

Wall Bracing. Part 2: IRC Wall Bracing Requirements



Builder Brief: BB1007

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Introduction

In Part 1 of this series of guides, the general role of wall bracing was discussed and important code concepts and definitions were introduced. In this document (Part 2), the detailed requirements of IRC Section R602.10 Wall Bracing are presented, various useful applications are discussed and illustrated, and a step-by-step procedure and worksheet is provided.

The application of this guide is limited to the following conditions:

- International Residential Code, 2006 Edition
- One- and two-family dwellings
- Conventional wood frame construction
- Wind speed of 100 mph or less per IRC Section R301.2

Seismic Design Category (SDC) of A/B per IRC Section R301.2

By limiting the scope of this guide to lower wind and seismic conditions, the IRC bracing provisions are greatly simplified, but still adequately cover the State of Pennsylvania. The reader is referred to additional requirements in the IRC for conditions beyond those listed above.

The sections of this guide (Part 2 of 3) are organized as follows:

- Wall Bracing Methods
- Wall Bracing Amounts
- Special Connection Requirements
- Addressing Large Wall Openings, Tall Walls, and Bump-outs

A step-by-step design approach and worksheet are provided in Appendix A.

Wall Bracing Methods

Table 1 summarizes commonly used IRC wall bracing methods (additional methods are listed in the IRC R602.10.1). The tabulated bracing methods and braced panel width requirements are the basic “building blocks” used to design and construct buildings with code-compliant wall bracing. Only braced wall panels meeting or exceeding the minimum width requirements are considered when determining compliance with required

bracing amounts (see next section and Table 3). Figure 1 illustrates several of the bracing methods.

TABLE 1

Common IRC Wall Bracing Methods and Braced Wall Panel Requirements

(based on IRC Section R602.10.1, R602.10.3, R602.10.4, R602.10.5, and R602.10.6)

Typical Bracing Methods ¹	Braced Wall Panel Minimum Width (length along wall of each brace) ²
Traditional Bracing Methods	
METHOD 1: 1x4 Wood let-in brace or approved metal brace	Brace angle must be at least 45 degrees and not more than 60 degrees from horizontal. <i>(each such brace counts as a “braced wall panel”.</i> Approved metal braces should be specified and installed in accordance with the manufacturer’s data and code evaluation report)
METHOD 3: Wood structural panels or METHOD 4: Fiberboard	48 inches minimum <i>(braced wall panels that are 48 inches wide or more count toward required bracing amounts in accordance with actual length of each braced wall panel segment along a braced wall line; multiple sheathing panels may be used to form an individual braced wall panel)</i>
METHOD 5: Gypsum board	96 inches minimum (single side) 48 inches minimum (both sides) <i>(for ‘both sides’ application, braced wall panels longer than 48 inches count toward required bracing amounts in accordance with actual length; for ‘single side’ application, braced wall panels longer than 96 inches count toward required bracing amount in accordance with actual length)</i>
Special Bracing Methods	
R602.10.5 Continuous wood structural panel sheathing	24 inches and greater – see Table 2 <i>(braced wall panels complying with minimum width requirements of Table 2 count toward required bracing amount in accordance with actual panel width or length along wall)</i> <i>NOTE: This method is an extension of Method 3, but it requires all sheathable areas of any individual braced wall line to be sheathed, including areas above and below wall openings; minimum 2-foot-wide panels are required at each end of the braced wall line at corners (see Figure 1c and Figure 2).</i> ³

