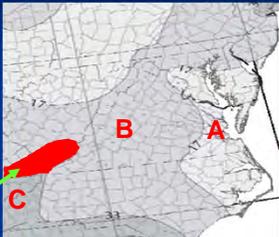


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Applicability R602.10.3



All buildings in SDC A-B-C: use wind





Exception- Townhouses in SCD C: Must apply both wind and seismic



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Required Length of Bracing R602.10.3

Determining Required Length of Bracing:

- Step 1. **Choose it!**
Select required amount from table
- Step 2. **Adjust it!**
Multiply by adjustment factors
- Step 3. **Compare it!**
Actual bracing must be > required



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Required Length of Bracing R602.10.3

NEW!

Table R602.10.3(3) Required Bracing based on Seismic

Table R602.10.3(1) Required Bracing based on Wind

Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Minimum Total Length (Feet) of Braced Wall Panels Required Along Each Braced Wall Line	
			Method LB ^a	Method CB
100	Roof	20	3.0	2.0
		30	3.0	2.0
	Floor	20	6.0	4.0
		30	6.0	4.0
		40	12.0	8.0
		50	12.0	8.0
		60	18.0	12.0
		70	18.0	12.0
		80	24.0	16.0
		90	24.0	16.0
110	Roof	20	3.0	2.0
		30	3.0	2.0
	Floor	20	6.0	4.0
		30	6.0	4.0
		40	12.0	8.0
		50	12.0	8.0
		60	18.0	12.0
		70	18.0	12.0
		80	24.0	16.0
		90	24.0	16.0

Table R602.10.3(4) Adjustments for Seismic

Seismic Risk Category	Adjustment Factor
Seismic Risk Category I	1.0
Seismic Risk Category II	1.25
Seismic Risk Category III	1.5
Seismic Risk Category IV	2.0



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Table R602.10.3(1)

Required amount of bracing is a function of:

- Wind speed:
 - ≤ 85
 - ≤ 90
 - ≤ 100
 - < 110
- Story
- BWL spacing
- Bracing method

Table R602.10.3(1) Bracing Requirements based on WIND

Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Minimum Total Length (Feet) of Braced Wall Panels Required Along Each Braced Wall Line			
			Method LB ^a	Method CB	Method RWL WSP, PFC, PFC, CS, CS-PP	Method CS-PP
100	Roof	20	3.0	2.0	4.0	3.0
		30	3.0	2.0	4.0	3.0
	Floor	20	6.0	4.0	8.0	6.0
		30	6.0	4.0	8.0	6.0
		40	12.0	8.0	16.0	12.0
		50	12.0	8.0	16.0	12.0
		60	18.0	12.0	24.0	18.0
		70	18.0	12.0	24.0	18.0
		80	24.0	16.0	32.0	24.0
		90	24.0	16.0	32.0	24.0
110	Roof	20	3.0	2.0	4.0	3.0
		30	3.0	2.0	4.0	3.0
	Floor	20	6.0	4.0	8.0	6.0
		30	6.0	4.0	8.0	6.0
		40	12.0	8.0	16.0	12.0
		50	12.0	8.0	16.0	12.0
		60	18.0	12.0	24.0	18.0
		70	18.0	12.0	24.0	18.0
		80	24.0	16.0	32.0	24.0
		90	24.0	16.0	32.0	24.0

Notice: amount of bracing required is expressed in "feet."



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Table R602.10.3(1)

TABLE R602.10.3(1)
BRACING REQUIREMENTS BASED ON WIND SPEED

• 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 (mph)	Story Location	Braced Wall Line Spacing (feet)	Methods			
			Method LIB*	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB*	Methods CS-WSP, CS-G, CS-PF
≤ 90	1-story	10	3.5	3.5	2.0	2.0
		20	7.0	7.0	4.0	3.5
		30	9.5	9.5	5.5	5.0
	2-story	10	7.0	7.0	4.0	3.5
		20	13.0	13.0	7.5	6.5
		30	18.5	18.5	10.5	9.0
100	1-story	10	4.0	4.0	2.5	2.5
		20	8.0	8.0	5.0	4.5
		30	11.0	11.0	7.0	6.5
	2-story	10	8.0	8.0	5.0	4.5
		20	15.0	15.0	9.0	8.0
		30	22.0	22.0	13.0	11.5
120	1-story	10	4.5	4.5	3.0	3.0
		20	9.0	9.0	6.0	5.5
		30	12.0	12.0	8.5	8.0
	2-story	10	9.0	9.0	6.0	5.5
		20	17.0	17.0	11.0	10.0
		30	25.0	25.0	16.0	14.5
140	1-story	10	5.0	5.0	3.5	3.5
		20	10.0	10.0	7.0	6.5
		30	13.5	13.5	10.0	9.5
	2-story	10	10.0	10.0	7.0	6.5
		20	19.0	19.0	12.0	11.0
		30	28.0	28.0	17.5	16.0
160	1-story	10	5.5	5.5	4.0	4.0
		20	11.0	11.0	8.0	7.5
		30	15.0	15.0	11.0	10.5
	2-story	10	11.0	11.0	8.0	7.5
		20	21.0	21.0	13.0	12.0
		30	31.0	31.0	19.0	17.5

* Interpolation allowed

Adjustment - Exposure

Table R602.10.3(2):

Exposure Category	Consult Table R301.2(1)	
	One story structure	Two-story structure
B	1.00	1.00
	1.20	1.30
C	1.50	1.60
	1.60	1.70
D	1.00	1.00
	1.40	1.40



Category B
Urban - suburban Wooded



Category C
Grasslands, flat plains Scattered trees
Near water in hurricane prone regions



Category D
Unobstructed, flat Outside hurricane prone regions
Unbroken ice, salt flats

Factor = 1.0

Adjustment - Eave-to-Ridge

Table R602.10.3(2):

Eave to Ridge Height	Roof only	Roof + 1 floor		Roof + 2 floors	
		≤ 5 ft	> 5 ft	≤ 5 ft	> 5 ft
Relatively flat roof	≤ 5 ft	0.70	1.00	0.90	1.00
	10 ft	1.00	1.30	1.10	1.30
	15 ft	1.30	1.60	1.30	1.60
	20 ft	1.60	1.90	1.60	1.90
	25 ft	1.90	2.20	1.90	2.20
	30 ft	2.20	2.50	2.20	2.50
10' eave to ridge height	≤ 5 ft	0.85	1.15	0.90	1.10
	10 ft	1.15	1.45	1.10	1.30
	15 ft	1.45	1.75	1.30	1.60
	20 ft	1.75	2.05	1.60	1.90
	25 ft	2.05	2.35	1.90	2.20
	30 ft	2.35	2.65	2.20	2.50
Steep roof pitch	≤ 5 ft	0.90	1.20	1.00	1.30
	10 ft	1.20	1.50	1.30	1.60
	15 ft	1.50	1.80	1.60	1.90
	20 ft	1.80	2.10	1.90	2.20
	25 ft	2.10	2.40	2.20	2.50
	30 ft	2.40	2.70	2.50	2.80

Factor = 1.0

Adjustment - Wall height

Table R602.10.3(2):

Wall height	Any story	Adjustment Factor	
		8 ft	9 ft
Interior view	≤ 8 ft	0.90	0.95
	9 ft	1.00	1.00
	10 ft	1.00	1.00
	11 ft	1.05	1.10
	12 ft	1.10	1.15
	> 12 ft	1.15	1.20

Wall < 10': factor < 1.0
Wall = 10': factor = 1.0
Wall > 10': factor > 1.0

Adjustment - Number of BWLs

Table R602.10.3(2):

Number of braced wall lines (per plan direction)F	Any story	Adjustment Factor	
		2	≥ 3
Number of braced wall lines in a given direction	2	1.00	1.30
	3	1.30	1.45
	4	1.45	1.60
	≥ 5	1.60	1.75



2 BWLs
1.00



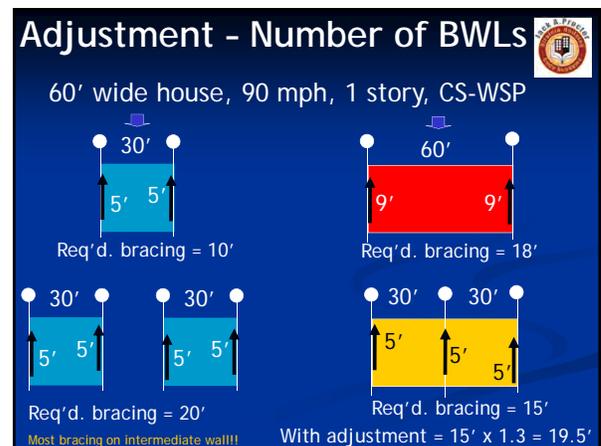
3 BWLs
1.30



4 BWLs
1.45



≥ 5 BWLs
1.60



Interior Finish

Interior finish material on all BWPs:

- ½" gypsum board nailed or screwed
- Equivalent material permitted
- May be eliminated - use adjustment factor per Table R602.10(2) (not applicable with Method GB and portal frames)

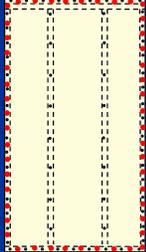


Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.4	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
--	-----------	--	------------	--

Adjustment - Gypsum Board Fastening

Gypsum board fastening	Any story	4 in. o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB
------------------------	-----------	---	------------	----

- Change nails (screws) from 7" o.c. to 4" o.c. along edges
- Reduce bracing by 30%

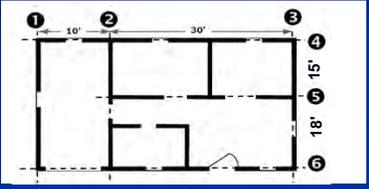


Factor = 0.7

Example

Find required length of bracing for **BWL 3**:

- 90 mph wind
- Suburban site
- 1st of 2 story
- 15' eave-ridge
- 12' walls




4' BWPs, Method-WSP, Typical of 4

Step 1: Choose it!

Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE*		
			Method LIB*	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB†
≤ 90	1st	10	3.5	3.5	2.0
		20	7.0	7.0	3.5
		30	9.5	9.5	5.0
		40	12.5	12.5	6.5
		50	15.5	15.5	8.0
		60	18.5	18.5	9.5
	2nd	10	7.0	7.0	4.0
		20	13.0	13.0	7.0
		30	16.5	16.5	9.0
		40	20.0	20.0	11.0
		50	23.5	23.5	13.0
		60	27.0	27.0	15.0

Tabular value = 10.5'

Step 2: Adjust it!

Exposure category	Structure	Roof eave-to-ridge height	Wall height adjustment	Number of braced wall lines (per plan direction)†
Two-story structure	B	1.00	1.00	3
	C	1.20	1.00	3
	D	1.60	1.00	3
	Not permitted			
Roof eave-to-ridge height	≤ 5 ft	1.00	1.00	3
	5 to 10 ft	1.15	1.00	3
	10 to 15 ft	1.30	1.00	3
	15 to 20 ft	1.45	1.00	3
Wall height adjustment	9 ft	0.95	1.00	3
	10 ft	1.00	1.00	3
	11 ft	1.05	1.00	3
	12 ft	1.10	1.00	3

Total reqd. = 10.5' x 1.00 x 1.15 x 1.10 x 1.30 = 17.3' required

Step 3: Compare it!

Required: 17.3' of wall bracing
Actual: 16' of wall bracing



Fails

Quiz Question

What is the min. required length of bracing of BWL 4?

- 1 story
- Wall height = 9'
- Eave-to-ridge = 15'
- Method SFB
- 109 mph wind
- Exposure B

Step 1: Choose it!

TABLE R602.10.3(1)
BRACING REQUIREMENTS BASED ON WIND SPEED

• EXPOSURE CATEGORY B
• 30 FT MEAN ROOF HEIGHT
• 10 FT EAVE TO RIDGE HEIGHT
• 10 FT WALL HEIGHT
• 2 BRACED WALL LINES

Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE*			
			Method LIB ^a	Method GB	Method DWB, WSP, PBS, PCP, PLS, CS, SFB ^b	Methods CS-WSP, CS-G, CS-PP
109	1st	10	5.5	5.5	3.0	3.0
		20	10.0	10.0	6.0	6.0
		30	14.5	14.5	8.5	8.5
		40	19.5	19.5	11.0	11.0
		50	23.0	23.0	13.0	13.0
		60	27.5	27.5	15.5	15.5
110	1st	10	10.5	10.5	6.0	6.0
		20	19.0	19.0	11.0	9.5
		30	27.5	27.5	16.0	13.5
		40	36.0	36.0	20.5	17.5
		50	44.0	44.0	25.5	21.5
		60	52.5	52.5	30.0	26.5
110	2nd	10	NP	15.5	9.0	7.5
		20	NP	28.5	16.5	14.0
		30	NP	41.0	23.5	20.0
		40	NP	53.0	30.5	26.0
		50	NP	65.5	37.5	32.0
		60	NP	77.5	44.5	37.5

Step 2: Adjust it!

Exposure category	One-story structure	B	1.00	All methods
		C	1.20	
		D	1.50	
Two-story structure		B	1.30	
		C	1.60	
		D	1.80	
Three-story structure		B	1.40	
		C	1.70	
		D	2.10	
Roof eave-to-ridge height	Roof only	≤ 3 ft	1.00	
		10 ft	1.20	
		15 ft	1.50	
	Roof + 1 floor	≤ 5 ft	0.85	
		10 ft	1.00	
		15 ft	1.15	
	Roof + 2 floors	≤ 5 ft	0.90	
		10 ft	1.10	
		15 ft	Not Estimated	
Wall height adjustment	Any story	≤ 8 ft	0.95	
		10 ft	1.00	
		11 ft	1.05	
		12 ft	1.10	
Number of braced wall lines (per plan direction) ^c	Any story	2	1.00	
		3	1.45	
		4	1.50	

Total req'd. = 7.25' x 1.00 x 1.30 x 0.95 x 1.45 = 13.0'

Quiz Question

Which one of the following is a true statement about braced wall panels on a BWL?

- a) Maximum spacing is 60'
- b) First panel must be a maximum of 12.5' from end of BWL
- c) Maximum spacing is 25' edge-to-edge
- d) BWLs greater than 16' require at least two braced wall panels

Bracing Methods

Intermittent & Continuous

Bracing Methods Topics

- Bracing
 - BWP methods
 - Portal frame methods
- Mixing methods
- Continuous sheathing
- Interior finishes

Table R602.10.4 Bracing Methods



Continuous

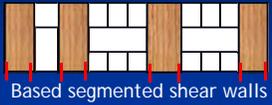


Intermittent

Bracing Method	Minimum Thickness	Minimum Length	Fasteners	Notes
WSP	3/8"	48"	6d @ 6" o.c. edges, 12" field	Wood structural panels
SFB	3/8"	48"	8d @ 3" o.c. edges, 6" field	Structural fiberboard
GB	5/8"	48"	8d @ 6" o.c. edges, 12" field	Gypsum board
PFH	N/A	N/A	N/A	Portal frame with hold-downs
PFG	N/A	N/A	N/A	Portal frame at garage
CS-WSP	3/8"	48"	6d @ 6" o.c. edges, 12" field	Wood structural panels
CS-SFB	3/8"	48"	8d @ 3" o.c. edges, 6" field	Structural fiberboard
CS-G	3/8"	48"	6d @ 6" o.c. edges, 12" field	Wood structural panels adjacent at garage
CS-PF	N/A	N/A	N/A	Wood structural panel portal frame

Table R602.10.4 Bracing Methods

Intermittent:
Sheathing at BWP locations only



Based segmented shear walls

Continuous:
Sheath entire wall, including above and below openings



Based on perforated shear walls

Table R602.10.4 Bracing Methods

Intermittent

- LIB: let-in bracing
- WSP: wood structural panels
- SFB: structural fiber board
- GB: gypsum board
- PFH: portal frame with hold-downs
- PFG: portal frame at garage

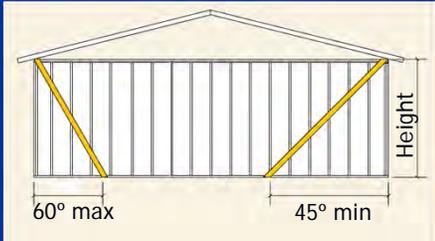
Continuous sheathing

- CS-WSP: wood structural panels
- CS-SFB: structural fiberboard
- CS-G: wood structural panels adjacent at garage
- CS-PF: wood structural panel portal frame



