Wall Bracing II:
Meeting the IRC® Bracing Provisions for Wind and Seismic

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Meet the Team

Ron Nuttall

Matt Brown

2018 IRC Load Path, Lateral Forces and Limitations

www.apawood.org/webinars

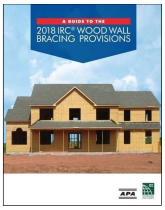
Warren Hamrick

Simplified Wall Bracing & APA Wall Bracing Calculator for the 2018 IRC

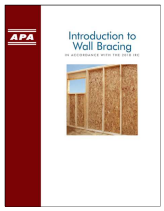
September 29th
10am PDT/ 1pm EDT

Resources

www.iccsafe.org
- Item 7102S12



www.apawood.org
- Form F430



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Bracing Topics

Forces	Basics	Bracing
Load Path	Limits	Braced Wall Lines
Lateral Forces	Wind Exposure	Braced Wall Panels
Stiffened Walls		Required Length
		Simplified Wall Bracing
		APA Simplified Wall Bracing
		APA Wall Bracing Calculator

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Bracing Topics

Forces	Basics	Bracing
		Braced Wall Lines
		Braced Wall Panels
		Required Length
		Simplified Wall Bracing
		APA Simplified Wall Bracing
		APA Wall Bracing Calculator

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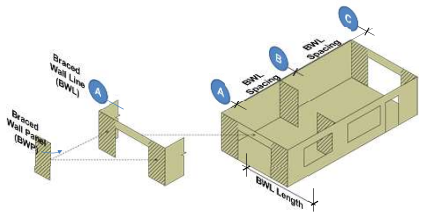
BWP, BWL, and Spacing



R202, R602.10.1, R602.10.2

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Bracing: Panel Material – Intermittent

Intermittent Bracing Methods:

LIB	- Let-in diagonal brace
DWB	- 3/4" Diagonal wood boards
WSP	- 3/8" Wood structural panel
BV-WSP	- 7/16" Wood structural panel with stone or masonry veneer
SFB	- 1/2" Structural fiberboard
GB	- 1/2" Interior gypsum wallboard or gypsum sheathing particleboard

Table R602.10.4

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Bracing: Panel Material – Intermittent

Intermittent Bracing Methods:

PBS	- 3/8" Particleboard sheathing
PCP	- Portland cement plaster on studs
HPS	- 7/16" Hardboard panel siding
ABW	- Alternate braced wall
PFH	- Portal frame with hold-downs
PFG	- Portal frame at garage door openings in SDC A-C

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Bracing: Panel Material – Intermittent

Method LIB – Let-in Brace

- Angled 45 to 60 degrees from horizontal
- Extends continuously from bottom plate to top plate
- 1x4 lumber or approved metal strap
- Application limited
  - 8' to 10' wall height only
- Interior gypsum required

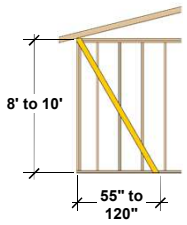

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Table R602.10.4

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Bracing: Panel Material – Intermittent

Method LIB – Let-in Brace

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Table R602.10.4

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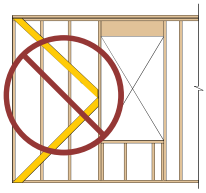
Bracing: Panel Material – Intermittent

Method LIB – Let-in Brace

- Must extend continuously from bottom plate to top plate



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Bracing: Panel Material – Intermittent

Method DWB – Diagonal Wood Boards

- Wood boards 3/4" (1" nominal) thick applied diagonally
- Studs spaced 24" max.

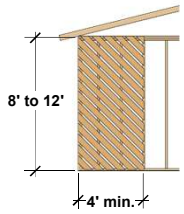

Table R602.10.5

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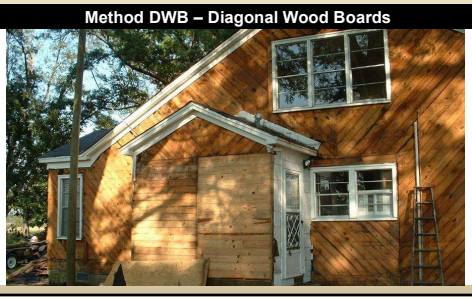
Bracing: Panel Material – Intermittent

Method DWB – Diagonal Wood Boards



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Bracing: Panel Material – Intermittent

Method WSP – Wood Structural Panel

- 3/8" min. thickness
- Wood structural panel defined in R604

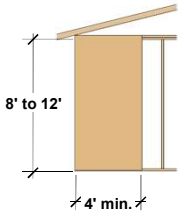

Table R602.10.5

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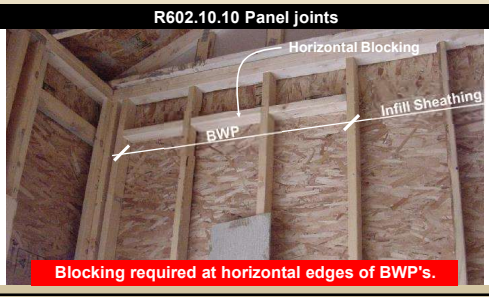
Bracing: Joints

R602.10.10 Panel joints



Blocking required at horizontal edges of BWP's.

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Bracing: Joints

2003 Missouri Tornado

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Bracing: Panel Material – Intermittent

Method WSP – Wood Structural Panel

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Bracing: Panel Material – Intermittent

Method SFB – Structural Fiberboard Sheathing

- 1/2" or 25/32" thick
- Studs spaced 16" o.c. max.
- Must conform to ASTM C 208
- Nailing 3" o.c. edge, 6" o.c. field

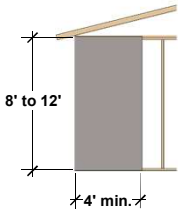

Table R602.10.5

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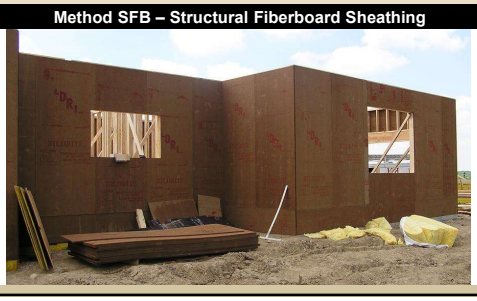
Bracing: Panel Material – Intermittent

Method SFB – Structural Fiberboard Sheathing



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Bracing: Panel Material – Intermittent

Method GB – Gypsum Board

- 1/2" min. thick for studs spaced 24" o.c. max.
- 4' minimum length
- Nailing at 7" o.c.
- Bracing length:
  - Single sided = 0.5 x actual length
  - Double sided = 1x actual length

No floating corners.