R602.10.6 Alternate braced wall panels	32 inches minimum <i>(each 32" alternate braced wall panel may be substituted for a 48" braced wall panel of another bracing method).</i> <i>NOTE: This method is also similar to Method 3, but it requires additional sheathing nailing and use of hold-down brackets at each end of each such braced wall panel directly anchored to foundation; limited to 1-story and first floor of 2-story applications)</i>
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Table 1 Notes:
 Refer to IRC Section R602.10.3, R602.10.5, and R602.10.6 for important installation requirements, material thickness requirements, and details related to fastening for each bracing method.
¹The guide is also applicable to the IRC 2000 provided requirements for interior braced wall lines and braced wall line spacing are ignored. This guide is also applicable to the IRC 2003 without modification.
²For alternative minimum braced panel widths, refer to Part 3 of this series of guides.
³The continuous structural sheathing method is not required on "all walls" of a building as implied by a code change added to Section R602.10.5 of the IRC 2003 and 2006. A correction and clarification is in progress through the current International Code Council's code development cycle (2006/2007) and several states have already made this adjustment.

TABLE 2
Minimum Braced Wall Panel Width (Length) Requirements in a Braced Wall Line Using Continuous Structural Sheathing^{a,b}
 (based on IRC Table R602.10.5)

Largest Adjacent Opening Height (inches)	Minimum Braced Wall Panel Length (inches)		
	8-ft Wall	9-ft Wall	10-ft Wall
102	N/A	N/A	38
99	N/A	N/A	37
96	N/A	N/A	36
93	N/A	35	35
90	N/A	34	34
87	N/A	33	33
84	32	32	32
81	30	30	30
78	29	29	30
75	28	28	30
72	27	27	30
69	26	27	30
66	25	27	30
63	24	27	30

Table 2 Notes
 N/A indicates that opening height exceeds limits permitted for use with IRC Section R602.10.5.
 For continuous structural sheathed braced wall lines containing only garage openings and which support a light frame roof only, braced wall panels shall be permitted to have a maximum height-to-width ratio of 4:1. Minimum panel width shall not be less than 24 inches.
 a. Interpolation between braced wall line spacing amounts is permissible.
 b. Table applies to stud walls up to 10' tall. For walls 12' tall, multiply bracing amounts by 1.2 (IRC Section 301.3).