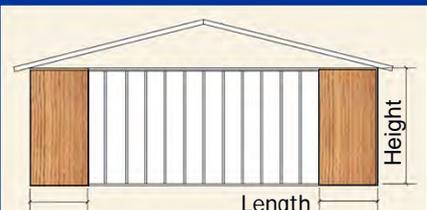

LIB: Let-in Bracing

- 1x4 wood or metal strap
- 45° to 60° angle
- 2-8d nails per stud



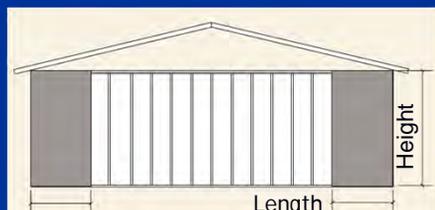
WSP: Wood Structural Panel

- Minimum 3/8" thick OSB or plywood
- Typical fasteners: 6d nails @ 6" o.c. edges, 12" field
- 48" minimum length



SFB: Structural Fiberboard

- 1/2" or 25/32" - stud spacing @ 16" o.c. only
- Typical fasteners: 8d common nails at 3" o.c. edges, 6" field
- 48" minimum length



GB: Gypsum Board

- ½" minimum thickness
- 48" minimum length (double sided)
- Typical fasteners: Type W or S screws
- Fastener spacing: 7" edge/field

PFH

Single Portal Frame

Single portal frame when abutting a continuing wall

Double Portal Frame

Double portal frame when there is no abutting wall continuation

Portal Frames

- Tested assembly
- Cannot be engineered
- Must construct exactly as shown

PFG

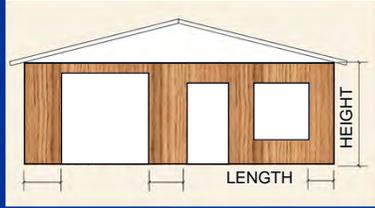
Continuous Sheathing



All surfaces must be sheathed, including above and below windows, doors, gable end walls, etc. for the entire length of the BWL.

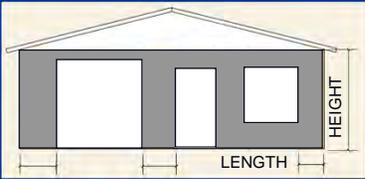
CS-WSP

- Minimum 3/8" thick OSB or plywood
- Typical fasteners: 6d nails @ 6" o.c. edges, 12" o.c. field
- 24" minimum length



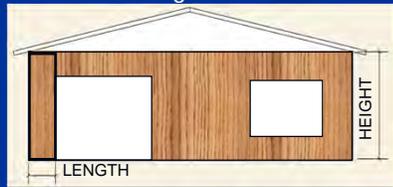
CS-SFB

- 1/2" structural fiberboard
- Typical fasteners: 8d common nails at 3" o.c. edges, 6" field
- 24" minimum length
- Wind speed ≤ 100 mph



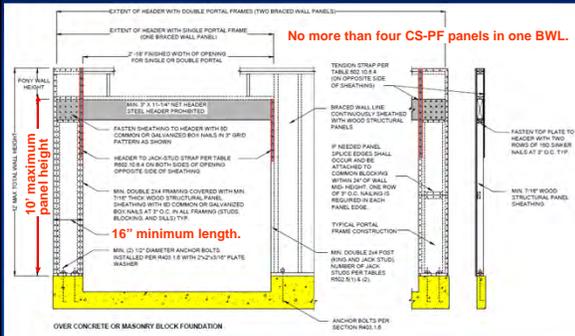
CS-G

- Minimum 3/8" thick OSB or plywood
- Typical fasteners: 6d nails @ 6" o.c. edges, 12" o.c. field
- No floor above; one side of garage only
- 24" minimum length



CS-PF

No more than four CS-PF panels in one BWL.

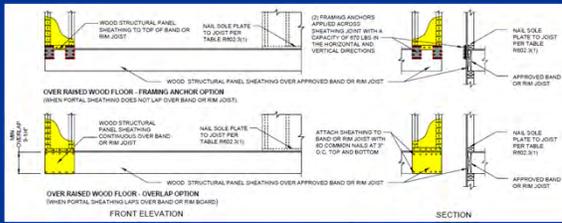


10" maximum panel height

16" minimum length.

CS-PF

Can be constructed on a raised floor.



FRONT ELEVATION SECTION

Pony Walls on Portal Frames

Design capacity of strap and studs

MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (ft)	MAXIMUM TOTAL WALL HEIGHT (ft)	MAXIMUM OPENING WIDTH (ft)	TENSION STRAP CAPACITY REQUIRED (lb ^f)		
				Basic Wind Speed (mph)		
				85	90	100
2x4 No. 2 Grade	0	10	18	1000	1000	1000
			9	1000	1000	1000
			18	1000	1000	1750
	2	10	18	1000	1000	2100
			9	1000	1000	1025
			18	1875	2400	3575
	2	12	18	1500	1875	2075
			9	2000	2500	DR
			18	3175	4000	DR
	4	12	18	2000	2500	DR
			9	4175	DR	DR
			18	1000	1000	1325
2x6 Stud Grade	2	12	18	1650	2050	2625
			9	2025	2450	3425
			18	1125	1500	2225
4	12	18	2550	3150	DR	
		9	3125	3675	DR	
		18	DR	DR	DR	

Mixing Methods R602.10.4.1

Mixing methods from story/story is permitted.

Mixing Methods R602.10.4.1

Mixing methods from BWL/BWL is permitted in wind speeds ≤ 100 mph.

Mixing Methods R602.10.4.1

Mixing intermittent methods on the same BWL is permitted (except townhouses in SDC C).

Design for which ever method which the highest value required bracing.

Mixing Methods R602.10.4.1

Mixing continuous sheathing methods CS-WSP, CS-G and CS-PF on the same BWL is permitted.

CS-PF and CS-G are prohibited with CS-SFB.

Mixing Methods R602.10.4.1

Mixing intermittent and continuous methods on a BWL is permitted:

- BWL both interior and exterior
- Intermittent on interior
- Continuous on exterior

Mixing Methods R602.10.4.1

Mixing intermittent and continuous methods on a BWL is permitted:

- Required bracing per GB
- Continuous portions must have end conditions
- Prohibited in townhouses in SDC C

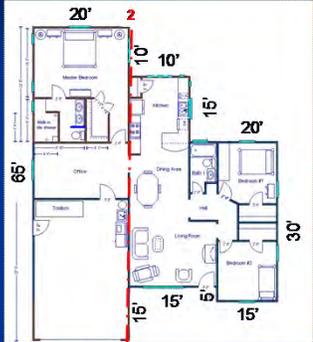


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Mixing Methods R602.10.4.1

Example BWL2:

- Interior portions will be GB.
- Exterior portions will be CS-WSP and CS-PF.



93



Quiz Question

True or False:
A braced wall line may contain panels with Method GB and Method CS-WSP.

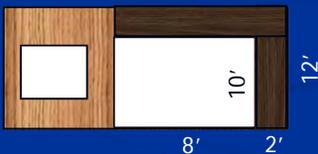
True:
Method CS-WSP can be mixed on the same braced wall line with an intermittent method, typically GB.

95

Quiz Question

Which of the following statements is correct regarding CS-PF?

- a) BWP length is 2'
- b) BWP length is 10'
- c) BWP is required on each side of the opening
- d) 2' pony wall atop a 10' portal frame is prohibited



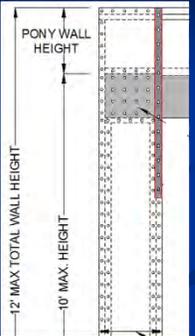
96

Quiz Question

What size studs and tension strap are needed for:

- 10' tall PFH with 3' tall pony wall atop
- 16' long opening.
- Suburban area, 100 mph

- a) 2x4, 4175 lbs
- b) 2x6, 2650 lbs
- c) 2x6, 3150 lbs
- d) Design required (DR)
- e) Not allowed



97

Panel Lengths

Minimum Length and Contribution



98

BWP Length Topics

- Minimum lengths
- Contributing length
- Partial credit



99

Min. Panel Length R602.10.5

The length necessary to be considered a braced wall panel.

METHOD (See Table R602.10.4)	MINIMUM LENGTH OF BRACED WALL PANELS (in)					CONTRIBUTING LENGTH (in)	
	MINIMUM LENGTH ¹						
	Wall Height						
	8 ft	9 ft	10 ft	11 ft	12 ft		
DWG, WSP, SFB, FBS, PSP, WFS	48	48	48	53	58	Actual ²	
GB	48	48	48	53	58	Double sided = Actual Single sided = 0.5 x Actual	
LB	56	62	68	NP ³	NP ³	Actual ²	
ABW	28	32	34	38	42	48	
PFH	Supporting roof only	16	16	16	18	20	48
	Supporting one story and roof	24	24	24	27	29	48
FFG	24	27	30	33	38	1.5 x Actual ²	
CS-G	24	27	30	33	36	Actual ²	
CS-FF	16	16	20	22	24	Actual ²	

Interpolation permitted



100

Min. Panel Length R602.10.5

For CS-WSP and CS-SFB, length is based on height of adjacent opening.

