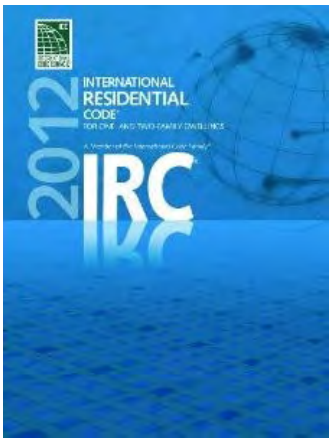
Wall Bracing Made Easy



TECHNICAL TRAINING

Participant Manual

About the author, Charles (Chuck) Bajnai:

Chuck has worked for Chesterfield County, VA since 2001as a residential plan reviewer. He has held these positions at the ICC and state levels:

- Chief Residential Plan Reviewer for Chesterfield County
- Past chairman of the ICC Ad Hoc Committee for Wall Bracing (AHWB)
- Past chairman of the ICC Building Code Action Committee (BCAC)
- Past member of ICC Educational Development Committee
- Past chairman of the Deck Code Coalition
- Past co-chairman of the VBCOA –IRC Committee
- Voting member of ACI 332 committee

Chuck is a graduate of The University of Michigan, 1969 BSME, 1976 BA-Architecture, 1977 MA-Architecture and is a licensed architect, Michigan and registered architect, Virginia.

Special thanks to **Brian Foley**, Building Official, Fairfax County, VA and member of the Ad Hoc Wall Bracing Committee. We arm wrestled writing every word in R602.10 and R602.12. We have taught this class approximately eighty times in four different states and his

Special thanks to **Bill Dupler, Rick Witt and Ron Clements**, my supervisors in Chesterfield County who have allowed me to pursue this opportunity and take time away from my daily responsibilities to share this class with thousands of others.

I also wish to thank the following organizations for their continued support:

- Virginia Building Code Officials Association (VBCOA)
- Virginia Department of Housing and Community Development (DHCD)

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Chief Residential Plan Reviewer

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WELCOME TO WALL BRACING (WB) CLASS

Introduction

The 2012 International Residential Code (IRC) sets requirements related to construction of one- and two-family dwellings and townhouses, three stories or less in height. This manual addresses provisions in the IRC, Chapter R602.10 and R602.12 from the wind perspective. It does not cover seismic requirements.

Since there were only minor changes to wall bracing in the 2015 IRC and 2018 IRC, this training book also applies for these code editions as well.

Class Objective

At the completion of this training class, the participant will be able to perform a wall bracing analysis to determine if the structure is code compliant.

Target Audience

- Residential plan reviewers and inspectors,
- Registered Design Professionals: architects and engineers,
- Contractors and plan preparers.

Design of the Training Manual

This training manual is designed to walk the student through IRC, Section R602 and explain the processes and procedures that are required to show compliance with the enforcement of the wall bracing provisions. It has been prepared to provide a "follow-along" guide for the wall bracing class:

- The relevant material from section R602.10 – *classical*, and R602.12 *simplified* wall bracing,
- Work sheets for both the *classical* and *simplified* wall bracing methods,
- Space for your notes,
- All of the skill checks to test your comprehension,
- Important code tables.

This class is not designed to necessarily prepare you for the residential plan review certification exam, but it should provide you with the knowledge and skills to successfully answer questions regarding wall bracing.

Icons used in training manual

This icon requests you to complete the appropriate line number on the work sheet for CLASS EXAMPLE #1.

This icon indicates where you will complete CLASS EXAMPLE#2

Key concept. Particular attention should be paid to understand this idea.

This icon indicates a *skill check* question based on the information provided in class.

Wall bracing pre-test

1. What does "LIB" mean? _____
2. What is the maximum length of a house that is allowed per the wall bracing section of the code? _____(feet) x _____(feet)
3. What does "CS" (as in CS-WSP) mean?
   _____
4. In your area, wall bracing is a function of which lateral load(s)?
   Wind loads, Seismic loads, Both, Depends (circle all that apply)
5. What is the maximum stud height allowed in the wall bracing section of the code? _____(feet)

Answers to these questions should be addressed throughout the class. Check yourself.

MODULE 1: BASIC ENGINEERING PRINCIPLES

- Design trends
- Load path
- Optional methods of analysis

DESIGN TRENDS

Since the 1960s, there have been numerous design trends which have influenced the International Residential Code (IRC), and have required it to evolve from a "pocket code" to a book which is as voluminous as the International Building Code (IBC).

- Ranch style houses 1500 sqft (1960s)
- Bi and tri level houses 2500 sqft (1970-1990s)
- Mega-mansions 9000 sqft (2000s)

Besides the fact that houses are larger, several layout concepts have made houses more appealing:

- Open concept,
- High ceilings.
- Two- story great rooms and foyers,
- Natural light, more windows.

Materials continually come to the market place. They provide new options for the builder, but each new material challenges the building code to keep pace:

- Narrow portal frames,
- Energy saving sheathing,
- New hardware,
- Other _____.

LOAD PATH

Load path is defined as "the route a load takes from where it is applied, through the various structural members, all the way to the ground."

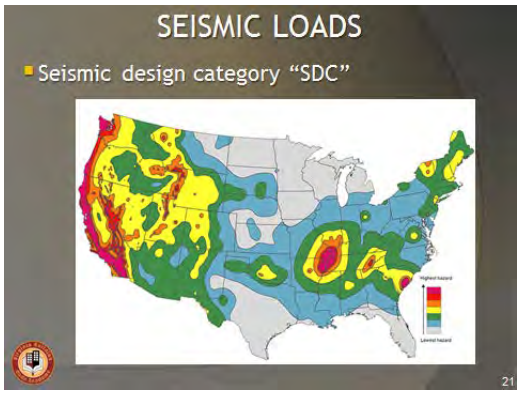
Most of the time when talking of load path, we think of vertical load path – how gravity loads are brought down to the ground. There are *dead loads*, such as the materials in house construction, and *live loads*, such as snow load and occupant loads that have to find resolution through the house all the way to the ground.

Similarly there are horizontal loads which must also be transferred to the ground. Horizontal loads might include:

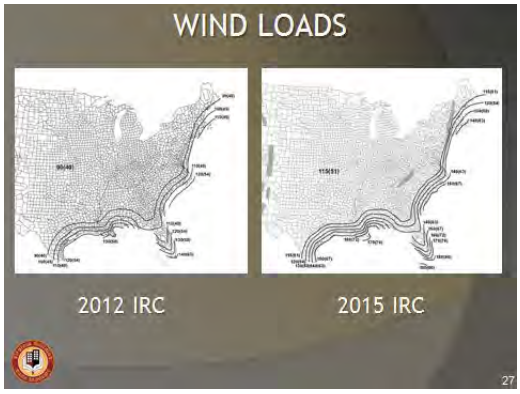
- Wind
- Seismic
- Floods

Seismic Design Category (SDC)

1. Everyday there are seismic events happening across the globe. Most are small tremors with little or no consequence.
2. The largest recorded earthquake had a magnitude of 9.5, on May 22, 1960 near Valdivia in southern Chile.
3. The larges recorded earthquake in the United States was a 9.2 on March 28, 1964 in Alaska.



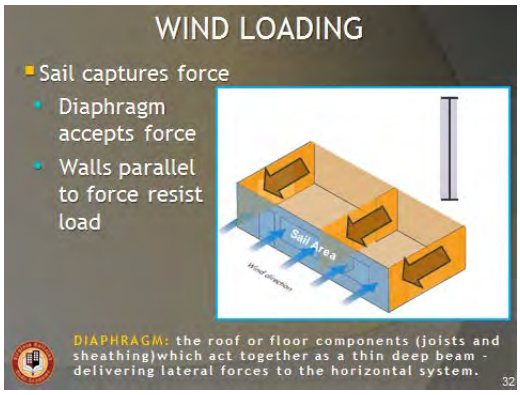
Wind



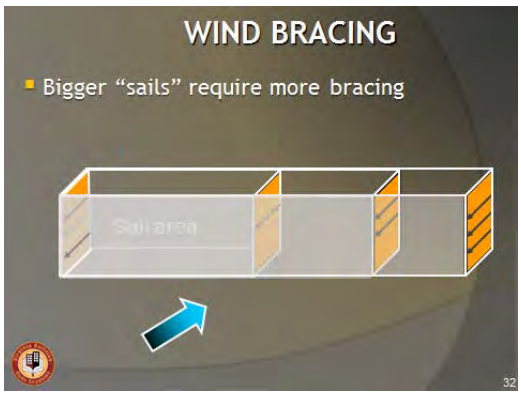
1. ASCE-7 is modifying the wind maps between 2012 and 2015.
2. The highest wind speed ever recorded on earth was in 1996 at an unmanned weather station on Barrow Island, Australia at 253 mph.
3. The highest recorded wind speed in the United States was 231 mph on April 12, 1934 at the Mount Washington Observatory in New Hampshire.

Horizontal wind loads are transferred from

- The receiving wall (perpendicular to the wind)
- To the roof and floor diaphragms
- To the side walls (parallel to the wind)
- To the foundation
- To the ground.



WALLS PARALLEL TO THE WIND,
RESIST THE WIND.

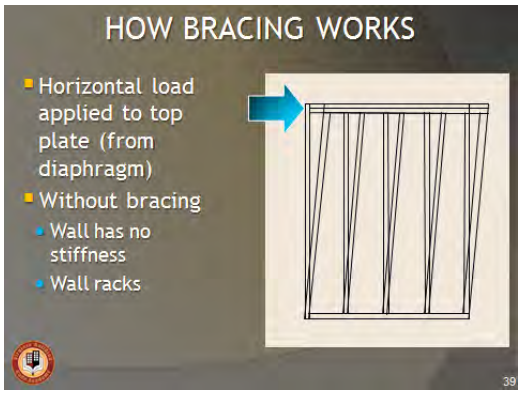


The bigger the sail area, the more bracing that will be required.

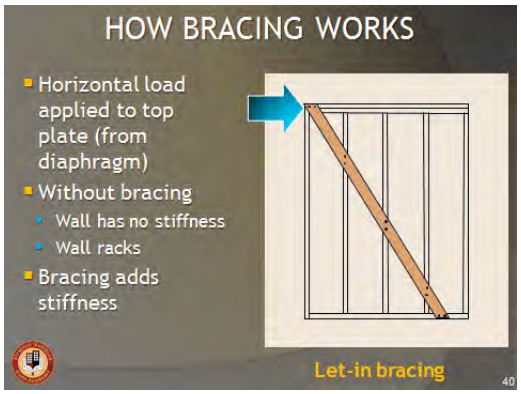
Wind loads accumulate from the top of the structure to the bottom of the structure. The roof has only a fraction of the load on it compared to the first floor diaphragm or the foundation wall where the entire load has to be restrained.

Wall Bracing

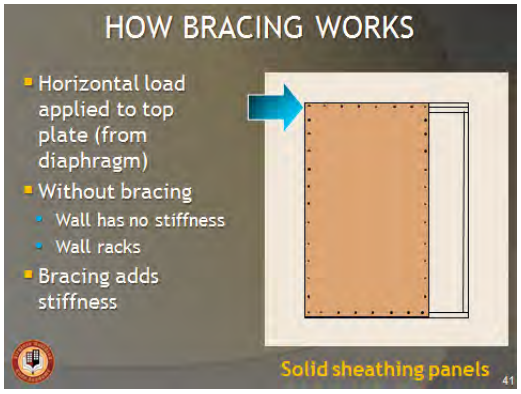
Wall bracing is intended to resist racking.
As little as 3/8" of racking can make doors stick.



Diagonal braces (let in braces) nailed to each stud transfer the lateral load from the top diaphragm to the bottom diaphragm.

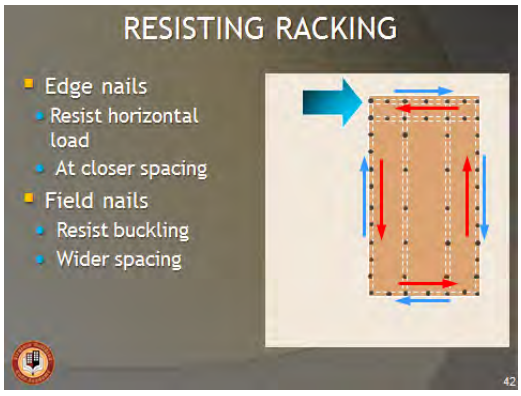


Panel sheathing also can transfer lateral loads between the top plate(s) to the bottom plate.



The edge nails around the sheathing do all the work. The lateral force imposed by the wind or earthquake is resisted by the shear strength of the nails against the sheathing. The nails farthest from the centroid do more work than the closer nails.

The field nails are to resist buckling.



SKILL CHECK 1.1

Which design trend does not influence wall bracing?

1. Coffered ceilings
2. Two-story walls
3. Windows / natural light
4. Open concept

SKILL CHECK 1.2

True or false:

A <u>load path</u> is the direction a load travels

- From where it is applied
- All the way down to the floor.

SKILL CHECK 1.3

Match columns:

Sidewall	Delivers the load to the side walls
Receiving wall (sail)	Delivers the load to the ground
Diaphragm	Resists wind forces
Foundation	Captures wind loads

SKILL CHECK 1.4

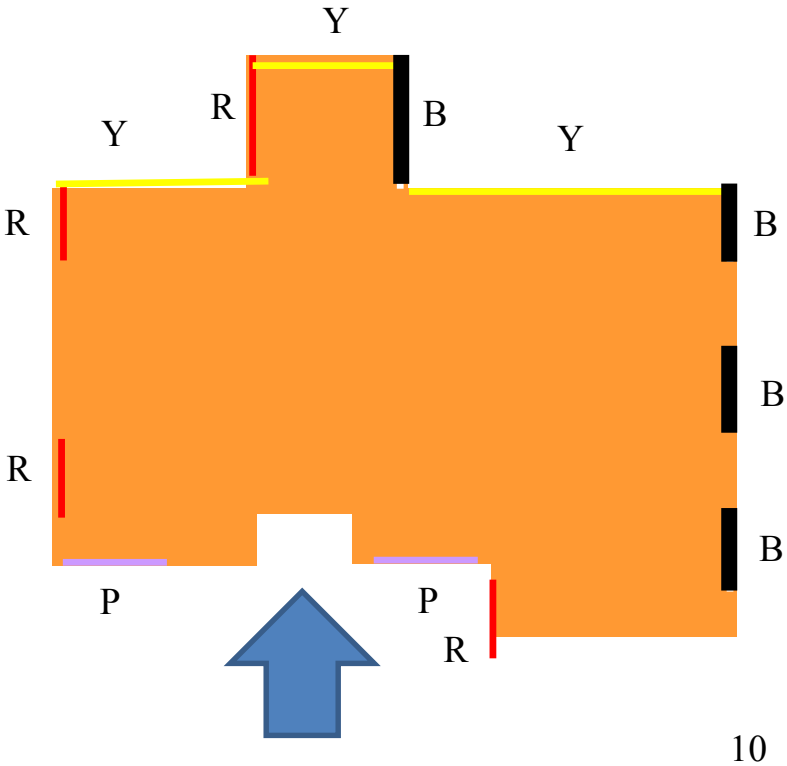
The biggest lateral loads will be seen at:

1. The top floor
2. The second floor
3. The garage level floor.

SKILL CHECK 1.5

Which walls resist the wind load shown?

1. Red (R)
2. Black (B)
3. Purple (P)
4. Yellow (Y)
5. Purple and yellow
6. Red and black



BRACING OPTIONS

There are three main categories of bracing solutions which we will discuss:

- Prescriptive solutions from the I-codes
- Alternative "standards" as acknowledged in the I-codes
- Engineered products.

Prescriptive solutions

The IRC provides prescriptive language for assuring adequate wall bracing intended for:

- New dwellings
- Townhouses
- Additions
- Conversions

The wall bracing limitations in IRC, Section R602.10 include:

- Wood frame construction
- Maximum wind speed of 110 mph
- Seismic Design Category A-D_2
- Wall height limit of 12'
- Roof height from the eave to the ridge of 20'.

If you are outside the limitations of the IRC, the IBC Chapter 23 – WOOD offers both engineered methodologies and prescriptive solutions similar to the IRC.

The genesis of "wall bracing" comes from the IBC. The performance-based IBC requires "shear walls" to be designed by engineers. The equivalent in the prescriptive IRC is what we call "braced walls". *When you hear "shear walls" think IBC; when you hear "braced walls" think of the IRC.*

For shear wall design, the IBC passes you off to ASCE-7 for the design of the *main wind force resisting system* (MWFRS).

ASCE-7 in turn, passes you off to the Special Design Provisions for Wind and Seismic (SDPWS) for designing shear walls. One of its major provisions is that shear walls have a maximum *aspect ratio* (i.e. relationship between the height of a panel and the length of the panel). Even if you do not understand the engineering, you can definitely understand aspect ratio. SDPWS says the maximum aspect ratio for blocked wood structural panels (WSP) is 3.5:1, and for gypsum board (GB) 2:1.

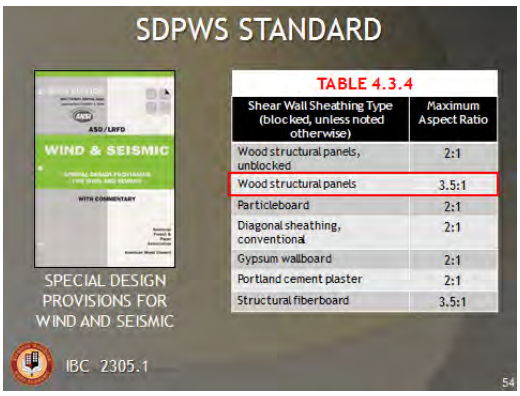
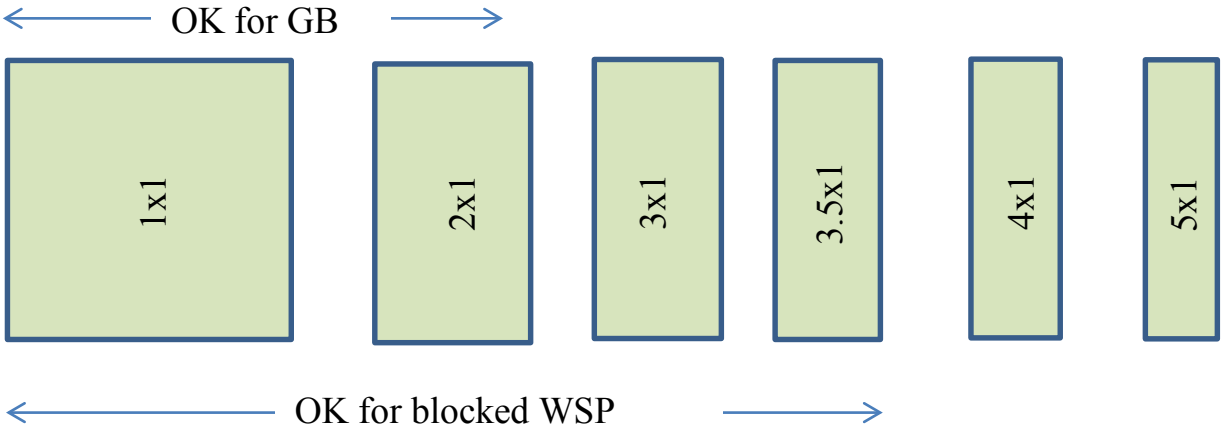


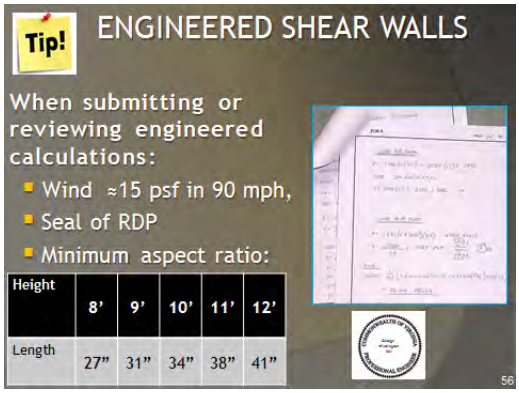
TABLE 4.3.4

Shear Wall Sheathing Type (blocked, unless noted otherwise)	Maximum Aspect Ratio
Wood structural panels, unblocked	2:1
Wood structural panels	3.5:1
Particleboard	2:1
Diagonal sheathing, conventional	2:1
Gypsum wallboard	2:1
Portland cement plaster	2:1
Structural fiberboard	3.5:1



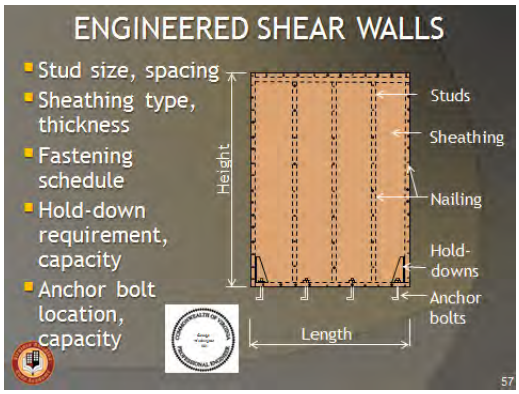
If you have to review the registered design professional's (RDP) calculations, recognize that a 90 mph wind speed is equivalent to approximately 15 psf force.

The maximum length for a shear wall will vary with the height of the panel, but should not exceed the maximum aspect ratio.



RDP's shear wall design should provide:

- Stud size and spacing
- Sheathing type and thickness
- Fasteners (nails, screws)
- Hold-downs
- Anchor bolts
- Seal



Alternative standards

The IBC and IRC say that as an alternative to the prescriptive and engineered solutions in the ICC codes other standards are permitted:

- AISI Standard for Cold Formed Steel
- Wood Frame Construction Manual
- WFCM Guide
- ICC 400 for log structures

Engineered products

There are engineered hardware products which may solve specific, unique situations. Engineered *moment frames,* while not cheap, are specifically designed for a particular engineered application. An inexpensive alternative is a *proprietary product* which can be ordered from a catalog. Each manufacturer has an ICC-ES report which will provide the equivalency for the specific model. When installed in accordance with the manufacturer's instructions, they are a great option.

SKILL CHECK 1.6

IRC wall bracing does NOT apply for which of the following project types?

1. Townhouses
2. Log homes
3. Carport to garage conversion
4. Additions

SKILL CHECK 1.7

An engineer's design is NOT required for which of the following?:

1. Four-story townhouse
2. 12' tall walls
3. 110 mph wind speeds
4. Cold-formed steel framing

SKILL CHECK 1.8

The maximum length of a 9.5' tall engineered shear wall with OSB is?

1. 27"
2. 33"
3. 35"

37"

MODULE 2: LENGTH OF WALL BRACING REQUIRED

- Worksheet
- Table R602.10.3(1)
- 6 Rules for braced wall lines
- Average braced wall line spacing
- Braced wall panel methods
- Adjustment Table R602.10.3(2)

The length of wall bracing is determined by

Wind table length	Table R602.10.3(1)
x <u>Adjustment factors</u>	Table R602.10.3(2)
Total required length	

The amount of bracing required is buried in the Table R602.10.3(1). Our job is to pull the number out of the table by following the work sheet and filling in the blanks:

- Wind speed
- Story
- Braced wall line- average braced wall line spacing
- Braced wall panel method

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

- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT LEVEL-TO-RIDGE HEIGHT
- 10 FOOT 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[a]			
			Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 85		10	3.5	3.5	2.0	1.5
		20	6.0	6.0	3.5	3.0
		30	8.5	8.5	5.0	4.5
		40	11.5	11.5	6.5	5.5
		50	14.0	14.0	8.0	7.0
		60	16.5	16.5	9.5	8.0
		10	6.5	6.5	3.5	3.0
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8.0
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.0	13.0
		60	31.5	31.5	18.0	15.5
		10	NP	9.0	5.5	4.5
		20	NP	17.0	10.0	8.5
		30	NP	24.5	14.0	12.0
		40	NP	32.0	18.0	15.5
		50	NP	39.0	22.5	19.0
		60	NP	46.5	26.5	22.5
≤ 90		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
		40	12.5	12.5	7.5	6.0
		50	15.5	15.5	9.0	7.5
		60	18.5	18.5	10.5	8.0
		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
		40	24.0	24.0	14.0	12.0
		50	29.5	29.5	17.0	14.5
		60	35.0	35.0	20.0	17.0
		10	NP	10.5	6.0	5.0
		20	NP	19.0	11.0	9.5
		30	NP	27.5	15.5	13.5
		40	NP	35.5	20.5	17.5
		50	NP	44.0	25.0	21.5
		60	NP	52.0	30.0	25.5

(continued)

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

- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT LEVEL-TO-RIDGE HEIGHT
- 10 FOOT 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[a]			
			Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 100		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	19.0	19.0	11.0	9.0
		60	22.5	22.5	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.0	8.0
		30	23.0	23.0	13.0	11.0
		40	29.5	29.5	17.0	14.5
		50	36.5	36.5	21.0	18.0
		60	43.5	43.5	25.0	21.0
		10	NP	12.0	7.5	6.0
		20	NP	22.5	13.5	11.5
		30	NP	34.0	19.5	15.5
		40	NP	44.0	25.0	21.5
		50	NP	54.0	31.0	25.5
		60	NP	64.0	36.5	31.0
≤ 110		10	5.5	5.5	3.0	3.0
		20	10.0	10.0	6.0	5.0
		30	14.5	14.5	8.5	7.0
		40	18.5	18.5	11.0	9.0
		50	23.0	23.0	13.0	11.5
		60	27.5	27.5	16.5	13.5
		10	10.5	10.5	6.0	5.0
		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	25.5
		10	NP	13.5	8.0	7.5
		20	NP	26.5	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

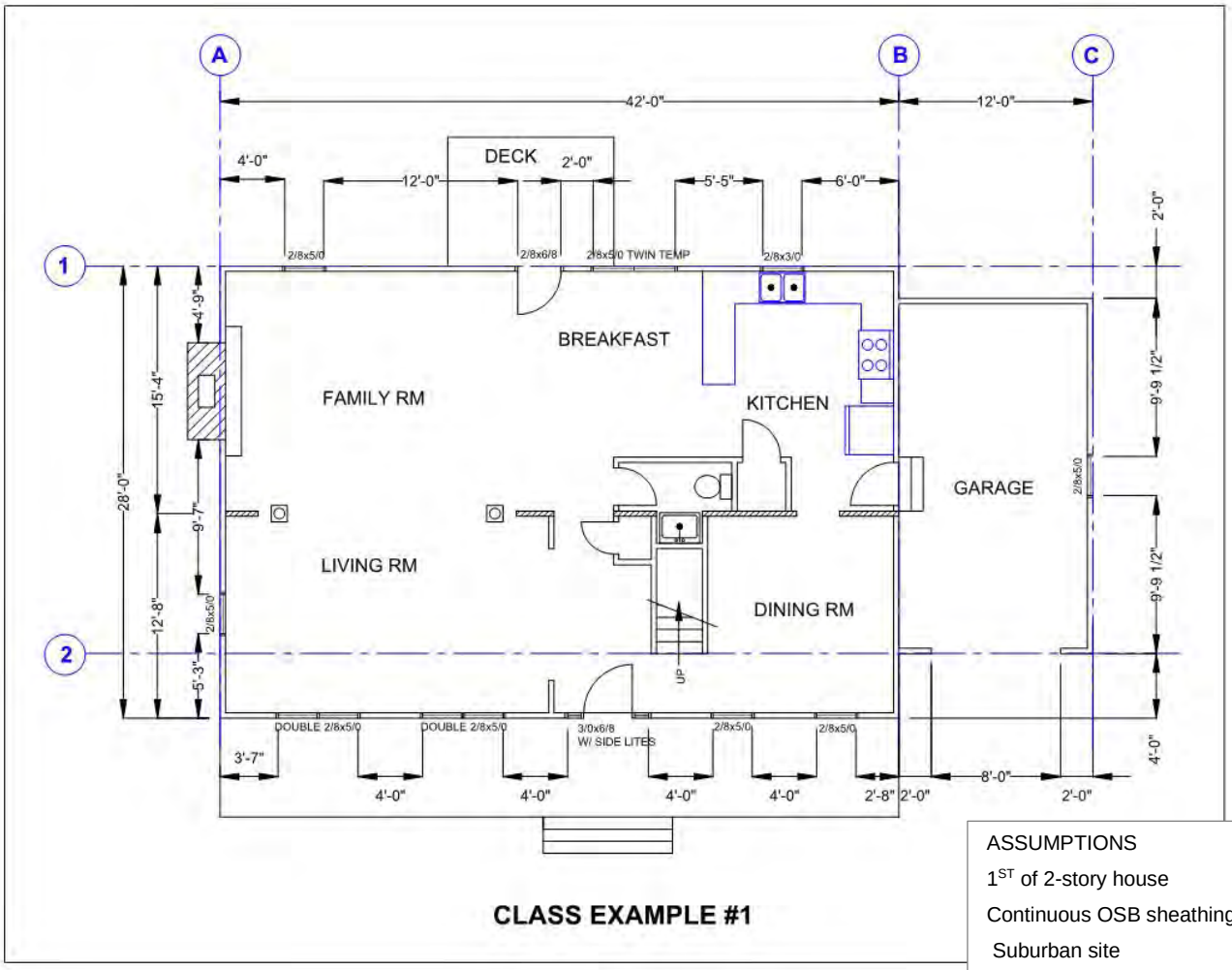
For SI: 1 inch = 25.4 mm; 1 foot = 305 mm; 1 mile per hour = 0.447 m/s

a. Linear interpolation shall be permitted.

b. Method LIB shall have gypsum board fastened to at least one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.

c. Method CS-SFB does not apply where the wind speed is greater than 100 mph.

