Description

- This 6-hour seminar provides a comprehensive explanation of the 2012 International Residential Code® (IRC®) bracing requirements. It guides the participant through an in-depth review and analysis of the bracing requirements for wood-frame residential structures. The seminar is designed to clarify the application of wall bracing provisions in the IRC wall bracing Sections R602.10 – R602.12.

Goal

- The participant will successfully apply the provisions of the 2012 IRC to problems involving bracing requirements for wood-framed residential structures.

Objectives

- Upon completion, participants will be better able to:
  1. Identify the forces that act on a house.
  2. Describe the history of bracing and how it works.
  3. Apply the wall bracing provisions of the IRC.
  4. Grasp the physical limits under which bracing can be used.
Objectives (continued)

5. Select from the various bracing options available.
6. Determine how much bracing is required, and how adjustment factors are applied.
7. Recognize special considerations for bracing.
8. Apply attachment details, and pony and cripple wall details.

Target Audience

- Designers
- Plans examiners
- Inspectors
- Builders
- Contractors
- Architects & Engineers

Resources

- www.iccsafe.org
  Item no. 7102S12
- www.apawood.org
  Publication F430
- www.iccsafe.org
  Item no. 7102S12

Forces and History

- Load Path
- Lateral Forces
- Stiffened Walls
- Bracing History

Limits

- Irregular Buildings
- Wind Exposure

Bracing

- Locate BWL
- Required Length
- BWP Location
- Panel Material & Ends
- Sufficient Length
- Connections
- Foundation
- Simplified Wall Bracing

Examples

- Wind 90 mph, Exp B, SDC A
- Wind 85 mph, Exp B, SDC D2
- Wind 95 mph, Exp C, SDC B
Bracing Topics

<table>
<thead>
<tr>
<th>Forces &amp; History</th>
<th>Limits</th>
<th>Bracing</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 1</td>
<td>Chapter 2</td>
<td>Chapter 3</td>
<td>Chapter 4</td>
</tr>
</tbody>
</table>

Load Path

**Vertical (Gravity) Load Path**

1. Ridge Beam
2. Post
3. Header
4. Jack Studs
5. Sill Plate
6. Foundation
7. Ground

Lateral (Sideways) Load Path
Load Path

1. Load on wall
2. Transfer to roof
3. Connections
4. Transfer to wall
5. Transfer to foundation

R301.1 Application
The construction of buildings... shall result in a... complete load path... for the transfer of all loads... to the foundation.

Load Path

Bracing Topics

Forces and History Limits Bracing Examples

- Load Path
- Lateral Forces
- Stiffened Walls
- Bracing Provisions
Lateral Forces

Wind

Seismic

Force = Pressure x Area

Force = Mass x Acceleration

Effects of Forces

Racking
Base Shear
Overturning

Resisted by Bracing
Resisted by Anchors
Resisted by Hold-downs and Dead Load

Resisted by Hold-downs and Dead Load
Lateral Forces

Base Shear

Lateral Forces

Overturning

Lateral Forces

hold-down

Anchors

Lateral Forces

2003 Missouri Tornado
Lateral Forces

2003 Missouri Tornado

Introduction: Lateral Forces

Wind Speed

Wind Speed – USA

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Introduction: Lateral Forces

Earthquake

Bracing Topics

- Forces and History
  - Load Path
  - Lateral Forces
  - Stiffened Walls
  - Bracing History
- Limits
- Bracing
- Examples

Stiffened Walls

Wall Framing

Hinge
Stiffened Walls

Wall Framing

Panel resistance imparted to wall framing (Prevents hinging)

Stiffened Walls

Wall Framing

Hinge

Interior Finish

Braced Wall Panel (Prevents hinging)

1. Areas requiring wind design in Table R301.2(4)B may not use the IRC for lateral provisions.

Stiffened Walls

BWP (Prescriptive)

- Limitations
  - 3-Stories Maximum
  - Wind < 110 mph (1)
  - SDC A-D2
  - Others (see IRC Chap. 3)

- Typically without hold-downs

Shear Walls (Engineered)

- Applications
  - Any building size/shape
  - Wind – no limit
  - SDC – no limit
  - Calculations required

- Typically with hold-downs

(1) Areas requiring wind design in Table R301.2(4)B may not use the IRC for lateral provisions.

Stiffened Walls

Shear Walls

Prescribed material and nailing

Calculated load, material and nailing

Hold-down capacity calculated

VS.

Braced Wall Panel (BWP)

VS.

Shear Wall
Wall Bracing

- R602.10 Wall Bracing
- "Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1."

History of Bracing

History of Wall Bracing

Uniform Building Code – 1927
- All exterior walls and partitions shall be thoroughly and effectively angle braced.

Southern Building Code – 1946
- Sheathing shall be applied on the exterior walls of buildings more than one story in height, corners shall be braced by a let-in 1 x 4 or 1 x 6 continuous diagonal brace.

Uniform Building Code – 1952
- All exterior walls and partitions shall be thoroughly and effectively angle braced or sheathed with approved panels adequately nailed along all edges.
History of Bracing


All exterior walls and main cross stud partitions shall be effectively and thoroughly braced at each end or as near thereto as possible, and at least every 25 feet of length by one of the following methods:

A. Nominal 1-inch by 4-inch…
B. Wood boards of 5/8-inch…
C. Plywood sheathing…
D. Fiberboard sheathing…
E. Gypsum sheathing…
F. Particleboard sheathing…


International Residential Code – 2000

- Bracing percentage requirement added
- Continuous wood structural panel bracing method added

International Residential Code – 2006

- Alternate braced wall panel adjacent to door or window opening added
- Continuous sheathing 4:1 and 6:1 aspect ratio panels at garage door added
History of Bracing

International Residential Code – 2009
- Methods renamed from number designation to abbreviation
- Wall bracing length determined by the greater length requirement from separate wind and seismic bracing length tables
- Intermittent portal frame at garage added
- Continuous sheathing with structural fiberboard added
- Table of effective braced length for braced panels less than 48 in. long added
- Braced panel end distance limit of 12.5 ft. cumulative for SDC A-C with intermittent bracing
- Additional bracing requirements for structures with masonry veneer moved to wall bracing section
- Anchorage for masonry foundations with short wall lengths added
- Angled wall lines added
- Imaginary braced wall lines added

International Residential Code – 2012
- Reorganization of wall bracing section
- Simplification of end distance and distance between braced wall panels
- Simplification of braced wall line length
- New method – Simplified Wall Bracing
### Limits – Story Height

#### In-plane lateral forces

Requirements for story height exist to limit the wind and seismic provisions.

In-plane forces (lateral forces along a wall line):
- Story height limit – 11 ft. 7 in
- Stud height – 10 ft.

Except: Stud height may be increased to 12 ft., therefore maximum story height may be 13 ft. 7 in

---

#### Limits – Stud Height

**Size, Height and Spacing of Wood Studs - Table R602.3(5)**

<table>
<thead>
<tr>
<th>Stud Size (Inches)</th>
<th>Bearing Walls</th>
<th>Nonbearing Walls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LATERALLY UNSUPPORTED STUD HEIGHT</td>
<td>MAXIMUM SPACING WHEN SUPPORTING</td>
</tr>
<tr>
<td></td>
<td>(INCHES)</td>
<td>CEILING, ROOF, OR HABITABLE ATTIC ONLY</td>
</tr>
<tr>
<td>2 x 3</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2 x 4</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>3 x 4</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>2 x 5</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>2 x 6</td>
<td>10</td>
<td>24</td>
</tr>
</tbody>
</table>

---

**R301.3**

1. R301.3 – Item 1. Exception permits the stud height to be 12’ provided bracing length is increased by a factor of 1.2.
2. R301.3 Permits floor framing depths greater than 16” when maximum story height is 11’-7” or less.
Limits - Seismic

- R301.2.2 Seismic provisions.
  - The seismic provisions of this code shall apply to...
    - Townhouses in SDC C, D0, D1 and D2
    - Detached one and two family dwellings in SDC D0, D1 and D2

Limits - Seismic

- Seismic Design Category C

<table>
<thead>
<tr>
<th>Seismic Design Category</th>
<th>One- and two-family</th>
<th>Townhouses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; B</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>C</td>
<td>N/A</td>
<td>Seismic Req. Apply</td>
</tr>
<tr>
<td>D₀</td>
<td>Seismic Req. Apply</td>
<td>Seismic Req. Apply</td>
</tr>
<tr>
<td>D₁</td>
<td>Seismic Req. Apply</td>
<td>Seismic Req. Apply</td>
</tr>
<tr>
<td>D₂</td>
<td>Seismic Req. Apply</td>
<td>Seismic Req. Apply</td>
</tr>
</tbody>
</table>

Wind and Seismic Requirements

R202 TOWNHOUSE

- Three or more attached units
- Units extend from foundation to roof
- Open space on at least two sides

Open two sides
**Limits - Townhouse**

R202 TOWNHOUSE
- Three or more attached units
- Units extend from foundation to roof
- Open space on at least two sides

