Slide 1

Wall Bracing III:

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

Slide 2

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

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Meet the Team

Warren Hamrick

Matt Brown

2018 IRC Load Path, Lateral Forces and Limitations

Ron Nuttall

Meeting the IRC ® Bracing Provisions for Wind and Seismic

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Learning Objectives

- Apply the IRC Wall Bracing provision to example plans
- Understand both the IRC and APA simplified methods
- Input plan information into the APA Wall Bracing Calculator

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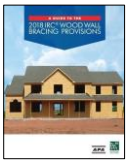
Resources

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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Example #1

Example:

- SDC C, Single-family dwelling
- Wind 115 mph, Wind Exposure C
- Method WSP
- Upper floor of two-story home
- Story height is 9 ft.
- Roof eave-to-ridge height is 16 ft.

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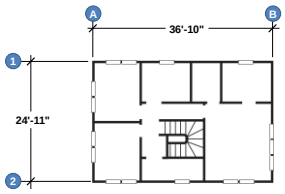
Example #1



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Bracing: Required Length

Decision Tree for Determining Required Bracing Length

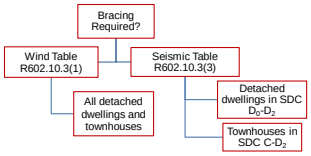

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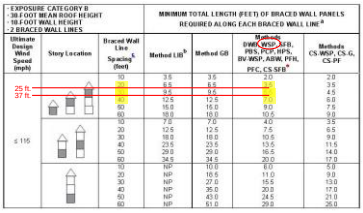
Table R602.10.3(1) –
Minimum Required Length of Bracing



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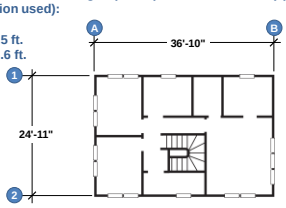
Example #1

Minimum length of WSP bracing required per Table R602.10.3(1) – (linear interpolation used):

BWL 1 and 2 = 4.5 ft.
BWL A and B = 6.6 ft.



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Bracing: Required Length

Adjustment Factor —
Wind Exposure Category, Mean Roof Height

Table R602.10.3(2)

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

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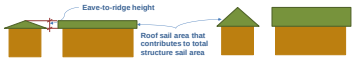
Bracing: Required Length

Adjustment Factor — Roof Eave-to-Ridge Height

Table R602.10.3(2)

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



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Bracing: Required Length

Adjustment Factor — Story Height

Table R602.10.3(2)

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

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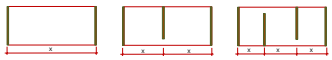
Bracing: Required Length

Adjustment Factor — Number of Braced Wall Lines

Table R602.10.3(2)

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

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Example #1

Applicable Adjustment Factors, Table R602.10.3(2)

#1 – Exposure category (C) – 1.3

#2 – Roof eave-to-ridge height (16 ft.) – 1.36

#3 – Story height (9 ft.) – 0.95

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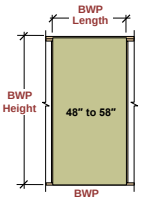
Bracing: Panel Material – Intermittent

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]



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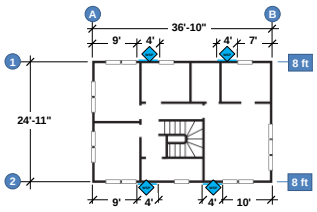
BWL 1 and 2: Required length = 4.5 ft. x 1.3 x 1.36 x 0.95 = 7.6 ft.
Provided length = 8 ft. - OK



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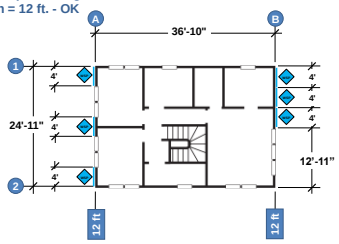
BWL A and B: Required length = 6.6 ft. x 1.3 x 1.36 x 0.95 = 11.1 ft.
Provided length = 12 ft. - OK



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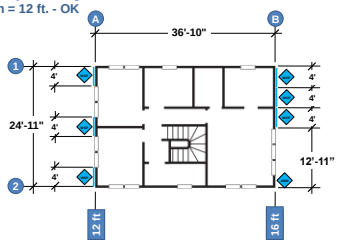
BWL A and B: Required length = 6.6 ft. x 1.3 x 1.36 x 0.95 = 11.1 ft.
Provided length = 12 ft. - OK



