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IRC Wall Bracing Code Compliance Guide for Builders, Designers, and Plan Reviewers

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Final: September 2, 2025

VERSION 5.0

About Applied Building Technology Group (ABTG)
At ABTG, we believe sound science and engineering are the foundation of building design, construction, and innovation. It is the solid base on which successful building technologies can grow and benefit consumers with robust market competition and effective regulation. ABTG engages in building science and engineering research, code development and compliance resources, standards development, and other services to support a vibrant and successful building industry.

About this Guide
This Guide addresses the appropriate and code-compliant bracing of wood frame walls of homes to resist collapse due to extreme wind and earthquake hazards within the scope of this guide. It is based on the 2024 International Residential Code (IRC). However, the concepts, principles, and many of the requirements apply similarly for the 2009, 2012, 2015, 2018, and 2021 editions of the IRC. The user of this Guide should ensure the locally-adopted edition of the IRC is followed, particularly with respect to the appropriate wind speed and seismic design category to use.

This Guide was funded through a grant by the Foam Sheathing Committee (FSC) of the American Chemistry Council with the objective of ensuring the proper integration of continuous insulation (ci), particularly foam plastic insulating sheathing (FPIS), with various code-compliant wall bracing materials and methods. For additional guidance on the various applications and functions of FPIS ci for energy code and building code compliance, including an IRC wall bracing calculator, refer to continuousinsulation.org.

The most recent version of any ABTG resource can be found at appliedbuildingtech.com.

DISCLAIMER

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Introduction

The requirement for bracing conventional wood frame dwellings is not new. For years, builders have successfully braced homes using a variety of techniques, even before the first building codes in the United States required it. Conventional wood frame dwellings must be adequately braced to resist lateral (racking) forces due to wind and earthquakes. To achieve this structural safety objective, Section R602.10 of the 2024 International Residential Code (IRC) offers several prescriptive wall bracing options and requirements. While the growing number of bracing options and requirements has created some confusion, understanding the options and rules, and using them efficiently, provides many practical advantages.

The main objective of this Guide is to provide designers, code officials, and builders with a practical understanding of the IRC bracing provisions for code-compliant dwellings. A second objective is to demonstrate how builders, designers, and plan reviewers can use the IRC bracing provisions to create maximum value in a diverse housing market.

The Guide is divided into six sections intended to supplement and enhance the IRC wall bracing provisions:

- Section 1: Basic Concepts for Code-Compliant Wall Bracing
- Section 2: IRC Wall Bracing Methods
- Section 3: Applying the Code
- Section 4: “Beyond Code” Bracing Solutions
- Section 5: Wall Bracing Options for Foam-Sheathed Walls
- Section 6: Resources and References

In addition, Appendix A provides a useful wall bracing design and plan check worksheet. Appendix B offers two complete wall bracing design examples, including use of the wall bracing design and plan check worksheet from Appendix A. Appendix C demonstrates a simple and efficient engineering-based approach to the application of the IRC bracing provisions by design professionals.

Finally, an IRC wall bracing calculator is available as a free tool to efficiently apply and document compliance with the IRC wall bracing provisions. It is an automated version of the wall bracing design and plan check worksheet included in Appendix A.

Section 1: Basic Concepts for Code-Compliant Wall Bracing

1.1 Why Is Wall Bracing Needed?

Wall bracing provides lateral resistance against horizontal racking loads from wind and earthquakes and prevents the wall studs from distorting in the plane of the wall (racking) in "domino fashion," thus preventing building collapse. As shown in Figure 1, racking loads on a building are considered to act separately in two perpendicular plan directions (i.e., N-S and E-W or front-rear and left-right). At least two wall lines parallel to each plan direction (usually on opposite sides of the building) must be designed to resist potential racking loads. In some cases, interior wall lines must be used for bracing.

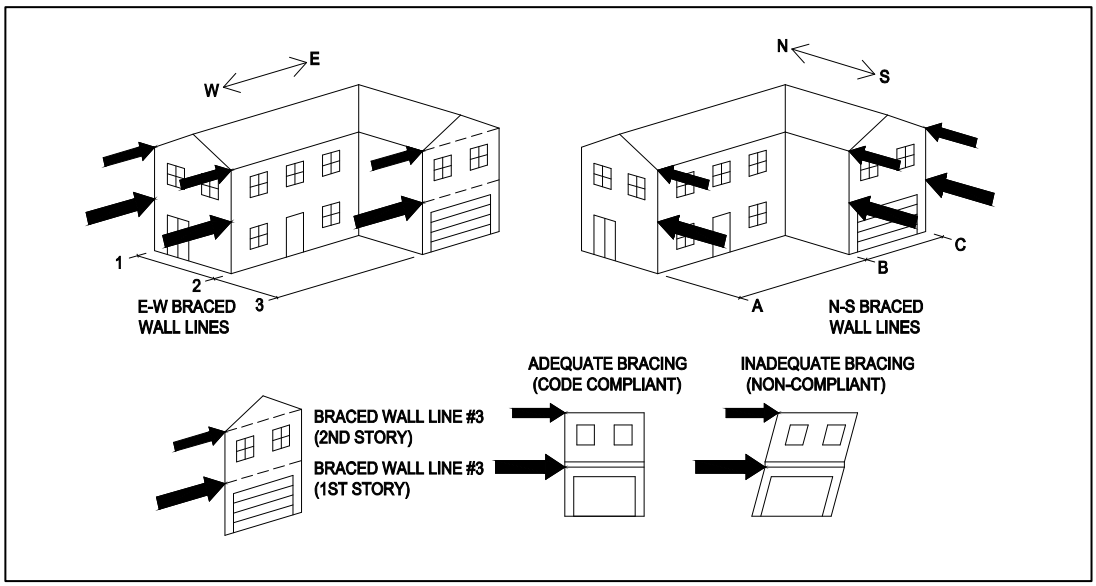


Figure 1. Wall Bracing and Racking Forces

1.2 How Does Wall Bracing Work?

When bracing a wall, code-compliant bracing elements or "braced wall panels" are located in required amounts on wall lines that are required to resist racking loads, known as "braced wall lines" (see Section 1.5 and Section 1.6 for details). For simplicity, building codes have developed prescriptive bracing strategies that look only at designated "braced wall lines" and individual "braced wall panels" on those braced wall lines. In reality, walls act as a **system** in resisting racking forces, where nearly every component and wall segment provides some racking resistance.

The entire building—wall, floor, and roof assemblies—interact to resist and distribute racking loads.[1] The minimum bracing requirements of the IRC modestly incorporate some of this whole-building system effect.[2] While standard interior partition walls also contribute to racking resistance, the IRC does not account for their contribution. In addition, roof and floor diaphragms help distribute racking loads from walls with less bracing to those with more bracing. By considering only designated braced wall lines without considering the complete building system as a whole, the IRC bracing provisions generally result in conservative solutions. For example, if an individual braced wall line (e.g., garage opening wall) is deemed "non-compliant" when strictly applying the IRC, it may actually be acceptable from the standpoint of the entire building system. To make practical use of these building system performance realities requires solutions that go beyond the simple assumptions on which a prescriptive code or engineering code is based. Refer to Section 4 and Section 6 for additional support and resources.

[1] Crandell and Kochkin, 2003.
[2] Crandell, 2007; Crandell and Martin, 2009.

Each braced wall line requires different amounts of bracing depending on the individual share of the racking load acting on the building as a whole (Figure 1). The amount of bracing required for a given wall line depends on design factors addressed in Table 1.

Table 1. Design Factors Affecting Wall Bracing Amounts

Design Factor	Comment
The design wind or earthquake load (magnitude of hazard).	Buildings in higher hazard areas, with large design wind speeds or earthquake ground motions, experience greater potential racking load.
The size of the building and how many stories are supported by a braced wall line.	Walls supporting multiple stories have greater racking loads than those supporting only a roof. Lower story walls serve to resist an accumulation of lateral load from upper story levels that must be passed down to the foundation and then to earth, much the same way that gravity (vertical) loads have a load path.
The spacing between braced wall lines.	For buildings that have widely-spaced wall lines and large interior open areas, the racking load shared by each wall line is increased relative to a building that has many closely-spaced wall lines in each plan direction.
The type or method of wall bracing used (strength of brace).	The method of bracing will also determine how much bracing is needed. Some methods allow for less bracing and narrower braced wall panels in comparison to other methods that require more bracing and wider braced wall panels to achieve equivalent performance (i.e., racking resistance meeting or exceeding racking load). When used in accordance with code, all bracing methods and materials provide roughly equivalent performance.

1.3 When Should I Consider Wall Bracing?

The design factors addressed in Table 1 impact the amount of space available on a given wall for placing windows, doors, and other non-bracing sheathing products such as foam plastic insulating sheathing (FPIS) used for energy-code compliance or enhanced energy-saving performance.[3] Wall bracing can affect other important architectural objectives or design requirements and should be considered as early as possible in the building design process. In addition, the IRC requires the following information to be included within building plans to obtain a building permit:

> **IRC Section R106.1.3 Information on braced wall design.** For *buildings* and structures utilizing braced wall design, and where required by the *building official*, *braced wall lines* shall be identified on the *construction documents*. Pertinent information including, but not limited to, bracing methods, location and length of *braced wall panels* and foundatoin requirements of *braced wall panels* at top and bottom shall be provided.

Plan Ahead! In the building planning stages, a simple plan adjustment often makes the difference between an efficient, code-compliant bracing plan and one that is inefficient or non-compliant. In some cases, an engineered solution may be required where the IRC prescriptive solutions are insufficient for the architectural requirements. Using this Guide and the IRC bracing provisions to plan ahead will help turn bracing challenges into solutions that are efficient, practical, and code-compliant.

[3] Refer to Section 5 for guidance on integration of FPIS with various bracing methods.

1.4 Scope Limitations

This Guide is limited to the following use conditions:

- International Residential Code, 2024 Edition[4]
- Conventional wood frame construction
- One- and two-family dwellings of no more than three-stories[5]
- Ultimate Design Wind Speed of less than 140 mph (3-second gust)
- Seismic Design Category (SDC) of A/B/C per IRC Section R301.2.2

This Guide is intended to be a helpful companion to the IRC for typical wall bracing applications in the low to moderate wind and seismic hazard regions of the U.S. Within the above scope limitations, the user should use both documents side by side. Therefore, this document references relevant sections within the 2024 IRC. In addition, this Guide is not an exhaustive treatment of the IRC wall bracing provisions. In no case should any information in this Guide be taken to supersede the intent or specific requirements of the 2024 IRC or the locally applicable building code including local amendments to the IRC, if any.

By limiting the scope as noted above, the IRC bracing provisions and this Guide are simplified. However, they still cover the majority of conditions in the United States. To identify your specific seismic and wind speed location, see Figures (1) through (7) in IRC R301.2.2.1 for Seismic Design Categories and Figure (2) in IRC R301.2 for Ultimate Design Wind Speeds. In addition, the building site's wind exposure category (B-suburban/wooded, C-open terrain, D-coastal [or any broad fetch of open water]) must be identified per IRC Section R301.2.1.4 and the mapped design wind speed must be adjusted for topographic wind speed-up effects as applicable per IRC Section R301.2.1.5.

1.5 Definitions

The following definitions explain some important terms used throughout the IRC bracing requirements and this Guide. Refer also to IRC Chapter 2.

Braced Wall Line. A straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing.

Braced Wall Line, Continuously Sheathed. A *braced wall line* with structural sheathing applied to all sheathable surfaces including the areas above and below openings.

Braced Wall Line, Intermittent Bracing. A *braced wall line* with discrete structural sheathing panels or braces provided only at specified locations and not requiring continuous structural sheathing on other portions of a wall.

Braced Wall Panel. A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material [or bracing members] and anchors. The panel's length meets the requirements of its particular bracing method, and contributes toward the total amount of bracing required along its *braced wall line* in accordance with IRC Section R602.10.1.

[4] Much of the content of this Guide is also relevant to the 2009, 2012, 2015, 2018, and 2021 editions of the IRC; however, section number referencing and possible technical changes between code editions should be verified. For example, a key change in the 2024 IRC relative to the 2021 IRC, clarifies that wall height (not story height) is used to adjust required bracing amounts in IRC Section R602.10.3.1 and Tables R602.10.3(2) and R602.10.3(4).

[5] Townhouses in SDC C are excluded from this Guide because additional seismic design limitations in IRC Section R301.2.2 and Section R602.10 apply and are outside the scope of this Guide. However, this requirement is not scientifically justified given that wind and seismic forces do not change based on building occupancy and the same structural and bracing requirements must be satisfied regardless of a dwelling's classification as single-family detached or single-family attached (townhouse) construction. In some cases, this limitation for townhouses in SDC C has been waived by local code amendment or by approved design. In fact, many of the limitations of IRC Section R301.2.2.6 for building irregularities (constraints on configuration) do not apply to conventional construction in IBC Section 2308 until the next higher seismic design category, SDC D.

1.6 Key Concepts and Rules

This section presents a number of key concepts and rules that are fundamental to understanding and correctly applying the IRC bracing provisions.

Braced Wall Line (IRC Section R602.10.1) – Walls that are braced to resist racking are identified as braced wall lines (BWLs) on building plans as shown in Figure 2 and Figure 3. Generally, all exterior walls are considered part of a braced wall line (dashed lines in Figure 2 and Figure 3) and are required to be properly braced with braced wall panels (BWPs). It is important to recognize that none of the actual wall line (and braced wall panels) need to fall on the designated (dotted) line representing a BWL provided the designated BWL meets the rules discussed below (see Figure 2 and Figure 3). Although not always required, interior walls also may be used as braced wall lines to minimize the amount of bracing required on exterior walls or to comply with the maximum 60' braced wall line spacing addressed in the IRC provisions.

There are several rules and limitations for designating the layout of individual braced wall lines on each story level and each plan direction of a building. These rules are intended to accommodate building plans that are not perfectly rectangular with wall lines that contain offsets (i.e., are not in a single straight line). Two important rules are as follows:

BWL Offset Rule (IRC Section R602.10.1.2) – Figure 2 illustrates limitations on the permissible offset of braced wall panels in off-set portions of a designated braced wall line (shown as a dotted line).

Per the 2021 and 2024 IRC no more than two-thirds of the required braced wall panel length shall be located to one side of the dotted line representing a braced wall line. However, this recently added rule conflicts with what is demonstrated in Figure R602.10.1.1 of the code (see Figure 3), is somewhat arbitrary, and may be considered unnecessary (or erroneous) where the offset limits are properly followed. Figure R602.10.1.1 aligns more closely with the original development and intent of the IRC bracing provisions. Therefore, the approach illustrated in Figure R602.10.1.1 is adopted for the purposes of this Guide (also consistent with IRC versions predating the 2021 edition).

At the time of this writing a code change proposal is pending for the 2027 IRC to remove the two-thirds limit and replace it with a limit that requires that braced wall panels not all be offset to one side of the designated braced wall line.

BWL End Rule (IRC Section R602.10.1.1) – The end of a braced wall line can be determined in two ways as shown in Figure 2 and Figure 3. The end may occur at the intersection of a perpendicular exterior wall (actual wall line) or projection thereof, or with the intersection of a perpendicular braced wall line (dashed line representing the bracing effect of actual walls).

These above rules have important implications for flexible and efficient bracing designs. They also are important to consider when locating BWPs along or near the ends of a BWL as addressed later. While not addressed in the scope of this Guide, the ends of a BWL must be known to be able to determine its length, which is used to determine the amount of seismic bracing required in high-hazard earthquake areas. Wind bracing amounts in the IRC are not dependent on BWL length and the BWL only needs to provide sufficient space for the length of wind bracing required and the additional Braced Wall Panel Location requirements discussed later and shown in Figure 4.

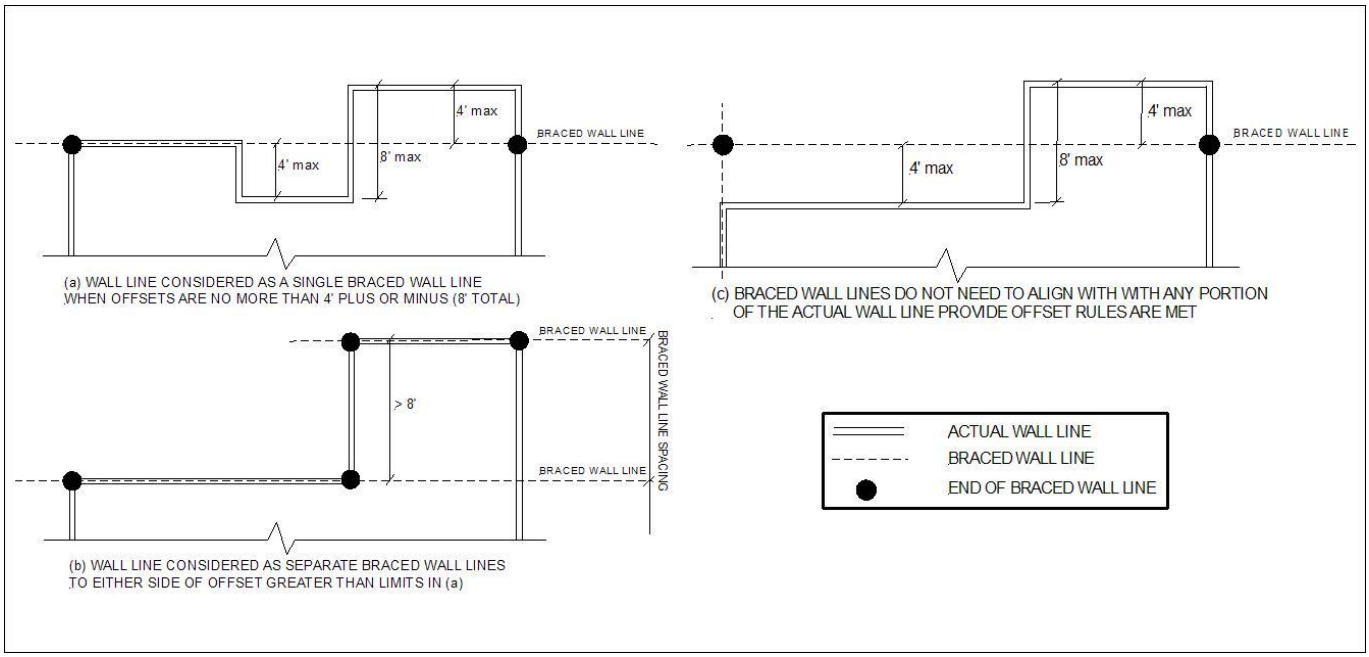


Figure 2. Braced Wall Line Layout Rules (Offsets and Ends)

Braced Wall Line Spacing (IRC Section R602.10.1.3) – Braced wall line spacing establishes the amount of racking load that must be resisted by the two or more parallel braced wall lines in each plan direction. Figure 3 shows a graphical representation of the relationship between braced wall lines and braced wall line spacing. The racking load must be resisted by incorporating an adequate amount of braced wall panels in each braced wall line. As the spacing between parallel braced wall lines increases, the surface area of the building between the braced wall lines that takes the out-of-plane wind loading and transfers it to the braced wall lines also increases. Therefore, the required bracing amounts are dependent on the spacing between parallel braced wall lines. This consideration influences the space that is available for wall openings on exterior walls, which may require using interior braced wall lines to help share the bracing load and reduce the amount of bracing required on each of the parallel braced wall lines. While the total bracing load and amount of bracing remains essentially unchanged, the additional braced wall line allows the required bracing amount to be distributed to more braced wall lines. This practice, when used or necessary, has a number of potential benefits.

For example, an interior braced wall line B in Figure 3 is added in between BWL A and BWL C. This reduces the BWL spacing. Since BWL B shares some of the load, BWL A and C require less bracing than when using BWL A and C alone. As a result, use of a particular bracing method may be brought into compliance with the code, more openings may be accommodated, or a more efficient use of energy-saving wall sheathings (i.e., exterior continuous insulation) may be achieved without compromising wall bracing requirements or requiring two exterior sheathing layers, one structural for bracing purposes and the other non-structural for insulation purposes**.**

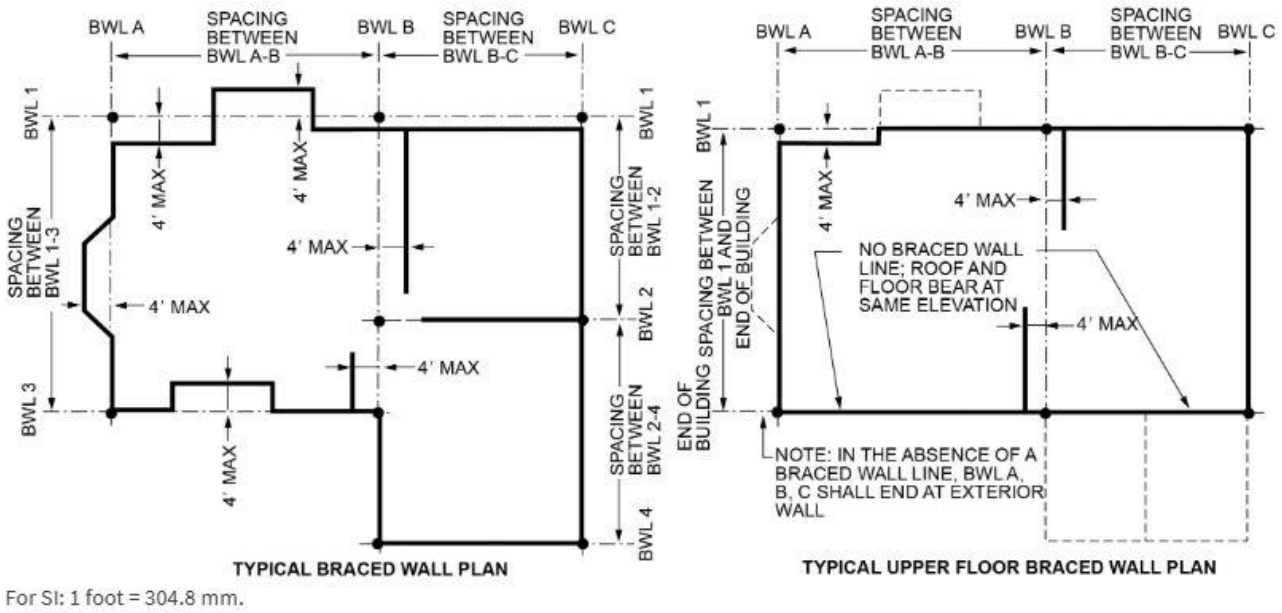


Figure 3. Braced Wall Lines – IRC Figure R602.10.1.1[6]

Finally, the IRC provides minimum required bracing amounts tabulated for braced wall lines spaced apart by up to a maximum of 60' for wind loads (see Table 8). For braced wall line spacing greater than 60', additional braced wall lines or engineering will be required (see Section 4). For example, if the distance between BWL A and BWL C in Figure 3 were greater than 60', then BWL B would be required to allow use of the IRC bracing provisions. It is important to note that the spacing assigned to BWL A and C is the distance to BWL B; the spacing assigned to BWL B is permitted to be the average distance to BWL A and BWL C. Using the greater of the two distances would be conservative and is not required by code (see IRC Table R602.10.3(1), footnote 'c', also shown in Table 8).

