

APA Simplified Wall Bracing Method Using Wood Structural Panel Continuous Sheathing

1. BASIS OF THE SYSTEM REPORT

- 2012 International Residential Code (IRC): Sections R104.11 Alternative Materials, Design and Methods of Construction and Equipment, R301.1.3 Engineered Design, and R602.12 Simplified Wall Bracing
- 2012 AWC Wood Frame Construction Manual for One and Two Family Dwellings (WFCM)
- APA Reports T2011L-33, T2012L-16, T2012L-30 and other test data

2. SYSTEM DESCRIPTION

The Simplified Wall Bracing Method described in this report provides building officials, builders and designers with an approach and the supporting technical information to meet the requirements of the 2012 IRC Simplified Wall Bracing (Section R601.12). In the development of this report, the 2012 IRC Simplified Wall Bracing has been modified to increase its applicability to a greater percentage of home designs. To achieve broad applicability and acceptance, the system uses the most common type of wall sheathing, wood structural panels, based on their superior structural performance. To provide the user with the greatest possible architectural latitude, this system report only covers continuously sheathed wood structural panel bracing (2012 IRC Method CS-WSP) with an increased sheathing thickness (called “Performance Category” in product standards) and a closer nailing schedule on the first story of a two-story structure. This approach increases the performance of the bracing panels on the first story due to the additional restraint provided by the mass and stiffness of the structure above, through strength from increased fastening and with the use of thicker wood structural panel continuous sheathing. This enhanced performance on the bottom story of two-story structures leads to reduced length of required bracing in these areas, allowing for the method to be used on homes with abundant window and door openings on the front and back elevations. These decreases in the required bracing for the bottom story of a two-story structure are shown in Table 3.

Additional minimum braced wall panel length information taken from the 2012 IRC Section R602.10 has been added to this APA Simplified Wall Bracing Method. While this adds some level of complexity over the 2012 IRC method, it greatly increases the usability of the method.

Design simplification and flexibility are achieved through the enhanced sheathing thickness and nailing described in this report. Intermittent wood structural panel (Method WSP) and other bracing methods, except as specified in Section 3.1, are outside the scope of this report. Like the IRC simplified bracing method, the APA Simplified Wall Bracing Method shall be permitted for houses located in areas of low wind and seismicity. To increase the usability of the method, this report includes a number of additional details to augment the IRC simplified bracing provisions. Also included are references to specific areas of the IRC and other publications when additional information is required. Buildings meeting the requirements of this report meet all of the bracing requirements of the 2012 IRC Section R602.10 Wall Bracing with the enhancements discussed in Section 3 of this report.

3. METHODOLOGY

3.1 Applicability

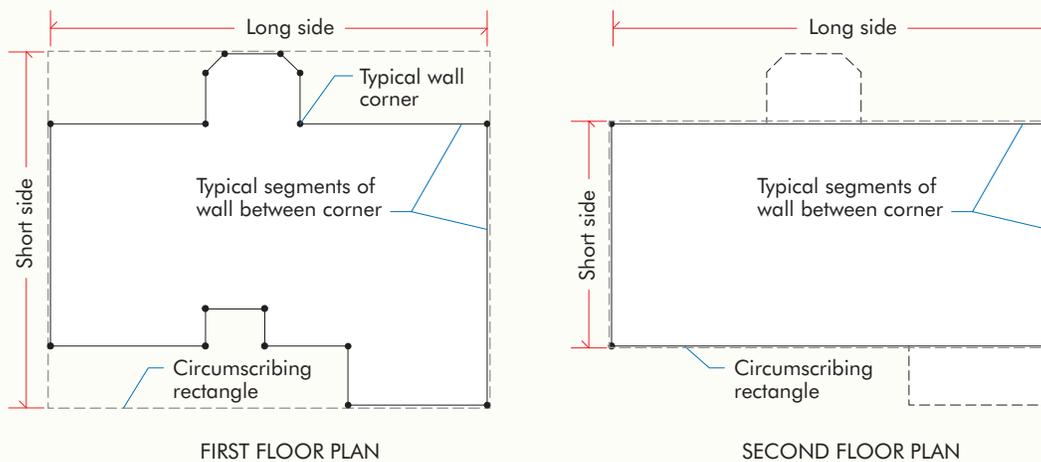
Residential structures must meet all of the following conditions when using this method:

- 1) The entire building shall be continuously sheathed with wood structural panels in accordance with the requirements specified in this section.
- 2) Other bracing provisions of the 2012 IRC Section R602.12, except as specified herein, are outside the scope of this method.
- 3) The foundation or basement wall shall be concrete or masonry, or concrete slab; and the structure above shall be 2 stories or less.
- 4) Floor cantilevers shall be no more than 24 inches beyond the foundation or bearing wall below.
- 5) Stud wall height shall be 10 feet or less when using the minimum required bracing lengths specified in Table 3 of this report unless adjustments are made for other wall heights up to 12 feet in accordance with Footnote c to Table 3 of this report.
- 6) Roof eave-to-ridge height shall be 15 feet or less.
- 7) Interior finish of exterior walls shall consist of minimum 1/2-inch gypsum boards installed on the interior side fastened in accordance with the 2012 IRC Table R702.3.5. Interior gypsum finish is not required on continuously sheathed wood structural panels adjacent to garage openings (Method CS-G) and continuously sheathed portal frame (Method CS-PF) bracing panels (see Section 3.5 of this report).
- 8) Basic wind speed shall be 100 mph or less and the Wind Exposure Category shall be B or C.
- 9) Seismic Design Category shall be A, B or C for detached one- and two-family dwellings or Seismic Design Category A or B for townhouses.
- 10) Cripple walls, if present, shall be considered the first story of the permitted two stories when using this method.

3.2 Circumscribed Rectangle

The building shall be circumscribed as shown in Figure 1. The rectangle shall surround all enclosed offsets and projections, such as sunrooms and attached garages, unless an attached garage or portion of the building is to be designed as a separate structure in accordance with the 2012 IRC Section R301.1.3 or a separate element in accordance with Appendix A of this report. Open structures, such as carports and decks, shall be permitted to be excluded. The rectangle shall have no side longer than 60 feet and the ratio between the long side and the short side shall not exceed 3:1.

FIGURE 1

RECTANGLE CIRCUMSCRIBING AN ENCLOSED BUILDING**3.3 Wood Structural Panel Sheathing Materials**

The wood structural panel sheathing shall be Rated Sheathing with a minimum 7/16 Performance Category, meeting the requirements of DOC PS1 or PS2.

3.4 Wood Structural Panel Sheathing Attachment

The wood structural panel sheathing shall be attached to framing in accordance with the following requirements:

- 1) The sheathing shall be installed with minimum 8d common nails (0.131 x 2-1/2 inches) spaced at 4 inches on center at panel edges and at 12 inches on center over intermediate supports. For single-story or the top story of two-story buildings, the sheathing may be installed with 8d common nails (0.131 x 2-1/2 inches) spaced at 6 inches on center at panel edges and 12 inches at intermediate supports.
- 2) The sheathing shall be applied continuously over all areas of the exterior walls except windows and doors, and including gable ends; and shall be installed either vertically or horizontally.
- 3) All horizontal panel joints shall occur over and be nailed to common framing or blocking with an appropriate panel edge-nailing schedule in accordance with the 2012 IRC Section R602.10.10.
- 4) A 24-inch return corner, as defined in the 2012 IRC Section R602.10.7, shall be located at the end of each *braced wall line* as defined in the 2012 IRC Section R602.10.1. An 800-lbf hold-down attached to the end stud of the braced wall panel closest to the corner shall be permitted for use on both adjacent walls in lieu of the 24-inch return corner.

3.5 “Qualified” Bracing Panel

A single “qualified” bracing panel shall consist of a full-height portion of an exterior wall continuously sheathed with wood structural panels with a minimum length as shown in Tables 1 and 2 of this report. The bracing panel shall have no openings, except that small drilled holes in the wall sheathing and not penetrating the wall framing up to 1-1/2 inches for the passage of wiring and utilities shall be permitted. When using narrow wall bracing methods CS-G and CS-PF, the minimum permissible lengths and contributing lengths for computing available bracing shall be as shown in Table 1 of this report. When using Method CS-WSP, Table 1 provides the minimum permissible lengths and contributing lengths based both on the wall height and the adjacent clear opening height. If an 8- or 9-foot tall wall line is present, Method CS-WSP braced wall segments less than the Table 1 minimum length may be used but with a corresponding reduction in contributing lengths for computing available bracing in accordance with Table 2 of this report.