*Not open two sides (therefore, not a townhouse)*

**Limits - Weight**

R301.2.2.2.1 Weight of Materials
Average dead loads shall not exceed:
- 15 or 25 psf for roofs/ceiling assemblies
- 10 psf for floor assemblies
- 15 psf for exterior wall assemblies

**Wind Requirements**
- Weight of materials provisions do not apply

**Seismic Requirements**
- Weight of materials provisions apply

**Seasons – Irregular Buildings**

<table>
<thead>
<tr>
<th>Snow Load, R301.2.3</th>
<th>Load</th>
<th>Design Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 70 psf</td>
<td>Prescriptive</td>
<td></td>
</tr>
<tr>
<td>&gt; 70 psf</td>
<td>Engineered</td>
<td></td>
</tr>
</tbody>
</table>

R301.2.2.2.5 Irregular buildings

**Wind Requirements**
- Irregular building provisions do not apply

**Seismic Requirements**
- Irregular building provisions apply
Limits: Wind Exposure

R301.2.1.1 Wind Limitations and Wind Design Required
- When wind speeds are 110 mph or greater  OR
- When IRC Figure R301.2(4)B requires wind design

The following references may be used to design the walls to resist lateral forces:
- WFCM
- ICC 600
- ASCE-7
- AISI S230 (steel)
- IBC

Figure R301.2(4)B shows where the IRC wall bracing requirements do not apply. Another code or standard must be used to brace the walls against lateral loads.
R301.2.1 Wind Design Criteria

- Component and cladding loads for wall coverings, windows, etc. per Table R301.2(2) and adjusted per Table R301.2(3) shall be used...

### Limits: Wind Exposure

#### Exposure A:
Large city centers with at least 50 percent of the buildings having a height in excess of 70 feet for a distance of 0.5 mile upwind from the structure being designed.

#### Exposure B:
Urban and suburban areas, wooded areas or other terrain with many closely spaced obstructions having the size of single family dwellings or larger.
**Limits: Wind Exposure**

Exposure C (1 of 2):
Open with scattered obstructions or undulations generally less that 30 feet in height extending for 1,500 feet in any direction.

Exposure C (2 of 2):
Within Exposure B terrain, but located directly adjacent to open areas of Exposure C for a distance of more than 600 ft.

Exposure D:
Flat, unobstructed areas exposed to wind flowing over open water for at least 1 mile. Extends inland 1,500 feet.

**Bracing Topics**

Forces & History

Limits

Irregular Buildings

Wind Exposure

Questions
Bracing Topics

Forces & History | Limits | Bracing | Examples
--- | --- | --- | ---
Locate BWL | Required Length | BWP Location | Panel Material & Ends
Sufficient Length | Connections | Foundation | Simplified Wall Bracing

Bracing: BWL Spacing

How many BWL's?

Bracing: BWL Spacing

Loaded wall versus resisting walls
Table R602.10.1.3

Wind

Seismic

SDC D, D₁, & D₂ (all dwellings)

BWL Spacing = 25' max.
Permitted to be = 35' max.
1. To accommodate one room not exceeding 900 ft²
2. For all BWLs when bracing length is increased and L/W < 3:1

Locating BWL here makes distance between BWL's less.
**Bracing: BWL Spacing**

- **Wall Lines with BWP Offset Limitations**
  - Wall lines with BWP that are counted as part of a BWL must be parallel to the BWL.
  - Offsets out-of-plane up to 4' are permitted for any wall line.
  - There is an angle wall exception which will be discussed later.
### Bracing: BWL Spacing

#### How many BWL’s?

- **Wall sheathing in a diagonal wall section may be counted for a wall line’s bracing length if the diagonal wall line is 8” or less in length.**

#### R602.10.1.4 Angled Walls

<table>
<thead>
<tr>
<th>Angle from BWL (degrees)</th>
<th>Projected BWL Length from Angled Wall Line (ft.)</th>
<th>Angled Wall Line Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>3.9</td>
<td>5.8</td>
</tr>
<tr>
<td>30</td>
<td>3.5</td>
<td>5.2</td>
</tr>
<tr>
<td>45</td>
<td>2.9</td>
<td>4.3</td>
</tr>
</tbody>
</table>

### Bracing: BWL Spacing

#### Angled Walls

- **R602.10.1.4**

#### Bracing Topics

<table>
<thead>
<tr>
<th>Forces &amp; History</th>
<th>Limits</th>
<th>Bracing</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate BWL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required Length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BWP Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel Material &amp; Ends</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sufficient Length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simplified Wall Bracing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Wind Speed
Seismic Risk

Both wind speed and seismic risk must be considered when defining required wall bracing. The required bracing length is the greater of the two bracing lengths.

Bracing: Required Length

Bracing Length Tables

2012 – Two bracing length tables
- Wind Table R602.10.3(1)
- Seismic Table R602.10.3(3)

Required bracing length is the maximum of the two tables’ bracing length x all adjustment factors.

Bracing: Required Length

When considering whether wind or seismic requirements control, a number of factors must be considered.
- Wall bracing length - either wind or seismic requirements may control. Use the longest required length.
- Hold-downs, Roof Ties, Limits – if wind or seismic requirements require additional connections or limits, they must be applied regardless of which requirement set controls.

Wind Requirements
- Braced wall line spacing
- Wall height
- Eave to ridge height
- Roof ties

Seismic Requirements
- Wall length
- Braced wall line spacing
- Hold-downs
- Material weight limits

Decision Tree for Determining Required Bracing Length

R602.10.3, Tables R602.10.3(1), R602.10.3(2), R602.10.3(3) & R602.10.3(4)
Bracing: Required Length

Bracing Requirements Based on Wind Speed

Wind Bracing Table based on:
- Wind Exposure Category B
- Mean roof height of 30 ft.
- Eave to ridge height of 10 ft.
- Wall height of 10 ft.
- Two braced wall lines

Required bracing length is determined by:
- Wind speed
- Story location
- Wall line spacing
- Bracing method

Table R602.10.3(1)

Bracing: Required Length

Adjustment Factors

Wind bracing adjustment factors are in Table R602.10.3(2)

1. Wind exposure category
2. Eave-to-ridge height
3. Wall height
4. Number of braced wall lines
5. 800-lb hold-down on top story
6. Application of interior gypsum board finish
7. Gypsum board fastening

Table R602.10.3(2)
Bracing: Required Length

Adjustment Factor – Roof Eave-to-Ridge Height

<table>
<thead>
<tr>
<th>Support Condition</th>
<th>Roof Eave-to-Ridge Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof only</td>
<td>≤ 5'</td>
</tr>
<tr>
<td></td>
<td>0.7</td>
</tr>
<tr>
<td>Roof + floor</td>
<td>0.85</td>
</tr>
<tr>
<td>Roof + 2 floors</td>
<td>0.9</td>
</tr>
<tr>
<td>NP – Not Permitted</td>
<td></td>
</tr>
</tbody>
</table>

Table R602.10.3(2)

Bracing: Required Length

Adjustment Factor – Wall Height

<table>
<thead>
<tr>
<th>Wall Height (ft.)</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>8'</td>
<td>0.90</td>
</tr>
<tr>
<td>9'</td>
<td>0.95</td>
</tr>
<tr>
<td>10'</td>
<td>1.0</td>
</tr>
<tr>
<td>11'</td>
<td>1.05</td>
</tr>
<tr>
<td>12'</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table R602.10.3(2)

Bracing: Required Length

Adjustment Factor – Number of Braced Wall Lines

<table>
<thead>
<tr>
<th>Number of Braced Wall Lines</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>1.30</td>
</tr>
<tr>
<td>4</td>
<td>1.45</td>
</tr>
<tr>
<td>≥ 5</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Table R602.10.3(2)

Footnote c

Table R602.10.3(2) Footnote c allows the adjustment factor to be 1.0 when the braced wall line spacing on exterior lines neglects the interior lines.

For example – when interior BWLs are only needed for seismic bracing or when they are only needed to support BWLs in the story above.
Bracing: Required Length

Adjustment Factors – wind cont.

<table>
<thead>
<tr>
<th>Adjustment Factor</th>
<th>Bracing Method</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional 800-lb hold-down at each BWP for top story only</td>
<td>DWB, WSP, SFB, PBS, PCP, and HPS</td>
<td>0.80</td>
</tr>
<tr>
<td>Interior finish</td>
<td>DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, and CS-SFB</td>
<td>1.4</td>
</tr>
<tr>
<td>Gypsum board fastening – 4&quot; o.c. at all panel edges, blocked horizontal joints</td>
<td>GB</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table R602.10.3(2)
Bracing: BWP Location

Bracing: BWP Location

BWP Spacing – 2009 and earlier

BWP Spacing – 2012 Edition

R602.10.2.2 Location of Braced Wall Panels, R602.10.2.3 Minimum Number of BWPs

Placement Requirements
- BWP to begin no more than 10’ feet from the end of a BWL.
- BWP located not more than 20’ o.c. from edge to edge
- Two BWPs per BWL when BWL > 16 ft. AND Minimum 1- 48” BWP or 2- reduced length BWPs for BWL ≤ 16 ft.

