2009 IRC Wall Bracing Provisions

Bob Clark
APA
Raised Wood Floors?
Bracing in the IRC

2006 Bracing – 7 pages
Commentary – 157 pages

2009 Bracing – 26 pages
Commentary – 255 pages
APA – The Engineered Wood Association

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2009 IRC: Significant Changes

- Significant Changes from the 2007 Supplement to the 2009

1. Renamed, reorganized section and bracing methods within
2. Wall Bracing is no longer calculated as a percentage of the braced wall line length for wind
3. Required wall bracing for seismic and wind are separated in two separate tables (seismic only SDC C and D categories)
4. Required wall bracing for wind is based on the spacing of braced wall lines and adjustment factors (including wind exposure)
5. Braced wall line lengths are defined
6. For wind, braced wall lines may be spaced at 60’ max
7. Two new bracing methods – PFG and CS-SFB
Bracing Topics

Introduction
Getting Started
Bracing Basics
Connections
Other Topics


APA

R602.10
Introduction: Lateral Forces

Wind Speed

Earthquake
Introduction: Lateral Forces

Wind Speed & Seismic Design Categories

- Special Wind
- 150
- 140
- 130
- 120
- 110
- 100
- 90
- 85
- 0
- A
- B
- C
- D0
- D1
- D2
- E

117
83
67
50
33
17
0
Introduction: Lateral Forces

Wind

Force = Pressure x Area

Seismic

Force = Mass x Acceleration
Introduction: Lateral Forces

**Effects of Forces**

- **Racking**
  - Resisted by Bracing

- **Base Shear**
  - Resisted by Anchors

- **Overturning**
  - Resisted by hold-downs & Dead Load
Introduction: Lateral Forces
Introduction: Lateral Forces

Anchors

hold-down
Introduction: Load Path

1. Load on wall/roof
2. Transfer to roof
3. Connections
4. Transfer to wall
5. Transfer to foundation
Introduction: BWP vs. Shear Walls

**BWP (Prescriptive)**
- Limitations:
  - 3-Stories Maximum
  - Wind ≤110 mph
  - 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) Wind ≤ 100 mph in hurricane-prone regions.
Introduction: BWP vs. Shear Walls

Prescribed material & nailing

Calculated load, material & nailing

Braced Wall Panel (BWP)

VS.

Shear Wall

Hold-down capacity calculated
Introduction: BWP vs. Shear Walls

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."

Wind speeds greater than:
- 100 mph in hurricane-prone regions\(^{(1)}\), or
- 110 mph elsewhere to be designed using one of the following:
  - WFCM
  - ICC 600
  - ASCE-7
  - AISI S230 (steel)
Introduction: BWP vs. Shear Walls
Introduction: BWP vs. Shear Walls

Wall Framing

Panel resistance imparted to wall framing (Prevents hinging)
Introduction: BWP vs. Shear Walls

Wall Framing

Gypsum Sheathing

Braced Wall Panel (Prevents hinging)

Hinge
Getting Started: Terminology

BWP, BWL & Spacing

Braced Wall Panel (BWP)
Braced Wall Line (BWL)

BWP Spacing

BWL Spacing

R202
Getting Started: Terminology

R602.10.1.4
Getting Started: Terminology

6'  21' unbraced length  10'

2'  25'  2'

R602.10.1.4
Bracing Basics: BWL Spacing

Wind

BWL Spacing = 60' max.

Seismic

SDC C (only applies to townhouses)
BWL Spacing = 35' max.
Permitted to be = 50' max.