We will use CLASS EXAMPLE #1 for practice. An enlarged plan is provided in the back of the book.



CLASS EXAMPLE #1

ASSUMPTIONS
1ST of 2-story house
Continuous OSB sheathing
Suburban site
Eave-to –ridge height 15'
Wall height 9'
GB interior walls
No extra hold-downs
Blocked horizontally

WORK SHEET

In order to determine code compliance, it is simple as 1-2-3!

1. Use the attached work sheet (aka spreadsheet),
2. Fill in the blanks, and
3. At the bottom of each column, you will be able to determine if the braced wall line will PASS or FAIL.

WORK SHEET - CLASSICAL WALL BRACING

(a clean copy is provided in the rear of this book)

					CLASS EXAMPLE #1		CLASS EXAMPLE #2	
REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)		85, 90, 100, <110		85, 90, 100, <110		85, 90, 100, <110	
		2	STORY							
		3	BWL NAME / IDENTIFIER							
		4	AVERAGE BWL SPACING		feet		feet		feet	
		5	BWP METHOD							
		6	TABULAR REQUIRED BWP LENGTH (minimum)		feet		feet		feet	
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY		B, C, D		B, C, D		B, C, D	
		8	EAVE - RIDGE HEIGHT		feet		feet		feet	
		9	WALL HEIGHT		feet		feet		feet	
		10	NUMBER OF BWLs (in same direction)		2, 3, 4, ≥5		2, 3, 4, ≥5		2, 3, 4, ≥5	
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?		YES NO		YES NO		YES NO	
		12	ADD PAIR OF 800# HOLD-DOWNS?		YES NO		YES NO		YES NO	
		13	HORIZONTAL JOINTS BLOCKED?		YES NO		YES NO		YES NO	
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.		YES NO		YES NO		YES NO	
		15	TOTAL REQUIRED BWP LENGTH (minimum)		feet		feet		feet	
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)
		17		1						
		18	WSP, SFB = ACTUAL	2						
		19	SS - GB = ½ ACTUAL	3						
		20	DS - GB = ACTUAL	4						
		21	CS-PF = 1.5 X ACTUAL	5						
		22	PFG = 1.5 ACTUAL	6						
		23	PFHG, ABW = 4 FEET	7						
		24	ACTUAL BWP PROVIDED		feet		feet		feet	
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO	YES	NO	YES	NO
LOCATION	R602.10.2.2	26	BWPs ≤ 20 FEET APART?		YES	NO	YES	NO	YES	NO
		27	BWP LENGTH		feet		feet		feet	
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES	NO	YES	NO	YES	NO
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END		YES	NO	YES	NO	YES	NO
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2	END 1	END 2	END 1	END 2
		31	PASS / FAIL		PASS	FAIL	PASS	FAIL	PASS	FAIL

TABULAR

REQUIRED

ADJUSTMENTS

ACTUAL

LOCATION

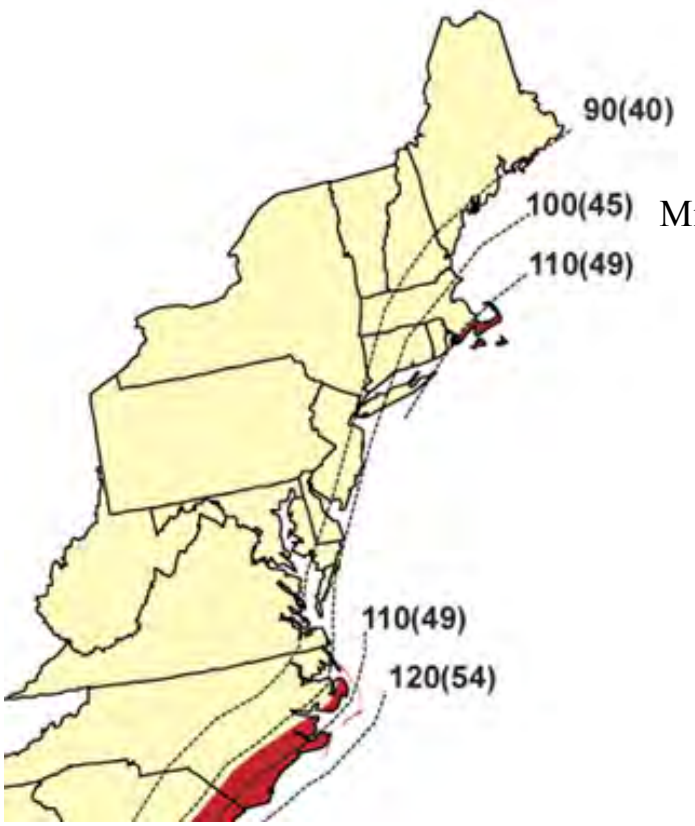
CLASS EXAMPLE #1

Line 1: wind speed

The wind speed is the first determinant required for entry into the table. The table has four wind speeds:

- ≤ 85 mph
- ≤ 90 mph
- ≤ 100 mph
- < 110 mph

REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF BOLT HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet



Miles per hour (meters per second)

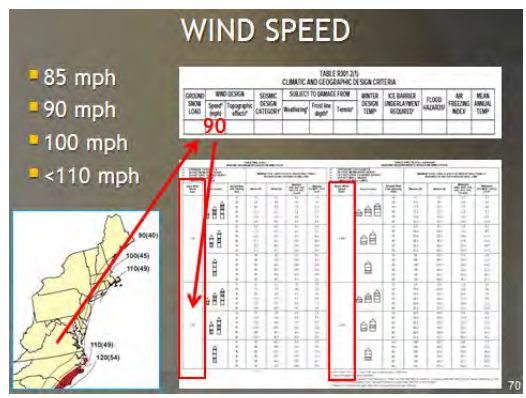


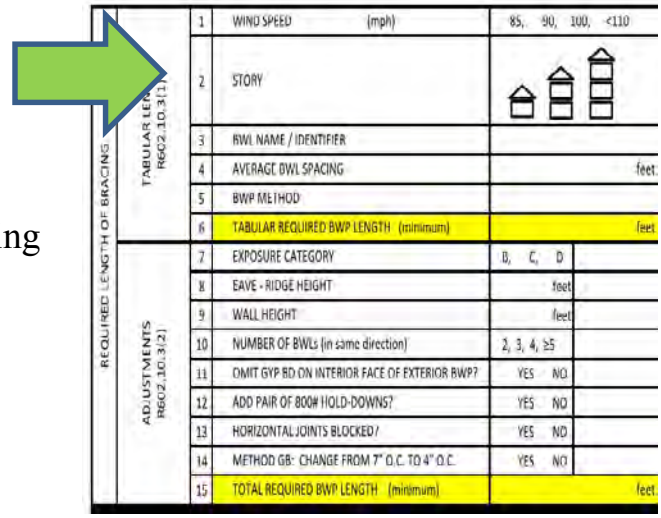
TABLE R301.2(1)
CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA

GROUND SNOW LOAD	WIND DESIGN		SEISMIC DESIGN CATEGORY[f]	SUBJECT TO DAMAGE FROM			WINTER DESIGN TEMP[e]	ICE BARRIER UNDERLAYMENT REQUIRED[h]	FLOOD HAZARDS[g]	AIR FREEZING INDEX[i]	MEAN ANNUAL TEMP[j]
	Speed[d] (mph)	Topographic effects[k]		Weathering[a]	Frost line depth[b]	Termite[c]					
	90										

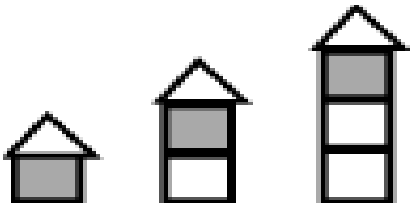
CLASS EXAMPLE #1

Line 2: story

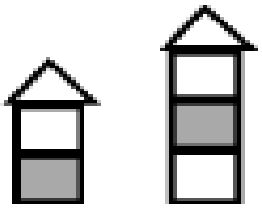
Wind loads accumulate from the top of the house to the bottom of the house where the applied force is greatest. Therefore the story is critical in determining the length of wall bracing required.



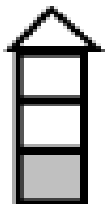
REQUIRED LENGTH OF BRACING			
TABULAR LEN R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
	2	STORY	
	3	BWL NAME / IDENTIFIER	
	4	AVERAGE BWL SPACING	feet
	5	BWP METHOD	
	6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
	8	EAVE - RIDGE HEIGHT	feet
	9	WALL HEIGHT	feet
	10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
	11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
	12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
	13	HORIZONTAL JOINTS BLOCKED?	YES NO
	14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
	15	TOTAL REQUIRED BWP LENGTH (minimum)	feet



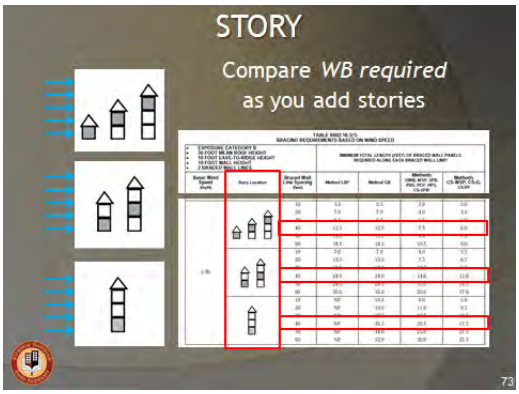
Roof above

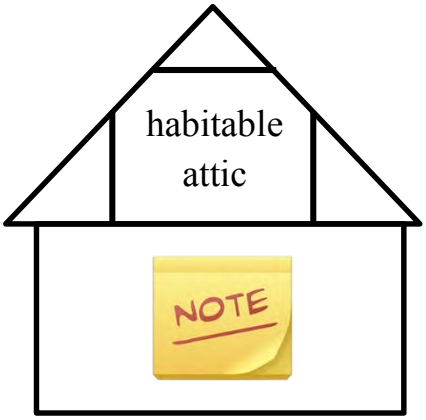


Roof and floor above



Two floors and roof above

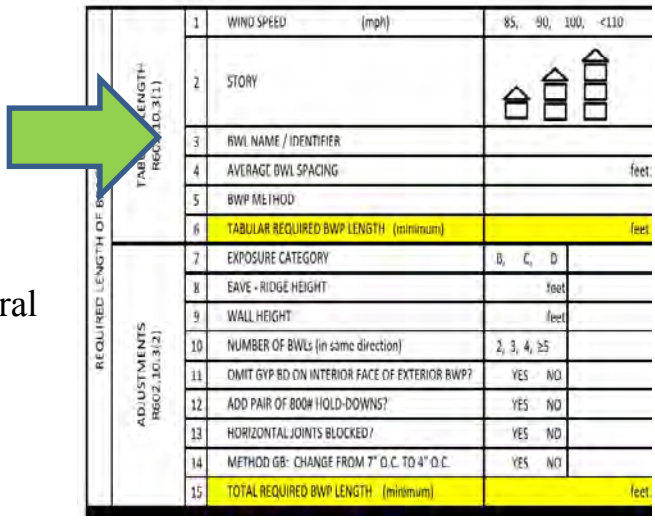




For sake of wall bracing, this would be considered as the 1st of a one-story building.

20

Line 3: braced wall line identifier



REQUIRED LENGTH OF BWL	TABULAR LENGTH- R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

"BRACED WALL LINE"

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

"BRACED WALL LINE, CONTINUOUSLY SHEATHED"

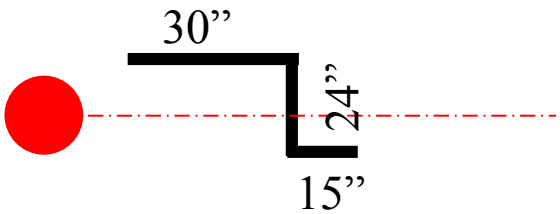
- A *braced wall line*
- with structural sheathing applied to all sheathable surfaces including the areas above and below openings.

Braced wall lines are governed by six rules:

1. Straight
2. Run in both directions
3. Must start/stop at another BWL
4. Applies to all floors
5. Maximum 4' offset
6. Maximum 60' spacing between BWLs

BWL Rule 1: Braced wall lines must be straight. No offsets are allowed.

Walls perpendicular to the BWL do not contribute.



- The 24” wall segment does not contribute anything because it is not parallel to the BWL.
- 30” and 15” does not equal 45”, but rather (1) at 30” and (1) at 15. Both segments will be evaluated independently.

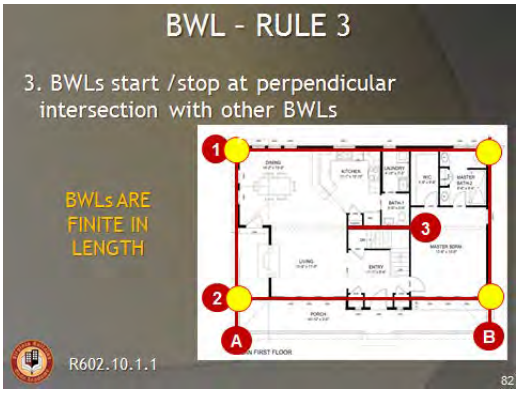
BWL Rule 2: Braced wall lines are required in both directions around the perimeter of the house.

Use letters in one direction and numbers in the other direction. Although nothing mandates how the BWLs are to be identified, you will find it easier if you don’t just number the BWLs sequentially 1-2-3-4-5-6 around the clock.

Reason: You might have to add another BWL and it might mess up your sequencing.

BWL Rule 3: Both ends of a BWL must start and stop at an intersection with a perpendicular BWL.

In the case shown, BWL #3 does not start or stop at the intersection with another BWL. In order for it to work, it must be extended, and start at A and end at B.



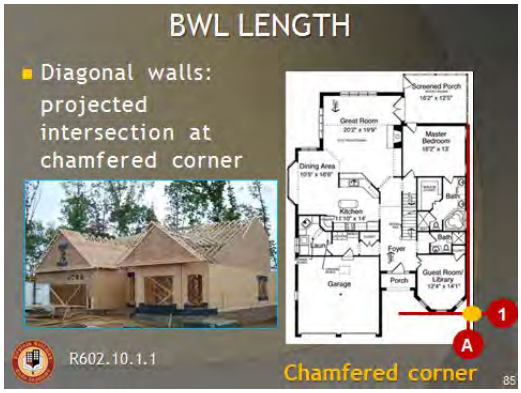
BWLs have a finite length. Their length is measured between the intersections at the most remote perpendicular BWL on each end.

Exception

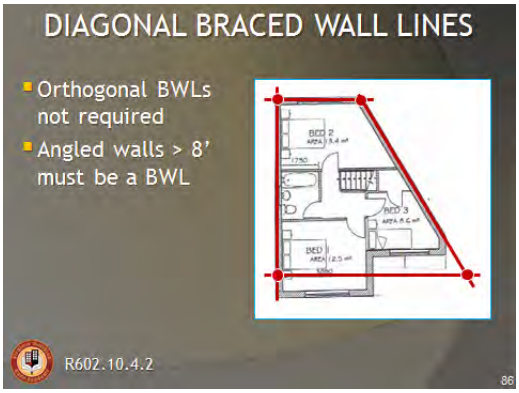
1. When there is no perpendicular BWLs, as in the case of a walk out basement, use the length of the wall between the concrete walls

Where there are no perpendicular BWLs, as in the case of a full length, shed dormer on the second floor, use the length to the end of the house.

2. If the intersection of a BWL is to a diagonal wall, two conditions may occur:
   a. If the diagonal wall is less than 8' long, neglect it and use the perpendicular projection.



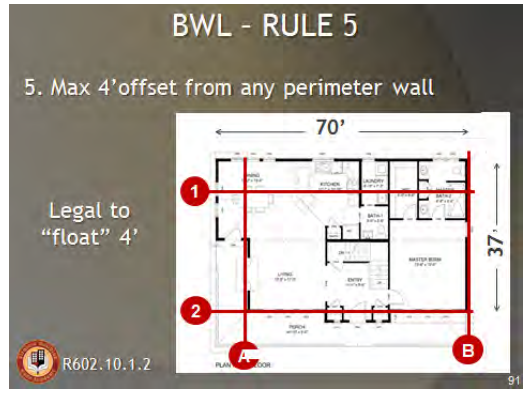
   b. If the diagonal wall is greater than 8' long, treat it as any other BWL, and measure it from the intersection end points.

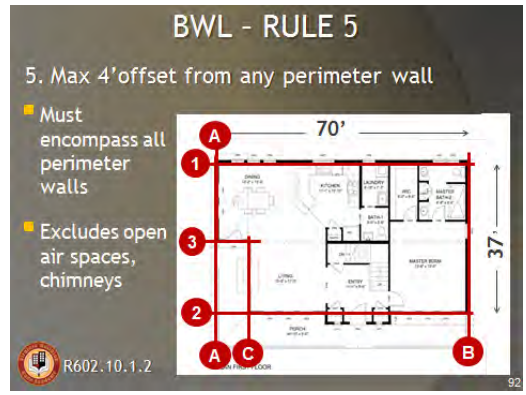


BWL Rule 4: BWLs are required for all floors of a multi-story structure. The BWLs of one story do not have to align with the BWLs of another story.

BWL Rule 5: Since by definition, BWLs are imaginary, then BWLs are allowed to be offset from the perimeter walls:

- Up to 4' in one direction,
- Up to 8' total in both directions
- Not 8' in one direction.
- Same applies to an interior BWL.
- BWLs are allowed to "float"
- Must encompass every part of all of the exterior walls





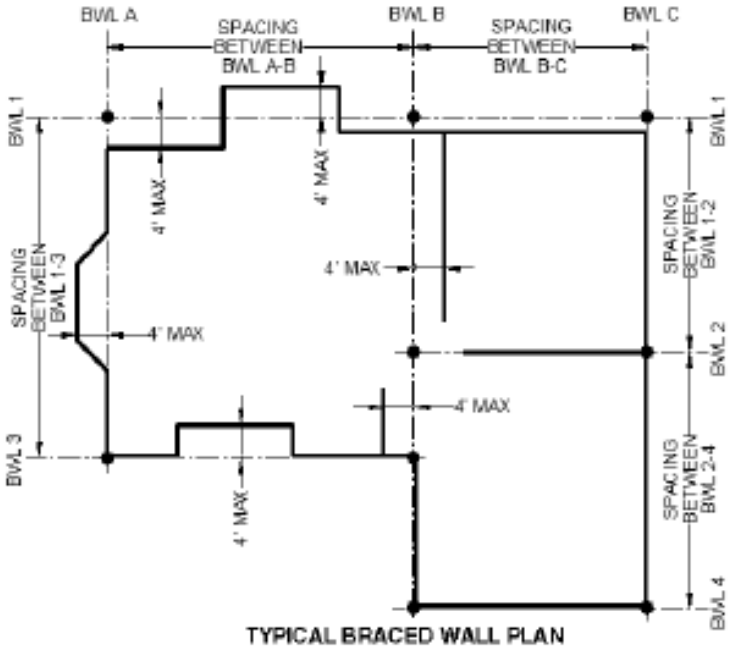


FIGURE R602.10.1.1
BRACED WALL LINES

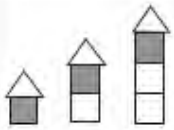
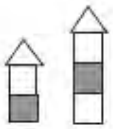
BWL Rule 6: Maximum spacing between BWLs is 60'. Two tables reiterate this requirement:

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	Ultimate design wind speed 100 mph to < 140 mph	Detached, townhouse	60 feet	None
Seismic bracing	SDC A – C	Detached	Use wind bracing	
	SDC A – B	Townhouse	Use wind bracing	
	SDC C	Townhouse	35 feet	Up to 50 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).
	SDC D_0, D_1, D_2	Detached, townhouses, one- and two-story only	25 feet	Up to 35 feet to allow for a single room not to exceed 900 square feet. Spacing of all other braced wall lines shall not exceed 25 feet.
	SDC D_0, D_1, D_2	Detached, townhouse	25 feet	Up to 35 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m², 1 mile per hour = 0.447 m/s.

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

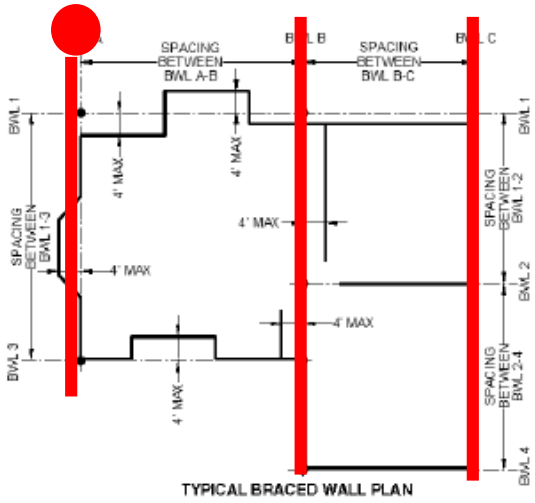
• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFC, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 110		10	3.5	3.5	2.0	1.5
		20	6.0	6.0	3.5	3.0
		30	8.5	8.5	5.0	4.5
		40	11.5	11.5	6.5	5.5
		50	14.0	14.0	8.0	7.0
		60	16.5	16.5	9.5	8.0
		10	6.5	6.5	3.5	3.0
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8.0
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.5	13.0
		60	31.5	31.5	18.0	15.5
		10	NP	9.5	5.5	4.5
		20	NP	17.0	10.0	8.5
		30	NP	24.5	14.0	12.0
		40	NP	32.0	18.5	15.5
		50	NP	39.5	22.5	19.0
		60	NP	46.5	26.5	23.0

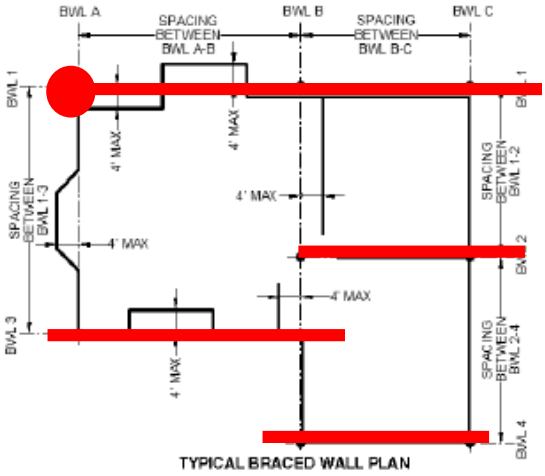
Why is the BWL spacing limited to 60’? SAIL AREA. The more sail

area on one face, the more bracing that is required on perpendicular walls. When the sail area gets too large, there will not be enough wall area on the perpendicular walls to provide adequate bracing.

Method North/South – East/West

Starting on the left side of the structure, put all the vertical BWLs in to cover all of the north/south perimeter walls. Then starting at the top, add all of the horizontal BWLs to cover all of the east/west perimeter walls

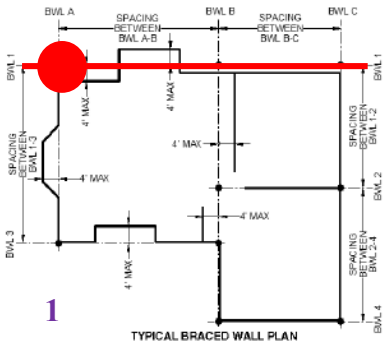


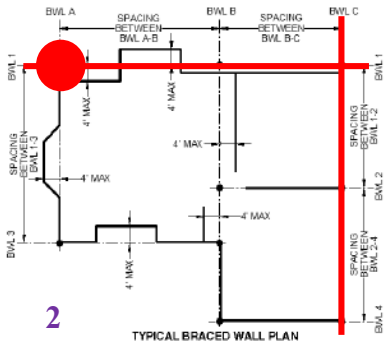


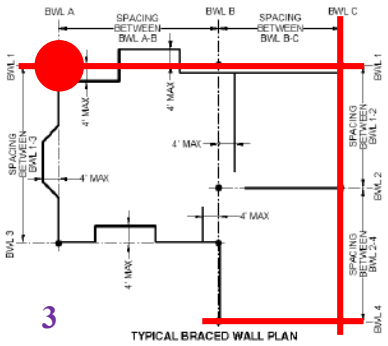
Note: Your plans may be more or less complicated than this example. Get the perimeter covered first, then add interior BWLs as required or as the calculations dictate.

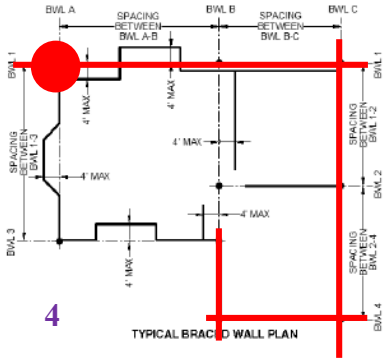
Method “around the clock”

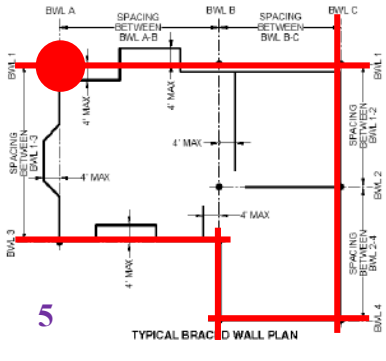
Go around the perimeter of the structure in a clockwise direction, starting at the upper left end and complete the loop.

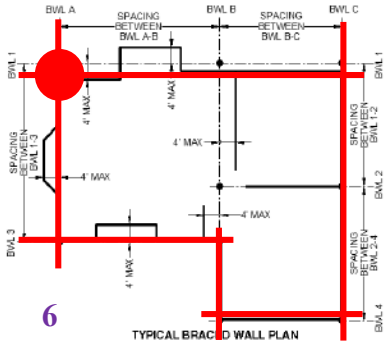




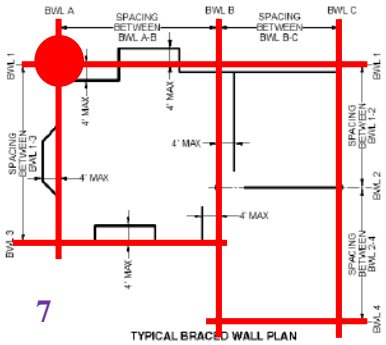


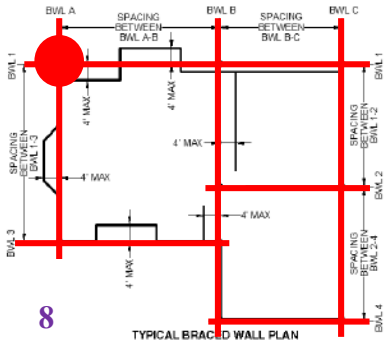






Then add or extend any BWLs through the interior as needed.