Braced Panel Starting Location

Wind Panel begins up to 10 ft. from the corner

Distance from Corner
8’ to 12’

Corner (end of wall line)
Bracing: BWP Location

Overview – 2009 and earlier

<table>
<thead>
<tr>
<th>Wall Bracing Parameter</th>
<th>Intermittent</th>
<th>CS-WSP</th>
<th>CS-SFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind &amp; SDC A-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D_{10}D_{2}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind &amp; SDC A-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D_{10}D_{2}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel end distance</td>
<td>12.5'</td>
<td>8'</td>
<td>Not Permitted</td>
</tr>
<tr>
<td>Combined</td>
<td>8' or 8' (a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corner return length</td>
<td>Not required</td>
<td>24&quot; Min. (b)</td>
<td>32&quot; Min. (b)</td>
</tr>
</tbody>
</table>

(a) For WSP, 8' with 24" panel at corner or 1,800 lb hold down per R602.10.1.4.1, exception items 1 & 2.
(b) In lieu of a corner return, an 800 lb hold-down may be fastened to the side of the BWP closest to the corner per R602.10.5.3, exception item 2.

Bracing: BWP Location

Overview – 2012 IRC

<table>
<thead>
<tr>
<th>Wall Bracing Parameter</th>
<th>Intermittent</th>
<th>CS-WSP, CS-G, CS-PF</th>
<th>CS-SFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind &amp; SDC A-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D_{10}D_{2}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind &amp; SDC A-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D_{10}D_{2}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel end distance</td>
<td>10'</td>
<td>0' or 10' (a)</td>
<td>10'</td>
</tr>
<tr>
<td>Corner return length</td>
<td>Not required</td>
<td>24&quot; Min. (b)</td>
<td>32&quot; Min. (b)</td>
</tr>
</tbody>
</table>

(a) For WSP, 10' with 24" panel at corner or 1,800 lb hold down per R602.10.2.2.1, exception items 1 & 2.
(b) In lieu of a corner return, an 800 lb hold-down may be fastened to the side of the BWP closest to the corner per Figure R602.10.7, End Condition 2.


Wind – 2009 IRC

- 25' Centers
- "X" End
- BWP length

Wind – 2012 IRC

- 25' Centers
- "X" End
- BWP length

- 12'-6" Max
- 25' Max

48"
Bracing: BWP Location


Wind – 2012 IRC

- 20’ Spacing
- 10’ End
- BWP length

10’ max

20’ max

48”

48”

R602.10.2.2

Bracing: BWP Location

Does this meet code?

Yes, 20’ maximum not exceeded.

Wind – 2012 IRC

- 20’ Spacing
- 10’ End
- BWP Length

16’

48”

48”

36’

R602.10.2.2

Bracing: BWP Location

Does this meet code?

No, BWP required to begin no more than 10 feet from the end of the wall.

Wind – 2012 IRC

- 20’ Spacing
- 10’ End
- BWP Width

12’

36’

R602.10.2.2

Bracing: BWP Location

Does this meet code?

No, 20’ maximum exceeded.

Wind – 2012 IRC

- 20’ Spacing
- 10’ End
- BWP Width

28’

48”

R602.10.2.2

Bracing: BWP Location


Wind – 2012 IRC

- 20’ Spacing
- 10’ End
- BWP length

10’ max

20’ max

48”

48”

R602.10.2.2
Bracing: BWP Location

Does this meet code?
No, width requirement not met.

20' Spacing
10' End
BWP Width

Note:
If BWP is supporting a story above, nailing must be a maximum 4" o.c.

Bracing: BWP Location

Does this meet code?
Yes, width requirements are met.

20' Spacing
10' End
BWP Width

Bracing: BWP Location

Does this meet code?
Yes, width requirements are met.

20' Spacing
10' End
BWP Width

Note:
Increase BWP width to 24" if supporting a story above.

Bracing Topics

Forces & History
Limits
Bracing
Examples
Locate BWL
Required Length
BWP Location
Panel Material & Ends
Sufficient Length
Support
Connections
Simplified Wall Bracing

Questions
Bracing Topics

<table>
<thead>
<tr>
<th>Forces &amp; History</th>
<th>Limits</th>
<th>Bracing</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Locate BWL</td>
<td>Required Length</td>
<td>BWP Location</td>
</tr>
<tr>
<td></td>
<td>Panel Material &amp; Ends</td>
<td>Sufficient Length</td>
<td>Connections</td>
</tr>
<tr>
<td></td>
<td>Foundation</td>
<td>Simplified Wall Bracing</td>
<td></td>
</tr>
</tbody>
</table>

**Bracing: Panel Material - Intermittent**

Intermittent Bracing Methods:
- LIB - Let-in diagonal brace
- DWB - 3/4” Diagonal wood boards
- WSP - 3/8” Wood structural panel
- BV-WSP – 7/16” Wood structural panel with stone or masonry veneer
- SFB - 1/2” Structural fiberboard
- GB - 1/2” Interior gypsum wallboard or gypsum sheathing particleboard
- PBS - 3/8” Particleboard sheathing
- PCP - Portland cement plaster on studs
- HPS - 7/16” Hardboard panel siding
- ABW - Alternate braced wall
- PFH - Portal frame with hold-downs
- PFG - Portal frame at garage door openings in SDC A-C

Method LIB – Let-in Brace
- Angled 45 to 60 degrees from horizontal
- Extends continuously from bottom plate to top plate
- 1x4 lumber or approved metal strap
- Application limited
  - 8’ to 10’ wall height only

Panel Material & Ends
- Intermittent Bracing
- Continuous Sheathing
- Narrow Bracing
- Mixed Methods
- Interior Finish
- Ends Conditions – Continuous Sheathing
- Joints
**Bracing: Panel Material - Intermittent**

**Method LIB – Let-in Brace**

Must extend continuously from bottom plate to top plate.

---

**Bracing: Panel Material - Intermittent**

**Method DWB – Diagonal Wood Boards**

- Wood boards 3/4" (1" nominal) thick applied diagonally
- Studs spaced 24" max.

---

**Method DWB – Diagonal Wood Boards**

8' to 12'

4' min.
Bracing: Panel Material - Intermittent

Method WSP – Wood Structural Panel
- 3/8” min. thickness
- Wood structural panel defined in R604

Method SFB – Structural Fiberboard Sheathing
- 1/2” or 25/32” thick
- Studs spaced 16” o.c. max.
- Must conform to ASTM C 208
- Nailing 3” o.c. edge, 6” o.c. field
Bracing: Panel Material - Intermittent

Method GB – Gypsum Board
- 1/2” min. thick for studs spaced 24” o.c. max.
- 4’ minimum length
- Nailing at 7” o.c.
- Bracing length:
  - Single sided = 0.5 x actual length
  - Double sided = 1x actual length

No floating corners!

Method PBS – Particleboard Sheathing
- 3/8” or 1/2” min. thickness
- Studs 16” o.c. max.
- 4’ minimum length
- Nailing at 3” edge, 6” field
- Minimum 8d nails for 1/2” thick sheathing

Method PCP – Portland Cement Plaster
- Studs 16” o.c. max.
- Installed in accordance with R703.6
- Nailing 6” o.c.
Bracing: Panel Material - Intermittent

Method PCP – Portland Cement

Method HPS – Hardboard Panel Siding
- 7/16” minimum thickness
- Studs 16” on center
- Nailing 4” o.c. edge and 8” o.c. field

8’ to 12’

4’ min.