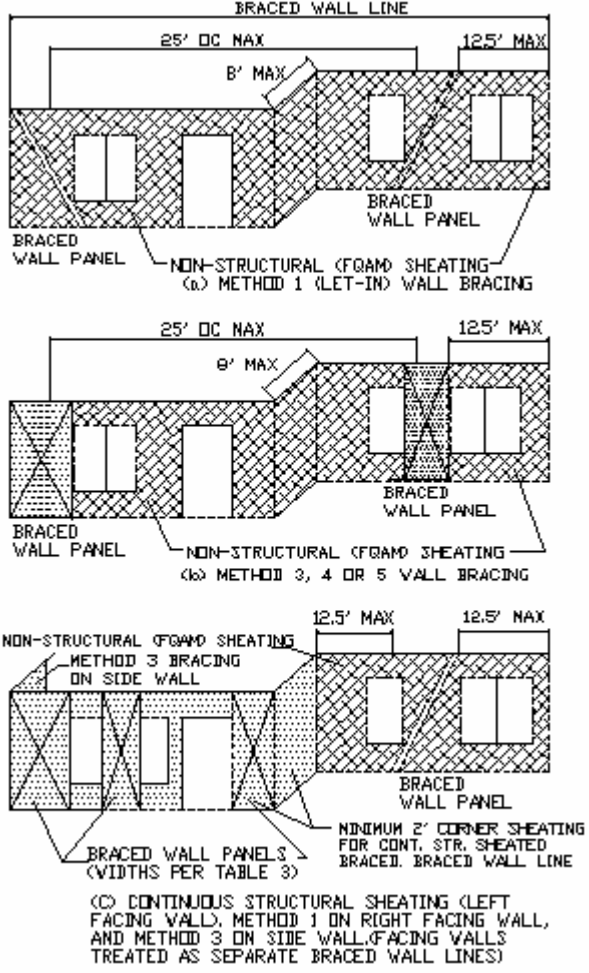


Figure 1. Illustration of Bracing Methods

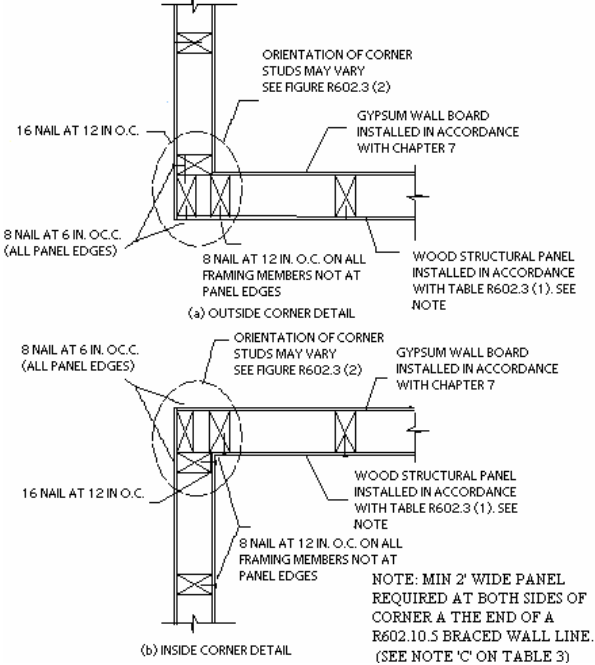


Figure 2. Corner Framing for Continuous Structural Sheathing (Based on IRC Figure R602.10.5)

Wall Bracing Amounts

The minimum required wall bracing amounts for commonly-used bracing methods are shown in Table 3 for conditions applicable to the state of Pennsylvania.



Refer to Part 1 of this guide for important information on the following definitions: braced wall line, braced wall panel, braced wall panel location, and braced wall line spacing. These definitions involve concepts and requirements that are very important to a code-compliant and efficient application of required wall bracing amounts on a given braced wall line or building plan.

For many braced wall lines of one or two story homes, traditional Method 1 let-in bracing may be the simplest method to use in terms of determining and applying required bracing amounts. The amount of bracing is simply determined by the spacing of code compliant 1x4 wood let-in or approved metal braces along a braced wall line (see Figure 1a). As shown in Table 3, the spacing of Method 1 braces along a braced wall line decreases from 25'oc as the spacing between braced wall lines increases beyond 35'oc. This requirement increases the racking strength of a Method 1 braced wall line to offset the added racking load from a greater than 35' spacing between braced wall lines (refer to IRC Section R602.10.1.1, exception statement). Also note that a Method 3 brace may be used in place of any required Method 1 braced on a given braced wall line based on the principle of equivalence (i.e., Method 3 panel brace is at least as strong as a Method 1 let-in brace).

For the other common bracing methods featured in Table 3, bracing amounts are given as the minimum percentage of braced wall line length that must be braced by code-compliant braced wall panels (see Table 1 and Figure 1b and c). To determine the minimum required length of bracing for a given braced wall line, use the following simple equation:

$$\text{Minimum Required Length of Braced Wall Panels} = [\text{Braced wall line length}] \times [(\text{Percentage from Table 3A or B})/100] \quad \text{Eq. 1}$$

Example:

Given: 25% amount of bracing required for a braced wall line (Table 3) 32' braced wall line length

$$\text{Solution: } [32'] \times [25\% / 100] = 32' \times 0.25 = 8'$$

Therefore, a total of 8' of braced wall panels is the minimum required amount of bracing for this example braced wall line (i.e., two 4' braced wall panels). The requirement that braced wall panels must be located within 12.5' of the ends of a braced wall line and no more than 25'oc along a braced wall line must also be met.

