Introduction to Wall Bracing

In Accordance with 2006 International Residential Code (IRC)

APA
Wall Bracing is one of the most important structural elements of any house, but it can also be one of the most confusing. The 2006 International Residential Code (IRC) outlines a number of options for wall bracing, but it can easily leave builders and building officials with questions.

- What forces act on a house?
- Why is wall bracing so important?
- What are braced wall segments and braced wall lines?
- How long do the bracing segments have to be?
- How much bracing is needed, and where?
- How is the percentage of bracing in a wall line determined?
- When are adjustments to the amount of bracing required?
- What about corner windows or bracing segments not at the end of braced wall lines?
- What about corner windows or bracing segments not at the end of braced wall lines in certain Seismic Design Categories?
- Are offsets permitted in a braced wall line?

This guide from APA answers many of these questions and shows how to meet basic requirements for wall bracing in accordance with the 2006 IRC. If what you want to know about bracing in wood-framed homes is not fully explained here, visit APA’s wall bracing web site at www.wallbracing.org, or call the APA Product Support Help Desk at (253) 620-7400.
WHAT FORCES ACT ON A HOUSE?

A house must be built to safely resist the loads anticipated during its lifetime. Lateral loads – those acting on the side of a house – result from winds or earthquakes as shown in Figures 1 and 2.

Figure 1
Walls must be strong enough to resist the wind forces that push against the home.

Figure 2
In an earthquake, the seismic ground motion acts on the foundation, while inertia attempts to keep the roof from moving with the foundation, causing forces on the walls.

Because high-wind events or earthquakes are infrequent, it can be difficult to grasp their possible damaging effects on a structure. Ensuring that homes can withstand lateral loads is critical to the safety of the building and its occupants in the event of high wind or an earthquake.
**WHY IS WALL BRACING SO IMPORTANT?**

During a high wind event or an earthquake, a house must be able to resist lateral loads. Wall studs alone, as shown in Figure 3, cannot resist the racking forces, but braced walls, such as those in Figure 4, have much more strength to resist the loads.

**Figure 3**

Without sufficient bracing, the walls of a house can rack, causing cosmetic damage, performance problems, and even structural failure.

![Figure 3 Diagram](image1)

**Figure 4**

Walls with adequate bracing are unlikely to rack or collapse during high wind or an earthquake.

![Figure 4 Diagram](image2)

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(a) For information on offsets in a braced wall line, see page 12.

Note: Wall framing not shown for clarity.
WHAT ARE BRACED WALL SEGMENTS AND BRACED WALL LINES?

The building codes (IBC and IRC) use the terms braced wall panel and braced wall line throughout. To help avoid confusion between the terms “wall panel” and “braced wall panel,” this publication uses the term “braced wall segment.” (Braced wall panel = braced wall segment.)

A “braced wall segment,” shown in Figure 5, is a segment or portion of a braced wall line. It consists of the wall panel or panels (e.g., plywood or OSB Rated Sheathing), the framing, and the fasteners. Multiple braced wall segments form braced wall lines, as shown in Figure 6.

Braced wall lines are what resist lateral loads in a house, as shown in Figure 7. Braced wall lines, in accordance with 2006 IRC, can be no more than 25 feet apart in high seismic regions (Seismic Design Categories D₀, D₁, or D₂) and 35 feet elsewhere (SDC A–C), but IRC Sections R602.10.1.1 and R602.10.11.1 provide exceptions for using greater spacing.

Figure 5

The code provisions (2006 IRC R602.10) dictate proper size and construction of braced wall segments, including materials, fastener spacing, and minimum length of the panel.

Figure 6

The 2006 IRC Table R602.10.1 requires:
1. Braced wall segments at ends of braced wall lines,
2. Braced wall segments at least every 25 feet on center in a braced wall line, and
3. A minimum amount (percentage) of braced wall segments in each braced wall line. See page 9 to determine percentage of bracing.