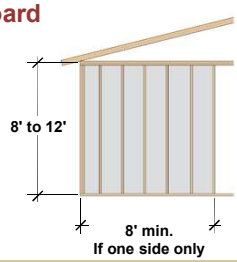

Table R602.10.5

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Bracing: Panel Material – Intermittent

Method GB – Gypsum Board

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Bracing: Panel Material – Intermittent

Method PBS – Particleboard Sheathing

- 3/8" or 1/2" min. thickness
- Studs 16" o.c. max.
- 4' minimum length
- Nailing at 3" edge, 6" field
- Minimum 8d nails for 1/2" thick sheathing

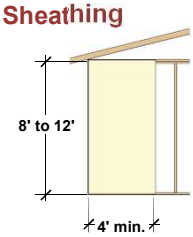

Table R602.10.4

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Bracing: Panel Material – Intermittent

Method PCP – Portland Cement Plaster

- Studs 16" o.c. max.
- Installed in accordance with R703.6
- Nailing 6" o.c. on all framing members

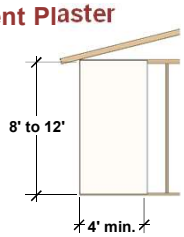

Table R602.10.5

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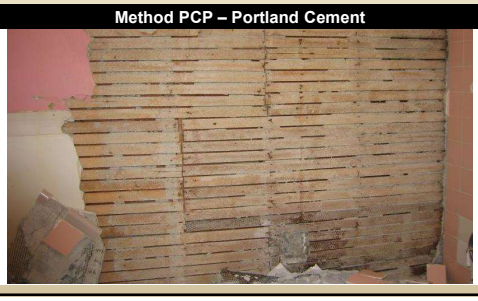
Bracing: Panel Material – Intermittent

Method PCP – Portland Cement



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Bracing: Panel Material – Intermittent

Method HPS – Hardboard Panel Siding

- 7/16" minimum thickness
- Studs 16" on center
- Nailing 4" o.c. edge and 8" o.c. field

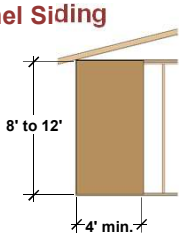

Table R602.10.5

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Bracing: Panel Material – Intermittent

Method HPS – Hardboard Panel Siding

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APA

Bracing: Panel Material – Intermittent

Minimum Length of BWPs

Table R602.10.5 Minimum length for braced wall panels

Method (See Table R602.10.4)	Minimum Length[a] (inches) Wall Height 8 ft	9 ft	10 ft	11 ft	12 ft	Contributing Length (inches)
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP	48	48	48	53	58	Actual[b]
GB	48	48	48	53	58	Double sided = Actual Single sided = 0.5 × Actual
LIB	55	62	69	NP	NP	Actual[b]

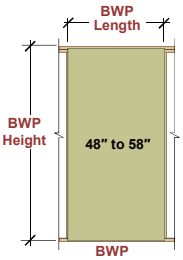

Table R602.10.5

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Bracing: Panel Material – Intermittent

Partial Credit for Narrow BWPs

Table R602.10.5.2 Effective length of braced panels less than 48"

For Methods DWB, WSP, SFB, PBS, PCP, HPS			
Actual Length	Effective Length of BWP 8'	9'	10'
48"	48"	48"	48"
42"	36"	36"	N/A
36"	27"	N/A	N/A

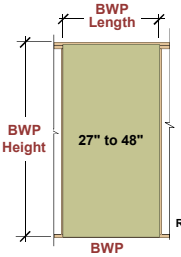

Table R602.10.5.2

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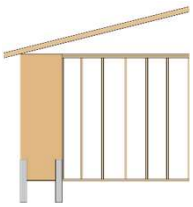
Bracing: Panel Material – Intermittent

Method ABW - Alternate Braced Wall

- Equivalent to 48" panel
- For use on bottom story only
- Minimum length varies with SDC and height
- Nailing:
  - Single story – 6" o.c. min
  - Bottom of two story – 4" o.c. min
- Minimum hold-down capacity changes with SDC and height



R602.10.6.1, Table R602.10.5

APA

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Bracing: Panel Material – Intermittent

Method ABW - Alternate Braced Wall

Table R602.10.5 Minimum length for braced wall panels (excerpt)

Minimum ABW Length					
	Wall Height (ft)				
	8	9	10	11	12
SDC A-C	28	32	34	38	42
SDC D_0-D_2	32	32	34	NP	NP

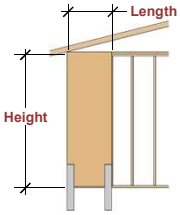

Table R602.10.5

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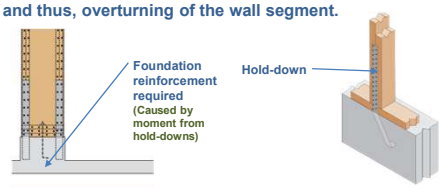
Bracing: Panel Material – Intermittent

Method ABW - Alternate Braced Wall Hold-down:

- A prefabricated metal anchoring device that attaches the framing of a wall system to the structure below. The hold-down prevents uplift of the studs and thus, overturning of the wall segment.



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Bracing: Panel Material – Intermittent

Method ABW - Alternate Braced Wall

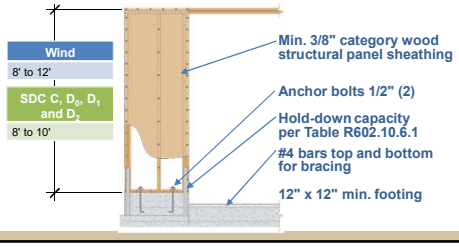

Figure R602.10.6.1

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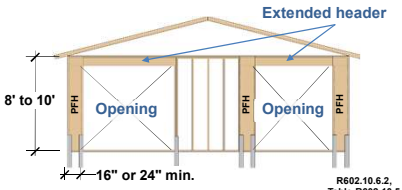
Bracing: Panel Material – Intermittent

Method PFH – Intermittent Portal Frame

- 16" min panel length for 1-story, 24" min for 2-story
- Header 6' min. to 18' max.
- Each vertical panel replaces a 48" braced wall panel



R602.10.6.2, Table R602.10.5

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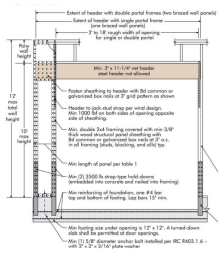
Bracing: Panel Material – Intermittent



Method PFH – Intermittent Portal Frame

- Extended header
- Min 1,000-lb strap capacity (opposite side from sheathing)
- 3" o.c. nailing
- Min. 3/8" thick wood structural panel
- (2) 3,500-lb strap-type hold-down
- (1) 5/8" anchor bolt

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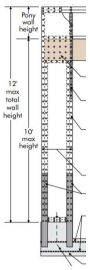
Bracing: Panel Material – Intermittent

Method PFH with taller walls

- Wall height up to 12 ft tall
- Portal height limited to 10 ft (top of header)
- Pony wall built above portal header
- 4 ft max pony wall height
- Pony walls require tension straps (Table R602.10.6.4)
- Number of jack studs required for single portal post in Table R602.7(1) & (2)



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Bracing: Panel Material – Intermittent

Method PFH – Intermittent Portal Frame

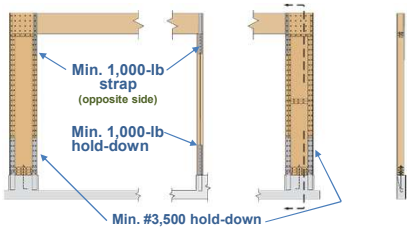

Figure R602.10.6.2

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Bracing: Panel Material – Intermittent

Method PFH – Intermittent Portal Frame

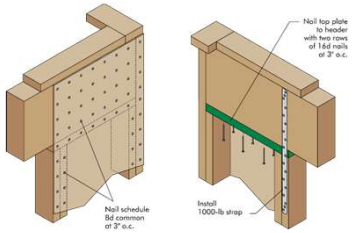

Figure R602.10.6.2

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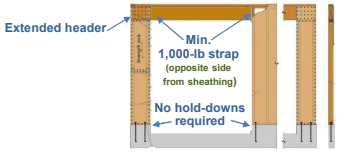
Bracing: Panel Material – Intermittent

Method PFG – Intermittent Portal Frame at Garage

- For use in SDC A-C only
- Bracing length = 1.5 x length of panel
- Minimum 24" length
- Header 6' min. to 18' max.