SKILL CHECK 2.1

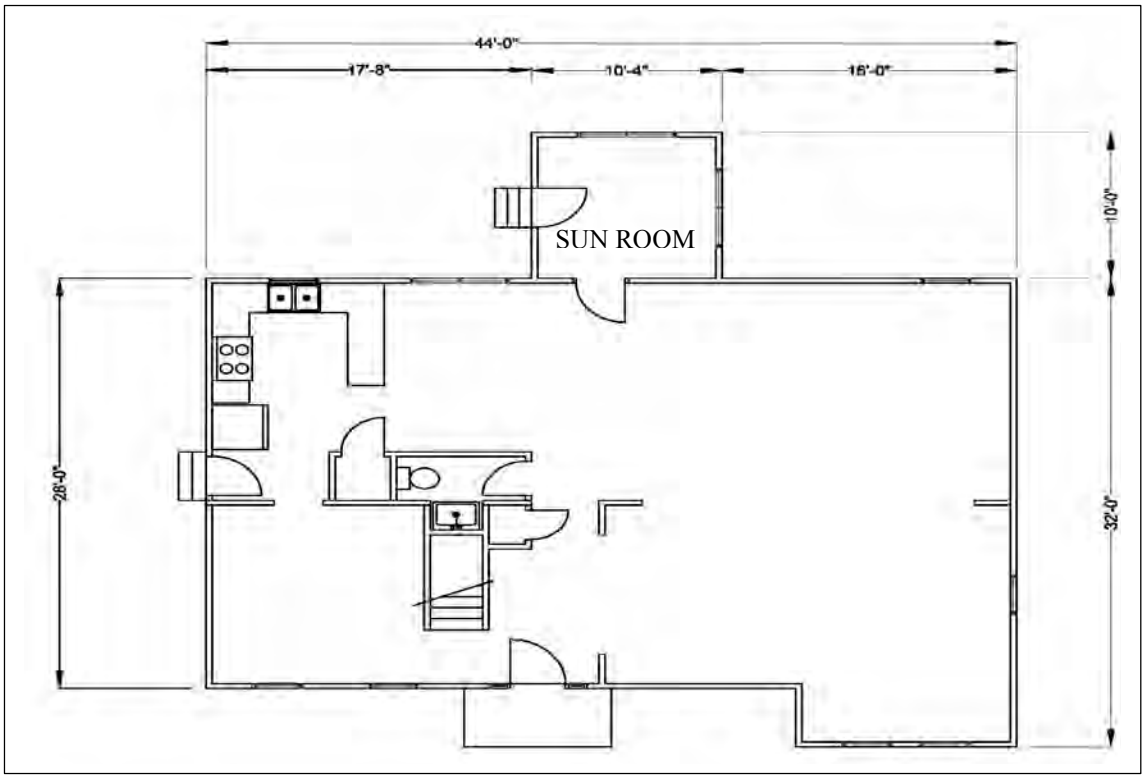
What is the largest 1 story house I can build with just 4 BWLs?

1. 60’ x 60’
2. 64’ x 64’
3. 68’ x 68’
4. 72’ x 72’

SKILL CHECK 2.2

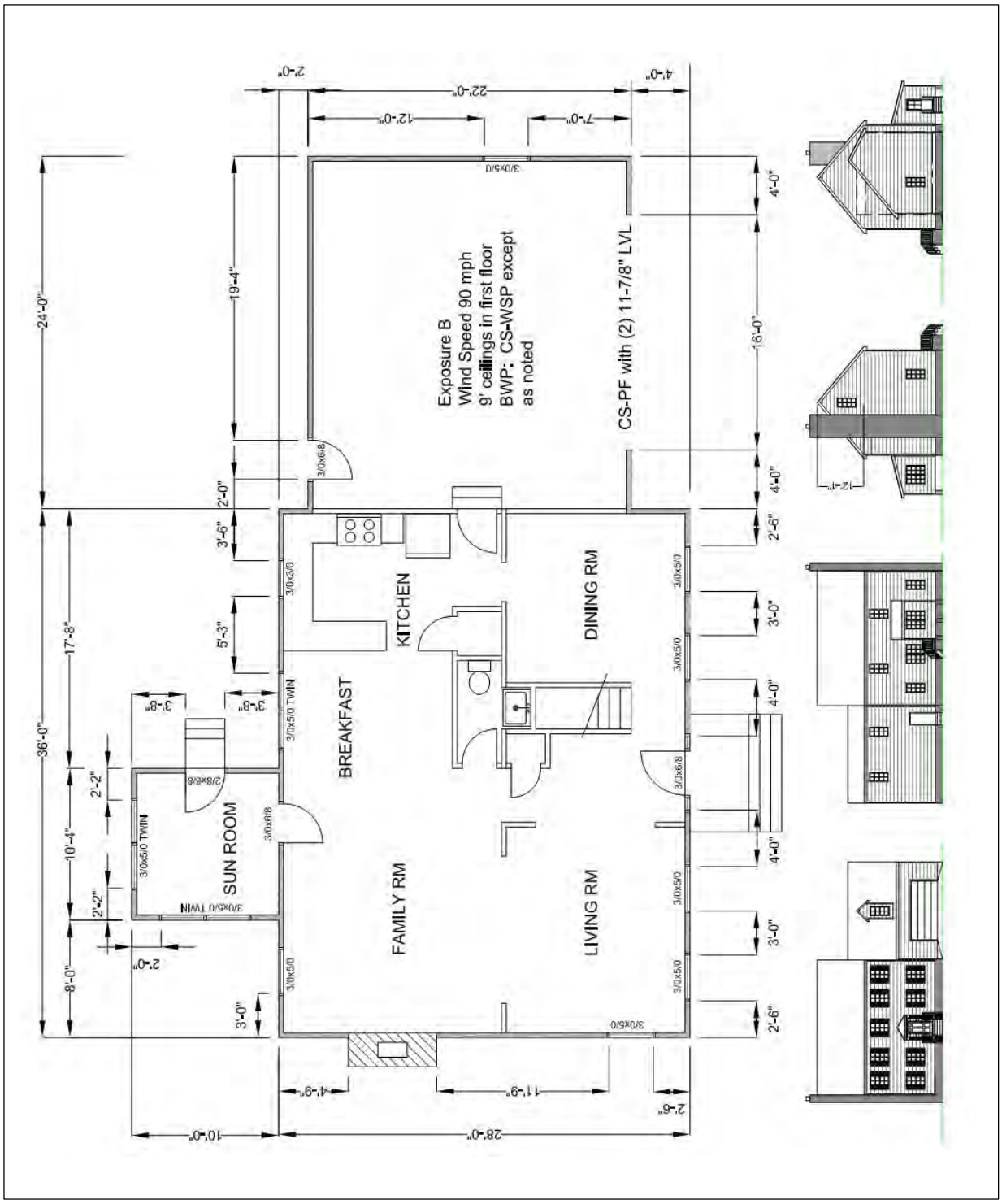
What is the fewest number of BWLs required for this house?

5, 6, 7, 8?



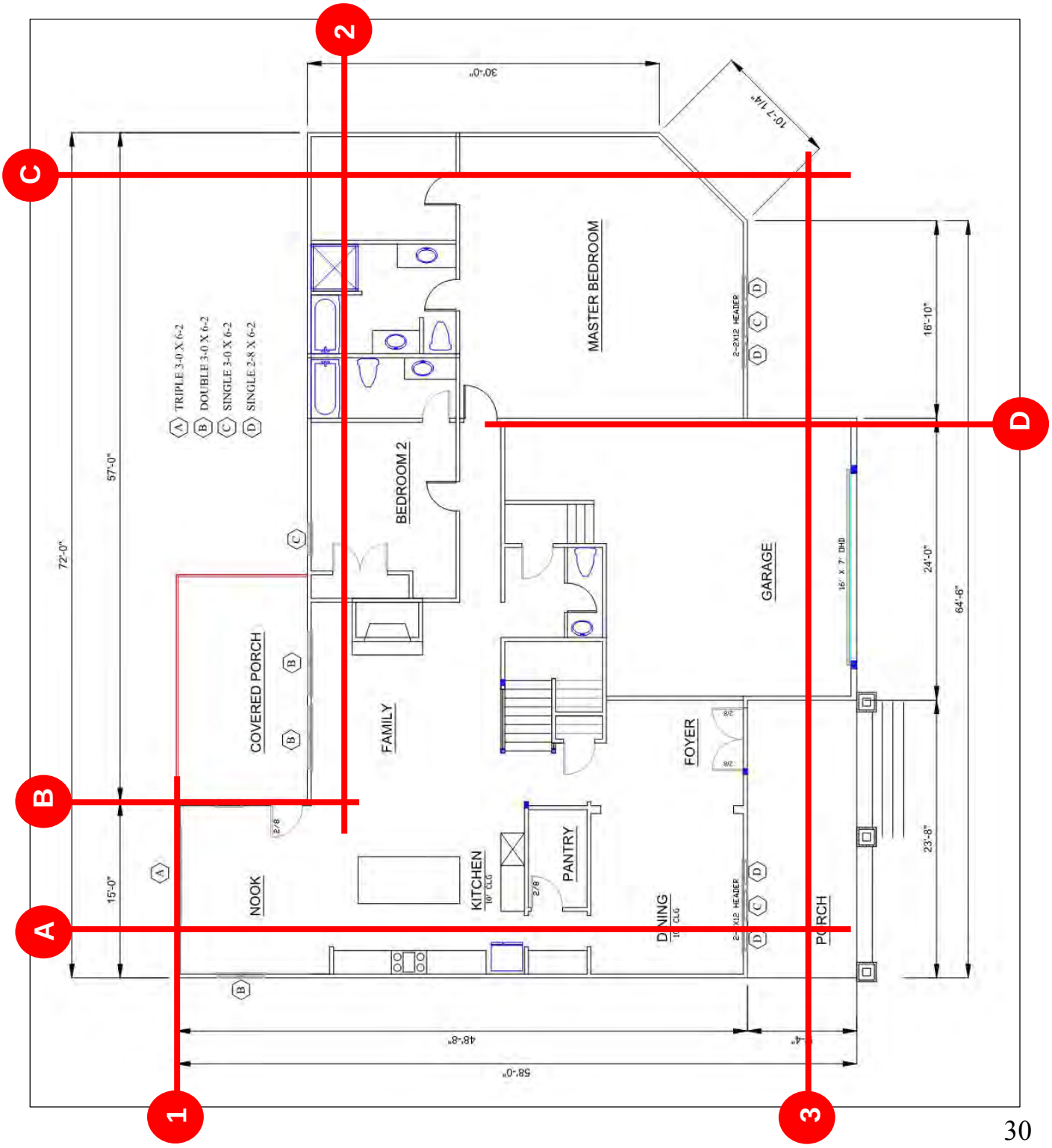
SKILL CHECK 2.3

You be the designer. Place and label the most efficient BWLs for this house.



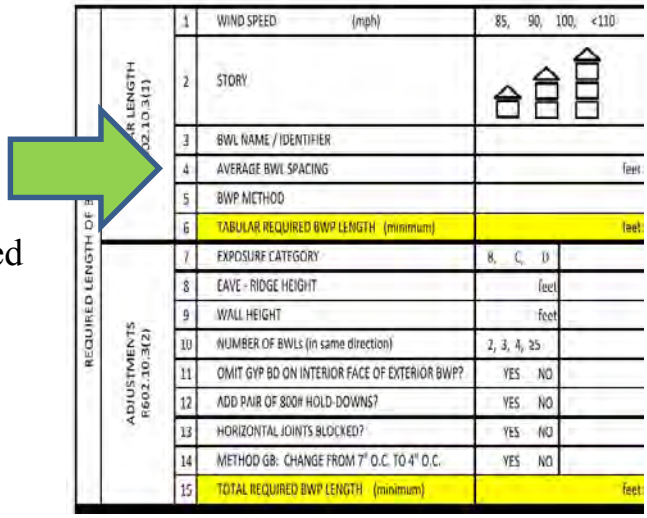
SKILL CHECK 2.4

You be the plan reviewer. PASS or FAIL?



Line 4: average BWL spacing

CLASS EXAMPLE #1

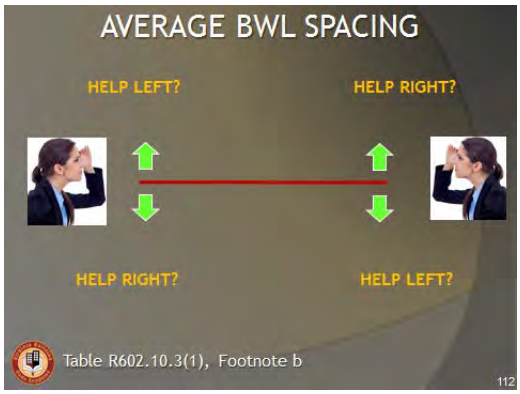


REQUIRED LENGTH OF BWP	1	WIND SPEED (mph)	85, 90, 100, <110
	2	STORY	
	3	BWL NAME / IDENTIFIER	
	4	AVERAGE BWL SPACING	feet
	5	BWP METHOD	
	6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
	8	EAVE - RIDGE HEIGHT	feet
	9	WALL HEIGHT	feet
	10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
	11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
	12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
	13	HORIZONTAL JOINTS BLOCKED?	YES NO
	14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
	15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

By BWL rule 6, that the maximum BWL spacing is 60'. Table R602.10.3(1) footnote b says:

"Where a braced wall line has parallel braced wall lines on one or both sides of differing dimensions, the *average dimension* shall be permitted to be used for braced wall line spacing." If you do not want to average the spacing(s) use the largest spacing.

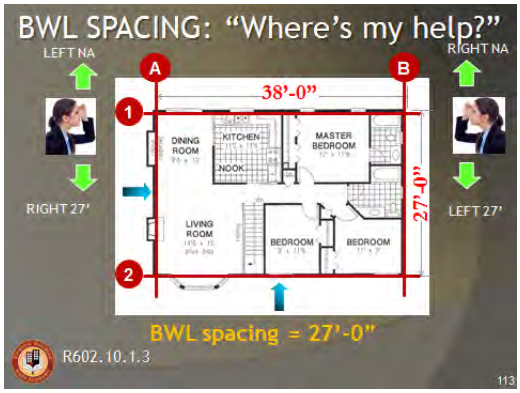
We call the "averaging" methodology: "WHERE'S MY HELP"



1. Stand at one end of the BWL facing down its length
2. Look to your left: Is there any bracing help?
3. If yes, how far away is the nearest help?
4. If none, disregard.
5. Look to your right: Is there any bracing help?
6. If yes, how far away is the nearest help?
7. If none, disregard.
8. Now reverse your position. Stand at the other end of the BWL facing at the end you just came from (now you will be looking west).
9. Look to your left: Is there any bracing help?

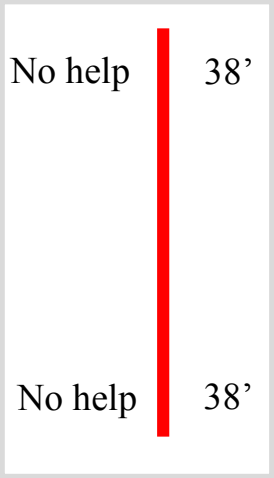
10. If yes, how far away is the nearest help? If none, disregard.
11. Look to your right: Is there any bracing help?
12. If yes, how far away is the nearest help? If none, disregard.
13. The minimum numbers you will have is 2 and the maximum numbers you will have is 4 for each BWL.

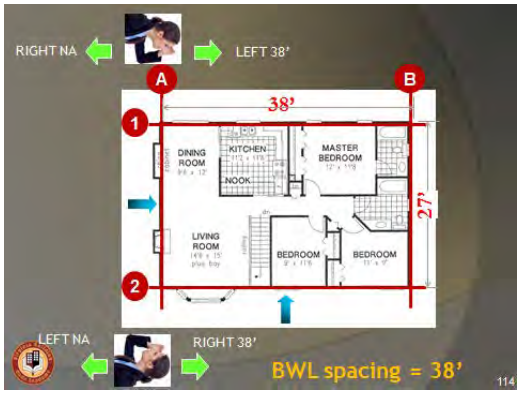
Study BWL 1



No help
+ 27'
No help
+ 27'
54'
AVG 54' ÷ 2 = 27'

Study BWL A

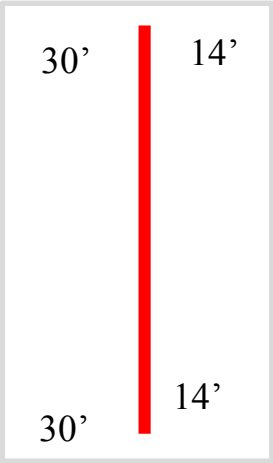


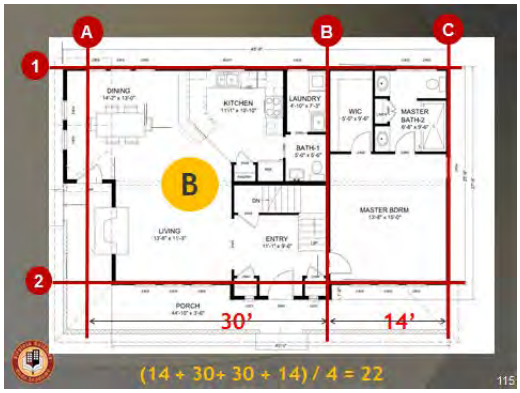


No help
+ 38'
No help
+ 38'
76'
AVG 76' ÷ 2 = 38'

Study BWL B

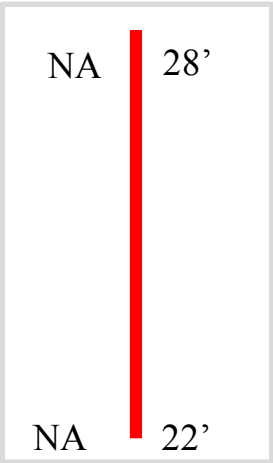
14’
+ 30’
14’
+ 30’
88’
AVERAGE 88’ ÷ 4 = 22’

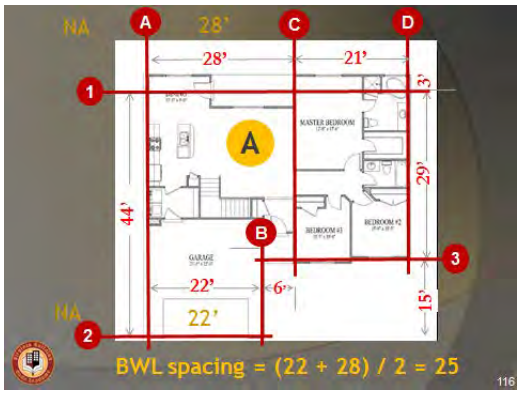




Study BWL A

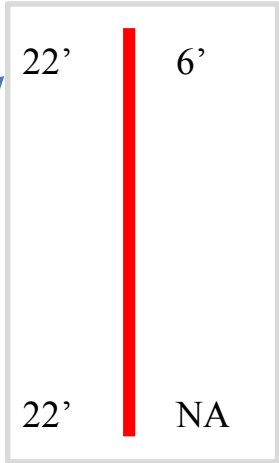
NA
+ 28’
NA
+ 22’
50’
AVG 50’ ÷ 2 = 25’

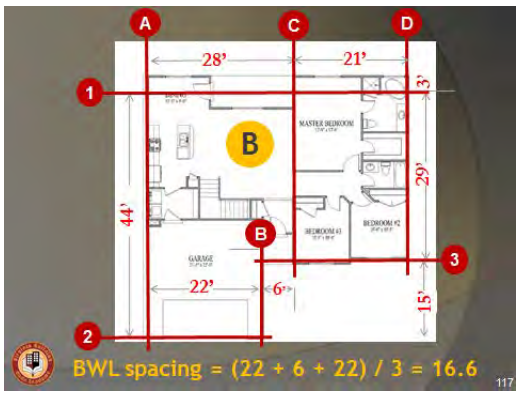




Study BWL B

22’
+ 6’
22’
+ NA
50’
AVG 50’ ÷ 3 = 16.6’



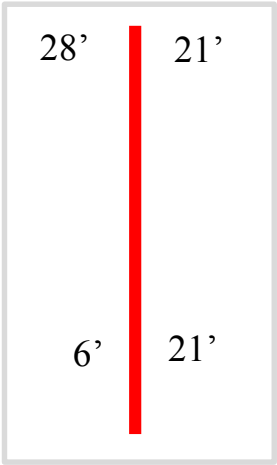


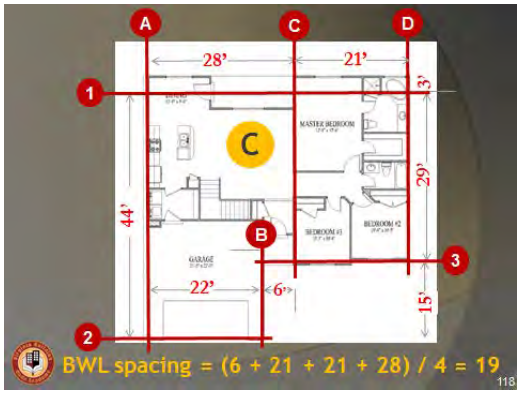
Notice that even though BWL 3 does not continue to BWL A,

BWL B still gets help from BWL A, so the 22’ is counted *twice*!

Study BWL C

28’
+ 21’
6’
+ 21
76’
AVG 76’ ÷ 4 = 19’

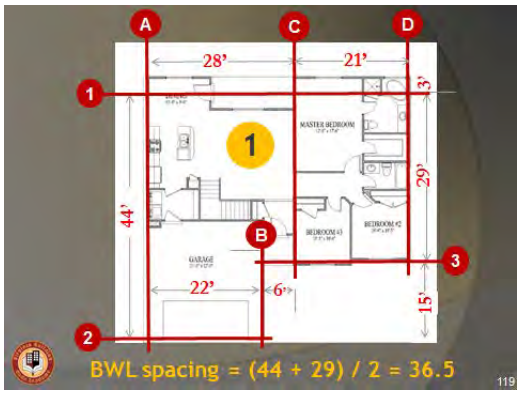




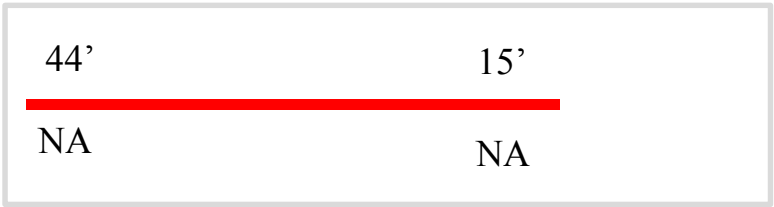
Study BWL 1

NA + 44’ + NA + 29’ = 73

AVG 73’ ÷ 2 = 36.5’

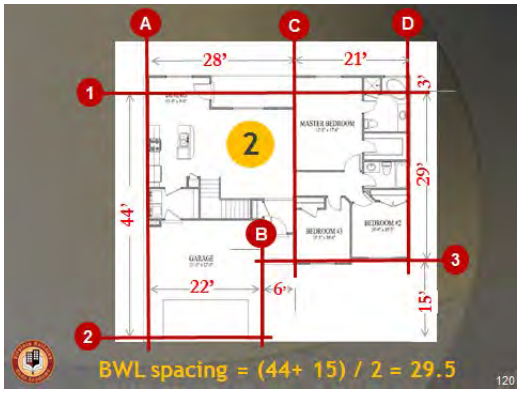


Study BWL 2



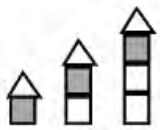
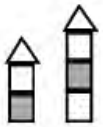
NA + 44’ + NA + 15’ = 59

AVG 59’ ÷ 2 = 29.5’



All that effort was required to determine the “average” braced wall spacing needed for looking up the length of bracing required in Table R602.10.3(1).

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

• EXPOSURE CATEGORY B • 30 FOOT MEAN ROOF HEIGHT • 10 FOOT EAVE-TO-RIDGE HEIGHT • 10 FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 90		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
		40	12.5	12.5	7.5	6.0
		50	15.5	15.5	9.0	7.5
		60	18.5	18.5	10.5	9.0
		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
		40	24.0	24.0	14.0	12.0
		50	29.5	29.5	17.0	14.5
		60	35.0	35.0	20.0	17.0
		10	NP	10.5	6.0	5.0
		20	NP	19.0	11.0	9.5
		30	NP	27.5	15.5	13.5
		40	NP	35.5	20.5	17.5
		50	NP	44.0	25.0	21.5
		60	NP	52.0	30.0	25.5

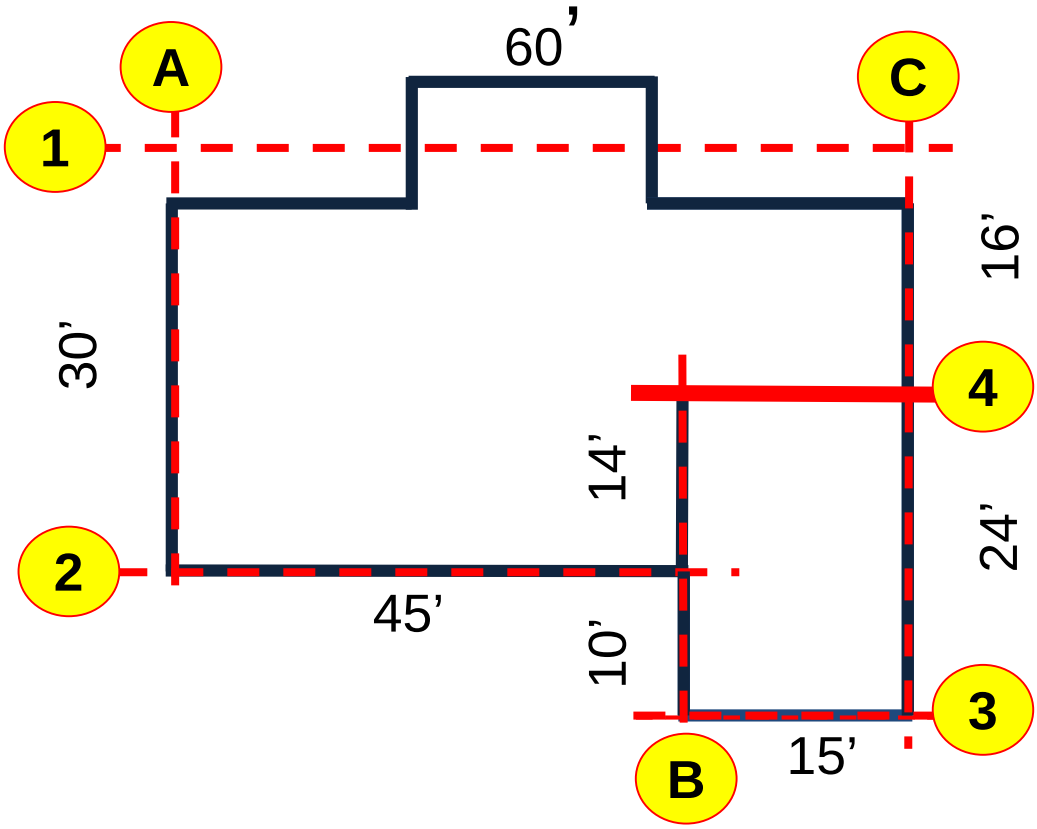
SKILL CHECK 2.5

Which of the following statements is false about the placement of BWLs?