TABLE 3: Minimum Wall Bracing Amounts

For Seismic Design Categories A/B and Wind Speed of ≤ 100 mph^{a,b,c} (based on IRC Table R602.10.1 and Sections R602.10.1.1, R602.10.5, and R602.10.6)

Braced Wall Line Condition	Braced Wall Line Spacing (feet)	Method 1	Method 3	Method 4	Method 5		R602.10.5 Continuous Structural Sheathing	
					One Side	Both Sides	Case A	Case B
					Supporting Roof Only	≤ 35	25'OC	16%
	40	22'OC	18%	18%	36%	18%	16%	15%
	45	20'OC	21%	21%	42%	21%	19%	17%
	50	18'OC	23%	23%	46%	23%	20%	19%
Supporting Roof plus One Story	≤ 35	25'OC	16%	25%	50%	25%	14%	13%
	40	22'OC	18%	29%	58%	29%	16%	15%
	45	20'OC	21%	32%	64%	32%	19%	17%
	50	18'OC	23%	36%	72%	36%	20%	19%
Supporting Roof plus Two Stories	≤ 35	NP	25%	35%	70%	35%	23%	20%
	40	NP	29%	40%	80%	40%	26%	23%
	45	NP	32%	45%	90%	45%	29%	26%
	50	NP	36%	50%	100%	50%	32%	29%

Table 3 Notes:

NP = not permitted

a. Interpolation between braced wall line spacing amounts is permissible.

b. Table applies to stud walls up to 10' tall. For walls 12' tall, multiply bracing amounts by 1.2 (IRC Section 301.3).

c. For Method 1 bracing, braces shall be located no more than 12.5' from the ends of a braced wall line and shall be spaced along a braced wall line as shown in the table. For the other methods, braced wall panels shall not be spaced greater than 25' OC and also shall be located no more than 12.5' from the ends of a braced wall line. However, for R602.10.5 continuous structural panel sheathing, a minimum 2' length of full-height sheathing is required at the corners per Figure 1c. Refer to Table 1 for minimum lengths of individual braced wall panels and other requirements for each bracing method.

d. Case A applies to braced wall lines with maximum clear opening height not exceeding 86" (8' stud walls), 95" (9' stud walls) or 102" (10' stud walls). Case B applies to braced wall lines with maximum opening height not exceeding 65" (8' stud walls), 74" (9' stud walls) or 80" (10' stud walls). The maximum clear opening height in a continuous structural sheathed braced wall line is the rough opening with the largest height measured from the bottom of the rough opening to the top of the rough opening.

e. Method 5 (one side) bracing amounts are doubled relative to Method 5 (both sides) to account for the difference in strength of the two applications of Method 5 bracing. This consideration was overlooked in development of the IRC wall bracing provisions, but is included in the IBC Section 2308 wall bracing provisions.

Special Connection Requirements

The following list brings attention to some special connection requirements for brace wall panels (refer also to IRC Section R602.10.8):

Sole plates at braced wall panel locations must be connected to wood floor framing in accordance with Table R602.3(1) Fastener Schedule or to foundations in accordance with R403.1.6 Foundation Anchorage using nails or anchor bolts as required.

Brace panels or braces must be attached to wall framing in accordance with bracing method descriptions in Section R602.10.3.

All horizontal and vertical joints of sheathing used as braced wall panels shall be supported by and attached to wall framing or blocking per IRC Section R602.10.7¹.

Alternate braced wall panels must be connected to wall framing using 8d common nails, end studs of the braced wall panel must be connected to the foundation using hold-down brackets, and sole plates must be connected to the foundation with anchor bolts at 16 inches on center (two per each 32 inches of braced wall panel length) in accordance with Section R602.10.6.

Continuous sheathed corners must have sheathing connected to a common corner stud in accordance with Figure R602.10.5 of the IRC or, alternatively, additional fastening of end studs of adjoining walls is required per Figure 1 of this guide (see also Figure R602.10.5 of IRC 2006).