R602.10.6.3, Table R602.10.5

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Bracing: Panel Material – Intermittent

Method PFG – Intermittent Portal Frame at Garage

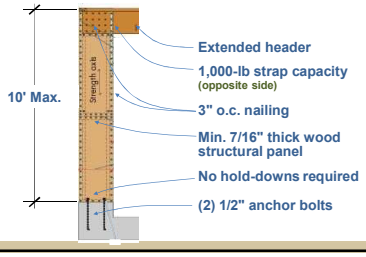

Figure 2.10.6.3

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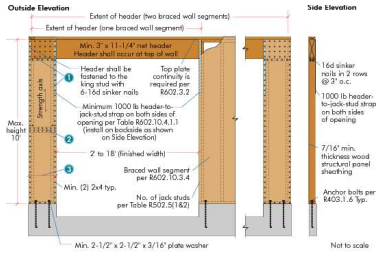
Bracing: Panel Material – Intermittent



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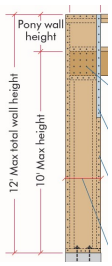
Bracing: Panel Material – Intermittent

Method PFG with taller walls

- Wall height up to 12 ft tall
- Portal height limited to 10 ft (top of header)
- Pony wall built above portal header
- 4 ft max pony wall height
- Pony walls require tension straps (Table R602.10.6.4)
- Number of jack studs required for single portal post in Table R602.7(1)



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Bracing: Panel Material – Intermittent

Minimum Length of Narrow BWPs

Table R602.10.5 Minimum length for braced wall panels (excerpt)

Method (See Table R602.10.4)		Minimum Length[a] (inches) Wall Height 8 ft	9 ft	10 ft	11 ft	12 ft	Contributing Length (inches)
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP		48	48	48	53	58	Actual[b]
ABW	SDC A, B and C	28	32	34	38	42	48
	SDC D_0, D_1 and D_2	32	32	34	NP	NP	
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	SDC A, B and C	24	27	30	33[d]	36[d]	1.5 × Actual[b]

Bracing: Panel Material – Proprietary

Other bracing methods per code report

- Prefabricated units
- Laminated kraft-paper board
- Fiberboard in various thicknesses

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Bracing: Panel Material – Proprietary

Bracing Per Code Report

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Bracing: Panel Material – Continuous

Continuous Sheathing Bracing Methods:

- CS-WSP Continuously sheathed wood structural panel
- CS-G Continuously sheathed wood structural panel adjacent to garage openings
- CS-PF Continuously sheathed portal frame
- CS-SFB Continuously sheathed structural fiberboard

Table R602.10.4

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Bracing: Panel Material – Continuous

Main Concepts

- Allows for narrow BWP's without hold-downs
- BWL's must be fully sheathed with wood structural panel or structural fiberboard sheathing (continuously sheathed)

R602.10.4.2, Table R602.10.5

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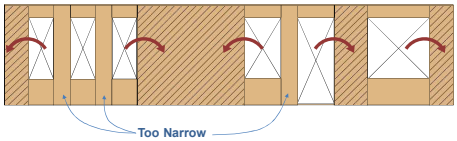
Bracing: Panel Material – Continuous

Sheathing Requirements:

1. Sheath full height areas including gable ends
2. Sheath above and below openings
3. Adjacent openings determine minimum BWP length



R602.10.4.2 & R602.10.5

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Bracing: Panel Material – Continuous

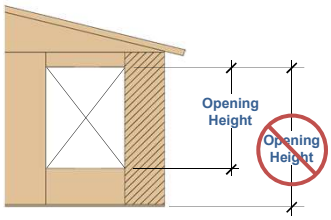

Figure R602.10.5

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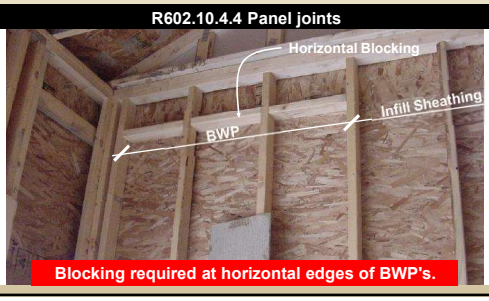
Bracing: Joints

R602.10.4.4 Panel joints



Blocking required at horizontal edges of BWP's.

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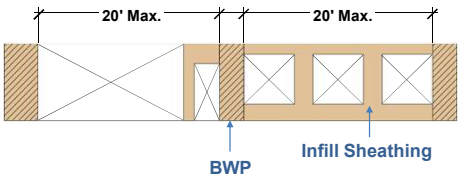
Bracing: Panel Material – Continuous



R602.10.4 & Figure R602.10.5

APA

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Bracing: Panel Material – Continuous

Method CS-WSP

- Full-height sheathed wall segments having a length equal or greater than Table R602.10.5 are counted toward the total bracing length.
- Wall minimum length is based on wall height and height of the adjacent clear opening.

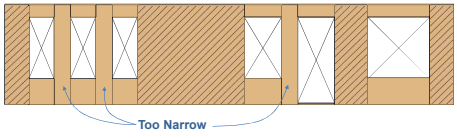

Table R602.10.5

APA

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Bracing: Panel Material – Continuous

Method CS-WSP

Table R602.10.5 Minimum Length of Braced Wall Panels (in)

Method	Adjacent Clear Opening Height (in)	Wall Height (ft)				
		8	9	10	11	12
CS-WSP	64	24	27	30	33	36
	68	26	27	30	33	36
	72	27	27	30	33	36
	76	30	29	30	33	36
	80	32	30	30	33	36
	84	35	32	32	33	36
	88	38	35	33	33	36
	92	43	37	35	35	36
	96	48	41	38	36	36
	100		44	40	38	38
	104		49	43	40	39
	108		54	46	43	41
	112			50	45	43
	116			55	48	45
	120			60	52	48

Table R602.10.5

APA

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Bracing: Panel Material – Continuous

Method CS-WSP

Table R602.10.5 Minimum Length of Braced Wall Panels (in)

Method	Adjacent Clear Opening Height (in)	Wall Height (ft)				
		8	9	10	11	12
CS-WSP	124				56	51
	128				61	54
	132				66	58
	136					62
	140					66
	144					72
CS-G	a	24	27	30	33	36
CS-PF	≤120	16	18	20	Note e	Note e

a. Garage opening adjacent to method CS-G panel shall have header. Max opening height includes header height.
b. Max header height 10 feet, pony wall may be used above header.