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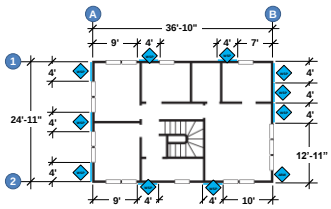
Example #1



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Example #2

Example:

- SDC C, Single-family dwelling
- Wind 115 mph, Wind Exposure C
- Method CS-WSP
- Bottom floor of two-story home
- Story height is 10 ft.
- Roof eave-to-ridge height is 16 ft.

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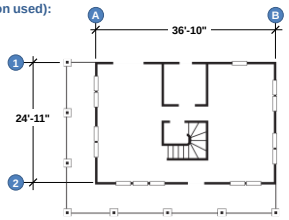
Example #2

Minimum length of CS-WSP bracing required per Table R602.10.3(1) — (linear interpolation used):



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Bracing: Required Length

Decision Tree for Determining Required Bracing Length

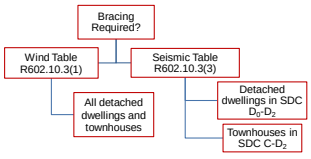

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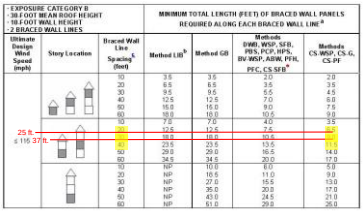
Table R602.10.3(1) –
Minimum Required Length of Bracing



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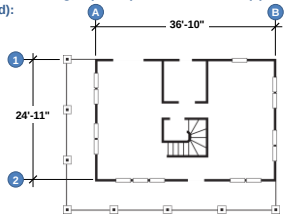
Example #2

Minimum length of CS-WSP bracing required per Table R602.10.3(1) – (linear interpolation used):

BWL 1 and 2 = 7.75 ft.
BWL A and B = 10.75 ft.



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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)

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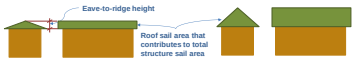
Bracing: Required Length

Adjustment Factor—Roof Eave-to-Ridge Height

Table R602.10.3(2)

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



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Bracing: Required Length

Adjustment Factor — Story Height

Table R602.10.3(2)

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

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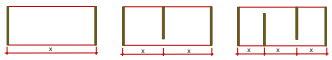
Bracing: Required Length

Adjustment Factor — Number of Braced Wall Lines

Table R602.10.3(2)

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



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Example #2

Applicable Adjustment Factors, Table R602.10.3(2)

- #1 – Exposure category (C) – 1.3
- #2 – Roof eave-to-ridge height (16 ft.) – 1.18

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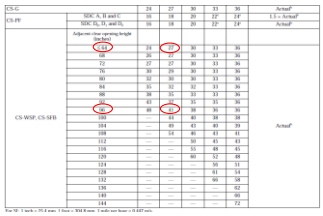
Minimum Length of BWP Table R602.10.5



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Example #2

Example:

- Clear opening height at doors = 8 ft.
  - Minimum BWP length = 41" per Table R602.10.5
- Clear opening height at windows = 5 ft.
  - Minimum BWP length = 27" per Table R602.10.5

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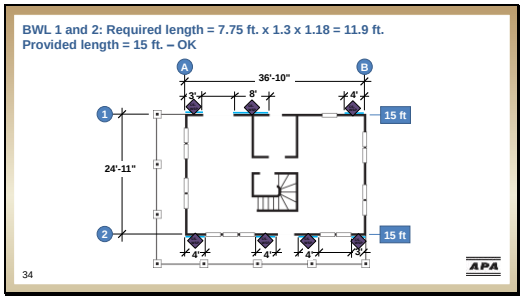

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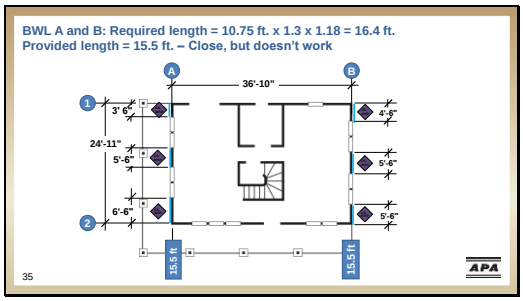