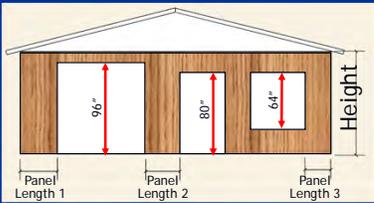
METHOD (See Table R602.10.4)	MINIMUM LENGTH OF BRACED WALL PANELS (in)					CONTRIBUTING LENGTH (in)	
	MINIMUM LENGTH ¹						
	Wall Height						
	8 ft	9 ft	10 ft	11 ft	12 ft		
CS-WSP CS-SFB	Adjacent opening vertical dimension (in)					Actual ²	
	≤ 64	24	27	30	33		36
	68	26	27	30	33		36
	72	27	27	30	33		36
	76	30	29	30	33		36
	80	32	30	30	33		36
	84	35	32	32	33		36
	88	38	35	33	33		36
	92	43	37	35	35		36
	96	48	41	38	36		36
	100	44	40	38	38		36
	104	48	41	40	39		36
	108	54	46	43	41		36
	112	55	46	45	43		36
116	60	52	48	46	36		
120	60	52	48	46	36		
124		56	51				
128		60	54				
132		66	58				
136			62				
140			66				
144			72				



101

Min. Panel Length R602.10.5

For panels between openings of differing heights, the taller opening governs.



102

Min. Panel Length R602.10.5

5'-2" Window = 62"

27" minimum

Adjacent opening vertical dimension (in)	8 ft	9 ft	10 ft	11 ft	12 ft
≤ 64	24	27	30	33	36
68	26	27	30	33	36
72	27	27	30	33	36
76	30	29	30	33	36
80	32	30	30	33	36
84	35	32	32	33	36
88	38	35	33	33	36
92	43	37	35	35	36
96	48	41	38	36	36
100	44	40	38	38	36
104	48	41	40	39	36
108	54	46	43	41	36
112	55	46	45	43	36
116	60	52	48	46	36
120	60	52	48	46	36
124		56	51		
128		60	54		
132		66	58		
136			62		
140			66		
144			72		



103

Min. Panel Length R602.10.5

6'-8" Door = 80"

Adjacent opening vertical dimension (in)	8 ft	9 ft	10 ft	11 ft	12 ft
54	24	27	30	33	36
66	26	27	30	33	36
72	27	27	30	33	36
75	30	30	33	33	36
84	32	30	30	33	36
84	35	32	33	33	36
96	38	35	33	33	36
92	43	37	35	35	36
96	48	41	38	36	36
100	44	40	38	36	36
104	49	43	40	38	36
108	54	46	43	41	
112		50	45	43	
116		55	48	45	
120		60	52	49	
124			56	51	
128			61	54	
132			66	58	
136			69	62	
140				66	
144				72	

30" minimum

Contributing Length R602.10.5.1

The length a panel can contribute towards the minimum required length of bracing.

METHOD (See Table R602.10.4)	MINIMUM LENGTH* (in)					CONTRIBUTING LENGTH (in)	
	Wall Height						
	8 ft	9 ft	10 ft	11 ft	12 ft		
DWG, WSP, SFB, PBS, PCP, HPS	48	48	48	53	58	Actual*	
GB	48	48	48	53	58	Double sided = Actual Single sided = 0.5 x Actual	
LB	55	62	68	NP	NP	Actual*	
ABW	28	32	34	38	42	48	
PFH	Supporting roof only	18	16	16	18*	20*	48
	Supporting one story and roof	24	24	24	27*	29*	48
	PS-G	24	27	30	33*	36*	1.5 x Actual
	CS-G	24	27	30	33	36	Actual*
CS-PF	18	18	20	22*	24*	Actual*	

Partial Credit R602.10.5.2

For intermittent methods: DWB, WSP, SFB, PBS, PCP and HPS.

Actual Length of Braced Wall Panel (in)	Contributing Length of Braced Wall Panel (in) *	
	8 ft Wall Height	9 ft Wall Height
48	48	48
42	36	36
36	27	N/A

Does not apply to continuous methods.

Angled BWPs R602.10.

Only projected length can contribute. Can only apply to one BWL.

NOTE: IF THE DIAGONAL WALL IS GREATER THAN 8 FEET LONG, THEN IT MUST BE TREATED AS A SEPARATE BRACED WALL LINE.

Quiz Question

Using CS-PF, what is the minimum length of the panel shown?

Adjacent opening vertical dimension (in)	8 ft	9 ft	10 ft	11 ft	12 ft
54	24	27	30	33	36
66	26	27	30	33	36
72	27	27	30	33	36
75	30	30	33	33	36
84	32	30	30	33	36
84	35	32	33	33	36
96	38	35	33	33	36
92	43	37	35	35	36
96	48	41	38	36	36
100	44	40	38	36	36
104	49	43	40	38	36
108	54	46	43	41	
112		50	45	43	
116		55	48	45	
120		60	52	49	
124			56	51	
128			61	54	
132			66	58	
136			69	62	
140				66	
144				72	

Options: 16", 18", 20", 22"

Quiz Question

Using continuous sheathing, what is the minimum length of the panel shown?

Adjacent opening vertical dimension (in)	8 ft	9 ft	10 ft	11 ft	12 ft
54	24	27	30	33	36
66	26	27	30	33	36
72	27	27	30	33	36
75	30	30	33	33	36
84	32	30	30	33	36
84	35	32	33	33	36
96	38	35	33	33	36
92	43	37	35	35	36
96	48	41	38	36	36
100	44	40	38	36	36
104	49	43	40	38	36
108	54	46	43	41	
112		50	45	43	
116		55	48	45	
120		60	52	49	
124			56	51	
128			61	54	
132			66	58	
136			69	62	
140				66	
144				72	

Options: 22", 24", 33", 36"

Quiz Question



METHOD (See Table R602.10.4)	MINIMUM LENGTH OF BRACED WALL PANELS					CONTRIBUTING LENGTH (IN)	
	MINIMUM LENGTH * (IN)						
	Wall Height						
	8 ft	9 ft	10 ft	11 ft	12 ft		
DWG, WSP, SFB, PBS, PFP, HPS	48	48	48	53	58	Actual*	
DB	48	48	48	53	58	Double sided - Actual Single sided - 0.5 x Actual	
UB	55	62	69	76	83	Actual*	
ABW	28	32	34	38	42	48	
PFH	Supporting roof only	16	18	18	19	20	48
	Supporting one story and roof	24	24	24	27	29	48
PFC	24	27	30	33	36	0.5 x Actual*	
CS-S	24	27	30	33	36	Actual*	
CS-P	18	18	20	22	24	Actual*	

How much length does an 30" long x 10' tall PFG contribute towards the required wall bracing?

24"
 30"
 45"
 48"

110

Quiz Question



What is the total contributing length of the braced wall panels in **BWL B**?

61"
 75"
 88"
 96"

111

Ends of BWLs with Continuous Sheathing

End Panels and Return Panels



112

Ends of BWLs with Continuous Sheathing Topics

- Return panels
- End panels
- Hold-downs



113

Cont. Sheathing R602.10.7



Table R602.10.7 End Conditions for BWLs with Continuous Sheathing

Return panel: 24" for braced wall lines sheathed with wood structural panels
32" for braced wall lines sheathed with structural fireboard

Distance D: 24" for braced wall lines sheathed with wood structural panels
32" for braced wall lines sheathed with structural fireboard

Hold-down device: This device is attached to the edge of the braced wall panel closest to the corner and to the foundation on each bracing level.

114

Cont. Sheathing R602.10.7



End Condition 1:

Return panel
24" for CS-WSP
32" for CS-SFB

115

Cont. Sheathing R602.10.7

End Condition 2:

NO return panel

END CONDITION 2

BWP at end of the BWL plus 800# hold-down

Cont. Sheathing R602.10.7

End Condition 3:

NO return panel

END CONDITION 3

48" BWP at end of the BWL

Cont. Sheathing R602.10.7

End Condition 4:

Return panel
24" for CS-WSP
32" for CS-SFB

END CONDITION 4

End Panel:
D ≥ 24" for CS-WSP
≥ 32" for CS-SFB

Cont. Sheathing R602.10.7

End Condition 5:

NO return panel

END CONDITION 5

No end panel -
BWP within 10' of the end of the BWL plus 800# h.d.