Braced Wall Panel (IRC Section R602.10.1.2) – Shown in Figure 4, a braced wall panel (BWP) is a section of a braced wall line that is specifically braced with a code-compliant bracing method (e.g., let-in brace, a wood structural panel, or other bracing methods). Section 2 of this Guide addresses the various braced wall panel construction methods. Braced wall panels must meet minimum width requirements (length of wall covered) to count toward the minimum bracing amounts required for each individual braced wall line. The minimum widths required for braced wall panels of the various bracing methods constrain the layout and spacing of wall openings in a code-compliant braced wall line. The IRC also provides a number of useful options for adjusting braced wall panel widths or specifying "narrow panel" bracing methods (i.e., portal frames) that will be discussed later in Section 2.

[6] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.1.1

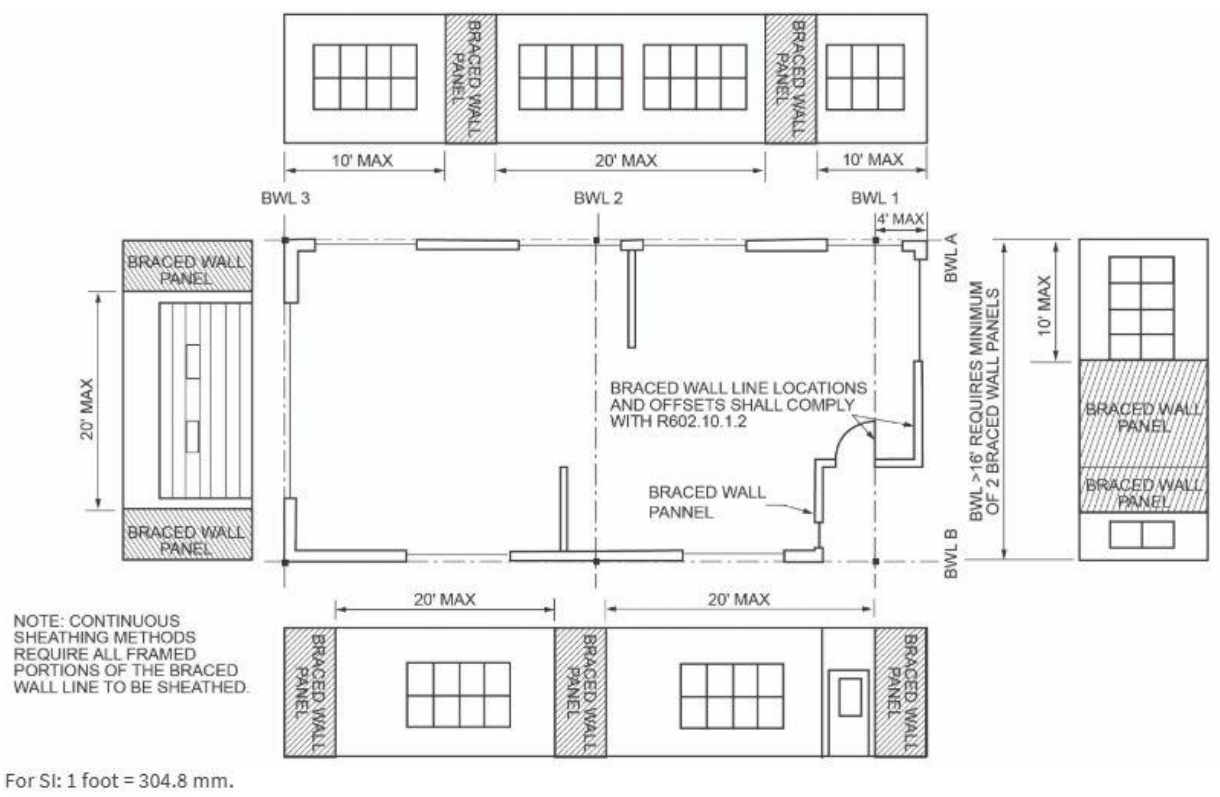


Figure 4. Braced Wall Panel End Distance Requirements – IRC Figure R602.10.2.2[7]

Braced Wall Panel Location (IRC Section R602.10.2.2) – In addition to being used to meet minimum bracing amounts, the location of braced wall panels along each braced wall line must meet additional constraints:

1. Braced wall panels must be spaced no greater than 20' o.c. along a braced wall line between adjacent edges, and
2. Braced wall panels must begin no more than 10' from the end of a braced wall line.

For the continuous sheathing bracing methods (IRC Sections R602.10.4.2 and IRC Section R602.10.7), specific prescribed end conditions must be met. Some conditions require an additional panel be located at the end of the adjoining wall or that a modest hold-down connection be provided to avoid this requirement for the adjoining wall. These requirements are discussed later in Section 2.3.

Minimum Number of Braced Wall Panels (IRC section R602.10.2.3) – Braced wall lines >16' in length require a minimum of two braced wall panels; braced wall lines of ≤16' in length require at least two braced wall panels OR one panel ≥48".

[7] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.2.2

The above requirements ensure that for walls no longer than 16', a single 48" braced wall panel can be used. In addition, IRC Section R602.10.1.2 requires a 48" minimum total length of bracing in each BWL. Thus, for walls greater than 16' in length, generally two or more BWPs or one large BWP will be required to meet the above requirements for BWP location on a BWL.

Braced Wall Panel Uplift Load Path (IRC Section R602.10.2.1) – It is critical that the entire building, and especially the braced wall panels, have an adequate uplift load path to address roof uplift loads. Many building failures that appear to be caused by bracing failures are actually a result of an inadequate uplift load path to carry roof uplift forces through the framing system down to the foundation. IRC Section R602.3.5, which makes use of roof uplift provisions in IRC Section R802.11, specifically addresses the uplift provisions for braced wall panels.

Mixing Bracing Methods (IRC Section R602.10.4.1) – The IRC includes an explicit but limited ability to mix the various bracing methods on a building plan to maximize cost-effectiveness or other objectives such as energy efficiency (see Section 5 for more details about the advantages of mixing different bracing methods on the same building). In addition, there are a few general provisions that apply to the mixing of bracing methods on a plan as follows (based on the scope limitation of this Guide):

1. Mixing bracing methods from story to story is permitted.
2. Mixing bracing methods from braced wall line to braced wall line within a story is permitted.
3. Mixing intermittent bracing methods along a braced wall line is permitted.
4. Mixing of continuous sheathing methods is permitted within a continuously sheathed braced wall line (ABW, PFH, and PFG methods also are allowed).
5. Mixing of continuous sheathing methods with intermittent bracing methods along a braced wall line is not permitted by code. However, based on the scope of this document (Seismic Design Category A/B/C, ultimate design wind speed of less than 140 mph, one- and two- family dwellings of no more than three-stories), the intent of this provision of the code is considered satisfied if the total bracing amount provided complies with that required for the intermittent bracing method (see Item 6 below) and the requirements for installation of each bracing method are followed.
6. The length of required bracing for a braced wall line with mixed bracing types shall be based on the bracing type that requires the greater bracing length (see Table 8 and Table 9).

Angled Walls (IRC Section R602.10.1.4) – Braced wall panels on angled walls may be counted toward the minimum bracing length requirement as follows:

1. Braced wall lines shall be permitted to angle out of plane with a maximum diagonal length of 8'.
2. The contributing length of the braced panel is the projected length of the panel along the braced wall line (see Figure 5).
3. The braced wall panel at the angled corner can contribute to only one of the adjacent braced wall lines.
4. Where the diagonal length is greater than 8', an angled wall shall be considered its own braced wall line.

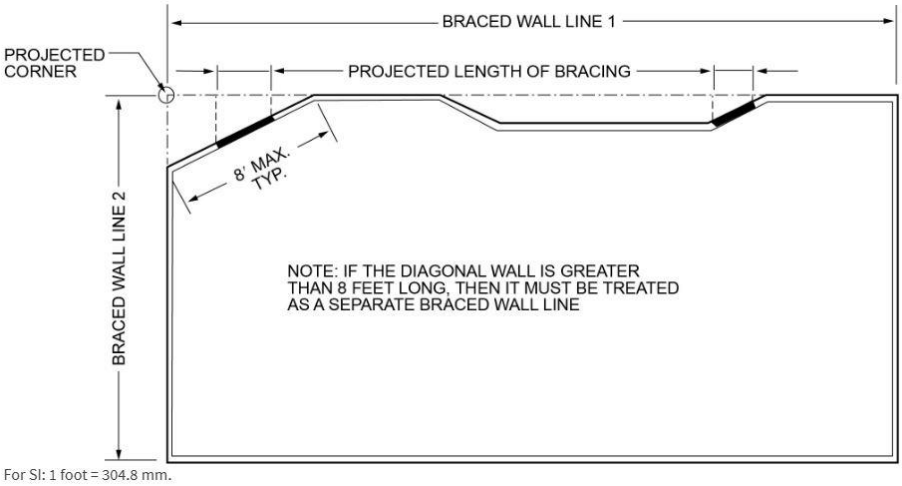


Figure 5. Angled Corners – IRC Figure R602.10.1.4[8]

Wall Height for Wood Framing (IRC Section R602.10.3.1) – The IRC differentiates between story height, wall height, and portal header height. The wall height is the distance from the lower edge of the bottom plate to the upper edge of the upper plate. The story height, however, is the distance from the upper surface of a floor to the upper surface of the floor above the story in question. Portal header height is the distance from top of concrete to top of the portal frame header. The differentiation between story height and wall height is shown in Figure 6. Portal header height is shown in Figure 8, Figure 9, and Figure 13. Be aware that while story height is not used in the determination of required bracing, IRC Section R301.3 limits the story height to 11'7", with some exceptions allowed.

The wall height is used to adjust required bracing amounts as discussed in Section 3 of this Guide. However, the 2021 IRC incorrectly uses the story height for this purpose. This was corrected back to use of wall height in the 2024 IRC.

[8] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.1.4

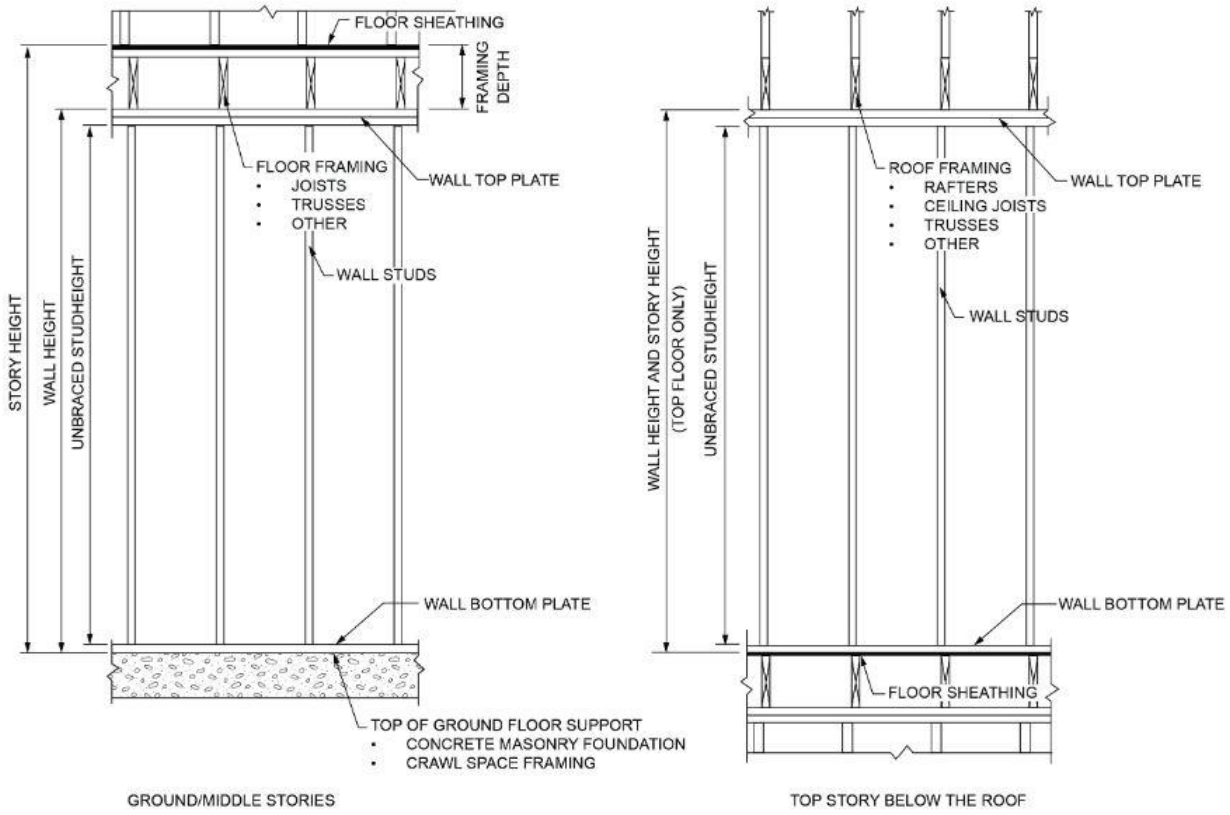


Figure 6. Wall Height for Wood Framing – IRC R602.10.3.1[9]

[9] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.3.1

Section 2: IRC Wall Bracing Methods

2.1 Overview

In this section, the various bracing methods in the IRC are presented and discussed. These bracing methods and their associated capabilities are the “building blocks” for arriving at optimal bracing designs that are code compliant, cost effective, and coordinated with other design objectives such as energy efficiency and affordability (see Section 5). Therefore, it is important to start with a working knowledge of the various bracing methods featured in the IRC.

The IRC bracing methods are divided into two basic categories as illustrated in Figure 7:

- Intermittent Braced Wall Panel Construction Methods
- Continuous Sheathing Wall Bracing Methods

Within each of these categories of bracing methods are various means to address problems commonly encountered in practice, such as narrow braced wall panels used at garage openings and other similar conditions. Mixing of bracing methods as shown in Figure 7(c) is also possible within certain limitations addressed earlier in Section 1.

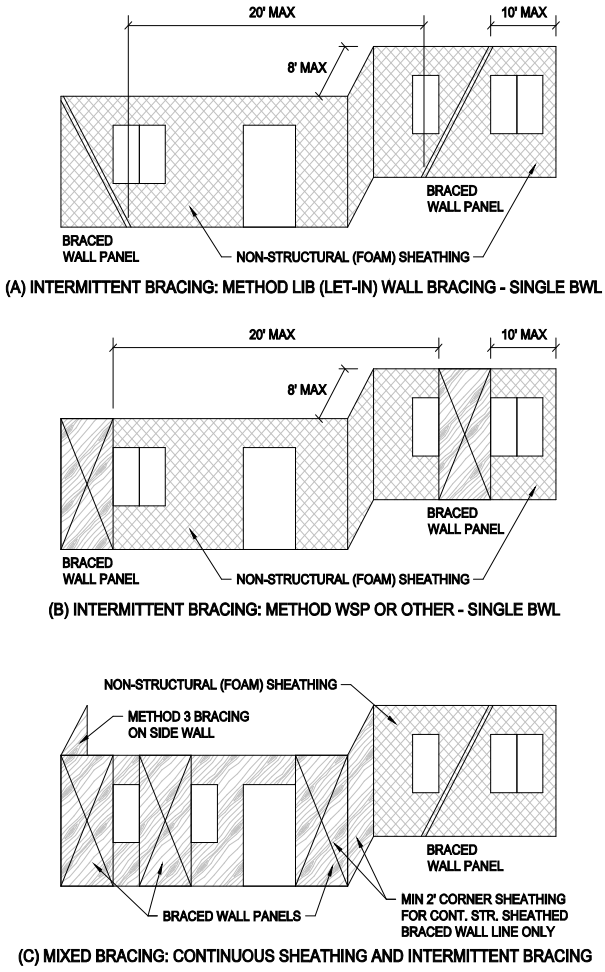


Figure 7. Illustration of Intermittent, Continuous, and Mixed Bracing Methods

2.2 Intermittent Braced Wall Panel Construction Methods

The intermittent bracing methods include traditional methods of bracing and are retained and improved in modern editions of the IRC to ensure consistency of all bracing methods, including continuous and “narrow panel” bracing methods addressed later. Table 2 lists the intermittent BWP construction methods along with basic construction requirements as addressed in IRC Section R602.10.4. As referenced in Table 2, BWP minimum length requirements vary according to bracing method as well as wall height as shown in Table 3. In addition, the IRC includes a “partial credit” approach for many of these methods (see Table 4) whereby the braced wall panel length may, depending on wall height, be reduced to only 36" inches from the commonly required minimum of 48". In such cases, the **contributing length** of the braced wall panel shown in Table 3 is used in lieu of the **actual** braced wall panel length in determining compliance with required bracing amounts addressed later in Section 3.

In accordance with IRC Section R104.2.2, other approved proprietary bracing materials may be used on the basis of equivalency as normally indicated by a code evaluation report for the proprietary bracing method. For example, an approved metal brace may be substituted for the LIB bracing method (although many metal braces are just for temporary bracing and are not equivalent to LIB) or a proprietary sheathing may be substituted for one of the bracing methods using a code-recognized sheathing material. Proprietary bracing methods are worth considering because they may offer some multi-functional advantages over the code-recognized bracing methods in Table 2 (e.g., composite panels known as structural insulated sheathing can provide bracing, continuous insulation per energy code, and a water-resistive barrier system).

Equivalency does not necessarily mean that an alternative bracing method must have the exact same or better performance properties (i.e., shear strength and stiffness) than those in the code. This only applies if it is being used as a “one-for-one” substitute. Alternative bracing methods can be stronger or weaker so long as the bracing amounts required are adjusted proportionately to achieve equivalent performance in providing overall racking strength to a building or a given braced wall line.

Table 2. Intermittent Bracing Methods and Requirements (based on IRC Table R602.10.4[10])

Method	Material	Minimum Thickness	Connection Criteria	BWP Minimum Length & Maximum Wall Height
LIB	Let-in-bracing	1x4 wood or approved metal straps 45° to 60° angles maximum 16" stud spacing	Wood: 2-8d common nails or 3-8d ($2^1/_2$"x0.113" dia.) per stud including top and bottom plate Metal: per manufacturer	• Each such brace counts as a "braced wall panel" with actual length dependent on brace angle (see Table 3) • For LIB bracing, wall height shall not exceed 10'
DWB	Diagonal wood boards	$^3/_4$" (1"nominal) maximum 24"stud spacing	2-8d ($2^1/_2$"×0.113" dia.) nails or 2 staples, $1^3/_4$" per stud	• See Table 3 and "partial credit" allowance of Table 4 • Maximum wall height of 12'
WSP	Wood structural panel IRC Section R604	$^3/_8$" for maximum 16" stud spacing	6d common (2"x0.113" dia.) nails 6" o.c. at edges 12" o.c. in the field (For application on exterior side of exterior walls this fastening is limited to ultimate wind speed and exposure of 140/B, 115/C, or 110/D – refer to Table (3) in IRC R602.3)	• Refer to Table 3 and "partial credit" allowance of Table 4 • Maximum wall height of 12'
		$^7/_{16}$" for maximum 24" stud spacing	8d common (2.5"x0.131" dia.) nails 6" o.c. at edges 12" o.c. in the field. (For 24" stud spacing, limited to ultimate wind speed and exposure as above; for 16" stud spacing, the limits are 170/B, 140/C, 135/D)	• Refer to Table 3 and "partial credit" allowance of Table 4 • Maximum wall height of 12'
BV-WSP	Wood structural panel with stone or masonry veneer IRC Section R602.10.6.5	$^7/_{16}$"	8d common ($2^1/_2$"x0.131" dia.) nails 4" o.c. at panel edges 12" o.c. at intermediate supports 4" o.c. at braced wall panel end posts	• Refer to Table 3 only, "partial credit" of Table 4 does not apply to BV-WSP • Maximum wall height of 12'

[10] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.4_TblR602.10.4

Table 2. Intermittent Bracing Methods and Requirements (based on IRC Table R602.10.4[10])

Method	Material	Minimum Thickness	Connection Criteria	BWP Minimum Length & Maximum Wall Height
SFB	Structural fiberboard sheathing	1/2" or 25/32" for maximum 16" stud spacing	For 1/2", 1 1/2"x0.120" dia. galvanized roofing nails For 25/32", 1 3/4"x0.120" dia. galvanized roofing nails 3" o.c. at edges 6" o.c. in the field	• Refer to Table 3 and "partial credit" allowance of Table 4 • Maximum wall height of 12'
GB	Gypsum board (one or both sides of BWP)	1/2"	Nails or screws at 7" spacing at panel edges and at intermediate supports Exterior gypsum sheathing at GB braced wall panels, use fastener size and type in accordance with Table (1) in IRC R602.3 Interior gypsum panels at GB braced wall panels, use fastener size and type in accordance with IRC Table R702.3.5	• Refer to Table 3 only, "partial credit" of Table 4 does not apply to GB • Maximum wall height of 12'
PBS	Particleboard sheathing IRC Section R605	3/8" or 1/2" for maximum 16" stud spacing	For 3/8", 6d common (2"x0.113" dia.) nails For 1/2", 8d common (2 1/2"x0.131" dia.) nails 3" o.c. at edges 6" o.c. in the field	• Refer to Table 3 and "partial credit" allowance of Table 4 • Maximum wall height of 12'
PCP	Portland cement plaster	IRC Section 703.7 for maximum 16"stud spacing	1 1/2", 11 gage, 0.120" dia., 7/16" dia. head nails -or- 7/8", 16 gage staples 6" o.c. on all framing members	• Refer to Table 3 and "partial credit" allowance of Table 4 • Maximum wall height of 12'
HPS	Hardboard panel siding	7/16" for maximum 16" stud spacing	0.092" dia., 0.225" head nails with length to accommodate 1 1/2" penetration into studs 4" o.c. at edges 8" o.c. in the field	• Refer to Table 3 and "partial credit" allowance of Table 4 • Maximum wall height of 12'

Table 2. Intermittent Bracing Methods and Requirements (based on IRC Table R602.10.4[10])

Method	Material	Minimum Thickness	Connection Criteria	BWP Minimum Length & Maximum Wall Height
ABW	Alternate braced wall	3/8"	See IRC Section R602.10.6.1 for special framing, fastening, and hardware requirements	• 28" minimum; See IRC Section R602.10.6.1 and discussion below on "Narrow Panel Bracing for Intermittent Bracing Methods" • Maximum wall height of 12'
PFH	Portal frame with hold-downs	3/8"	See IRC Section R602.10.6.2 for special framing, fastening, and hardware requirements	• 16" minimum (supporting one story) • 24" minimum (supporting two stories) • See IRC Section R602.10.6.2 and discussion below on "Narrow Panel Bracing for Intermittent Bracing Methods" • Maximum portal header height of 10', with allowed pony wall above for maximum wall height of 12'
PFG	Portal frame at garage	7/16"	See IRC Section R602.10.6.3 for special framing, fastening, and hardware requirements	• 24" minimum for 8' wall height • See IRC Section R602.10.6.3 and discussion below on "Narrow Panel Bracing for Intermittent Bracing Methods" • Maximum portal header height of 10', with allowed pony wall above for maximum wall height of 12'

IMPORTANT: IRC Section R602.10.4.3 requires all of the above intermittent bracing methods (except GB, BV-WSP, ABW, PFH, and PFG) to be used together with interior finish of 1/2" gypsum wall board (or equal) installed in accordance with IRC Section R702.3.5 on the inside surface of the wall. Otherwise, required bracing amounts for Methods DWB, WSP, SFB, PBS, PCP, and HPS must be increased as addressed in Section 3 of this Guide (Table 8 and Table 9).