Addressing Large Wall Openings, Tall Walls, and Bump-outs

With some limitation, code-compliant great room walls with large openings amounts, garage opening walls with narrow braced wall panels, and other similar conditions can be constructed with proper application of the IRC wall bracing provisions. These particular conditions have caused much

confusion. Therefore, the following code-compliant examples illustrate the concepts involved. Additional options for these and other similar conditions are not addressed in the IRC (refer to Part 3 of this series of guides).

Garage Opening Braced Wall Line Supporting Roof Only – As shown in Figure 3, this application uses a special exception for narrow braced panel widths used in garage opening walls per footnote ‘b’ of Table 2 (similar to footnote ‘b’ in Table R602.10.5 in the IRC). It applies to attached or detached garages provided the garage opening braced wall line supports a roof only and the garage opening wall is braced with the continuous structural sheathing method (including 2-foot minimum corner panels at ends of continuous structural sheathed garage opening wall per Figure 3).

Large Openings within Code-Compliant Braced Wall Lines – Very frequently, large openings are encountered within or at the ends of braced wall lines for garage openings, additions, bump-outs, etc. This condition also is commonly encountered in modern homes for entry foyers and great rooms. For the limits shown in Figure 4, the IRC wall bracing provisions can accommodate these types of conditions in code-compliant braced wall lines.

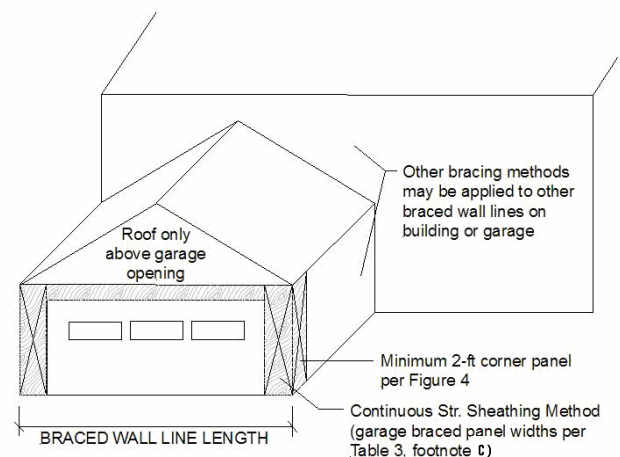


Figure 3. Garage Opening Wall per Table 3, footnote c (IRC Table R602.10.5).

¹An exception statement in IRC Section R602.10.7 permits use of unblocked horizontal joints in panel sheathing. However, such practice reduces braced wall panel strength by approximately one-half, is not accounted for with increased bracing amounts, and is not a recommended practice for braced wall panel construction. Unblocked horizontal sheathing joints should be permitted only where sheathing is not required to meet minimum bracing amounts.

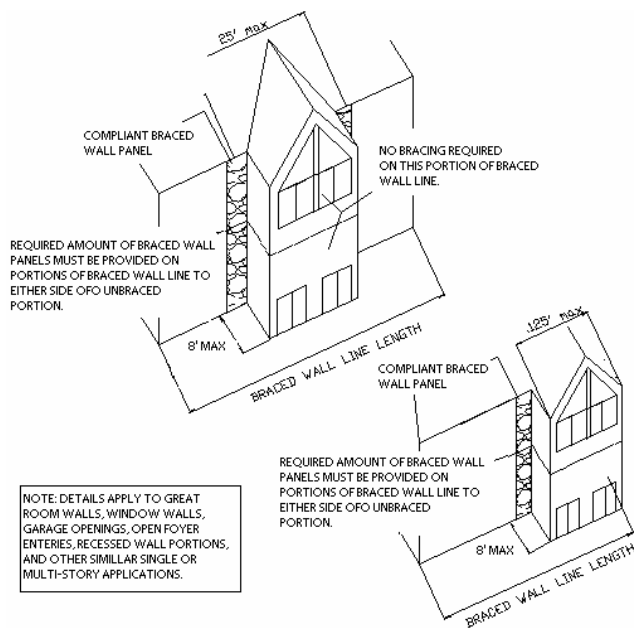


Figure 4. Limits for including large openings in braced wall lines.