Table R602.10.4

Bracing: Panel Material - Intermittent

Method HPS – Hardboard Panel Siding

Table R602.10.5  Minimum length for braced wall panels

<table>
<thead>
<tr>
<th>Minimum Length (inches)</th>
<th>Contributing Length (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB</td>
<td>Double sided = Actual</td>
</tr>
<tr>
<td>48 48 48 53 58</td>
<td>Single sided = 0.5 × Actual</td>
</tr>
<tr>
<td>LIB</td>
<td>55 52 62 69 NP NP Actual</td>
</tr>
</tbody>
</table>

Copyright 2013 International Code Council
Bracing: Panel Material - Intermittent

Partial Credit for Narrow BWP

<table>
<thead>
<tr>
<th>Method/DWB, WSP, SFB, PBS, PCP, HPS</th>
<th>For Methods DWB, WSP, SFB, PBS, PCP, HPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Length</td>
<td>Effective Length of BWP</td>
</tr>
<tr>
<td>48”</td>
<td>48”</td>
</tr>
<tr>
<td>42”</td>
<td>36”</td>
</tr>
<tr>
<td>36”</td>
<td>27”</td>
</tr>
</tbody>
</table>

Method ABW - Alternate Braced Wall

- Equivalent to 48” panel
- For use on bottom story only
- Minimum length varies with SDC and height
- Nailing:
  - Single story – 6” o.c. min
  - Bottom of two story – 4” o.c. min
- Minimum hold-down capacity changes with SDC and height

Hold-down:

- A prefabricated metal anchoring device that attaches the framing of a wall system to the structure below.
- The hold-down prevents uplift of the studs and, thus, overturning of the wall segment.
- Foundation reinforcement required (Caused by moment from hold-downs)
**Bracing: Panel Material - Intermittent**

**Method ABW - Alternate Braced Wall**
- Min. 3/8" thick wood structural panel sheathing
- Anchor bolts 1/2" (2)
- Hold-down capacity per Table R602.10.6.1
- #4 bars top and bottom for bracing
- 12" x 12" min. footing

**Method PFH – Intermittent Portal Frame**
- 16" min panel length for 1-story, 24" min for 2-story
- Header 6' min. to 18' max.
- Each vertical panel replaces a 48" braced wall panel

**Bracing: Panel Material - Intermittent**

**Method PFH with taller walls**
- Wall height up to 12 ft. tall
- Portal height limited to 10 ft. (top of header)
- Pony wall built above portal header
- 4 ft. max pony wall height
- Pony walls require tension straps (Table R602.10.6.4)
- Number of jack studs required for single portal post in Table R502.5(1)
**Bracing: Panel Material - Intermittent**

**Method PFH – Intermittent Portal Frame**

- Min. 1,000 lb strap (opposite side)
- Min. 1,000 lb hold-down
- Min. #4,200 hold-down

**Method PFG – Intermittent Portal Frame at Garage**

- For use in SDC A-C only
- Bracing length = 1.5 x length of panel
- Minimum 24" length
- Header 6’ min. to 18’ max.

- Extended header
- Min. 1,000 lb strap (opposite side from sheathing)
- No hold-downs required

**R602.10.6.2**

**Figure R602.10.6.2**

**Bracing: Panel Material - Intermittent**

**Method PFH – Intermittent Portal Frame**

- Min. 1,000 lb hold-down
- Install 1000 lb strap

**Method PFG – Intermittent Portal Frame at Garage**

- Min. 7/16" thick wood structural panel
- (2) 1/2" anchor bolts
- Extended header
- 1,000 lb strap capacity (opposite side)
- 3” o.c. nailing
- Min. 7/16" thick wood structural panel
- No hold-downs required

**R602.10.6.3**

**Table R602.10.5**

- Header schedule 6d common at 3’ o.c.
Method PFG with taller walls
- Wall height up to 12 ft. tall
- Portal height limited to 10 ft. (top of header)
- Pony wall built above portal header
- 4 ft. max pony wall height
- Pony walls require tension straps (Table R60210.6.4)
- Number of jack studs required for single portal post in Table R502.5(1)

Bracing: Panel Material - Intermittent

Minimum Length of Narrow BWPs

Table R602.10.5 Minimum length for braced wall panels (excerpt)

<table>
<thead>
<tr>
<th>Method</th>
<th>Minimum Length* (inches)</th>
<th>Contributing Length (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(See Table R602.10.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall Height</td>
<td>8 ft.</td>
<td>9 ft.</td>
</tr>
<tr>
<td>DWE, WSP, SFB, PBS, PCF, HPS, BV-WSP</td>
<td>48.0</td>
<td>48.0</td>
</tr>
<tr>
<td>ABW</td>
<td>29.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Supporting roof only</td>
<td>16.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Supporting one story and roof</td>
<td>24.0</td>
<td>24.0</td>
</tr>
<tr>
<td>PFG</td>
<td>24.0</td>
<td>27°</td>
</tr>
</tbody>
</table>

Bracing: Panel Material - Proprietary

Other bracing methods per code report
- Prefabricated units
- Laminated Kraft-paper board
- Fiberboard in various thicknesses
Bracing: Panel Material - Proprietary

Bracing Per Code Report

Bracing: Panel Material - Proprietary

Bracing Per Code Report

Bracing Topics

- Bracing
  - Locate BWL
  - Required Length
  - BWP Location

- Panel Material & Ends
  - Sufficient Length
  - Connections
  - Foundation
  - Simplified Wall Bracing

- Panel Material & Ends
  - Interim Bracing
  - Continuous Sheathing
  - Mixed Methods
  - Interior Finish
  - Ends Conditions
    - Continuous Sheathing
    - Joints

Bracing: Panel Material - Continuous

- Continuous Sheathing Bracing Methods:
  - CS-WSP: Continuously sheathed wood structural panel
  - CS-G: Continuously sheathed wood structural panel adjacent to garage openings
  - CS-PF: Continuously sheathed portal frame
  - CS-SFB: Continuously sheathed structural fiberboard

Table R602.10.4
**Bracing: Panel Material - Continuous**

**Main Concepts**
- Allows for narrow BWP’s without hold-downs
- BWL’s must be fully sheathed with wood structural panel or structural fiberboard sheathing (continuously sheathed)

**Sheathing Requirements:**
1. Sheath full height areas including gable ends
2. Sheath above and below openings
3. Adjacent openings determine minimum BWP length

**Aspect Ratio:**
The ratio of the height of a bracing unit to its length.

\[
\text{Aspect Ratio} = \frac{\text{Height}}{\text{Length}}
\]

\[
\text{Aspect Ratio} = \frac{8'}{4'} = 2
\]
Bracing: Panel Material - Continuous

- Continuous Sheathing with Wood Structural Panel
  - Area above and below openings fully sheathed including gable ends
  - Min 3/8" wood structural panel sheathing

- Continuous Sheathing with Structural Fiberboard
  - Area above and below openings fully sheathed including gable ends
  - Min 1/2" structural fiberboard sheathing

<table>
<thead>
<tr>
<th>Wall Bracing Parameter</th>
<th>Continuously Sheathed Wood Structural Panel CS-WSP, CS-G, CS-PF</th>
<th>Continuously Sheathed Structural Fiberboard CS-SFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind applicability</td>
<td>&lt; 110 mph</td>
<td>≤ 100 mph</td>
</tr>
<tr>
<td>Seismic applicability</td>
<td>A - D₂</td>
<td>A - C</td>
</tr>
<tr>
<td>Permitted wall heights</td>
<td>8' to 12'</td>
<td>8' to 12'</td>
</tr>
<tr>
<td>Corner return length</td>
<td>24&quot; Min. (or hold downs at first BWP)</td>
<td>32&quot; Min. (or hold downs at first BWP)</td>
</tr>
<tr>
<td>Panel end distance</td>
<td>10'</td>
<td>10'</td>
</tr>
</tbody>
</table>

Wall minimum length is based on wall height and height of the adjacent clear opening.

Table R602.10.5
Bracing: Panel Material - Continuous
Method CS-WSP

Table R602.10.5 Minimum Length of Braced Wall Panels (in)

<table>
<thead>
<tr>
<th>Method</th>
<th>Clear Opening Height (ft.)</th>
<th>Wall Height (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-WSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>24</td>
<td>27</td>
</tr>
<tr>
<td>68</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>72</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>76</td>
<td>29</td>
<td>27</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>84</td>
<td>32</td>
<td>27</td>
</tr>
<tr>
<td>88</td>
<td>35</td>
<td>27</td>
</tr>
<tr>
<td>92</td>
<td>37</td>
<td>27</td>
</tr>
<tr>
<td>96</td>
<td>40</td>
<td>27</td>
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<td>100</td>
<td>44</td>
<td>28</td>
</tr>
<tr>
<td>104</td>
<td>48</td>
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<td>108</td>
<td>52</td>
<td>30</td>
</tr>
<tr>
<td>112</td>
<td>56</td>
<td>31</td>
</tr>
<tr>
<td>116</td>
<td>60</td>
<td>32</td>
</tr>
<tr>
<td>120</td>
<td>64</td>
<td>32</td>
</tr>
</tbody>
</table>

Bracing: Panel Material - Continuous
Method CS-G
Wood structural panel adjacent to garage opening
- Full-height sheathed wall segments to either side of garage openings
- Roof covering dead loads of 3 psf or less (seismic requirement only)
- Applied to one wall line of garage only
- Panel length = bracing length
- 4:1 aspect ratio

Garage only, supporting roof with 3 psf covering.

4:1 Aspect Ratio (24” min.)
### Bracing: Panel Material - Continuous

**Method CS-PF**  
Continuous portal frame

- Walls on either or both sides of openings in garage may have wall segment with a maximum 6:1 height-to-length ratio.
- No hold-downs required
- Top of wall at 12' max
- Panel length = bracing length

Garage Opening

10' max (12' max with pony wall)

### Bracing: Panel Material - Continuous

**Method CS-PF**  
Continuous portal frame

Garage only, story above permitted.