Figure 7

Properly spaced braced wall lines, made up of braced wall segments, resist racking loads.
**HOW LONG DO BRACING SEGMENTS HAVE TO BE?**

Table 1 summarizes the minimum braced wall segment length requirements in the 2006 IRC. The minimum length depends on the bracing method and the type of construction material specified. The narrowest wall bracing segments the IRC allows are 16 inches, for the continuous wood structural panel sheathing method (IRC R602.10.5). See Table 2.

<table>
<thead>
<tr>
<th><strong>TABLE 1</strong></th>
<th><strong>2006 IRC BRACING METHODS AND MINIMUM BRACED SEGMENT LENGTH</strong></th>
<th><strong>(See referenced sections for detailed requirements.)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IRC Section</strong></td>
<td><strong>Bracing Method</strong></td>
<td><strong>Construction Description</strong></td>
</tr>
<tr>
<td>R602.10.3</td>
<td>1</td>
<td>Nominal 1x4 let-in bracing</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Wood boards of 5/8” net thickness applied diagonally</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Wood structural panel sheathing</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Fiber board sheathing</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Gypsum sheathing</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Particle board sheathing</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Plaster</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Hardboard panel siding</td>
</tr>
<tr>
<td>R602.10.5</td>
<td>Continuous Sheathing</td>
<td>Wood structural panel sheathing</td>
</tr>
<tr>
<td>R602.10.6</td>
<td>Alternate</td>
<td>Wood structural panel sheathing</td>
</tr>
</tbody>
</table>

(a) 96” sheathed one side, 48” sheathed two sides.

The code allows a narrower length for the continuous wood structural panel sheathing method because of its superior structural performance. See Table 2. Wood structural panels form a strong, stiff shell when properly connected together. APA built on this concept in the development of the Narrow Wall Bracing Method, which enables the minimum length of a braced wall segment to be as narrow as 16 inches. For more information on the APA Narrow Wall Bracing Method, consult [www.wallbracing.org](http://www.wallbracing.org).

Table 2 details the minimum bracing segment lengths using continuous wood structural panel sheathing, with both the methods listed in 2006 IRC R602.10.5 and the APA Narrow Wall Bracing Method.

<table>
<thead>
<tr>
<th><strong>TABLE 2</strong></th>
<th><strong>MINIMUM LENGTH OF BRACED WALL SEGMENTS USING CONTINUOUS WOOD STRUCTURAL PANEL SHEATHING</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bracing Method</strong></td>
<td><strong>Braced Wall Segment Height-to-Width Ratio</strong></td>
</tr>
<tr>
<td>2006 IRC R602.10.5</td>
<td>2:1</td>
</tr>
<tr>
<td></td>
<td>3:1</td>
</tr>
<tr>
<td></td>
<td>4:1</td>
</tr>
<tr>
<td>APA Narrow Wall Bracing</td>
<td>6:1</td>
</tr>
</tbody>
</table>

[^1]: See [www.wallbracing.org](http://www.wallbracing.org) for details.
**Figure 8**

This figure demonstrates how the minimum bracing segment lengths in Table 2 are determined (for 3:1 and 4:1 height-to-length ratios). The same principles apply to 2:1 or 6:1 height-to-length ratio panels.

<table>
<thead>
<tr>
<th>Height to length ratio</th>
<th>Calculating minimum bracing panel lengths using IRC R602.10.5</th>
<th>Example calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:1</td>
<td>Min. length = height/3</td>
<td>Min. length = 96'/3 = 32&quot;</td>
</tr>
<tr>
<td></td>
<td>0.85 x height or less</td>
<td>0.85 x 96&quot; = 82&quot; or less</td>
</tr>
<tr>
<td>4:1</td>
<td>Min. length = height/4</td>
<td>Min. length = 96'/4 = 24&quot;</td>
</tr>
<tr>
<td></td>
<td>0.65 x height or less</td>
<td>0.65 x 96&quot; = 62&quot; or less</td>
</tr>
</tbody>
</table>
HOW MUCH BRACING IS NEEDED, AND WHERE?

