



# **APPENDIX A1** **WIND AND SEISMIC BRACING GUIDELINE FOR** **ONE AND TWO FAMILY DWELLINGS AND** **TOWNHOUSES**

## **Lateral Loads**

All buildings are subject to vertical and lateral loads. Vertical loads consist of people, furniture, snow and the weight of the building itself. Lateral load is primarily wind and seismic forces. In St. Louis County, wind load governs lateral design for one and two family dwellings whereas wind and seismic loads govern the lateral design of townhouses (3 or more attached dwellings in which each dwelling unit extends from the foundation to roof and each dwelling unit has open space on at least two sides). This Appendix A1 may be used to design one or two family dwellings and townhouses. Many designers prefer to use St. Louis County's Simplified Bracing Method for Designing a One or Two Family Dwelling located in a wind exposure A or B. This method is commonly referred to as the "Simplified Method."

## **Load Path**

All loads regardless of whether they are vertical or horizontal must be able to pass load from the areas in which the load is applied to the foundation. This is called the load path.

For a simple one story building, the seismic/wind load that acts on a wall is transferred to the roof construction, which acts as a diaphragm. Diaphragms are deep, thin beams and can be any sheathed roof or floor.

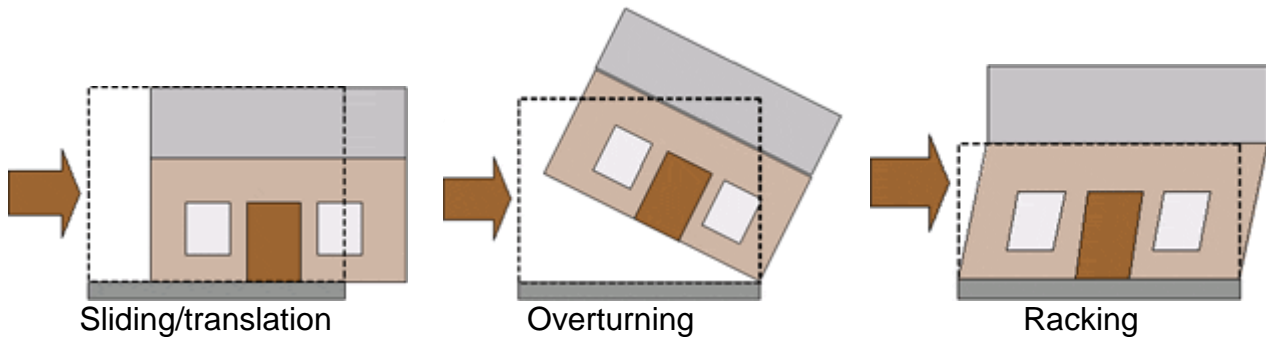
Once in the roof diaphragm, the load is then resisted by the braced wall panels in the walls which run parallel to the direction of the seismic/wind force. Braced wall panels are basically vertical thin beams that are designed to be stiff enough to transfer load from a diaphragm into the foundation.

The load path process would be similar if the building had multiple floors. The load would be passed from diaphragm above to the braced wall panels below until it reaches the foundation. However, since the braced wall panels of the lower floors resist more loads, they have stricter requirements for their design.

## Failure Modes

Seismic/wind loads can cause three types of failure for a structure (see figure 1). As the braced wall panels transfer load to the foundation, the structure must have resistance against sliding and overturning. Anchor bolts and tie downs accomplish this and are specified in the building code. Racking is prevented by the braced wall panels and their connections to the diaphragms and foundation.

Figure 1



## International Residential Code/2009 (IRC)

When utilizing the International Residential Code (IRC) for the design of your braced wall panels, you must know the wind speed and seismic design category in order to choose the system which best works for your building. For St. Louis County, the wind speed is 90 mph and the seismic design category is C. One and two family dwellings in a seismic design category C only need to be designed for windloads. Townhouses shall be designed for both wind and seismic forces.

This Appendix A1 summarizes the prescriptive bracing methods found in the IRC/2009. The Missouri Registered Architect or Engineer must establish, usually on the cover sheet of the drawings, the type of bracing to be used in each braced wall line. The design professional then must identify all the braced wall line locations and dimension and locate all braced wall panel locations for each floor of the dwelling unit. Many times a door or window will be added or relocated prior to the submission of an addendum to this office for approval. By showing the location and dimensions of each braced wall panel, the design professional has identified those "do not modify" areas on the drawings.

If you wish to deviate from the IRC prescriptive methods, you must have the lateral load resisting system professionally designed. In such cases involving a one or two family dwelling, structural calculations addressing wind forces are required per Chapter 16 of the International Building Code/2009. A townhouse that does not meet the IRC prescriptive design shall have structural calculations addressing both seismic and wind forces per the International Building Code/2009. Please refer to Engineered Design at the end of this Appendix A1 for more information.

## Framed Walls

Exterior wood framed walls shall be able to resist longitudinal or in-plane (racking loads) and transverse (perpendicular) wind and seismic loads, where applicable. The IRC/2009 places limitations on the wall heights. One can exceed the wall heights for a particular loading condition if structural calculations are provided.

Table 3 (Wind) and Table 7 (Seismic) in this appendix will provide lengths of braced wall panels needed to carry the longitudinal (in-plane) wall loads from wind or seismic forces. These two bracing tables are based on a 10' nominal wall height. The actual height from the bottom of the sill plate to the top of the double top plate may be 10'-2" to account for pre-cut stud heights. Both tables allow for the wall bracing to be adjusted to allow for a 12' nominal wall height. Walls that exceed this 12' nominal wall height are referred to as tall framed walls. A tall framed wall may be located in a braced wall line as long as the tall framed wall is not used as a braced wall panel, and the braced wall line containing the tall wall meets all of the code prescribed criteria. Note that a tall framed wall usually adjoins adjacent two or three stories of exterior wall framing, with each story exterior wall having its own braced wall line. In this situation, the tall wall framing is part of each stories braced wall lines and must comply with the prescriptive criteria. Please refer to the Braced Wall Line and Braced Wall Panel Section of this appendix for more information.

Tables R602.3(5) and R602.3.1 of the IRC/2009 limits the wall heights with regard to a transverse (perpendicular) wind or seismic loading situation. Bearing wall heights (Table R602.2(5)) are summarized below:

10' high, 2x4 studs at 24" o.c., is able to carry a maximum of 32' long trussed roof.

10' high, 2x4 studs at 16" o.c., is able to carry one floor and a maximum of 32' long trussed roof

10' high, 2x6 studs at 24" o.c., is able to carry one floor and a trussed roof

10' high, 2x6 studs at 16" o.c., is able to carry two floors and a trussed roof

Table R602.3.1 of the IRC/2009 allows for stud heights higher than 10' carrying small or negligible vertical loads.

## Braced Wall Line and Braced Wall Panels

The length of a braced wall line shall be measured as the distance between the ends of the wall line. The end of a braced wall line shall be considered to be either:

1. The intersection with perpendicular exterior walls or projection thereof,  
or
2. The intersection with perpendicular braced wall lines.

The end of the braced wall line shall be chosen such that the maximum length results. This line can be imaginary line or a line superimposed over a wall. All exterior walls shall be part of a braced wall line.

Interior braced wall lines maybe avoided if the perpendicular distances between the braced wall lines are

Less than or equal to 60' apart for wind loads

Or

Less than or equal to 50' apart for seismic (townhouses)

Braced wall panels may be offset out of plane up to 4 feet from the braced wall line provided the total out to out offset of braced wall panels in a braced wall line is not more than 8 feet. Please refer to Figure 2 of examples.

Braced wall panels locations shall be located at each end of a braced wall line and spaced along the braced wall line not more than 25' center to center of braced wall panels. The outside edge of the end brace wall panel may be located 12'-6" in from the end of the braced wall line as long as the braced wall panel on the opposite end of the braced wall line is located at the end of the braced wall line. Both end braced wall panels may be set in from the end of a braced wall line as long as the cumulative distances is less than or equal to 12'-6".

Note: An 800 pound hold down is required on the outside corner of a braced wall panel used in a continuously sheathed (CS-WSP or CS-PF) method. The 800 pound hold down load must be properly transferred to the foundation.