#### Table R602.10.6.4: Tension Strap Capacity Required for Resisting Wind Pressures Perpendicular to 6:1 Aspect Ratio Walls

<table>
<thead>
<tr>
<th>BASIC WIND SPEED (mph)</th>
<th>Exposure B</th>
<th>Exposure C</th>
<th>Exposure D</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 90 100 85 90 100 85 90 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tension strap capacity required (lb)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 × 4 No. 2 Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table R602.10.5: Minimum Wall Stud Framing Nominal Size and Grade

<table>
<thead>
<tr>
<th>MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE</th>
<th>MAXIMUM PONY WALL HEIGHT (feet)</th>
<th>MAXIMUM TOTAL WALL HEIGHT (feet)</th>
<th>MAXIMUM OPENING WIDTH (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 × 4 No. 2 Grade</td>
<td>9 1000 1000 1000 1000 1000 1000</td>
<td>9 1000 1000 1000 1000 1000 1000</td>
<td>9 1000 1000 1000 1000 1000 1000</td>
</tr>
<tr>
<td>2 × 4 No. 2 Grade</td>
<td>16 1000 1000 1000 1000 1000 1000</td>
<td>16 1000 1000 1000 1000 1000 1000</td>
<td>16 1000 1000 1000 1000 1000 1000</td>
</tr>
<tr>
<td>2 × 4 No. 2 Grade</td>
<td>2 10 18 1000 1000 1000 1000 1000</td>
<td>2 10 18 1000 1000 1000 1000 1000</td>
<td>2 10 18 1000 1000 1000 1000 1000</td>
</tr>
</tbody>
</table>

---

Figure R602.10.6.4

[Diagram showing Bracing: Panel Material - Continuous]

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### Bracing: Panel Material - Continuous

Methods PFH, PFG and CS-PF cont.

**Table R602.10.6.4 cont.: Tension Strap Capacity Required for Resisting Wind Pressures Perpendicular to 6:1 Aspect Ratio Walls**

<table>
<thead>
<tr>
<th>MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE</th>
<th>MAXIMUM PONY WALL HEIGHT (feet)</th>
<th>MAXIMUM TOTAL WALL HEIGHT (feet)</th>
<th>MAXIMUM OPENING WIDTH (feet)</th>
<th>BASIC WIND SPEED (mph)</th>
<th>85</th>
<th>90</th>
<th>100</th>
<th>85</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 4 No. 2 Grade</td>
<td>4</td>
<td>12</td>
<td></td>
<td>Exposure B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>1775</td>
<td>2350</td>
<td>3550</td>
<td>DR</td>
<td>DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>1600</td>
<td>1000</td>
<td>1725</td>
<td>DR</td>
<td>DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>1650</td>
<td>3025</td>
<td>3690</td>
<td>DR</td>
<td>DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 6 Stud Grade</td>
<td>2</td>
<td>12</td>
<td></td>
<td>Exposure C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>1125</td>
<td>1000</td>
<td>2225</td>
<td>DR</td>
<td>DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>2650</td>
<td>3150</td>
<td>2775</td>
<td>DR</td>
<td>DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>3125</td>
<td>3675</td>
<td>3800</td>
<td>DR</td>
<td>DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bracing: Panel Material - Continuous**

- Continuous Sheathing with Structural Fiberboard
  - Wall minimum length based on wall height and height of adjacent clear opening
  - Maximum wall height = 12’
  - Length requirements for braced wall panels in Table R602.10.5
    - Same minimum bracing length requirements as CS-WSP
    - Same aspect ratio (opening height limits) as CS-WSP

---

*2012 IRC Wall Bracing* 

12/11/2017
Bracing: Panel Material - Continuous

Method CS-SFB

Bracing Basics: Mixing Bracing Methods

R602.10.4.1 Item 1

BWP method variation permitted from story to story with any type of sheathing
Bracing Basics: Mixing Bracing Methods

R602.10.4.1 Item 2

BWP method variation permitted from BWL to BWL within a story for intermittent sheathing

For continuous and intermittent sheathing, variation may only occur in SDC A-C with winds ≤ 100 mph

R602.10.4.1 Item 3

BWP method variation within a BWL permitted ONLY in SDC A-B and for detached houses in SDC C with intermittent bracing

Greatest required bracing length for panel materials must be used.
Not applicable for use with continuous sheathing OR dwellings in SDC D0-D2

R602.10.4.1 Item 4

Mixing of CS-WSP, CS-G and CS-FP along a BWL is permitted in any SDC

Greatest required bracing length for all panel materials in BWL must be used.
Not applicable for dwellings in SDC D0-D2

R602.10.4.1 Item 5

BWP method variation in a BWL with continuous sheathing on exterior walls and intermittent on interior walls permitted ONLY in SDC A-B and for detached houses in SDC C

Greatest required bracing length for all panel materials in BWL must be used.
Not applicable for dwellings in SDC D0-D2
Bracing Basics: Braced Panel Construction

R602.10.4.3 Braced Wall Panel Interior Finish Material

- Interior Finish (Gypsum) Required
  - ½" thickness min
- Method LIB

Exceptions:
1. Wall panels braced with Methods GB, BV-WSP, ABW, PFH, PFG and CS-PF.
2. When an approved interior finish material with an in-plane shear resistance equivalent to gypsum board is installed.
3. For all methods except LIB, omitting gypsum wall board is permitted when the length of bracing in Tables R602.10.3(1) and R602.10.3(3) is multiplied by the factors in Tables R602.10.3(2) or R602.10.3(4).
**Bracing: End Conditions**

**R602.10.7 End Conditions for Braced Wall Lines with Continuous Sheathing**

End Conditions – BWP at Corner

- **Condition 1** - Return panel on perpendicular wall
- **Condition 2** - In lieu of a return panel, an 800 lb hold-down may be fastened to the corner stud.
- **Condition 3** - Minimum 48" BWP, no return required

<table>
<thead>
<tr>
<th>WSP return panel – 24” minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFB return panel – 32” minimum</td>
</tr>
</tbody>
</table>

**R602.10.7 End Conditions for Braced Wall Lines with Continuous Sheathing**

End Conditions - BWP offset from corner

- **Condition 4** - Corner panel and return panel on perpendicular wall
- **Condition 5** - In lieu of a corner panel, an 800 lb hold-down may be fastened to end of the BWP.

| WSP return panel and corner panel – 24” minimum |
| SFB return panel and corner panel – 32” minimum |

**Bracing: Panel Material - Continuous**

Continuous Sheathing | Corner Requirements

Table R602.3(1) Item 8 - Corner Stud Requirements

**Gypsum**

BWP Material or Infill

16d nail at 12” o.c.
Bracing Topics

Bracing
- Locate BWL
- Required Length
- BWP Location

Panel Material & Ends
- Intermittent Bracing
- Continuous Sheathing
- Mixed Methods
- Interior Finish
- Ends Conditions – Continuous Sheathing
- Joints

Bracing: Joints

All vertical panel joints shall occur over studs

<table>
<thead>
<tr>
<th></th>
<th>Gypsum Method GB</th>
<th>Wood Structural Panel Method WSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>48”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bracing: Joints

Horizontal Blocking

R602.10 Panel joints
Blocking required at horizontal edges of BWP’s.

Bracing: Joints

R602.10 Exceptions

Blocking is required at vertical edges of BWP’s, except:

Exception 1 – Vertical panel joints may occur over doubled studs when nailed at 10” o.c. with 10d box nails.
**Bracing: Joints**

R602.10.10 Exceptions

Blocking is required at horizontal edges of BWP's

Exceptions:

2. Blocking at horizontal joints is not required in infill areas.

3. Where the bracing length provided is 2x the minimum length required (Tables R602.10.3(1) and R602.10.3(3)) blocking at horizontal joints shall not be required in braced wall panels constructed using Methods WSP, SFB, GB, PBS or HPS.

4. When Method GB panels are installed horizontally, blocking of horizontal joints is not required.

---

**Bracing Topics**

<table>
<thead>
<tr>
<th>Forces &amp; History</th>
<th>Limits</th>
<th>Bracing</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate BWL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required Length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BWP Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel Material &amp; Ends</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sufficient Length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simplified Wall Bracing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Questions**

What is the minimum length of bracing allowed in a braced wall line?