Table 3. Minimum Length Requirements for Braced Wall Panels[a] (based on IRC Table R602.10.5[11])

Method (See Table 2)		Minimum Length (in)					Contributing Length (in)[b]
		Wall Height					
		8'	9'	10'	11'	12'	
DWB, WSP, BV-WSP, SFB, PBS, PCP, HPS		48	48	48	53	58	Actual (or in accordance with Table 4)
GB		48	48	48	53	58	Double Sided = Actual Singe Sided = 0.5 x Actual
LIB	60˚ brace angle	55	62	69	NP	NP	Actual
	45˚ brace angle	96	108	120	NP	NP	96 (max)
ABW	SDC A, B and C, wind speed <140mph	28	32	34	38	42	48
Method (See Table 2)		Portal header height					Contributing Length (in)
		8'	9'	10'	11'	12'	
PFH	Supporting roof only	16	16	16	c	c	48
	Supporting one story and roof	24	24	24	c	c	48
PFG		24	27	33	c	c	1.5 x Actual

NP = Not permitted

a. Linear interpolation shall be permitted.

b. Contributing length is the horizontal length of a BWP along a BWL that can be counted toward the required bracing amount for a BWL (see Section 3). Use actual length when it is greater than or equal to the minimum length.

c. Maximum header height of 10', but wall height shall be permitted to be increased to 12' with a pony wall.

As indicated in Table 2 and Table 3 above, the following contributing lengths apply when BWPs are less than the required minimum BWP length of 48" for Methods DWB, WSP, SFB, PBS, PCP, and HPS. The effective length is the “contributing length” that applies toward the required amount of bracing in a BWL (see Section 3).

Table 4. Effective Lengths for BWP Less than 48 Inches in Actual Length – IRC Table R602.10.5.2[12]

Actual Length of Braced Wall Panels (in)	Contributing Length of Braced Wall Panels (in)	
	8' wall height	9' wall height
48	48	48
42	36	36
36	27	N/A

[11] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.5_TblR602.10.5

[12] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.5.2_TblR602.10.5.2

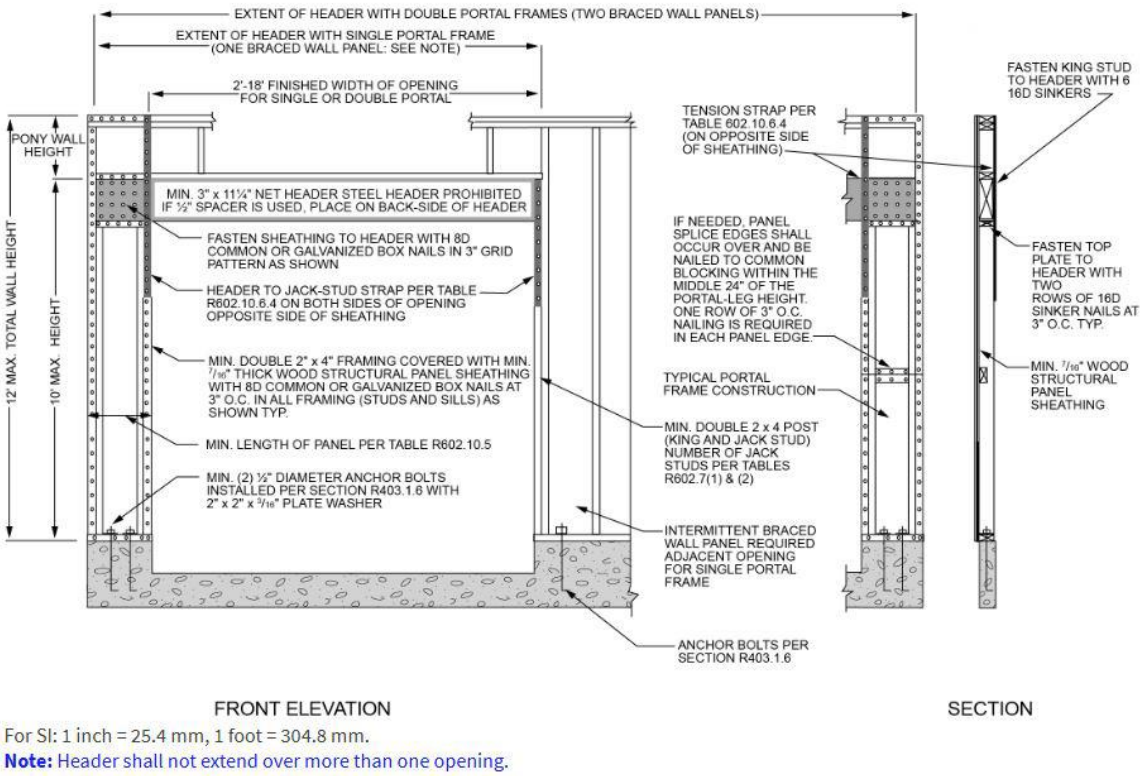
Narrow Panel Bracing for Intermittent Bracing Methods

Table 2 also includes various "narrow panel" bracing methods (i.e., ABW, PFH, and PFG) for use alone or together in braced wall lines with the standard intermittent bracing methods. These special bracing methods require different framing and connection techniques that are beyond typical conventional wood framing practices. They also have use limitations. Therefore, they are discussed in greater detail as follows:

Method PFG (Portal Frame at Garage without hold-down brackets)

- Use only at garage door openings supporting no more than one floor plus a roof.[13]
- Method PFG shall be constructed in accordance with Figure 8 and IRC Section R602.10.6.3.
- PFG panels may be used on one or both sides of the door opening as shown in Figure 8 with a header clear span ranging from 2' to 18'.
- For the purpose of determining contributing length (Section 3), the length of each PFG braced wall panel shall be multiplied by a factor of 1.5 as shown in Table 3.
- Braced wall panel length shall be a minimum of one-fourth the height of the PFG as shown in Figure 8 (see Table 3).
- PFG height to the top of header shall be a maximum of 10' as shown in Table 3 and Figure 8. A pony wall may be used to allow a wall height of up to 12'.
- PFG panels must be installed directly on a foundation (use on lowest story only).
- Header to jack-stud straps are sized in accordance with IRC Table R602.10.6.4. The strap provides structural continuity between the header and the wall segment to produce a "moment frame" effect and provides uplift restraint to the PFG header as well as out-of-plane stability to resist wind loads.
- The method is limited to headers spanning a single opening as noted in Figure 8 (this was a clarification added to the 2024 IRC).

[13] The limitation of PFG to garage openings only is not justified by the original research supporting this method. Therefore, it may be used for other applications, such as large window or door openings on an intermittent braced wall line provided such use is locally approved and the other requirements and limitations are followed.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

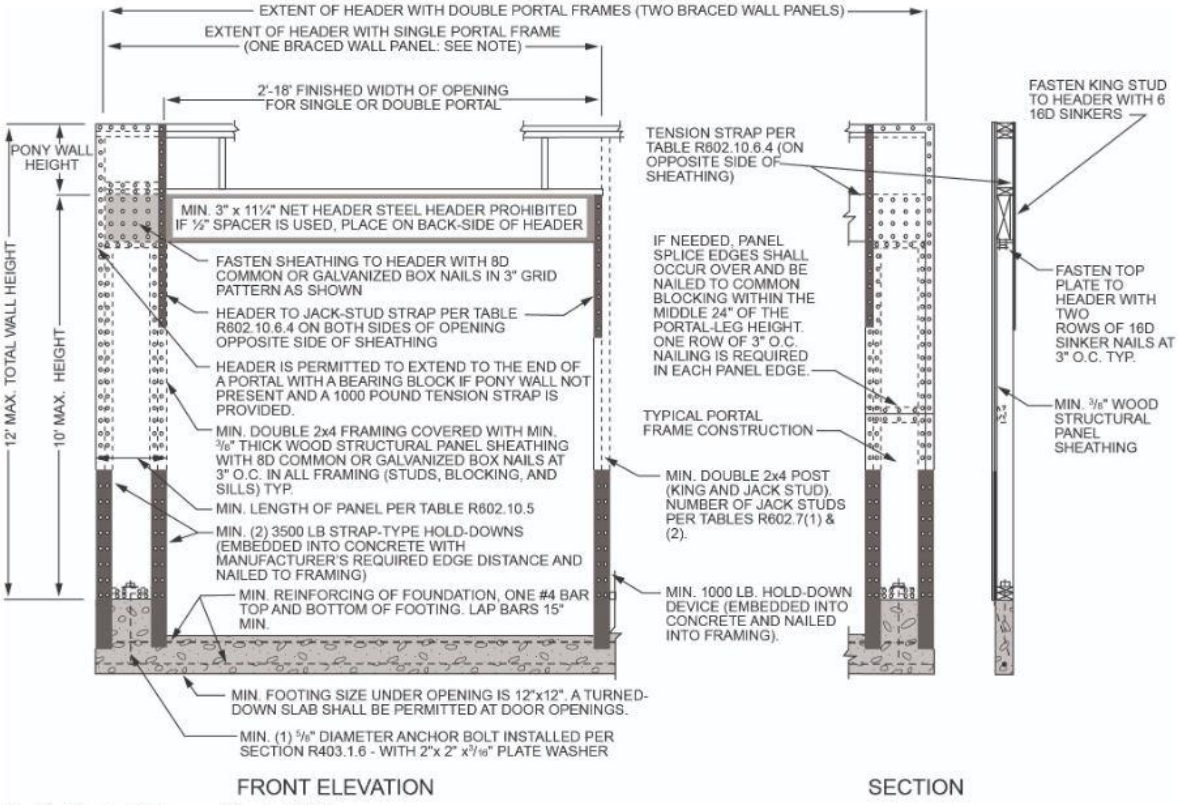
Note: Header shall not extend over more than one opening.

Figure 8. Method PFG Portal Frame at Garage Door Openings – IRC Section R602.10.6.3[14]

[14] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.6.3

Method PFH (Portal Frame with Hold-down Brackets)

- Use on any BWL alone or together with intermittent bracing.
- Construct per Figure 9 permitting braced wall panels as narrow as 16" wide (supporting roof only) or 24" wide (supporting roof plus one floor).
- For the purpose of determining provided bracing amounts (Section 3), each PFH panel counts as 48" of braced wall panel (see Table 3).
- Use for any large opening with header clear span of 6' to 18' (not just limited to garage openings).
- PFH height shall be a maximum of 10' as shown in Figure 9. A pony wall may be used to allow a wall height of up to 12'.
- Portal frame braced wall panels must be directly supported on and anchored to a foundation with hold-down straps (use on lowest story only).
- The foundation must be continuous across the entire length of the braced wall line. The foundation shall be reinforced as shown on Figure 9.
- Header to jack-stud straps are determined per IRC Table R602.10.6.4. The strap provides uplift restraint to the CS-PF header as well as out-of-plane stability to resist wind loads.
- The method is limited to headers spanning a single opening as noted in Figure 9 (this was a clarification added to the 2024 IRC).



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Note: Header shall not extend over more than one opening.

Figure 9. Method PFH Portal Frame with Hold Downs – IRC Section R602.10.6.2[15]

[15] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.6.2

Method ABW (Alternate Braced Wall Panel with Hold-down Brackets)

The ABW method was one of the original “narrow panel” bracing methods in the IRC; however, the “partial credit” approach and the newer portal framing methods, both discussed above, are generally preferred. Determine minimum width of ABW per IRC Table R602.10.5 and Figure 10. Requirements include:

- Can be substituted for any 48" wide panel (counts as 48" of braced wall panel length for bracing amount).
- Alternate braced wall panels must be directly anchored to foundation with hold-down anchors or straps (use on lowest story only).
- The panels shall be supported on a foundation or on floor framing supported directly on a foundation that is continuous across the entire length of the braced wall line.
- The hold-down force of each panel shall be in accordance with Table 5.
- In the first story of a two-story building, each braced wall panel shall meet the conditions above except that the wood structural panel sheathing edge nailing spacing shall not exceed 4" o.c.

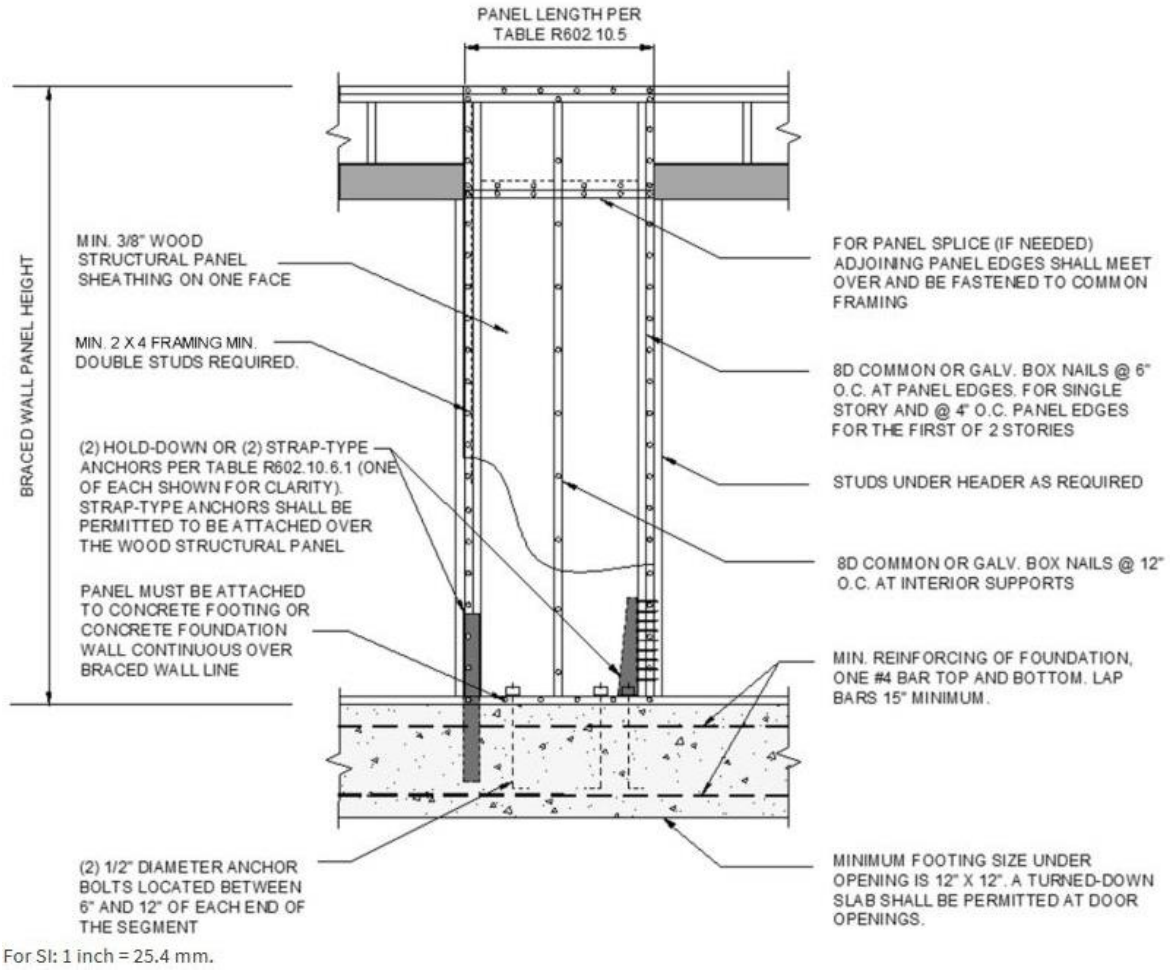


Figure 10. Alternate Braced Wall Panel – IRC Section R602.10.6.1[16]

[16] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.6.1

Table 5. Hold-Down Forces for Method ABW Braced Wall Panels (excerpt from IRC Table R602.10.6.1[17])

Seismic Design Category & Wind Speed	Supporting/Story	Hold-Down Force (lbs)				
		Height of Braced Wall Panel				
		8'	9'	10'	11'	12'
SDC A, B, and C Ultimate design wind speed < 140 mph	One story	1,800	1,800	1,800	2,000	2,200
	First of two stories	3,000	3,000	3,000	3,300	3,600
For SI: 1 foot = 304.8 mm, 1 pound = 4.45 N, 1 mile per hour = 0.447 m/s. NP = Not permitted						

Fitting Large Openings within Code-Compliant Intermittently Braced Wall Lines

Frequently, building designs include large openings within or at the ends of braced wall lines, especially for entry foyers and "great rooms." For the limits shown in Figure 11, based on the key concepts and rules addressed in Section 1.6, the IRC intermittent wall bracing methods can accommodate these types of conditions in code-compliant braced wall lines without requiring use of the "narrow panel" bracing methods or the continuous sheathing methods (discussed later) in the portion of a braced wall line with large openings.

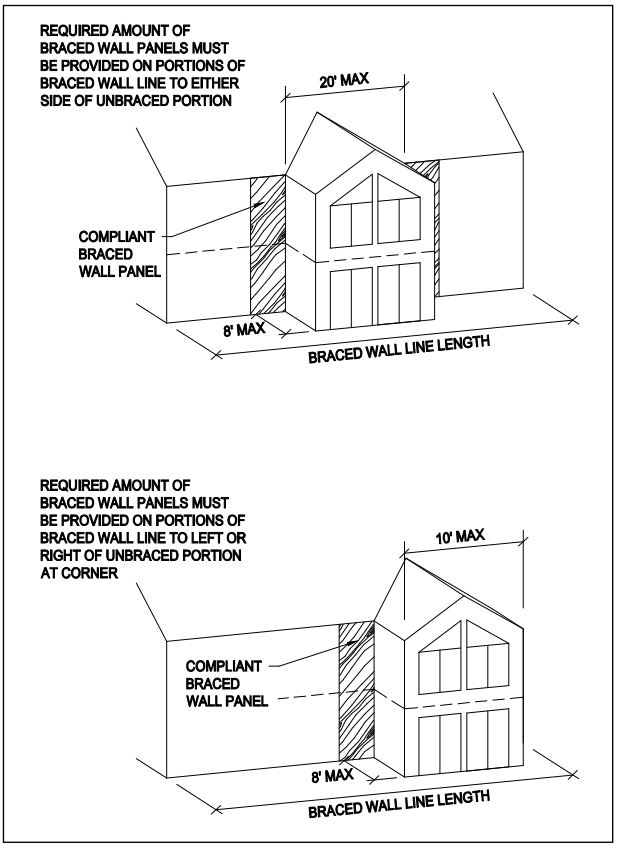


Figure 11. Limits for Large Openings in Braced Wall Lines with Intermittent Bracing

[17] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.6.1_TblR602.10.6.1

2.3 Continuously Sheathed Methods

Continuous sheathing methods offer some advantages relative to the more traditional intermittent bracing methods while providing at least equivalent performance. The primary advantages include a lesser required length of bracing and smaller braced wall panel widths than generally possible with the intermittent bracing methods. However, these walls must be continuously sheathed with either wood structural panels or structural fiberboard sheathing (or other proprietary sheathings approved for this purpose). In addition, a number of stipulations affect the appropriate use of these methods.

As shown in Table 6, three methods apply to continuous sheathing with wood structural panels and one with structural fiberboard sheathing.

Table 6. Continuous Sheathing Bracing Methods (based on IRC Table R602.10.4[18])

Method	Sheathing Material	Minimum Thickness	Connection Criteria	BWP Minimum Length & Maximum Wall Height
CS-WSP (IRC Section R602.10.4)	Continuously sheathed wood structural panel	3/8"	Table 2, Method WSP[a]	• Refer to Table 7 • Maximum wall height of 12'
CS-G (adjacent to garage openings only on one side of garage)	Continuously sheathed wood structural panel	3/8"	See Method CS-WSP	• Refer to Table 7 • Maximum wall height of 12'
CS-PF (IRC Section R602.10.6.4)	Continuously sheathed portal frame	7/16"	IRC Section R602.10.6.4 and discussion below on "narrow panel" bracing	• Refer to Table 7 • Maximum header height of 10', but wall height shall be permitted to be increased to 12' with a pony wall.
CS-SFB (IRC Section R602.10.5)	Continuously sheathed structural fiber board	1/2" or 25/32" for maximum 16" stud spacing	Table 2, Method SFB	• Refer to Table 7 • Maximum wall height of 12'

a. Staples may be used if an approved nails-to-staples fastening conversion is followed.

IMPORTANT: IRC Section R602.10.4.3 requires all of the above continuously sheathed methods (except CS-PF) to be used together with interior finish of 1/2" gypsum wall board (or equal) installed in accordance with IRC Section R702.3.5 on the inside surface of the wall. Otherwise, required bracing amounts for Methods CS-WSP, CS-G, and CS-SFB must be increased as addressed in Section 3 of this Guide (see Table 8 and Table 9).

[18] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.4_TblR602.10.4

Continuous Sheathing Method General Provisions

Regardless of the continuous sheathing method used, they all share some common requirements as follows:

- All of the continuous sheathing methods require the same structural panel sheathing material (wood structural panels or structural fiberboard sheathing) to be used on all sheathable surfaces on one side of a braced wall line including areas above and below openings.
- Different bracing methods, other than those listed in Table 6, shall not be permitted along a braced wall line with continuous sheathing. Exceptions are ABW, PFH, and PFG, which are allowed to be mixed with the methods of Table 6.
- Only those full-height braced wall panels complying with the length requirements of Table 7 shall be permitted to contribute to the minimum required length of bracing (see Section 3).
- The ends of a continuous sheathed braced wall line shall be constructed in accordance with one of the methods shown in Figure 12 to provide overturning restraint (e.g., use of corner return panel, a 48” minimum brace wall panel, or use of a hold-down device).

Figure 12 shows various options to address different corner situations that may arise when using the continuous sheathing methods. These options give the user greater flexibility in the design of code compliant braced wall lines. For example, Conditions 2 and 5 eliminate the corner return panel in exchange for an 800-lb hold-down at the corner. Conditions 1, 2, 4, and 5 allow a door or window opening to be placed in close proximity to a corner (as is permitted with the intermittent bracing methods discussed earlier). In addition, the fastening of abutting studs at the wall corner must comply with the fastening requirements for framing as prescribed in IRC Table R602.3(1).