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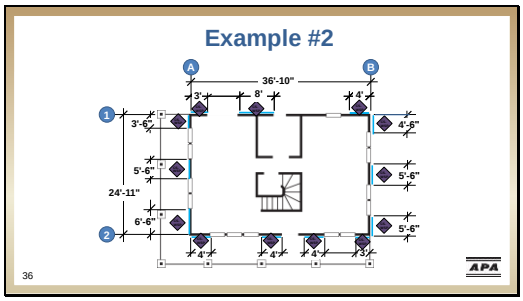

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Bracing Topics

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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IRC Simplified Wall Bracing (602.12)

Prescriptive Limits

- The structure must meet the following requirements:
  - Seismic Design Category (SDC) A, B, or C (SDC A or B for townhouses)
  - Ultimate Wind Speed of 130 mph or less with Wind Exposure Category B or C
  - One-, two-, or three-story structure
  - Wood structural panel (WSP) or structural fiberboard sheathing (WSP) is used to brace exterior walls with 1/2-in gypsum board fastened to the interior side of walls

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IRC Simplified Wall Bracing

Prescriptive Limits

- The structure must meet the following requirements:
  - 60 ft maximum length and width of the building
  - Max eave-to-ridge height of 15 ft
  - Max story height of 10 ft
  - Max ratio between long and short side of building: 3 to 1
  - Max cantilever of 24 inches beyond foundation
  - No cripple walls in three story buildings

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IRC Simplified Wall Bracing

Advantages to the Simplified Method:

- No seismic requirements
- Bracing only occurs on the perimeter (exterior walls)
  - (No braced wall line length or spacing)
- No additional adjustment factors to check
- No interpolation

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IRC Simplified Wall Bracing

Procedure:

1. Draw a rectangle around the perimeter of the building.

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Bracing: Simplified Wall Bracing

Rectangle Circumscribing an Enclosed Building

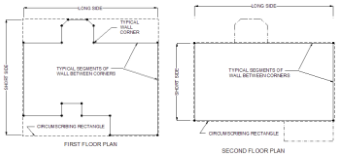

Figure R602.12.1

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Bracing: Simplified Wall Bracing

Procedure continued:

2. **Identify the number of bracing units required on each side of the rectangle.**

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IRC Simplified Wall Bracing

Minimum Number of Bracing Units on Each Side of the Circumscribed Rectangle

Table R602.12.4

Story Level	Eave-to Ridge Height (Feet)	Minimum Number of Bracing Units on Each Long Side a,b						Minimum Number of Bracing Units on Each Short Side a,b					
		Length of short side (ft) c						Length of long side (ft) c					
		10	20	30	40	50	60	10	20	30	40	50	60
1	10	1	2	2	2	3	3	1	2	2	2	3	3
2	10	2	3	3	4	5	6	2	3	3	4	5	6
3	10	2	3	4	6	7	8	2	3	4	6	7	8
1	15	1	2	2	3	3	4	1	2	2	3	3	4
2	15	2	3	4	5	6	7	2	3	4	5	6	7
3	15	2	4	5	6	7	9	2	4	5	6	7	9

a. Interpolation shall not be permitted.
b. Cripple walls or wood-framed basement walls in a walk-out condition of a one-story structure shall be designed as the first floor of a two-story house.
c. Actual lengths of the sides of the circumscribed rectangle shall be rounded to the next highest unit of 10 when using this table.

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IRC Simplified Wall Bracing

Bracing Methods for Simplified Wall Bracing

R602.12.2, R602.12.3

Material	Stud Spacing & Fastener Criteria	Fastener Spacing Criteria	Bracing Unit Method	Minimum Bracing Unit Length (feet)
Wood Structural Panel	Table R602.3(3)	6" edge 12" field	Continuous	3
			Intermittent	4
Structural Fiberboard Sheathing	Max 16" spacing Table R602.3(1)	3" edge 6" field	Continuous	3
			Intermittent	4

a. Mixing of wood structural panel and structural fiberboard sheathing in one building is not permitted.
b. Continuous and intermittent bracing units may be mixed from one story to another.
c. Continuous and intermittent bracing unit methods may not be mixed within one story.