(New) Section R602.10.2.3

- **BWL ≤ 16 ft.**: Minimum 2 BWPs any length
  - OR 1 BWP 48" long
- **BWL > 16 ft.**: Minimum 2 BWPs
Bracing: Sufficient Length

Determine whether there is sufficient space to place all the required bracing in a BWL

- Add length of qualified braced wall panel lengths
- Check against required length
- Locate space to place narrow panels if needed
- Check end distances and spacing between panels

First, we will review panel lengths

Bracing Length = $\frac{48'' + 48''}{12''} = 8'$
- Minimum panel width – OK
- Distance between panels – OK
- End distance – OK

Bracing Length = $\frac{48'' + 27'' + 48''}{12''} = 10.25'$
- 2006 - 48" min length requirement
- 2009/2012 - 36" braced panel is allowed with a reduced effective length
Bracing: Sufficient Length

Bracing Length = \frac{48'' + 48''}{12''} = 8' = 8' 48'' + 48''

- Minimum panel width – OK
- Distance between panels – OK
- End distance – OK

Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Braced Wall Line Spacing (ft.)</th>
<th>Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Method LIB</td>
<td>Method GB (double sided)</td>
</tr>
<tr>
<td>≤ 90 (mph)</td>
<td></td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50</td>
<td>15.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>18.5</td>
</tr>
<tr>
<td>≥ 90 (mph)</td>
<td></td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50</td>
<td>29.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>35</td>
</tr>
</tbody>
</table>

Bracing is insufficient (From Table – 40′ BWL)
**Bracing: Sufficient Length**

### Method CS-WSP

**Can interpolate for BWL spacing or for wall height.**

0.95 x 12” = 11.4’

Total Bracing Length = 11.5’ vs. 11.4’ Required

Bracing is OK

### Table R602.10.3(1)&(2), R602.10.4, R602.10.5

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Braced Wall Line Spacing (ft.)</th>
<th>Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 90 (mph)</td>
<td></td>
<td>Method LIB</td>
<td>Method GB (double sided)</td>
</tr>
<tr>
<td></td>
<td>Garage</td>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50</td>
<td>15.5</td>
</tr>
<tr>
<td></td>
<td>Garage</td>
<td>60</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>105 - 120 (mph)</td>
<td>One Story</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Garage Opening</td>
<td>20</td>
<td>7.5</td>
</tr>
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<td></td>
<td></td>
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<td>13.5</td>
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<td>40</td>
<td>16.5</td>
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<td></td>
<td></td>
<td>50</td>
<td>19.5</td>
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<tr>
<td></td>
<td></td>
<td>60</td>
<td>22.5</td>
</tr>
</tbody>
</table>

**Bracing is NG**

Table R602.10.3(1)&(2), R602.10.4, R602.10.5
### Bracing: Sufficient Length

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Braced Wall Line Spacing (ft.)</th>
<th>Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Method LIB</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
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<td>3.5</td>
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<tr>
<td>30</td>
<td></td>
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<td>9.5</td>
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<tr>
<td>40</td>
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<td>12.5</td>
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<tr>
<td>50</td>
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<td>15.5</td>
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<tr>
<td>60</td>
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<td></td>
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<td>30</td>
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<td>18.5</td>
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<td>40</td>
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<td></td>
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</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td>29.5</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td>35</td>
</tr>
</tbody>
</table>

Interpolate bracing length:

\[
5' - 3.5' = 1.5' \\
3.5' + 2 \times 0.15' = 3.8'
\]

Total Bracing Length = 4' vs. 3.8' Required

Bracing is OK

<table>
<thead>
<tr>
<th>PBS Bottom of Two Stories</th>
<th>90 mph</th>
<th>SDC A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Wind Direction

42'

Garage Opening

8'

2012 IRC Wall Bracing

Copyright 2013 International Code Council
Bracing: Sufficient Length

Total Bracing Length = 8' vs. 17' Required
Bracing is insufficient

Interpolated required bracing length:
17' – 14' = 3'
14' + 2x0.3' = 14.6'
Total Bracing Length = 8' vs. 14.6' Required
Bracing is insufficient

Basic Wind Speed (mph) | Story Location | Braced Wall Line Spacing (ft.) | Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line
---|---|---|---
< 90 (mph) | | | |
10 | 7 | 7 | 4 | 3.5 |
20 | 13 | 13 | 7.5 | 6.5 |
30 | 18.5 | 18.5 | 10.5 | 9 |
40 | 24 | 24 | 14 | 12 |
50 | 29.5 | 29.5 | 17 | 14.5 |
60 | 35 | 35 | 20 | 17 |

Method SFB

Wind Direction → → → 20°

Copyright 2013 International Code Council
## Bracing: Sufficient Length

### Table R602.10.3(1)

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Min. Total Length of Braced Wall Panels Required Along Each Braced Wall Line</th>
<th>Method LIB</th>
<th>Method GB (double sided)</th>
<th>Methods DWB, WSP, SFB, PBS, PCP, HPS</th>
<th>Continuous Sheathing</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 90 (mph)</td>
<td></td>
<td></td>
<td>7</td>
<td>7</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
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<td>13</td>
<td>10</td>
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<td>30</td>
<td></td>
<td></td>
<td>18.5</td>
<td>18.5</td>
<td>15.5</td>
<td>9</td>
</tr>
<tr>
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<td>29.5</td>
<td>29.5</td>
<td>17</td>
<td>14.5</td>
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<td></td>
<td></td>
<td>35</td>
<td>35</td>
<td>20</td>
<td>17</td>
</tr>
</tbody>
</table>

### Method SFB

- **Placement Requirement**: 4 ft. * 4 ft. = 8 ft.
- **Wind Requirement**: 7.5 ft.
- **Bracing Length**:
  - 7.5 ft. < 8 ft.
  - 8 ft. required, 8 ft. available

### Diagrams

1. **Diagram 1**: Basic wind speed ranging from 10 to 60 mph, with corresponding spacing for minimum total length of braced wall panels.
2. **Diagram 2**: Diagram of bracing placement and spacing requirements for Method SFB.
3. **Diagram 3**: Illustration of basic wind speed and story location for minimum total length of braced wall panels.
Bracing: Sufficient Length

Total Bracing Length = 20' vs. 16' Required
Bracing is OK

Bracing Basics: Percentage

Basic Wind Speed (mph) | Story Location | Braced Wall Line Spacing (ft.) | Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Method LIB</td>
<td>Method GB (double sided)</td>
</tr>
<tr>
<td>≤ 90 (mph)</td>
<td></td>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>18.5</td>
</tr>
<tr>
<td>&gt; 90 (mph)</td>
<td></td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>35</td>
</tr>
</tbody>
</table>

Bracing Basics: Percentage

Method WSP

Wind Requirement 4' + 4' = 8'
Wind Direction 28'

Bracing Basics: Percentage

Method WSP

Placement Requirement 4' + 4' = 8'
Bracing Length
Bracing Basics: Percentage

<table>
<thead>
<tr>
<th>Method WSP</th>
<th>Placement Requirement</th>
<th>Wind Requirement</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4' + 4' = 8'</td>
<td>10.5'</td>
<td>20' Centers</td>
</tr>
<tr>
<td></td>
<td>4' + 5' + 4' = 13'</td>
<td></td>
<td>10' Ends</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BWP Width</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bracing Length</td>
</tr>
</tbody>
</table>

Wind Requirement:
- 10.5' NA
- 48" WSP
- 4' + 5' + 5' = 13'

Questions

Bracing Basics: Percentage

<table>
<thead>
<tr>
<th>WSP Bottom of Two Story</th>
<th>30 mph</th>
<th>SDIC B</th>
</tr>
</thead>
<tbody>
<tr>
<td>10'</td>
<td>10.5'</td>
<td>NA</td>
</tr>
</tbody>
</table>

36'

Bracing Topics

Forces & History

Limits

Bracing

Examples

Locate BWL
Required Length
BWP Location
Panel Material & Ends
Sufficient Length
Support
Connections
Simplified Wall Bracing

Excerpt from Table R602.3(1) Items 13-19

<table>
<thead>
<tr>
<th>Item</th>
<th>Building Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Double top plates, face nail</td>
</tr>
<tr>
<td>14</td>
<td>Double top plates, minimum 24-inch offset of end joints, face nail in lapped area</td>
</tr>
<tr>
<td>15</td>
<td>Sole plate to joint or blocking, face nail</td>
</tr>
<tr>
<td>16</td>
<td>Sole plate to joint or blocking at braced wall panels</td>
</tr>
<tr>
<td>17</td>
<td>Stud to sole plate, toe nail</td>
</tr>
<tr>
<td>18</td>
<td>Top or sole plate to stud, end nail</td>
</tr>
<tr>
<td>19</td>
<td>Top plates, laps at corners and intersections, face nail</td>
</tr>
</tbody>
</table>
When braced wall panels are perpendicular to joists above or below, blocking shall be provided in line with the BWPs...

\textbf{R602.10.8 Item 1, Figure R602.10.8(1)}

3.7 BWP

(3) 16d nails at 16" o.c. along BWP 16d (3-1/2" x 0.135")

Continuous band or rim joist below BWP

**BWP Perpendicular to Framing**

8d toenailed at 6" o.c.
8d (2-1/2" x 0.113")

(3) 16d nails at 16" o.c. along BWP

Full height blocking above and below BWP

2-16d nails each side

**BWP Parallel to Framing**

Where joists are parallel to BWPs above or below... where a parallel framing member cannot be located... full-depth blocking at 16 inch spacing shall be provided...

**Bracing: Connections**

Blocking (not parallel)

8d nails toenailed at 6"o.c.