Quiz Question

Both BWLs are CS-WSP

Where do the 800# hold-downs belong?

A B

C D

A & C A & D

B & C B & D

2' x 5' windows
8' wall height

Quiz Question

A & C

END CONDITION 2

END CONDITION 5

METHOD (See Table N10.1.4)	MINIMUM LENGTH* (ft)				
	16'	18'	20'	24'	30'
CS-W	24	24	24	24	24
CS-F	32	32	32	32	32

Adjustment opening width (inches)

Width	16'	18'	20'	24'	30'
0-12	24	24	24	24	24
12-18	24	24	24	24	24
18-24	24	24	24	24	24
24-30	24	24	24	24	24
30-36	24	24	24	24	24

BWP Connections and Supports

Connecting the Pieces



122

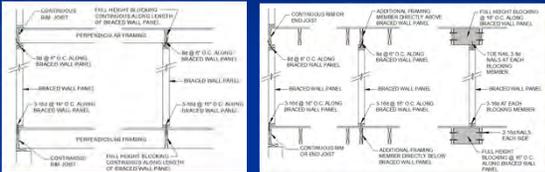
BWP Connections Topics

- Connections to floors
- Connections to roof framing
- Piers
- Stem walls
- Panel joints



123

Perpendicular Connections



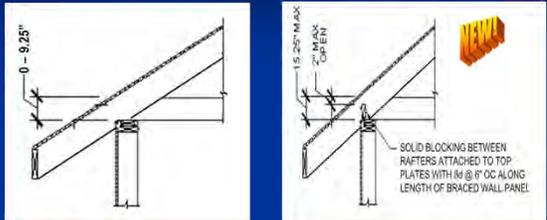
Joists perpendicular to BWPs

Joists parallel to BWPs



124

BWP Connections to Roof R602.10.8.1



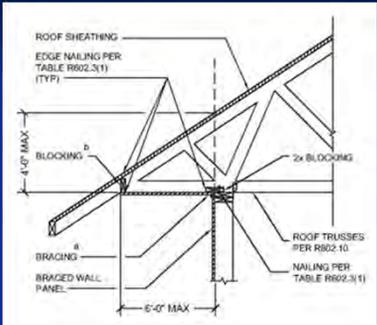
0" - 9.25"
No blocking required

9.25" - 15.25"
2x blocking required



126

BWP Connections to roof R602.10.8.1

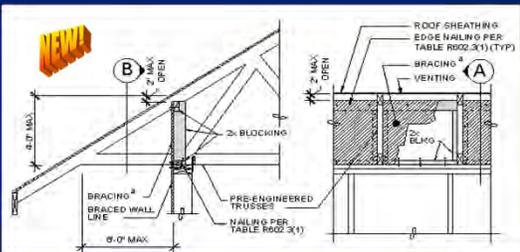


15.25" - 48" : soffit panel OR



127

BWP Connections to roof R602.10.8.1



15.25" - 48" : Vertical blocking panel
Greater than 48" : RDP design required



128

Piers/Posts R602.10.9

Structures supported on piers or posts must be designed by an RDP

129

BWP @ CMU Stem Walls R602.10.9

Short Stem Walls

Tall Stem Walls

130

BWP @ CMU Stem Walls R602.10.9

Threaded Rod Alternate

Typical Cross Section

- Rods may be anchored in footing after concrete is poured.
- Epoxy connection must have a pull-out capacity of 5,000 lbs.

131

BWP Joints R602.10.10

BWPs can be constructed of more than one piece of sheathing:

- Vertical joints at studs.
- Horizontal joints with blocking.
- Edge nailing at all joints.
- Sheathing sheets may also be placed horizontally.

132

Bracing Information R602.10

Building official may require all BWLs, BWPs and hold-downs be identified and located on the plans for each floor

133

Intermittent vs. Continuous

134

Whole House Exercise

137

New Form

Two page work sheet for verifying compliance

138

90 mph, Exp B,

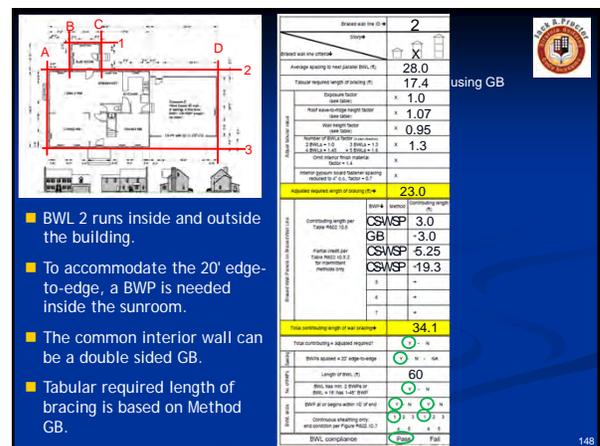
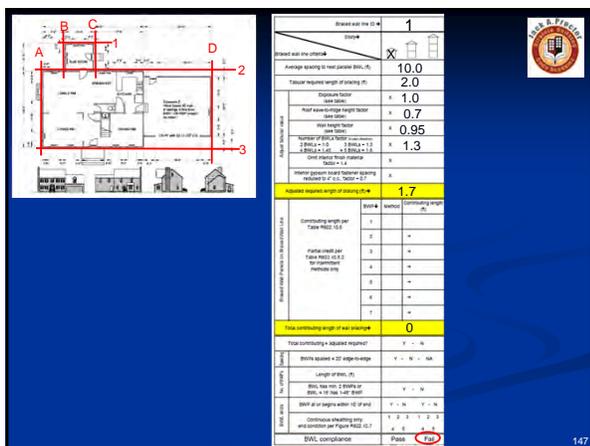
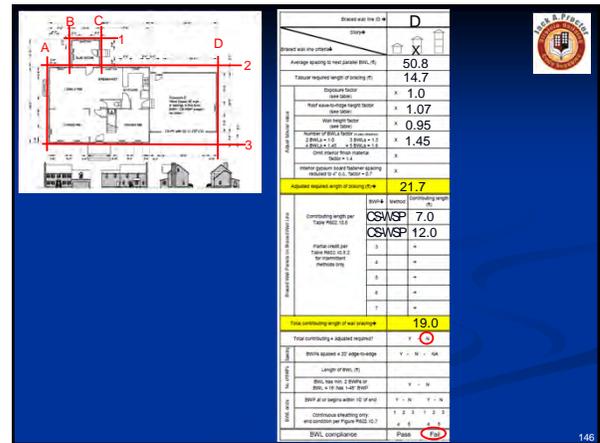
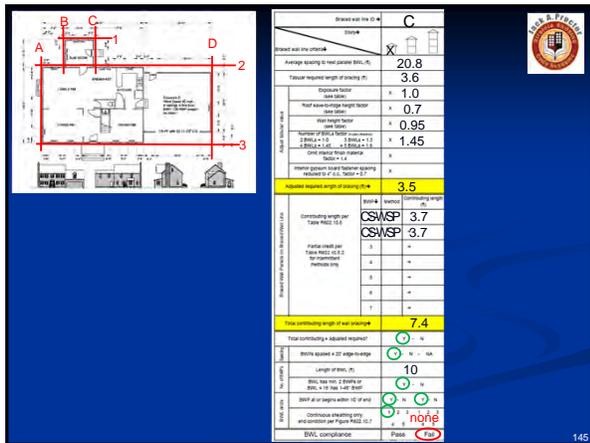
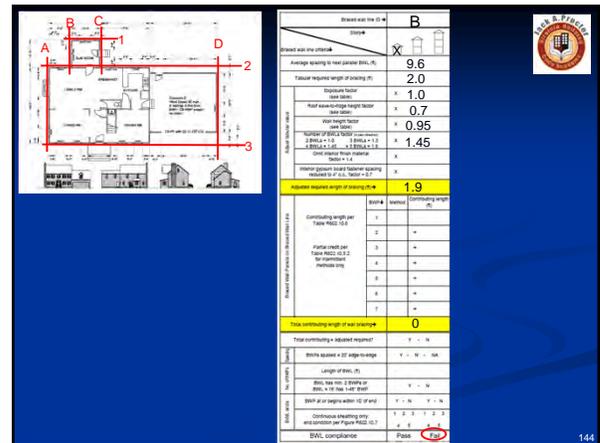
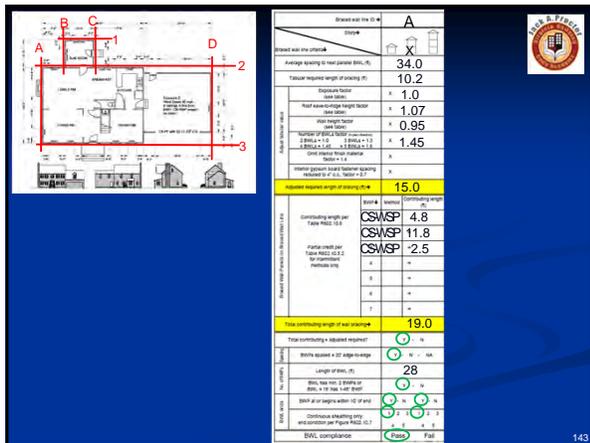
**9' WALL HEIGHT
BRACED WALL METHOD CS-WSP
FLOOR PLAN
Determine if BWL3 complies**

interpolation

**9:12 pitch on 24' wide house
= 9' eave to ridge height
Interpolating table = 0.94**

Exposure B
Wind Speed 90 mph
1/2 Ceilings in first floor
BWL: CS-WSP except
as noted