Table 7. Length Requirements for Braced Walls with Continuous Sheathing[a]
(based on IRC Table R602.10.5[19])

Method (See Table 6)		Minimum Length (in) Wall Height 8'	9'	10'	11'	12'	Contributing Length (in)[b]
CS-G		24	27	30	33	36	Actual
CS-WSP CS-SFB	Adjacent Clear Opening Height (in.)						
	≤64	24	27	30	33	36	Actual
	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		16	18	20	NP	NP	Actual

NP = Not permitted

a. Linear interpolation shall be permitted.

b. Contributing length is the length of a BWP along a BWL that can be counted toward the required bracing amount for a BWL (see Section 3). Use actual length when it is greater than or equal to the minimum length.

[19] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.5_TblR602.10.5

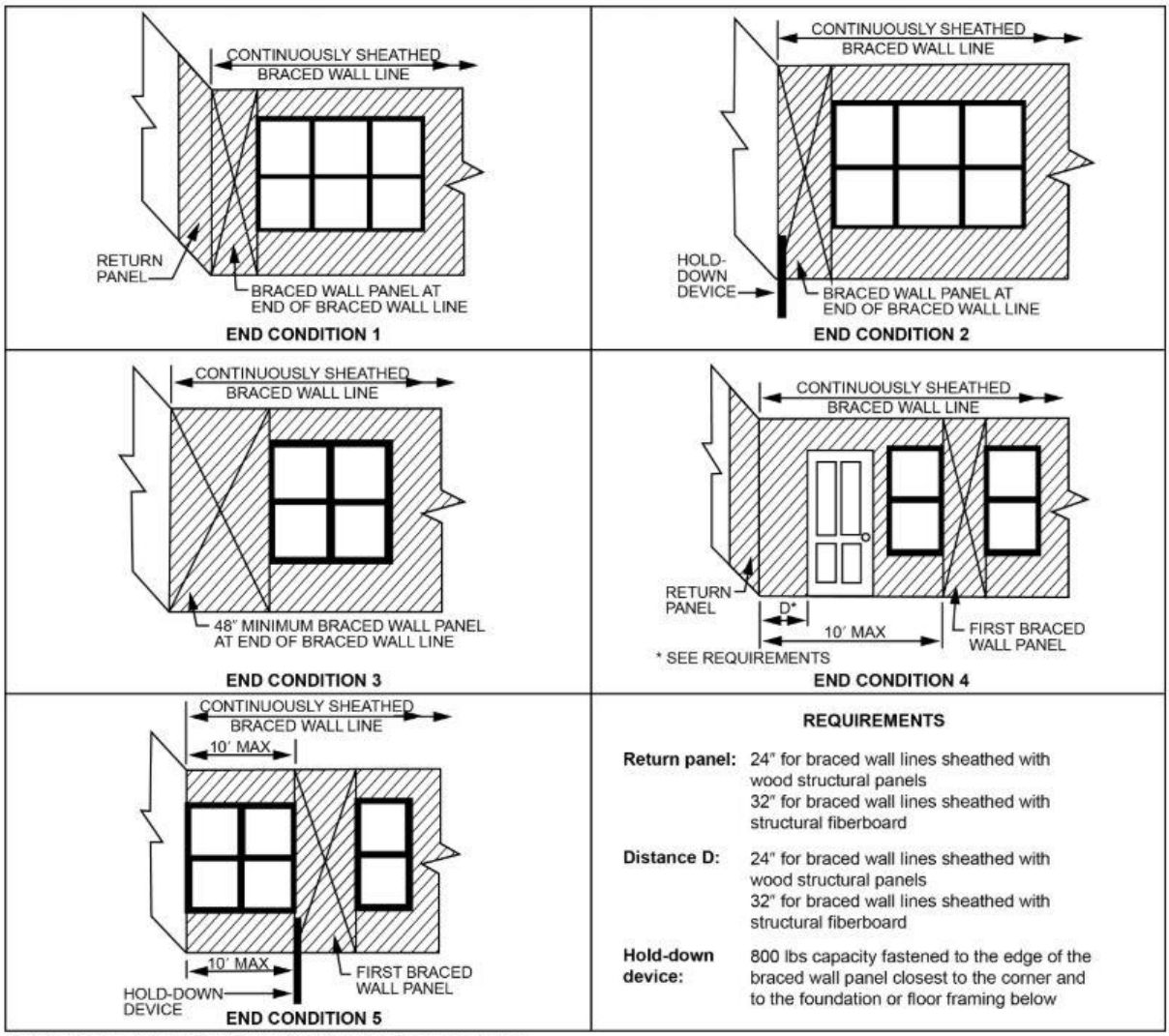


Figure 12. End Conditions for Braced Wall Lines with Continuous Sheathing – IRC Section R602.10.7[20]

These options also provide a means to switch to a different bracing method on the adjoining perpendicular wall at the end of the continuous sheathing braced wall line.

[20] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.7

Narrow Panel Bracing for Use with Continuous Wood Structural Panel Sheathing

Table 6 also includes two “narrow panel” bracing methods (CS-G and CS-PF) for use alone or together in braced wall lines with continuous wood structural panel sheathing (CS-WSP). These special bracing methods require different framing and connection techniques that are beyond typical conventional wood framing practices. They also have use limitations. Therefore, they are discussed in greater detail as follows:

Method CS-G

A special exception provides for CS-WSP braced wall panel widths as narrow as 2' for limited use in a garage opening wall per Table 7. Restrictions include:

- Must meet the requirements of the continuous sheathing method general provisions noted earlier above, including use of one of the end conditions of Figure 12, and is limited to the CS-WSP bracing method.
- Must be adjacent to a garage opening that supports a roof only (single story garage); limited to use on one side of garage only.

Method CS-PF

Use a portal frame without hold-down brackets that permits braced wall panels as narrow as 16" wide per Figure 13. Restrictions include:

- Must meet the requirements of the continuous sheathing method general provisions noted earlier above, including use of one of the end conditions of Figure 12, and is limited to the CS-WSP bracing method.
- Continuous portal frame braced wall panels shall be constructed in accordance with Figure 13. The number of continuous portal frame panels in a single braced wall line shall not exceed four.
- There shall be a maximum of two braced wall segments per header and the header clear span shall not be less than 2' or greater than 18'.
- CS-PF height shall be a maximum of 10' measured from the top of the header to the bottom of the bottom plate as shown in Figure 13. A pony wall may be used to allow a wall height of up to 12'.
- Head to jack-stud straps are determined per IRC Table R602.10.6.4. The strap provides uplift restraint to the CS-PF header as well as out-of-plane stability to resist wind loads.
- The method is limited to headers spanning a single opening as noted in Figure 13 (this was a clarification added to the 2024 IRC).

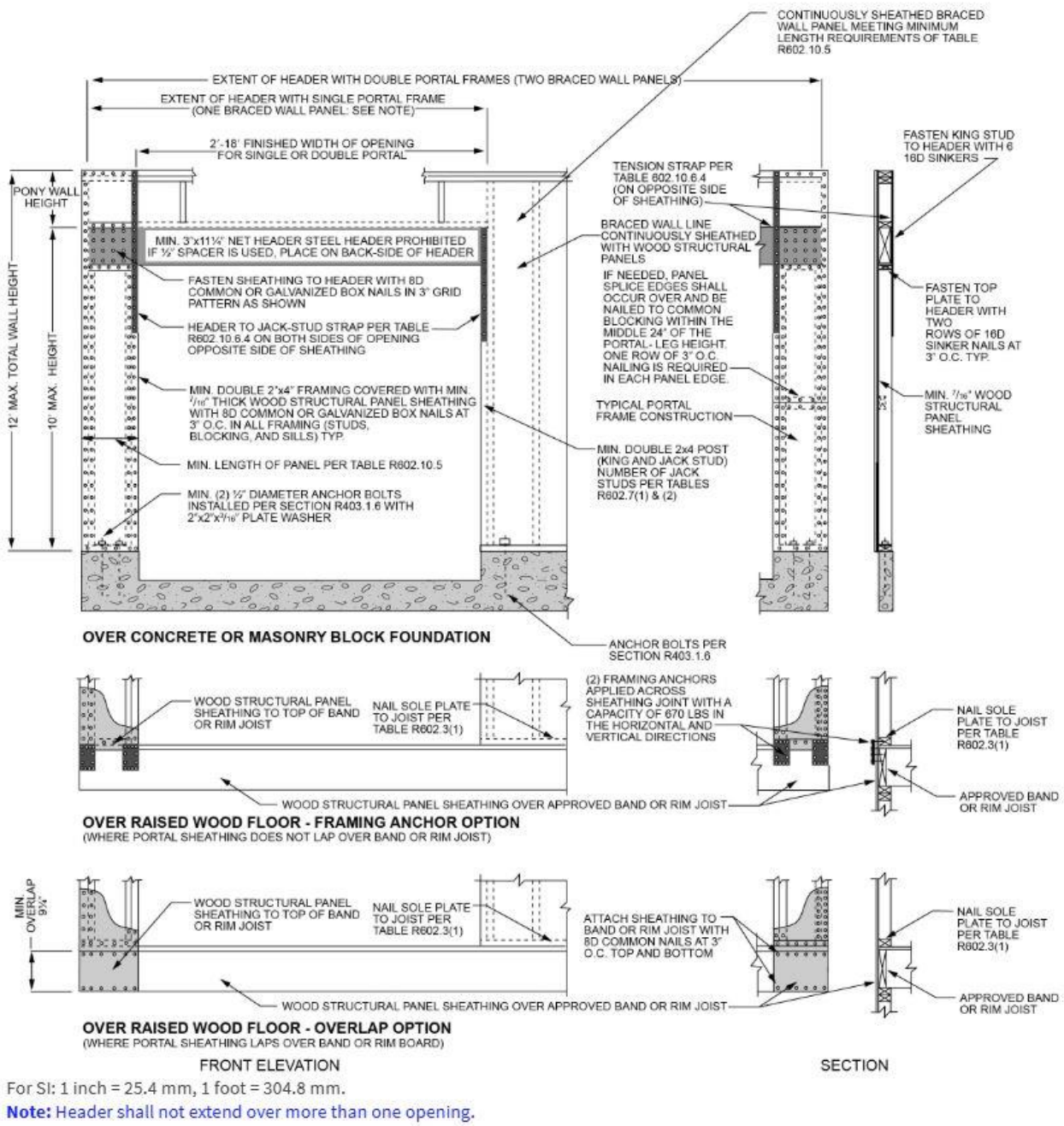


Figure 13. Method CS-PF: Continuous Portal Frame Construction – [IRC Section R602.10.6.4](https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.6.4)[21]

[21] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.6.4

2.4 Important Construction Requirements for Wall Bracing

IRC Section R602.3 provides design and construction requirements for the wall framing. These items must be considered and followed to ensure the braced wall design will be adequate. IRC Table R602.3(1) provides the fastening schedule for the roof, walls, floors, and panels/sheathing. The remainder of this section focuses on requirements that are of particular concern to the functionality of the braced wall system.

Basic Connection Requirements for Braced Wall Panels

Attach bracing panels or braces to wall framing in accordance with bracing method descriptions per Table 2 or Table 5 as based on IRC Section R602.10.4.

Support and attach all horizontal and vertical joints of sheathing used as braced wall panels to wall framing or minimum 2x blocking per IRC Section R602.10.4.4. Blocking is not required at horizontal sheathing joints under the following exceptions:

1. Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels*.
2. For methods WSP, PBS, and CW-WSP, blocking may by omitted provided an adjustment factor of 2.0 per Table (2) in IRC R602.10.3 is applied to the required bracing length.
3. When Method GB panels are installed horizontally, blocking of horizontal joints is not required.
4. Vertical joints of panel sheathing shall be permitted to occur over double studs, where adjoining panel edges are attached to separate studs with the required panel edge fastening schedule, and the adjacent studs are attached together in accordance with IRC Table R602.3(1) for application with braced wall panels.

Braced wall panels attached with adhesive (glue) are not permitted in SDC C or D per IRC Table R602.10.4, but this limitation is not applicable to the scope of this Guide, except in the case of a single-family detached home in SDC C.

Connect bottom (sole) plates at braced wall panel locations to wood floor framing (joists or blocking) with 3-16d box nails ($3^1/_2$" x 0.135"), 2-16d common nails ($3^1/_2$" x 0.162"), or 4-3"x0.131" nails at 16" o.c. per IRC Table R602.3(1) or to foundations using $^1/_2$" diameter anchor bolts (or equivalent) per IRC Section R403.1.6 (includes requirements for anchor bolt placement in BWL sole plates).

Blocking Requirements for Floor and Roof Framing at Braced Wall Panel Locations

Where braced wall panels are not aligned with floor and roof framing members, the IRC contains blocking requirements to ensure the proper transfer of lateral loads into and out of the braced panels (refer to IRC Section R602.10.8). Like a continuous load path to resist wind uplift loads, a continuous load path is also required to transfer racking loads from the building roof and floor framing into and out of braced wall panels. However, where the distance between the BWP top plate and roof sheathing at eaves is $9^1/_4$" or less, blocking between roof rafters or trusses at BWP locations “shall not be required” for SDC A, B, and C and this allowance is applicable to the scope of this Guide.

Braced Wall Panel Wind Uplift Connections

The following provisions are required to ensure that braced wall panels perform adequately when subjected to roof uplift loads while also resisting lateral (racking) load from wind:

> **R602.3.5 Braced wall panel uplift load path.** *Braced wall panels* located at exterior walls that support roof rafters or trusses (including *stories* below top *story*) shall have the framing members connected in accordance with one of the following:
>
> 1. Fastening in accordance with Table R602.3(1) where:
>
> 1.1. The ultimate design wind speed does not exceed 115 mph (51 m/s), the wind exposure category is B, the roof pitch is 5:12 or greater, and the roof span is 32 feet (9754 mm) or less.
>
> 1.2. The net uplift value at the top of a wall does not exceed 100 plf (146 N/mm). The net uplift value shall be determined in accordance with Section R802.11 and shall be permitted to be reduced by 60 plf (86 N/mm) for each full wall above.

2. Where the net uplift value at the top of a wall exceeds 100 plf (146 N/mm), installing *approved* uplift framing connectors to provide a continuous load path from the top of the wall to the foundation or to a point where the uplift force is 100 plf (146 N/mm) or less. The net uplift value shall be as determined in Item 1.2 above.
3. Wall sheathing and fasteners designed to resist combined uplift and shear forces in accordance with accepted engineering practice.

While not specifically required by the IRC, it also is advisable to follow the above uplift connection requirements for portions of walls that are not BWPs to ensure a continuous load path from the roof, through bearing walls, to the foundation, or to a point where the uplift load is 100 plf or less. Refer to IRC Section R802.11 for additional information and requirements for addressing a wind uplift continuous load path. A code-compliant wind-uplift load path is necessary to achieve the intended performance of the IRC wall bracing provisions.

Braced Wall Panel Support

IRC Section R602.10.9 contains the following requirements for support of braced wall panels:

- Floor cantilevers complying with IRC Section R502.3.3 that support braced wall panels are permitted. The floor cantilevers shall have solid blocking at the bearing wall below except when the floor cantilever is not more than 24" in length, a full-height rim joist is provided at the end of the cantilevered floor joists, and the Seismic Design Category is A, B, or C.
- Elevated post and pier foundations supporting braced wall panels must be laterally braced in accordance with accepted engineering practice (i.e., the IRC does not provide a prescriptive bracing solution for this type of foundation system).
- Masonry stem walls less than 48" in length supporting braced wall panels must be reinforced per IRC Section R602.10.9. In addition, masonry stem walls shall not be used to support ABW or PFH braced wall panels, which require embedded hold-down devices.
- Concrete stem walls less than 48" in length, greater than 12" in height, and less than 6" thick must have reinforcement sized and located per IRC Figure R602.10.9.

Section 3: Applying the Code

Refer to Section 1 of this Guide for important information on basic concepts and requirements related to braced wall lines, braced wall panels, braced wall panel location, braced wall line spacing, mixing of bracing methods, and angled walls.

Refer to Section 2 of this Guide for specific requirements related to the various braced wall panel construction methods. Section 3 relies on information from these previous sections.

Refer to this wall bracing calculator as a tool to efficiently implement the IRC's wall bracing provisions for a specific building plan.

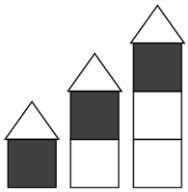
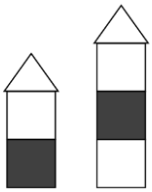
3.1 Overview

The primary objective of the IRC wall bracing provisions – to ensure that dwellings are adequately braced to prevent collapse – is summed-up in Table 8 and Table 9 for the scope of this Guide where only bracing for wind design is required to be checked. Thus, Table 8 and Table 9 must be applied in unison with the various concepts and detailed requirements found in Section 1 and Section 2 of this Guide. To assist in integrating all the relevant information for a code-compliant wall bracing design, this section:

1. Provides a comprehensive step-by-step procedure for applying the code (Section 3.2).
2. Demonstrates how to calculate the required length of bracing using minimum required length of braced wall panel, Table 8, and its many adjustment factors or multipliers, Table 9 (Section 3.3).
3. Shows how to determine the length of bracing provided by code compliant braced wall panels within a braced wall line (Section 3.4).

In the end, a code-compliant bracing plan will contain an acceptable arrangement of braced wall lines, each with an acceptable arrangement of braced wall panels having a total contributing length that meets or exceeds the minimum length of bracing required by Table 8, including all applicable adjustment factors found in Table 9.

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
<95		10	2.5	2.5	1.5	1.5
		20	4.5	4.5	2.5	2.5
		30	6.5	6.5	4.0	3.5
		40	8.5	8.5	5.0	4.0
		50	10.5	10.5	6.0	5.0
		60	12.5	12.5	7.0	6.0
		10	5.0	5.0	3.0	2.5
		20	8.5	8.5	5.0	4.5
		30	12.5	12.5	7.0	6.0
		40	16.0	16.0	9.5	8.0
		50	20.0	20.0	11.5	10.0
		60	23.5	23.5	13.5	11.5
		10	NP	7.0	4.0	3.5
		20	NP	13.0	7.5	6.5
		30	NP	18.5	10.5	9.0
		40	NP	24.0	13.5	11.5
		50	NP	29.5	17.0	14.5
		60	NP	35.0	20.0	17.0

[22] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.3_TblR602.10.3_1

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

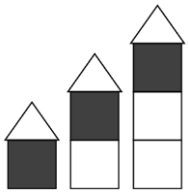
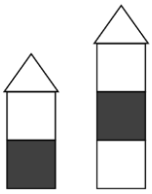
• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
≤100		10	2.5	2.5	1.5	1.5
		20	4.5	4.5	2.5	2.5
		30	7.0	7.0	4.0	3.5
		40	9.5	9.5	5.0	4.5
		50	11.5	11.5	6.5	5.5
		60	13.5	13.5	7.5	6.5
		10	5.0	5.0	3.0	2.5
		20	9.5	9.5	5.0	4.5
		30	13.5	13.5	7.5	6.5
		40	17.5	17.5	10.0	8.5
		50	21.5	21.5	12.5	10.5
		60	26.0	26.0	14.5	12.5
		10	NP	7.5	4.5	3.5
		20	NP	14.0	8.0	7.0
		30	NP	20.0	11.5	9.5
		40	NP	26.0	15.0	12.5
		50	NP	32.5	18.5	15.5
		60	NP	38.0	21.5	19.0

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

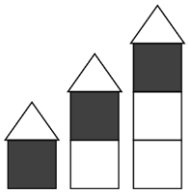
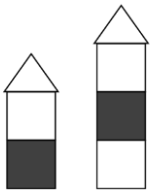
• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
≤105		10	3.0	3.0	1.5	1.5
		20	5.0	5.0	3.0	2.5
		30	7.5	7.5	4.5	4.0
		40	10.0	10.0	5.5	5.0
		50	12.5	12.5	7.0	6.0
		60	15.0	15.0	8.5	7.0
		10	5.5	5.5	3.0	2.5
		20	10.0	10.0	5.5	5.0
		30	15.0	15.0	8.5	7.0
		40	19.5	19.5	11.0	9.5
		50	24.0	24.0	14.0	11.5
		60	28.5	28.5	16.0	14.0
		10	NP	8.5	5.0	4.0
		20	NP	15.0	9.0	7.5
		30	NP	22.0	12.5	10.5
		40	NP	29.0	16.5	14.0
		50	NP	35.5	20.5	17.0
		60	NP	42.0	24.0	20.5

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

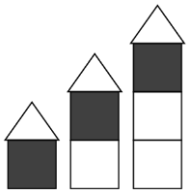
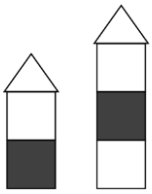
• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
≤110		10	3.5	3.5	2.0	1.5
		20	6.0	6.0	3.5	3.0
		30	8.5	8.5	5.0	4.5
		40	11.5	11.5	6.5	5.5
		50	14.0	14.0	8.0	7.0
		60	16.5	16.5	9.5	8.0
		10	6.5	6.5	3.5	3.0
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8.0
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.5	13.0
		60	31.5	31.5	18.0	15.5
		10	NP	9.5	5.5	4.5
		20	NP	17.0	10.0	8.5
		30	NP	24.5	14.0	12.0
		40	NP	32.0	18.5	15.5
		50	NP	39.5	22.5	19.0
		60	NP	46.5	26.5	23.0

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

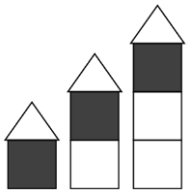
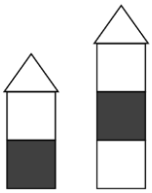
• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
≤115		10	3.5	3.5	2.0	2.0
		20	6.5	6.5	3.5	3.5
		30	9.5	9.5	5.5	4.5
		40	12.5	12.5	7.0	6.0
		50	15.0	15.0	9.0	7.5
		60	18.0	18.0	10.5	9.0
		10	7.0	7.0	4.0	3.5
		20	12.5	12.5	7.5	6.5
		30	18.0	18.0	10.5	9.0
		40	23.5	23.5	13.5	11.5
		50	29.0	29.0	16.5	14.0
		60	34.5	34.5	20.0	17.0
		10	NP	10.0	6.0	5.0
		20	NP	18.5	11.0	9.0
		30	NP	27.0	15.5	13.0
		40	NP	35.0	20.0	17.0
		50	NP	43.0	24.5	21.0
		60	NP	51.0	29.0	25.0

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

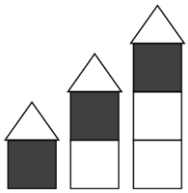
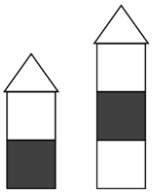
• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
≤120		10	4.0	4.0	2.5	2.0
		20	7.0	7.0	4.0	3.5
		30	10.5	10.5	6.0	5.0
		40	13.5	13.5	8.0	6.5
		50	16.5	16.5	9.5	8.0
		60	19.5	19.5	11.5	9.5
		10	7.5	7.5	4.5	3.5
		20	14.0	14.0	8.0	7.0
		30	20.0	20.0	11.5	9.5
		40	25.5	25.5	15.0	12.5
		50	31.5	31.5	18.0	15.5
		60	37.5	37.5	21.5	18.5
		10	NP	11.0	6.5	5.5
		20	NP	20.5	11.5	10.0
		30	NP	29.0	17.0	14.5
		40	NP	38.0	22.0	18.5
		50	NP	47.0	27.0	23.0
		60	NP	55.5	32.0	27.0

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

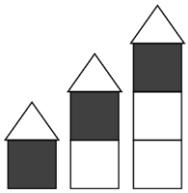
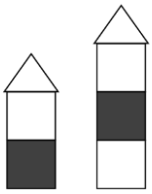
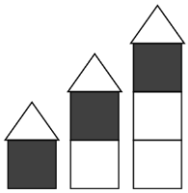
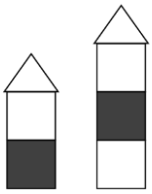
• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
≤130		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.5	19.5	11.0	9.5
		60	23.0	23.0	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.5	8.0
		30	23.0	23.0	13.5	11.5
		40	30.0	30.0	17.5	15.0
		50	37.0	37.0	21.5	18.0
		60	44.0	44.0	25.0	21.5
		10	NP	13.0	7.5	6.5
		20	NP	24.0	13.5	11.5
		30	NP	34.5	19.5	17.0
		40	NP	44.5	25.5	22.0
		50	NP	55.0	31.5	26.5
		60	NP	65.0	37.5	31.5

Table 8. Bracing Requirements Based on Wind Speed (based on IRC Table R602.10.3(1) [22])

• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]			
Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing[b] (feet)**	**Method LIB[c]**	**Method GB**	**Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFG, CS-SFB**	**Methods CS-WSP, CS-G, CS-PF**
<140		10	5.5	5.5	3.0	2.5
		20	10.0	10.0	5.5	5.0
		30	14.0	14.0	8.0	7.0
		40	18.0	18.0	10.5	9.0
		50	22.5	22.5	13.0	11.0
		60	26.5	26.5	15.0	13.0
		10	10.0	10.0	6.0	5.0
		20	18.5	18.5	11.0	9.0
		30	27.0	27.0	15.5	13.0
		40	35.0	35.0	20.0	17.0
		50	43.0	43.0	24.5	21.0
		60	51.0	51.0	29.0	25.0
		10	NP	15.0	8.5	7.5
		20	NP	27.5	16.0	13.5
		30	NP	39.5	23.0	19.5
		40	NP	51.5	29.5	25.0
		50	NP	63.5	36.5	31.0
		60	NP	75.5	43.0	36.5

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

NP = Not Permitted.

a. Linear interpolation shall be permitted. Values for ≤105mph and ≤110mph are provided in this Guide for the user's convenience based on the required bracing amount being proportional to the square of the basic wind speed.

b. Where three or more parallel braced wall lines are present and the distances between adjacent braced wall lines are different, the average dimension shall be permitted to be used for braced wall line spacing.

c. Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with IRC Table R602.3(1) for exterior sheathing or IRC Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8".