1. BWLs must be straight.
2. BWLs must run in each plan direction.
3. BWLs are not required on diagonal walls > 8’ long.
4. BWLs are permitted to float up to 4’ from the BWP.

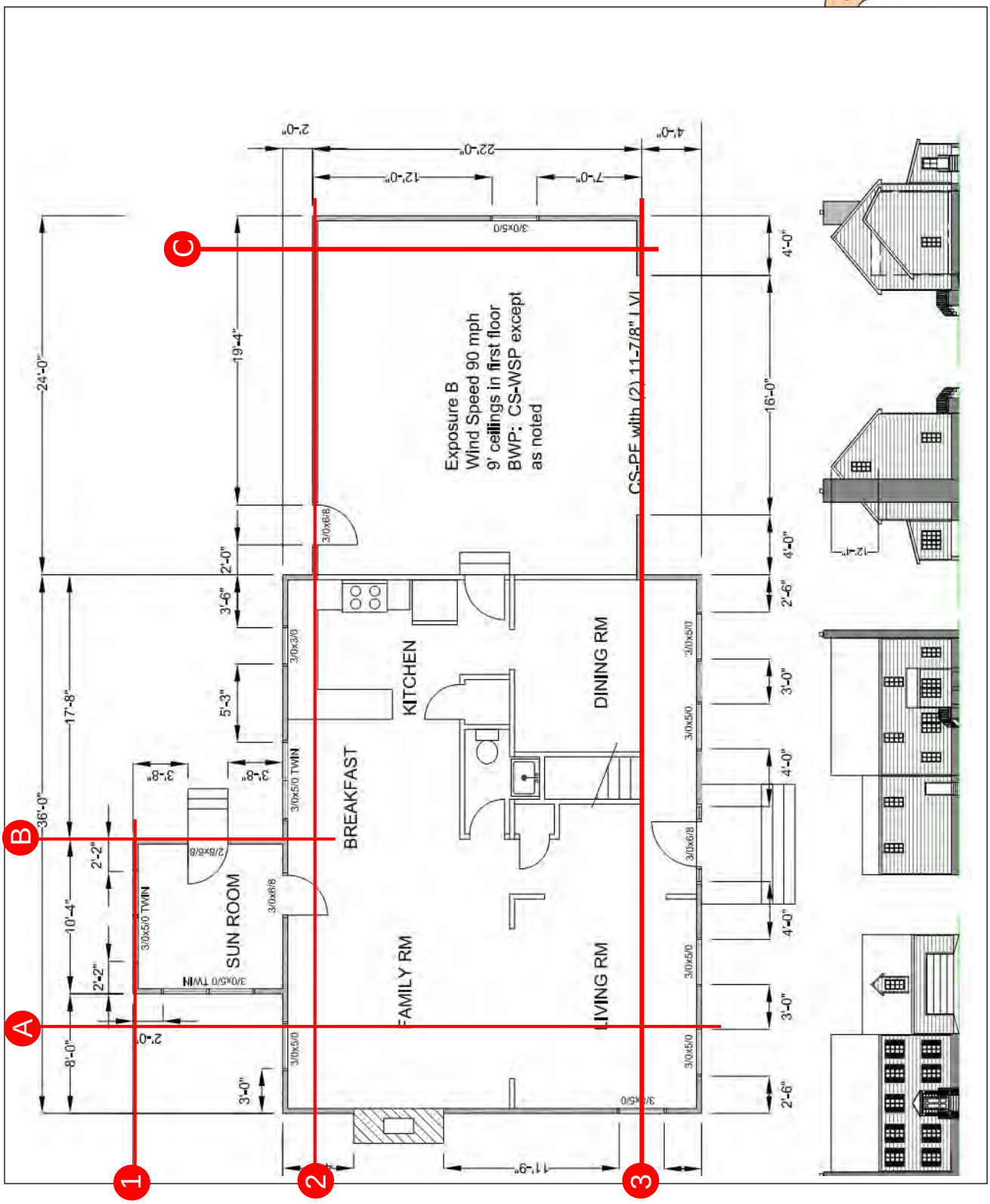
SKILL CHECK 2.6

What is the average spacing for BWL 4?



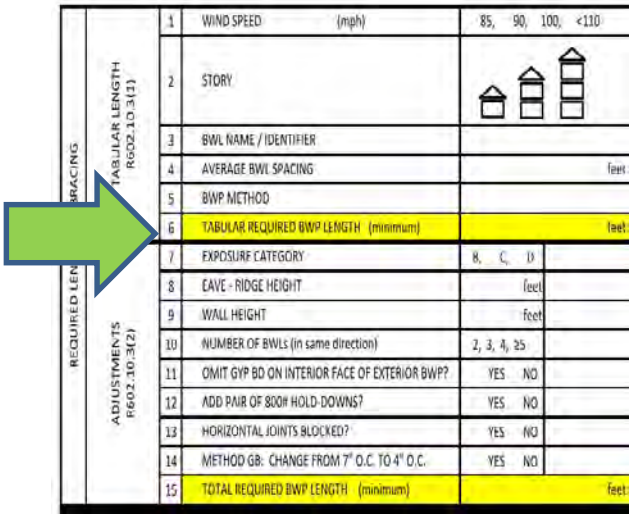
SKILL CHECK 2.7

What is the average spacing for BWL C?



4

CLASS EXAMPLE #1



REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

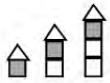
Line 5: methods

There are four columns in the table differentiating materials:

1. LIB,
2. GB,
3. Intermittent: DWB, WSP, SFB, etc
4. Continuous: CS-WSP, CS-G, CS-PF

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

- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT EAVE-TO-RIDGE HEIGHT
- 10 FOOT 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[a]			
			Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 85		10				
		20	6.0	6.0	3.5	3.0
		30	8.5	8.5	5.0	4.5
		40	11.5	11.5	6.5	5.5
		50	14.0	14.0	8.0	7.0
		60	16.5	16.5	9.5	8.0
		10	6.5	6.5	3.5	3.0
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8.0
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.0	13.0
		60	31.5	31.5	18.0	15.5
		10	NP	9.0	5.5	4.5
		20	NP	17.0	10.0	8.5
		30	NP	24.5	14.0	12.0
		40	NP	32.0	18.0	15.5
		50	NP	39.0	22.5	19.0
		60	NP	46.5	26.5	22.5
≤ 90		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
		40	12.5	12.5	7.5	6.0
		50	15.5	15.5	9.0	7.5
		60	18.5	18.5	10.5	9.0
		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
		40	24.0	24.0	14.0	12.0
		50	29.5	29.5	17.0	14.5
		60	35.0	35.0	20.0	17.0
		10	NP	10.5	6.0	5.0
		20	NP	19.0	11.0	9.5
		30	NP	27.5	15.5	13.5
		40	NP	35.5	20.5	17.5
		50	NP	44.0	25.0	21.5
		60	NP	52.0	30.0	25.5

(continued)

Table R602.10.4 has a complete list of all the allowable bracing methods.

INTERMITTENT METHODS

CONTINUOUS METHODS

TABLE R602.10.4
BRACING METHODS

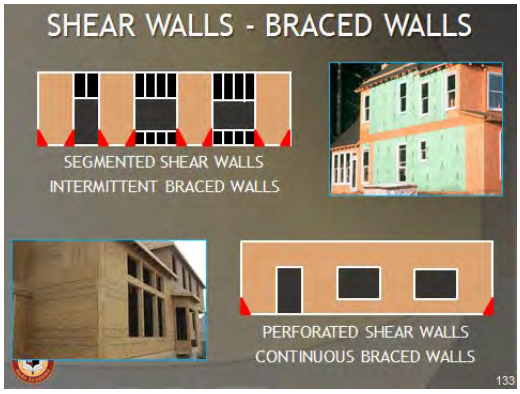
	METHODS, MATERIAL	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA[a]	
				Fasteners	Spacing
Intermittent Bracing Method	**LIB** Let-in-bracing	1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16" stud spacing		Wood: 2-8d common nails or 3-8d (2½" long x 0.113" dia.) nails	Wood: per stud and top and bottom plates
				Metal strap: per manufacturer	Metal: per manufacturer
	DWB Diagonal wood boards	¾"(1" nominal) for maximum 24" stud spacing		2-8d (2½" long × 0.113" dia.) nails or 2 - 1¾" long staples	Per stud
	WSP Wood structural panel (See Section R604)	⅜"		Exterior sheathing per Table R602.3(3)	6" edges 12" field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	BV-WSP[c] Wood structural panels with stone or masonry veneer (See Section R602.10.6.5)	3/16"	See Figure R602.10.6.5	8d common (2½" × 0.131) nails	4" at panel edges 12" at intermediate supports 4" at braced wall panel end posts
	SFB Structural fiberboard sheathing	½" or 25/32" for maximum 16" stud spacing		1½" long × 0.12" dia. (for ½" thick sheathing) 1¾" long × 0.12" dia. (for 25/32" thick sheathing) galvanized roofing nails or 8d common (2½" long × 0.131" dia.) nails	3" edges 6" field
	GB Gypsum board	½"		Nails or screws per Table R602.3(1) for exterior locations	For all braced wall panel locations: 7" edges (including top and bottom plates) 7" field
				Nails or screws per Table R702.3.5 for interior locations	
	PBS Particleboard sheathing (See Section R605)	⅜" or ½" for maximum 16" stud spacing		For ⅜", 6d common (2" long × 0.113" dia.) nails For ½", 8d common (2½" long × 0.131" dia.) nails	3" edges 6" field
	PCP Portland cement plaster	See Section R703.6 for maximum 16" stud spacing		1½" long, 11 gage, 7/16" dia. head nails or 7/8" long, 16 gage staples	6" o.c. on all framing members
	HPS Hardboard panel siding	7/16" for maximum 16" stud spacing		0.092" dia., 0.225" dia. head nails with length to accommodate 1½" penetration into studs	4" edges 8" field
	ABW Alternate braced wall	⅜"		See Section R602.10.6.1	See Section R602.10.6.1
Intermittent Bracing Methods	**PFH** Portal frame with hold-downs	⅜"		See Section R602.10.6.2	See Section R602.10.6.2
	PFG Portal frame at garage	7/16"		See Section R602.10.6.3	See Section R602.10.6.3
Continuous Sheathing Methods	**CS-WSP** Continuously sheathed wood structural panel	⅜"		Exterior sheathing per Table R602.3(3)	6" edges 12" field
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener
	CS-G[b,c] Continuously sheathed wood structural panel adjacent to garage openings	⅜"		See Method CS-WSP	See Method CS-WSP
	CS-PF Continuously sheathed portal frame	7/16"		See Section R602.10.6.4	See Section R602.10.6.4
	CS-SFB[a] Continuously sheathed structural fiberboard	½" or 25/32" for maximum 16" stud spacing		1½" long × 0.12" dia. (for ½" thick sheathing) 1¾" long × 0.12" dia. (for 25/32" thick sheathing) galvanized roofing nails or 8d common (2½" long × 0.131" dia.) nails	3" edges 6" field

Let-in Bracing (LIB) and Gypsum Board (GB) are the weakest of the bracing materials. This can be recognized by referring to Table R602.10.3(1). Notice that these two methods require more bracing than their counterparts, intermittent and continuous sheathing under the same conditions.

Intermittent and continuous methods have their origin in the IBC.

"SHEAR" WALLS = IBC

"BRACED" WALLS = IRC



"SEGMENTED" SHEAR WALLS = "INTERMITTENT" BRACED WALLS

"PERFORATED" SHEAR WALLS = "CONTINUOUS" BRACED WALLS

The two most common <u>intermittent sheathing</u> methods are:

- Wood Structural Panels (WSP) (plywood, OSB)
- Structural Fiber Board (SFB)

While both methods provide the same bracing, note that the requirements in Table R602.10.4 specifies that SFB shall have twice as many nails as the WSP.

The three most common <u>continuous sheathing</u> methods are:

- Continuously Sheathed – Wood Structural Panels (CS-WSP)
- Continuously Sheathed – Structural Fiberboard (CS-SFB)
- Continuously Sheathed- Portal Frame (CS-PF)

Note: the portal frame length is actually the wall portion, and does not include the header portion.

Portal frames are wood's approximate equivalent to a steel moment frame. The corners are so strongly constructed that they not only transfer vertical and horizontal forces, but also carry *bending moment*s around the corner.

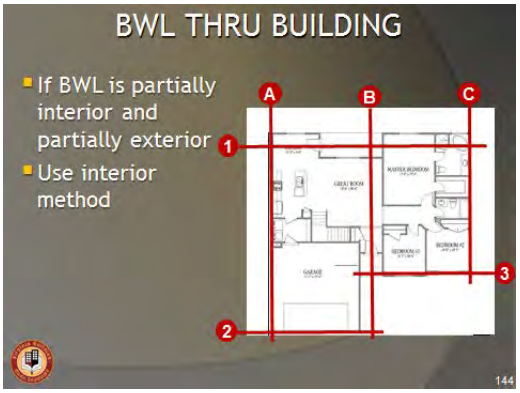
Wood portal frames cannot be calculated mathematically. The only way that their strength can be proven is by testing the whole assembly. Hence, no deviations from the portal frames are permitted. The specifics about each of the portal frames can be gleaned from the code's detail drawings.

Be cognizant of the following:

- The header must extend over the braced wall panel, not just to the jack studs,
- The header cannot be steel, and must be a minimum of (2) 2x12,
- The header cannot exceed 20' long,
- Nailing in the corner is 3" o.c., horizontal and vertical.
- A minimum 1000# strap is required on the inside of the portal frame. If there is a pony wall above the header, the strap will have to comply with Table RR602.10.6.4.
- Hold-downs or anchor bolts are specific to each portal frame design.

Portal frames can be a single portal, double portal or combinations of single and double portals.

If the BWL runs through the structure, with the outside being either intermittent or continuous, and the inside being either LIB or GB, use the more restrictive method – LIB or GB – when entering the Table R602.10.3(1).



CLASS EXAMPLE #1

REQUIRED LENGTH

TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
	2	STORY	
	3	BWL NAME / IDENTIFIER	
	4	AVERAGE BWL SPACING	feet
	5	BWP METHOD	
	6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
	8	EAVE - RIDGE HEIGHT	feet
	9	WALL HEIGHT	feet
	10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
	11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
	12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
	13	HORIZONTAL JOINTS BLOCKED?	YES NO
	14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
	15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

Line 6: tabular required BWP length

CLASS EXAMPLE #1

All of the information has been accumulated to now look up the required length of bracing in Table R602.10.3(1).

REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

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

- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT EAVE-TO-RIDGE HEIGHT
- 10 FOOT 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[a]			
			Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 90		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
		40	12.5	12.5	7.5	6.0
		50	15.5	15.5	9.0	7.5
		60	18.5	18.5	10.5	9.0
		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
		40	24.0	24.0	14.0	12.0
		50	29.5	29.5	17.0	14.5
		60	35.0	35.0	20.0	17.0
		10	NP	10.5	6.0	5.0
		20	NP	19.0	11.0	9.5
		30	NP	27.5	15.5	13.5
		40	NP	35.5	20.5	17.5
		50	NP	44.0	25.0	21.5
		60	NP	52.0	30.0	25.5

6

SKILL CHECK 2.8

Based on the information provided on the work sheet below, what is the tabular required bracing for this structure?

H OF BRACING	TABULAR LENGTH R602.10.3(1)			
	1	WIND SPEED (mph)	85, 90, 100, <110
	2	STORY	
	3	BWL NAME / IDENTIFIER	A
	4	AVERAGE BWL SPACING	45 feet
	5	BWP METHOD	cs-wsp
	6	TABULAR REQUIRED BWP LENGTH (minimum)	feet

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

• EXPOSURE CATEGORY B • 30 FOOT MEAN ROOF HEIGHT • 10 FOOT EAVE-TO-RIDGE HEIGHT • 10 FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 85		10	3.5	3.5	2.0	1.5
		20	6.0	6.0	3.5	3.0
		30	8.5	8.5	5.0	4.5
		40	11.5	11.5	6.5	5.5
		50	14.0	14.0	8.0	7.0
		60	16.5	16.5	9.5	8.0
		10	6.5	6.5	3.5	3.0
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8.0
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.0	13.0
		60	31.5	31.5	18.0	15.5
		10	NP	9.0	5.5	4.5
		20	NP	17.0	10.0	8.5
		30	NP	24.5	14.0	12.0
		40	NP	32.0	18.0	15.5
		50	NP	39.0	22.5	19.0
		60	NP	46.5	26.5	22.5
≤ 90		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
		40	12.5	12.5	7.5	6.0
		50	15.5	15.5	9.0	7.5
		60	18.5	18.5	10.5	9.0
		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
		40	24.0	24.0	14.0	12.0
		50	29.5	29.5	17.0	14.5
		60	35.0	35.0	20.0	17.0
		10	NP	10.5	6.0	5.0
		20	NP	19.0	11.0	9.5
		30	NP	27.5	15.5	13.5
		40	NP	35.5	20.5	17.5
		50	NP	44.0	25.0	21.5
		60	NP	52.0	30.0	25.5

(continued)

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

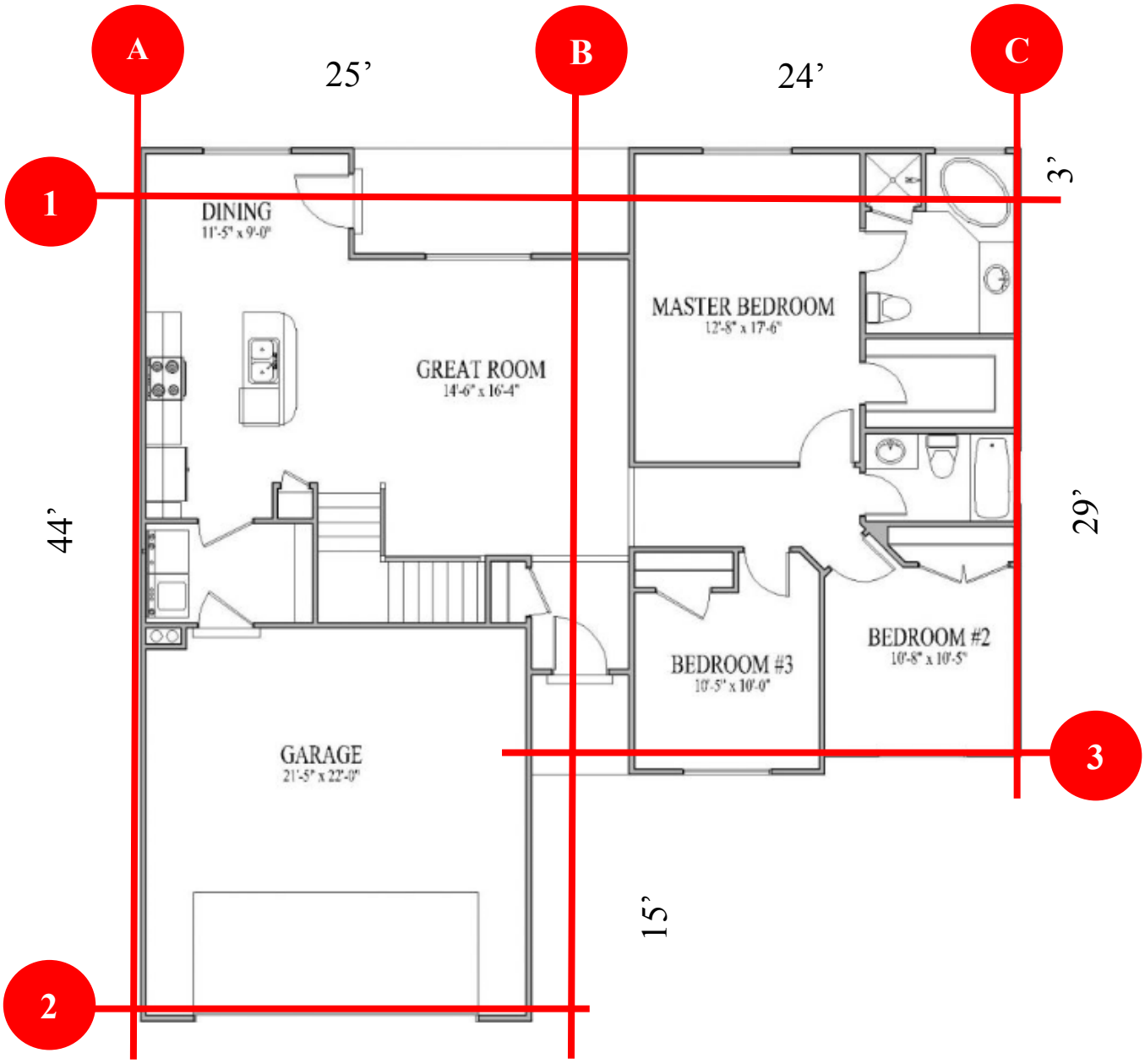
• EXPOSURE CATEGORY B • 30 FOOT MEAN ROOF HEIGHT • 10 FOOT EAVE-TO-RIDGE HEIGHT • 10 FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 100		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	19.0	19.0	11.0	9.5
		60	22.5	22.5	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.0	8.0
		30	23.0	23.0	13.0	11.0
		40	29.5	29.5	17.0	14.5
		50	36.5	36.5	21.0	18.0
		60	43.5	43.5	25.0	21.0
		10	NP	12.5	7.5	6.0
		20	NP	23.5	13.5	11.5
		30	NP	34.0	19.5	16.5
		40	NP	44.0	25.0	21.5
		50	NP	54.0	31.0	26.5
		60	NP	64.0	36.5	31.0
< 110[c]		10	5.5	5.5	3.0	3.0
		20	10.0	10.0	6.0	5.0
		30	14.5	14.5	8.5	7.0
		40	18.5	18.5	11.0	9.0
		50	23.0	23.0	13.0	11.5
		60	27.5	27.5	15.5	13.5
		10	10.5	10.5	6.0	5.0
		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	25.5
		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

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 mile per hour = 0.447 m/s.
a. Linear interpolation shall be permitted.
b. Method LIB shall have gypsum board fastened to at least one side with nails or screws in accordance withTable R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.
c. Method CS-SFB does not apply where the wind speed is greater than 100 mph.

SKILL CHECK 2.9

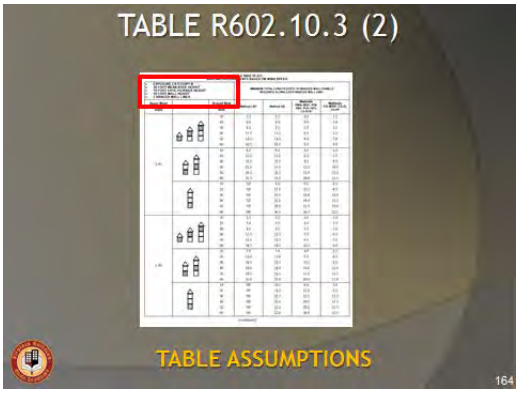
What is the tabular required length for bracing for BWL B?

Wind	90 mph
Method	Exterior OSB, Interior GB
Floor	1st of 2-story



ADJUSTMENTS

The assumptions made in regards to Table R602.10.3(1) are contained in the upper left corner of the table:



- Exposure category B
- 30’ mean roof height
- 10’ eave-to-ridge height
- 10’ tall walls
- 2 braced wall lines in one plan direction

Any changes to these assumptions require an adjustment to the tabular required bracing.

The adjustments for wind are in Table R602.10.3(2). They include adjustments for:

- Exposure category,
- Eave to ridge height
- Wall height
- Number of BWLs
- Additional hold-downs
- Omit GB on the inside of exterior BWPs
- Adding nails on interior walls using method GB
- Lateral blocking

TABLE R602.10.3(2)
WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ADJUSTMENT BASED ON	STORY/ SUPPORTING	CONDITION	ADJUSTMENT FACTOR[a, b] [multiply length from Table R602.10.3(1) by this factor]	APPLICABLE METHODS
Exposure category	One-story structure	B	1.00	All methods
		C	1.20	
		D	1.50	
	Two-story structure	B	1.00	
		C	1.30	
		D	1.60	
	Three-story structure	B	1.00	
		C	1.40	
		D	1.70	
Roof eave-to-ridge height	Roof only	≤ 5 feet	0.70	
		10 feet	1.00	
		15 feet	1.30	
		20 feet	1.60	
	Roof + 1 floor	≤ 5 feet	0.85	
		10 feet	1.00	
		15 feet	1.15	
		20 feet	1.30	
	Roof + 2 floors	≤ 5 feet	0.90	
		10 feet	1.00	
		15 feet	1.10	
		20 feet	Not permitted	
Wall height adjustment	Any story	8 feet	0.90	
		9 feet	0.95	
		10 feet	1.00	
		11 feet	1.05	
		12 feet	1.10	
Number of braced wall lines (per plan direction)[c]	Any story	2	1.00	
		3	1.30	
		4	1.45	
		≥ 5	1.60	
Additional 800-pound hold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB, PBS, PCP, HPS
Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB,PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound = 4.48 N.

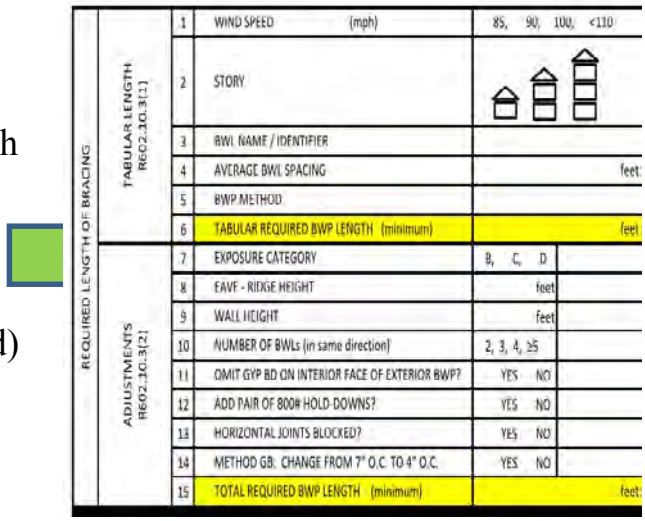
a. Linear interpolation shall be permitted.

b. The total adjustment factor is the product of all applicable adjustment factors.

c. The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.

Line 7: exposure category

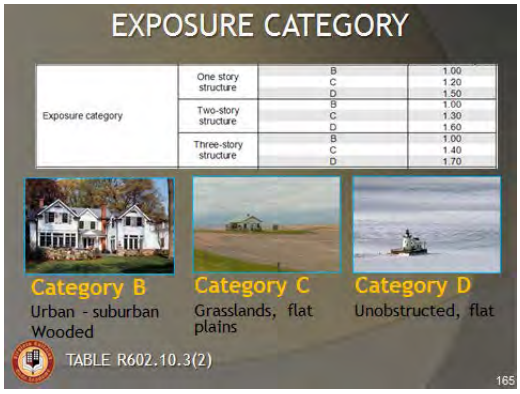
CLASS EXAMPLE #1



REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

Exposure categories can be found in Section R301.2.1.4. The options include:

- Exposure category A: Large cities with at least 50% of the buildings with a height in excess of 70' tall.
- Exposure category B: Urban and suburban areas, with wooded (buffered) lots. *Exposure B is automatically assumed.*
- Exposure category C: Open terrain and grasslands with scattered obstructions (trees) having typical heights less than 30', at least 1500 feet (approximately quarter mile) from the structure.
- Exposure category D: Flat, unobstructed areas exposed to winds flowing over open water for at least a mile.



Where a house is surrounded by trees on two or three sides and open water on the other side(s), the whole house has to be designed for Exposure category C.