(3) 16d nails at 16" o.c. along BWP

Full height blocking @ 16" o.c. above and below BWP

2-16d nails each side

**Bracing: Connections**
Bracing: Connections

BWP Connection Requirements to Roof Framing

<table>
<thead>
<tr>
<th>SDC Wind Speed</th>
<th>Distance (bottom of roof sheathing to top of plate)</th>
<th>Blocking¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDC A, B, C Wind &lt; 100 mph</td>
<td>9.25&quot; or less</td>
<td>Not required, attach per R602.3(1)</td>
</tr>
<tr>
<td></td>
<td>9.25&quot; to 15.25&quot;</td>
<td>Per R602.10.8.2.2 Item 1 and Figure R602.10.8.2(1)</td>
</tr>
<tr>
<td>SDC D0, D1, D2 Wind ≥ 100 mph</td>
<td>15.25&quot; or less</td>
<td>Per R602.10.8.2 Item 2 and Figure R602.10.8.2(1)</td>
</tr>
<tr>
<td>All SDCs Wind &lt; 110 mph</td>
<td>15.25&quot; to 48&quot;</td>
<td>Per R602.10.8.2 Item 3 and Figure R602.10.8.2(2) or R602.10.8.2(3)</td>
</tr>
</tbody>
</table>

¹ Rafter or truss plate connection per Table R602.3(1)

Bracing: Connections

BWP Perpendicular to Rafters or Roof Trusses

For SDC A, B and C and wind speeds less than 100 mph, where:
- distance < 15.25" to top of rafters or roof trusses to perpendicular top plates
- rafters or roof trusses shall be connected to the top plates of braced wall panels with blocking
- in accordance with Figure R602.10.8.2(1) and attached using Table R602.3(1).

For SDC D0, D1 and D2 or wind speeds of 100 mph or greater, where:
- distance < 15.25" to top of rafters or roof trusses to perpendicular top plates
- rafters or roof trusses shall be connected to the top plates of braced wall panels with blocking
- in accordance with Figure R602.10.8.2(1) and attached using Table R602.3(1).

For all Seismic Design Categories and wind speeds, where:
- Distance > 15.25" to top of rafters or roof trusses to perpendicular top plates
- Perpendicular rafters or roof trusses shall be connected to the top plates of braced wall panels in accordance with Figure R602.10.8.2(2) or Figure R602.10.8.2(3).
Bracing: Connections

BWP Perpendicular to Rafters or Roof Trusses

Forces & History

Limits

Bracing

Examples

Locate BWL
Required Length
BWP Location
Panel Material & Ends
Sufficient Length
Connections
Foundation
Simplified Wall Bracing

Questions

Bracing: Foundation

Soil friction
Lateral bearing capacity

Weight of soil
Weight of the structure and footing
Bearing capacity of soil

Sliding
Resisted by soil friction and lateral bearing capacity of soil.

Overturning
Resisted by weight of structure and footing, weight of soil on footing, and bearing capacity of soil.
### Bracing: Foundation

**Wall Bracing – Foundation Requirements (R602.10)**

<table>
<thead>
<tr>
<th>Code Section</th>
<th>Provision</th>
<th>SDC A-C</th>
<th>High Seismic Regions SDC D0-D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>R602.10.6, Figures R602.10.6.1 and R602.10.6.2</td>
<td>Alternate wall bracing (ABW, PFH)</td>
<td>Methods ABW and PFH required 1-#4 horizontal top and bottom of footing</td>
<td>Methods ABW and PFH required 1-#4 horizontal at top and bottom of footing</td>
</tr>
<tr>
<td>R602.10.9, Figure R602.10.9</td>
<td>Short concrete or masonry walls below BWPs</td>
<td>Rebar required complying with Figure R602.10.9 if wall length, height, and thickness are L ≤ 48&quot; AND H &gt; 12&quot; AND T &lt; 6&quot;</td>
<td>Rebar required complying with Figure R602.10.9 if wall length, height, and thickness are L ≤ 48&quot; AND H &gt; 12&quot; AND T &lt; 6&quot;</td>
</tr>
</tbody>
</table>

**Main Concepts**

- Code provisions defined in R602.9.
- Supported on continuous footings.
- There are two methods for determining the required braced panel length for cripple walls (R602.10.11).

**Cripple Walls**

**Main Concepts**

- A framed wall extending from the top of the foundation to the underside of the floor framing of the first story above grade plane.
Cripple Walls

Seismic Design Categories A-D$_1$

Cripple Wall Supporting One Story

<table>
<thead>
<tr>
<th>Bracing Length from Tables R602.10.3(1) or (3) for Roof only</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.15 x (Roof only Bracing Length)</td>
</tr>
</tbody>
</table>

14' BWP edge to edge

Redesignated as a Two-story

<table>
<thead>
<tr>
<th>Bracing Length from Tables R602.10.3(1) or (3) for Roof only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof + Floor Bracing Length</td>
</tr>
</tbody>
</table>

20' BWP edge to edge

Cripple Wall or Story Above Grade?
See Chapter 2 Definitions:
• Story Above Grade
• Grade Plane

Cripple Walls

Seismic Design Categories A-D$_1$

Cripple Wall Supporting Two Stories

<table>
<thead>
<tr>
<th>Bracing Length from Tables R602.10.3(1) or (3) for Roof only</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.15 x (Roof + 1 Floor BP Length)</td>
</tr>
</tbody>
</table>

14' BWP edge to edge

Redesignated as a Three Story

<table>
<thead>
<tr>
<th>Bracing Length from Tables R602.10.3(1) or (3) for Roof only</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP length for Roof + 2 Floors</td>
</tr>
</tbody>
</table>

20' BWP edge to edge

Stacked framing not permitted
Bracing: Foundation

Footings:
- Anchor bolt placement
  - Bolts embedded 7 inches
  - Total length = 7” + plate(s) depth + threaded end

Footing depth
- Minimum 12 inches (R403.1.4)
- Frost depth controls in many areas

Footing width, W
- Table R403.1 lists minimum footing widths

Bracing: Foundation

1/2” bolt with 7” min. embedment in concrete or masonry
7 bolt dia. min. to 12” max.
6’ Max.
End of Plate

Bracing Topics

Forces & History
Limits
Bracing
Examples
Locate BWL
Required Length
BWP Location
Panel Material & Ends
Sufficient Length
Connections
Foundation
Simplified Wall Bracing

Questions
Bracing: Simplified Wall Bracing

Prescriptive Limits
The structure must meet the following requirements:
- Seismic Design Category (SDC) A, B, or C (SDC A or B for townhouses)
- Basic Wind Speed of 90 mph or less with Wind Exposure Category A or B
- One or two story structure
- Wood structural panel (WSP) or structural fiberboard sheathing (SFB) is used to brace exterior walls with 1/2 in. gypsum board fastened to the interior side of walls
- 60 ft. maximum length and width of the building
- Max eave-to-ridge height of 15 ft.
- Wall max height of 10 ft.
- Max ratio between long and short side of building: 3 to 1
- Max cantilever of 24 inches beyond foundation
- No cripple walls in two story buildings

Advantages to the Simplified Method:
- No seismic requirements
- Bracing only occurs on the perimeter (exterior walls)
- No braced wall line length or spacing
- No additional adjustment factors to check
- No interpolation
Bracing: Simplified Wall Bracing

Procedure:

1. Draw a rectangle around the perimeter of the building and stagger the required number of bracing units along the four wall lines.

Bracing: Simplified Wall Bracing

Procedure cont.:

2. Identify the number of bracing units required on each side of the rectangle.

<table>
<thead>
<tr>
<th>Story Level</th>
<th>Eave-to-Ridge Height (Feet)</th>
<th>Minimum Number of Bracing Units on Each Long Side (^{ab})</th>
<th>Minimum Number of Bracing Units on Each Short Side (^{ab})</th>
<th>Length of short side (ft.)</th>
<th>Length of long side (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1 2 2 2 2 3 3 1 2 2 2 3 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2 3 3 4 5 6 2 3 3 4 5 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1 2 3 3 4 4 1 2 3 3 4 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2 3 4 5 6 7 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Interpolation shall not be permitted.
b. Cripple walls or wood-framed basement walls in a walk-out condition of a one-story structure shall be designed as the first floor of a two-story house.
c. Actual lengths of the sides of the circumscribed rectangle shall be rounded to the next highest.
**Bracing: Simplified Wall Bracing**

### Bracing Methods for Simplified Wall Bracing

<table>
<thead>
<tr>
<th>Material</th>
<th>Stud Spacing &amp; Fastener Criteria</th>
<th>Fastener Spacing Criteria</th>
<th>Bracing Unit Method</th>
<th>Minimum Bracing Unit Length (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Structural Panel</td>
<td>Table R602.3(3)</td>
<td>6&quot; edge 12&quot; field</td>
<td>Continuous</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intermittent</td>
<td>4</td>
</tr>
<tr>
<td>Structural Fiberboard Sheathing</td>
<td>Max 16&quot; spacing</td>
<td>Table R602.3(1)</td>
<td>Continuous</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intermittent</td>
<td>4</td>
</tr>
</tbody>
</table>

---

### Narrow Bracing Methods for Simplified Wall Bracing

<table>
<thead>
<tr>
<th>Narrow Bracing Method</th>
<th>Equivalent Bracing Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-G</td>
<td>0.5</td>
</tr>
<tr>
<td>CS-PF</td>
<td>0.5</td>
</tr>
<tr>
<td>PFF</td>
<td>1</td>
</tr>
<tr>
<td>PFG</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Each narrow bracing method is worth one or less than one 3 ft. or 4 ft. bracing unit.