Table 9. Adjustment Factors for Table 8 Bracing Requirements (based on IRC Table R602.10.3[2][23])

Item Number	Adjustment Based On	Story/Supporting	Condition	Adjustment Factor[a,b] (multiply length from Table 8)	Applicable Methods
f1	Exposure category[c]	One-story structure	B	1.00	All methods
			C	1.20	
			D	1.50	
		Two-story structure	B	1.00	
			C	1.30	
			D	1.60	
		Three-story structure	B	1.00	
			C	1.40	
			D	1.70	
f2	Roof eave-to-ridge height	Roof only	≤ 5 feet	0.70	
			10 feet	1.00	
			15 feet	1.30	
			20 feet	1.60	
		Roof + 1 floor	≤ 5 feet	0.85	
			10 feet	1.00	
			15 feet	1.15	
			20 feet	1.30	
		Roof + 2 floors	≤ 5 feet	0.90	
			10 feet	1.00	
			15 feet	1.10	
			20 feet	Not permitted	
f3	Wall Height (IRC Section R602.10.3.1)	Any story	8 feet	0.90	
			9 feet	0.95	
			10 feet	1.00	
			11 feet	1.05	
			12 feet	1.10	
f4	Number of braced wall lines (per plan direction)[d]	Any story	2	1.00	
			3	1.30	
			4	1.45	
			> 5	1.60	

[23] https://codes.iccsafe.org/content/IRC2024P2/chapter-6-wall-construction#IRC2024P2_Pt03_Ch06_SecR602.10.3_TblR602.10.3_2

Table 9. Adjustment Factors for Table 8 Bracing Requirements (based on IRC Table R602.10.3[2][23])

Item Number	Adjustment Based On	Story/Supporting	Condition	Adjustment Factor[a,b] (multiply length from Table 8)	Applicable Methods
f5	Additional 800-pound hold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB, PBS, PCP, HPS
f6	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
f7	Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB
f8	Horizontal blocking	Any story	Horizontal block is omitted	2.0	WSP, PBS, CS-WSP

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.48 N.

a. Linear interpolation shall be permitted.

b. The total adjustment factor is the product of all applicable adjustment factors.

c. The same adjustment factor shall be applied to all braced wall lines on all floors of the structure, based on the worst-case exposure category.

d. The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.

3.2 Applying the Code: Step by Step

The best way to approach applying the wall bracing provisions of the IRC to a building plan is like a routine and methodical accounting task. Follow the steps below, capturing your information on the worksheet found in Appendix A, to arrive at a code-compliant wall bracing plan.

Step 1: Designate and label BWLs on the building plan for each story level and plan direction (N-S and E-W); identify BWL endpoints and check BWL offsets for compliance with the 4' offset rule and verify that the offset portions are not all located to one side of any designated braced wall line (see Section 1.6).[24]

Step 2: Determine the BWL support condition (roof only, roof plus one floor, or roof plus two floors) and assign a BWL spacing value (feet) to each BWL based on the average distance to the adjacent parallel BWLs (see Section 1.6).

Step 3: Select a braced wall panel construction method or methods for each braced wall line (see Section 2) and record the braced wall line length in feet.

Step 4: Determine the tabulated minimum required length of bracing for each BWL (see Table 8) and multiply by all appropriate adjustment factors in Table 9.

Step 5: Determine the total contributing length of code-compliant BWPs provided in each BWL (verify compliance with BWP minimum required length; the contributing length must include adjustments to contributing length as appropriate to the specific BWP construction method – see Section 2).

Step 6: Verify that the provided total contributing length of bracing from Step 5 meets or exceeds the minimum required length of bracing from Step 4. If successful, go to Step 7. If not, **see NOTE in box below** and repeat steps 1-5 as needed.

Step 7: Verify that the BWP spacing limit (e.g., maximum 20' edge-to-edge) and end distance (e.g., maximum 10') of BWPs from the ends of a BWL are met. Also verify that special end conditions are provided with the continuous sheathing methods (see Section 2.3).

If the bracing requirements are NOT met in the above steps, consider the following options to find a compliant solution for each non-compliant BWL:

- Reduce or shift braced wall line openings to allow space for required BWPs.
- Reduce BWL spacing (or use interior braced wall lines) to reduce the minimum required bracing amount.
- Limit braced wall line offsets that exceed the 4’ (+/-) offset allowance to minimize the number of BWL endpoints that trigger the need to locate BWPs within 10' of each BWL endpoint.
- Select a different bracing method that requires less bracing length, or use one of the various means to reduce BWP widths as discussed in Section 2.
- Use a supplemental solution (see Section 4).

Using this wall bracing calculator makes the above process of adjusting a bracing design to an optimized compliant solution much less time consuming.

[24] As noted in Section 1.6, the 2024 IRC includes an additional stipulation that not more than two-thirds of the braced wall panels are offset to one side of a designated braced wall lines which is not consistent with the original intent of the IRC wall bracing provisions. At the time of this writing, this is being proposed for correction in the 2027 IRC.

3.3 Calculating the Required Length of Bracing

Step 4 of Section 3.2 directs the code user to determine the required length of bracing using Table 8 and its many adjustment factors in Table 9. The minimum total length of braced wall panels required on a given braced wall line depends on:

- The design wind speed for the building site (per Chapter 3 of the IRC, including consideration of the site wind exposure and topographic effects, if any).
- The number of stories supported by the BWL under consideration.
- The spacing of adjacent BWLs.
- The braced wall panel construction method used.
- Various adjustment factors in Table 9 that "fine tune" bracing amounts to a specific building application.

In addition, IRC Section R602.10.2.3 requires that for braced wall lines greater than 16' a minimum of two braced wall panels be used, and for braced wall lines of 16' or less that either at least two panels or one panel equal to 48" or more be used.

Determining the required bracing length for each braced wall line can be easily achieved with the use of a hand-held calculator and the following formula:

Minimum Required Bracing = (Tabulated Bracing Length per Table 8) x (applicable adjustments in Table 9)

OR

L' = L x (f1) x (f2) x (f3) x (f4) x (f5) x (f6) x (f7) x (f8)

Where:
L' = the adjusted minimum required length of bracing
L = the tabulated (unadjusted) length of bracing from Table 8
(f1)-(f8) = various adjustment factors from Table 9 – use as applicable

For example, consider the house in Figure 14 and BWL #2 in the East-West plan direction supporting one floor and the roof (i.e., the bottom story street-facing entry wall line).

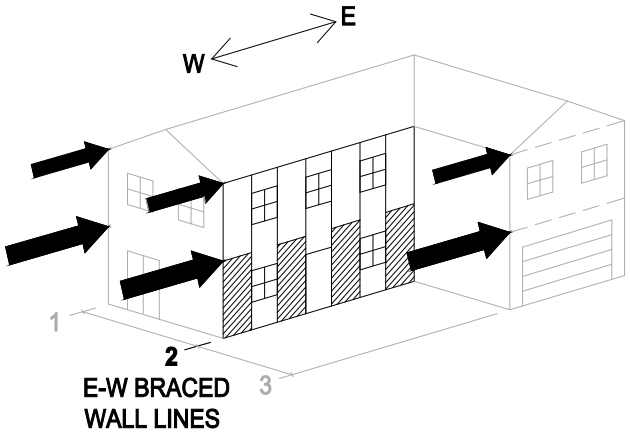


Figure 14. Example House Plan for Bracing Length Calculation

Assume the following conditions:

Design Wind Speed:	115 mph, Exposure B (no topographic effects)
BWL Supporting:	roof + 1 floor
BWL Spacing:	30' (average distance to BWL #1 and #3)
Roof Eave-to-Ridge Height:	13'
Wall Height:	9'
Bracing Method:	WSP (intermittent bracing)

Resulting Unadjusted Length and Adjustment Factors:

L (Table 8):	10.5'	(tabulated length of bracing, unadjusted)
Factor (f1):	1.0	(exposure B, 2 stories)
Factor (f2):	1.1	(roof eave-to-ridge height, interpolated)
Factor (f3):	0.95	(9' wall height)
Factor (f4):	1.3	(three braced wall lines in E-W plan direction)
Factor (f5):	1.0	(N/A, 800# hold-down not used on BWPs)
Factor (f6):	1.0	(N/A, gypsum board finish provided on interior side)
Factor (f7):	1.0	(N/A, GB bracing method not used)
Factor (f8):	1.0	(blocking not omitted; all BWP edges attached to framing or blocking)

Plugging the numbers into the bracing length equation and multiplying yields:

L' = 10.5' x (1.0) x (1.1) x (0.95) x (1.3) x (1.0) x (1.0) x (1.0) x (1.0) = 14.26'

The calculated decimal feet of bracing required can be converted to feet-inches as follows using a hand-held calculator:

14.26' = 14' + ? inches

0.26' x 12" per foot = 3" (rounded to nearest inch)

14.26' = 14'-3"

Thus, a total of 14'-3" of bracing is required on BWL#2 for the bottom story of the example house shown in Figure 14 for the conditions as given above.

In Appendix B of this Guide, calculation of the required bracing lengths is demonstrated for a variety of bracing methods and conditions on two typical house plans.

Also, refer to this wall bracing calculator to assist in efficiently developing and evaluating code compliant wall bracing solutions.

3.4 Verifying the Provided Length of Bracing

In Section 3.2, Step 5 prompts the user to determine the length of bracing **provided** in a braced wall line by determining the total contributing length of code-compliant braced wall panels. In Step 6, this amount is then compared to the required amount of bracing (as determined in the previous section or Step 4) to verify compliance. This process is repeated for each braced wall line in a building. The provided length of bracing (cumulative contributing length of each braced wall panel) within a braced wall line is determined as follows:

- Using the example from Section 3.3, the required amount of bracing for BWL #2 (first story level) was determined to be 14'-3" of WSP bracing method. In Figure 14, there are four potential locations for BWPs on the exterior wall line designated as BWL #2 (assuming the wall does not continue through the garage). Thus, the width of each of these four wall segments must be roughly 43" (14'-3" divided by 4, or 171"/4 = 43" rounded to the nearest inch) assuming equal panel widths.
- However, a 43" BWP length is less than the minimum BWP length required for the WSP intermittent bracing method (see Table 3). Consequently, a 48" BWP width is required for each wall segment for a total of 4 panels x 4' per panel = 16' of total bracing. This amount of bracing, if feasible for BWL #2, exceeds the required 14'-3" of WSP bracing.
- If insufficient space exists for 48"-long BWPs, other alternatives must be considered such as the CS-WSP or CS-SFB bracing methods. Using the “partial credit” approach for braced wall panels less than 48" in length (see Table 4) can also be considered but, in this case, would only result in the allowance for 46" actual braced wall panel actual length, giving an contributing length of 43" (by interpolation using Table 4). However, using four 46" BWPs panels would satisfy the required bracing amount of 14'-3" (i.e., 4 panels x 43" contributing length per panel = 172" or 14'-4").
- For this particular example, using the continuous sheathing methods (or a code-approved proprietary bracing method) appears to be more practical for the lower story BWL #2, but it also would require verifying acceptable BWP lengths for each wall segment based on adjacent opening clear heights (see Section 2.3).
- For other braced wall lines, however, the intermittent bracing methods would generally present few challenges, especially on the second story level.

In Appendix B of this Guide, determination of braced wall panel lengths provided by use of various braced wall panel construction methods is demonstrated for two typical house plans and a variety of conditions. Also, refer to this wall bracing calculator to assist in efficiently developing, evaluating, and documenting code compliant wall bracing solutions. While the calculator assists in determining required bracing amounts based on user inputs, the user must still verify that individual BWP lengths comply with the minimum length requirements of Table 3 and Table 4. The user must then confirm that the total provided contributing length of BWPs in each BWL meets or exceeds the required bracing amount as described in the example above.

Section 4: "Beyond Code" Bracing Solutions

4.1 Overview

When the IRC bracing methods fail to provide a workable or code-compliant solution for a given braced wall line or for a dwelling as a whole, consider:

- Custom engineered solutions (Section 4.2).
- Useful engineering concepts (Section 4.3).
- Code approved proprietary bracing products (Section 4.4).

4.2 Custom Engineered Solutions

Using custom engineered bracing solutions for an entire dwelling or for a non-compliant portion of a dwelling is permitted per IRC Section R104.2 and Section R301.1.3.

In general, an engineered solution must comply with accepted engineering practice using the building code resources and standards listed in Section 6 of this Guide using the editions (dates) as referenced in the locally adopted building code. Accepted engineering practice may also involve use of recognized design resources such as the *Residential Structural Design Guide – 2000 Edition*[25], which provides data and insights beyond those found in building codes, design standards, and typical textbooks (See Section 6).

Remember, however, that none of these sources of "accepted engineering practice" replace the need for practical engineering judgment in designing a wall bracing solution for a conventional wood frame dwelling. In part, this is because the structural performance of conventional light-frame construction – particularly at a system level – is not easily or accurately predicted by current conventions of engineering theory and analysis.[26] Therefore, it is important to employ a design professional or engineer that has a practical understanding of residential wood frame construction and structural design.

Unfortunately, in many cases the application of accepted engineering practice as regulated in the building code generally results in a very conservative design for lateral bracing in comparison to the IRC wall bracing provisions. However, for buildings within the scope of the IRC, the engineering approach used to develop the IRC bracing requirements (i.e., Table 8 and Table 9) may be considered as an acceptable engineering practice. (In fact, it is recognized as such by its use as the basis for the IRC bracing provisions.) The IRC engineering approach for "braced walls" (as different from "shear walls," the term for traditionally engineered walls) is detailed in Crandell (2007) and Crandell and Martin (2009) (see Section 6). This method, however, must be applied by a registered design professional in conformance with locally applicable laws for the practice of engineering. The design professional must also determine design loads as required by the locally applicable building code. While this may add design fees to the cost of construction, a specific analysis using the IRC engineering procedure can result in significant cost-savings and construction efficiencies.

As an alternative to the above described method, it is also possible to apply the IRC bracing provision in a manner consistent with engineering principles. An example design showing a reasonably efficient solution for a fairly complex house plan is included in Appendix C. The design example was developed as a result of the ICC Ad Hoc Wall Bracing Committee's interest in exploring various ways to configure and implement the IRC's wall bracing provision when first introduced in the 2009 edition of the IRC.

[25] HUD, 2000.

[26] Crandell and Kochkin, 2003.

4.3 Useful Engineering Concepts

In many cases, an engineered bracing solution may meet the intent of the building code for a specific bracing problem and also address a common bracing design issue with a solution that can be used repetitively on different plans with similar conditions.

Use of these engineering concepts may require local building official approval and will generally require the services of a design professional.

Interior Partition Walls as a Bracing Method

Because standard interior partition walls are constructed in much the same manner as Method GB wall bracing (except for the fastening schedule), these types of interior walls can be considered for their contribution to the bracing of a residential building. However, standard interior finishes on the inside face of exterior braced wall lines should not be additionally considered because its contribution is already partly factored into the prescribed bracing amounts in the IRC as part of a conservative whole building system effect adjustment used in the analysis of the IRC bracing provisions.[27]

A double-sided interior partition wall with a minimum $^1/_2$" gypsum wall board on both faces and using standard fastening per IRC Table R702.3.5 provides approximately one-half the bracing strength of Method GB with panels on "both sides." As a rule of thumb, interior partition walls with segments of at least 48" width and a minimum $^1/_2$" thick gypsum panels on both wall faces may be counted as a braced wall line (i.e., Method GB with gypsum panels on one side is approximately equivalent to a standard interior partition wall with gypsum panels on both sides). These partition walls, if used as a braced wall line, still require adequate fastening of the top plate to the roof/floor above and the bottom plate to the floor framing/slab below.

Altering Braced Wall Panel Location Requirements

The IRC requirement to locate braced wall panels no further than 10' from the ends of braced wall lines and no more than 20' between adjacent edges comes from a traditional practice. In the 1958 HUD Minimum Property Standards, a 25' o.c. (now 20' edge-to-edge) requirement was intended for high seismic regions as a way to provide additional wall bracing beyond the standard requirement for a brace at the end of each braced wall line. However, design calculations show that panels can be spaced further apart – provided the wall top plate and its splices are designed to collect in-plane or parallel shear (racking forces) along the top of the wall and transfer them to the braced wall panels. In fact, a **system** of elements (including more than just the top plate) transfers these forces along wall lines and into braced wall panels. This consideration and a general approach to designing collectors (e.g., top plates and top plate splices) are presented in the *Residential Structural Design Guide – 2000 Edition.*[28] As a result, in specific cases, braced wall panels can be designed to begin further than 10' from the ends of a braced wall line and spaced greater than 20' between adjacent edges along a braced wall line provided that:

- An adequate overall bracing amount is maintained for a braced wall line, and
- The collector (top plate) is designed to accommodate the additional in-plane tension or compression forces that result from a wider spacing of braced wall panels. Typically, this only affects the number or size of fasteners used in lap-splices of the top plate.

[27] Crandell and Martin 2009.

[28] HUD, 2000.

Allowance for Bracing Transfer

Buildings that are adequately braced on three sides are stable against lateral loads due to the ability of racking forces (shear) to be redistributed by torsional (twisting) response of the building (see Figure 15). Therefore, bracing amounts for braced wall lines on the longer side of a dwelling or on a garage may be reduced to the minimum required in Table 8 and Table 9 or less. In these cases, the amount of bracing equivalent to that which was removed must be placed on (transferred to) the opposite side of the building. This approach provides an easy and practical solution when addressing bracing of garages where little or no bracing is provided at the garage opening wall line, but ample space is provided for additional bracing on the rear wall as well as the side walls of the garage. However, as the aspect ratio of the building or building portion becomes significantly greater than 1:1, the ability to transfer bracing between the narrower sides becomes limited by the loss of torsional rigidity (deflection). For an example of efficiently designing an entire building using rigid diaphragm torsional force distribution, refer to Example 6.5 in the *Residential Structural Design Guide – 2000 Edition*.[29]

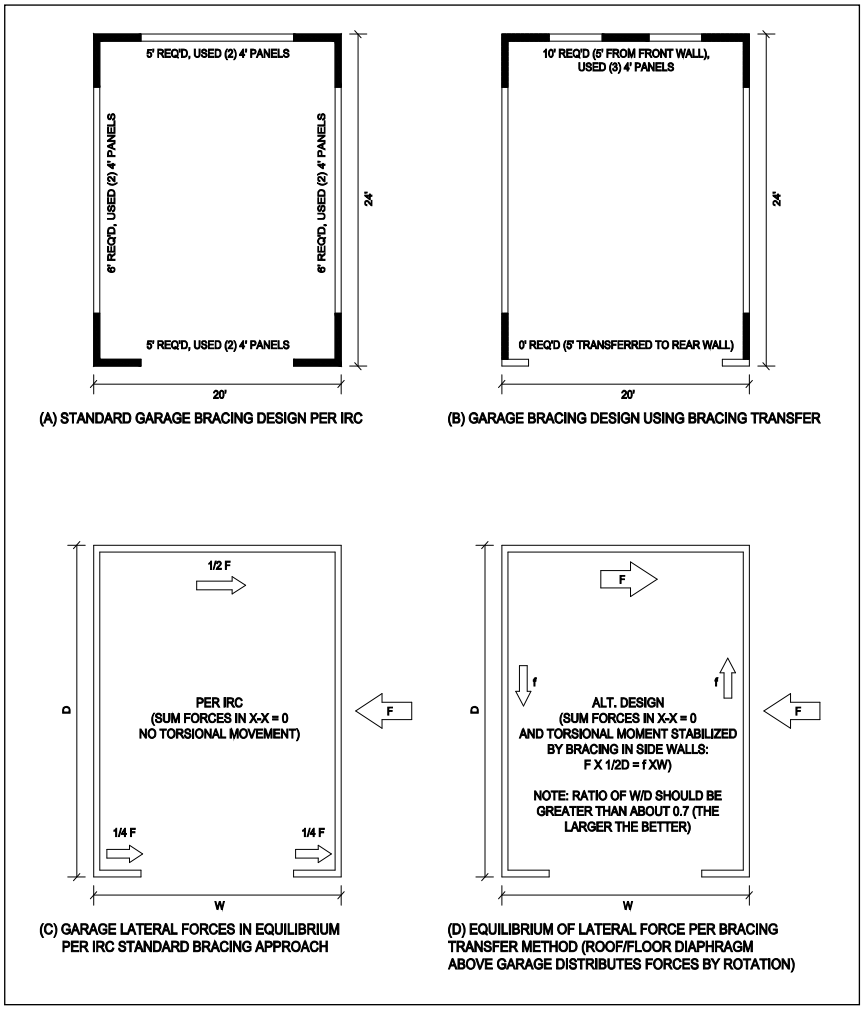


Figure 15. Bracing Transfer

[29] HUD, 2000

Allowance for >4' ± limit for Offsets within a Braced Wall Line

The 4' offset limit for braced wall lines in the IRC is not based on analysis or specific data. However, data from the Northridge earthquake,[30] as well as whole-building tests,[31] have demonstrated that the existing 4' offset limit is potentially conservative and somewhat arbitrary. (See Section 6.) No measurable difference in performance of homes with and without 4' offsets in braced wall lines was observed in carefully studied damage statistics for single-family detached homes.[32] Therefore, it should be acceptable to use engineering judgment in applying the existing 4' offset limit in the IRC's prescriptive provisions.