SDC D₀, D₁, & D₂ (all dwellings)
BWL Spacing = 25' max.
Permitted to be = 35' max.
- to accommodate one room not exceeding 900 ft²
- L/W < 3:1
- Top Plate Splice (12-16d)
- Increase bracing by factor of 1.4

Table R602.10.1.2(1),
Table R602.10.1.5,
& R602.10.1.5
10' = Max. Stud Height\(^{(1)}\)
16" = Max. Floor Framing Height\(^{(2)}\)

16" Max Floor Framing
(Joist Depth)

(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.
## Getting Started: Loads & Limits

### Wind Requirements Only

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

### Wind and Seismic Requirements

R301.2.2
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
Getting Started: Loads & Limits

Snow Load, R301.2.3

<table>
<thead>
<tr>
<th>Load</th>
<th>Design Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 70 psf</td>
<td>Prescriptive</td>
</tr>
<tr>
<td>&gt; 70 psf</td>
<td>Engineered</td>
</tr>
</tbody>
</table>
Bracing Topics

Introduction

Getting Started

Bracing Basics

Connections

Other Topics

- Braced Panel Construction
- Intermittent Bracing Methods
- Continuous Bracing Methods
- Mixing Bracing Methods
- BWP Placement
- BWL Spacing
- Required Bracing Length

APA
Bracing Basics: Intermittent Bracing

Intermittent Bracing Methods:
LIB - Let-in diagonal brace
DWB - 3/4" Diagonal wood boards
WSP - 3/8" Wood structural panel
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 - Intermittent portal frame
PFG - Intermittent portal frame at garage door openings in SDC A-C
Bracing Basics: Intermittent Bracing

**Method LIB – Let-in Brace**

- Angled 45 to 60 degrees from horizontal
- 1x4 lumber or approved metal strap
- Application limited
  - 1st and 2nd story in SDC A & B
  - 1st story in SDC C
  - Not permitted in SDC D0-D2
  - 16” o.c. stud spacing maximum

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R602.10.2
Bracing Basics: Intermittent Bracing

Method LIB – Let-in Brace

Must extend continuously from bottom plate to top plate
Bracing Basics: Intermittent Bracing

Method DWB – Diagonal Wood Boards

- Wood boards 3/4" (1" nominal) thick applied diagonally

8' to 12'

4' min.

R602.10.2
Bracing Basics: Intermittent Bracing

Method WSP – Wood Structural Panel
- 3/8" min. thickness

8' to 12'
4' min.

R602.10.2
Bracing Basics: Intermittent Bracing

Method SFB – Structural Fiberboard Sheathing
- 1/2" or 25/32" thick

R602.10.2
Bracing Basics: Intermittent Bracing

**Method GB – Gypsum Board**

- 1/2" min. thickness

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8' to 12'

4’-8’ min.

R602.10.2
Bracing Basics: Intermittent Bracing

Method PBS – Particleboard Sheathing

- 3/8" min. thickness
- Application Limited
  - 16” o.c. stud spacing maximum

8' to 12'

4' min.

R602.10.2
Method PCP – Portland Cement Plaster (Stucco)

- Installed in accordance with R703.6
- Application Limited
  - 16” o.c. stud spacing maximum

8' to 12'
4' min.

R602.10.2
Bracing Basics: Intermittent Bracing

Method HPS – Hardboard Panel Siding
- 7/16" min. thickness
- Application Limited
  - 16” o.c. stud spacing maximum

8' to 12'
4' min.
Exceptions:
1. Wall panels braced with Methods GB, ABW, PFG and PFH.
2. When an approved interior finish material with an in-plane shear resistance equivalent to gypsum board is installed.
3. For Methods DWB, WSP, SFB, PBS, PCP and HPS, omitting gypsum wall board is permitted when the length of bracing in Tables R602.10.1.2(1) and R602.10.1.2(2) is multiplied by a factor of 1.5.(1.4)
Bracing Basics: Braced Panel Construction

All vertical panel joints shall occur over studs

Gypsum
Method GB

Wood Structural Panel
Method WSP

R602.10.8
Bracing Basics: Braced Panel Construction

Blocking is required at horizontal edges of BWP's

Exceptions:
1. Blocking at horizontal joints is not required in wall segments that are not counted as braced wall panels.
2. Where the bracing length provided is 2x the minimum length required (Tables R602.10.1.2(1) and R602.10.1.2(2)) blocking at horizontal joints shall not be required in braced wall panels constructed using Methods WSP, SFB, GB, PBS or HPS.
3. When Method GB panels are installed horizontally, blocking of horizontal joints is not required.