Line 8: roof eave-to-ridge height

Eave-to-ridge height affects sail area and sail area dictates wall bracing:

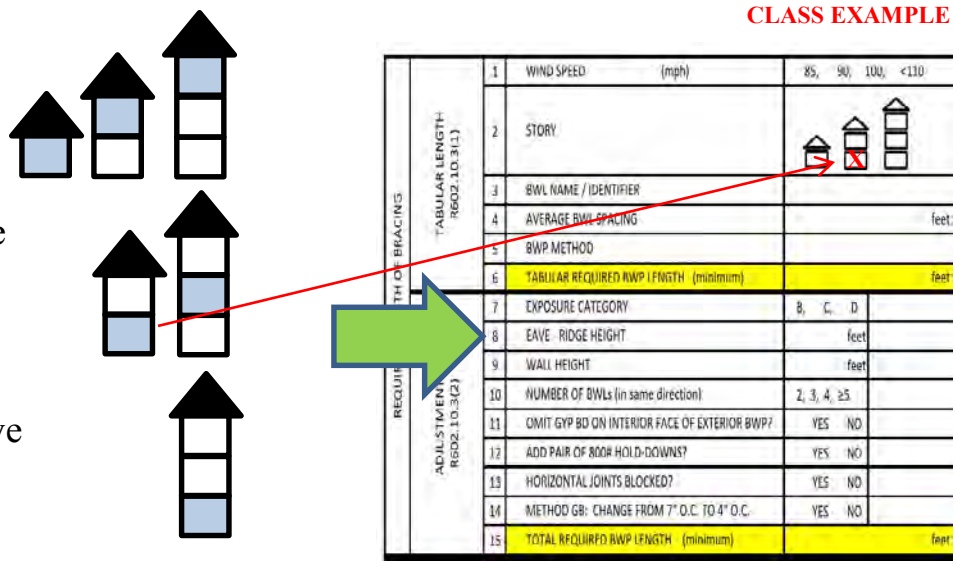
- Less than 10' eave-to-ridge, less sail area, and less bracing required,
- More than 10' eave-to-ridge, more sail area, and more bracing required.

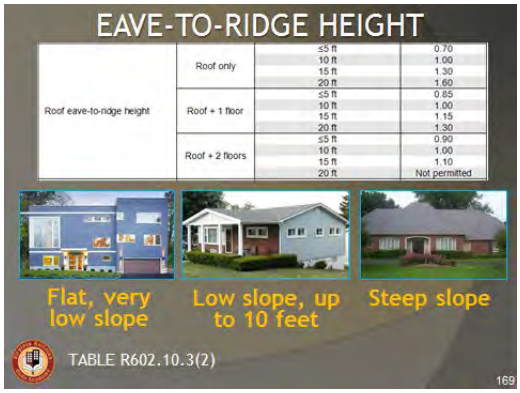
CLASS EXAMPLE #1

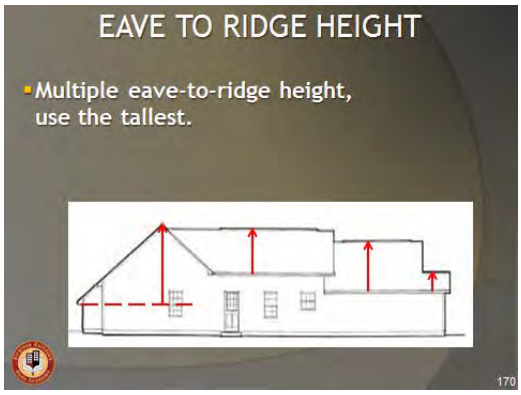
Roof only above

Roof and one floor above

Roof and two floors above







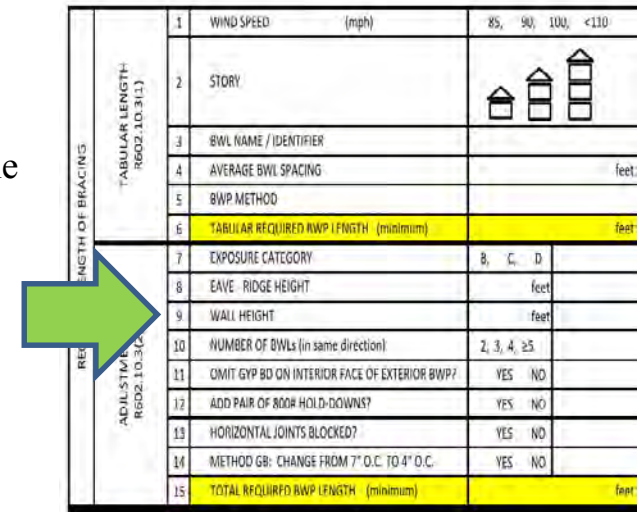
When the roof line has multiple eave-to-ridge heights, use the tallest height.

Line 9: wall height

CLASS EXAMPLE #1

The same concept applies for wall height as the eave-to-ridge height adjustment. The assumption is 10' wall height, as measured between the bottom of the bottom plate to the top of the top plate(s):

- If the wall height is less than 10', less sail area and less bracing required
- If the wall height is more than 10', more sail area and more bracing required.



TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110	
	2	STORY		
	3	BWL NAME / IDENTIFIER		
	4	AVERAGE BWL SPACING	feet	
	5	BWP METHOD		
	6	TABULAR REQUIRED BWP LENGTH (minimum)	feet	
ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D	
	8	EAVE RIDGE HEIGHT	feet	
	9	WALL HEIGHT	feet	
	10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5	
	11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO	
	12	ADD PAIR OF ROOF HOLD-DOWNS?	YES NO	
	13	HORIZONTAL JOINTS BLOCKED?	YES NO	
	14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO	
	15	TOTAL REQUIRED BWP LENGTH (minimum)	feet	

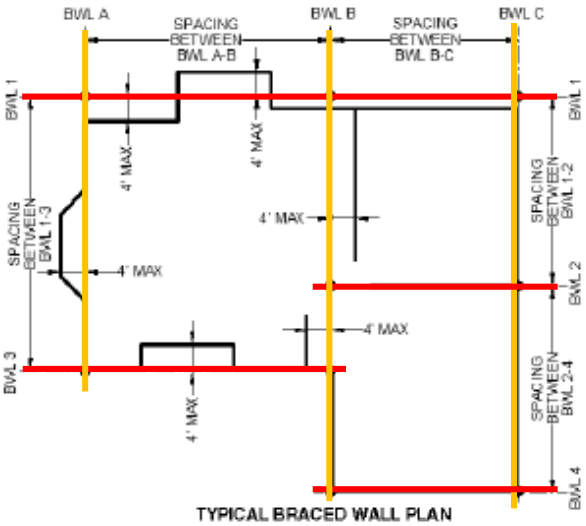
Line 10: number of BWLs

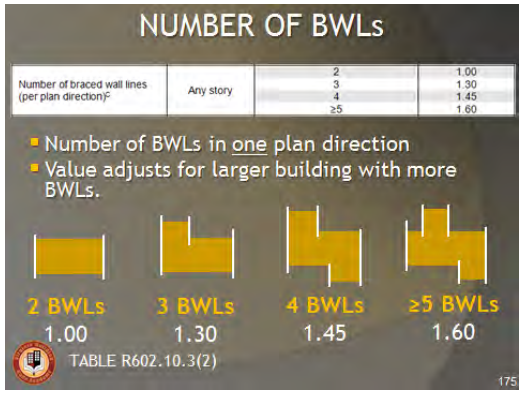
CLASS EXAMPLE #1

This adjustment factor counts the number of BWLs in one direction. The assumption in Table R602.10.3(1) is two BWLs. More than two BWLs requires more bracing – this appears to be counter-intuitive.

Remember: count only the number of BWLs in one plan direction.

ED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUS R602.1	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet



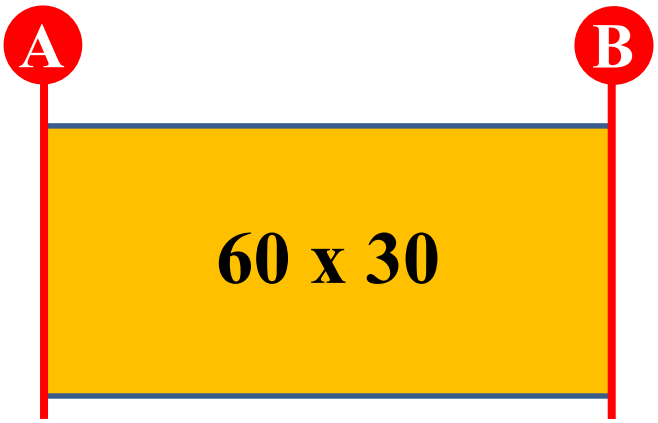


In this example, there are 3 BWLs running north/south, and 4 BWLs running east/west – not 7 BWLs.

Here is the reason it works and the reason it is imperative that the designer should be frugal with the placement of BWLs. More BWLs is not automatically a better thing.

Consider these two houses. Run the calculations and see if you can understand the logic.

The *PURE* solution

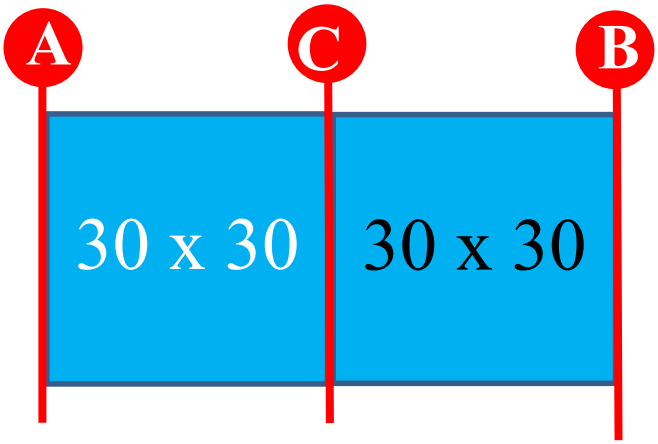


Assume

- 90 mph
- 1 story
- CS-WSP

Wall bracing spacing A-B ____ft

Tabular length required for A ____ft
Tabular length required for B ____ft
Total tabular length north/south ____ft



Now consider the same house but with one additional BWL.

Wall bracing spacing A-C, B-C ____ft

Tabular length required for A ____ft
Tabular length required for B ____ft
Tabular length required for C ____ft
Total tabular length north/south ____ft

Adjustment factor 3 BWLs ____
Total adjusted length required ____ft

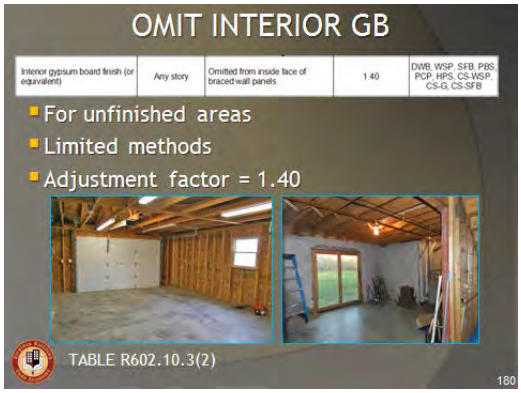
How many BWLs doe our CLASS EXAMPLE #1 have?

Line 11: omit GB on the inside of exterior BWPs

There is a 1.4 correction factor (i.e. 40% penalty) for omitting GB on the inside of the exterior BWPs. What this adjustment factor implies is that 40% of the bracing capability of an exterior BWP is provided by the GB and 60% by the exterior sheathing.

CLASS EXAMPLE #1

REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet



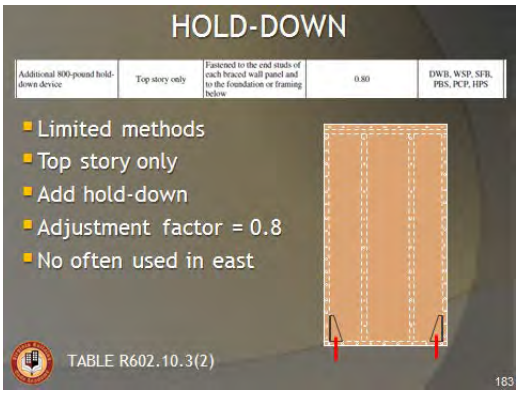
Line 12: add one 800# hold-down

By adding one 800# hold-down, there is a 30% reduction in the length of required bracing.

This can be a practical and inexpensive way to resolve a problem when you are short on wall bracing.

CLASS EXAMPLE #1

REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

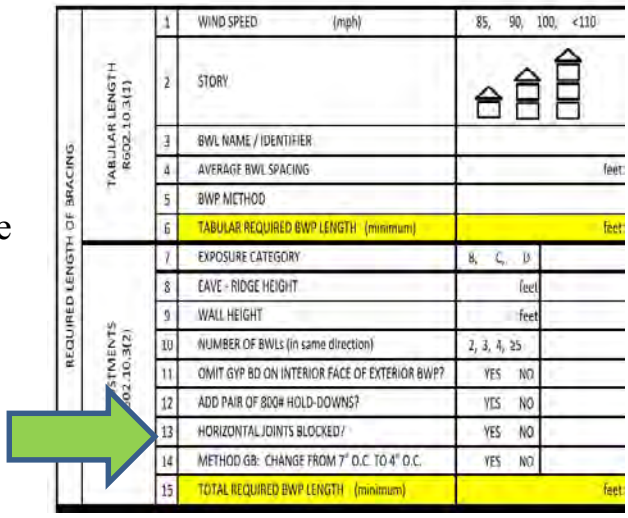


800# hold-down

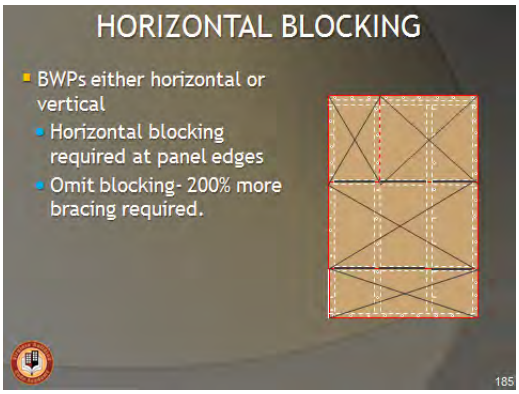
Line 13: horizontal joints blocked

CLASS EXAMPLE #1

BWP do not have to be full sections of sheathing. The "panel" can be fabricated from pieces of sheathing, as long as the horizontal joints are blocked. If the joints are not blocked, the adjustment factor penalizes the installation by 100%, that is, twice as much bracing is required. This is a rare event that the plan reviewer would not likely ever discover. However, the inspectors have to be cognizant of this.



REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	
		4	AVERAGE BWL SPACING	feet
		5	BWP METHOD	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D
		8	EAVE - RIDGE HEIGHT	feet
		9	WALL HEIGHT	feet
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO
		13	HORIZONTAL JOINTS BLOCKED?	YES NO
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO
		15	TOTAL REQUIRED BWP LENGTH (minimum)	feet

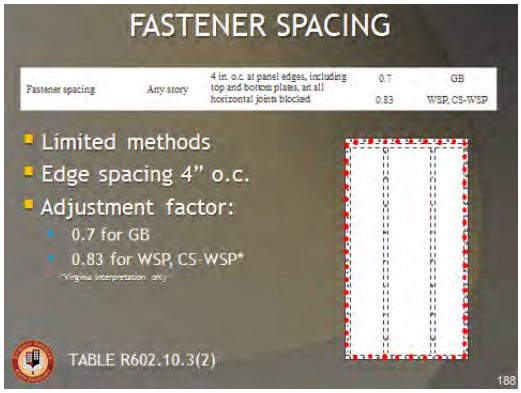


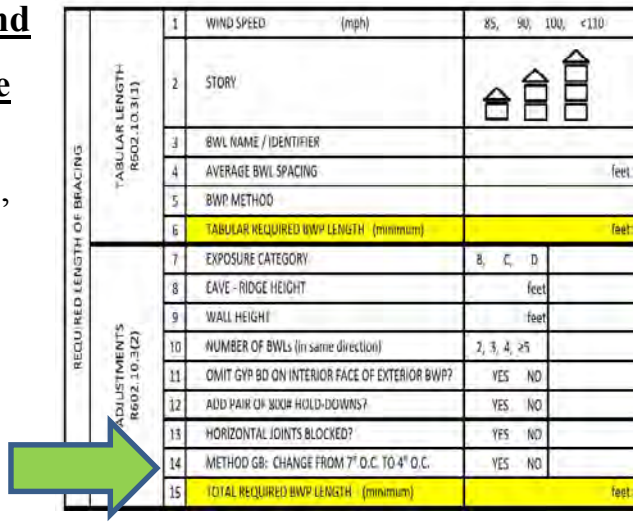
Line 14: For *method GB*, nail GB at 4" o.c. instead of 7" o.c.

CLASS EXAMPLE #1

Note: This only applies for method GB, and not when GB is used as the interior surface of exterior sheathing.

There is a 30% credit if the GB is nailed at 4" o.c. instead of the required 7" o.c.

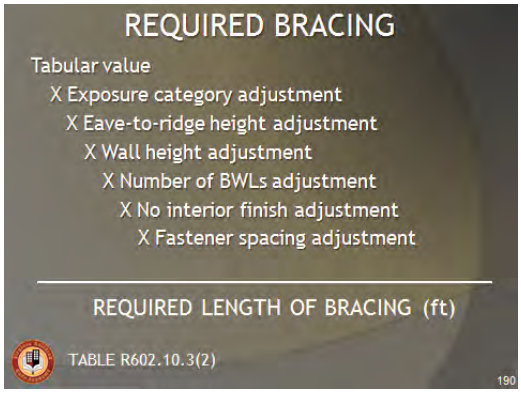


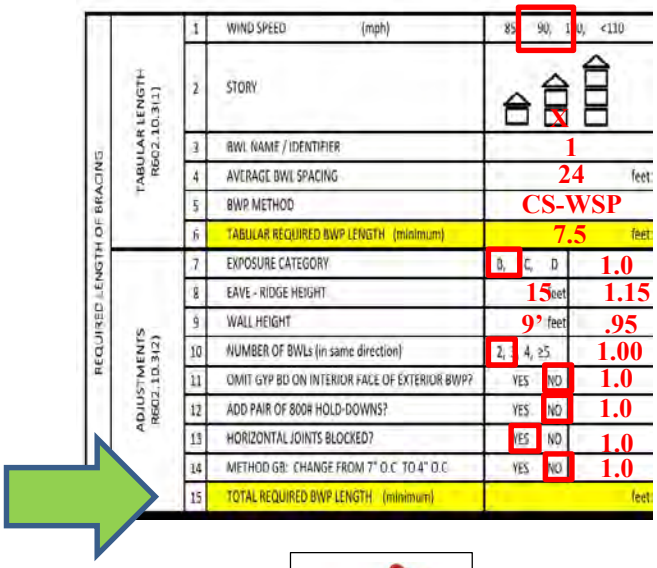


Line 15: total required length of bracing

CLASS EXAMPLE #1

To get the total required length of bracing, *multiply* the tabular value in line 6, by each of the adjustment factors.





- The penalty for extra BWLs appears severe. Be frugal with them.
- It might be more advantageous to run BWLs thru the house rather than start and stop them multiple times along the same side of the house.

- To actually do a calculation and get it to pass might require several trial and error attempts.

- This class is intended for use with structures in SDC A-B-C.
- Structure in SDC D, and townhouses in SDC C, have to use the more conservative (typically seismic) values in
  table R602.10.3(1) or (3)
  and adjustments in R602.10.3(2) and (4) respectively.
- The work sheet will work with SDC C-D, you just have to use the other similar tables which we have not discussed in this class.

SKILL CHECK 2.10

What is the tabular length of bracing required?

TH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110
		2	STORY	
		3	BWL NAME / IDENTIFIER	1
		4	AVERAGE BWL SPACING	30 feet
		5	BWP METHOD	WSP
		6	TABULAR REQUIRED BWP LENGTH (minimum)	feet

A. 9.0’,

B. 10.5’,

C. 15.5’,

D. 18.5’

SKILL CHECK 2.11

What is the adjustment factor for a

- 20’ eave-to-ridge height
- 2nd floor of a 3- story house?

A. 1.10

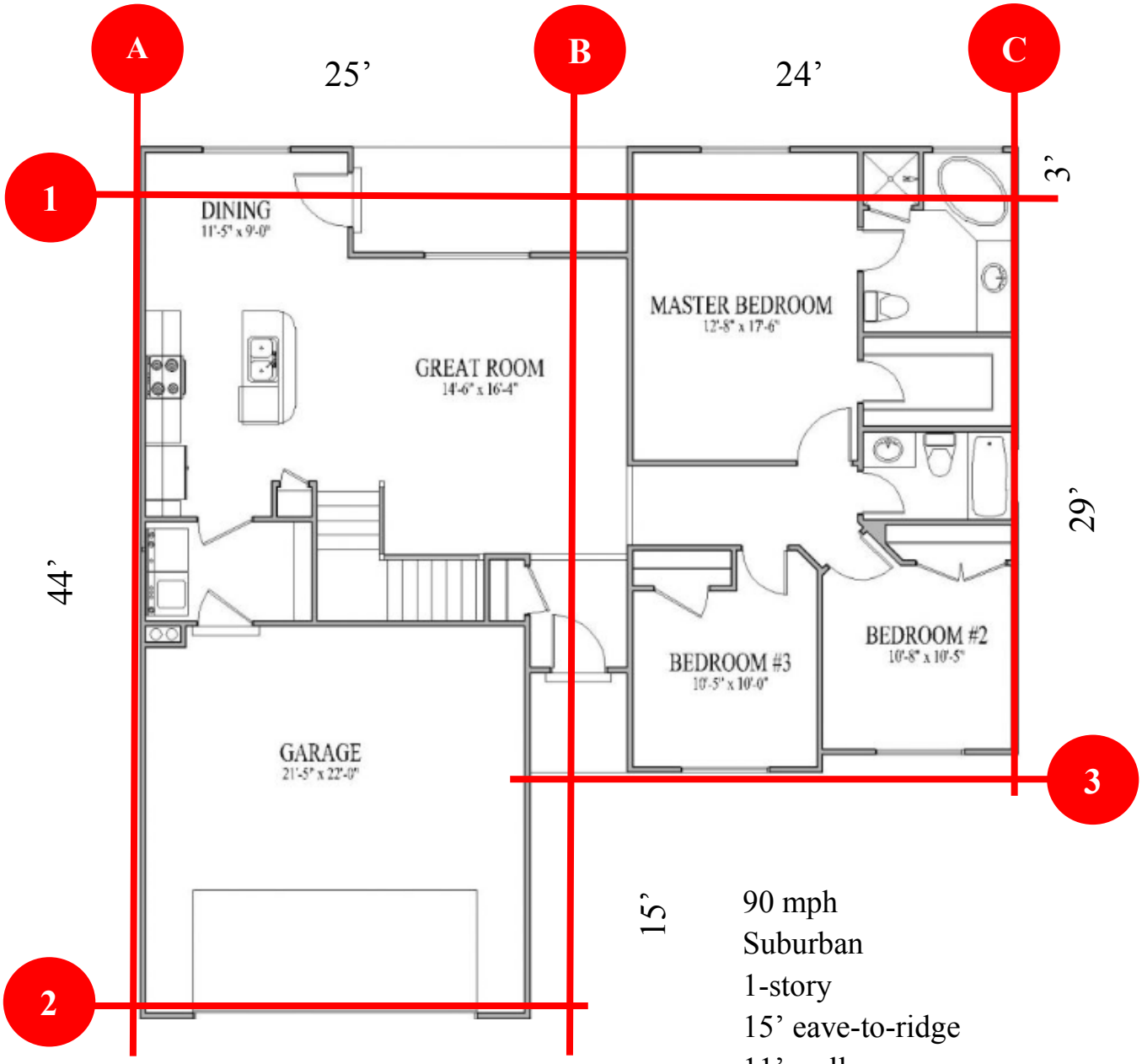
B. 1.30

C. 1.60

D. Not permitted

SKILL CHECK 2.12

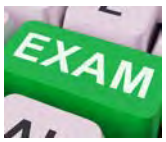
You be the plan reviewer. BWL #1 Was the work sheet (see next page) calculated correctly for this house?



90 mph
Suburban
1-story
15’ eave-to-ridge
11’ walls
Method WSP

REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85 90, 100, <110	
		2	STORY	X	
		3	BWL NAME / IDENTIFIER	1	
		4	AVERAGE BWL SPACING	40 feet	
		5	BWP METHOD	WSP	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	7.5 feet	
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D	
		8	EAVE - RIDGE HEIGHT	15 feet	1.3
		9	WALL HEIGHT	11 feet	1.05
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5	
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO	
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO	
		13	HORIZONTAL JOINTS BLOCKED?	YES NO	
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO	
		15	TOTAL REQUIRED BWP LENGTH (minimum)	10.25 feet	

GO TO CLASS EXAMPLE #2 IN THE BACK OF THE BOOK
Complete lines 1-15



- Actual BWPs
- Minimum length of qualified BWPs
- Contributing length
- Mixing methods

Lines 16-23: Actual BWPs

Now that the required length of wall bracing has been calculated, the worksheet will now prompt you to determine how much wall bracing has actually been provided, and if it is sufficient.

The actual length of wall bracing will be dependent on the method and its "contributing" length. Not all methods contribute equally, and not all wall sheathing counts towards the *required length of bracing*.

CLASS EXAMPLE #1

REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110		
		2	STORY			
		3	BWL NAME / IDENTIFIER			
		4	AVERAGE BWL SPACING			feet
		5	BWP METHOD			
		6	TABULAR REQUIRED BWP LENGTH (minimum)			feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D		
		8	EAVE - RIDGE HEIGHT	feet		
		9	WALL HEIGHT	feet		
		10	NUMBER OF BWLs (in same direction)	2, 3, 4, ≥5		
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES	NO	
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES	NO	
		13	HORIZONTAL JOINTS BLOCKED?	YES	NO	
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES	NO	
		15	TOTAL REQUIRED BWP LENGTH (minimum)			feet
ACTUAL LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1		
		18	WSP, SFB = ACTUAL	2		
		19	SS - GB = ½ ACTUAL	3		
		20	DS - GB = ACTUAL	4		
		21	CS-PF = 1.5 X ACTUAL	5		
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED			feet
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH	YES	NO	
LOCATION	R602.10.2.2	26	BWPs ≤ 20 FEET APART?	YES	NO	
		27	BWP LENGTH			feet
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)	YES	NO	
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END	YES	NO	
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION	END 1	END 2	
		31	PASS / FAIL	PASS	FAIL	

"MINIMUM BWP LENGTH" can be defined as the minimum horizontal dimension of a sheathed wall panel in order to be qualified as a braced wall panel.

Sometimes "BWP length" is incorrectly labeled "width".

MINIMUM LENGTH OF A QUALIFIED BWP

In order to be deemed a *qualified* BWP it must be of sufficient length as to meet the requirements of Table R602.10.5. This table lists all of the recognized bracing methods, both intermittent and continuous.