Exposure B
Wind Speed 90 mph
1/2 Ceilings in first floor
BWL: CS-WSP except
as noted



- BWL 2 runs inside and outside the building.
- To accommodate the 20' edge-to-edge, a BWP is needed inside the sunroom.
- The common interior wall can be a double sided GB.
- Tabular required length of bracing is based on Method GB.

Simplified Wall Bracing

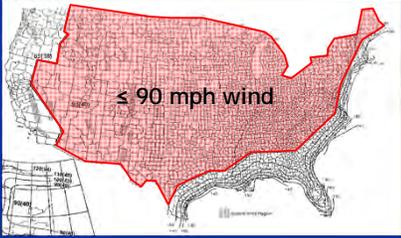
Keep it Simple **NEW!**



2

Goal

Offer the majority of the country an easy approach as a subset of the "classic" method.




4

Simplified Wall Bracing

Cannot mix simplified with classic



Simple houses = simple solutions
Simple solutions = less flexibility



5

Simplified Wall Bracing Topics

- Prerequisites
- Methodology and materials
- Bracing units
- Bracing distribution
- Classic wall bracing carry-overs and comparisons



6

Prerequisites

Minimum Building Conditions



7

Prerequisites R602.12

1. Maximum of 2 stories above a solid foundation or basement.




8

Prerequisites R602.12

2. Floors may not cantilever more than 24" beyond the foundation or bearing wall.



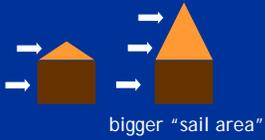
Prerequisites R602.12

3. Wall heights cannot exceed 10'.



Prerequisites R602.12

4. Eave to ridge height cannot exceed 15'.



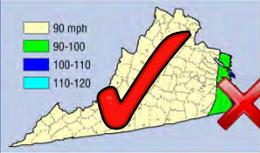
Prerequisites R602.12

5. Gypsum board or equivalent (e.g., wood paneling) on interior side of bracing.



Prerequisites R602.12

6. Wind speed \leq 90 mph - in Exposure B.

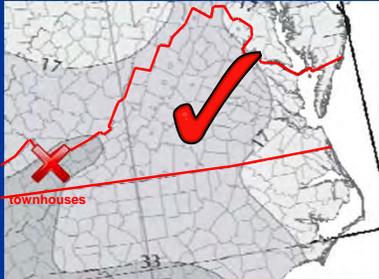


90 mph
90-100
100-110
110-120



Prerequisites R602.12

7. Seismic Design Category A, B or C (no townhouses in SDC C).



Prerequisites R602.12



8. Cripple walls and wood framed walls below the first floor:

- Prohibited in two-story
- Permitted in one-story

Quiz Question

The maximum height of a wall when using Simplified Wall Bracing is:



- 9 feet
- 10 feet
- 12 feet
- 15 feet

Quiz Question

True or False:
An unfinished detached garage can be braced using Simplified Wall Bracing.



False: An unfinished garage cannot be constructed unless there is gypsum board or equivalent on the opposite side of all bracing.

Methodology & Materials

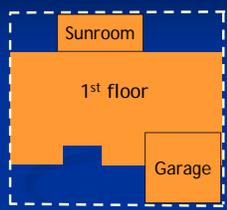
Circumscribed Rectangle

Rectangle Topics R602.12.1

- Circumscribed rectangle
- Projections
- Open structures
- Size of the circumscribed rectangle

Circumscribed Rectangle R602.12.1

Draw a rectangle around the outside of the structure.



Circumscribe around all offsets and projections, including sunrooms and attached garages.

Circumscribed Rectangle R602.12.1

Don't include...

- Open structures: porches, decks, carports
- Chimneys

21

Circumscribed Rectangle R602.12.1

Rectangles may be different for each floor.

22

Circumscribed Rectangle R602.12.1

Rectangle can also apply to a new addition to an existing house.

23

Circumscribed Rectangle R602.12.1

Maximum length of either side of the rectangle is 60'.

24

Circumscribed Rectangle R602.12.1

Maximum ratio:
 $\frac{\text{long side}}{\text{short side}} = 3:1$

25

Circumscribed Rectangle R602.12.1

Example: 50' x 38'

26

Sheathing Materials R602.12.2



Min. $\frac{3}{8}$ " OSB or plywood

Min. $\frac{1}{2}$ " structural fiberboard

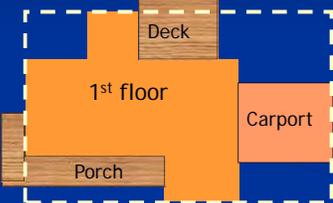
Sheathing Materials R602.12.2

Cannot mix OSB and structural fiberboard on the same house.



Quiz Question

True or False: The circumscribed rectangle below is correctly drawn.



False: Open structures, such as carports are not included in the circumscribed rectangle

Quiz Question

Which is not a bracing material for Simplified Wall Bracing?

- Structural fiberboard
- Plywood
- OSB
- Gypsum board

Bracing Units

3' or 4'

Bracing Units R602.12.3

A "Bracing Unit" (BU) must be:

- Full height sheathing without openings
- No vertical or horizontal offsets



Bracing Units R602.12.3

BU length depends on application:

	Fully sheathed (3' BUs)	Intermittent (4' BUs)
OSB		
SFB		

33

Bracing Units R602.12.3

No mixing of materials or applications

	Fully sheathed (3 BUs)	Intermittent (4' BUs)
OSB		
SFB		

34

Multiple Bracing Units R602.12.3.1

Multiple bracing units:

- Wall panel lengths longer than the minimum length - full credit
- Wall panel lengths less than the minimum length - no credit

35

Multiple Bracing Units R602.12.3.1

Wall panel lengths longer than the minimum length - full credit

B.U. = Actual length ÷ 3' (or 4')

Section 1
 $13' \div 3' = 4.33$ BU

Section 2:
 $2.5' \div 3' < 1.00$
 Therefore = 0 BU

36

Multiple Bracing Units R602.12.3.1

Actual total number of BUs

1 BU + 1.3 BU + 2 BU + 1.8 BU

Actual BUs = 6.1

Calculate each side of the rectangle independently

37

Required Number of BUs R602.12.4

Length of long side defines the # BUs on the short sides and vice versa

Bigger sail area of long side

More wall bracing required on short side

38

Required Number of BUs R602.12.4

Tabular value of **required BUs**:

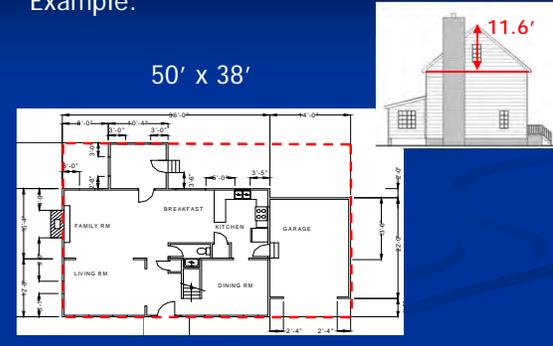
- Number applies to each side of rectangle
- Round rectangle size up to next unit of 10'
- No interpolation allowed

STORY LEVEL	EAVE-TO-RIDGE HEIGHT (FEET)	MINIMUM NUMBER OF BRACING UNITS ON EACH LONG SIDE ^{R602.12.4.1}										MINIMUM NUMBER OF BRACING UNITS ON EACH SHORT SIDE ^{R602.12.4.2}									
		Length of short side (ft)					Length of long side (ft)					Length of short side (ft)					Length of long side (ft)				
		10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60		
1	10	1	2	2	2	3	3	1	2	2	2	3	3	1	2	2	2	3	3		
	15	1	2	3	3	4	4	1	2	3	3	4	4	1	2	3	3	4	4		
2	10	2	3	3	4	5	6	2	3	3	4	5	6	2	3	4	4	5	6		
	15	2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7		