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IRC Simplified Wall Bracing

R602.12.6

Narrow Bracing Methods for Simplified Wall Bracing

Narrow Bracing Method	Equivalent Bracing Units
CS-G	0.50
CS-PF	0.75
PFH, ABW	1.00
PFG	0.75

Each narrow bracing method is worth one, or less than one, 3 ft or 4 ft bracing unit.

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IRC Simplified Wall Bracing

Procedure continued:

3. Stagger the required number of bracing units along the four wall lines.

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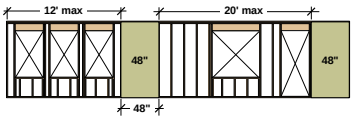
IRC Simplified Wall Bracing

- Distribution Requirements (R602.12.5)
  - Bracing unit shall begin no more than 12 feet from any corner
  - Distance between adjacent edges shall be no more than 20 feet
  - Walls longer than 8 feet require a minimum of one bracing unit



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IRC Simplified Wall Bracing

Example

- SDC B
- Wind 115 mph, Wind Exposure B
- Method CS-WSP
- 1 Story
- Walls—9 ft
- Eave to ridge height—15 ft

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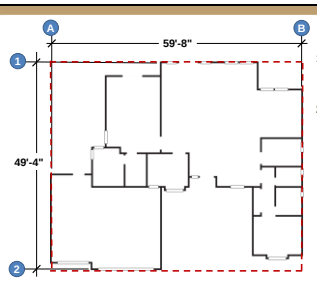

1. Draw rectangle around the entire building
2. Check the length of the N-S and E-W sides the of rectangle

Less than 60 ft?

OK

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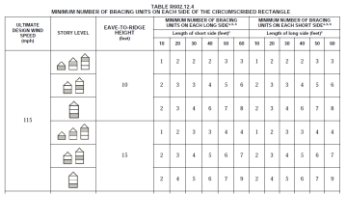
IRC Simplified Wall Bracing



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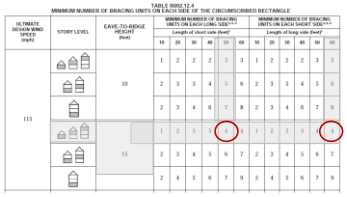
IRC Simplified Wall Bracing



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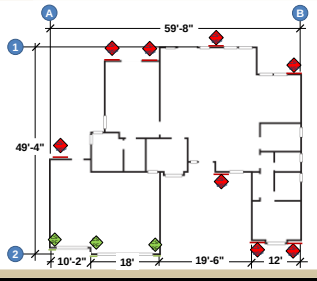

1. 4 bracing units required along each wall line
2. With CS-WSP, the minimum bracing unit length is 3 ft
3. Panels must be within 12 ft of the end of wall line and within 20 ft of one another

Sufficient space?

Yes, CS-PF units are only worth 0.75 units each so 5 B.U.s min will be needed on the south wall.

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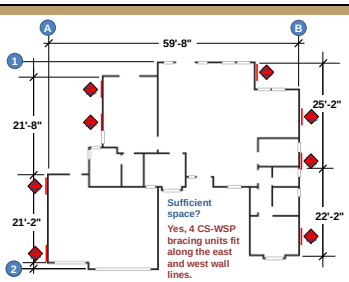

Sufficient space?

Yes, 4 CS-WSP bracing units fit along the east and west wall lines.

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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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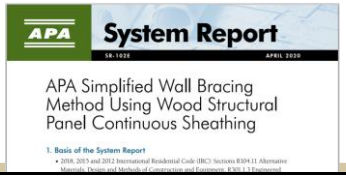
Wall Bracing

What if…

There was a simpler way to brace house designs?



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What is it?

APA Simplified Wall Bracing Method

- It is prescriptive, not engineered
- It takes advantage of the full strength of OSB and plywood
- It recognizes the strength found in shorter bracing panels
- It greatly reduces the complexity in designing bracing in single family houses
- It is based on the "simplified bracing" concept found in the IRC (R602.12)
- Its foundation is in years of testing and experience in the design of shear walls and diaphragms by APA

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What is it?