The amount of wall bracing needed in each braced wall line, as specified by the building codes, depends on the Seismic Design Category (SDC) or wind speed, the stories above the braced wall line, and the method of bracing being used.

Braced segments must occur at each end of the braced wall line and at least every 25 feet on center. They must also make up a certain percentage of the braced wall line. Table 3 summarizes the bracing requirements.

### TABLE 3

**2006 IRC BRACING REQUIREMENTS** (For complete details see Table R602.10.1 of the IRC)

<table>
<thead>
<tr>
<th>Seismic Design Category (SDC) or Wind Speed</th>
<th>Stories Above Braced Wall Line(a)</th>
<th>Method of Bracing Permitted(b)(c)</th>
<th>Amount of Bracing Per Wall Line (For Method 3 Bracing and For Other Methods Permitted)</th>
<th>Maximum Spacing Between Braced Wall Lines (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDC A and B or winds 100 mph and less</td>
<td>0</td>
<td>Methods 1–8</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Methods 1–8</td>
<td>16%</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Methods 2–8</td>
<td>25%</td>
<td>35%</td>
</tr>
<tr>
<td>SDC C or winds less than 110 mph</td>
<td>0</td>
<td>Methods 1–8</td>
<td>16%</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Methods 2–8</td>
<td>30%</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Methods 2–8</td>
<td>45%</td>
<td>60%</td>
</tr>
<tr>
<td>SDC D, and D, or winds less than 110 mph</td>
<td>0</td>
<td>Methods 2–8</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Methods 2–8</td>
<td>45%</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Methods 2–8</td>
<td>60%</td>
<td>85%</td>
</tr>
<tr>
<td>SDC D, or winds less than 110 mph</td>
<td>0</td>
<td>Methods 2–8</td>
<td>25%</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Methods 2–8</td>
<td>55%</td>
<td>75%</td>
</tr>
</tbody>
</table>

(a) Stories above braced wall line.

(b) Continuous structural panel sheathing (IRC R602.10.5) is permitted everywhere.

(c) Alternate braced wall segments (IRC R602.10.6) are permitted in one story and the first story of two-story houses, and limited to continuous foundations.

(d) See IRC Section R602.10.11.1 for exceptions.

(e) See IRC Section R602.10.11.1 for exceptions.

The amount of wall bracing needed in each braced wall line, as specified by the building codes, depends on the Seismic Design Category (SDC) or wind speed, the stories above the braced wall line, and the method of bracing being used.

Braced segments must occur at each end of the braced wall line and at least every 25 feet on center. They must also make up a certain percentage of the braced wall line. Table 3 summarizes the bracing requirements.

<table>
<thead>
<tr>
<th>Method of Bracing Permitted</th>
<th>For Method 3 Bracing</th>
<th>For Other Methods Permitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods 1–8</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>Methods 1–8</td>
<td>16%</td>
<td>25%</td>
</tr>
<tr>
<td>Methods 2–8</td>
<td>25%</td>
<td>35%</td>
</tr>
<tr>
<td>Methods 2–8</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Methods 2–8</td>
<td>45%</td>
<td>60%</td>
</tr>
<tr>
<td>Methods 2–8</td>
<td>60%</td>
<td>85%</td>
</tr>
<tr>
<td>Methods 2–8</td>
<td>25%</td>
<td>40%</td>
</tr>
<tr>
<td>Methods 2–8</td>
<td>55%</td>
<td>75%</td>
</tr>
</tbody>
</table>
**HOW IS THE PERCENTAGE OF BRACING IN A WALL LINE DETERMINED IN ACCORDANCE WITH THE 2006 IRC?**

The bracing percent in a given wall line is simply the sum of the length of the qualifying braced wall segments* in the braced wall line divided by the total length of the braced wall line. For example, the percentage of bracing in Figure 9 is the sum of the two bracing segments E and F, divided by the length L and multiplied by 100%. Figure 10 illustrates the percentage of wall bracing in a line with the continuous wood structural panel sheathing bracing described in IRC R602.10.5.