TABLE R602.10.5
MINIMUM LENGTH OF BRACED WALL PANELS

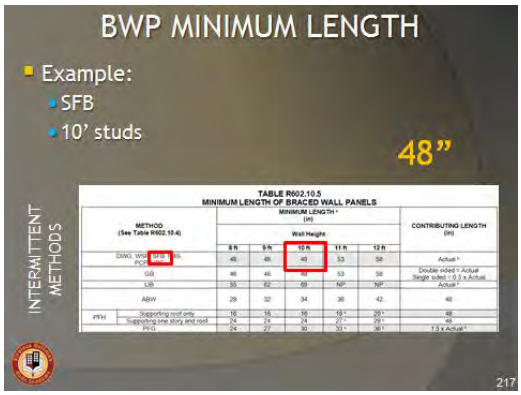
METHOD (See Table R602.10.4)		MINIMUM LENGTH [a] (in) Wall Height 8 ft	9 ft	10 ft	11 ft	12 ft	CONTRIBUTING LENGTH (in)
DWG, WSP, SFB, PBS, PCP, HPS		48	48	48	53	58	Actual [b]
GB		48	48	48	53	58	Double sided = Actual Single sided = 0.5 x Actual
LIB		55	62	69	NP	NP	Actual [b]
ABW		28	32	34	38	42	48
PFH	Supporting roof only	16	16	16	18 [c]	20 [c]	48
	Supporting one story and roof	24	24	24	27 [c]	29 [c]	48
PFG		24	27	30	33 [c]	36 [c]	1.5 x Actual [b]
CS-G		24	27	30	33	36	Actual [b]
CS-PF		16	18	20	22 [c]	24 [c]	1.5 x Actual [b]
CS-WSP, CS-SFB	Adjacent opening vertical dimension (in)						
	≤ 64	24	27	30	33	36	Actual [b]
	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	
	104		49	43	40	39	
	108		54	46	43	41	
	112			50	45	43	
	116			55	48	45	
	120			60	52	48	
	124				56	51	
	128				61	54	
	132				66	58	
	136					62	
	140					66	
	144					72	

Notice that while wall studs in chapter 6 are limited to 10’ tall, there is an exception in Section R301.3 that allows walls to be 12’ tall if they comply with R602.

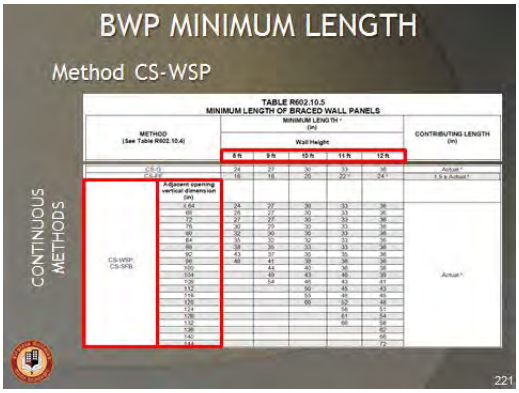
The top portion of Table R602.10.5 shows the intermittent methods for wall heights between 8’ and 12’. Based on the height of the BWP, the minimum <u>qualified</u> length is provided.

Note that LIB is based on being laid up at a 60 degree angle above horizontal.

Example: Structural Fiberboard (SFB) panels that are 10’ tall must be at least 48” long in order to be qualified as a BWP.

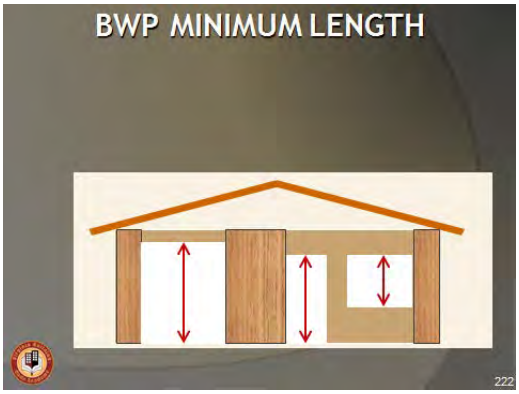


The bottom of Table R602.10.5 shows the continuous wall bracing methods. However the minimum length for CS-WSP and CS-SFB is determined slightly different. The minimum length to be considered *qualified,* is a function of the adjacent wall openings on either side of the BWP. It is a function of the strength of the material above and below any openings.



Notice that the table is not a linear distribution of the length in all cases, and hence more or less may be required depending on the height of the wall. This is NOT a mistake, but based on engineered calculations.

When there are openings on both sides of the BWP, the minimum length is based on the taller of the two openings.



Example 1: the shortest qualified 9' tall, CS-WSP with a 62" tall window is 27".

Example 2: the shortest qualified 9' tall, CS-WSP with an 80" tall door is 30".

SKILL CHECK 3.1

What is the minimum length of 12' tall gyp board, if it is to be considered a qualified BWP?

A. 48"

B. 53"

C. 55"

D. 58"

SKILL CHECK 3.2

What is the minimum length for a 10' tall, PFH supporting a floor and a roof above, if it is to be considered a qualified BWP?

A. 16"

B. 18"

C. 20"

D. 24"

E. 27"

F. 29"

SKILL CHECK 3.3

Is this a qualified bracing panel?

Yes or No

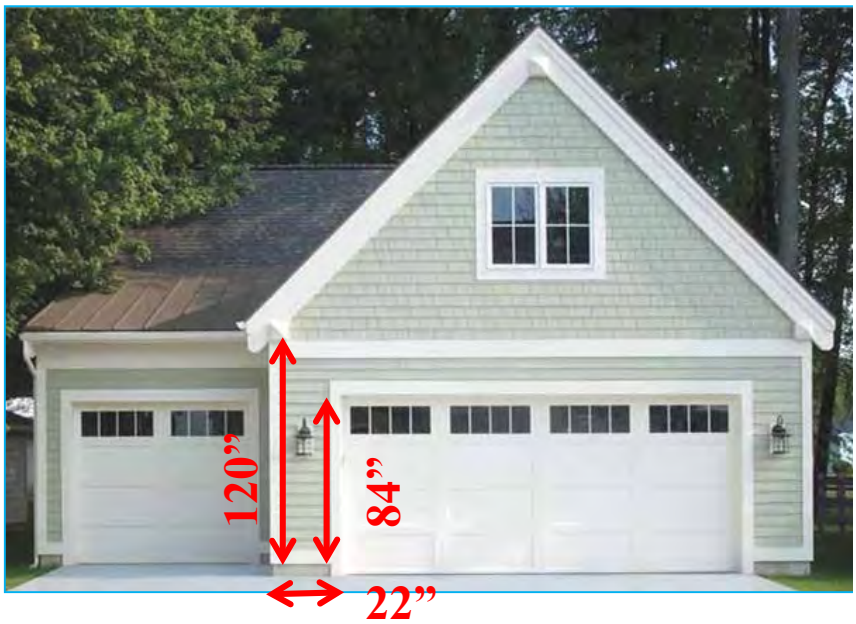
SKILL CHECK 3.4

Would either of these methods qualify as a bracing panel?

CS-PF?

or

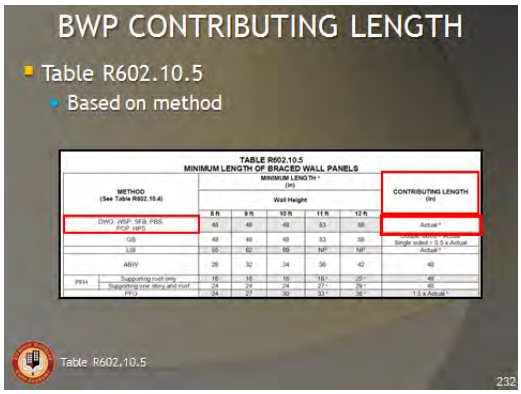
CS-WSP?



CONTRIBUTING LENGTH

Not all braced wall panels are capable of carrying the same loads. Because of this, Table R602.10.5 provides a "contributing" allowance for each method.

Intermittent methods, like WSP, contribute their *actual* length. A 72" long WSP would be given 72" of credit.



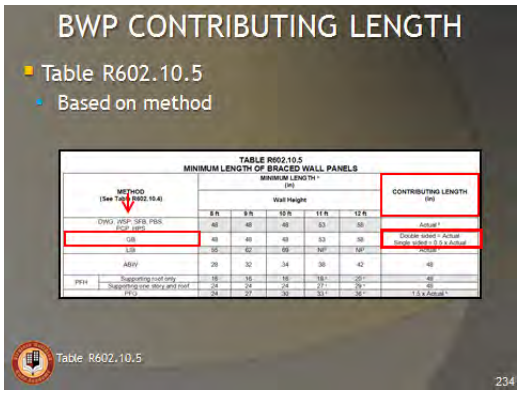
For methods WSP and SFB partial credit can be taken for panel lengths less than what is shown in Table R602.10.5.

TABLE R602.10.5.2
PARTIAL CREDIT FOR BRACED WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH

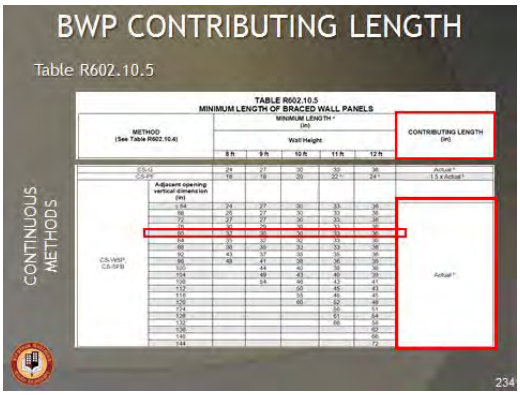
ACTUAL LENGTH OF BRACED WALL PANEL (Inches)	CONTRIBUTING LENGTH OF BRACED WALL PANEL (Inches)[a]	
	8-foot Wall Height	9-foot Wall Height
48	48	48
42	36	36
36	27	N/A

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
N/A = Not Applicable.
a. Linear interpolation shall be permitted.

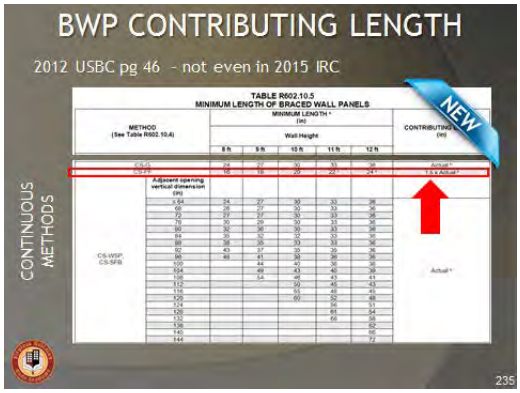
GB contributes its *actual* length if it is double sided, but only half if it is sheathed on one side only. For the sake of differentiating between the two options, double sided GB is sometimes referred to as DSGB (not in the code book per se); likewise single sided GB is sometimes referred to as SSGB (also not in the code book per se).

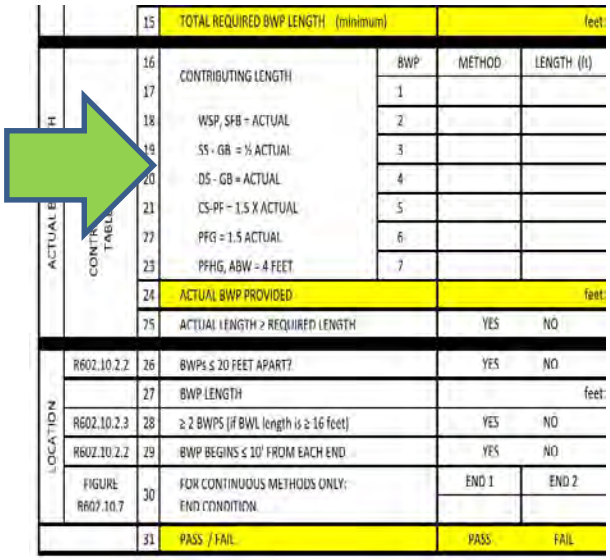


Similarly, CS-WSP and CS-SFB contribute their actual length, assuming that they meet the minimum qualified length.



CS-PF in the 2012 VA Code mimics the contributing length from the 2015 IRC; it provides 1.5x actual length, again assuming the portal(s) meet the minimum qualified length.





		15	TOTAL REQUIRED BWP LENGTH (minimum)			feet
ACTUAL BWP CONTRIBUTING TABLE		16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1		
		18	WSP, SFB = ACTUAL	2		
		19	SS - GB = ½ ACTUAL	3		
		20	DS - GB = ACTUAL	4		
		21	CS-PF = 1.5 X ACTUAL	5		
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED			feet
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO
LOCATION	R602.10.2.2	26	BWPs ≤ 20 FEET APART?		YES	NO
		27	BWP LENGTH			feet
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES	NO
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END		YES	NO
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2
		31	PASS / FAIL		PASS	FAIL

Line 24: Calculate the actual BWP length provided

Add the lengths of the individual BWPs to determine the total length of the actual BWPs provided.

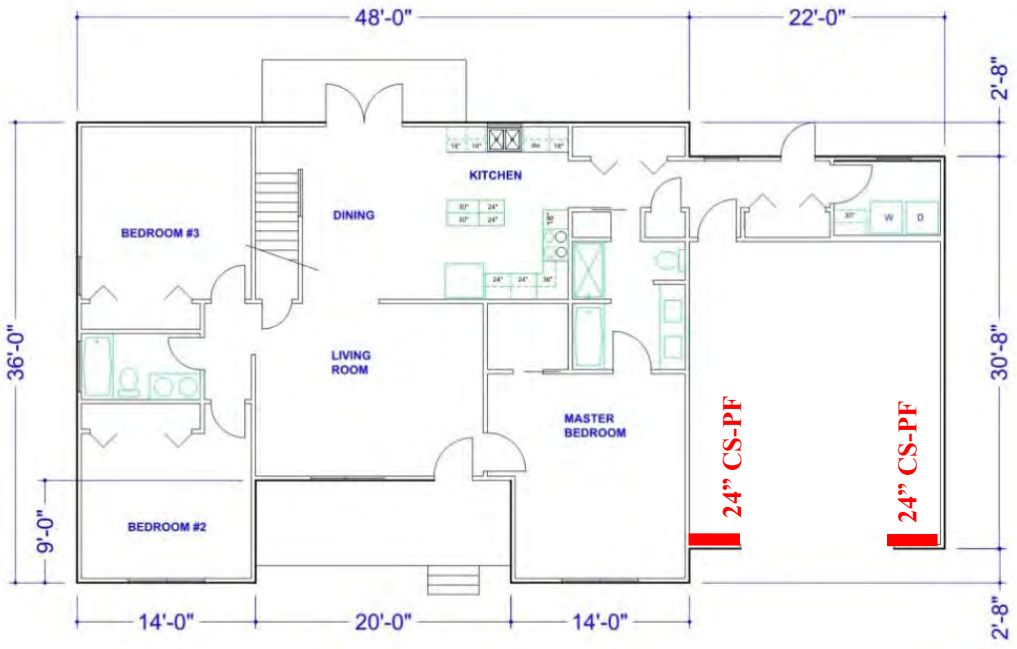
Line 25: Compare the actual length to the required length.

Compare lines 15 and 25. Is the actual length of bracing greater or equal to the required length of bracing?

		15	TOTAL REQUIRED BWP LENGTH (minimum)			feet:
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1		
		18	WSP, SFB = ACTUAL	2		
		19	SS - GB = ½ ACTUAL	3		
		20	DS - GB = ACTUAL	4		
		21	CS-PF = 1.5 X ACTUAL	5		
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED			feet:
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO
ON	R602.10.2.2	26	BWPs ≤ 20 FEET APART?		YES	NO
		27	BWP LENGTH			feet:
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES	NO
	602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END		YES	NO
	RE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2
		31	PASS / FAIL		PASS	FAIL

SKILL CHECK 3.5

How much contributory length do I get from the two 24” CS-PFs at the garage with the 2012 IRC? With the 2015 IRC?



SKILL CHECK 3.6

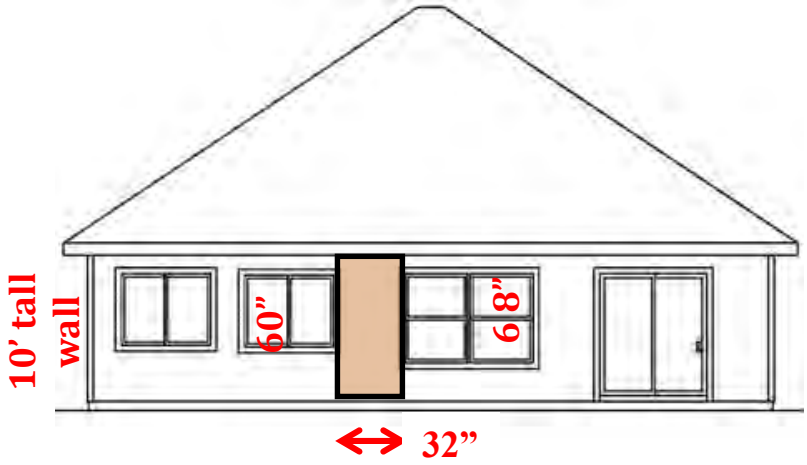
The contractor is having difficulty making this BWL compliant. If the contractor changes from intermittent WSP to CS-WSP along this BWL, how much <u>extra</u> bracing can he get credit for?

A. 0”

B. 30”

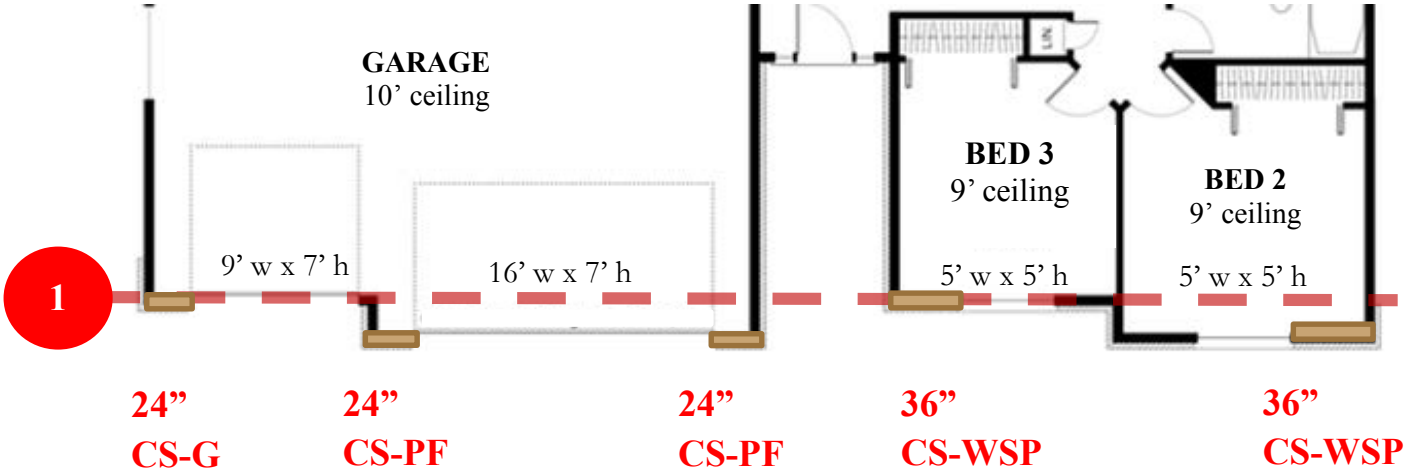
C. 32”

D. 48”



SKILL CHECK 3.7

Using the spreadsheet, calculate the cumulative, contributing length from these BWPs?



		15	TOTAL REQUIRED BWP LENGTH (minimum)			feet
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1		
		18	WSP, SFB = ACTUAL	2		
		19	SS - GB = ½ ACTUAL	3		
		20	DS - GB = ACTUAL	4		
		21	CS-PF = 1.5 X ACTUAL	5		
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED			feet
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO

MIXING METHODS

The code allows the builders to mix bracing methods along the same BWL. While we typically see continuous sheathing, not all parts of the country do it this way. Hence, the code offers several rules for mixing methods.

Mixing Rule 1: You can mix methods between floors. The method you use on the first floor can be different on the second floor.
Example: CS-WSP on the first floor and WSP on the second floor.

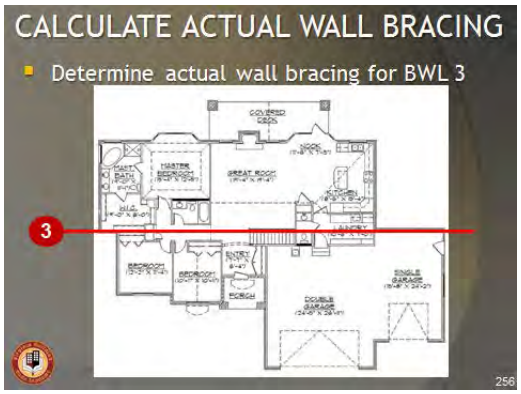
Mixing Rule 2: You can mix intermittent methods on the same BWL. Or you can mix continuous methods on the same BWL. Normally you cannot mix continuous and intermittent methods on the same BWL. However, if you mix methods on the same BWL, you have to do the calculations based on the weakest of the methods chosen.
Example: WSP and SFB on the same wall line.

Mixing Rule 3: You cannot mix CS-WSP and CS-SFB on the same BWL. Continuous method must be continuous. You can however use CS-WSP on one BWL and CS-SFB on a different BWL.

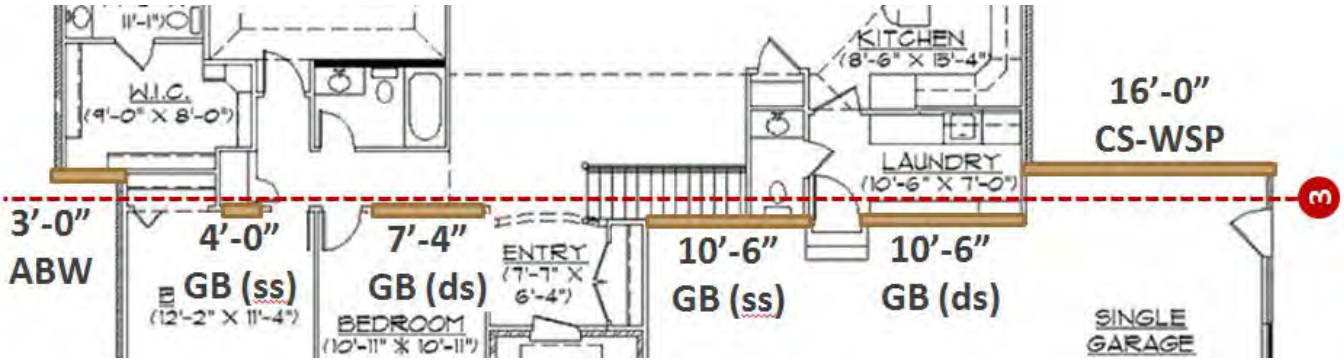
Mixing Rule 4: You can mix any of the narrow methods (ABW, PFH, PFG, CS-PF) with CS-WSP.
Example: CS-WSP and CS-PF on the same BWL.

Mixing Rule 5: When the BWL extends through the structure, and there is part of the wall line that is an exterior wall and part of the wall line that is an interior wall, you can mix intermittent and continuous methods. Again, when doing the calculation, you have to use the weakest method of the methods chosen.

Example:, you can use CS-WSP for the exterior walls, and method GB for the interior walls. The required length of bracing from Table R602.10.3(1) would be based on method GB.



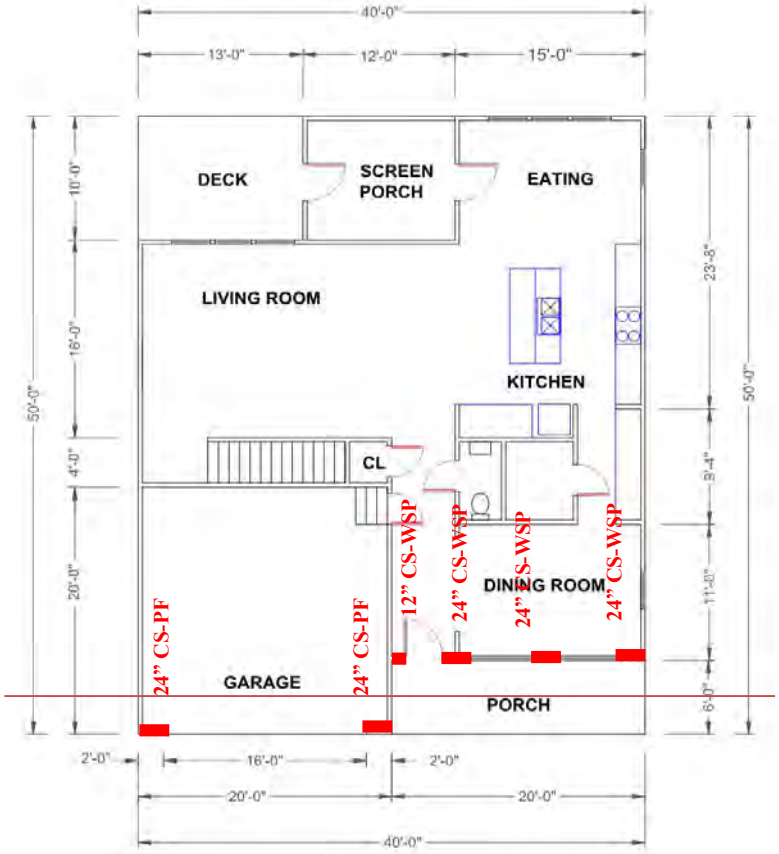
To see how the calculation would look, let us study this example using the work sheet.



ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1	ABW	4.0'
		18	WSP, SFB = ACTUAL	2	SSGB	2.0'
		19	SS - GB = ½ ACTUAL	3	DSGB	7.33'
		20	DS - GB = ACTUAL	4	SSGB	5.25'
		21	CS-PF = 1.5 X ACTUAL	5	DSGB	10.5'
		22	PFG = 1.5 ACTUAL	6	CS-WSP	16.0'
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED		45'-1"	feet
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO

SKILL CHECK 3.8

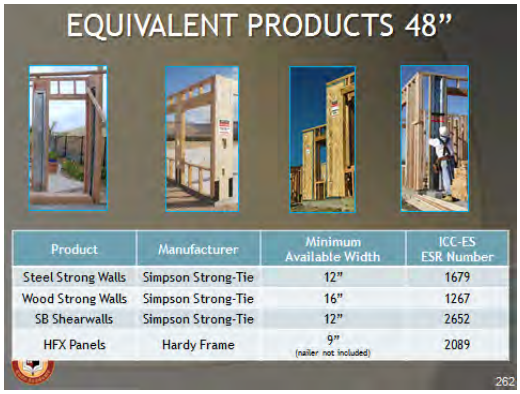
Was BWL #3 calculated correctly?



8' ceilings / house
10' ceiling / garage
7' tall garage door
5'-2" tall windows
6'-8" tall door

ACTUAL BWP	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		1	**CS-PF**	**2'**
		2	**CS-PF**	**2'**
		3	**CS-WSP**	**1'**
		4	**CS-WSP**	**2'**
		5	**CS-WSP**	**2'**
		6	**CS-WSP**	**2'**
		7		
ACTUAL BWP LENGTH (ft)				**11'**

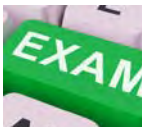
Proprietary, pre-manufactured braced wall systems are available. Each should have an ICC-ES (or equivalent) report stating how much "contributing" length the individual panels can be credit with.



Product	Manufacturer	Minimum Available Width	ICC-ES ESR Number
Steel Strong Walls	Simpson Strong-Tie	12"	1679
Wood Strong Walls	Simpson Strong-Tie	16"	1267
SB Shearwalls	Simpson Strong-Tie	12"	2652
HFX Panels	Hardy Frame	9" (nailer not included)	2089

Inspectors should be sure these panels are installed in accordance with the manufacturer's installation instructions.