Table R602.10.5

APA

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Bracing: Panel Material – Continuous

Method CS-G

- Wood structural panel adjacent to garage opening
  - Full-height sheathed wall segments to either side of garage openings
  - Roof covering dead loads of 3 psf or less (seismic requirement only)
  - Applied to one wall line of garage only
  - Panel length = bracing length
  - 4:1 aspect ratio
  - Not a Portal Frame

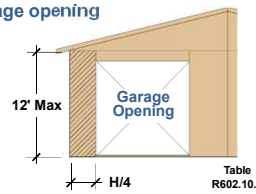

Table R602.10.5

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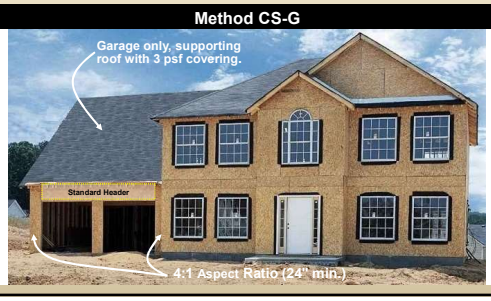
Bracing: Panel Material – Continuous

Method CS-G



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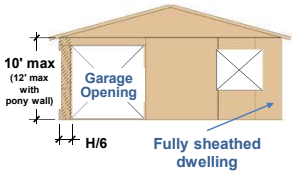
Bracing: Panel Material – Continuous

Method CS-PF

Continuous portal frame

Walls on either or both sides of openings in garage may have wall segment with a maximum 6:1 height-to-length ratio.

- No hold-downs required
- OK on raised floor
- Top of header at 10' max
- Top of wall at 12' max
- Panel length = bracing length



R602.10.6.4

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Bracing: Panel Material – Continuous

Method CS-PF

R602.10.6.4, Table R602.10.5

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Bracing: Panel Material – Continuous

Method CS-PF

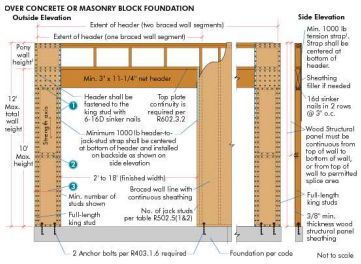

Figure R602.10.6.4

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Bracing: Panel Material – Continuous

Methods PFH, PFG and CS-PF

Table R602.10.6.4: Tension Strap Capacity Required for Resisting Wind Pressures Perpendicular to 6:1 Aspect Ratio Walls

MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (feet)	ULTIMATE DESIGN WIND SPEED (mph)					
				110	115	130	110	115	130
				Exposure B			Exposure C		
				Tension strap capacity required (lbf)					
2 × 4 No. 2 Grade	0	10	18	1000	1000	1000	1000	1000	1000
	1	10	9	1000	1000	1000	1000	1000	1275
			16	1000	1000	1750	1800	2325	3500
			18	1000	1200	2100	2175	2725	DR
	2	10	9	1000	1000	1025	1075	1550	2500
			16	1525	2025	3125	3200	3900	DR
			18	1875	2400	3575	3700	DR	DR
	2	12	9	1000	1200	2075	2125	2750	4000
			16	2600	3200	DR	DR	DR	DR
			18	3175	3850	DR	DR	DR	DR

Bracing: Panel Material – Continuous

Methods PFH, PFG and CS-PF cont.

Table R602.10.6.4 cont.: Tension Strap Capacity Required for Resisting Wind Pressures Perpendicular to 6:1 Aspect Ratio Walls

MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (feet)	ULTIMATE DESIGN WIND SPEED (mph)					
				110	115	130	110	115	130
				Exposure B			Exposure C		
				Tension strap capacity required (lbf)					
2 × 4 No. 2 Grade	4	12	9	1775	2350	3500	3550	DR	DR
			16	4175	DR	DR	DR	DR	DR
2 × 6 Stud Grade	2	12	9	1000	1000	1325	1375	1750	2550
			16	1650	2050	2925	3000	3550	DR
			18	2025	2450	3425	3500	4100	DR
	4	12	9	1125	1500	2225	2275	2775	3800
			16	2650	3150	DR	DR	DR	DR
			18	3125	3675	DR	DR	DR	DR

Bracing: Panel Material – Continuous

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Bracing: Panel Material – Continuous

Method CS-SFB

Continuous Sheathing with Structural Fiberboard

- Wall minimum length based on wall height and height of adjacent clear opening
- Maximum wall height = 12'
- Length requirements for braced wall panels in Table R602.10.5
  - Same minimum bracing length requirements as CS-WSP
  - Same aspect ratio (opening height limits) as CS-WSP

R602.10.5

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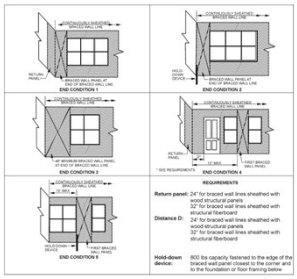
Continuously Sheathed End Conditions

All continuously sheathed BWLs must have one of the five end conditions shown.



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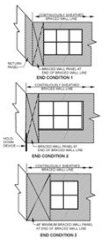
Continuously Sheathed End Conditions

R602.10.7 - End Conditions for Braced Wall Lines with Continuous Sheathing



- End Conditions 1 – 3: BWP at Corner
  - Condition 1 – Return panel
    - WSP BWL - return panel = 24" minimum
    - SFB BWL - return panel = 32" minimum
  - Condition 2 – In lieu of a return panel, an 800-lb hold-down may be fastened to the corner stud.
  - Condition 3 – In lieu of a return panel, a minimum 48" BWP (actual length) at the corner

R602.10.7

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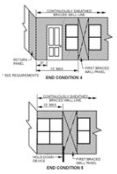
Continuously Sheathed End Conditions

R602.10.7 - End Conditions for Braced Wall Lines with Continuous Sheathing



- End Conditions 4 – 5: BWP offset from corner
  - Condition 4 – Sheathed corner and return panel
    - WSP BWL - sheathed corner panel (D) = 24" minimum
    - SFB BWL - sheathed corner panel (D) = 32" minimum
    - WSP BWL - return panel = 24" minimum
    - SFB BWL - return panel = 32" minimum
  - Condition 5 – In lieu of a corner panel, an 800-lb hold-down may be fastened to end of the BWP closest to the corner.

R602.10.7

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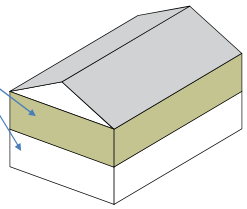
Bracing Basics: Mixing Bracing Methods

R602.10.4.1 Item 1

BWP method variation permitted from story to story with any type of sheathing



R602.10.4.1 Item 1

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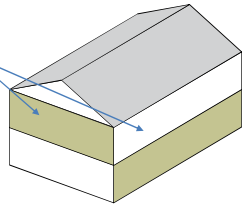
Bracing Basics: Mixing Bracing Methods

R602.10.4.1 Item 2

BWP method variation permitted from BWL to BWL within a story for intermittent sheathing

- For continuous and intermittent sheathing, variation may only occur in SDC A-C with winds < 130 mph



R602.10.4.1 Item 2

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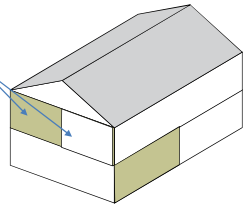
Bracing Basics: Mixing Bracing Methods