**Figure 9**

To calculate the percentage of bracing in a wall line in this figure, consider the following:

\[ \text{% Bracing in wall line } C = \frac{(E+F)}{L} \times 100\% \]

For example:

- \( E = 4' \)
- \( F = 4' \)
- \( L = 20' \)

\[ \text{% Bracing} = \frac{(4'+4')}{20'} \times 100\% = 40\% \]

**Figure 10**

In this example using the continuous wood structural panel sheathing bracing (IRC R602.10.5), the percentage of bracing calculates to 31%. Minimum bracing lengths are in accordance with Table 2. The 24-inch-long segment next to the door is too narrow to count as a bracing segment because, as shown in Table 2, a braced wall segment next to the door must be 32 inches long for the 8-foot wall.

The amount of bracing = \((32'+0'+24'+26')/12' = 6.83'\)

The percent of wall braced = \(6.83'/22' \times 100\% = 31\% \) which, for example, exceeds the requirement of 25% given in Table 3 for SDC A-B/100 mph with two stories above the braced wall line.

* This publication uses the term "qualifying bracing segment." A qualifying bracing segment is one that meets the minimum length requirements of Tables 1 and 2.
**WHEN ARE ADJUSTMENTS TO THE AMOUNT OF BRACING REQUIRED?**

The code allows for reductions in the percentage of bracing required in a wall line when using continuous wood structural panel sheathing (IRC R602.10.5). When using tall walls however – walls greater than 10 feet tall – the 2006 IRC requires increases in the percentage of bracing (IRC R301.3).

**Reductions**

When using continuous wood structural panel sheathing bracing (IRC R602.10.5), the amounts of bracing required as shown in Table 3 may be decreased by a factor of:

- 0.9 for walls with openings 0.85 x the wall height and less, or
- 0.8 for walls with openings of 0.65 x wall height and less.

**Figure 11**

*The amount of bracing required can be reduced for certain conditions.*

<table>
<thead>
<tr>
<th>Maximum opening size in wall line</th>
<th>Amount of bracing reduction factor for wall line</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>0.8</td>
</tr>
<tr>
<td>0.65 x H</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Example**

- If per Table 3 the wall line requires 25% and the wall is braced per IRC R602.10.5 with no opening in the wall line greater than 0.65 x H, then the 25% may be reduced to 25% x 0.8 = 20%
- If per Table 3 the wall line requires 45% and the wall is braced per IRC R602.10.5 with no opening in the wall line greater than 0.85 x H, then the 45% may be reduced to 45% x 0.9 = 40.5%

**Increases**

For walls 12 feet tall, the amount of bracing required must be increased by 1.2. In accordance with IRC Section R301.3, a braced wall can be 12 feet tall if three conditions are met:

1. It is wood framed,
2. It is braced in accordance with IRC Table R602.10.1 (Table 3 in this guide), and
3. The amount of bracing required by IRC Table R602.10.1 is increased by 1.2.

Note that stud heights greater than 10 feet must be justified by analysis or in accordance with IRC Table R602.3.1 (IRC Section R602.3.1), as applicable.

**For High Seismic (SDC D₀, D₁, and D₂)**

For Seismic Design Categories (SDC) D₀, D₁ and D₂, adjustments to bracing amounts for interior braced wall lines based on wall line spacing (IRC R602.10.11.1) and adjustments when using stone and masonry veneer (IRC R703.7), may be made.

For SDC D₀, D₁ and D₂, when the dead load of the roof/ceiling exceeds 15 psf, the bracing amounts must be multiplied by 1.1 for walls supporting a roof only and 1.2 for walls supporting a roof and one story (IRC Table R301.2.2.2.1).
What about corner windows or bracing segments not at the end of braced wall lines?