TABLE 1

**MINIMUM LENGTH OF BRACED WALL PANELS
(EXCERPT FROM THE 2012 IRC TABLE R602.10.5, MODIFIED IN ACCORDANCE WITH R602.12.3, ITEM 1)**

Method		Minimum Length (in.)			Contributing Length (in.)
		Wall Height			
		8 ft	9 ft	10 ft	
CS-G		24	27	30	Actual Length ^(a)
CS-PF		16	18	20	1.5 x Actual Length ^(a)
CS-WSP	Adjacent clear opening height (in.)				Actual Length ^(a)
	≤ 60	24	27	30	
	64	24	27	30	
	68	26	27	30	
	72	27	27	30	
	76	30	29	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.

3.5.1 Partial Credit for CS-WSP Panels

CS-WSP panels in 8- or 9-foot tall walls between 20 and 24 inches in length that do not meet the minimum length requirements of Table 1 shall be permitted for use as bracing units at a full or reduced contributing length (depending on the adjacent opening height), as shown in Table 2 of this report based on the latest APA research results, as documented in APA Reports T2012L-16 and T2012L-30.

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	24
		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

3.6 Computing “Qualified” Wall Bracing Length

Within an exterior wall, only those full-height wall panels with a length greater than or equal to the lengths specified in Tables 1 and 2 of this report shall be deemed to contribute to resisting lateral load, and counted toward the required bracing length. The total bracing length along the side of a rectangle is equal to the sum of the contributing lengths of each “qualified” wall panel. Any length of a “qualified” bracing panel over the minimum bracing length required in Table 1 of this report shall be permitted for use toward the total bracing length required for that wall. Thus, if the minimum requirement for a specific method is 24 inches in accordance with Table 1 of this report and two such panels with lengths of 26 and 34 inches are present, $(26 + 34 =) 60$ inches or $(60/12 =) 5$ feet of bracing are present and shall be permitted for use in determining the total bracing length for that wall.

For Methods CS-G and CS-PF, the bracing length on either side of the opening is considered a “qualified” bracing panel and contributes to bracing lengths for meeting the minimum length requirements of Table 1 of this report. An example is provided in Appendix B.

3.7 Length of Bracing Required

Determining the bracing length required is relatively straightforward:

- 1) Circumscribe the building with a rectangle. The rectangle shall enclose the maximum building length and width dimensions as described in Section 3.2.
- 2) Ensure that the long side of the rectangle is not greater than 3 times the short side of the rectangle. If it is greater, consider using the multiple rectangle method covered in Appendix A. The alternatives are to:
 - use the “legacy” bracing provisions of the 2012 IRC Section R602.10,
 - use the multiple rectangle method in conjunction with the APA Simplified Wall Bracing Method (see Appendix A), or
 - have the structure designed in accordance with the 2012 IRC Section R301.1.3 and the International Building Code (IBC).
- 3) With the dimensions of this circumscribed rectangle, use Table 3 of this report to determine the bracing length that is required on each wall perpendicular to the side used to enter the table. Note that interpolation shall be permitted. Either value, the rounded or interpolated value, shall be multiplied by a wall height adjustment factor in accordance with Footnotes (c) and (d) to Table 3 of this report, as applicable.

3.8 “Distribution Rules” for Bracing Panels

Once the required bracing length has been determined for each side of the circumscribed rectangle using Table 3 of this report, this bracing length shall be distributed along the actual exterior walls of the structure. In distributing these bracing panels, all of the following “Distribution Rules” shall be met:

- 1) The first “qualified” bracing panel on each side of the rectangle shall begin within 12 feet of the wall corner. The 12 feet is measured between the wall corner and closest edge of the first full-height “qualified” bracing panel.
- 2) The distance between the closest edges of adjacent full-height “qualified” bracing panels shall be 20 feet or less.
- 3) Any wall with a length of 8 feet or greater shall have at a minimum of 3 feet of bracing.