R602.10.4.1 Item 3

BWP method variation within a BWL permitted ONLY in SDC A-B and for detached houses in SDC C with intermittent bracing

- Greatest required bracing length for panel materials must be used.
- Not applicable for use with continuous sheathing OR dwellings in SDC D0-D2



R602.10.4.1 Item 3

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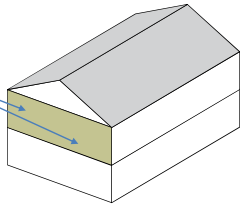
Bracing Basics: Mixing Bracing Methods

R602.10.4.1 Item 4

Mixing of CS-WSP, CS-G and CS-PF along a BWL is permitted in any SDC



R602.10.4.1 Item 4

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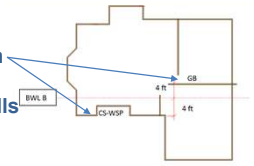
Bracing Basics: Mixing Bracing Methods

R602.10.4.1 Item 5

BWP method variation in a BWL with continuous sheathing on exterior walls and intermittent on interior walls permitted ONLY in SDC A-B and for detached houses in SDC C



- Greatest required bracing length for all panel materials in BWL must be used
- Not applicable for dwellings in SDC D0-D2

R602.10.4.1 Item 5

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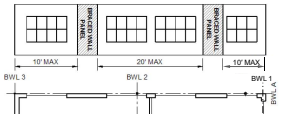
Bracing: BWP Location

R602.10.2.2 Location of Braced Wall Panels, R602.10.2.3 Minimum Number of BWPs

Placement Requirements



- BWP to begin no more than 10' feet from the end of a BWL
- BWP located not more than 20' o.c. from edge to edge
- Two BWPs per BWL when BWL > 16 ft AND
- Minimum 1- 48" BWP or 2- reduced length BWPs for BWL < 16 ft

R602.10.2.2, R602.10.2.3

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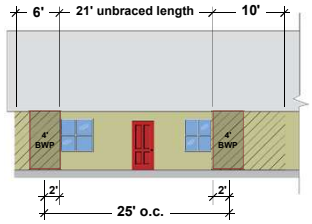
Bracing: BWP Location

BWP Spacing – 2009 and earlier



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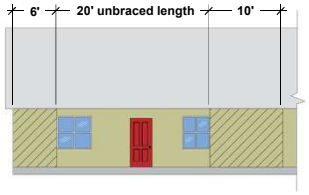
Bracing: BWP Location

BWP Spacing – 2018 Edition



R602.10.2.2

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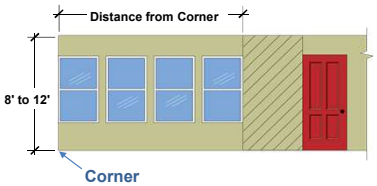
Bracing: BWP Location

Braced Panel Starting Location



Wind
Panel begins up to 10 ft from the corner

R602.10.2.2, R602.10.2.2.1

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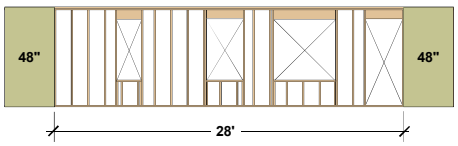
Bracing: BWP Location

Does this meet code? (8' height)

No, 20' maximum exceeded.



Wind – 2018 IRC
- ☒ 20' Spacing
- ☑ 10' End
- ☑ BWP Width

R602.10.2.2

APA

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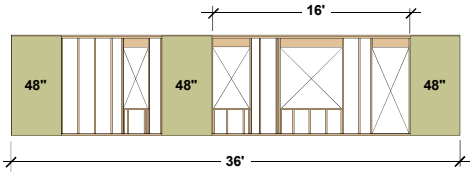
Bracing: BWP Location

Does this meet code? (8' height)

Yes, 20' maximum not exceeded.



Wind – 2018 IRC
- ☑ 20' Spacing
- ☑ 10' End
- ☑ BWP Length

R602.10.2.2

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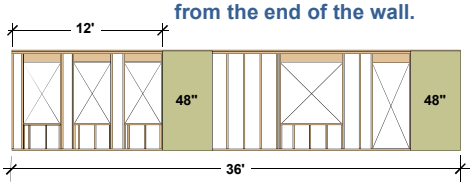
Bracing: BWP Location

Does this meet code? (8' height)

No, BWP required to begin no more than 10 feet from the end of the wall.



Wind – 2018 IRC
- ☑ 20' Spacing
- ☒ 10' End
- ☑ BWP Width

R602.10.2.2

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Bracing Topics

Forces | Basics | Bracing

- Braced Wall Lines
- Braced Wall Panels
- Required Length
- Simplified Wall Bracing
- APA Simplified Wall Bracing
- APA Wall Bracing Calculator

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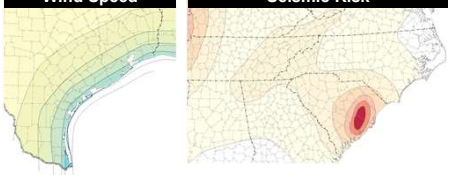
Bracing: Required Length

Wind Speed | Seismic Risk



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

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Bracing: Required Length

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

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

Wind Requirements	Seismic Requirements
▪ Braced wall line spacing ▪ Wall height ▪ Eave to ridge height ▪ Roof ties	▪ Wall length ▪ Braced wall line spacing ▪ Hold-downs ▪ Material weight limits

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Bracing: Required Length

Bracing Length Tables

2018 – Two bracing length tables

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

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

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R602.10.3, Tables R602.10.3(1), R602.10.3(2), R602.10.3(3) & R602.10.3(4)

APA

Bracing: Required Length Wind

Bracing Requirements Based on Wind Speed

Wind Bracing Table based on:

- Wind Exposure Category B
- Mean roof height of 30 ft
- Eave to ridge height of 10 ft
- Wall height of 10 ft
- Two braced wall lines

Required bracing length is determined by:

- Wind speed
- Story location
- Wall line spacing
- Bracing method

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Table R602.10.3(1)

APA

Bracing: Required Length Wind

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

Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[1]			
			Method LIB[3]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB[2]	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

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Table R602.10.3(1)

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Required Length

Table R602.10.3(2) - Adjustment Factors

Wind bracing adjustment factors:

1. Wind exposure category
2. Eave-to-ridge height
3. Story height
4. Number of braced wall lines
5. 800-lb hold-down on top story
6. Application of interior gypsum board finish
7. Gypsum board fastening
8. Horizontal blocking

Table R602.10.3(2)

APA

Footnote b – the total adjustment factor is the product of all applicable adjustment factors

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Required Length

Adjustment Factor #1 – Exposure Category[d]

Number of Stories	Exposure Category/Height Factor		
	Exposure B	Exposure C	Exposure D
1	1.0	1.2	1.5
2	1.0	1.3	1.6
3	1.0	1.4	1.7

Footnote d – New to 2018 IRC – The same adjustment factor is applied to the whole structure.