Exception: The hold down is not required if the corner of the braced wall line is framed in accordance with Figure 3 of this appendix. Figure 3 details the end braced wall panel at the end of a braced wall line with a 24" long wood structural panel sheathing perpendicular to the end braced wall panel. In addition, an 800 pound hold down is not required on the outside edge of an end braced wall panel that meets all of the following criteria:

- The outside edge of the braced wall panel is located less than or equal to 12"-6" from the end of the braced wall line
- there is a 24" minimum long wood structural panel sheathing at the end of the braced wall line closest to the braced wall panel
- there is a 24" minimum long wood structural panel sheathing perpendicular and adjacent to the braced wall line containing the braced wall panel

## Collector Design

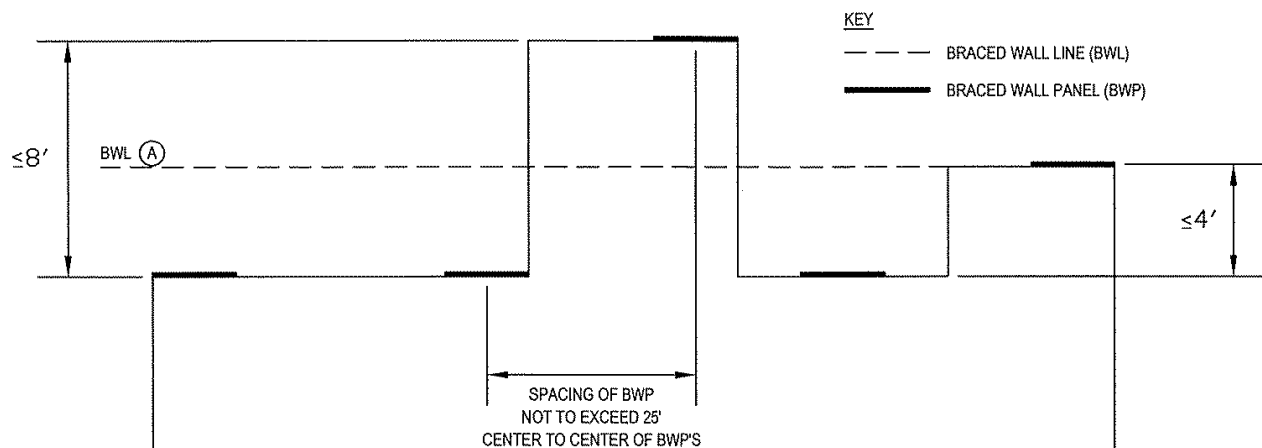
The first braced wall panel may be located up to 20' from the end of a braced wall line if all of the following criteria is met:

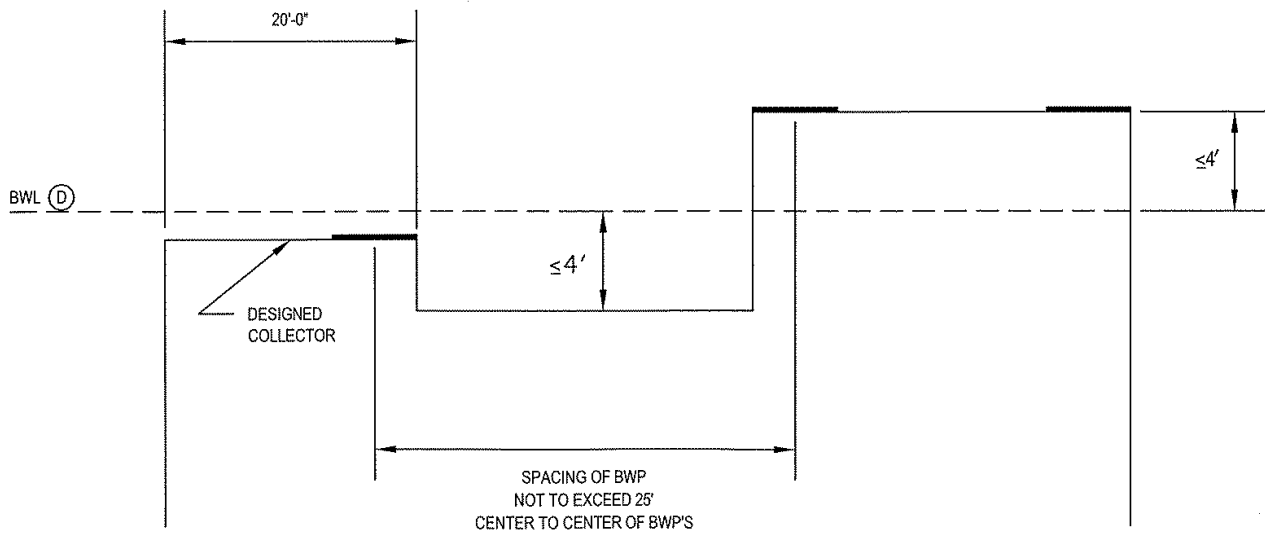
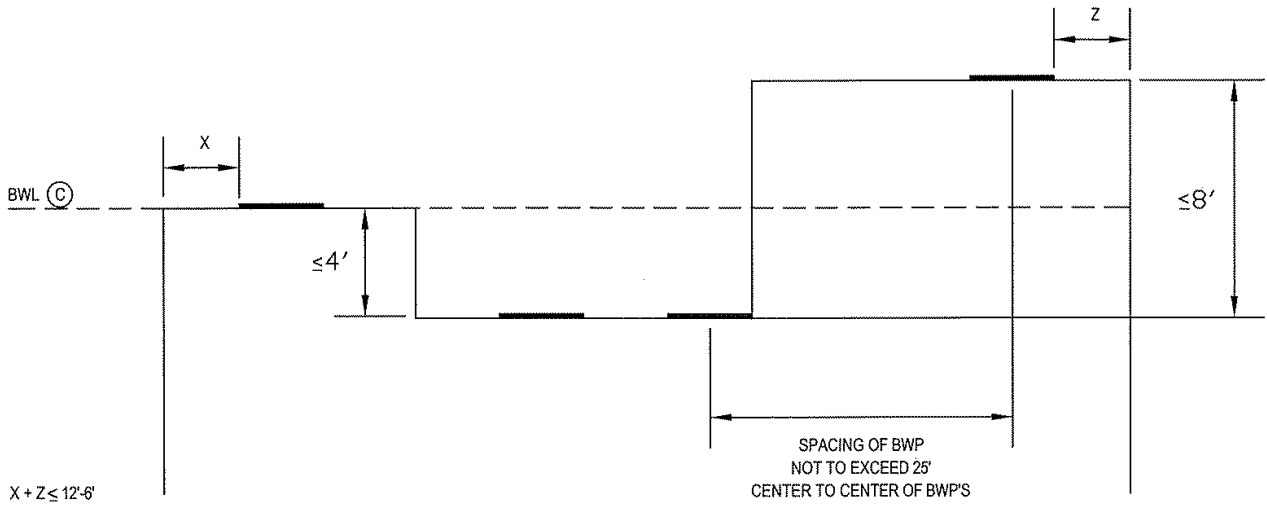
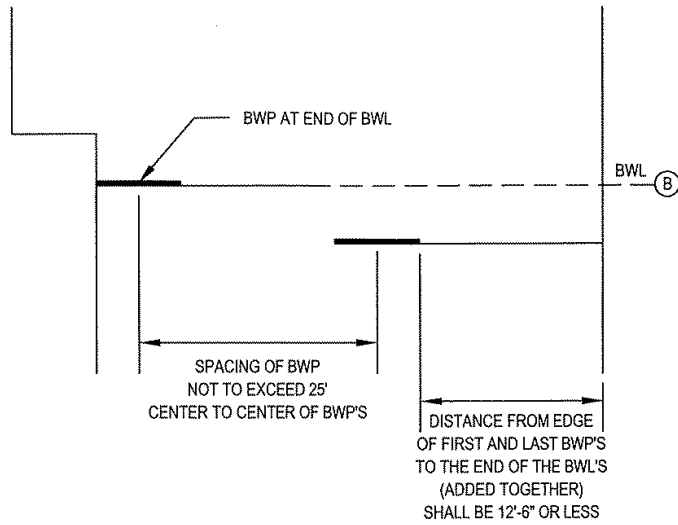
- a. The double top plate between the end of the braced wall line and the opposite end of the first braced wall panel shall be placed in a continuous straight line with no offsets.
- b. The braced wall panel is in the top story or in a story located below the top story. The braced wall panel height, the distance measured from the bottom of the sole/sill plate to the top of the double top plate, shall not be greater than 10' (10"-2" to account for precut studs) .
- c. The braced wall panel at the opposite end of the braced wall line shall be located at the end of the braced wall line.

- d. The braced wall line shall be braced with intermittent or continuous wood structural panel sheathing (WSP) installed in accordance with Table R602.10.1.2 (1) and, if applicable, Table R602.10.1.2 (2). A townhouse may have brick veneer on one exterior wall up to the maximum height noted in footnote d in Table 6.
- e. The 2x4 double top plates shall be #2 grade Douglas Fir or Spruce-Pine-Fir. The 2x6 double top plates shall be stud grade Douglas Fir or Spruce-Pine-Fir. The end joints in the double top plate of the braced wall line shall be offset a minimum of 48". 30-16d box nails shall be applied directly (face nailing) each side of a double top plate splice in the braced wall line. The nails may be placed in a single or double row with the following clearances measured to the centerline of the nail:
  - i. 1/2" edge clearance
  - ii. 3" end clearance
  - iii. 3" nail to nail spacing parallel to grain 1/2" between rows of nails perpendicular to grain
- f. An 800 pound hold down is required on the outside corner of this braced wall panel used in a continuous sheathing wood structural panel CS-WSP method. The 800 pound hold down load must be properly transferred to the foundation.