Combined Roof Uplift and Shear Load Path

As mentioned, the 2009 IRC bracing provisions first introduced wind uplift connection requirements for braced wall panels that support roof members (see Section 2.4). The additional connections, when required, may be provided by metal strapping or by appropriate installation of wall sheathing that is also used for bracing. Appropriate installation for combined uplift and shear resistance generally requires that additional fasteners be added to the horizontal edges of sheathing panels and that the panels lap over horizontal joints in wall and floor framing to resist the calculated roof uplift wind force less the resistance provided by dead load (as factored according to code). The sheathing fasteners used to resist roof uplift forces are in addition to the fasteners required to resist shear loads or racking. In addition, supplemental wind uplift straps generally are still required at edges of wall openings where uplift forces are concentrated. One procedure for design of wood structural panels to resist combined uplift and shear is found in Section 307 of the *ICC 600 Standard for Residential Construction in High-Wind Regions* (see Section 6). The same principles apply to residential construction in lower wind regions as addressed by the IRC.

4.4 Proprietary Bracing Products

A variety of proprietary bracing materials and pre-fabricated braced wall panels or frame products are available that provide efficient solutions where racking loads are high and wall space is limited. Some of these bracing products are "in-wall" systems that fit within the thickness of wall framing and allow the use of a continuous thickness of FPIS ci on all wall surfaces (similar to Method LIB). Typically, these types of braces are more expensive than "site-built" braced wall panels and require a greater level of coordination between foundation and framing phases for proper anchorage. In addition, engineering support may be required, especially for anchorage and foundation design. In some localities, special inspections may be required.

Contact the proprietary brace manufacturer for additional guidance and requirements.

For these proprietary products, minimum braced panel or frame widths range from 12" to 24" or more; allowable racking (shear) loads range from under 1,000 lbs to over 10,000 lbs per brace depending on width and type of panel construction. In some cases, these products can be directly substituted for braced wall panels required in the IRC provided the proprietary panel has at least equivalent allowable shear strength and stiffness. Alternatively, required bracing lengths can be adjusted as a means of manufacturer-provided equivalent performance data, usually found in the form of a code evaluation report.

[30] HUD, 1999.

[31] Crandell and Martin, 2009.

[32] HUD, 1999.

Section 5: Wall Bracing Options for Foam-Sheathed Walls

5.1 Wall System Design – Bracing and Beyond

When used properly, various wall bracing methods included in IRC Section R602.10 provide equivalent and code-compliant minimum performance. Being able to select from among different bracing methods on the basis of equivalent performance facilitates a competitive market in which both cost and performance of wall assemblies can be optimized by the code user. Thus, the code user is able to arrive at code-compliant solutions that strike the best overall balance between various wall design decisions including:

- Resistance to structural loads
- Energy efficiency
- Support of wall coverings
- Moisture resistance
- Architectural appearance and function (e.g., size and distribution of windows and doors, interior and exterior wall layout, etc.)
- Affordability or cost-effectiveness

5.2 Why Use FPIS?

The functions of a wall assembly and the advantages of using FPIS are well known and highlighted in Table 10 and Figure 16. FPIS can serve many different functions in a wall design – continuous insulation, water-resistive barrier, air barrier, siding backer board, etc. – so it is important that the designer is aware that bracing requirements are only one of the many functions that must be considered in the design of a code-compliant (or “code plus”) wall assembly. For example, with energy conservation becoming increasingly important and marketable for a variety of reasons, the insulation value of FPIS makes it an ideal wall component and is included in most modern energy codes as continuous insulation (ci). Fortunately, racking requirements can be easily addressed to compliment the use of FPIS ci, which is not intended to provide bracing unless specified in the form of a proprietary structural insulating composite panel (see Section 4.4).

Although FPIS is NOT an acceptable wall bracing material on its own, the additional benefits – especially for energy efficiency and moisture resistance – and the range of available of compatible bracing techniques makes it a preferred choice in many wall configurations. For information on the various applications and benefits of FPIS, refer to a variety of design and construction resources at continuousinsulation.org. In particular, this resource guide for code compliant applications of FPIS provides actionable design information covering the multi-functional capabilities of FPIS for robust wall assemblies. More importantly, the ANSI/ABTG FS200.1 standard provides a consensus-based approach to code-compliant and optimized wall designs using FPIS. At the time of this writing, the FS200.1 standard is slated for inclusion in the 2027 editions of the IRC and IBC.

Table 10. Wall Functions and the Role of FPIS ci in Above-Grade Residential Walls

Wall Function	FPIS Role in Wall Function	IRC Code Reference[a]	Comments
Provide strength and rigidity	Use with approved bracing methods. Use with approved load path methods. Use with appropriate siding requirements to resist wind pressure.	Section R602.10 Table 602.3(1), R802.11 Table R703.3(1), R703.11.2 R303.8	All sheathings must comply with structural requirements of the code. Wind-pressure design values are available from FPIS manufacturers based on the ANSI/ABTG FS100 standard. FPIS wind pressure rating is required when it is not used as oversheathing and spans open framing cavities.
Control heat flow	Reduces thermal shorts by insulating the entire wall surface, not just between studs.	Chapter 11	Continuous FPIS insulation reduces heat loss through wall framing by insulating the whole wall (see Figure 16). Also, may help meet energy requirements with lower cost 2x4 walls instead of 2x6 walls.
Control air flow	Recognized as a code-compliant air barrier material.	N1102.1.2	Most FPIS products are air barrier materials and can be used as such with taped joints and other installation details for continuous of the air barrier assembly.
Control rain penetration	Recognized as a code-compliant water-resistive barrier (WRB) system.	R703.2 Table R703.3(1)	Many FPIS materials and accessories (e.g., joint tape and flashing tapes) are code-compliant water-resistive barrier systems, so a separate WRB/wrap is not required.
Control water vapor flow	Controls water vapor flow through the wall and reduces the potential for condensation in the wall as a code-recognized vapor control method while providing drying potential when teamed with an appropriate interior vapor retarder (or no interior vapor retarder).	R702.7	Water vapor becomes a problem in walls when it condenses into liquid water on or adsorbs into cold materials. When specified at an appropriate R-value, FPIS reduces the potential for condensation in walls by helping to keep the inside of the wall above the "dew point" temperature.

a. In accordance with IRC 2024.

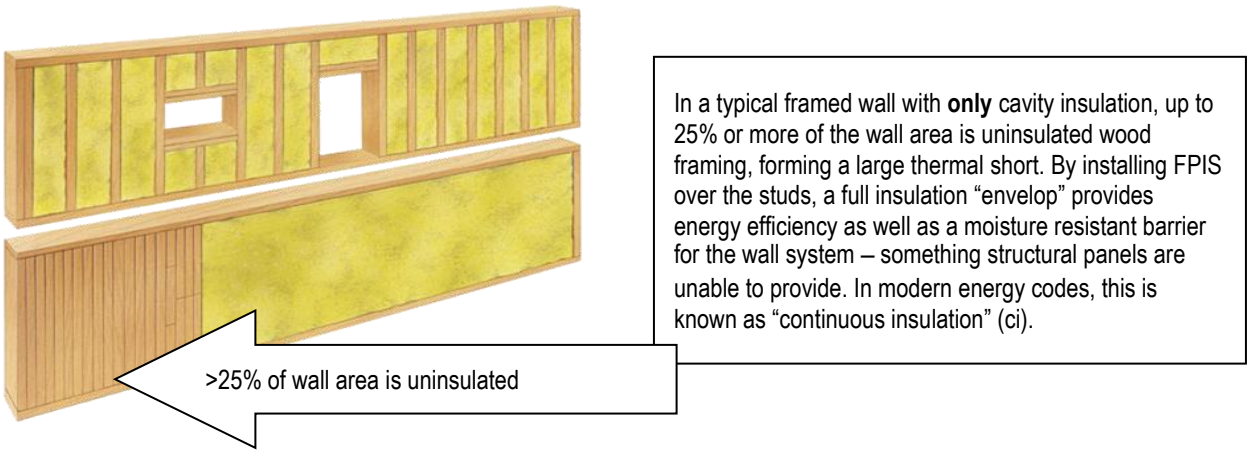


Figure 16. Cavity Insulation and Wall Framing

Remember that bigger does not necessarily mean stronger. Using larger studs (e.g., 2x6 vs. 2x4) does not affect or improve resistance to lateral loads and may not provide the most efficient, code-compliant means of insulating a wall and supporting the structure. Think of the wall as a system where all functions need to be addressed and optimized for cost-effectiveness and performance.

In addition, modern U.S. building codes provide guidance for connection of claddings and furring through FPIS up to 4" thick. For more information, refer to this online resource on cladding connections and Chapter 4 of the ANSI/ABTG FS200.1 standard for prescriptive fastening solutions and a design methodology for a multitude of connection options.

Finally, there are many effective ways to install flanged fenestration and door components on walls with FPIS to provide support and flashing. Refer to this online window installation resource for more information on detailing and installation guidance.

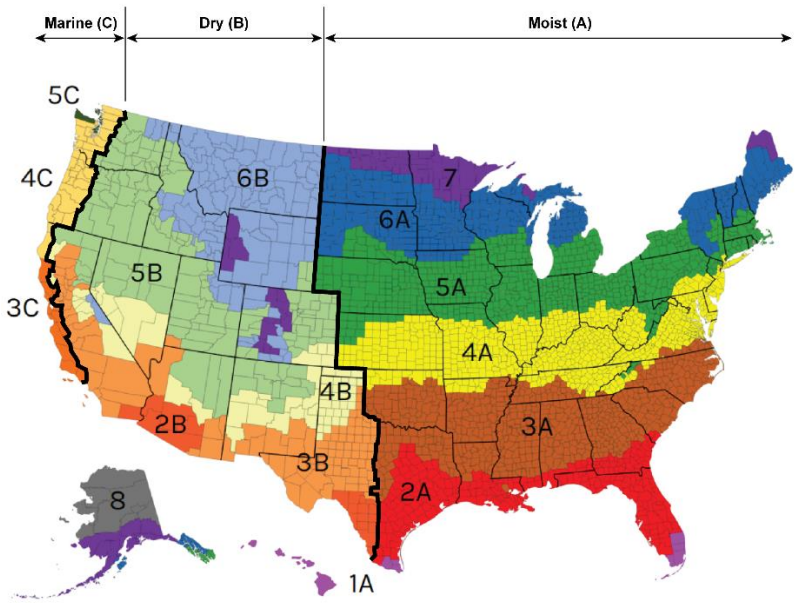
5.3 Meeting Energy Code Requirements

Always confirm that applicable energy code requirements are being met, regardless of the type of bracing method and insulation strategy used. In many locations, installing FPIS ci will easily provide the required wall R-values. Energy code requirements are found in Chapter 11 of the IRC. In most cases, continuous insulation is a prescriptive requirement or provided as part of a wall insulation option (see Table 11). Many other equivalent solutions are also possible in the energy code with different cavity and continuous insulation combinations. Where FPIS ci is used it can support structural optimization, like using 2x4 framing instead of 2x6, while still meeting the energy code. If also used as an approved water-resistive barrier and air barrier (see Table 10), it can result in construction efficiencies and also improved overall wall and building performance.

Table 11. IRC Chapter 11 Wall Insulation Provisions (same as IECC-R) and Climate Zone Map

Climate Zone	Wood Frame Walls	
	2018 IECC	2021/2024 IECC
0, 1, and 2	R13 (U-0.084)	R13 or R0+10ci (U-0.084)
3	R20 or R13+5ci (U-0.060)	R20 or R13+5ci or R0+15ci (U-0.060)
4 except Marine		R30 or R20+5ci or R13+10ci or R20ci (U-0.045)
5 and Marine 4		
6	R20+5ci or R13+10ci (U-0.045	
7 and 8		

NOTE: "R20" is a 2x6 wall with cavity insulation only. "R13+5ci" is a 2x4 wall with R13 cavity insulation and R5 continuous insulation. "R20+5ci" is a 2x6 wall with R20 cavity and R5 continuous insulation. "R0+20ci" is a wall with no cavity insulation and all exterior continuous insulation. Etc.



U.S. Climate Zone Map

Based on map from U.S. Department of Energy

The prescriptive wall insulation R-value solutions listed in or determined to be equivalent by way of the maximum assembly U-factor indicated in Table 11 must also comply with the water vapor control and vapor retarder options by climate zone in the accordance with IRC Section R702.7. Use this wall calculator to quickly evaluate a multitude of wall assembly options to consider efficient alternative code compliant solutions for both of these code requirements.

5.4 Which Bracing Method(s) Can Be Used with FPIS?

As summarized in Table 12, different bracing methods can be used to construct code-compliant, foam-sheathed walls. Remember also that more than one bracing method can be used on a dwelling or even within a braced wall line.

Table 12. Common Wall Bracing Methods and FPIS Applications

Bracing Method[a]	FPIS Applications
LIB: 1x4 wood let-in brace or approved metal brace	**Pros**: Use FPIS continuously and of uniform thickness on exterior of building as the sole sheathing material, WRB, and siding backing (generally most applicable for smaller, affordable, and energy efficient homes). **Cons**: Not practicable for braced wall lines with substantial wall opening amounts for windows and doors; generally limited to modest one- or two-story structures and lower wind and seismic zones. The FPIS must be wind pressure rated per the ANSI/ABTG FS100 standard (see Table 10).
WSP: Wood structural panels **SFB:** Structural fiberboard	**Pros**: Efficient use of bracing materials intermittently and only where needed on the wall. Use 1/2" thicker FPIS between braced panels to maintain uniform wall thickness and minimum required R-values over the braced panels (i.e., "oversheathing"). **Cons**: Intermittent braced wall panels less than 48" wide (or 36" wide with "partial credit") do not count toward required bracing amounts so these methods may not be applicable to braced wall lines with substantial wall opening amounts for windows and doors.
GB: Gypsum board	**Pros**: Use single-sided, interior application with exterior FPIS on wall lines or use on interior braced wall lines (both sides) to meet braced wall line spacing limits or to reduce bracing amount required on parallel exterior braced wall lines for use with bracing methods noted above on the exterior walls. Consider using a 4" edge / 8" field fastener spacing for maximum GB bracing value. **Cons**: Must attach gypsum panels using more stringent fastening schedule than standard for interior finishes. This may require coordination with drywallers or builder attention to install additional gypsum fasteners prior to the drywallers finishing joints.
CS-WSP: Continuous wood structural panel sheathing **CS-SFB:** Continuous structural fiber board sheathing	**Pros**: Place FPIS over wood structural panels for both insulation and as a water-resistive barrier behind siding when properly detailed (taped joints, flashed at wall system penetrations); in cold climates, properly sized FPIS can serve to protect wood sheathing and framing from condensation or seasonal moisture accumulation by creating a "warm wall." (See Section 5.2.). Under limited conditions, the IRC Section R703.3.3 permits siding to be attached to minimum 7/16" thick WSP through up to 2-inch-thick FPIS for simple and effective installation. **Cons**: Size and install siding fasteners to adequately penetrate studs through exterior sheathing layers where siding is required to be fastened directly to studs. (See Section 5.2.)
Method ABW: Alternate braced wall panels	**Pros:** Allows for minimum 32" braced wall panel but otherwise similar to Method WSP in terms of FPIS applications. **Cons:** Requires additional framing expense for hold-down brackets and additional fastening of sheathing.
Method PFH or PFG: Portal Frame with hold-downs or at garage	**Pros:** Use at garage doors or other larger openings where there are limited wall areas adjacent to the openings. Allows a minimum 16" or 24" braced wall panel; otherwise similar to Method CS-WSP in terms of FPIS applications. **Cons:** Framing methods are non-typical and require special attention for proper assembly.
a. Refer to Section 2 of this Guide for a more complete listing of bracing methods and details.	

Because a variety of bracing methods can be used – even along one wall – optimizing the wall bracing design for a building can be achieved on a BWL-by-BWL basis. Using two or three different bracing methods on a single building often results in the most efficient and cost-effective designs. Refer to this wall bracing calculator tool to assist in making wall bracing decisions for an individual braced wall line or for an entire building.

Section 6: Resources and References

- Applied Building Technology Group's Continuous Insulation Website: www.continuousinsulation.org
    - IRC Wood Wall Bracing Calculator: www.continuousinsulation.org/irc-wood-wall-bracing-calculator
    - Continuous Insulation Resource Guide (2024 Codes): www.continuousinsulation.org.
- ANSI/ABTG FS200.1 – 2022 "Standard for Use of Foam Plastic Insulating Sheathing (FPIS) in Building Envelopes: Above-grade Walls." Available as a free download at www.appliedbuildingtech.com/standards.
- *International Residential Code* (ICC, 2009; 2012; 2015; 2018; 2021; 2024) – www.iccsafe.org
- *International Building Code* (ICC, 2006-2024) – www.iccsafe.org
- *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2005; 2010; 2016; 2022) – www.asce.org
- *National Design Specification for Wood Construction* (AF&PA, 2005; 2008; 2012; 2015; 2018; 2024) – www.awc.org
- *Special Design Provisions for Wind and Seismic* (AF&PA, 2005; 2008; 2012; 2015; 2018; 2021) – www.awc.org
- *Standard for Residential Construction in High-Wind Regions, ICC 600-2008; 2014; 2020* – www.iccsafe.org
- "The Story Behind IRC Wall Bracing Provisions," Jay H. Crandell, P.E. (*Wood Design Focus*, Summer 2007), www.appliedbuildingtech.com
- "The Story Behind the 2009 IRC Wall Bracing Provisions (Part 2: New Wind Bracing Requirements)," Jay H. Crandell, P.E. and Zeno Martin, P.E. (*Wood Design Focus*, Spring 2009), www.appliedbuildingtech.com
- "Common Engineering Issues in Conventional Construction," Jay H. Crandell, P.E. and Vladimir Kochkin, P.E. (*Wood Design Focus*, Vol. 13, No. 3, Fall 2003).
- *Evaluation of Housing Performance and Seismic Design Implications in the Northridge Earthquake* (HUD, 1999). Available as free download at www.huduser.org.
- *Residential Structural Design Guide – 2000 Edition* (HUD, 2000). Available as free download at www.huduser.gov.
- *A Guide to the 2018 IRC® Wood Wall Bracing Provisions + 2021 Supplement* (ICC, 2021), www.iccsafe.org

Appendix A:
Wall Bracing Design & Plan Check Worksheet

STEP 1			STEP 2		STEP 3		STEP 4		STEP 5	STEP 6	STEP 7		Comments
Braced Wall Line ID	Maximum BWP Offset from BWL ≤4'? (Yes or No)	BWPs are not all offset to one side of the BWL?[33] (Yes or No)	Support Condition Roof only Roof+1 floor Roof +2 floors	BWL Spacing (feet)	Selected Bracing Method(s)	Braced Wall Line Length (feet)	Tabulated Required Bracing Length from Table 8 (inches)	Adjusted Bracing Length Required Table 9 (inches)	Contributing Bracing Length Provided by BWPs (inches)	Is Value in STEP 4 ≥ Value in STEP 5 (Yes or No)	Is BWP distance from ends of BWL ≤10'? (Yes or No)	Do BWPs comply with maximum 20' spacing along BWP? (Yes or No)	

33 See discussion in Section 1.6 regarding IRC "offset rules" and the approach applied in this Guide.

Appendix B:
Design Examples

This appendix presents two complete wall bracing design examples to illustrate application of the various bracing methods and the provisions in IRC Section R602.10. Both examples demonstrate the use of a simple step-by-step design method as explained in this Guide (refer to Section 3 and the bracing worksheet in Appendix A). The two examples are described as follows (see Table 13 for additional details):

Example #B1 illustrates a very simple, affordable home application that presents few challenges. Two representative bracing methods are featured for comparison purposes and to illustrate differences and similarities in requirements.

Example #B2 represents a more complicated building plan that requires some effort to achieve code compliance, regardless of the IRC bracing method used. This example also illustrates how to implement some of the more advanced recommendations found in this Guide to address difficult conditions or challenging design objectives. For example, combining multiple bracing methods or techniques on the same plan clearly highlights the design flexibility available to select wall assemblies that best serve structural, cost, durability, and energy performance objectives of a given project.

Because each building plan may present unique challenges or design objectives, it is impossible to illustrate every conceivable application or code-compliant solution for wall bracing. While these examples apply concepts that are appropriate to a variety of applications, it is advisable to verify compliance with the locally-applicable building code, refer to additional resources as needed, and use a design professional when in doubt.

Also, refer to Section 5 for information on strategies for integrating wall bracing methods with energy efficient wall assemblies using FPIS ci. Some of these strategies are necessarily considered in the following two design examples to evaluate and coordinate energy code and building code compliance as shown in Table 13 for each design example.