Table R602.10.3(2)

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Required Length

Adjustment Factor #2 – Roof Eave-to-Ridge Height

Apply applicable factor to each story:

Support Condition	Roof Eave-to-Ridge Height			
	≤ 5'	10'	15'	20'
Roof only	0.7	1.0	1.3	1.6
Roof + floor	0.85	1.0	1.15	1.3
Roof + 2 floors	0.9	1.0	1.1	NP

NP – Not Permitted

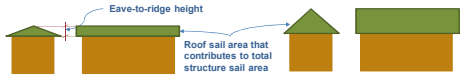

Table R602.10.3(2)

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Required Length

Adjustment Factor #3 – Story Height

Apply applicable factor to each story:

Story Height (ft)	Adjustment Factor
8'	0.90
9'	0.95
10'	1.0
11'	1.05
12'	1.1

Footnote a – Linear interpolation is OK

Changed from "wall" height in 2015 IRC to "story" height in 2018 IRC

Table R602.10.3(2)

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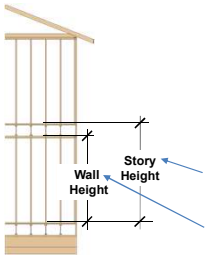
Table R602.10.3(2) – Adjustment Factor #3 – Story height (continued)



Story Height (ft)	Adjustment Factor
8'	0.90
9'	0.95
10'	1.0
11'	1.05
12'	1.1

Adjustment Factor #3 is based on the assumption of a 10-foot "Story Height" for Table R602.10.3(1) – Bracing Requirements Based on Wind Speed

Table R602.10.3(1) still says it is based on the assumption of a 10-foot "Wall Height."

APA

Required Length

Adjustment Factor #4 – Number of Braced Wall Lines (per plan direction)

Apply applicable factor to each direction at each story:

Number of Braced Wall Lines	Adjustment Factor
2	1.0
3	1.30
4	1.45
> 5	1.60

Table R602.10.3(2)

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Required Length

Adjustment Factor #5 – Additional 800-pound hold-down device

Bracing Method	Adjustment Factor
DWB, WSP, SFB, PBS, PCP, and HPS	0.80

- Applicable to top story only
- Installed at both ends of each braced wall panel
- A continuous load path to the foundation is required

Table R602.10.3(2)

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Required Length

Adjustment Factor #6 – Interior gypsum board finish (or equivalent)

Bracing Method	Adjustment Factor
DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, and CS-SFB	1.4

- Applicable when finish is omitted from inside face of braced wall panels
- Only likely to occur at gable end walls, walk-out basements, and exterior garage walls
- See section R602.10.4.3

Table R602.10.3(2)

APA

92

Required Length

Adjustment Factor #7 – Gypsum board fastening

Bracing Method	Adjustment Factor
GB	0.7

- Applicable when panels are fastened at 4" o.c. at perimeter and all horizontal joints are blocked
- In lieu of fasteners at 7" o.c. per Method GB
- Only applies to perimeter fasteners – fasteners in field remain at 7" o.c.

Table R602.10.3(2)

APA

93

Required Length

Adjustment Factor #8 – Horizontal blocking

Bracing Method	Adjustment Factor
WSP, CS-WSP	2.0

- Applicable when horizontal blocking is omitted as required per R602.10.4.4

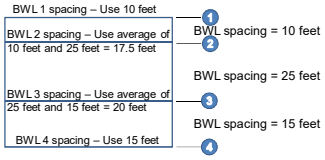
Table R602.10.3(2)

APA

94

Required Length

- In the 2015 IRC – this only applied to some of the methods
- In the 2018 IRC – this footnote applies to all methods



APA

95

Bracing: Required Length Seismic

Bracing Requirements Based on Seismic Design Category

Seismic Bracing Table based on:

- Soil class D
- Wall height of 10 ft
- 10 psf floor dead load
- 15 psf roof/ceiling dead load
- Braced wall line spacing ≤ 25 ft

Required bracing length is determined by:

- Seismic Design Category
- Story location
- Braced wall line length
- Bracing method

Table R602.10.3(1)

APA

96

Bracing: Required Length Seismic

TABLE R602.10.3(3)
BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY

- SOIL CLASS D[a]
- WALL HEIGHT = 10 FEET
- 10 PSF FLOOR DEAD LOAD
- 15 PSF ROOF/CEILING DEAD LOAD
- BRACED WALL LINE SPACING ≤ 25 FEET

Seismic Design Category	Story Location	Braced Wall Line Length (feet)[b]	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[c,f]				
			Method LIB[d]	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB[e]	Method WSP	Methods CS-WSP, CS-G, CS-PF
C (townhouses only)		10	2.5	2.5	2.5	1.6	1.4
		20	5.0	5.0	5.0	3.2	2.7
		30	7.5	7.5	7.5	4.8	4.1
		40	10.0	10.0	10.0	6.4	5.4
		50	12.5	12.5	12.5	8.0	6.8
		10	NP	4.5	4.5	3.0	2.6
		20	NP	9.0	9.0	6.0	5.1
		30	NP	13.5	13.5	9.0	7.7
		40	NP	18.0	18.0	12.0	10.2
		50	NP	22.5	22.5	15.0	12.8
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1

Table R602.10.3(3)
APA

97

Required Length Seismic

Table R602.10.3(4) - Adjustment Factors

Seismic adjustment factors:

- Story height
- Braced wall line spacing
- Wall dead load
- Roof/ceiling dead load
- Walls with stone or masonry veneer
- Interior gypsum board finish
- Horizontal blocking

Table R602.10.3(4)
APA

98 Footnote b – the total adjustment factor is the product of all applicable adjustment factors

Required Length Seismic

Adjustment Factor #1 – Story Height

Apply applicable factor to each story:

Story Height (ft)	Adjustment Factor
8'	1.0
9'	1.0
10'	1.0
11'	1.2
12'	1.2

Footnote a – Linear interpolation is OK

Table R602.10.3(4)
APA

99

Required Length Seismic

Adjustment Factor #2 – Braced Wall Line Spacing

Apply applicable factor to each story:

Braced Wall Line Spacing, Townhouses in SDC-C	Adjustment Factor
≤ 35 feet	1.0
> 35 feet and ≤ 50 feet	1.43

Table R602.10.3(4)

APA

100

Required Length Seismic

Adjustment Factor #3 – Braced Wall Line Spacing

Apply applicable factor to each story:

Braced Wall Line Spacing, in SDC-D0, D1, D2	Adjustment Factor
> 25 feet and ≤ 30 feet	1.2
> 30 feet and ≤ 35 feet	1.4

Table R602.10.3(4)

APA

101

Required Length Seismic

Adjustment Factor #4 – Wall Dead Load

Apply applicable factor to each story:

Wall Dead Load	Adjustment Factor
> 8 psf and < 15 psf	1.0
< 8 psf	0.85

Table R602.10.3(4)

APA

102

Required Length Seismic

Adjustment Factor #5 – Roof/Ceiling Dead Load

Apply applicable factor to each story:

Roof/Ceiling Dead Load	Adjustment Factor
1, 2 or 3 story building ≤ 15 psf	1.0
2 or 3 story building > 15 psf and ≤ 25 psf	1.1
1 story building or top story > 15 psf and ≤ 25 psf	1.2

Table R602.10.3(4)

APA

103

Required Length Seismic

Adjustment Factor #6 – Walls with Stone or Masonry Veneer

6	Walls with stone or masonry veneer, townhouses in SDC[d, e]		1.0	All methods
			1.5	
			1.5	

Table R602.10.3(4)