Basis of design

- The components that control the performance of bracing are panel thickness and fasteners.
  - Since the 3/8" code minimum panel thickness is relatively seldom used, the APA method is based on the more commonly used 7/16" thickness.
  - Fasteners aren't very expensive, so the APA method increases the frequency of the fastening along panel edges.
  - All exterior wall areas sheathed with wood structural panels.
- When APA put the three together, we discovered another level of performance in CS-WSP.

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Comparison of Simplified Methods

IRC Simplified vs. APA Simplified

Comparison Table		
	IRC	APA
Minimum thickness WSP	3/8"	7/16"
Nailing at panel edges	6" o.c.	4" o.c.
Required bracing	Number of units	Total length of bracing
Minimum Length bracing unit	36"	Same as CS-WSP
Narrow bracing	Portal frames only	Can be as narrow as 20" without portal frame
Portal Frames	CS-G = 1/2 unit CS-PF and PFG = 3/4 unit	CS-PF 1.5 x actual length
Partial length bracing	Not allowed	Allowed in 8' & 9' walls

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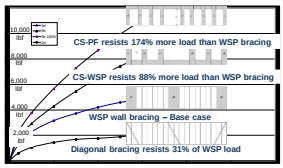
APA Simplified Wall Bracing Method

What is this method based on?



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APA Full-Scale 3D Wall Bracing Tests, Form T2007-73

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APA Simplified Wall Bracing Method

Streamlining the process

- **Four steps:**
  1. Check the system criteria, lateral support and limitations.
  2. Determine required bracing length from Table 3 and apply wall height multiplier.
  3. Identify full height wall sections and whether they meet the minimum lengths per Tables 1 and 2 and the distribution requirements.
  4. Add all qualifying bracing panels from step 3 on each side of the home and compare to step 2.

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Bracing Calculation Example

1. **The house must meet the system criteria**
   - ✓ No side longer than 60 feet
   - ✓ Three stories or less
   - ✓ Wall heights ≤ 12 feet
   - ✓ Roof to eave to ridge height ≤ 15 feet
   - ✓ Ultimate wind speeds ≤ 130 mph
   - ✓ Check lateral support and foundations
   - ✓ Single family must be in SDC A, B or C

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Bracing Calculation Example

1. The design parameters

House depth—40 feet
Roof height ≤ 15 feet
9' first floor height
8' second floor height
Wind Exposure Category—B
115 mph ultimate wind zone
2nd Floor above garage
Drywall inside of exterior walls

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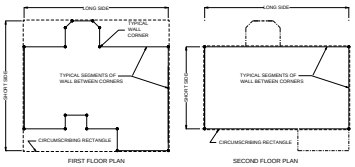
Bracing Calculation Example

2. Draw a rectangle around the house; measure each side.



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Bracing Calculation Example

2. Draw a rectangle around the house; measure each side
— Go to Table 3 and determine amount of bracing

MINIMUM REQUIRED BRACING LENGTH ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE FOR WIND EXPOSURE B

Wind Speed	Story Level	Eave-to-Ridge Height (ft)	Minimum Required Bracing Length on Each Long Side — Length of Short Side (ft) 10	20	30	40	50	60	Minimum Required Bracing Length on Each Short Side — Length of Long Side (ft) 10	20	30	40	50	60
90 mph nominal for the 2012 IRC or 115 mph ultimate for the 2018 and 2015 IRC		10	2.0	3.5	5.0	6.0	7.5	9.0	2.0	3.5	5.0	6.0	7.5	9.0
			2.9	5.4	7.4	9.9	12.0	14.0	2.9	5.4	7.4	9.9	12.0	14.0
			4.1	7.9	11.2	14.5	17.8	21.0	4.1	7.9	11.2	14.5	17.8	21.0
		15	2.6	4.6	6.5	7.8	9.8	11.7	2.6	4.6	6.5	7.8	9.8	11.7
			3.3	6.2	8.5	11.4	13.8	16.1	3.3	6.2	8.5	11.4	13.8	16.1
			4.5	8.7	12.3	16.0	19.6	23.1	4.5	8.7	12.3	16.0	19.6	23.1

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Bracing Calculation Example

2. Draw a rectangle around the house; measure each side
— Go to Table 3 and determine amount of bracing
— Apply the wall height adjustment factor

11.4' x .95 = 10.83' required bracing

TABLE 3
MINIMUM REQUIRED BRACING LENGTH ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE FOR WIND

c. The Wall Height Adjustment Factor, as shown below, shall be used to multiply the minimum bracing lengths listed in the table above to accommodate wall heights from 8 to 12 feet based on IRC Table R602.10.3(2). Interpolation shall be permitted.