In some cases, a greater bracing length is required to meet the Distribution Rules than is required by Table 3. In this case, the greater bracing length required by the Distribution Rules shall govern. In any cases, the bracing length required by Table 3 or the Distribution Rules, whichever is greater, shall be met.

TABLE 3

MINIMUM REQUIRED BRACING LENGTH ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE FOR WIND EXPOSURE B^{(a)(b)(c)(d)}

Wind Speed	Story Level	Eave-to Ridge Height (ft)	Minimum Required Bracing Length on Each Long Side						Minimum Required Bracing Length on Each Short Side					
			Length of Short Side (ft)						Length of Long Side (ft)					
			10	20	30	40	50	60	10	20	30	40	50	60
90		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
		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	8.6	11.4	13.8	16.2	3.3	6.2	8.6	11.4	13.8	16.2
100		10	2.5	4.0	6.0	7.5	9.5	11.0	2.5	4.0	6.0	7.5	9.5	11.0
			3.7	6.6	9.1	12.0	14.9	17.5	3.7	6.6	9.1	12.0	14.9	17.5
		15	3.3	5.2	7.8	9.8	12.4	14.3	3.3	5.2	7.8	9.8	12.4	14.3
			4.3	7.6	10.5	13.8	17.1	20.1	4.3	7.6	10.5	13.8	17.1	20.1

For SI: 1 ft = 304.8 mm

(a) Based on the 2012 IRC Table R602.10.3(1) and modified for the first story of a two story structure in accordance with the latest APA research results, as documented in APA Report T2011L-33.

(b) Interpolation shall be permitted.

(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 the 2012 IRC Table R602.10.3(2). Interpolation shall be permitted.

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

(d) For Wind Exposure Category C, multiply length required from table above by 1.2 for single-story buildings and 1.3 for two-story buildings.

(e) The first of two stories shall be continuously sheathed with wood structural panels attached with 8d common nails (0.131 x 2-1/2 inches) spaced 4 inches on center around the panel perimeter and at 12 inches on center over intermediate supports.

4. LATERAL SUPPORT

For bracing panels in exterior walls located along eaves, the vertical distance between the top plate and the underside of the roof sheathing shall be 9-1/4 inches or less at bracing panel locations. For vertical distances greater than 9-1/4 inches, the APA Simplified Wall Bracing Method shall still be permitted for use providing the attachment details of the 2012 IRC Section R602.10.8.2 are met. These details are not duplicated here because the limitation of 9-1/4 inches is not commonly exceeded.

5. LIMITATIONS

Recommendations provided in this report are subject to the following conditions:

- 1) The exterior walls of the structure shall be continuously sheathed with a minimum 7/16 Performance Category wood structural panel sheathing meeting the requirements of DOC PS1 or PS2 and shall be attached to framing with 8d common nails (0.131 x 2-1/2 inches) at 4 inches on center around the panel perimeter and at 12 inches on center over intermediate supports.
- 2) The APA Simplified Wall Bracing Method shall be applicable to buildings of no more than two stories, subject to the applicability listed in Section 3.1 of this report.
- 3) When placed over masonry or concrete stem walls, wall bracing panels used in the APA Simplified Wall Bracing Method shall meet the requirements of the 2012 IRC Section R602.10.9.
- 4) While the APA Simplified Wall Bracing Method is not part of the code, it is based on the code and other modifications permitted by the 2012 IRC Sections R301.1.3 Engineering Design. Further modifications to the APA Simplified Wall Bracing Method by the user of this report are beyond the scope of this report.
- 5) This report is subject to periodic review. The latest copy of this report is available for free download at www.apawood.org/publications.