GO TO CLASS EXAMPLE #2 IN THE BACK OF THE BOOK
Complete lines 17-25



MODULE 4: WALL BRACING LOCATIONS

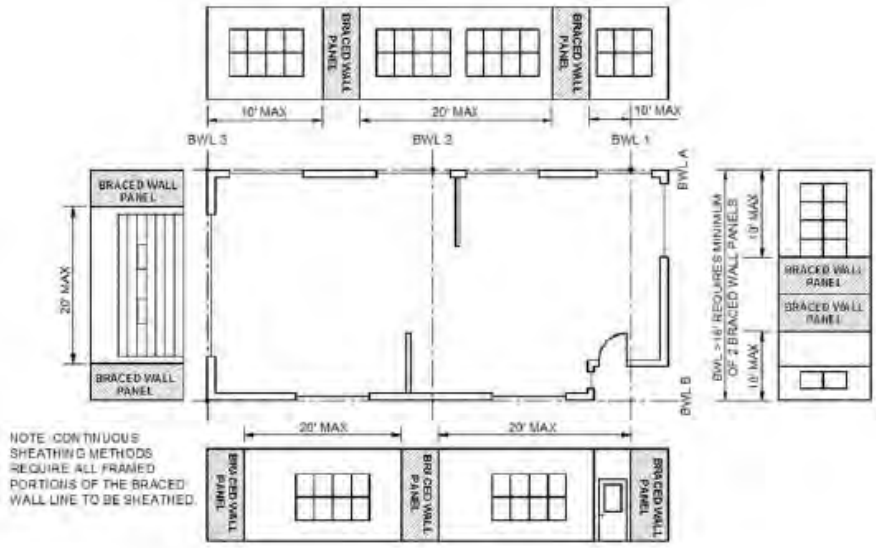
- Location requirements
- End conditions
- Connection issues for wall bracing
- Fuzzy issues

LOCATION REQUIREMENTS

It is not enough to just have the correct length of bracing; the bracing must be distributed along the walls within a prescribed set of rules. The final part of the work sheet prompts you with questions to ascertain where the BWPs should be located with respect to the BWL, not to the actual house walls.

The code does not want all of the bracing in one corner of the house (i.e. make one corner of the house very rigid, and the other portions of the house very flexible).

The code book offers a good illustration of the location requirements.

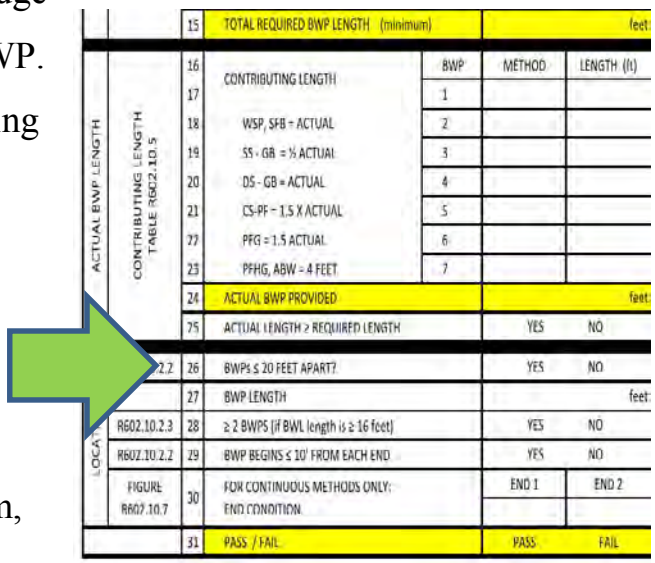


For SI: 1 foot = 304.8 mm.

FIGURE R602.10.2.2
LOCATION OF BRACED WALL PANELS

Line 26: Are the BWPs ≤ 20' apart?

The measurement is made from the right edge of one BWP to the left edge of the next BWP. The infill between the BWPs can be anything or even an opening.



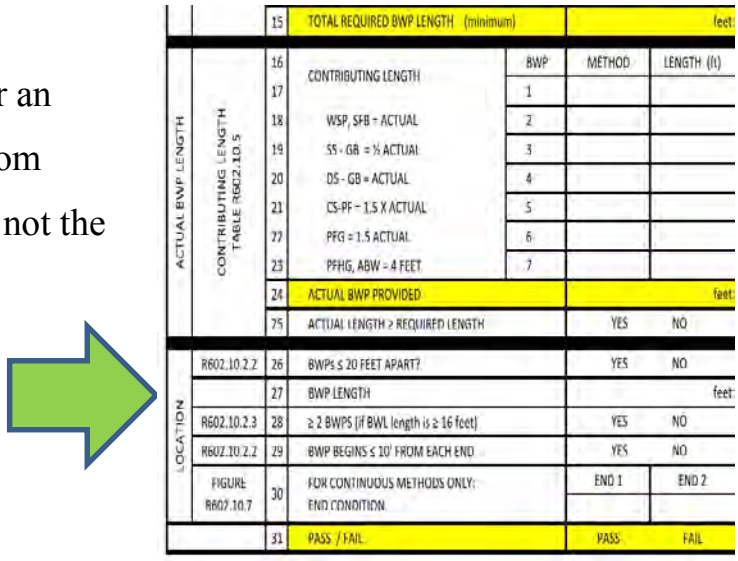
		15	TOTAL REQUIRED BWP LENGTH (minimum)			feet:
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1		
		18	WSP, SFB = ACTUAL	2		
		19	SS - GB = ½ ACTUAL	3		
		20	DS - GB = ACTUAL	4		
		21	CS-PF = 1.5 X ACTUAL	5		
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED			feet:
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO
LOCATION	2.2	26	BWPs ≤ 20 FEET APART?		YES	NO
		27	BWP LENGTH			feet:
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES	NO
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END		YES	NO
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2
		31	PASS / FAIL		PASS	FAIL

If there is a wall projection, like a sun room,

- and it is offset ≤8' from the main structure,
- and the BWL is offset 4',
- and the BWPs are within 20',
- then the sunroom could be all glass!!

Line 27: What is the length of the BWL?

This question is intended to check for an answer on Line 28. It is measured from where the BWL starts and stops, and not the actual length of the wall.



		15	TOTAL REQUIRED BWP LENGTH (minimum)			feet:
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1		
		18	WSP, SFB = ACTUAL	2		
		19	SS - GB = ½ ACTUAL	3		
		20	DS - GB = ACTUAL	4		
		21	CS-PF = 1.5 X ACTUAL	5		
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED			feet:
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO
LOCATION	R602.10.2.2	26	BWPs ≤ 20 FEET APART?		YES	NO
		27	BWP LENGTH			feet:
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES	NO
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END		YES	NO
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2
		31	PASS / FAIL		PASS	FAIL

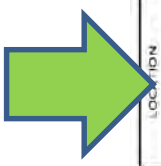
Line 28: For BWLs ≥ 16' (on line 27), are there at least two BWPs?

For BWLs < 16' long, two qualified BWPs are required OR at least one 48" BWP is required. For BWLs > 16', a minimum of two qualified BWPs are required.

A long BWP may appear on the work sheet as one BWP, but it can be considered as multiple BWPs with zero distance edge to edge. This is perfectly acceptable, provided the other location requirements are satisfied.

Line 29: BWL within 10' of the start/end point

If there is a panel within 10' of the end of the BWL, mark YES on the work sheet.



		15	TOTAL REQUIRED BWP LENGTH (minimum)		8.2	feet
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1	CS-WSP	4.00
		18	WSP, SFB = ACTUAL	2	CS-WSP	12.00
		19	SS - GB = ½ ACTUAL	3	CS-WSP	5.42
		20	DS - GB = ACTUAL	4	CS-WSP	6.00
		21	CS-PF = 1.5 X ACTUAL	5	CS-WSP	12.00
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED		39.42	feet
		25	ACTUAL LENGTH > REQUIRED LENGTH		YES	NO
LOCATION	R602.10.2.2	26	BWPs ≤ 20 FEET APART?		YES	NO
		27	BWP LENGTH		58	feet
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES	NO
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END		YES	NO
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2
		31	PASS / FAIL		PASS	FAIL

Note:

If the BWP is "beyond" (up to 4') the BWL it can still be credited to the BWL. This could mean that the first BWP is 14' off the corner of the structure.

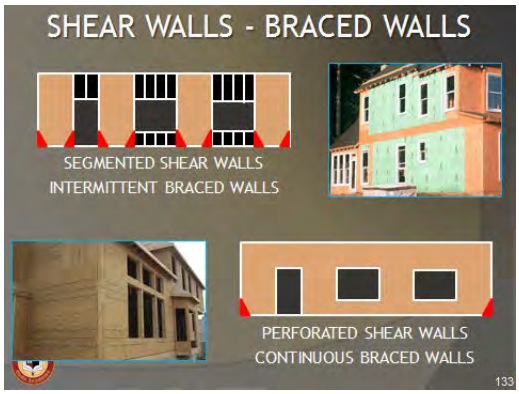
Line 30: End conditions required exclusively for continuous methods.

The origin of end conditions is based on the requirements indirectly related to the IBC (cross-referenced to the Special Design Provisions for Wind and Seismic (SDPWS)). In it, there is a requirement that all intermittent "shear walls" are to have hold-downs at the end of each panel.

		15	TOTAL REQUIRED BWP LENGTH (minimum)			feet:
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
		17		1		
		18	WSP, SFB = ACTUAL	2		
		19	SS - GB = ½ ACTUAL	3		
		20	DS - GB = ACTUAL	4		
		21	CS-PF = 1.5 X ACTUAL	5		
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ABW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED			feet:
		25	ACTUAL LENGTH > REQUIRED LENGTH		YES	NO
LOCATION	R602.10.2.2	26	BWPs ≤ 20 FEET APART?		YES	NO
		27	BWP LENGTH			feet:
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES	NO
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END		YES	NO
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2
		31	PASS / FAIL		PASS	FAIL

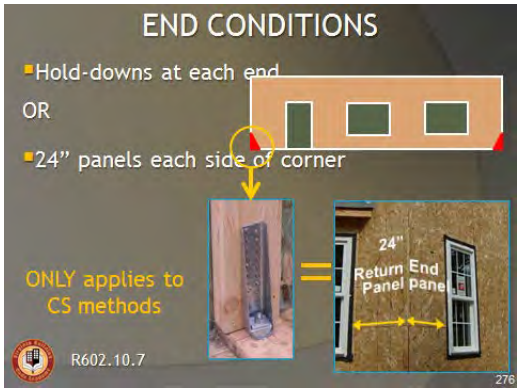
As we discussed earlier, the SDPWS has specific provisions shear walls:

1. Segmented shear walls (equivalent to intermittent braced walls) require hold-downs for each shear wall.
2. Perforated shear wall (equivalent to continuous braced walls) require hold-downs at the end of each wall.



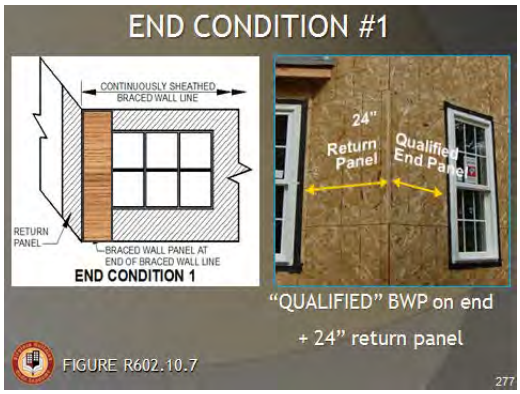
END CONDITIONS

The code offers five, end conditions which are intended to provide equivalent hold-down strength as is required in the IBC. They only apply to continuous sheathing.



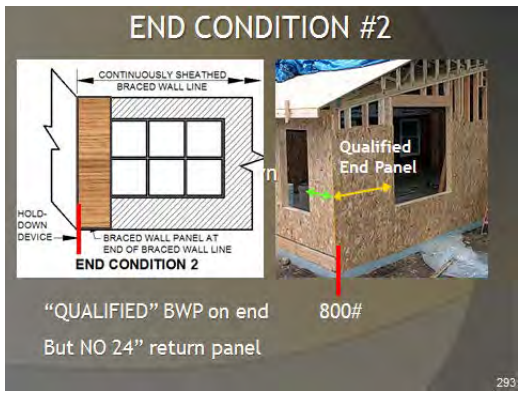
End condition 1

- A qualified end panel
- A 24” return panel
- No hold-down required



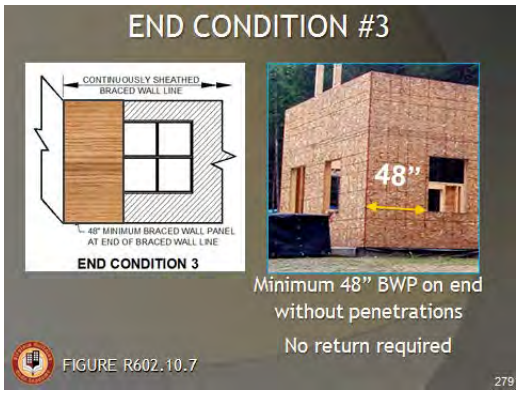
End condition 2

- A qualified end panel
- < 24” return panel
- A hold-down on the corner stud of the BWP is required



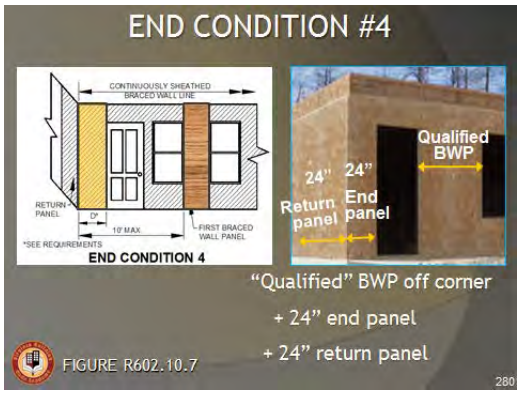
End condition 3

- A solid, 48” BWP on corner (without openings)
- No return panel required
- No hold-down required



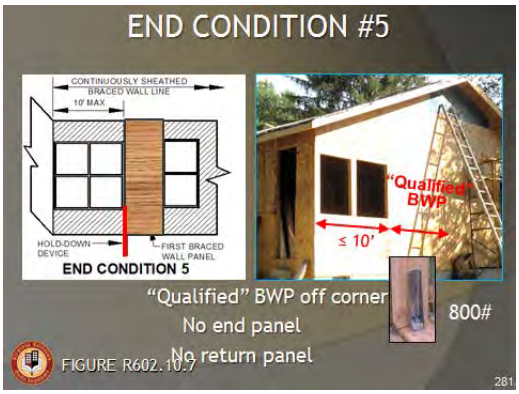
End condition 4

- The first qualified panel is not on the corner (but within 10’ of the BWL (maximum 14’ of the corner))
- A 24” end panel
- A 24” return panel
- No hold-down required

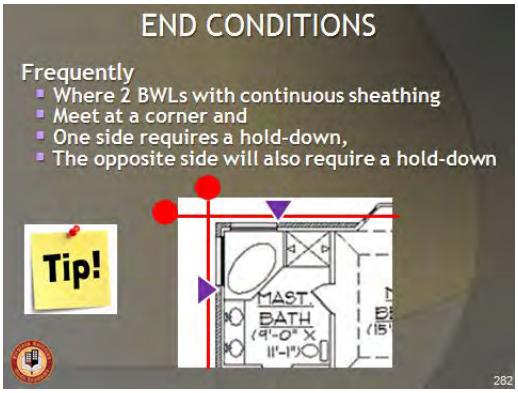


End condition 5

- The first qualified panel is not on the corner (but within 10' of the BWL (maximum 14' of the corner))
- < 24" end panel
- < 24" return panel
- A hold-down on the last stud of the BWP is required



Assuming a continuously sheathed house: Since the end panel on one BWL is the return panel on the other BWL, then if a hold-down is required on one wall, chances are strong that a second hold-down will be required on the opposing wall.



In this CLASS EXAMPLE, notice that we assumed continuous sheathing, so line 30 on the spreadsheet has to be completed. If either of the boxes says *2* or *5*, the house plans should show an 800# h.d. near the corner.

Line 31: Did this BWL pass?

If there were no problems with any of the parameters, and the work sheet was done correctly, then the BWL passes. If there were flaws along the way, they would have been noted and the BWL would fail, and the plan preparer has to go back and manipulate the design:

- Change doors, windows or walls,
- Add more braced lines to cut down the BLW spacing ,
- Add more sheathing,
- Add portal frames.

CLASS EXAMPLE #1

REQUIRED LENGTH OF BRACING	TABULAR LENGTH R602.10.3(1)	1	WIND SPEED (mph)	85, 90, 100, <110	
		2	STORY	1 2 3	
		3	BWL NAME / IDENTIFIER	A	
		4	AVERAGE BWL SPACING	42	feet
		5	BWP METHOD	CS-WSP	
		6	TABULAR REQUIRED BWP LENGTH (minimum)	12.5	feet
	ADJUSTMENTS R602.10.3(2)	7	EXPOSURE CATEGORY	B, C, D	1.0
		8	EAVE - RIDGE HEIGHT	15' feet	1.15
		9	WALL HEIGHT	9' feet	.95
		10	NUMBER OF BWLS (in same direction)	2, 3, 4, 5	1.45
		11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?	YES NO	1.0
		12	ADD PAIR OF 800# HOLD-DOWNS?	YES NO	1.0
		13	HORIZONTAL JOINTS BLOCKED?	YES NO	1.0
		14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.	YES NO	1.0
		15	TOTAL REQUIRED BWP LENGTH (minimum)	19.8	feet

				BWP	METHOD	LENGTH (ft)
ACTUAL BWP LENGTH	CONTRIBUTING LENGTH TABLE R602.10.5	16	CONTRIBUTING LENGTH			
		17		1	CS-WSP	5.3
		18	WSP, SFB = ACTUAL	2	CS-PF	3.0
		19	SS - GB = ½ ACTUAL	3	CS-PF	3.0
		20	DS - GB = ACTUAL	4	DSGB	8.5
		21	CS-PF = 1.5 X ACTUAL	5	SSGB	4.0
		22	PFG = 1.5 ACTUAL	6		
		23	PFHG, ADW = 4 FEET	7		
		24	ACTUAL BWP PROVIDED		23.8	feet
		25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES	NO

LOCATION	R602.10.2.2	26	BWPs ≤ 20 FEET APART?	YES	NO
		27	BWP LENGTH	58	feet
	R602.10.2.3	28	≥ 2 BWPS (if BWL length is ≥ 16 feet)	YES	NO
	R602.10.2.2	29	BWP BEGINS ≤ 10' FROM EACH END	YES	NO
	FIGURE R602.10.7	30	FOR CONTINUOUS METHODS ONLY: END CONDITION	END 1: 3	END 2: 3
		31	PASS / FAIL	PASS	FAIL

SKILL CHECK 4.1

The greatest BWL spacing can be:

20', 50', 60', unlimited

The greatest BWP spacing can be:

20', 50', 60', unlimited

SKILL CHECK 4.2

End conditions #2, #3 and #5 do not require a return panel?

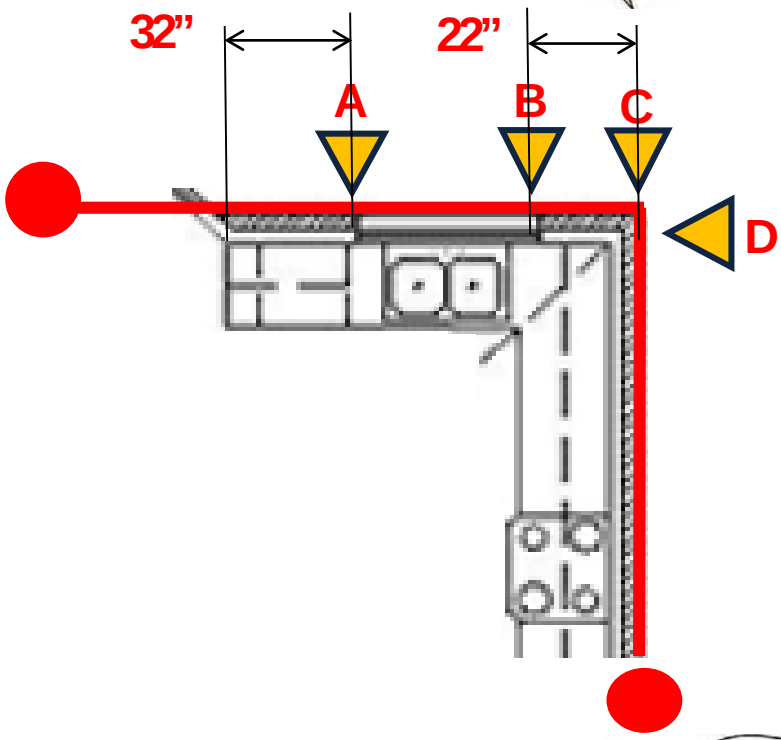
True or false?

SKILL QUESTION 4.3

This house is entirely CS-WSP.

Wall height is 10’

Window height is 64”



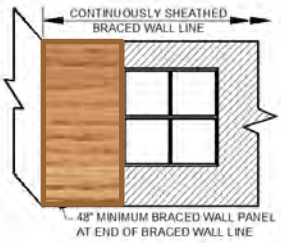
Where would you put hold-downs?

1. A
2. B
3. C
4. A, D
5. None required

SKILL QUESTION 4.4

End condition #3 applies to Method WSP?

True or false?



END CONDITION 3

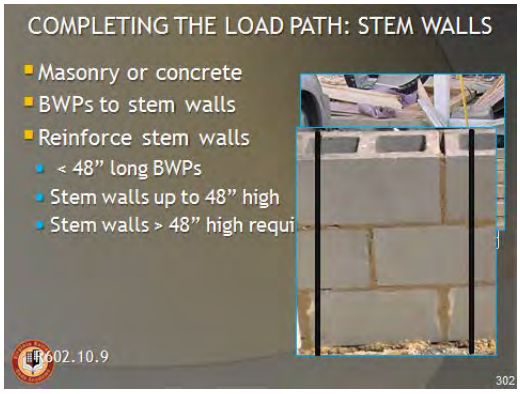
CONNECTION ISSUES FOR WALL BRACING

Earlier, we noted that wind hits the "sail" wall and transmits the force the diaphragms: the floor and the roof diaphragms. It is important then that these intersections are connected well.

The code offers several alternatives for how the roof diaphragm has to be connected to the wall so as to ensure that the horizontal forces are transferred to the vertical BWPs. This is typically an inspection issue, but is it worthy of mentioning.

Likewise the BWPs have to transmit the vertical loads to the floor or foundation below. The code provides options for how to construct the walls when the joists run parallel to the wall line and when the joists run perpendicular to the wall.

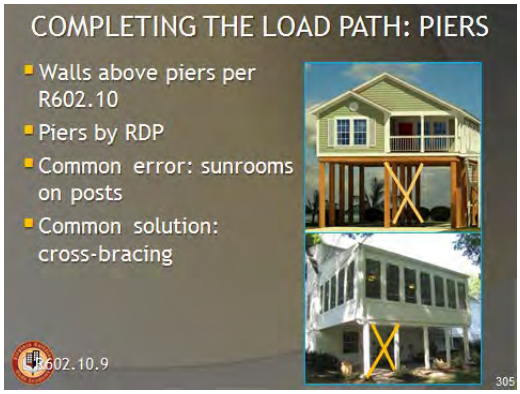
Eventually the BWPs have to transfer their loads to the foundation wall. It is important that the foundation wall is not the weak link in the load path.



While this is typically an inspection issue, it is important that the plan reviewer note on the plans that a stem wall may be required if the foundation wall is short and/or small. The code offers several options with either rebar bent up into a bond beam, or the more popular method of using 5/8" threaded rod into the footing.

BWPs are allowed to bear on cantilevered floor systems provided the cantilevers are in compliance with Section R502.

It is more problematic when BWPs are supported on beams that are posted to the ground. Cross bracing is a huge concern. <u>The code requires BWPs bearing on posts be detailed by a registered design professional (RDP).</u>



FUZZY ISSUES

Here is what is *not* in the code book. Since they are not in the book, these are "best practices" to make life simple for all concerned.

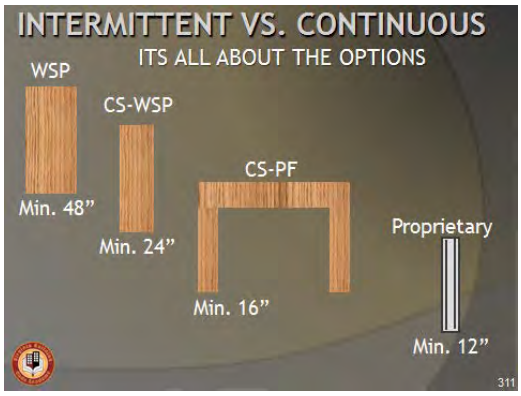
What to do with complicated gable-end walls? The walls are broken up into many little triangles none of which appear to have any sizeable wall area. Simple gables, no problem. Complicated gables: JUST OSB IT AND FORGET ABOUT IT!

What to do with gable dormers? JUST OSB IT AND FORGET ABOUT IT!

What to do with shed dormers – are they walls or roof? Depends! If the shed dormer is long with respect to the length of the roof, treat is as a wall. If the shed dormer is short, forget about it and let the rest of the roof perform as a diaphragm.

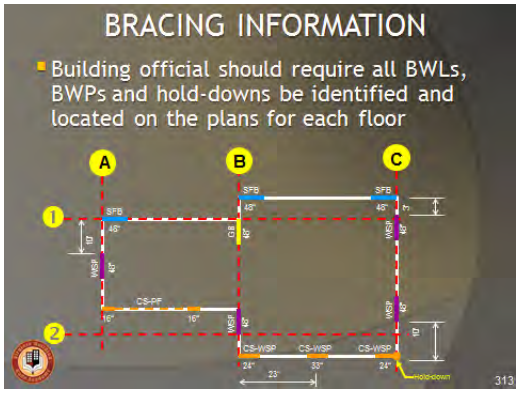
Summary

The code has provided many options in cases where 48” long BWPs are too restrictive. There are portal frames and proprietary products which alleviate the need to hire an engineer for those difficult situations.



Plan submittal requirements

Plan reviewers are not mind readers. It is imperative that the designer or plan preparer provide a braced wall line layout and calculations. The layout plan will show where the designer placed the BWLs - which in turn leads to BWL spacing. The layout should show the location and length of all the BWPs. It should also note the location of any special hold-downs. The calculation sheets are imperative also because it demonstrates to the plan reviewer that the BWL is compliant.



The code offers some relief to the building officials who opt to dismiss wall bracing analysis for the second floor - when the second floor complies to these few requirements:

1. The ceiling height of the second floor is ≤ the ceiling height of the first floor
2. The second floor windows are ≤ size and height of the first floor windows
3. The second floor windows are relatively aligned with the first floor windows.

In these cases the adjustment factors are always equal to or less than the adjustment factors for the first floor – and if the first floor passes, then the second floor will too.

SKILL CHECK 4.5

You be the plan reviewer. Does this house pass?