APPENDIX A

Wall Bracing Design Approach and Plan Check Worksheet

Applying the wall bracing provisions of the IRC to a building plan is best approached like a routine accounting task. While it is not as easy as 1-2-3, it is as easy as 1-2-3-4-5. The following five steps (included in the worksheet below) define a routine “accounting” approach for application of the IRC wall bracing provisions:

STEP 1: Identify braced wall lines on a preliminary plan (e.g., check offsets and label separate braced wall lines on each side of the building)

STEP 2: For each plan direction (N-S and E-W) and story level, determine the spacing between braced wall lines.

STEP 3: Select a bracing method for each braced wall line and determine required bracing amounts for each braced wall line.

STEP 4: Determine the bracing amount provided by code compliant braced wall panels on each braced wall line and verify that the minimum required bracing amount from Step 3 is met or exceeded.

STEP 5: Verify braced wall panel spacing limit (e.g., maximum 25 feet on center) and corner

distance (e.g., braced wall panel starts no more than 12.5 feet from the end of a braced wall line) are met for each braced wall line.

If bracing requirements are not met in Steps 4 or 5 for any braced wall line, then one or more of the following actions should be considered and the above process repeated until a code-compliant solution is found by “trial and error” and experience:

Reduce or shift braced wall line openings to allow space for required braced panel widths, location, and amount.

Reduce spacing between braced wall lines (or use interior braced wall lines) to reduce the minimum required bracing amount.

Limit braced wall line offsets so that separate offset wall lines on a building side (elevation) may be considered as one braced wall line which eliminates the need for additional braced wall panels within 12.5 feet of the end of each separate braced wall line on a given building side.

Select a different bracing method that allows narrower braced panel width to be used (Table 1) and/or a reduced bracing amount (Table 3).

If a code-compliant solution is not feasible following this approach, refer to Part 3 of this series of guides for supplemental solutions.

References

1. IRC 2006. International Residential Code 2006.
2. Crandell, J., and S. Herrenbruck. 2006. Residential wall bracing principles and design options. *Journal of Building Safety*. August 2006.
3. Kasal, B., M. Collins, P. J. Paevere, and G. C. Foliente. 2004. Design models of light-frame wood buildings under lateral loads. *ASCE Journal of Structural Engineering*. Vol. 130. No. 8: 1263-1271.
4. Residential Structural Design Guide – 2000 Edition, U.S. Department of Housing and Urban Development, Washington, DC (available as free download from www.huduser.org).

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Wall Bracing Worksheet

General Information ¹	A	B ²	C	D	E	F ³	G	H	I	J
	STEP 1 – Braced Wall Line ID#	STEP 2 – Braced Wall Line Spacing (feet)	STEP 3 – Bracing Method	STEP 3 – Braced Wall Line Length (inches)	STEP 3 – Required Bracing Percentage (Table 3)	STEP 3 – Required Total Length of Braced Wall Panels (inches)	STEP 4 – Total Length of Braced Wall Panels Provided (inches)	STEP 4 – Value in Column G ≥ Value in Column F ?	STEP 5 – Brace wall panels begin within 12.5' of ends of braced wall line?	STEP 5 – Braced wall panels spaced along braced wall line at 25' oc maximum?
Plan Identification: _____										

Walls Supporting (check one):										
__ roof only										
__ roof plus one floor										
__ roof plus two floors										
Braced Wall Lines Parallel to (check one):										
__ N-S Plan Direction										
__ E-W Plan Direction										

Table Notes:

1. Use one worksheet for each story level and plan direction (two worksheets for each story level).
2. Braced wall line spacing shall be the greater distance to braced wall lines to either side of the braced wall line under consideration.
3. Use Equation 1 in guide as follows: $[value\ in\ column\ D] \times [(value\ in\ column\ E)/100] = record\ result\ in\ column\ F$

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