### Braced Wall Line Examples:

Figure 2





**BRACED WALL PANELS (TABLE 1)<sup>A, B</sup>**

ABBREVIATION	MATERIALS	MIN THICKNESS	MIN. LENGTH	CONNECTIONS
WSP (See CS-WSP or CS-PF below for continuous sheathing)	Wood structural panel	3/8"	4' length for 8' to 10' high wall 4'-5" length for 11' high wall 4'-10" length for 12' high walls	6d commons (use 8d commons for 7/16" thickness) 6" o.c. edges, 12" o.c. field
SFB	Structural fiberboard sheathing	1/2"	4' length for 8' to 10' high walls 4'-5" length for 11' high walls 4'-10" length for 12' high walls	1 1/2" galvanized roofing nails or 8d common nails. 3" o.c. edges, 6" o.c. field studs placed @16" o.c.
GB	Gypsum board	1/2"	4' length for 8' to 10' high walls 4'-5" length for 11' high walls 4'-10" length for 12' high walls	1 1/2" galvanized roofing nail; 1 1/2" long galvanized staple; 1 1/4" Type W or S screws; or 1 1/8" pan head or button head screws
ABW <sup>c</sup>	Alternate braced wall	See Figure 3 See Table 2	See Figure 3 See Table 2	See Figure 3 See Table 2
PFH <sup>c,d, g</sup>	Intermittent portal frame	See Figure 5	See Figure 5	See Figure 5
PFG <sup>c,d,f, g</sup>	Intermittent portal frame at garage	See Figure 6	See Figure 6	See Figure 6
CS-WSP	Continuous sheathed wood structural panels	3/8"		6d common nails 6" o.c. at edges, 12" o.c. field or 16 gauge x 1 3/4" staples at 3" o.c. edge spacing and 6" o.c. field. Use 8d nails for 7/16" wood structural sheathing
CS-PF <sup>e, g</sup>	Continuously sheathed wood structural panels incorporating portal frames	3/8"		See Figure 3 for corner framing See Figure 7

**Footnotes**

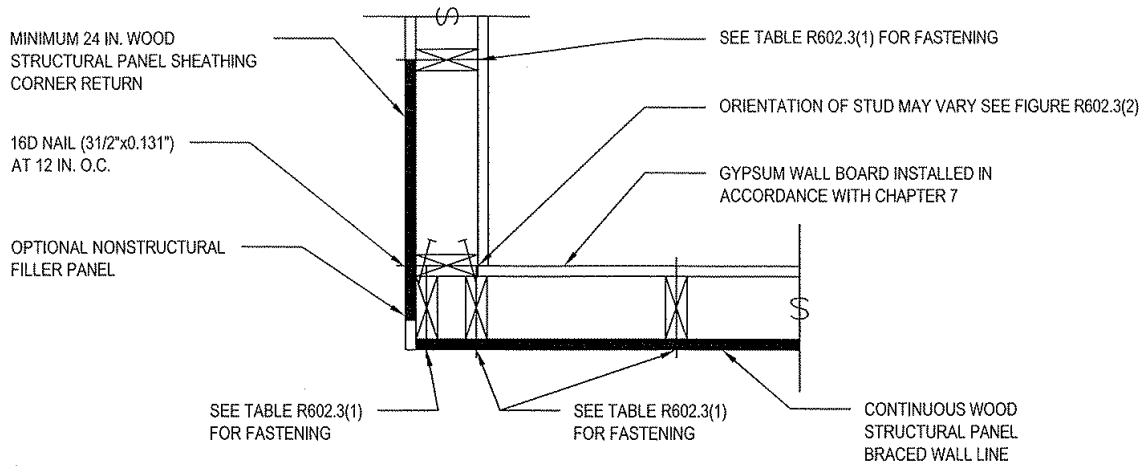
- A. Commonly used braced wall panels. Refer to the 2009 IRC for a complete list of bracing methods.
- B. See Tables 3 and 5 for required bracing lengths in a braced wall line. Note: Table 5 (seismic) is not applicable to one or two family dwellings.
- C. Foundation support under braced wall panel shall have a minimum #4 rebar placed horizontally at the top and bottom of the foundation. All spliced rebar shall be lapped a minimum of 15"
- D. Braced wall panel can only be used on a foundation supporting a roof or a story and a roof.
- E. Maximum of 4 portal frames may be used in a single braced wall line.
- F. The actual length may be increased by 50% when calculating required bracing length in a braced wall line.
- G. A pony wall may be placed on top of wall assembly. The total height of the lower wall and pony wall shall not exceed 12' in height. Provide tension straps in accordance with Table R602.10.4.1.1. As an option to Table R602.10.4.1.1, the lower wall and pony wall may be connected as follows:

The two walls or the wall and the gable end truss shall be strapped together on the interior side with a vertical 16 gauge metal 1 1/4" wide by 21" long strap. A minimum of 10" of the strap shall be connected to each wall or gable truss with 9-16d nails for

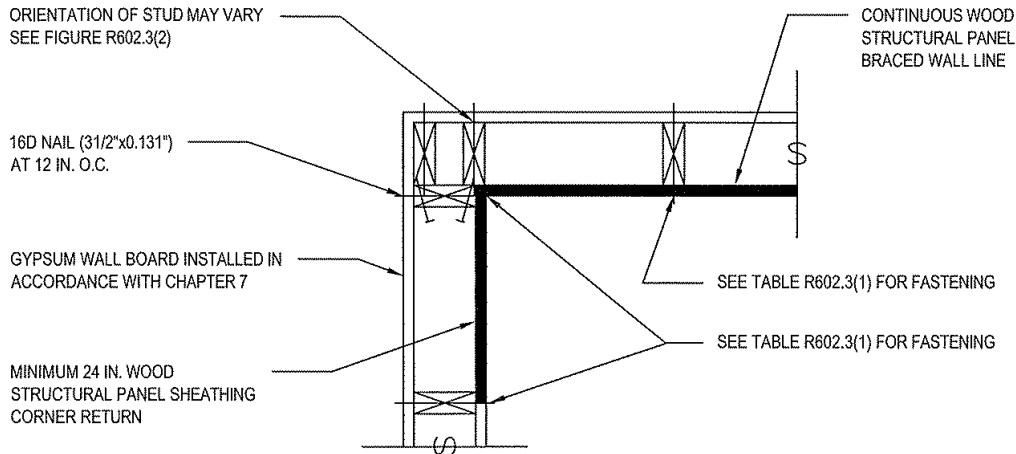
a total of 18-16d nails in the entire strap. Straps shall be located at each end of the connected walls or wall and gable truss where space allows for the 10" length of strap. The spacing between the straps may not exceed 4' on center. The straps shall not be bent horizontally to accommodate wood framing. If applicable, nailers should be added to one of the walls or gable end using a minimum of 9-16d nails to create the vertical plane needed to mount the strap.