---

### Example

- SDC B
- Wind 90 mph, Wind Exposure B
- Method CS-WSP
- 1 Story
- Walls - 9 ft.
- Eave to ridge height - 12 ft.

Example Highlights:
- Strategic placement of bracing units

---

1. Draw rectangle around the entire building
2. Check the length of the N-S and E-W sides of the rectangle
3. Less than 60 ft.? OK
Table R602.12.4 Minimum Number of Bracing Units

<table>
<thead>
<tr>
<th>STORY LEVEL</th>
<th>SAFE TO EDGE HEIGHT (ft)</th>
<th>MINIMUM NUMBER OF BRACING UNITS ON EACH WALL LINE</th>
<th>MINIMUM NUMBER OF BRACING UNITS ON EACH WALL LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Length of short side (ft)</td>
<td>Length of long side (ft)</td>
</tr>
<tr>
<td>10</td>
<td>10'2&quot;</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>18'</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>21'2&quot;</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>25'2&quot;</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Sufficient space? Yes, 4 CS-WSP bracing units fit along the east and west wall lines.

1. 4 bracing units required along each wall line.
2. With CS-WSP, the minimum bracing unit length is 3 ft.
3. Panels must be within 12 ft. of the end of wall line and within 20 ft. of one another.

Sufficient space? Yes, CS-WP units are only worth 0.5 units each so 5 B.U.s min will be needed on the south wall. Furthermore, 3 CS-PF are needed to space units less than 20 ft. apart.

Bracing Topics
Forces & History  Limits  Bracing  Examples
Locate BWL  Required Length  BWP Location
Required Length  Panel Material & Ends
Panel Material & Ends  Sufficient Length
Sufficient Length  Connections
Connections  Foundation
Foundation  Simplified Wall Bracing

Questions
Bracing Topics

Forces & History | Limits | Bracing | Examples
--- | --- | --- | ---
Wind 90 mph, Exp B, SDC A
Wind 90 mph, Exp B, SDC A
Wind 85 mph, Exp B, SDC D2
Wind 90 mph, Exp C, SDC B
Wind 105 mph, Exp C, SDC B

Examples

Symbol Key

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagonal let-in</td>
<td></td>
</tr>
<tr>
<td>Diagonal wood boards</td>
<td></td>
</tr>
<tr>
<td>Wood structural panel</td>
<td></td>
</tr>
<tr>
<td>Structural fiberboard</td>
<td></td>
</tr>
<tr>
<td>Gypsum wallboard</td>
<td></td>
</tr>
<tr>
<td>Particleboard</td>
<td></td>
</tr>
<tr>
<td>Portland cement</td>
<td></td>
</tr>
<tr>
<td>Hardboard</td>
<td></td>
</tr>
</tbody>
</table>

Example: SDC A, Wind 90 mph, Exp B

Example Attributes:
- SDC A, Single-family dwelling
- Wind 90 mph, Wind Exposure B
- Method SFB
- Roof only (top of two stories)
- Wall height is 8 ft.

Example Highlights:
- Bracing percent based on wind. This structure is exempt from the seismic requirements.
- BWP's on the second floor can be placed over an opening on the first floor.
- BWP's are permitted to occur up to 10 feet away from the ends of BWL's.
### Minimum Required Length of Bracing

#### Table R602.10.3 (1)

<table>
<thead>
<tr>
<th>Basic Wind Speed</th>
<th>Exposure Category</th>
<th>Method Location</th>
<th>5.5 ft. N/A</th>
<th>7.5 ft. N/A</th>
<th>10 ft. Wall Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
<tr>
<td>20</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
<tr>
<td>30</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
<tr>
<td>40</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
<tr>
<td>50</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
<tr>
<td>60</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
<tr>
<td>70</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
<tr>
<td>80</td>
<td>A, B</td>
<td>1</td>
<td>&lt;90</td>
<td>OK</td>
<td>35.0 m (115 ft)</td>
</tr>
</tbody>
</table>

**Upper Story**

- **Wall Bracing**: 36'-10"
- **Exposure Category**: B
- **30 ft. Mean Roof Height**: 36'-10"
- **10 ft. Eave to Ridge Height**: 36'-10"
- **Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line**
- **Methods**: DWB, WSP, SFB, PBS, PCP, CS-WSP, CS-G, CS-PF, CS-L, CS-SP
- **Sheathing**: PCP, HPSf, HPS

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Example cont.: SDC A, Wind 90 mph, Exp B

Example Attributes:
- SDC A, Single-family dwelling
- Wind 90 mph, Wind Exposure B
- Method SFB
- Roof plus 1 floor (bottom of two stories)
- Wall Height is 8 ft.
The 3.5 ft. and 3 ft. segments qualify using Table R602.10.5.2.

With the wall height adjustment, the required bracing length is 13 ft. x 0.9 = 11.7 ft.
Example: SDC A, Wind 90 mph, Exp B

Example 3
- SDC A
- Wind 90 mph
- Method WSP & GB
- 1 Story
- 8 ft. tall walls, 10 ft. eave to ridge height

Example Highlights:
- Strategic placement of BWL’s.
- Different bracing methods can be used together.
- Application of PFH
Exposure Category B, 30 ft. Mean Roof Height, 10 ft. Eave to Ridge Height, 10 ft. Wall Height, 2 Braced Wall Lines

Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Braced Wall Line Spacing (feet)</th>
<th>Method</th>
<th>Method GB (double sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 90</td>
<td></td>
<td></td>
<td>WSP</td>
<td>GB</td>
</tr>
<tr>
<td>10</td>
<td>3.5</td>
<td>3.5</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>7.0</td>
<td>7.0</td>
<td>4.0</td>
<td>3.5</td>
</tr>
<tr>
<td>30</td>
<td>9.5</td>
<td>1.5</td>
<td>5.5</td>
<td>5.0</td>
</tr>
<tr>
<td>40</td>
<td>12.5</td>
<td>12.5</td>
<td>7.5</td>
<td>6.0</td>
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<tr>
<td>50</td>
<td>15.5</td>
<td>15.5</td>
<td>9.0</td>
<td>7.5</td>
</tr>
<tr>
<td>60</td>
<td>18.5</td>
<td>18.5</td>
<td>10.5</td>
<td>9.0</td>
</tr>
<tr>
<td>70</td>
<td>21.5</td>
<td>21.5</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>24.0</td>
<td>24.0</td>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>26.5</td>
<td>26.5</td>
<td>16.0</td>
<td></td>
</tr>
</tbody>
</table>

| ≥ 90                   |                |                                | WSP    | GB                      |
| 10                     | 7.0           | 7.0                            | 4.0    | 3.5                     |
| 20                     | 13.0          | 13.0                           | 7.5    | 6.5                     |
| 30                     | 18.5          | 18.5                           | 10.5   | 9.0                     |
| 40                     | 24.0          | 24.0                           | 14.0   | 12.0                    |
| 50                     | 29.5          | 29.5                           | 17.0   | 14.5                    |
| 60                     | 35.0          | 35.0                           | 20.0   | 17.0                    |

Adjustment Factors:
- Wind Exposure B = 1.0
- 4 BWL = 1.45
- Walls - 8 feet tall = 0.9
- Eave to ridge height - 10 feet tall = 0.9

Total = 1.31

Use Table R602.10.3(1) to determine required bracing length

Exterior braced wall lines

<table>
<thead>
<tr>
<th>One Story</th>
<th>Wall Line</th>
<th>90 mph</th>
<th>SDC</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSP</td>
<td>D</td>
<td>1, 3, 4</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>GB</td>
<td>S</td>
<td>C</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Interior braced wall lines

<table>
<thead>
<tr>
<th>One Story</th>
<th>Wall Line</th>
<th>90 mph</th>
<th>SDC</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSP</td>
<td>A</td>
<td>D</td>
<td>11.1</td>
<td>NA</td>
</tr>
<tr>
<td>GB</td>
<td>B</td>
<td>C</td>
<td>20.2</td>
<td></td>
</tr>
</tbody>
</table>
Bracing Topics

<table>
<thead>
<tr>
<th>Forces &amp; History</th>
<th>Limits</th>
<th>Bracing</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wind 90 mph, Exp B, SDC A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wind 90 mph, Exp B, SDC A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wind 85 mph, Exp B, SDC D</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Wind 90 mph, Exp C, SDC B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wind 105 mph, Exp C, SDC B</td>
</tr>
</tbody>
</table>

Questions

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