R602.10.8
Bracing Basics: Intermittent Bracing

Method ABW - Alternate Braced Wall

- Narrower than 48", but equivalent to 48".
- For use in a 1-story, or 1st floor of 2-story dwelling

Wind Requirements

- Height – 8' to 12'
- Length – 28" to 42"

Seismic Requirements

- Height – 8' to 10'
- Length – 32" to 40"

Hold-down capacity per Table R602.10.3.2

#4 bars top and bottom for bracing
Min. footing is 12" x 12"

Figure R602.10.3.2
Bracing Basics: Intermittent Bracing

Method PFH – Intermittent Portal Frame
- 16" for 1-story, 24" for 2-story
- Replaces 48" braced panel

Extended header

Opening

16" or 24" min.

R602.10.3.3
Bracing Basics: Intermittent Bracing

Method PFH – Intermittent Portal Frame

- Extended header
- Strap capacity #1,000 (opposite side)
- 3" o.c. nailing
- Min. 3/8" thick wood structural panel*
- Hold-down capacity #4,200
- (1) 5/8" anchor bolt

10' Max.

R602.10.3.3
Bracing Basics: Intermittent Bracing

Method PFH – Intermittent Portal Frame

Min. #1,000 strap (opposite side)

Min. #1,000 hold-down

Min. #4,200 hold-down

R602.10.3.3
Bracing Basics: Intermittent Bracing

Method PFH – Intermittent Portal Frame

- Nail top plate to header with two rows of 16d nails at 3" o.c.
- Install 1000-lb strap

Nail schedule 8d common at 3" o.c.

R602.10.3.3
Bracing Basics: Intermittent Bracing

Method PFG – Intermittent Portal Frame at Garage

- For use in SDC A-C only
- Length of the panel is multiplied by 1.5
- Minimum 24” length
- Header 6' min. to 18' max.

Not to scale  R602.10.3.4
Bracing Basics: Intermittent Bracing

Method PFG – Intermittent Portal Frame at Garage

<table>
<thead>
<tr>
<th>1 or 2-Story</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
<td><strong>Min. length</strong></td>
</tr>
<tr>
<td>8'</td>
<td>24&quot;</td>
</tr>
<tr>
<td>9'</td>
<td>27&quot;</td>
</tr>
<tr>
<td>10'</td>
<td>30&quot;</td>
</tr>
</tbody>
</table>

Limited to 10' height maximum Including header height

R602.10.3.4
**Bracing Basics: Intermittent Bracing**

### Minimum Braced Panel Length

Table R602.10.3 Effective length of braced panels less than 48"

<table>
<thead>
<tr>
<th>Actual Length</th>
<th>Effective Length of BWP</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>8'</td>
</tr>
<tr>
<td>48&quot;</td>
<td>48&quot;</td>
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<tr>
<td>42&quot;</td>
<td>36&quot;</td>
</tr>
<tr>
<td>36&quot;</td>
<td>27&quot;</td>
</tr>
</tbody>
</table>

For Methods DWB, WSP, SFB, PBS, PCP, HPS

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**APA**

R602.10.3
Bracing Basics: Intermittent Bracing

Minimum Braced Panel Length – Walls 10 – 12 ft tall

Table R602.10.3.1 Minimum length for braced wall panels

<table>
<thead>
<tr>
<th>Method</th>
<th>BWP Height</th>
<th>Height</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBW, WSP, SFB, PBS, PCP, HPS &amp; GB two-sided</td>
<td>4'-0&quot;</td>
<td>10'</td>
<td>4'-10&quot;</td>
</tr>
<tr>
<td>Method GB single-sided</td>
<td>8'-0&quot;</td>
<td>11'</td>
<td>9'-8&quot;</td>
</tr>
</tbody>
</table>
Bracing Basics: Intermittent Bracing