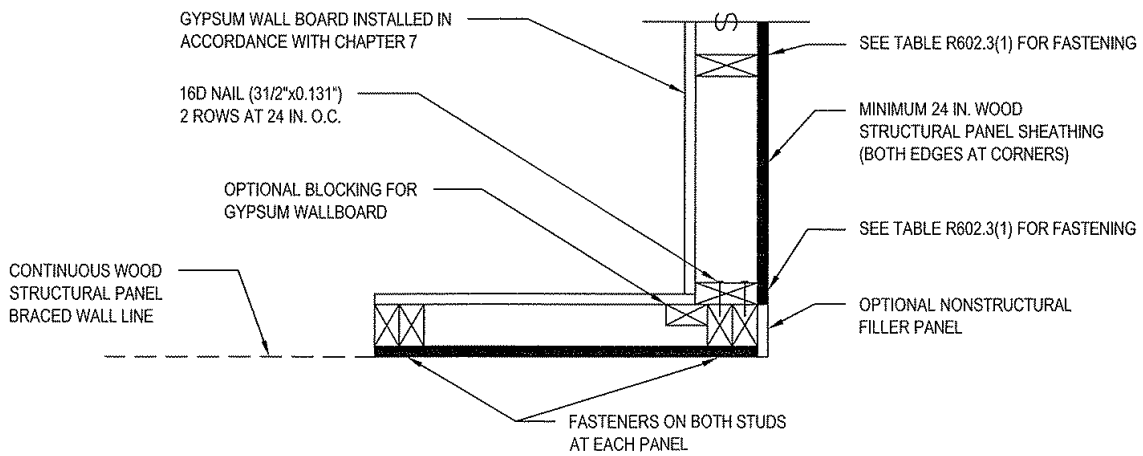
**Figure 3**



**OUTSIDE CORNER DETAIL**

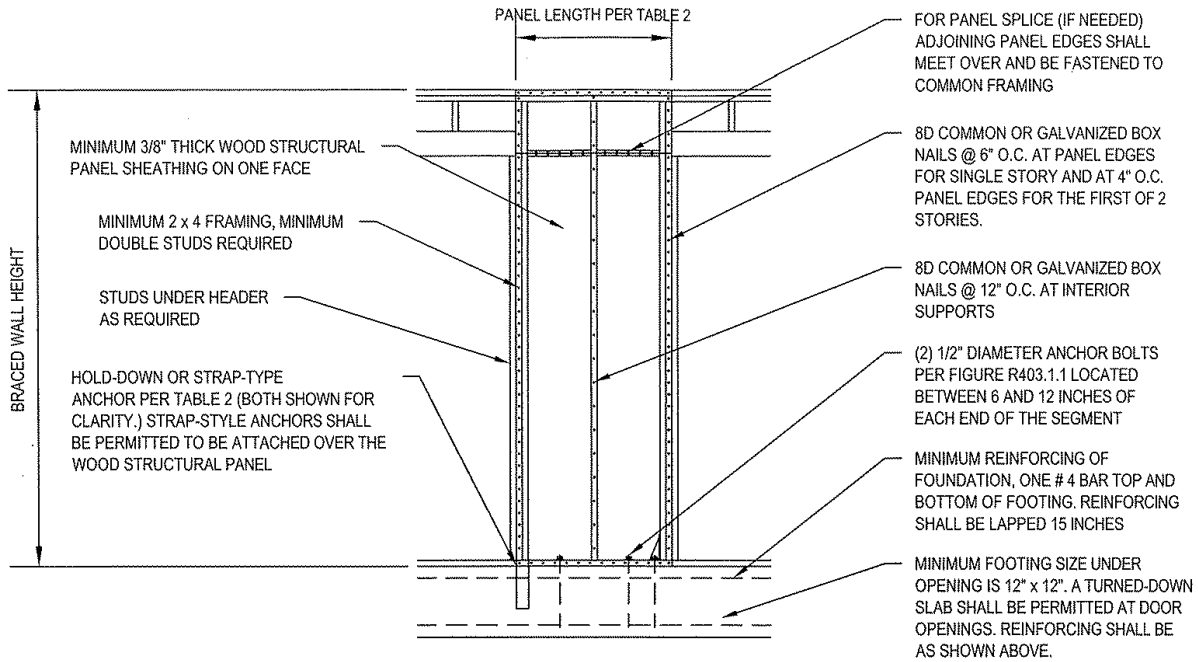


**INSIDE CORNER DETAIL**



**GARAGE DOOR CORNER DETAIL**

**Figure 4 Alternate Braced Wall Panel (ABW)**

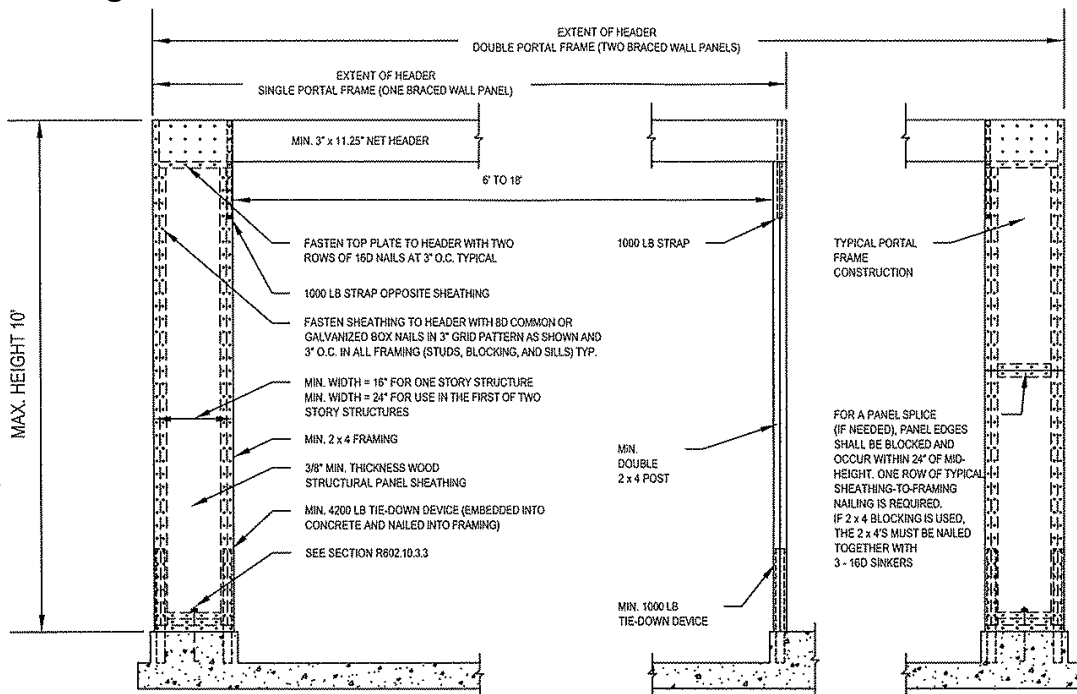


**Table 2**

**MINIMUM LENGTH REQUIREMENTS AND HOLD-DOWN FORCES FOR METHOD ABW BRACED WALL PANELS**

	HEIGHT OF BRACED WALL PANEL				
	8 ft	9 ft	10 ft	11 ft	12 ft
Minimum sheathed length	2'-4"	2'-8"	2'-10"	3'-2"	3'-6"
R602.10.3.2, item 1 hold-down force (1b)	1800	1800	1800	2000	2200
R602.10.3.2, item 2 hold-down force (1b)	3000	3000	3000	3300	3600

**Figure 5 Method PFH: Intermittent Portal Frame with Hold-Downs**



**Figure 6 Method PFG:**

**Portal Frame at garage Door Openings in Seismic Design Categories A, B and C**

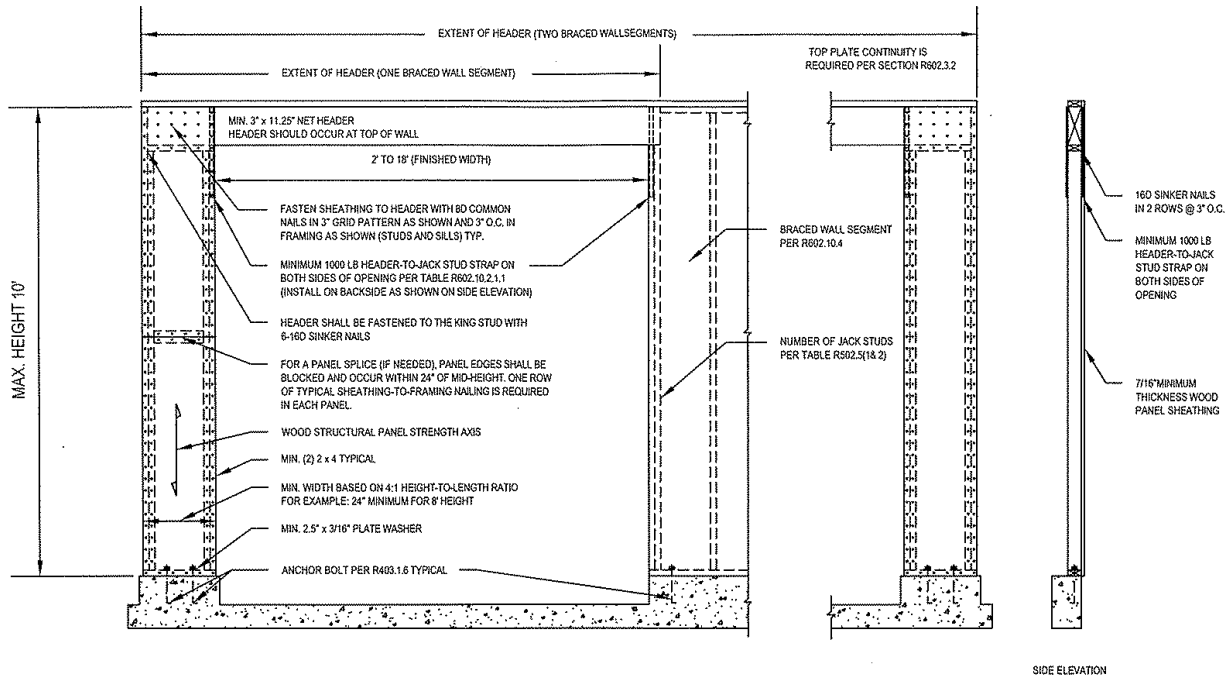


Figure 7 Method CS-PF:

Continuous Portal Frame Panel Construction

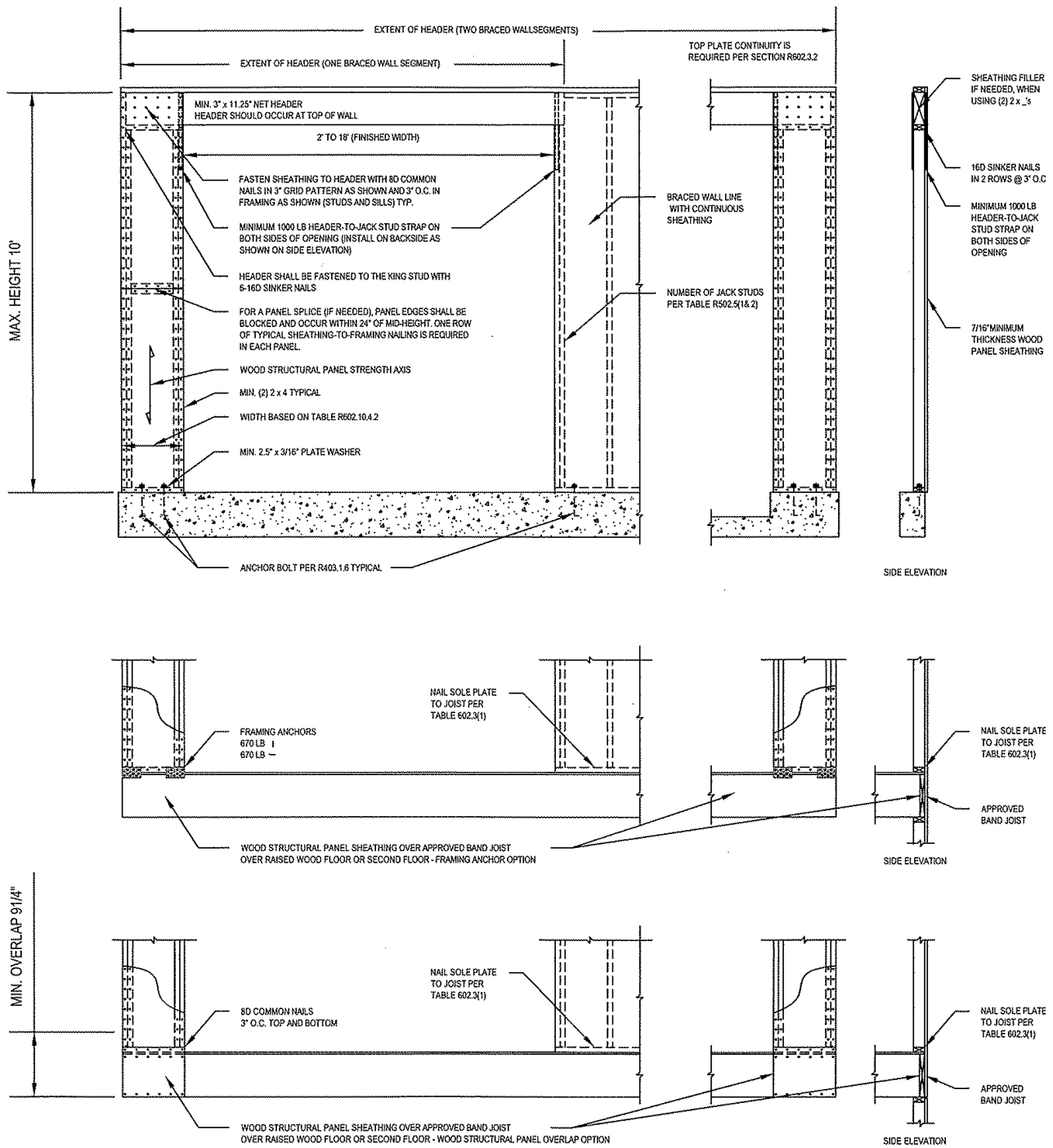


Table 3<sup>a, b, c, d, e, f</sup>

**LENGTH OF BRACING BASED ON WIND SPEED  
(BRACED WALL LINES ARE PARALLEL WITH THE WIND DIRECTION)**

Story Location <sup>i</sup>	Perpendicular distance between Braced Wall Lines (feet)	MINIMUM TOTAL LENGTH (feet) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE		
		Gypsum boards (GB) both sides of BWP <sup>g</sup>	WSP, SFB, ABW, PFH, and PFG <sup>h</sup>	Continuous wood structural panel sheathing CS-WSP and CS-PF
Top story	10	3.5	2.0	2.0
	20	7.0	4.0	3.5
	30	9.5	5.5	5.0
	40	12.5	7.5	6.0
	50	15.5	9.0	7.5
	60	18.5	10.5	9.0
Story below the top story	10	7.0	4.0	3.5
	20	13.0	7.5	6.5
	30	18.5	10.5	9.0
	40	24.0	14.0	12.0
	50	29.5	17.0	14.5
	60	35.0	20.0	17.0
Story below the top two stories	10	10.5	6.0	5.0
	20	19.0	11.0	9.5
	30	27.5	15.5	13.5
	40	35.5	20.5	17.5
	50	44.0	25.0	21.5
	60	52.0	30.0	25.5

Footnotes to Table 3

- a. Interpolation is permitted.
- b. Bracing lengths are based on a wind exposure Category B, A 30' mean roof height, 10' eave to ridge height, a 10' wall height, and 3 braced wall lines sharing the load in a give plan direction on a given story.
- c. For wind exposure C locations, multiply the length is the table by the following multiplier

<u># of Stories</u>	<u>Multiplier</u>
1	1.2
2	1.3
3	1.4

- d. For wall heights of 8, 9 or 12', the tabulated bracing length shall be multiplied by

<u>Wall height</u>	<u>Multiplier</u>
8'	0.90
9'	0.95
12'	1.1

An additional 2" variation in height is permissible to allow for precut studs.

- e. For roof eave to ridge heights is less than or greater than 10', the tabulated length of bracing shall be multiplied by the following factor.

<b>SUPPORT CONDITION</b>	<b>ROOF EAVE-TO-RIDGE HEIGHT</b>		
	<b>5 ft. or less</b>	<b>15 ft.</b>	<b>20 ft.</b>
Roof only	0.7	1.3	1.6
Roof + floor	0.85	1.15	1.3
Roof + 2 floors	0.9	1.1	NP

- f. The tabulated bracing length shall be multiplied by the following adjustment factor when there is more than 2 braced wall lines parallel to the wind direction:

<u># of Braced Wall Lines Parallel to the Wind Direction</u>	<u>Adjustment Factor</u>
3	1.3

4  
5 or greater

1.45  
1.6

- g. The amount of gypsum board bracing is based on the gypsum board being applied to both sides of a braced wall panel. The length shall be multiplied by 2 when gypsum board is applied to one side of wall.
- h. Bracing method WSP and SFB assumes a drywall finish on the inside of the braced wall panel. If drywall is not present, multiply the tabulated length by 1.5. This multiplier is not applicable to GB, ABW, PFH, PFG, CS-WSP, and CS-PF wall bracing.
- i. A framed basement cripple/walkout wall shall be braced as the lowest story. As an option, these walls may be braced using Section R602.10.9.

## Continuous Wood Structural Panel Sheathing (CS-WSP and CS-PF)

This method is detailed in Section R607.10.14 of the 2009 IRC. This bracing method can be applied to a single braced wall line in a story while other bracing methods are used in other braced wall lines. This method should not be confused with the “Simplified Bracing Method for One and Two Family Dwellings” when the entire structure is sheathed with wood structure panels and located in Wind Exposure A or B”. The Simplified Method may be found under the residential brochure tag at [www.stlouisco.com/pubworks](http://www.stlouisco.com/pubworks).

Continuous wood structural panel sheathing uses 3/8” thick plywood or Oriented Strand Board (OSB) sheathing over the entire braced wall line including areas above and below openings. Like the other bracing methods in this handout, the plans shall indicate the braced wall line locations and braced wall panel lengths and locations. The required length of braced wall panel is dependent on the adjacent wall opening (Table 4). The total braced wall panel lengths in a braced wall line shall meet or exceed the minimum required length of braced wall panels in Table 3 (Wind) and Table 7 (Seismic). The corners of a continuously sheathed braced wall line shall be constructed as shown in Figure 3.