Bracing may occur away from the end of a braced wall line and still be code compliant. See Figures 12, 13a and 13b.

For all bracing methods except continuous sheathing (2006 IRC R602.10.5) in Seismic Design Category A–C, bracing located less than 12.5 feet from the end of the wall line is considered to be at the end, as shown in Figure 12. If bracing is located more than 12.5 feet from the end, then an engineered collector is needed to help transfer lateral loads per code (IRC R104.11). See APA Technical Topic Collector Design for Bracing in Conventional Construction, Form TT-102, for more information on design of a collector.

Figure 12

Braced wall segments can occur up to 12.5 feet from the end of a wall in SDC A–C.

What about corner windows or bracing segments not at the end of braced wall lines in seismic design categories D₀, D₁, and D₂?

Per 2006 IRC R602.10.11.2, a braced wall segment must occur at the end of a braced wall line for all bracing methods except Method 3 (wood structural panel bracing). Wood structural panel bracing may be placed up to 8 feet from the end, provided one of the following provisions is met, as shown in Figures 13a and 13b:

1. A minimum 1800 lbf tie-down device is on each braced wall segment closest to the corner, as shown in Figure 13a, or
2. A minimum 24-inch-wide segment is at the corners, as shown in Figure 13b.

Figures 13a and 13b

For SDC D₀, D₁, and D₂, two options exist for bracing away from corners (Method 3 bracing only).
ARE OFFSETS PERMITTED IN A BRACED WALL LINE?

Many home designs feature offsets along walls. The 2006 IRC R602.10.1 permits offsets up to 4 feet, provided that the total out-to-out offset dimension is not greater than 8 feet, as shown in Figures 14, 15, and 16.

Figure 14
A braced wall line can have 4-foot offsets.

Figure 15
The code permits 8 feet total out-to-out offsets (4 feet each way) in a braced wall line.

Figure 16
Offsets may also occur in discontinuous braced wall lines.
**SUMMARY: PUTTING TOGETHER THE ELEMENTS OF A WELL-BRACED HOME**

This guide is intended to illustrate the basic wall bracing requirements in the 2006 IRC and to explain the importance of wall bracing. Most of the concepts described in this guide are illustrated in Figure 17:

- The difference between braced wall lines and braced wall segments and how they may occur in an actual structure can be seen in Figure 17 below.
- For a wall segment to count as bracing, it must be a certain length, depending on the method of bracing used.
- Bracing segments must occur at ends (or a distance from the end) of each wall line, be spaced no more than 25 feet on center, and not be less than a certain percentage, depending on location in the house, design wind speed or Seismic Design Category, and bracing type. Table 3 of this guide gives the required percentage of bracing that a wall must have, and Figures 9 and 10 show how to calculate the percentage of bracing that a wall has.
- Four-foot offsets can occur in a braced wall line.

**Figure 17**

*This diagram of a home shows wall bracing requirements from the 2006 IRC.*
MORE INFORMATION ON WALL BRACING

Learn more about bracing in A Guide to the 2006 Wood Wall Bracing Provisions, a comprehensive guide published by APA and the International Code Council. To order the book, contact the ICC at 1-800-786-4452 or visit the ICC store at www.iccsafe.org/store.

More information on wall bracing can be found in the following APA publications:

- Build Profit with Wood Walls, Form J435
- Brace Walls with Wood, Form G440
- Build Energy Efficient Walls, Form J440
- Technical Note: Water Vapor Permeance of Wood Structural Panels and Wood Wall Construction, Form J450
- Collector Design for Bracing in Conventional Construction, Form TT-102
- Explanation of IRC Continuous Structural Panel Sheathing Option to Meet Wall Bracing Requirements, Form TT-079
- Frequently Asked Questions About APA’s Narrow Wall Bracing Method, Form TT-080
- A Portal Frame With Hold Downs for Wall Bracing or Engineered Applications, Form TT-100

All of the publications can be found on APA’s bracing website, at www.wallbracing.org.
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