Bracing Per Code Report
Bracing Basics: Continuous Method

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)*
- Continuous sheathing with WSP is described in R602.10.4
- Continuous sheathing with SFB is described in R602.10.5

R602.10.4 & R602.10.5
Bracing Basics: Continuous Method

**Method CS-WSP**
Continuous Sheathing with Wood Structural Panel

- Area above and below openings fully sheathed
- Min 3/8” wood structural panel sheathing

**Method CS-SFB**
Continuous Sheathing with Structural Fiberboard Sheathing

- Area above and below openings fully sheathed
- Min 1/2" structural fiberboard sheathing
Method CS-WSP

Full-height sheathed wall segments having a width equal or greater than Table R602.10.4.2 are counted toward the total bracing length.

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

25' Max.

Infill Sheathing

Too Narrow

R602.10.4.2
Bracing Basics: Continuous Method

Opening Height

R602.10.4 & R602.10.5
## Bracing Basics: Continuous Method

### Method CS-WSP

<table>
<thead>
<tr>
<th>Method</th>
<th>Adjacent Clear Opening Height (ft)</th>
<th>Wall Height (ft)</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
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<tr>
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</tbody>
</table>

### Braced Panel Length Requirements for Continuously Sheathed Wall Lines (in)

| 2012 Table- Error |

### Method CS-G

<table>
<thead>
<tr>
<th>Method</th>
<th>Adjacent Clear Opening Height (ft)</th>
<th>Wall Height (ft)</th>
<th>8</th>
<th>9</th>
<th>10</th>
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</table>

### Method CS-PF

<table>
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<tr>
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<th>Adjacent Clear Opening Height (ft)</th>
<th>Wall Height (ft)</th>
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<th>9</th>
<th>10</th>
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<th>12</th>
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<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>24</td>
</tr>
</tbody>
</table>

a. Garage opening adjacent to method CS-G panel shall have header. Max opening height includes header height.
Bracing Basics: Continuous Method

**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
- Apply to only one wall of garage

---

Table R602.10.4.1
Bracing Basics: Continuous Method

Method CS-PF  Continuous portal frame
- Walls on either or both sides of openings 16”-24”.
- Used on different wall types

16”-24”  Fully sheathed dwelling

10' Max

Opening

R602.10.4.1.1
Bracing Basics: Continuous Method

Method CS-PF

Garage only shown, story above permitted.

16" min.

R602.10.4.1.1
Bracing Basics: Continuous Method

Method
CS-PF

Pony Wall

Figure R602.10.4.1.1

OVER CONCRETE OR MASONRY BLOCK FOUNDATION
Outside Elevation

Extent of header (two braced wall segments)
Extent of header (one braced wall segment)

Pony wall height

12’ Max. total wall height
10’ Max. height

Header shall be fastened to the king stud with 6-16D sinker nails required per R602.3.2
Minimum 1000 lb header-to-jack-stud strap shall be centered at bottom of header and installed on backside as shown on side elevation
2’ to 18’ (finished width)

Braced wall line with continuous sheathing
Min. number of studs shown
Full-length king stud

Full-length king stud
3/8” min. thickness wood structural panel sheathing

No. of jack studs per table R502.5(1&2)
2 Anchor bolts per R403.1.6 required
Foundation per code

Min. 1000 lb tension strap. Strap shall be centered at bottom of header.
Sheathing filler if needed
16d sinker nails in 2 rows @ 3” o.c.
Wood Structural panel must be continuous from top of wall to bottom of wall, or from top of wall to permitted splice area
Full-length king studs