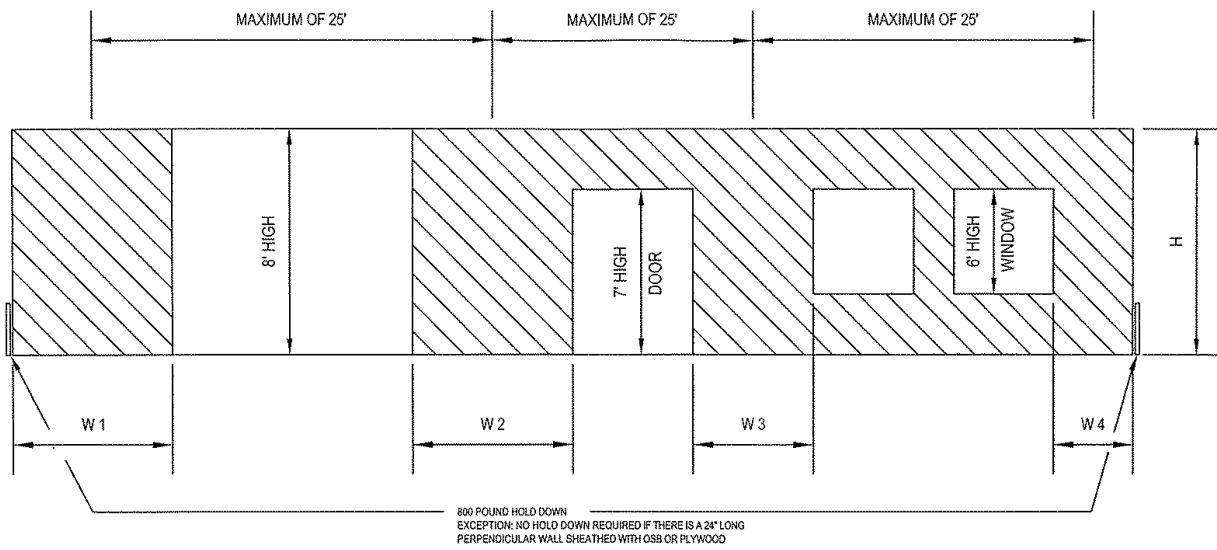
Method	Adjacent Clear Opening Height	Wall Height				
		8'	9'	10'	11'	12'
CS-WSP	64"	24"	27"	30"	33"	36"
	68"	26"	27"	30"	33"	36"
	72"	27"	27"	30"	33"	36"
	76"	30"	29"	30"	33"	36"
	80"	32"	30"	30"	33"	36"
	84"	35"	32"	32"	33"	36"
	88"	38"	35"	33"	33"	36"
	92"	43"	37"	35"	35"	36"
	96"	48"	41"	38"	36"	36"
	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"
	124"				56"	51"
	128"				61"	54"
132"				66"	58"	
136"					62"	
140"					66"	
144"					72"	
CS-PF <sup>b</sup>	≤ 120"	16"	18"	20"	N/A	N/A

For S1: 1 inch = 25.4 mm, 1 foot = 305 mm

- a. Interpolation shall be permitted.
- b. "Wall height" shall be measured from the bottom of the sill/sole plate to the top of the adjacent header that extends into the portal panel.

**Figure 8**

**CS-WSP (Continuous Wood Structural) Panel Sheathing Braced Wall Panel Example**



**Table 5**  
Minimum widths of braced wall panels for Figure 8

Wall Height H	8' High Overhead Door W1	8' High Overhead Door W2	7' High Door W3	6 High Window W4
8'	48"	48"	35"	27"
9'	41"	41"	32"	27"
10'	38"	38"	32"	30"
12'	36"	36"	36"	36"



**Table 6**

**Exterior Braced Wall Panel Attachment to other Framing Members<sup>1</sup>**

<u>CONDITION</u>	<u>CONNECTION</u>
Rafter/ceiling joist roof trusses parallel to the top plate of an exterior braced wall panel <sup>1</sup>	8d @ 6" o.c., toenail
Rafter/ceiling joists/trusses perpendicular to the top plate where the distance between the bottom surface of the roof sheathing to the upper surface of the top plate is 9 ¼" or less. <sup>1</sup>	Rafters: 2-16d, toenail Ceiling joists: 3-8d toenails Trusses: 3-16d, toenails
Rafter/ceiling joists/trusses perpendicular to the top plate where the distance between the bottom surface of the roof sheathing to the upper surface of the top plate is greater than 9 ¼" and equal to or less than 15 ¼". This situation requires blocking to be installed between the roof framing members. Note: Blocking may have 2" space between its top edge and the bottom of the roof sheathing to allow for soffit attic ventilation. <sup>1</sup>	Rafters: 2-16d, toenail Ceiling joists: 3-8d, toenail Trusses: 3-16d, toenail Blocking: Attached to rafters/joists/trusses with 3-8d, toenail. Blocking is attached to the top plate with 8d nails @6" o.c., toenailed
Rafter/ceiling joist/roof trusses perpendicular to the top plate where the bottom of the roof sheathing to the upper surface of the top plate is greater than 15 ¼". <sup>1</sup>	Braced wall panel and blocking installed per Section R602.10.6.2 Item 4
Bottom sole plate of a braced wall panel outside edge of the first/last braced wall panel braced using the CS-WSP method must be secured to the foundation to resist an 800# uplift force. Exception: 1. The braced wall panel is located at the end of the braced wall line and there is a 24" plywood or OSB sheathed wall perpendicular to this braced wall panel. 2. The first/last outside edge of the braced wall panel is within 12'-6" of an exterior corner that has 24" long plywood/OSB sheathing on each side of the corner.	3-16d 16" o.c., direct into the rim or band board
Anchor bolts securing and exterior sill of a braced wall panel shall be ½" in diameter, 7" embedment into the concrete, and spaced not more than 6' o.c. Exception: Unless otherwise detailed differently in the figures in this handout.	
<b>INTERIOR BRACED WALL PANELS</b>	
Ceiling or floor joist/truss located directly above an interior braced wall panel.	8d, 6" o.c., toenailed
Ceiling or floor joist/truss located directly below	3-16d, 16" o.c. direct

an interior braced wall panel.	
When floor/roof framing is perpendicular to the braced wall panel, add full height blocking between floor/roof framing above/below the braced wall panel	Secure full height blocking between the floor/roof framing members the entire length of the braced wall panel with 2-16d nails, direct, into each end of the blocking. The blocking shall be nailed to the top plate of the braced wall panel with 8d nails at 6" o.c. toenailed. The sole plate of the braced wall panel shall be nailed to the blocking with 3-16d nails at 16" o.c. direct.
When floor/roof framing is parallel to the braced wall panels and not located directly above/below the braced wall panel, add full height blocking between floor/roof framing at 16" o.c. spacing the braced wall panel shall be nailed to the top plate with 3-8d toenails. The sole plate of the bottom of the braced wall panel shall be nailed to each block with 3-16d direct.	Secure the full height blocking to the floor/roof framing members with 2-16d nails, direct, into each end of the blocking. Each block shall be nailed to the top plate of the braced wall panel with 3-8d nails toenailed. The sole plate of the braced wall panel shall be nailed to each block with 3-16d nails, direct.
<sup>1</sup> Wind Exposure Category C or greater shall be designed using Section R602.10.1.2.1	

This concludes wind bracing design of one or two family dwelling units or townhouse. **If you are designing a one or two family dwelling, you may stop here.**

A townhouse (a single family dwelling unit construction in a group of three or more attached units in which each unit extends from foundation to roof and with a yard or public way on at least two sides) must also be designed for a seismic Category C. **The following information is applicable to townhouses only:**

### **Irregular Buildings**

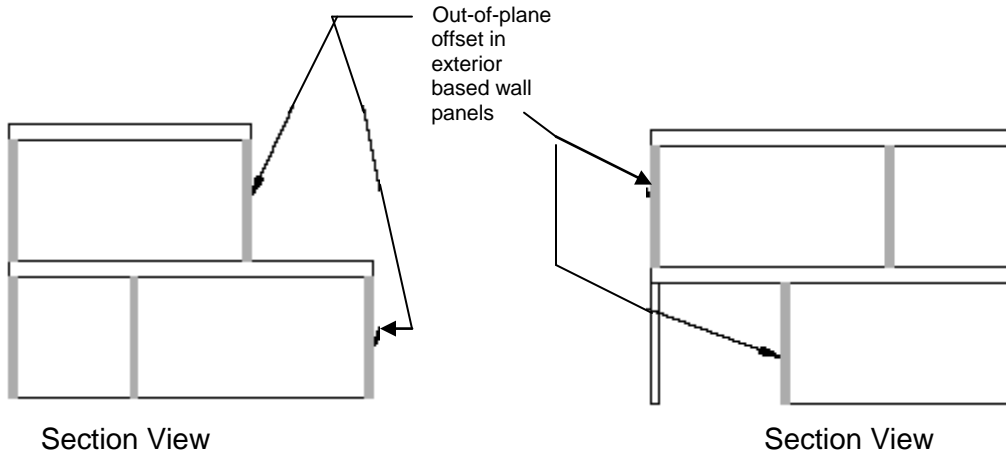
The following descriptions and diagrams of various conditions are considered irregular under section R301.2.2.2.5 and require, at a minimum, the irregular feature to be designed using Chapter 16 of the International Building Code (IBC)/2003. Please refer to the Engineered Design Section at the end of this Appendix if your design includes one or more of the irregular features listed below.