APPENDIX A

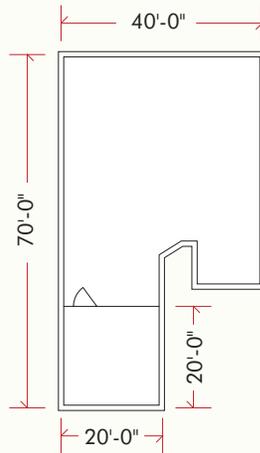
Wall Bracing for T- And L-Shaped Buildings

A common issue faced by residential designers using the APA Simplified Wall Bracing Method is determining the amount and placement of braced wall panels and wall lines in non-rectangular residential structures. Non-rectangular building configurations include T-, L-, and U-shaped buildings. For smaller structures, the APA Simplified Wall Bracing Method provides an easy solution by permitting the entire structure to be circumscribed by a rectangle. Even with the circumscribed rectangle procedure described in Section 3.2 of this report, some homes fall outside of the scope of the APA and IRC simplified bracing provisions due to their size or non-rectangular shape.

The multiple-rectangle procedure described on page 9 simplifies the design process, while still providing a safe and code-compliant structure. An example is presented on page 9 for an L-shaped building. The same principles apply to T- and U-shaped buildings, and other shapes that can be divided into multiple rectangles. This multiple-rectangle procedure shall be permitted when a structure has an exterior dimension greater than 60 feet, and thus, falls outside of the scope of the APA Simplified Wall Bracing Method, by dividing the structure into two or more elements that meet the maximum dimension requirements.

Figure A1 is an example of a floor plan that falls outside the requirements of the APA Simplified Wall Bracing Method because of the 70-foot building dimension.

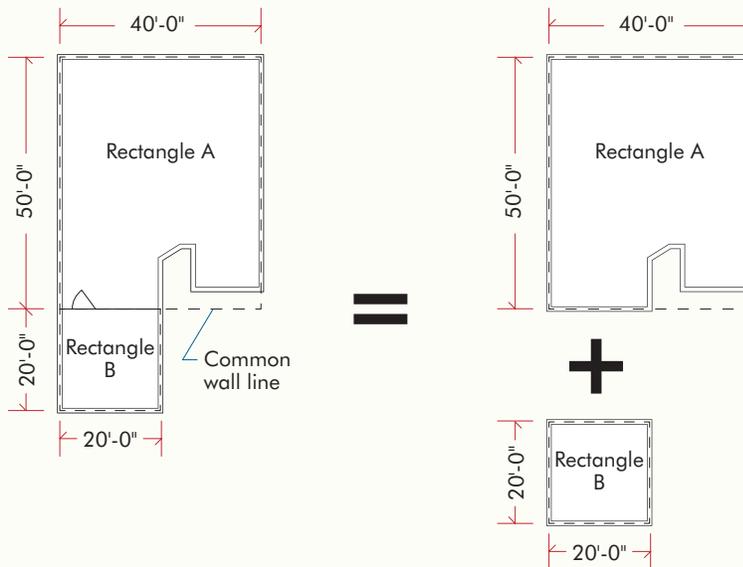
FIGURE A1
FLOOR PLAN



STEP 1: Divide the structure into rectangular elements. There are often multiple ways to do this. Typically, the easiest solution is to divide the building in such a way that the “common side” or “common wall line” of the two rectangles contains wall panels that are permitted to be used for bracing (see Figure A2).

FIGURE A2 – STEP 1

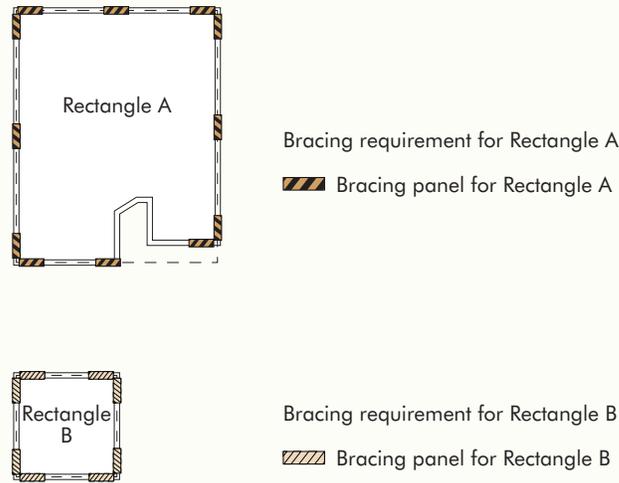
DIVIDE STRUCTURE INTO RECTANGULAR ELEMENTS



STEP 2: Determine bracing requirements for each individual rectangular element using the APA Simplified Wall Bracing Method. Each individual rectangle is treated and braced as if it were a completely independent and separate structure from the other rectangles. The braced wall line lengths and distance between braced wall lines are measured on each rectangle separately (see Figure A3). Note that any braced wall line with a length of 8 feet or greater must have at a minimum of 3 feet of equivalent bracing.