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

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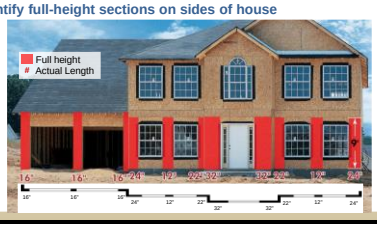
Bracing Calculation Example

3. Identify full-height sections on sides of house



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Bracing Calculation Example

3. Determine if segments meet minimum bracing length

TABLE 1
MINIMUM LENGTH OF BRACED WALL PANELS
(Excerpt from the 2018, 2015 and 2012 IRC Table R602.10.5, modified in accordance with R602.12.3, Item 1)

Method	Adjacent clear opening height (in.)	Minimum Length (in.) Wall Height 8 ft	9 ft	10 ft	Contributing Length (in.)
CS-G	—	32	27	30	Actual Length[a]
CS-PF	—	16	18	20	1.5 x Actual Length[a]
CS-WSP	≤ 60	24	27	30	Actual Length[a]
	64	24	27	30	
	68	26	27	30	
	72	27	27	30	
	76	30	30	30	
	80	32	30	30	
	84	35	32	32	
	88	36	35	33	
	92	36	36	35	
	96	36	36	36	
	100		36	36	
	104		36	36	
	108		36	36	
	112			36	
	116			36	
	120			36	

a. Use the actual length when it is greater than or equal to the minimum length.

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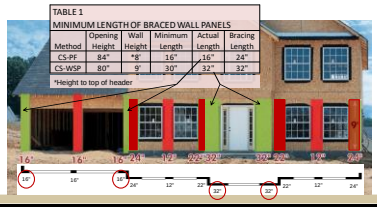
Bracing Calculation Example

3. Determine if segments meet minimum bracing length

TABLE 1
MINIMUM LENGTH OF BRACED WALL PANELS

Method	Opening Height	Wall Height	Minimum Length	Actual Length	Bracing Length
CS-PF	84"	*8'	16"	16"	24"
CS-WSP	80"	9'	30"	32"	32"

*Height to top of header



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Bracing Calculation Example

3. Determine if segments meet minimum bracing length
— If walls are 8' or 9', there is partial credit for short lengths

TABLE 2
PARTIAL CREDIT FOR CS-WSP LESS THAN FULL LENGTH WITH 8- AND 9-FOOT TALL WALLS[a]

Wall Height (ft)	Length of Full Height Method CS-WSP Panel (in.)	Adjacent to a Clear Opening Height (in.) or Less	Contributing Length of Braced Wall Panel (in.)
8 or 9	24	60	22
		64	22
		68	20
		72	18
		76	16
		80	14
	20	≤60	20
		64	18
		68	16
		72	15
		76	13
		80	11

a. Linear interpolation shall be permitted.

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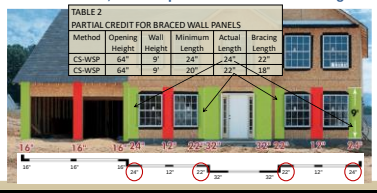
Bracing Calculation Example

3. Determine if segments meet minimum bracing length
—If walls are 8' or 9', there is partial credit for short lengths

TABLE 2
PARTIAL CREDIT FOR BRACED WALL PANELS

Method	Opening Height	Wall Height	Minimum Length	Actual Length	Bracing Length
CS-WSP	64"	9'	24"	24"	22"
CS-WSP	64"	9'	20"	22"	18"



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Bracing Calculation Example

4. Compile the amount of bracing on each side of house

24" + 24" + 22" + 18" + 32" + 32" + 18" + 22" = 192" = 16.0' eligible for bracing

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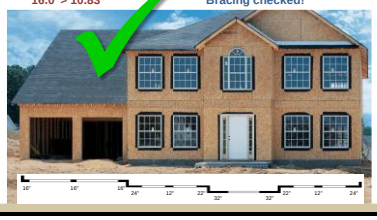
Bracing Calculation Example

16.0' > 10.83'

Bracing checked!