A Missouri Registered Design Professional may isolate an irregular feature within a building and provide calculations using the IBC on this irregular feature, then design the remaining areas of the building using the prescriptive requirements of the IRC. If this design approach is taken, the design professional shall clearly state within the calculations and plans that the design of the irregular feature has no effect on the prescriptive IRC details used in the remaining portions of the structure. This option is not available for irregular feature number 7.

The irregular features noted in Section R301.2.2.2.2 are noted as follows:

1. The exterior braced wall panels are not in one plane vertically from the foundation to the uppermost story (see Figure 9).

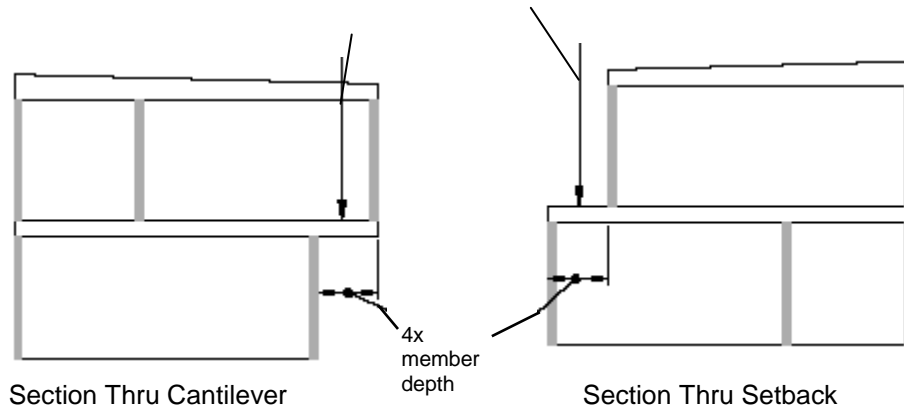
Figure 9  
Out-of-Plane Offset Irregularity



Exception: Floors with cantilevers or setbacks not exceeding four times the nominal depth of the floor joists (see Figure 3) are permitted to support braced wall panels provided that:

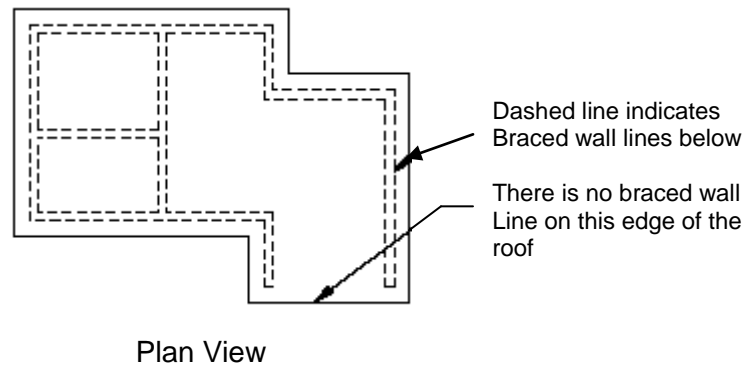
- A. Floor joists are 2 by 10 in nominal (actual: 1.5 by 9.25 in or larger) and spaced not more than 16 in. on center.
- B. The ratio of the back span to the cantilever is at least 2 to 1.
- C. Floor joists at ends of braced wall panels are doubled.
- D. A continuous rim joist is connected to the ends of all cantilevered joists. The rim joist shall be permitted to be spliced using a metal tie not less than 0.058 in. (16 gauge) thick and 1 ½ in. wide fastened with six 16d (0.162 by 3 ½ in.) common nails on each side. Steel used shall have a minimum yield of 33,000 psi, such as ASTM A653 SS, Grade 33, ASTM A 792 SS, Grade 33, or ASTM A875 SS, Grade 33.
- E. Gravity loads carried by joists at setbacks or by the end of cantilevered joists are limited to single story uniform wall and roof loads and the reaction from headers having a span of 8 ft. or less.

Figure 10  
Permitted Cantilever and Setbacks



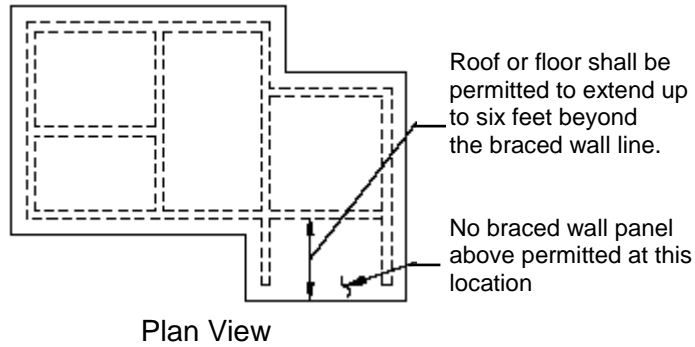
2. **Unsupported diaphragm.** A structure shall be considered to have an irregularity where a section of floor or roof is not laterally supported by braced wall lines on all edges. See Figure 11.

**Figure 11**  
Unsupported Diaphragm Irregularity



Exception: Portions of roofs or floors that do not support braced wall panels above shall be permitted to extend up to 6 ft. beyond a braced wall line. See Figure 12.

**Figure 12**  
Permitted Diaphragm Extension

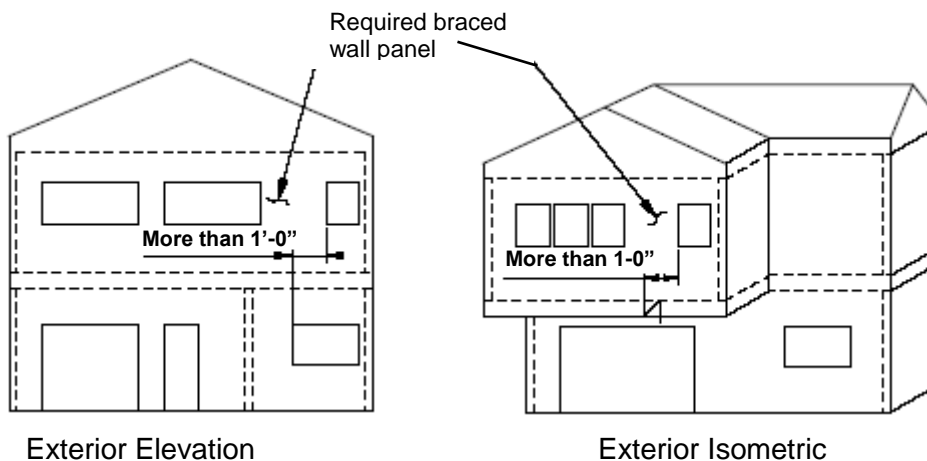


3. **Opening in wall below.** A structure shall be considered to have an irregularity where the end of a required braced wall panel extends more than 1 foot over an opening in the wall below (see Figure 13). This requirement is applicable to braced wall panels offset in plane and to braced wall panels offset out of plane as permitted by the exception to Item 1 in this Irregular Buildings Section of this Appendix A1.

**Exception:** Braced wall panels shall be permitted to extend over an opening not more than 8 ft in width in the wall below provided that the opening includes a header in accordance with the following:

- The building width, loading condition, and member species limitations of Table R502.5(1) shall apply and
- Not less than 1-2x12 or 2-2x10 for an opening not more than 4 feet in width or
- Not less than 2-2x12 or 3-2x10 for an opening not more than 6 feet in width or
- Not less than 3-2x12 or 4-2x10 for an opening not more than 8 feet in width and
- The entire length of the braced wall panels shall not occur over an opening in the wall below.