Table 13. Wall Assemblies & Bracing Methods Considered for Design Examples B1 and B2

Wall Components	Example B1 – One Story House (applies to IRC Chapter 11 Climate Zones 1-3)	Example B2 – Two-story House (applies to IRC Chapter 11 Climate Zones 4-8)
Bracing Method(s)	LIB – 1x4 wood let-in braces (or an equivalent metal brace suitable for permanent bracing) OR WSP – wood structural panel (intermittent bracing)	LIB-1x4 wood let-in bracing, GB – ½" gypsum wall boards, & CS-WSP - wood structural panel braces (use 7/16" OSB) Full-height panels / horizontal blocking is not omitted
Framing	2x4 studs at 16" o.c.	2x6 studs at 16" o.c. or 24" o.c. (can also use 2x4 studs at 16"o.c. on lower story and 16" o.c. or 24" o.c. on upper story)
Exterior Sheathing	~1" continuous R5 FPIS installed as a combined air/thermal/water barrier (use 1/2" thick FPIS over intermittent WSP brace wall panels if that bracing option is used to maintain uniform wall thickness – refer to Note 'a')	7/16" OSB sheathing where LIB is not used (covered with separate building wrap for air/water barrier)
Siding	Vinyl (see IRC R703.11.2 for installation over FPIS)	Vinyl (see IRC R703.11 and Table R703.3.3 for installation over wood structural panels)
Interior Finish	1/2" gypsum wall board	1/2" gypsum wall board
Cavity Insulation & Continuous Insulation (ci) [a]	R13 kraft-faced batts (2x4 cavity) with minimum R5 FPIS ci (if in a colder climate zone as per Example B2, then R10 FPIS ci would be required)	R20 kraft-faced batts (2x6 cavity) and R5 (~1") continuous insulation or R7.5(~1.5") continuous insulation for upgrade (if using 2x4 studs then use R13 cavity insulation with R10 ci in climate zones 4-8 or R5ci in southern climates as shown for Example B1)
Comments	• Requires least materials and layers on wall to achieve overall code compliance. • Provides energy efficiency comparable to 2x6 walls, but using standard 2x4 wall framing.	• Maximizes bracing efficiency for overall plan using combination of CS-WSP, LIB, and GB bracing. • Coordinates bracing with energy code use of continuous insulation for multiple climates.

a. The illustrated insulation strategies align with typical energy code prescriptive insulation requirements as discussed in Section 5.3 and shown in Table 11 of this Guide. Other equivalent insulation methods or combinations of cavity insulation and continuous insulation are permitted in accordance with the U-factor methodology of IRC Chapter 11 and these can be used to further optimize and coordinate wall bracing and energy energy code compliance. Regardless of the insulation and bracing methods used, coordination and compliance with IRC Section R702.7 for water vapor control and Section R703 for weather resistance is necessary to ensure moisture durability. Where these code-compliance matters are coordinated, the use of FPIS ci results in walls that are considered "robust" – properly braced, insulated, and resistant to moisture damage.

EXAMPLE #B1 – One Story Home (Simple Building Plan)

Objectives

- Evaluate bracing options as shown in Table 13 to allow comparison with respect to overall cost in coordinating code compliance for energy code and building code, which depends on local climate zone among other factors.

Given

- Typical one-story entry-level (starter) home with 8' ceiling height, 10' roof eave-to-ridge height (see Figure 17)
- Design wind speed = 115 mph (Exposure B, no topographic effect) per IRC Section R301.2
- Seismic Design Category A, B, or C (exempt from IRC seismic provisions)

Application of IRC Bracing Requirements

Due to the small size of this home (less than the 60' maximum plan dimension) and adequate space for bracing on exterior walls, no interior braced wall lines are required for this plan. As shown in the floor plan in Figure 17, four exterior braced wall lines are identified. The rear braced wall line is drawn to split the 8' offset in the rear wall line to comply with the maximum 4' offset limit.

Note that even though interior walls are not specifically designed as “braced wall lines,” they will contribute substantially to the racking strength of the whole building. Portions of the exterior walls where braced wall panels (or braces) are not located, but that include interior gypsum wall board finishes, also contribute additional racking strength to the building. These “non-structural” systems (from the standpoint of how the code defines bracing) may actually provide adequate bracing of this particular home plan even in the absence of specified braced wall panels on the exterior walls. However, always ensure that the required bracing is provided in compliance with the IRC.

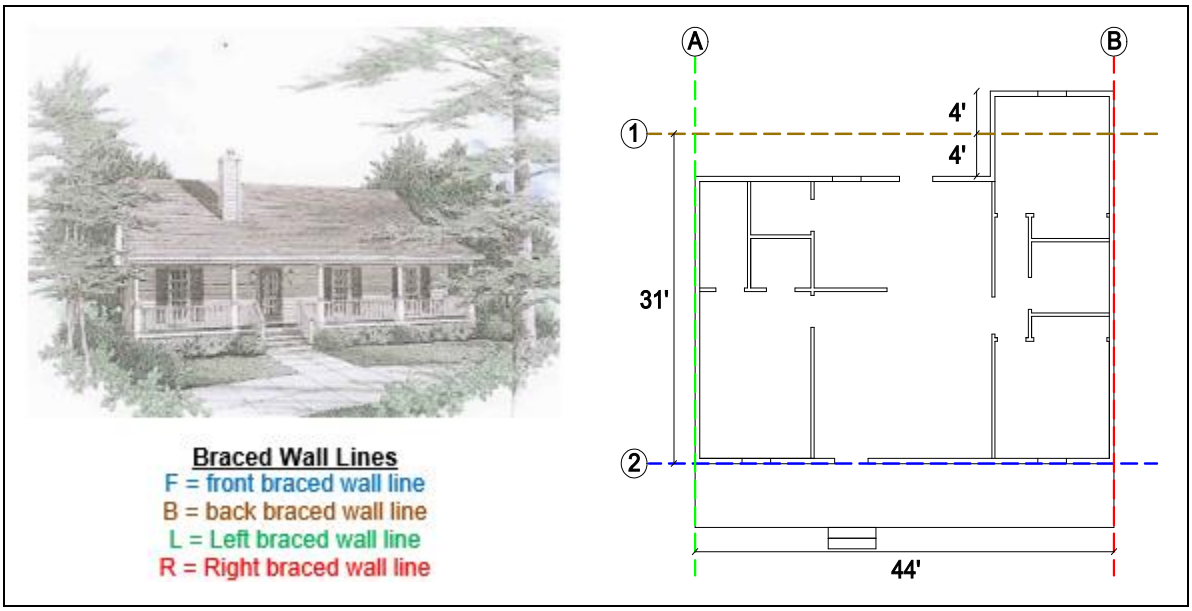


Figure 17. House Plan for Example #B1 with Designated Braced Wall Lines

House plan #3435VL: “Starter Home with Two Covered Porches” courtesy of www.architecturaldesigns.com

Refer to Table 14 for a detailed analysis of bracing requirements and two solutions (options) for each braced wall line in Example #B1.

Table 14. Wall Bracing Worksheet for Example #B1

STEP 1			STEP 2		STEP 3		STEP 4		STEP 5	STEP 6	STEP 7		COMMENTS
Braced Wall Line ID	Max Offset in Braced Wall Line ≤ 4'?	BWPs are not all offset to one side of the BWL[34]	Support Condition	Braced Wall Line Spacing (feet)	Selected Bracing Method	Braced Wall Line Length (feet)	Tabulated Bracing Length Required per Table 8 (feet)[35]	Adjusted Bracing Length **Required** per Table 8 and adjustments factors from Table 9 (feet)	Total **Contributing** Length of Braced Wall Panels **Provided** (feet)	**Required** Bracing Length ≥ **Provided** Length?	BWP panel end distances ≤10'?	BWP spacing 20' max.?	
2 (front BWL)	OK	OK	Roof Only	31'	Method LIB (60°)	44'	9.80'	9.80' x 0.90 = 8.8' (0.90 adjustment factor for 8' wall height)	13.8' provided (3 braces, each 60° brace provides 4.6' of bracing length along the wall)	OK	OK	OK	Two braces provide adequate bracing length placed at each end of wall; the third brace should be placed in the middle of the wall to meet the 20' max. requirement.
		OK			Method WSP	44'	5.65'	5.65' x 0.90 = 5.1' (0.90 adjustment factor for 8' wall height)	12' provided (3 braced panels, each provides 4' of bracing length)	OK	OK	OK	Two braced panels provide adequate bracing length placed at each end of wall; the third panel should be placed in the middle of the wall to meet the 20' max. requirement.
1 (back BWL)	OK	OK	Roof Only	31'	Method LIB (60°)	44'	9.80'	9.80' x 0.90 = 8.8'	13.8' provided (3 braces)	OK	OK	OK	Place one brace at left end, one between kitchen door and sink window, and one at bedroom #2.
		OK			Method WSP	44'	5.65'	5.65' x 0.90 = 5.1'	12' provided (3 braced panels)	OK	OK	OK	Place one panel at left end, one either just to the left or just to the right of the kitchen window, and one at the bedroom.
B (right BWL)	OK	OK	Roof Only	44'	Method LIB (45°)	35'	13.50'	13.50' x 0.90 = 12.2'	16' provided (2 braces, each 45° brace provides 8' of bracing length)	OK	OK	OK	Place each of two braces starting at 1' from wall ends to meet the 20' max. requirement.
		OK			Method WSP	35'	7.80'	7.80' x 0.90 = 7.0'	8' provided (2 braced panels, each provides 4' of bracing length)	OK	OK	OK	Place each of two panels starting at 3' from the wall ends to meet the 20' max. requirement (use 4' end distance to align panel edge with layout studs).

[34] See discussion in Section 1.6 regarding IRC "offset rules" and the approach applied in this Guide.
[35] The tabulated bracing lengths are interpolated values from Table 8 to align with the specific BWL spacings shown in Step 2.

A (left BWL)		Bracing amounts and location determined for braced wall line R may be used for braced wall line L. The required bracing can be located completely in the 27' long side wall and not along the 8' segment of wall that is offset due to the projection of bedroom #2 at the rear of the plan. The only limitation is that the end distances must not exceed 10'. The panel at the left end of line R (at the master bath) will have a 4' end distance (as measured from the intersection of BWL B and BWL L). The panel at the right end can begin no more than 10' from the right end of the wall (at the corner at the porch). Some may interpret the 8' wall segment at bedroom #2 as a separate braced wall line requiring at least one BWP, but this interpretation is not consistent with the intent of the IRC bracing provisions. Such interpretations do reflect the difficulty of developing prescriptive code language that adequately explains bracing requirements for buildings that have even a minor variation from a perfectly rectangular floor plan.

EXAMPLE #B2 - Two-Story Home (Complex Building Plan)

Objectives

- Achieve code-compliant wall bracing and energy code compliance as described in Table 13.
- Minimize cost to comply with energy and structural requirements in base plan.
- Achieve energy code-compliance without specifying dual sheathing (i.e., FPIS over structural sheathing) for the entire building by optimizing use of multiple bracing methods.
- Provide a wall bracing strategy to accommodate optional plan features in a model home plan.

Given

- Typical model house plan (see Figure 18 and Figure 19) with 8' ceiling heights
- Two-story with basement and attached garage (several architectural plan options)
- 6:12 roof pitch with 8' roof eave-to-ridge height
- Design Wind Speed = 100 mph (Exposure B, no topographic effects) per IRC Table R301.2
- Seismic Design Category A, B, or C (exempt from IRC seismic provisions)

Application of IRC Bracing Requirements

As shown in Figure 18, a number of braced wall lines are required for this plan, including two interior braced wall lines: one on the first floor in the left-to-right plan direction and another in the front-to-back plan direction.

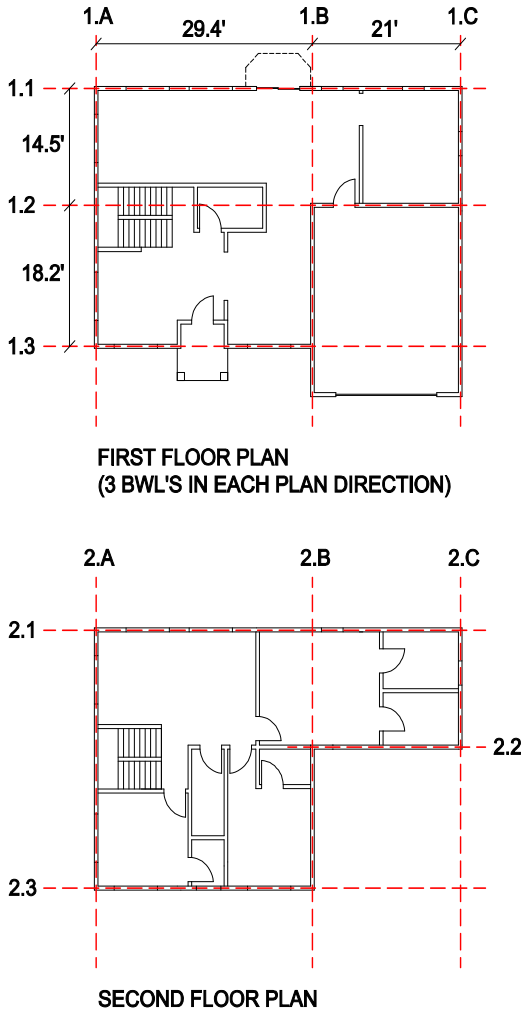


Figure 18. First and Second Story Floor Plans for Example #B2 with Designed Braced Wall Lines

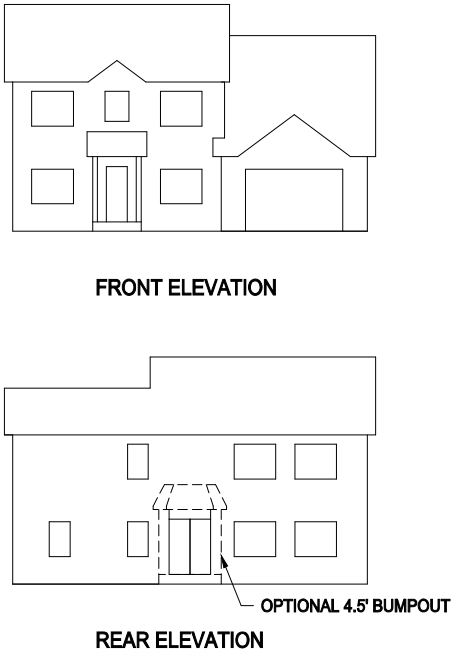


Figure 19. Plan Elevations Showing Front and Rear Braced Wall Line Conditions and Optional Plan Features

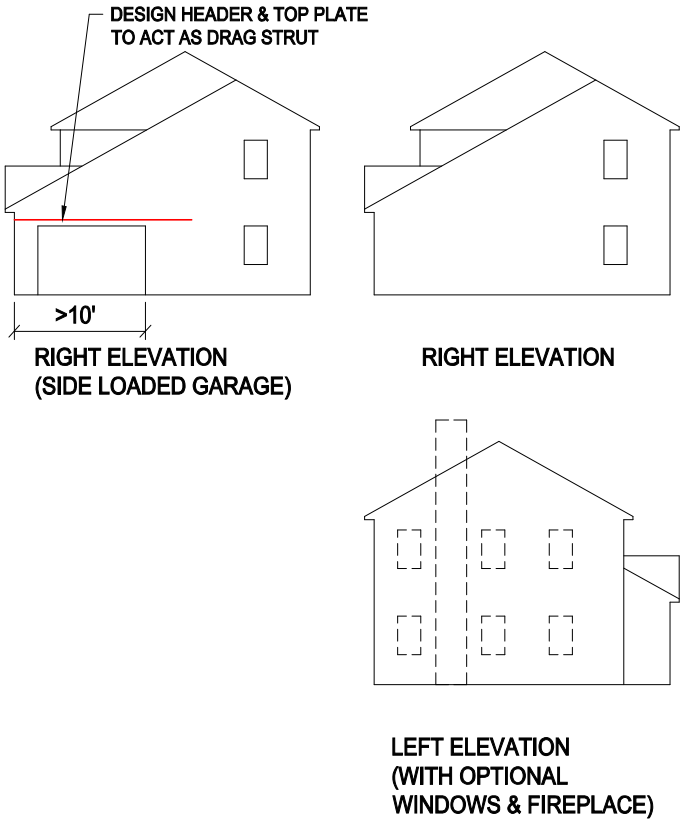


Figure 20. Plan Elevations Showing Side Exterior Braced Wall Line Conditions and Optional Plan Features

Table 15. Wall Bracing Worksheet for Example #B2

STEP 1			STEP 2		STEP 3		STEP 4		STEP 5	STEP 6	STEP 7		COMMENTS
Braced Wall Line ID	Max Offset in Braced Wall Line ≤ 4'?	BWPs are not all offset to one side of the BWL?	Support Condition	Braced Wall Line Spacing (feet)	Selected Bracing Method	Braced Wall Line Length (feet)	Tabulated Bracing Length Required per Table 8 (feet)	Adjusted Bracing Length **Required** per Table 8 and adjustments factors from Table 9 (feet)	Total **Contributing** Length of Braced Wall Panels **Provided** (feet)	**Required** Bracing Length ≥ **Provided** Length?	BWP panel end distances ≤10'?	BWP spacing 20' max.?	
Lower Story – Longitudinal Braced Wall Lines (Parallel To Left-To-Right Plan Direction)													
1.1 (rear wall)	OK	OK	Roof + 1 floor	14.5' + 0.5' = 15.0' (see comment)	Method LIB (60˚)	50'	9.00'	9.00' x 0.94 x 0.90 x 1.30 = 9.9' **0.94** – 8' roof eave-to-ridge height **0.90** – 8' wall height; or 0.95 if 9' ceiling option used **1.30** – 3 BWLs in this plan direction	13.8' provided (3 braces, each 60˚ brace provides 4.6' of bracing length along the wall)	OK	OK	OK	The braced wall line location for rear wall line is shifted 0.5' outward, which conservatively increases the braced wall line spacing, but reduces the effective offset of the bump-out to 4' eliminating the need to treat the optional bump out as a separate BWL.
1.2 (interior wall)	OK	OK	Roof + 1 floor	16.6' (average distance to 1.1 and 1.3)	Method GB (one side and two side as indicated)	50'	9.80' (based on GB both sides)	9.80' x 0.94 x 0.90 x 1.30 = 10.8' for GB two sided	22.2' provided (18.2' of GB both sides plus 8' of GB one side counted at 50% = 18.2 + 4' = 22.2' of bracing length)	OK	OK	OK	Lap interior braced wall line top plates with exterior wall top plate or use equivalent strap. NOTE: The 8' of GB one-sided is necessary to meet the 20' rule (not needed otherwise).
1.2-alt (alternate bracing for interior wall)	OK	OK	Roof + 1 floor	16.6'	Interior partition wall with 1/2" GWB on both sides installed per IRC Table R702.3.5	50'	9.80' (based on GB both sides)	9.80' x 0.94 x 0.90 x 1.30 = 10.8 for GB two sided	19.7' provided (39.3' of wall excluding door openings and segments less than 4' long; counted at 50% value of GB two sided = 39.3 x 0.5 = 19.7')	OK	OK	OK	See Section 4 for justification to use interior partition wall as bracing as shown; engineering approval may be required.
1.3 (front entry wall and garage opening wall)	OK	OK	Roof + 1 floor	18.2'	Method CS-WSP (entry wall) Method CS-G (garage wall)	54.6'	5.05'	5.05' x 0.94 x 0.90 x 1.30 = 5.6'	15.5' provided (11.5' of CS-WSP with panels of sufficient width next to openings and two 2' CS-G BWPs, which count because garage portion supports roof only)	OK	OK	OK	Use 48" Method WSP panel on side walls at corners at ends of BWL to meet CS-WSP corner requirements (See Section 2.3); also provides BWP for BWLs 1.A and 1.C.

Table 15. Wall Bracing Worksheet for Example #B2

STEP 1			STEP 2		STEP 3		STEP 4		STEP 5	STEP 6	STEP 7		COMMENTS
Braced Wall Line ID	Max Offset in Braced Wall Line ≤ 4'?	BWPs are not all offset to one side of the BWL?	Support Condition	Braced Wall Line Spacing (feet)	Selected Bracing Method	Braced Wall Line Length (feet)	Tabulated Bracing Length Required per Table 8 (feet)	Adjusted Bracing Length **Required** per Table 8 and adjustments factors from Table 9 (feet)	Total **Contributing** Length of Braced Wall Panels **Provided** (feet)	**Required** Bracing Length ≥ **Provided** Length?	BWP panel end distances ≤10'?	BWP spacing 20' max.?	
Lower-Story Transverse Braced Wall Lines (Parallel To Front-To-Back Plan Direction)													
1.A (left exterior side wall)	OK	OK	Roof + 1 floor	29.4' (to garage left side interior BWL 1.B)	Method LIB (45˚)	34'	16.20'	16.20' x 0.94 x 0.90 x 1.30 = 17.8' **1.30** – 3 BWLs in this plan direction	**NG!** – only room for two 45˚ LIB braces with window option	**NG!**	OK (see comments)	OK	With the window and fireplace option executed, the BWP closest to rear corner will be 14.5' from the corner which requires a designed collector (top plate) – see Section 4. Also, 800# strap is needed at CS-WSP panel closest to rear corner – see Section 2.3.
					Method CS-WSP	34'	7.85'	Method CS-WSP: 7.85' x 0.94 x 0.90 x 1.30 = 8.6'	**Use CS-WSP and re-calculate:** Method WSP: ~15' provided	OK			
1.B (garage left interior side wall)	OK	OK	Roof + 1 floor	25.2' (average distance to 1.A and 1.C)	Method GB (both sides) 1/2" GWB on garage interior face also required for fire separation from living area	18.2'	14.10'	14.10' x 0.94 x 0.90 x 1.30 x 0.70 = 10.9' 0.70 factor is used for GB with fasteners at 4" o.c. on edges and blocked at horizontal joints	19.7' provided	OK	OK (based on BWL end as defined by garage interior corner)	OK	Though BWL 1.B does not extend across building to the rear wall, it effectively does so through connections to the floor diaphragm above as required by provisions in the IRC – see Section 2.4.
1.C (right side wall)	OK	OK	Roof + 1 floor	21' (to interior BWL 1.B)	Method LIB (45º) + Method WSP	38'	12.00'	12.00' x 0.94 x 0.90 x 1.30 = 13.2'	20' provided (insufficient room for three LIB braces; use two 45˚ LIB braces and one 4' WSP panel = 8'+ 8'+ 4' = 20')	OK	OK	OK	Method WSP braced wall panel substitutes for one Method LIB as permitted by IRC "mixing" rules; brace length is based on Method LIB (see Section 1.6).