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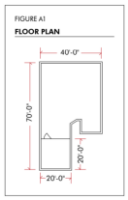
Multiple Rectangles



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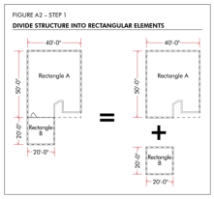
Multiple Rectangles



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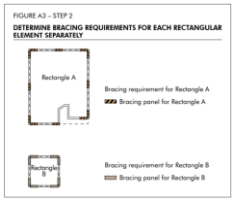
Multiple Rectangles



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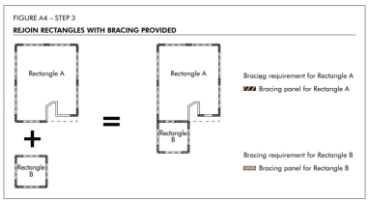
Multiple Rectangles



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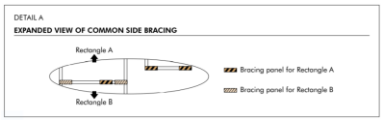
Multiple Rectangles



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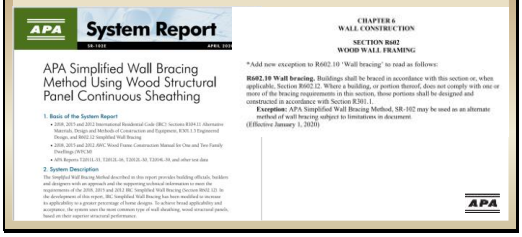
Code Accepted


APA System Report

APA Simplified Wall Bracing Method Using Wood Structural Panel Continuous Sheathing

1. Basis of the System Report

2. System Description

CHAPTER 6
WALL CONSTRUCTION

SECTION R602
WOOD WALL FRAMING

*Add new exception to R602.10 'Wall bracing' to read as follows:

R602.10 Wall bracing. Buildings shall be braced in accordance with this section or, when applicable, Section R602.12. Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1.

Exception: APA Simplified Wall Bracing Method, SR-102 may be used as an alternate method of wall bracing subject to limitations in document.
(Effective January 1, 2020)

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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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APA Wall Bracing Calculator

www.apawood.org/wall-bracing-calculator

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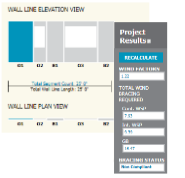
APA Wall Bracing Calculator

Benefits:

- The user locates the bracing segments, which offers user creativity while automating the code check, flagging incorrect or insufficient design.
- The output makes plan review clear and concise, and implementation into the construction plans straightforward.



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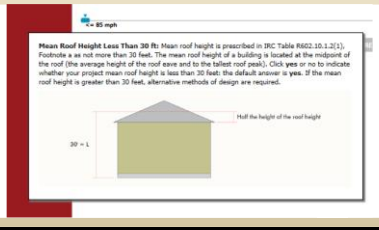
APA Wall Bracing Calculator



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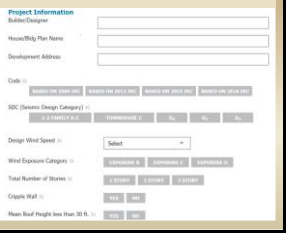
APA Wall Bracing Calculator

Step 1

- Design Criteria
  - Code
  - SDC
  - Wind Speed
  - Number of Stories



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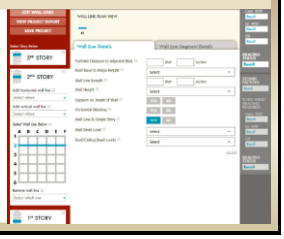
APA Wall Bracing Calculator

Step 2

- **Wall Line Details**
  - Distance to adjacent BWL
  - Line Length
  - Wall Height
  - Gypsum, Blocking



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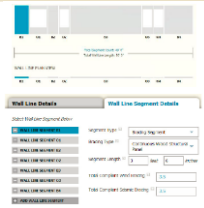
APA Wall Bracing Calculator

Step 3

- **Wall Line Segment Details**
  - Length BWPs
  - BWP material
  - BWP spacing
  - Total Compliant Bracing: Wind/Seismic



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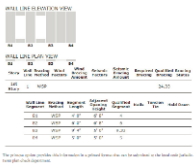
APA Wall Bracing Calculator

Step 4

- **Producing a Project Report**
  - PDF or Print
  - Summary Elevations
  - Wind & Seismic factors
  - Qualified Bracing vs. Required Bracing



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Example

Example:

- SDC A, Single-family dwelling
- Wind 115 mph, Wind Exposure C
- Method CS-WSP
- One-story home
- Wall height is 9 ft.
- Roof eave-to-ridge height is 16 ft.