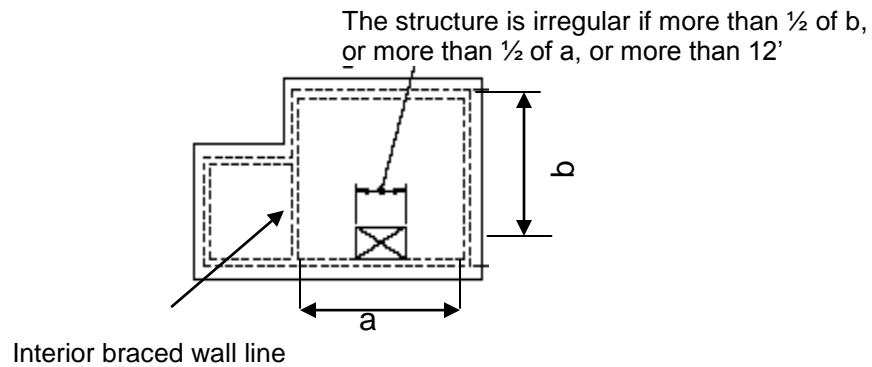
**Figure 13**  
Opening in Wall Below Irregularity



4. When an opening in a floor or roof exceeds the lesser of 12' or 50 percent of the least floor or roof dimension (See Figure 14).

**Figure 14**

## Diaphragm Opening

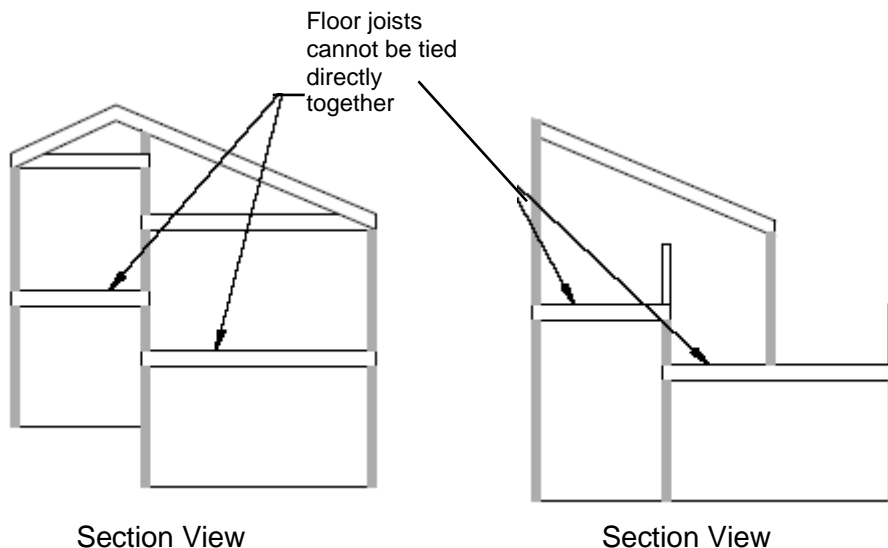


5. When portions of a floor level are vertically off-set (See Figure 15).

Exceptions:

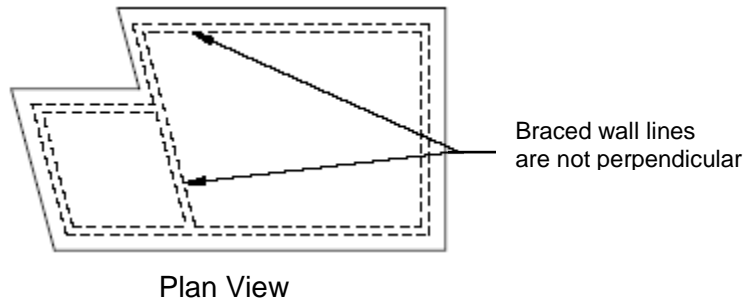
- A. Framing supported directly by a continuous foundation at the perimeter of the building.
- B. For wood light-frame construction, floors shall be permitted to be vertically offset when the floor framing is lapped or tied together as required by Section R502.6.1.

**Figure 15**  
Vertical Offset Irregularity



6. A structure shall be considered to have an irregularity where braced wall lines are not perpendicular to each other. See Figure 16.

**Figure 16**  
Non perpendicular Walls Irregularity



7. A story above grade constructed partially of braced wood wall framing and partially of masonry or concrete walls.

Exception: Fireplaces, chimneys, and masonry veneer as permitted by this code.

When this irregularity applies, the entire story shall be designed in accordance with accepted engineering practice.

**TABLE 7<sup>a, b, c, d</sup>**  
**BRACING REQUIREMENTS BASED ON SEISMIC**

			MINIMUM TOTAL LENGTH (feet) OF BRACED WALL PANELS (BWP's) REQUIRED ALONG EACH BRACED WALL LINE (BWL)		
Seismic Design Category (SDC) C	Story Location	Braced Wall Line Length (in feet)	Methods SFB and GB <sup>g h</sup>	Method WSP <sup>i</sup>	Continuous wood structural panel sheathing CS-WSP and CS-PF
	TOP STORY	10	2.5	1.6	1.4
		20	5.0	3.2	2.7
		30	7.5	4.8	4.1
		40	10.0	6.4	5.4
		50	12.5	8.0	6.8
	STORY BELOW THE TOP STORY	10	4.5	3.0	2.6
		20	9.0	6.0	5.1
		30	13.5	9.0	7.7
		40	18.0	12.0	10.2
		50	22.5	15.0	12.8
	STORY BELOW THE TOP TWO STORIES	10	6.0	4.5	3.8
		20	12.0	9.0	7.7
		30	18.0	13.5	11.5
		40	24.0	18.0	15.3
		50	30.0	22.5	19.1

- a. Assumes a soil class D.
- b. Wall height measured from bottom of sole/sill plate to the upper surface of the top plate is 10'. Multiply bracing length by 1.2 for wall heights up to 12'.
- c. Based on a braced wall line spacing (perpendicular distance between braced wall lines) of 35' or less. Multiply bracing lengths by 1.43 for braced wall line spacing greater than 35' but less than or equal to 50'.

- d. Wall deadloads shall be less than 15 psf.  
Exception: Brick or stone veneer weighing 50 psf or less, 5" or less in thickness, may be installed to a 30' height above the foundation (38' at gable ends). All bracing lengths shall be multiplied by 1.5.
- e. The table is applicable to roof/ceiling dead loads less than or equal to 15 psf. See Table R602.10.1.2(3) IRC/2009 for adjustments for heavier dead loads.
- f. Wood framed basement walkout walls shall be braced at the lowest story.
- g. Gypsum Bracing (GB) is on both sides of wall. If the gypsum board is only on one side of the wall, double the brace wall panel length.
- h. Braced wall lengths for structural fiberboard sheathing (SFB) assumes gypsum board on other side of the braced wall panel. If the gypsum board is omitted, multiply the braced wall length by 1.5.
- i. Braced wall length for wood structural panel (WSP) assumes gypsum board on the other side. If the gypsum board is omitted, multiply the braced wall length by 1.4.

## Engineered Design

If you wish to deviate from the prescriptive requirements of the International Residential Code/2009 Section R602.10, then you must have the lateral load resisting system of your building designed by a registered design professional licensed in the State of Missouri.

**Exception:** An exterior braced wall line that cannot be designed to meet the prescriptive wall bracing requirements of the IRC/2009 may be designed to meet structural performance requirements found in the IBC/2009. The design of such walls and the related structural calculations, shall be prepared by a Missouri Registered Design Professional. The entire braced wall line, includes the wall section that cannot meet the prescriptive requirements of the IRC/2009 must be designed using the IBC/2009. The remaining braced wall lines in the structure may comply with the prescriptive requirements of the IRC/2009.

The structural analysis shall compare the wind load on the structure utilizing a 90 mph wind under Section 1609 of the International Building Code (IBC)/2009 with the seismic forces on the structure ( $S_s=0.54$ ,  $S_1=0.18$ , soil site class D) using Section 1613 of the IBC/2009 then provide the design using the higher load.

**Exception:** One of two family dwellings are exempt from a seismic analysis and only required to be designed for wind. Townhouses shall be designed for both wind and seismic forces.

## Design Method and Calculations

Section 2305.1 of the IBC/2009, "General Design Requirements for Lateral-Force Resisting Systems," and accepted engineering practice shall be employed in the design professional's calculations.

Calculations and sealed structural details, at a minimum, must:

- Show a detailed analysis of the wind load determination.
- Show a detailed design of the building diaphragms and shear walls.



- Specify the sheathing thickness, nail sizes and nailing pattern for diaphragms and shear walls.
- Ensure there is an adequate load path to the foundation.
- Show a detailed analysis of all connections along the lateral load path.
- Ensure post-to-beam connections are capable of resisting shear and rotation.
- Bear the original signature and seal of the registered design professional.

**Calculations and structural details which do not meet the above requirements will delay the issuance of the building permit.**

### **Construction Documents**

**When submitting plans for a building that utilized an engineered design, 1 set of the sealed calculations must be attached to the plans. The 4 sets of sealed drawings must also include comprehensive details outlining the construction requirement of the diaphragms and shear walls.**