Table 15. Wall Bracing Worksheet for Example #B2

STEP 1			STEP 2		STEP 3		STEP 4		STEP 5	STEP 6	STEP 7		COMMENTS
Braced Wall Line ID	Max Offset in Braced Wall Line ≤ 4'?	BWPs are not all offset to one side of the BWL?	Support Condition	Braced Wall Line Spacing (feet)	Selected Bracing Method	Braced Wall Line Length (feet)	Tabulated Bracing Length Required per Table 8 (feet)	Adjusted Bracing Length **Required** per Table 8 and adjustments factors from Table 9 (feet)	Total **Contributing** Length of Braced Wall Panels **Provided** (feet)	**Required** Bracing Length ≥ **Provided** Length?	BWP panel end distances ≤10'?	BWP spacing 20' max.?	
Upper Story – Longitudinal Braced Wall Lines (Parallel To Left-To-Right Plan Direction)													
2.1 (2nd story rear wall)	OK	OK	Roof only	14.5' (to line of action for BWL 2.2')	Method LIB (60˚)	50'	4.63'	4.63' x 0.88 x 0.90 x 1.30 = 4.8' **0.88** – 8' roof eave-to-ridge height **0.90** – 8' wall height **1.30** – 3 BWLs in this plan direction	13.8' provided (use three 60˚ LIB braces instead of two to meet STEP 7 requirements)	OK	OK	OK	Place one brace each end of wall and one left of MBR window. (NOTE: Could replace with Method WSP panels, but LIB allows for thicker FPIS at corner where bathtub is located.)
2.2 (2nd story front wall)	OK	OK	Roof only	32.7'	Method CS-WSP (same as BWL 1.3)	29.4'	4.77'	4.77' x 0.88 x 0.90 x 1.30 = 4.9'	12.1' provided (all panels meet minimum CS-WSP BWP width requirements next to the windows)	OK	OK	OK	Inadequate space for Method WSP or Method LIB bracing to work (may be able to use Method WSP with approval of "partial credit" for narrower than 48" panel widths) Use 48" Method WSP panels at corners on flanking walls or apply 800# hold-down strap at corner – see Section 2.3.
2.2' (2nd story front offset at rear of garage)	OK	OK	Roof only	14.5'	Method LIB (45˚)	20.2'	4.63'	4.63' x 0.88 x 0.90 x 1.30 = 4.8'	8' provided (only one 45˚ LIB required for this short wall, as it is greater than 48")	OK	OK	OK	Place brace anywhere along length of wall.

Table 15. Wall Bracing Worksheet for Example #B2

STEP 1			STEP 2		STEP 3		STEP 4		STEP 5	STEP 6	STEP 7		COMMENTS
Braced Wall Line ID	Max Offset in Braced Wall Line ≤ 4'?	BWPs are not all offset to one side of the BWL?	Support Condition	Braced Wall Line Spacing (feet)	Selected Bracing Method	Braced Wall Line Length (feet)	Tabulated Bracing Length Required per Table 8 (feet)	Adjusted Bracing Length **Required** per Table 8 and adjustments factors from Table 9 (feet)	Total **Contributing** Length of Braced Wall Panels **Provided** (feet)	**Required** Bracing Length ≥ **Provided** Length?	BWP panel end distances ≤10'?	BWP spacing 20' max.?	
Upper Story – Transverse Braced Wall Lines (Parallel To Front-To-Back Plan Direction)													
2.A (2nd story left exterior side wall)	OK	OK	Roof only	29.4'	Method LIB (60˚ and 45˚)	34'	8.35'	8.35' x 0.88 x 0.90 x 1.30 = 8.6'	12.6' provided (use one 45˚ and one 60˚ brace: 8' + 4.6' = 12.6')	OK	OK	OK	Place 60˚ brace between optional windows at left side (behind optional chimney chase) and place 45˚ brace at front corner. Note a minimum 24" WSP is also required for end restraint of BWL 2.2 unless 800# hold-down strap is used at corner.
2.B (2nd story center wall to left of garage roof)	OK	OK	Roof only	25.2' (average distance to 2.A and 2.C)	Method LIB (45˚) Interior partition wall with 1/2" GWB on both sides installed per IRC Table R702.3.5	18.2' (based on ends at intersect with BWLs 2.2 and 2.2')	7.30'	7.30' x 0.88 x 0.90 x 1.30 = 7.5'	13.5' provided (use one 45˚ LIB brace and count interior partition wall at BDRM #2 discounted by 50% = 8' + 0.5 x 11' = 13.5')	OK	OK	OK	Note a minimum 24" WSP is also required for end restraint of BWL 2.2 (CS-WSP) unless 800# hold-down strap is used at corner. See Section 4 for justification of interior partition use – local approval/engineer may be required.
2.C (2nd story right side wall)	OK	OK	Roof only	21.0'	Method LIB (60˚ and 45˚)	17.8'	6.25'	6.25' x 0.88 x 0.90 x 1.30 = 6.4'	12.6' provided (one 45˚ and one 60˚ LIB brace = 8' + 4.6' = 12.6')	OK	OK	OK	Place 60˚ LIB brace between corner and optional window and 45˚ LIB brace in remaining length of full-height wall.

Comments on Plan Options Affecting Bracing Strategy

- **9' first story walls in lieu of standard 8' walls (applies to lower story walls only):**

  If this plan option is used, the bracing adjustment factor for wall height (see Table 9) will increase from 0.9 to 0.95, which will increase bracing lengths required by about 6%. In a couple of marginal cases, the bracing provided on some BWLs for the lower story may need slight revision. In addition, most metal LIB braces come in sizes appropriate for use on 8' and 10' wall heights. Thus, a different brace manufacturer or model number will be required where LIB is used in the bracing plan. Where metal LIB braces are used, be sure that they are not just appropriate for temporary bracing applications (not all metal brace types are equivalent to LIB bracing in the IRC). As an alternative, use of WSP braces can be easily substituted where LIB is specified. While structurally feasible, such substitution will affect the thickness (insulating value) of FPIS where placed over a WSP brace. Thus, energy efficiency and related energy code requirements may be affected and should be considered. Similarly, the water vapor control provisions in IRC Section R702.7 should be checked to confirm compliance based on the project's climate zone and the specified interior vapor retarder.

  In summary, if the 9' first story wall height option is used, LIB bracing on the first story level may become slightly more difficult to use, and the use of WSP, CS-WSP, or CS-SFB and other similar bracing methods or proprietary bracing materials should be considered. In addition, the garage opening CS-G bracing panels will need to be increased in width from 24" to 27" to comply with minimum width requirements (see Table 7). Alternatively, the CS-PF portal framing method may be used (see Section 2.3).

- **Side load and three car garage option (lower story, front wall, and right side wall):**

  In this case, the garage opening is part of a much longer braced wall line on the right side of the building. However, the garage door is located at one end of the wall such that a braced wall panel must be placed approximately 18' from the end of the wall line (exceeding the 10' prescriptive limit). This can be resolved simply by designing the garage door header and wall top plate to act as a "drag-strut" by ensuring that these members are adequately tied together at joints and splices to "drag" shear load into the rest of the wall line where the required amount of wall bracing is located. This is a simple task, but requires the services of an engineer. However, a standard detail for repetitive use should be feasible. (Refer to Section 4 for additional information.)

- **Window and Fireplace Option (left, lower-story wall):**

  These optional plan features are adequately addressed in the bracing requirements detailed in Table 15 above, except when **both** options (windows and fireplace) are included. If both are included, engineering will be needed to approve a 14.5' distance of the brace from rear end of BWL #1.A on the first and second story. If a design is required, follow the same procedure for "drag struts" as described above. In many cases, the resulting solution may only require a modest increase in nailing of top plate splices for the affected wall portion. Note that this design solution applies for any IRC bracing method that might be used on BWL #1.A. (Refer to Section 4 for additional information.)

- **Bump-out bay window (4.5' wall line offset created in rear wall line at bump-out):**

  Care should be taken when applying the "4' offset rule" (see Section 1.6) when identifying wall lines that are considered to be separate braced wall lines. In this case, if braced wall line "A" is located on an imaginary line 0.5' outward from rear wall, then the bump out does not create more than 4' offset from the indicated braced wall line location. To allow for this approach and the optional use of the bump-out bay window, the amount of bracing for BWL "A" should be based on the actual braced wall line spacing to the interior braced wall line B plus 0.5'. This situation does not require that the bump-out walls be considered as a separate braced wall line as permitted by IRC Section R602.10.1.2 (refer to Figure 2). Therefore, the bump-out can be considered as a part of the rear braced wall line without requiring separate bracing of the bump-out portion. This approach was used for BWL "1.1" on the first story of Example #B2 (Table 14).

Appendix C:
Engineered Design Example Using IRC Bracing Provisions

Perhaps one of the most efficient methods of designing a house is to use the IRC bracing provisions together with an engineering-based approach. The design principles and approach used to develop the IRC bracing provisions may also be employed to determine engineered solutions in a manner consistent with the IRC provisions.[36]

The following example demonstrates an engineering-based approach to applying the IRC's prescriptive (pre-engineered) bracing requirements.

EXAMPLE #C1

Objectives

- Apply IRC wall bracing provisions to an example plan (1st story level only).
- Demonstrate a simple and effective engineering-based method of meeting bracing requirements whereby the total wall bracing amount required for each story level and plan direction is determined and then the total bracing amount is distributed evenly to selected braced wall lines.

Given

- Typical large production house plan 2 1/2 story with basement and integral/attached garage (see Figure 21)
- Wind Speed – 115 mph (Exposure B)
- Seismic Design Category – SDC A/B (exempt)
- Special wind bracing amount adjustment factors Table 9:

  Main Building Portion
  - Wind Exposure B & 3 story – 1.0 (based on rear elevation)
  - Roof eave-to-ridge height, 13' – 1.1 factor
  - 9' Wall height: 0.95 (main building)

  Wings (Conservatory and Suite)
  - Wind Exposure B & 2 story – 1.0 (based on rear elevation)
  - Roof eave-to-ridge height, 10' – 1.0 factor
  - 10' Wall height: 1.0 (conservatory and 1st floor suite)

  General
  - # of BWLs adjustment (not applicable – bracing based on total for overall plan dimensions)
  - All bracing has interior GWB finish per IRC Chapter 7.

[36] Crandell and Martin, 2009

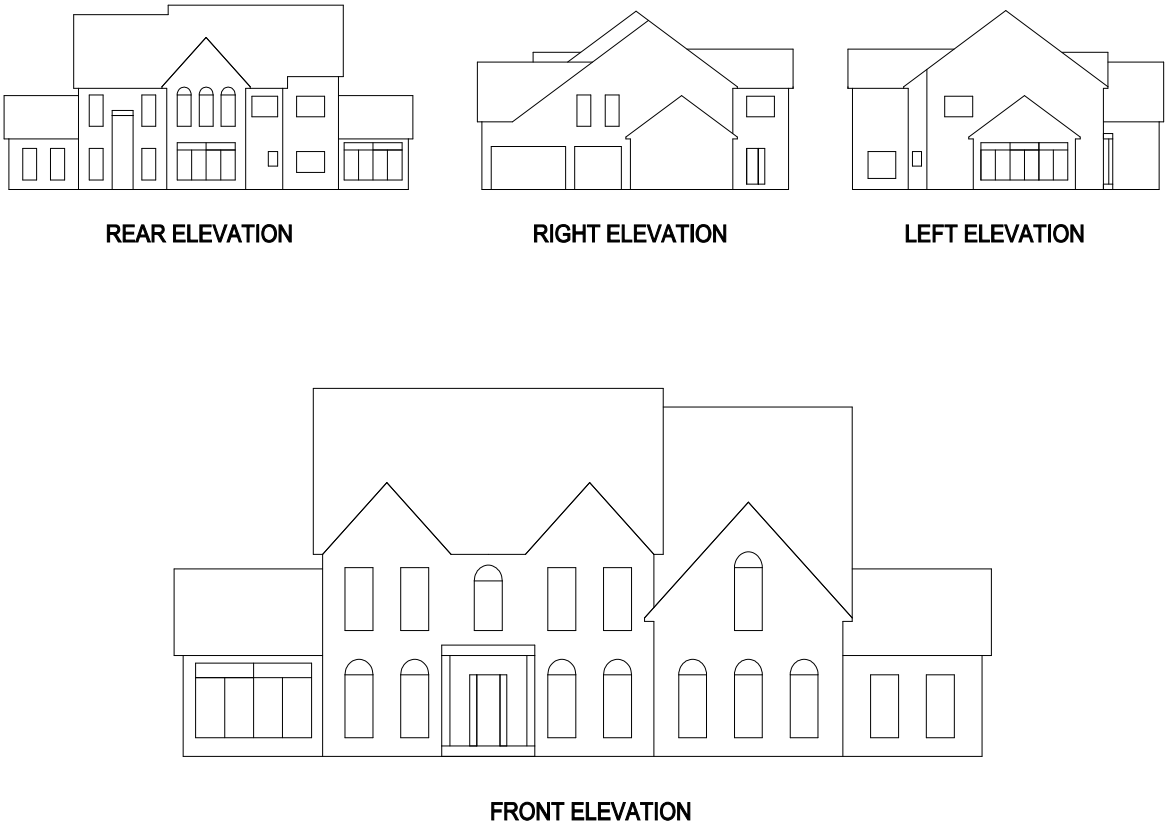


Figure 21. Elevation Views of Example House

Bracing Analysis

STEP 1: Determine Dimensions of Two-Story and One-Story Portions of 1st Story Floor Plan

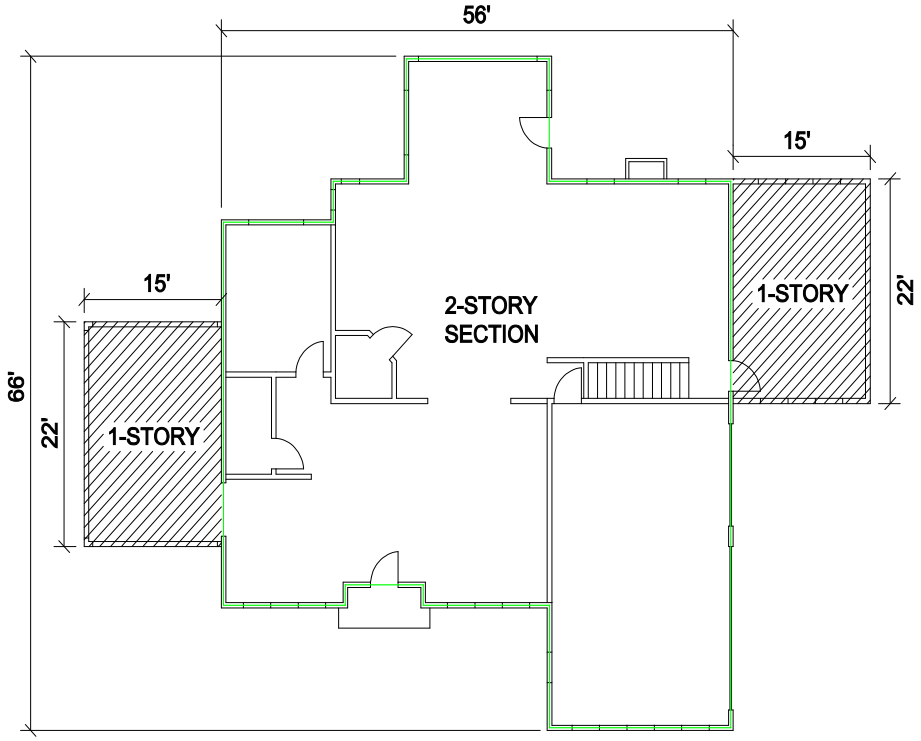


Figure 22. Plan View of Example House Plan

STEP 2: Determine Total Amount of Bracing Required for 1st Story Portions

Main Building (2-story Portion, 56' x 66')

Front-to-Back Direction: 2* x (19' WSP)(1.0)(1.1)(0.95) = **40 feet WSP** (total required)
Left-to-Right Direction: 2* x (22' WSP*)(1.0)(1.1)(0.95) = **46 feet WSP** (total required)

Conservatory & Suite (1-story Portions, 15' x 22' ea.)

Front-to-Back Direction: 2* x (3' WSP)(1.0)(1.0)(1.0) = **6 feet WSP** (total required)
Left-to-Right Direction: ~~2* x (4.3' WSP)(1.0)(1.0)(1.0)) = 9 feet WSP (total required)~~ NOT APPLICABLE, plan area is in "shadow" of sail area for main building in this wind loading direction.

***NOTE:** Factor of 2 doubles tabulated bracing, which is based on two braced wall lines to result in a total amount of bracing for the building portion/story level. Also, for 66' BWL spacing in left-to-right loading direction for main building portion, the 22' length for WSP is derived by linear proportioning relative to the 60' BWL spacing limit (i.e., 66'/60' x 20' = 22'). This is the same result as if Table 8 had been calculated for the larger BWL spacing.

STEP 3: Select & Identify First Story BWLs for Even Distribution of Required Bracing

Five wall lines in each plan direction are selected.

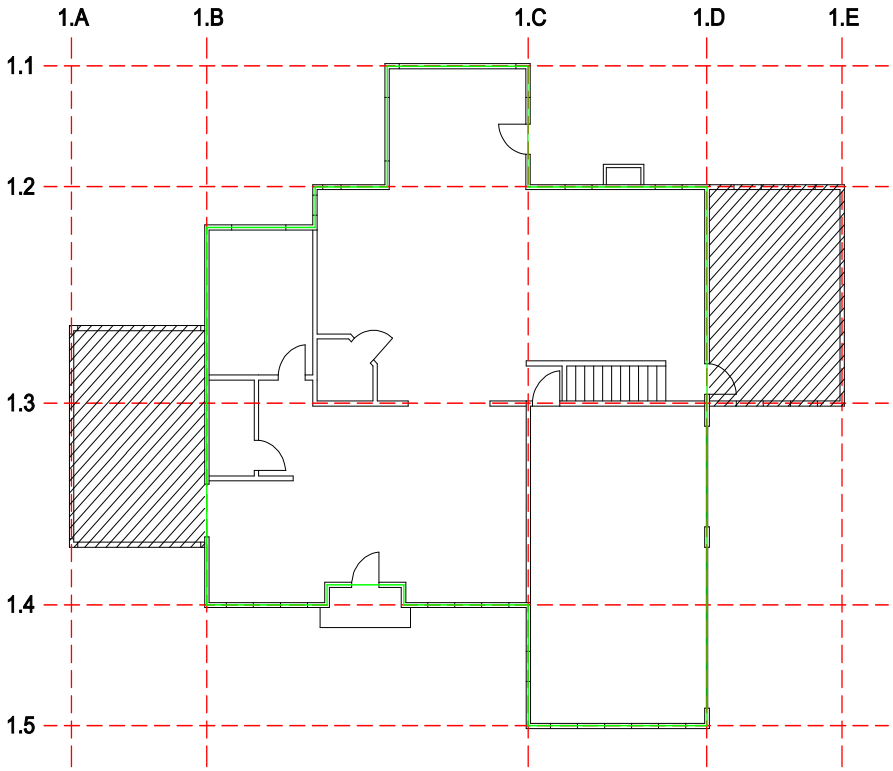


Figure 23. Plan View with Braced Wall Lines

STEP 4: Evenly Distribute Bracing to Selected Wall Lines & Check Compliance

Front-to-Back Wall Lines:

Wall Line A: 3' of WSP bracing required (50% of 6' WSP total required for conservatory)

➔ **OK**. 4' provided as CS-WSP (2' of bracing provided at each end with 2' corner returns). Could also use CS-PF if necessary to achieve 18" panel widths for a total of exactly 3' of bracing.

Wall Line B: 3' WSP (50% of conservatory bracing) + $^1/_3$ (40' WSP, main building) = 16.3' WSP required

➔ **OK**. ~16 of WSP bracing provided on exterior wall plus additional 22' of GWB interior wall not counted. One third of main building bracing is distributed to each of three Wall Lines (B, C, and D).

Wall Line C: $^1/_3$ (40' WSP, main building) = 13.3' WSP required

➔ **OK**. 9.5' WSP + 6' WSP (2-3.5' segments at partial credit) = 15.6' provided plus additional 20' of interior wall not counted.

Wall Line D: Same as Wall Line 2 = 16.3' WSP required

➔ **OK**. 5' of WSP is provided adjacent to one garage opening. Thus, 11.3' of WSP or equivalent must be provided on the interior wall line between suite and main building. Based on WSP (700 plf) and GB 2-sided (400 plf) per Crandell and Martin (2009), the equivalent amount of GB 2-sided required on the interior wall portion is (700/400) x 11.3' = (1.75) x 11.3' = 19.8'. 19' of interior wall is available (< 19.8', barely not OK). Therefore, use GB 2-sided with 4" o.c. fastening so required length is 0.7 x 19.8' GB-2sided (7" o.c.) = 14' required of GB 2-sided, 4" o.c. fastening. In summary, wall line has 5' of WSP on exterior portion and 19' of GB 2-sided (4" o.c. fastening) on interior portion, which is more than required.

Wall Line E: Same as Wall Line A = 3' of WSP required.
➔ **OK**. Use two 4-foot WSP panels at corners. 8' WSP provided.

Left-to-Right Wall Lines:

Distribute total bracing length required (46' WSP or equivalent) to the five wall lines as follows:

Wall Line 1: 8% x 46' WSP = 3.7' WSP
Wall Line 2: 17% x 46' WSP = 7.8' WSP
Wall Line 3: 50% x 46' WSP = 23' WSP
Wall Line 4: 17% x 46' WSP = 7.8' WSP
Wall Line 5: 8% x 46' WSP = 3.7' WSP
100% x 46' WSP = 46' WSP

NOTE: The above distribution can be taken to represent a maximal inward distribution of wall bracing to interior Wall Line 3 rather than to exterior Wall Lines 1, 2, 4, and 5. However, this still results in 25% of bracing on the front and back exterior building elevations with 50% on the interior (much like a simple tributary area bracing distribution). If the building had fewer interior walls (more interior open space) and less openings on the front and rear facing exterior walls, then more of the bracing could have been distributed toward Wall Lines 1, 2, 4, and 5 rather than Wall Line 3.

Verify adequate bracing is provided in each wall line to meet the distribution targets above:

Wall Line 1: 3.7' of WSP required.
➔ **OK**. Use 4' of CS-WSP (2' of bracing provided at each end with 2' corner returns).
Could also use CS-PF if necessary to achieve 22" panel widths for a total of exactly 3.7' of bracing.

Wall Line 2: 7.8' of WSP required.
➔ **OK**. ~16' of WSP provided.

Wall Line 3: 23' of WSP required.
➔ **OK**. Use 8' of CS-WSP on suite exterior wall portion. Thus, (23'- 8') = 15' of WSP equivalent is required on interior walls along Wall Line C. If GB 2-sided is used, the equivalent amount required for the interior wall portions is 1.75 x 15' = 26.25' GB, 2-sided (7" o.c. fastening).
The amount of GB 2-sided provided is 20' along garage wall plus 4' along pantry plus 9' along living room for a total of 33' feet provided > 26.25' required.
Other interior wall segments (single-sided GB and double-sided) are ignored. The wall line has more than adequate capacity to resist 50% of the story shear and provide 50% of required story bracing.

Wall Line 4: 7.8' of bracing required.
➔ **OK**. Two 4' WSP panels provided for 8' total.
Could use partial credit for other panels along front entry wall if needed.

Wall Line 5: 3.7' of bracing required.
➔ **OK**. Use two 3' braced wall panels each worth partial credit of 27" or 54" (4.5') total, which is more than the required 3.7' of WSP.