FIGURE A3 – STEP 2

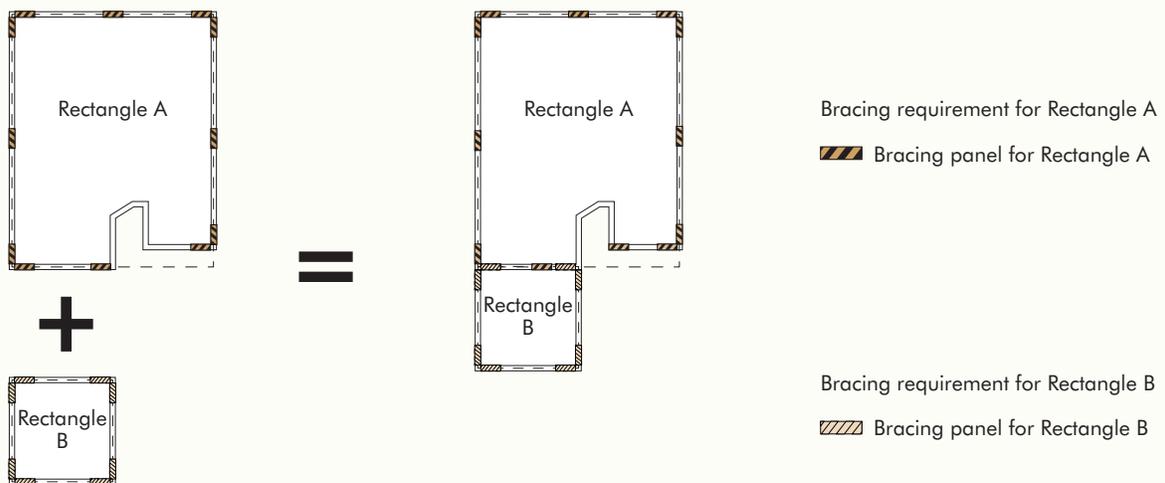
DETERMINE BRACING REQUIREMENTS FOR EACH RECTANGULAR ELEMENT SEPARATELY



STEP 3: Rejoin the rectangles with bracing provided, as shown in Figure A4. The rules that must be applied to the common side when rejoining the rectangles are presented below. Once rejoined, the increased common-side bracing will reflect the appropriate distribution of load. See Detail A.