The house is a one story structure

Wind speed 90 mph

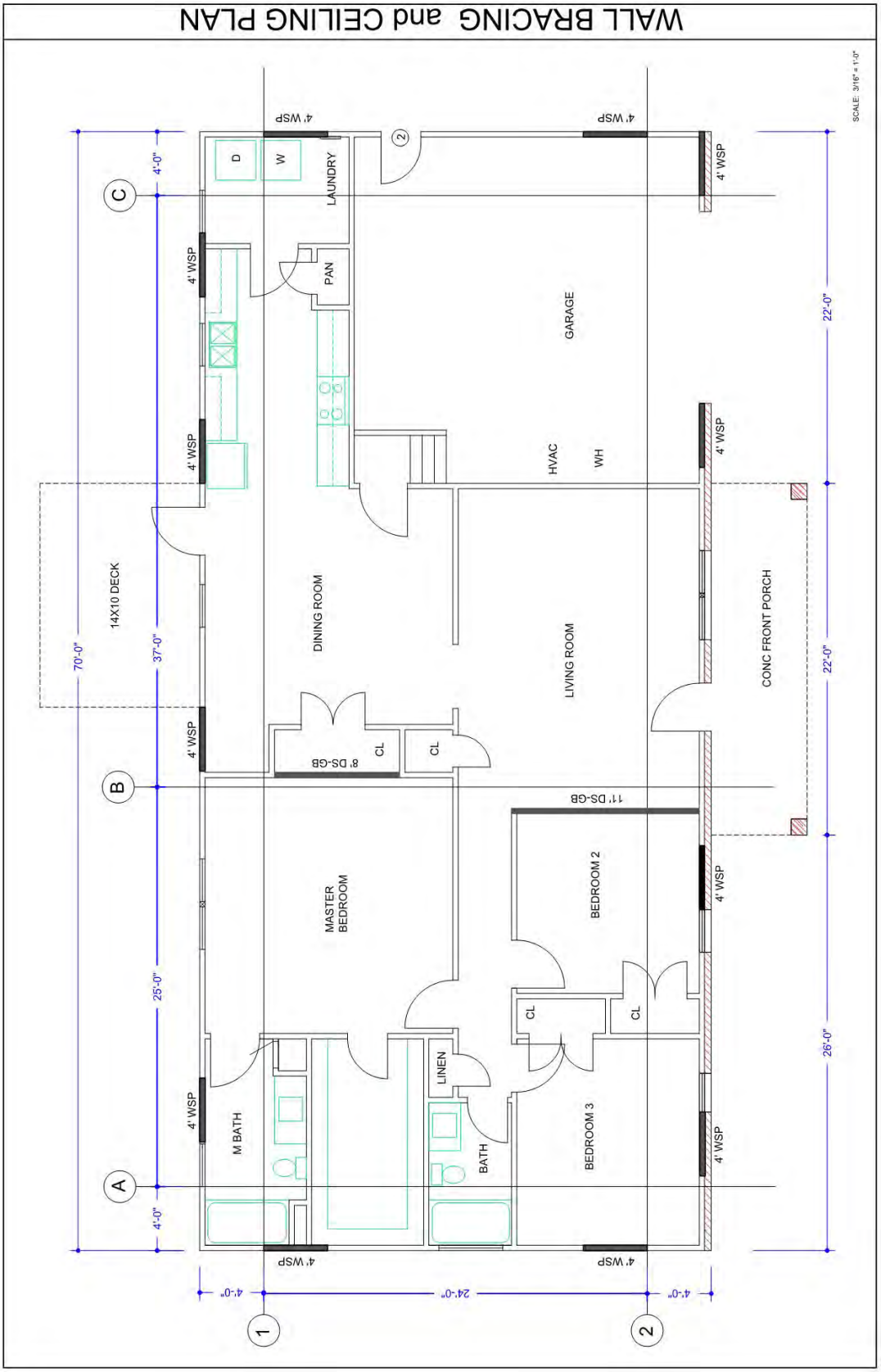
9’ ceilings

9’ eave to ridge

Blocked joints

No extra nails or hold-downs

WIND SPEED (MPH)			90		90		90		90		90	
BRACED WALL LINE			1		2		A		B		C	
STORY			X		X		X		X		X	
BRACED WALL PANEL METHOD			WSP SFB PCP HPS CS-SFB		WSP SFB PCP HPS CS-SFB		WSP SFB PCP HPS CS-SFB		WSP SFB PCP HPS CS-SFB		WSP SFB PCP HPS CS-SFB	
AVG BWL SPACING (ft)			24		24		25		31		37	
TABULAR REQUIRED (ft)				4.60		4.60		4.75		5.70		6.90
ADJUSTMENT	EXPOSURE		B	1.00	B	1.00	B	1.00	B	1.00	B	1.00
	EAVE-RIDGE HT (ft)		9.00	0.94	9.00	0.94	9.00	0.94	9.00	0.94	9.00	0.94
	WALL HEIGHT (ft)		9.00	0.95	9.00	0.95	9.00	0.95	9.00	0.95	9.00	0.95
	# BWLs		2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00
	OMIT INTERIOR GB		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
	ADD PAIR 800# HOLD DOWNS		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
	METHOD GB FASTEN @ 4" o.c		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
REQUIRED BWP LENGTH (ft)				4.11		4.11		4.24		5.09		6.16
ACTUAL BWP	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)
		1	WSP	4.00	WSP	4.00	WSP	4.00	DS - GB	8.00	WSP	4.00
		2		4.00		4.00		4.00		11.00		4.00
		3		4.00		4.00						
		4		4.00		4.00						
		5										
		6										
		7										
ACTUAL BWP LENGTH (ft)				16.00		16.00		8.00		19.00		8.00
ACTUAL ≥ REQUIRED				YES		YES		YES		YES		YES
SPACE	BWPs ≤ 20' APART			YES		YES		YES		YES		YES
# of BWPs	Length of BWL (ft)			62		62		24		24		24
	BWP 1 ≤ 16', 2 > 16'			YES		YES		YES		YES		YES
ENDS	BWP WITHIN 10' OF END		YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	CONTINUOUS END CONDITION											
BWL COMPLIANCE PASS-FAIL				PASS		PASS		PASS		PASS		PASS


WALL BRACING and CEILING PLAN
SCALE: 3/16" = 1'-0"
14X10 DECK
DINING ROOM
LIVING ROOM
GARAGE
HVAC
WH
PAN
LAUNDRY
D
W
CONC FRONT PORCH
MASTER BEDROOM
BEDROOM 2
BEDROOM 3
M BATH
BATH
LINEN
CL
8' DS-GB
11' DS-GB
4' WSP
70'-0"
37'-0"
25'-0"
22'-0"
26'-0"
4'-0"
24'-0"
A
B
C
1
2

GO TO CLASS EXAMPLE #2 IN THE BACK OF THE BOOK
Complete lines 26-31

CHUCK'S

INTERACTIVE

SPREADSHEET

9/14/2012

WORK SHEET - CLASSICAL WALL BRACING

WIND CALCULATION SHEET USING THE CLASSIC METHOD (BASED ON THE 2012 IRC OR 2009 VRC)

WIND SPEED (MPH)												
BRACED WALL LINE												
STORY												
BRACED WALL PANEL METHOD												
AVG BWL SPACING (ft)												
TABULAR REQUIRED (ft)												
ADJUSTMENT	EXPOSURE		B		B		B		B		B	
	EAVE-RIDGE HT (ft)											
	WALL HEIGHT (ft)											
	# BWLs											
	OMIT INTERIOR GB		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
	ADD PAIR 800# HOLD DOWNS		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
	METHOD GB FASTEN @ 4" o.c		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
REQUIRED BWP LENGTH (ft)												
ACTUAL BWP	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)
		1										
		2										
		3										
		4										
		5										
		6										
		7										
ACTUAL BWP LENGTH (ft)												
ACTUAL ≥ REQUIRED												
SPACE	BWPs ≤ 20' APART											
# of BWPs	Length of BWL (ft)											
	BWP 1 ≤ 16', 2 > 16'											
ENDS	BWP WITHIN 10' OF END											
	CONTINUOUS END CONDITION											
BWL COMPLIANCE PASS-FAIL												

created by Chuck Bajnai, phone (804) 717-6428

Version 9/14/2012

WIND CALCULATION SHEET USING THE CLASSIC METHOD (BASED ON THE 2012 IRC OR 2009 VRC)

WIND SPEED (MPH)												
BRACED WALL LINE												
STORY												
BRACED WALL PANEL METHOD												
AVG BWL SPACING (ft)												
TABULAR REQUIRED (ft)												
ADJUSTMENT	EXPOSURE		B		B		B		B		B	
	EAVE-RIDGE HT (ft)											
	WALL HEIGHT (ft)											
	# BWLs											
	OMIT INTERIOR GB		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
	ADD PAIR 800# HOLD DOWNS		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
	METHOD GB FASTEN @ 4" o.c		NO	1.00	NO	1.00	NO	1.00	NO	1.00	NO	1.00
REQUIRED BWP LENGTH (ft)												
ACTUAL BWP	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)	METHOD	LENGTH (ft)
		1										
		2										
		3										
		4										
		5										
		6										
		7										
ACTUAL BWP LENGTH (ft)												
ACTUAL ≥ REQUIRED												
SPACE	BWPs ≤ 20' APART											
# of BWPs	Length of BWL (ft)											
	BWP 1 ≤ 16', 2 > 16'											
ENDS	BWP WITHIN 10' OF END											
	CONTINUOUS END CONDITION											
BWL COMPLIANCE PASS-FAIL												

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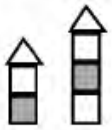
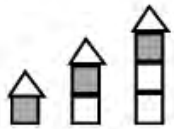
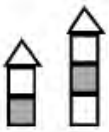
TABLE R602.10.3(1)

BRACING REQUIREMENTS BASED ON WIND SPEED

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

- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT EAVE-TO-RIDGE HEIGHT
- 10 FOOT 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[a]			
			Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 85		10	3.5	3.5	2.0	1.5
		20	6.0	6.0	3.5	3.0
		30	8.5	8.5	5.0	4.5
		40	11.5	11.5	6.5	5.5
		50	14.0	14.0	8.0	7.0
		60	16.5	16.5	9.5	8.0
		10	6.5	6.5	3.5	3.0
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8.0
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.0	13.0
		60	31.5	31.5	18.0	15.5
		10	NP	9.0	5.5	4.5
		20	NP	17.0	10.0	8.5
		30	NP	24.5	14.0	12.0
		40	NP	32.0	18.0	15.5
		50	NP	39.0	22.5	19.0
		60	NP	46.5	26.5	22.5
≤ 90		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
		40	12.5	12.5	7.5	6.0
		50	15.5	15.5	9.0	7.5
		60	18.5	18.5	10.5	9.0
		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
		40	24.0	24.0	14.0	12.0
		50	29.5	29.5	17.0	14.5
		60	35.0	35.0	20.0	17.0
		10	NP	10.5	6.0	5.0
		20	NP	19.0	11.0	9.5
		30	NP	27.5	15.5	13.5
		40	NP	35.5	20.5	17.5
		50	NP	44.0	25.0	21.5
		60	NP	52.0	30.0	25.5

(continued)

TABLE R602.10.3(1) continued

BRACING REQUIREMENTS BASED ON WIND SPEED

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

- EXPOSURE CATEGORY B
- 30 FOOT MEAN ROOF HEIGHT
- 10 FOOT EAVE-TO-RIDGE HEIGHT
- 10 FOOT 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[a]			
			Method LIB[b]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, CS-SFB[c]	Methods CS-WSP, CS-G, CS-PF
≤ 100		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	19.0	19.0	11.0	9.5
		60	22.5	22.5	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.0	8.0
		30	23.0	23.0	13.0	11.0
		40	29.5	29.5	17.0	14.5
		50	36.5	36.5	21.0	18.0
		60	43.5	43.5	25.0	21.0
		10	NP	12.5	7.5	6.0
		20	NP	23.5	13.5	11.5
		30	NP	34.0	19.5	16.5
		40	NP	44.0	25.0	21.5
		50	NP	54.0	31.0	26.5
		60	NP	64.0	36.5	31.0
< 110[c]		10	5.5	5.5	3.0	3.0
		20	10.0	10.0	6.0	5.0
		30	14.5	14.5	8.5	7.0
		40	18.5	18.5	11.0	9.0
		50	23.0	23.0	13.0	11.5
		60	27.5	27.5	15.5	13.5
		10	10.5	10.5	6.0	5.0
		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	25.5
		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

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 mile per hour = 0.447 m/s.

a. Linear interpolation shall be permitted.

b. Method LIB shall have gypsum board fastened to at least one side with nails or screws in accordance withTable R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.

c. Method CS-SFB does not apply where the wind speed is greater than 100 mph.

TABLE R602.10.3(2)

WIND ADJUSTMENT FACTORS

TABLE R602.10.3(2)
WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ADJUSTMENT BASED ON	STORY/ SUPPORTING	CONDITION	ADJUSTMENT FACTOR[a, b] [multiply length from Table R602.10.3(1) by this factor]	APPLICABLE METHODS
Exposure category	One-story structure	B	1.00	All methods
		C	1.20	
		D	1.50	
	Two-story structure	B	1.00	
		C	1.30	
		D	1.60	
	Three-story structure	B	1.00	
		C	1.40	
		D	1.70	
Roof eave-to-ridge height	Roof only	≤ 5 feet	0.70	
		10 feet	1.00	
		15 feet	1.30	
		20 feet	1.60	
	Roof + 1 floor	≤ 5 feet	0.85	
		10 feet	1.00	
		15 feet	1.15	
		20 feet	1.30	
	Roof + 2 floors	≤ 5 feet	0.90	
		10 feet	1.00	
		15 feet	1.10	
		20 feet	Not permitted	
Wall height adjustment	Any story	8 feet	0.90	
		9 feet	0.95	
		10 feet	1.00	
		11 feet	1.05	
		12 feet	1.10	
Number of braced wall lines (per plan direction)[c]	Any story	2	1.00	
		3	1.30	
		4	1.45	
		≥ 5	1.60	
Additional 800-pound hold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB, PBS, PCP, HPS
Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB,PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound = 4.48 N.

a. Linear interpolation shall be permitted.

b. The total adjustment factor is the product of all applicable adjustment factors.

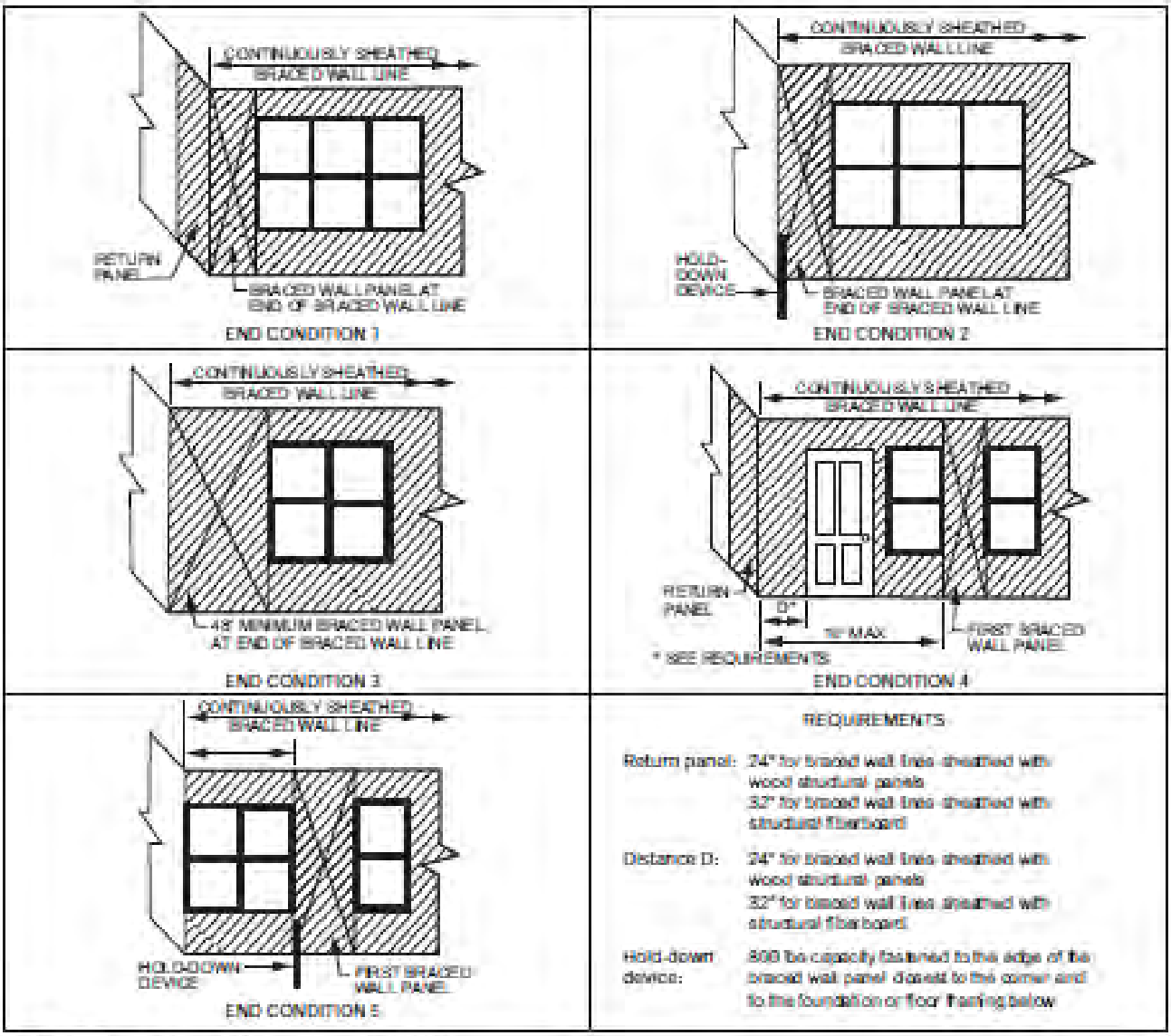
c. The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.

TABLE R602.10.5

MINIMUM LENGTH OF BRACED WALL PANELS

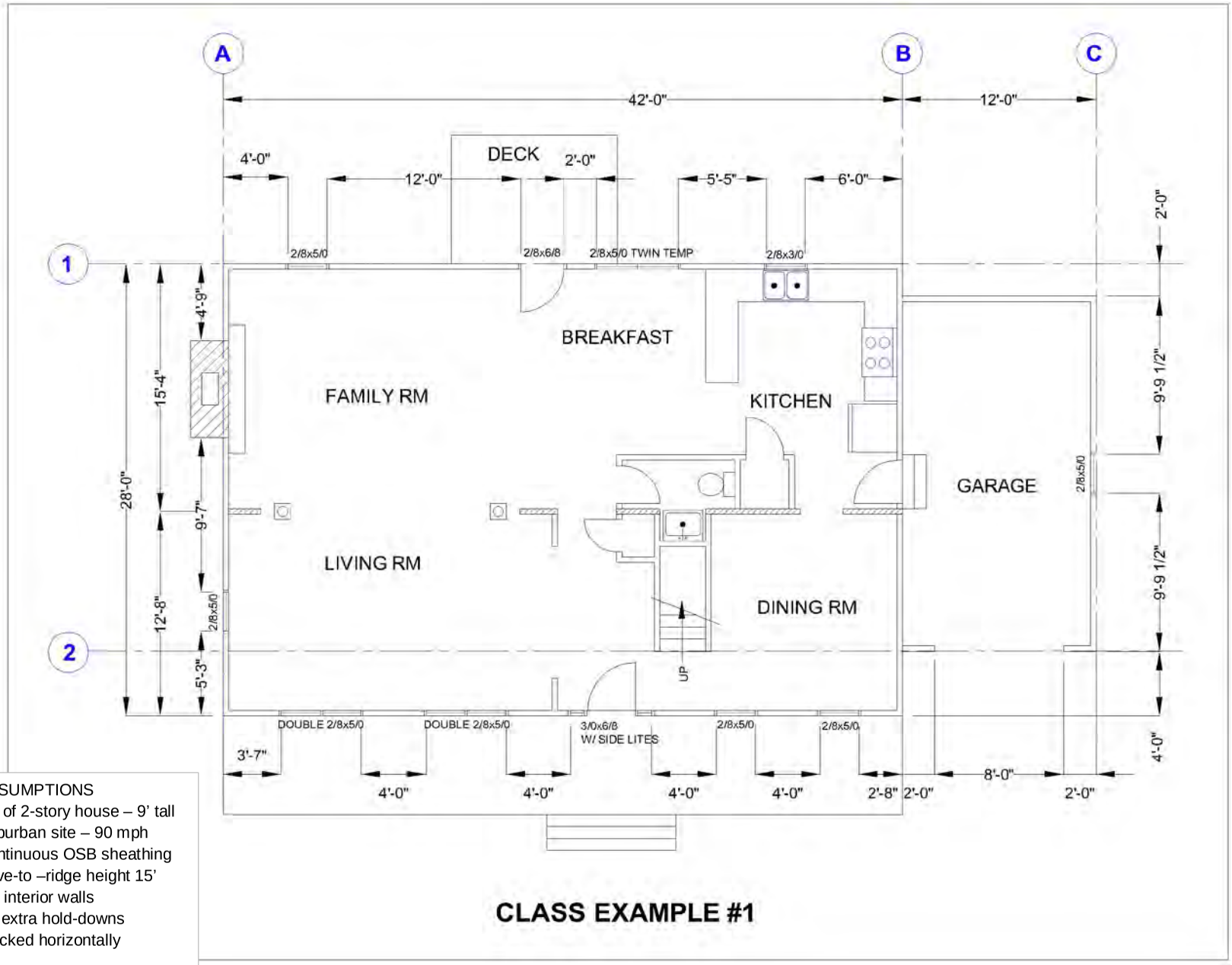
TABLE R602.10.5
MINIMUM LENGTH OF BRACED WALL PANELS

METHOD (See Table R602.10.4)		MINIMUM LENGTH [a] (in) Wall Height 8 ft	9 ft	10 ft	11 ft	12 ft	CONTRIBUTING LENGTH (in)
DWG, WSP, SFB, PBS, PCP, HPS		48	48	48	53	58	Actual [b]
GB		48	48	48	53	58	Double sided = Actual Single sided = 0.5 x Actual
LIB		55	62	69	NP	NP	Actual [b]
ABW		28	32	34	38	42	48
PFH	Supporting roof only	16	16	16	18 [c]	20 [c]	48
	Supporting one story and roof	24	24	24	27 [c]	29 [c]	48
PFG		24	27	30	33 [c]	36 [c]	1.5 x Actual [b]
CS-G		24	27	30	33	36	Actual [b]
CS-PF		16	18	20	22 [c]	24 [c]	1.5 x Actual [b]
CS-WSP, CS-SFB	**Adjacent opening vertical dimension (in)**						
	≤ 64	24	27	30	33	36	Actual [b]
	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	
	104		49	43	40	39	
	108		54	46	43	41	
	112			50	45	43	
	116			55	48	45	
	120			60	52	48	
	124				56	51	
	128				61	54	
	132				66	58	
	136					62	
	140					66	
	144					72	



SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.45 N.

FIGURE R602.10.7
END CONDITIONS FOR BRACED WALL LINES WITH CONTINUOUS SHEATHING



ASSUMPTIONS
1ST of 2-story house – 9' tall
Suburban site – 90 mph
Continuous OSB sheathing
Eave-to –ridge height 15'
GB interior walls
No extra hold-downs
Blocked horizontally

CLASS EXAMPLE #1

CLASS EXAMPLE #2

Using the spreadsheet, determine if BWL #1 passes

Wind 90 mph

Ceiling height 9’

Exposure B

1st of 2 stories

Eave to ridge height 15’

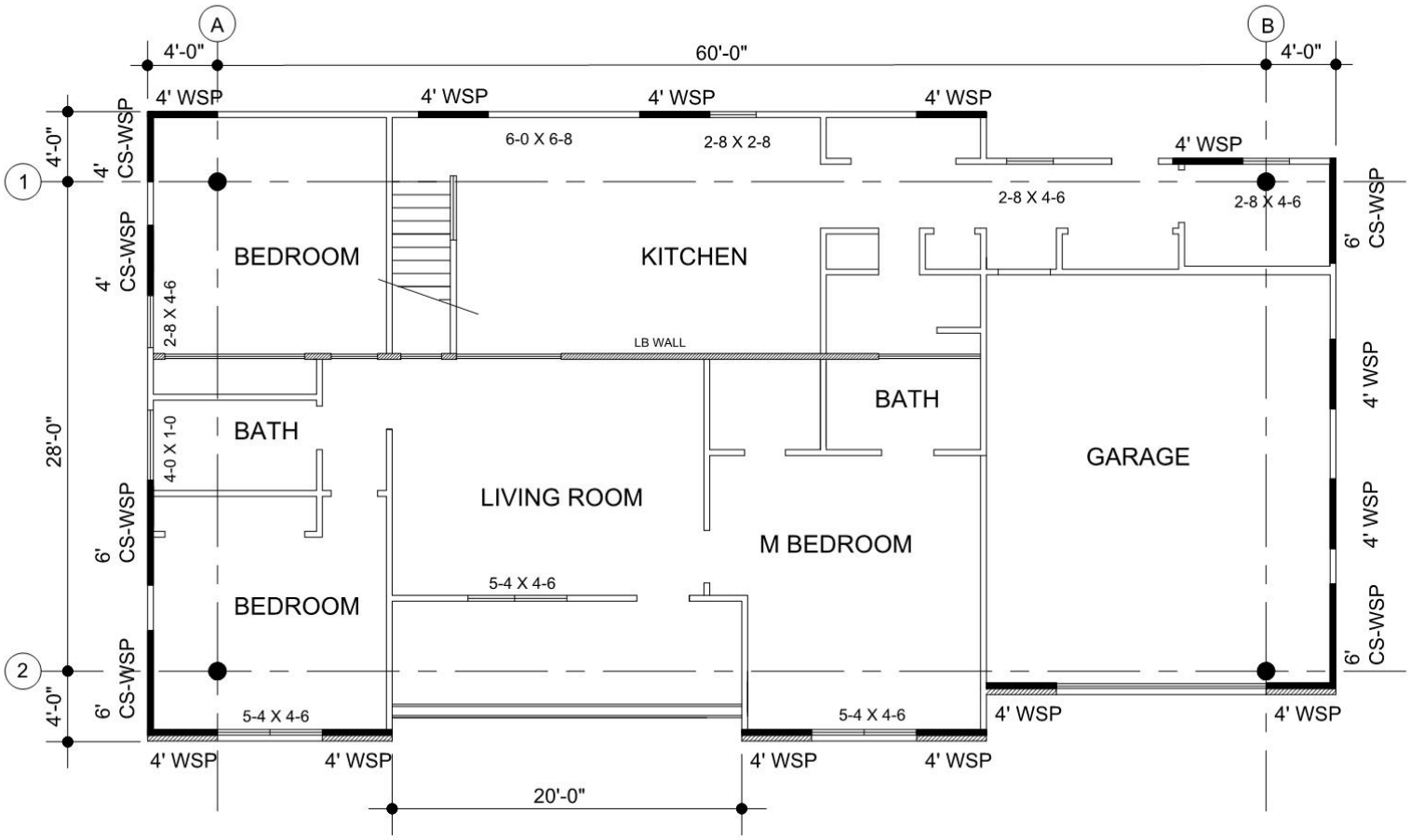
Did not omit GB on inside

Did not add 800# hd

Provided horizontal blocking

CLASS EXAMPLE #2

1	WIND SPEED (mph)		85, 90, 100, <110	
2	STORY			
3	BWL NAME / IDENTIFIER			
4	AVERAGE BWL SPACING		feet	
5	BWP METHOD			
6	TABULAR REQUIRED BWP LENGTH (minimum)		feet	
7	EXPOSURE CATEGORY		B, C, D	
8	EAVE - RIDGE HEIGHT		feet	
9	WALL HEIGHT		feet	
10	NUMBER OF BWLs (in same direction)		2, 3, 4, ≥5	
11	OMIT GYP BD ON INTERIOR FACE OF EXTERIOR BWP?		YES NO	
12	ADD PAIR OF 800# HOLD-DOWNS?		YES NO	
13	HORIZONTAL JOINTS BLOCKED?		YES NO	
14	METHOD GB: CHANGE FROM 7" O.C. TO 4" O.C.		YES NO	
15	TOTAL REQUIRED BWP LENGTH (minimum)		feet	
16	CONTRIBUTING LENGTH	BWP	METHOD	LENGTH (ft)
17		1		
18	WSP, SFB = ACTUAL	2		
19	SS - GB = ½ ACTUAL	3		
20	DS - GB = ACTUAL	4		
21	CS-PF = 1.5 X ACTUAL	5		
22	PFG = 1.5 ACTUAL	6		
23	PFHG, ABW = 4 FEET	7		
24	ACTUAL BWP PROVIDED		feet	
25	ACTUAL LENGTH ≥ REQUIRED LENGTH		YES NO	
26	BWPs ≤ 20 FEET APART?		YES NO	
27	BWP LENGTH		feet	
28	≥ 2 BWPS (if BWL length is ≥ 16 feet)		YES NO	
29	BWP BEGINS ≤ 10' FROM EACH END		YES NO	
30	FOR CONTINUOUS METHODS ONLY: END CONDITION		END 1	END 2
31	PASS / FAIL		PASS	FAIL



CLASS EXAMPLE #2