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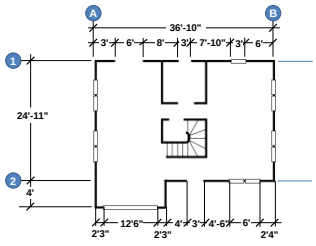

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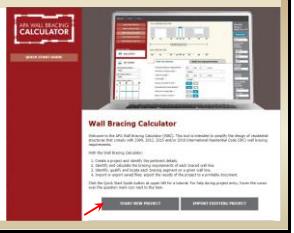
APA Wall Bracing Calculator

Step 1

- Entering Project Information
  - New Project
  - Import Existing Project



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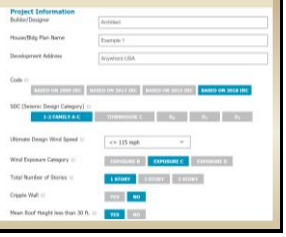
APA Wall Bracing Calculator

Step 1

- **Design Criteria**
  - Code
  - SDC
  - Wind Speed
  - Exposure
  - Number of Stories



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APA Wall Bracing Calculator

Step 2

- **Wall Line Details**
  1. Distance to adjacent BWL
  2. Eave to Ridge
  3. Line Length
  4. Wall Height
  5. Gypsum, Blocking

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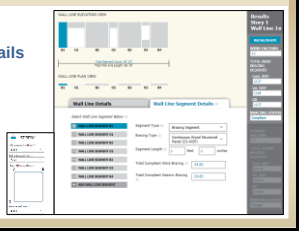
APA Wall Bracing Calculator

Step 3

- **Wall Line Segment Details**
  1. Length BWPs
  2. BWP material
  3. BWP spacing
  4. Total Compliant Bracing: Wind/Seismic



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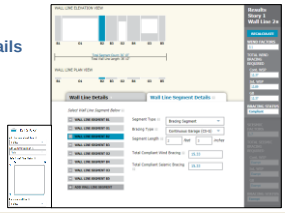
APA Wall Bracing Calculator

Step 3

- **Wall Line Segment Details**
  1. Length BWPs
  2. BWP material
  3. BWP spacing
  4. Total Compliant Bracing: Wind/Seismic



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APA
Wall Bracing Calculator

Step 4

- **Producing a Project Report**
  - PDF or Print
  - Summary Elevations
  - Wind & Seismic factors
  - Qualified Bracing vs. Required Bracing

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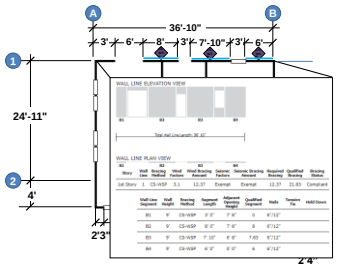

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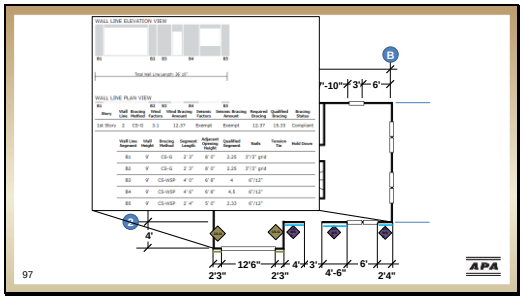

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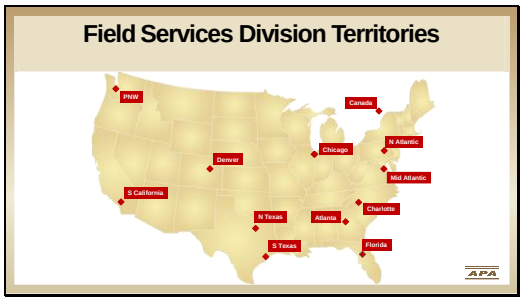

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