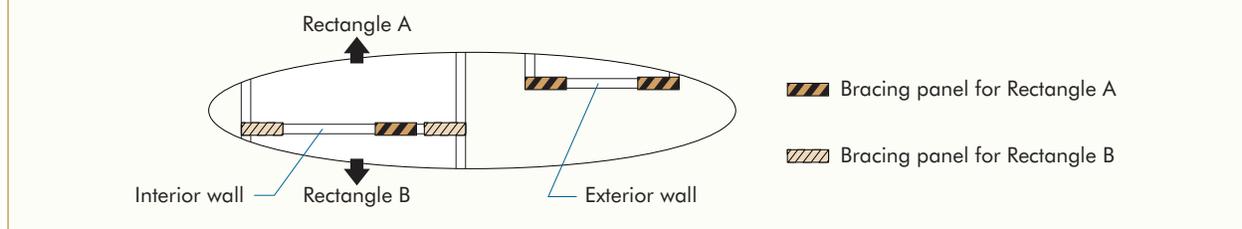
FIGURE A4 – STEP 3

REJOIN RECTANGLES WITH BRACING PROVIDED



DETAIL A

EXPANDED VIEW OF COMMON SIDE BRACING

**Rules for joining at the common side:**

- 1) The total bracing from both rectangles along the common side must be provided on the common side.
- 2) In the example shown in Figure A4, the common side of Rectangle A has a portion that is interior and a portion that is exterior to the house, while the common side of Rectangle B is entirely an interior wall. The bracing panels shall be permitted to be repositioned or redistributed along the common side as long as the total of the panels is at least equal to the total of the two separate rectangles.
- 3) The wall bracing location provisions of the APA Simplified Wall Bracing Method must be met along the common side, as well as along the extended wall line.
- 4) When the common wall line for both rectangles is an interior wall, the common wall bracing in the APA Simplified Wall Bracing Method shall be permitted to be made of Method GB (Gypsum Board) bracing. In this common wall line, the amount of doubled-sided Method GB bracing along the common wall shall be at least two times the required bracing length of Method CS-WSP bracing found in Table 3 of this report. The Method GB bracing shall be attached to both sides of the framing in accordance with the 2012 IRC Table R602.10.4. The Method GB panels shall be attached along all panel edges including the top and bottom plates. “Floating the corners” shall not be permitted.
- 5) When the common wall line for both rectangles has both exterior and interior wall line portions, the common wall bracing in the APA Simplified Wall Bracing Method shall be permitted to be made of both Method CS-WSP and Method GB bracing. In this case, the total length of the double-sided Method GB and the single-sided CS-WSP braced wall panels together shall not be less than two times the required length of Method CS-WSP bracing listed in Table 3 of this report (see Note 1 below). The Method GB bracing shall be installed as required in Item 4 above.
- 6) If insufficient bracing length is available along the common wall line in Item 5 above, use Method CS-WSP in the entire common wall line, including the interior wall line portion, to avoid the need to double the amount of wall bracing required in Table 3 of this report. If this still does not provide sufficient bracing length, consider other options provided in Section 3.7, Item 2, of this report.

Note 1: The 2012 IRC Section R602.10.4.1.5 permits mixing bracing methods in a wall line provided that the longest required bracing length of the mixed methods is used. As this report only provides the bracing amount for CS-WSP and the double-sided Method GB is approximately 1/2 of the capacity of Method CS-WSP, doubling the bracing amount listed in Table 3 of this report provides the required amount of bracing for such cases.

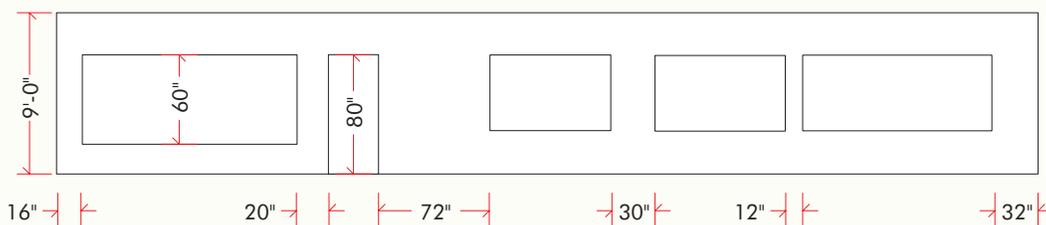
APPENDIX B

Example for Computing “Qualified” Wall Bracing Length

An example wall configuration is shown in Figure B1. Wood structural panels of 7/16 Performance Category meeting DOC PS2 are used to continuously sheath the wall with 8d common nails (0.131 x 2-1/2 inches) at 4 inches on center around the panel perimeter and at 12 inches on center over intermediate supports. The house configuration meets the applicability requirements of this report (i.e., Sections 3.1 and 3.8).

FIGURE B1

AN EXAMPLE WALL CONFIGURATION



THE QUALIFIED WALL BRACING LENGTH IS DETERMINED AS FOLLOWS:

Segment Length (in.)	Greater Than Length Required in Table 1	Contributing Length (in.)	Greater Than Length Required in Table 2	Contributing Length (in.)	Amount Of Bracing Length Contributed (in.)
16	No	0	No	0	0
20	No	0	Yes	11	11
72	Yes	72	–	–	72
30	Yes	30	–	–	30
12	No	0	No	0	0
32	Yes	32	–	–	32
Total =					145 in. or 12.1 ft

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