APA

104

Required Length Seismic

Adjustment Factor #7 – Walls with Stone or Masonry Veneer

7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 — D_2[d, f]	Any story	See Table R602.10.6.5	BV-WSP

Table R602.10.3(4)

APA

105

Required Length Seismic

Adjustment Factor #7 – Walls with Stone or Masonry Veneer

METHOD BV-WSP WALL BRACING REQUIREMENTS

SEISMIC DESIGN CATEGORY	STORY	BRACED WALL LINE LENGTH (FEET)					SINGLE-STORY HOLD-DOWN FORCE (pounds)[a]	CUMULATIVE HOLD-DOWN FORCE (pounds)[b]
		10	20	30	40	50		
		Minimum Total Length (feet) of Braced Wall Panels Required Along each Braced Wall Line						
D_0		4.0	7.0	10.5	14.0	17.5	NA	—
		4.0	7.0	10.5	14.0	17.5	1900	—
		4.5	9.0	13.5	18.0	22.5	3500	5400
		6.0	12.0	18.0	24.0	30.0	3500	8900

Table R602.10.6.5

APA

106

Required Length Seismic

Adjustment Factor #7 – Walls with Stone or Masonry Veneer

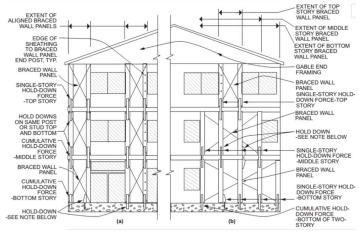


Figure R602.10.6.5

APA

107

Required Length Seismic

Adjustment Factor #8 – Walls with Stone or Masonry Veneer

8	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 — D_2[d, f]	First and second story of two-story dwelling	See Table R602.10.6.5	1.2	WSP, CS-WSP

Table R602.10.3(4)

APA

108

Required Length Seismic

Adjustment Factor #9 – Interior Gypsum Board Omitted

Bracing Method	Adjustment Factor
DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, and CS-SFB	1.5

Table R602.10.3(4)

APA

109

Required Length Seismic

Adjustment Factor #10 – Horizontal Blocking Omitted

Bracing Method	Adjustment Factor
WSP, CS-WSP	2.0

Table R602.10.3(4)

APA

110

Bracing: Required Length

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

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

Wind Requirements	Seismic Requirements
• Braced wall line spacing • Wall height • Eave to ridge height • Roof ties	• Wall length • Braced wall line spacing • Hold-downs • Material weight limits

APA

111

Bracing: Required Length

Bracing Length Tables

2018 – Two bracing length tables

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

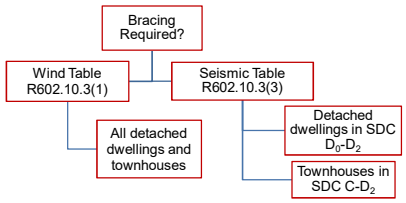
Required bracing length is the maximum of the two tables' bracing length x all adjustment factors

R602.10.3, Tables R602.10.3(1), R602.10.3(2), R602.10.3(3) & R602.10.3(4)

112

Bracing: Required Length

Decision Tree for Determining Required Bracing Length



R301.2.1, R301.2.2, R602.10.3

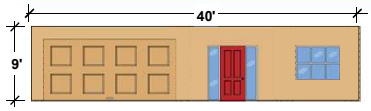
113

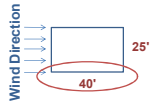
Bracing: Sufficient Length

Complete Analysis

Method CS-WSP

CS-WSP Bottom of Two Stories	110 mph	SDC Do
	?	?





Braced Wall Line Spacing
- 25 feet

Braced Wall Line Length
- 40 feet

Assumptions:
- Exp. B
- Eave-to-Ridge = 10ft
- 9ft story height
- 2 BWL
- 7psf wall dead load
- 15 psf roof/ceiling load
- No stone veneer

114

Bracing: Required Length

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

Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[1]			
			Method LIB[3]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB[2]	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

Table R602.10.3(1)

APA

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Bracing: Required Length

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

Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing (feet)	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[1]			
			Method LIB[3]	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB[2]	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

Table R602.10.3(1)

APA

116

Bracing: Required Length

Adjustment Factor — Wind Exposure Category, Mean Roof Height

Number of Stories	Exposure/Height Factor		
	Exposure B	Exposure C	Exposure D
1	1.0	1.2	1.5
2	1.0	1.3	1.6
3	1.0	1.4	1.7

Table R602.10.3(2)

APA

117

Bracing: Required Length

Adjustment Factor — Roof Eave-to-Ridge Height

Support Condition	Roof Eave-to-Ridge Height			
	≤5'	10'	15'	20'
Roof only	0.7	1.0	1.3	1.6
Roof + floor	0.85	1.0	1.15	1.3
Roof + 2 floors	0.9	1.0	1.1	NP

NP – Not Permitted

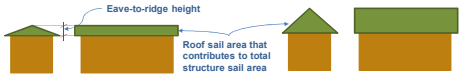


Table R602.10.3(2)

APA

118

Bracing: Required Length

Adjustment Factor — Story Height

Story Height (ft)	Adjustment Factor
8'	0.90
9'	0.95
10'	1.00
11'	1.05
12'	1.10

Table R602.10.3(2)

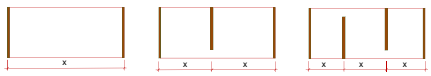
APA

119

Bracing: Required Length

Adjustment Factor — Number of Braced Wall Lines

Number of Braced Wall Lines	Adjustment Factor
2	1.00
3	1.30
4	1.45
≥ 5	1.60



– Braced wall line
x – Braced wall line spacing

Table R602.10.3(2)

APA

120

Wind: Adjust the Required Length

Exp. B: 1.0
Eave-to-Ridge = 10ft: 1.0
9ft wall height: 0.95
2 BWL: 1.0

8.0' x 1.0 x 1.0 x 0.95 x 1.0 = 7.6'

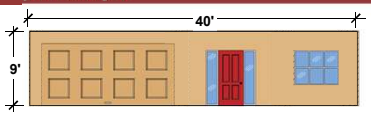
121

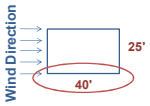
Bracing: Sufficient Length (seismic)

Complete Analysis

Method CS-WSP

CS-WSP	110 mph	SDC Do
Bottom of Two Stories	7.6'	?