39

Required Number of BUs R602.12.4

Example:



40

Required Number of BUs R602.12.4

Rectangle: 50'x38'

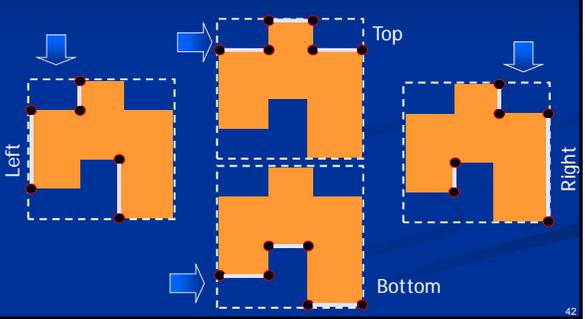
STORY LEVEL	EAVE-TO-RIDGE HEIGHT (FEET)	MINIMUM NUMBER OF BRACING UNITS ON EACH LONG SIDE ^{R602.12.4.1}										MINIMUM NUMBER OF BRACING UNITS ON EACH SHORT SIDE ^{R602.12.4.2}									
		Length of short side (ft)					Length of long side (ft)					Length of short side (ft)					Length of long side (ft)				
		10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60		
1	10	1	2	2	2	3	3	1	2	2	2	3	3	1	2	2	2	3	3		
	15	1	2	3	3	4	4	1	2	3	3	4	4	1	2	3	3	4	4		
2	10	2	3	3	4	5	6	2	3	3	4	5	6	2	3	4	4	5	6		
	15	2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7		

5 BUs on each long side,
6 BUs on each short sides

41

Required Number of BUs R602.12.4

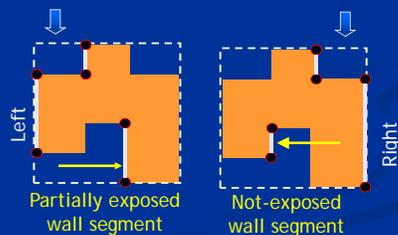
Facing side of the rectangle



42

Required Number of BUs R602.12.4

'Partially exposed' and 'not-exposed' wall segments may also apply to a side of the rectangle



43

Special Wall Construction

CS-PF, PFH, PFG, CS-G

44

CS-PF, Figure R602.10.6.2

Special wall construction: CS-PF

- Contributes 0.5 BU per panel
- Permitted only when fully sheathing

45

PFH, Figure R602.10.6.2

Special wall construction: PFH

- Contributes 1.0 BU per panel
- Permitted in all sheathing applications

46

PFG, Figure R602.10.6.3

Special wall construction: PFG

- Contributes 0.75 BU per panel
- Permitted in all sheathing applications

47

CS-G, Table R602.10.4

Special wall construction: CS-G

- Contributes 0.5 BU per panel
- Permitted only when sheathing is placed over entire structure

48

Quiz Question

How many bracing units are on the first floor front wall of the house below?

- 2.5
- 4.33
- 5.33
- 6.67

$1 + 1.66 + 0 + 0 + 1.66 + 1 = 5.33'$

49

Quiz Question

How many bracing units are required on the long side of the rectangle below?

First of two-story with 15' eave-to-ridge height

- 4
- 5
- 6
- 7

50

TABLE R602.12.4
MINIMUM NUMBER OF BRACING UNITS ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE

STORY LEVEL	EAVE-TO-RIDGE HEIGHT (FEET)	MINIMUM NUMBER OF BRACING UNITS ON EACH LONG SIDE ^{1,2}						MINIMUM NUMBER OF BRACING UNITS ON EACH SHORT SIDE ^{3,4}					
		Length of short side (ft)						Length of long side (ft)					
		10	20	30	40	50	60	10	20	30	40	50	60
1	10	1	2	2	2	3	3	1	2	2	2	3	3
		2	3	3	4	5	6	2	3	3	4	5	6
2	10	1	2	3	3	4	4	1	2	3	3	4	4
		2	3	4	5	6	7	2	3	4	5	6	7

First of two-story with 15' eave-to-ridge height

4
 5
 6
 7

Quiz Question

Match the portal frame with the number of equivalent bracing units.

PFH \longleftrightarrow 1.0
 PFG \longleftrightarrow 0.5
 CS-PF \longleftrightarrow 0.75

Bracing Unit Distribution

Three Rules

Distribution Rules R602.12.5

1. BU shall be placed on the perimeter of the building and begin within 12' of all wall corners.

No bracing on the inside of the house!!!

Distribution Rules R602.12.5

2. BUs shall be $\leq 20'$ apart edge to edge.

Distribution Rules R602.12.5

3. Wall segments $> 8'$ long must have at least one BU.

Conversely, wall segments $\leq 8'$ long do not require a BU.

Quiz Question

True or False:
A wall with a length of 8 feet is permitted to have no bracing units.

True

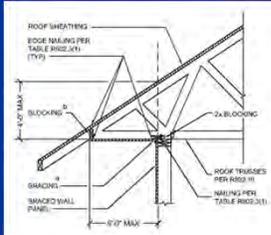


-8'

“Classic Wall Bracing” Carry-overs and Comparison

Classic Wall Bracing Carry-overs

- Bracing connections at roof construction.
- Masonry stem wall reinforcement.



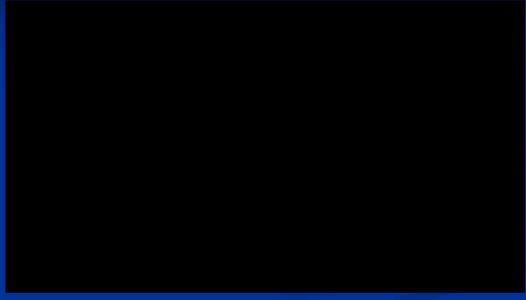

Comparison

Criteria	Classic Wall Bracing	Simplified Wall Bracing
Wind	< 110 mph	≤ 90 mph
Methodology	Braced wall lines	Circumscribed rectangle
Required bracing	Minimum length of bracing (feet)	Minimum number of bracing units
Methods and materials	8 materials, 14 methods (4 narrow)	2 materials, 4 classic narrow methods
Maximum size house	Unlimited	60' x 60'
Corner/End of BWL CS/fully sheathed	Return panel or 800 lb hold-down	None
Maximum wall ht	12'	10'

Break



Nailing Precision



Prerequisites

- Max 2 story ✓/N
- Full height - 10' ✓/N
- Clear height - 10' ✓/N
- Clear to ridge - 10' ✓/N
- 10' on top of B.U.s ✓/N
- Wind - 50 mph ✓/N
- Exposure B ✓/N
- ICC A.B.C. ✓/N
- Clipped walls ✓/N
- Use story building ✓/N
- Use story building ✓/N
- Permeability Pass ✓/N

Circumscribed Rectangle

Long Side: 60'
Short Side: 38'
Ratio of long side to short side: 1.6 +0.3 ✓

Required B.U.

Story Level	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1st	1	2	3	4	5	6	7	8	9	10
2nd	1	2	3	4	5	6	7	8	9	10
3rd	1	2	3	4	5	6	7	8	9	10
4th	1	2	3	4	5	6	7	8	9	10
5th	1	2	3	4	5	6	7	8	9	10
6th	1	2	3	4	5	6	7	8	9	10
7th	1	2	3	4	5	6	7	8	9	10
8th	1	2	3	4	5	6	7	8	9	10
9th	1	2	3	4	5	6	7	8	9	10
10th	1	2	3	4	5	6	7	8	9	10

Actual Wall Segments

Method	Long Side 1	Long Side 2	Short Side A	Short Side B
1 Fully equivalent = 1 B.U.	3.0' 1.0'	3.0' 1.0'	3.0' 1.0'	3.0' 1.0'
2 Fully equivalent = 1 B.U.	5.3' 1.8'	4.0' 1.3'	4.8' 1.6'	3.7' 1.2'
Method B.U. equivalents	3.5' 1.2'	3.0' 1.0'	3.0' 1.0'	12.0' 4.0'
PPG = +0.75 B.U.	19.3' 6.4'	CSFP 0.5	CSFP 0.5	7.0' 2.3'
CS.G. = +0.5 B.U.				4.0' 1.3'
CS.PP. = +0.5 B.U.				4.0' 1.3'
Total actual B.U.s provided	10.4	5.6	5.6	10.1
Actual B.U.s / Required B.U.s	✓/N	✓/N	✓/N	✓/N

Distribution

Walls off base at least 1 B.U.	Long Side 1	Long Side 2	Short Side A	Short Side B
Walls off base at least 1 B.U.	Y	N	Y	N
B.U. within 12' of each corner	N	Y	N	Y
B.U. within 20' edge to edge	N	N	Y	N
PASS / FAIL	PASS	FAIL	PASS	FAIL

Prerequisites

- Max 2 story ✓/N
- Full height - 10' ✓/N
- Clear height - 10' ✓/N
- Clear to ridge - 10' ✓/N
- 10' on top of B.U.s ✓/N
- Wind - 50 mph ✓/N
- Exposure B ✓/N
- ICC A.B.C. ✓/N
- Clipped walls ✓/N
- Use story building ✓/N
- Use story building ✓/N
- Permeability Pass ✓/N

Circumscribed Rectangle

Long Side: 60'
Short Side: 38'
Ratio of long side to short side: 1.6 +0.3 ✓

Required B.U.