Braced Wall Line Spacing
- 25 feet

Braced Wall Line Length
- 40 feet

Assumptions:
- Exp. B
- Eave-to-Ridge = 10ft
- 9ft story height
- 2 BWL
- 7psf wall dead load
- 15 psf roof/ceiling load
- No stone veneer

122

Required Length Seismic

Adjustment Factor #1 – Story Height

Apply applicable factor to each story:

Story Height (ft)	Adjustment Factor
8'	1.0
9'	1.0
10'	1.0
11'	1.2
12'	1.2

Footnote a – Linear interpolation is OK

Table R602.10.3(4)

123

Required Length Seismic

Adjustment Factor #3 – Braced Wall Line Spacing

Apply applicable factor to each story:

Braced Wall Line Spacing, in SDC-D0, D1, D2	Adjustment Factor
> 25 feet and ≤ 30 feet	1.2
> 30 feet and ≤ 35 feet	1.4

Table R602.10.3(4)

APA

124

Required Length Seismic

Adjustment Factor #4 – Wall Dead Load

Apply applicable factor to each story:

Wall Dead Load	Adjustment Factor
> 8 psf and < 15 psf	1.0
< 8 psf	0.85

Table R602.10.3(4)

APA

125

Required Length Seismic

Adjustment Factor #5 – Roof/Ceiling Dead Load

Apply applicable factor to each story:

Roof/Ceiling Dead Load	Adjustment Factor
1, 2 or 3 story building ≤ 15 psf	1.0
2 or 3 story building > 15 psf and ≤ 25 psf	1.1
1 story building or top story > 15 psf and ≤ 25 psf	1.2

Table R602.10.3(4)

APA

126

Required Length Seismic

Adjustment Factor #7 – Walls with Stone or Masonry Veneer

7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 — D_2[d, f]	Any story	See Table R602.10.6.5	BV-WSP

Table R602.10.3(4)

APA

127

Required Length Seismic

Adjustment Factor #9 – Interior Gypsum Board Omitted

Bracing Method	Adjustment Factor
DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, and CS-SFB	1.5

Table R602.10.3(4)

APA

128

Required Length Seismic

Adjustment Factor #10 – Horizontal Blocking Omitted

Bracing Method	Adjustment Factor
WSP, CS-WSP	2.0

Table R602.10.3(4)

APA

129

Bracing: Required Length

TABLE R602.10.3(3)
BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY

- SOIL CLASS D[a]
- WALL HEIGHT = 10 FEET
- 10 PSF FLOOR DEAD LOAD
- 15 PSF ROOF/CEILING DEAD LOAD
- BRACED WALL LINE SPACING ≤ 25 FEET

Seismic Design Category	Story Location	Braced Wall Line Length (feet)[b]	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[c,f]				
			Method LIB[d]	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB[e]	Method WSP	Methods CS-WSP, CS-G, CS-PF
D_0		10	NP	2.8	2.8	1.8	1.6
		20	NP	5.5	5.5	3.6	3.1
		30	NP	8.3	8.3	5.4	4.6
		40	NP	11.0	11.0	7.2	6.1
		50	NP	13.8	13.8	9.0	7.7
		10	NP	5.3	5.3	3.8	3.2
		20	NP	10.5	10.5	7.5	6.4
		30	NP	15.8	15.8	11.3	9.6
		40	NP	21.0	21.0	15.0	12.8
		50	NP	26.3	26.3	18.8	16.0
		10	NP	7.3	7.3	5.3	4.5
		20	NP	14.5	14.5	10.5	9.0
		30	NP	21.8	21.8	15.8	
		40	NP	29.0	29.0	21.0	
		50	NP	36.3	36.3	26.3	---

Table R602.10.3(1)

APA

130

Wind: Adjust the Required Length

9ft story height: 1.0
Braced wall line spacing: 1.0
Wall dead load: 0.85
Roof/ceiling dead load: 1.0
Stone or masonry veneer: 1.0
Interior gypsum: 1.0
Horizontal blocking: 1.0

12.8' x 1.0 x 1.0 x 0.85 x 1.0 = 10.88' Round up to 10.9'

APA

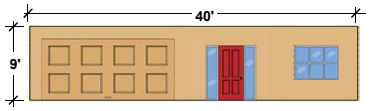
131

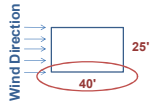
Bracing: Sufficient Length (seismic)

Complete Analysis

Method CS-WSP

CS-WSP Bottom of Two Stories	110 mph	SDC Do
	7.6'	10.9'





Braced Wall Line Spacing
- **25 feet**

Braced Wall Line Length
- **40 feet**

Assumptions:
- **Exp. B**
- **Eave-to-Ridge = 10ft**
- **9ft story height**
- **2 BWL**
- **7psf wall dead load**
- **15 psf roof/ceiling load**
- **No stone veneer**

APA

132

Minimum Length of BWP
Table R602.10.5

CS-G		24	27	30	33	36	Actual[b]
CS-PF	SDC A, B and C	16	18	20	22"	24"	1.5 × Actual[b]
	SDC D_0, D_1 and D_2	16	18	20	22"	24"	Actual[b]
CS-WSP, CS-SFB	Adjacent clear opening height (inches)						
	≤ 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	

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

133

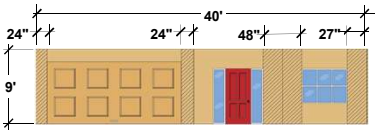
Bracing: Sufficient Length

Complete Analysis

Method CS-WSP

CS-WSP Bottom of Two Stories	110 mph	SDC Do
	7.6'	10.9'

Required Length: 10.9 feet
Total Bracing Length =
2' + 2' + 4' + 2.25' = 10.5' < 10.9'



134

Bracing: Sufficient Length

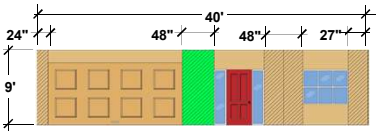
Complete Analysis

Method CS-WSP

CS-WSP Bottom of Two Stories	110 mph	SDC Do
	7.6'	10.9'

Required Length: 10.9 feet
Total Bracing Length =
2' + 2' + 4' + 2.25' = 10.5' < 10.9'

Turn CS-PF on right into 48" braced wall panel
2' + 4' + 4' + 2.25' = 12.25' > 10.9'



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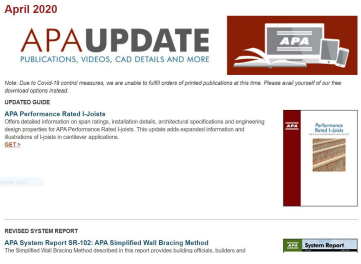
2018 IRC Wall Bracing

Questions?

Find your Local Field Services Representative
www.apawood.org/field-services
help@apawood.org
www.apawood.org

APA Update Newsletter
(www.apawood.org)



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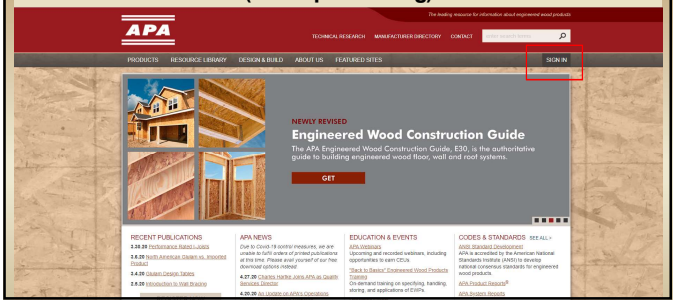

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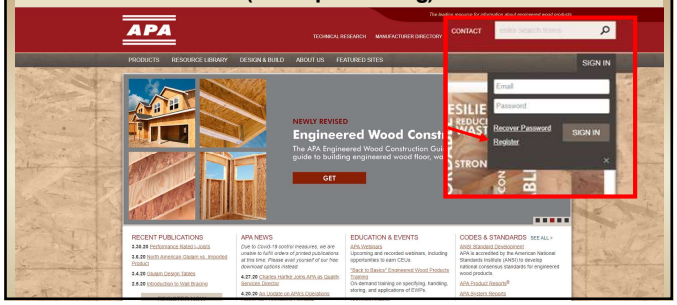

Field Services Division Territories

Thanks for Attending

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