Story Level	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1st	1	2	3	4	5	6	7	8	9	10
2nd	1	2	3	4	5	6	7	8	9	10
3rd	1	2	3	4	5	6	7	8	9	10
4th	1	2	3	4	5	6	7	8	9	10
5th	1	2	3	4	5	6	7	8	9	10
6th	1	2	3	4	5	6	7	8	9	10
7th	1	2	3	4	5	6	7	8	9	10
8th	1	2	3	4	5	6	7	8	9	10
9th	1	2	3	4	5	6	7	8	9	10
10th	1	2	3	4	5	6	7	8	9	10

Actual Wall Segments

Method	Long Side 1	Long Side 2	Short Side A	Short Side B
1 Fully equivalent = 1 B.U.	3.0' 1.0'	3.0' 1.0'	3.0' 1.0'	3.0' 1.0'
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Method B.U. equivalents	3.5' 1.2'	3.0' 1.0'	3.0' 1.0'	12.0' 4.0'
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Total actual B.U.s provided	10.4	5.6	5.6	10.1
Actual B.U.s / Required B.U.s	✓/N	✓/N	✓/N	✓/N

Distribution

Walls off base at least 1 B.U.	Long Side 1	Long Side 2	Short Side A	Short Side B
Walls off base at least 1 B.U.	Y	N	Y	N
B.U. within 12' of each corner	N	Y	N	Y
B.U. within 20' edge to edge	N	N	Y	N
PASS / FAIL	PASS	FAIL	PASS	FAIL

Prerequisites

- Max 2 story ✓/N
- Full height - 10' ✓/N
- Clear height - 10' ✓/N
- Clear to ridge - 10' ✓/N
- 10' on top of B.U.s ✓/N
- Wind - 50 mph ✓/N
- Exposure B ✓/N
- ICC A.B.C. ✓/N
- Clipped walls ✓/N
- Use story building ✓/N
- Use story building ✓/N
- Permeability Pass ✓/N

Circumscribed Rectangle

Long Side: 60'
Short Side: 38'
Ratio of long side to short side: 1.6 +0.3 ✓

Required B.U.

Story Level	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1st	1	2	3	4	5	6	7	8	9	10
2nd	1	2	3	4	5	6	7	8	9	10
3rd	1	2	3	4	5	6	7	8	9	10
4th	1	2	3	4	5	6	7	8	9	10
5th	1	2	3	4	5	6	7	8	9	10
6th	1	2	3	4	5	6	7	8	9	10
7th	1	2	3	4	5	6	7	8	9	10
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Total actual B.U.s provided	10.4	5.6	5.6	10.1
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Distribution

Walls off base at least 1 B.U.	Long Side 1	Long Side 2	Short Side A	Short Side B
Walls off base at least 1 B.U.	Y	N	Y	N
B.U. within 12' of each corner	N	Y	N	Y
B.U. within 20' edge to edge	N	N	Y	N
PASS / FAIL	PASS	FAIL	PASS	FAIL

Prerequisites

- Max 2 story ✓/N
- Full height - 10' ✓/N
- Clear height - 10' ✓/N
- Clear to ridge - 10' ✓/N
- 10' on top of B.U.s ✓/N
- Wind - 50 mph ✓/N
- Exposure B ✓/N
- ICC A.B.C. ✓/N
- Clipped walls ✓/N
- Use story building ✓/N
- Use story building ✓/N
- Permeability Pass ✓/N

Circumscribed Rectangle

Long Side: 60'
Short Side: 38'
Ratio of long side to short side: 1.6 +0.3 ✓

Required B.U.

Story Level	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1st	1	2	3	4	5	6	7	8	9	10
2nd	1	2	3	4	5	6	7	8	9	10
3rd	1	2	3	4	5	6	7	8	9	10
4th	1	2	3	4	5	6	7	8	9	10
5th	1	2	3	4	5	6	7	8	9	10
6th	1	2	3	4	5	6	7	8	9	10
7th	1	2	3	4	5	6	7	8	9	10
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Distribution

Walls off base at least 1 B.U.	Long Side 1	Long Side 2	Short Side A	Short Side B
Walls off base at least 1 B.U.	Y	N	Y	N
B.U. within 12' of each corner	N	Y	N	Y
B.U. within 20' edge to edge	N	N	Y	N
PASS / FAIL	PASS	FAIL	PASS	FAIL

Compare Classic and Simplified

Required by Classic Method

- Back = 14.8'
- Front = 12'
- Left = 19.7'
- Right = 29.1'

Required by Simplified Method

- Back: 5x3' = 15'
- Front: 5x3' = 15'
- Left: 7x3' = 21'
- Right: 7x3' = 21'

In Summary

You have "options"

R U smarter than a 5th grader??

Celebrity Version

5 th	Nuclear physics
4 th	Calculus
3 rd	Foreign languages
2 nd	Aritmetic
1 st	Measurements

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R U smarter than a 5th grader??

1st grade measurements

Using the simplified method:
a bracing unit must begin within

5', 10', 12', 12.5'
of a wall corner?

I am on a drug called "Charlie"... why do I care about this?



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R U smarter than a 5th grader??

1st grade measurements

Using the simplified method:
a bracing unit must begin within

5', 10', 12', 12.5'
of a wall corner?

12'



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R U smarter than a 5th grader??

2nd grade Aritmatic

If I am using OSB everywhere and have three sheathed wall segments:
(1) 30" + (1) 36" + (1) 72"

How many BUs credits?

Why do I get all of the tough questions?



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R U smarter than a 5th grader??

2nd grade Aritmatic

If I am using OSB everywhere and have three sheathed wall segments:
(1) 30" + (1) 36" + (1) 72"

How many BUs credits?

3 B.U.s is my final answer



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R U smarter than a 5th grader??

3rd grade foreign language

Which is not a simplified bracing material?

- Structural fiberboard
- Plywood
- Gypsum board
- OSB

This game ROCKS



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R U smarter than a 5th grader??

3rd grade foreign language

Which is not a simplified bracing material?

- Structural fiberboard
- Plywood
- Gypsum board
- OSB

Gypsum board - and blue suede shoes



R U smarter than a 5th grader??

4th grade Calculus

Using the simplified method, which rectangle works?

40' x 10'

60' x 20'

66' x 22'

Ohh Kermy!! I need your help!



R U smarter than a 5th grader??

60x20

Isn't Kermy wonderful!!

5th grade Calculus

Using the simplified method, which rectangle works?

40' x 10'

60' x 20'

66' x 22'



R U smarter than a 5th grader??

5th grade Nuclear Physics

If a 30' long house is intermittently sheathed with OSB, and

- one side has (3) 4' BUs
- and the other side has (4) 3' BUs

Will it provide the required bracing? Yes? or No?

If $E = mc^2$



R U smarter than a 5th grader??

5th grade Nuclear Physics

If a 30' long house is intermittently sheathed with OSB, and

- one side has (3) 4' BUs
- and the other side has (4) 3' BUs

Will it provide the required bracing? Yes? or No?

No! No! No! You can't mix 3' and 4' systems



R U smarter than a 5th grader??

Final exam question

The best reason to use the simplified method is:

- No more 800# h.d.
- No more return corners
- No more BWLs
- All of the above

You want the hold-downs? You can't handle the hold-downs!



R U smarter than a 5th grader??

Final exam question

The best reason to use the simplified method is:

- No more 800# h.d.
- No more return corners
- No more BWLs
- All of the above

All of the above and a lot more good reasons!



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Don't be overwhelmed



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That's All Folks



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