Min. 3” x 11-1/4” net header
Not to scale
## Bracing Basics: Continuous Method

### Method CS-PF

**Table R602.10.4.1.1: 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>
</tr>
</thead>
<tbody>
<tr>
<td>2 × 4 No. 2 Grade</td>
<td>0</td>
<td>10</td>
<td>18</td>
<td>85 90 100 85 90 100</td>
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<td></td>
<td></td>
<td></td>
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<td>Exposure B</td>
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<td>Exposure C</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Tension strap capacity required (lbf)</strong></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>9</td>
<td>1000 1000 1000 1000 1000 1000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>16</td>
<td>1000 1000 1000 1000 1000 1275</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>12</td>
<td>18</td>
<td>1000 1200 2100 2175 2725 DR</td>
</tr>
</tbody>
</table>

*Note: DR indicates Design Required.*
## Bracing Basics: Continuous Method

### Method CS-PF

Table R602.10.4.1.1 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>
</tr>
</thead>
<tbody>
<tr>
<td>2 × 4 No. 2 Grade</td>
<td>4</td>
<td>12</td>
<td>9</td>
<td>85 90 100 85 90 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>Exposure B Exposure C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td>Tension strap capacity required (lbf)</td>
</tr>
<tr>
<td>2 × 6 Stud Grade</td>
<td>2</td>
<td>12</td>
<td>16</td>
<td>9 1775 2350 3500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>1000 1325 1375 1750</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2050</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2925 3000 3550</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DR DR DR DR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2650 3150 DR DR DR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3125 3675 DR DR DR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DR DR DR DR</td>
</tr>
</tbody>
</table>
Bracing Basics: Continuous Method

Method CS-PF

Plan View

Garage Door

16" Garage returns

R602.10.4.1.1
Bracing Basics: Continuous Method

Method CS-G / PF

CS-G 24”min

CS-PF 16”min.

Extended Header for CS-PF
Bracing Basics: Continuous Method

Method CS-PF (RAISED OR SECOND FLOOR)
<table>
<thead>
<tr>
<th>Wall Bracing Parameter</th>
<th>Continuous Sheathing Wood Structural Panel (CS-WSP)</th>
<th>Continuous Sheathing 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 10'</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>12.5’ Wind / 8’ Seismic</td>
<td>12.5’</td>
</tr>
</tbody>
</table>
Outside Corner Detail

Gypsum
16d nail at 12" o.c.
Plywood/OSB

Inside Corner Detail

Gypsum
16d nail at 12" o.c.
Plywood/OSB

2009 IRC: Continuous Sheathing

Figure R602.10.4.4(1)
Continuous Sheathing Method Corner Details

(Figures R602.10.4.4(2),(3),(4),(5))

1. BWP meeting min. required length at both ends of BWL
   - Min. 2’ return corner for CS-WSP
Continuous Sheathing Method Corner Details

(Figures R602.10.4.4(2),(3),(4),(5))

2. BWL with Continuous Sheathing w/o Corner Return Panel
   - 800 lb Hold-down in lieu of corner return

2009 IRC: Connections
Continuous Sheathing Method Corner Details

(Figures R602.10.4.4(2),(3),(4),(5))

3. BWL with Continuous Sheathing where the first BWP is away from the End of the Wall
   ▪ Minimum 2’ Panels at both Sides of Corner
4. BWL with Continuous Sheathing where the first BWP is away from the End of the Wall w/ Hold-Down
   - 800 lb Hold-down in lieu of corner return
BWP method variation within a BWL permitted *ONLY* in SDC A-B and for detached houses in SDC C with *intermittent bracing*

Not applicable for use with continuous sheathing or dwellings in SDC D₀-D₂
# Bracing Basics: BWP Placement

## Overview

<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>SDC D₀-D₂</td>
<td>Wind &amp; SDC A-C</td>
<td>SDC D₀-D₂</td>
</tr>
<tr>
<td>Panel end distance</td>
<td>12.5’</td>
<td>0’ or 8’ (a)</td>
<td>12.5’</td>
</tr>
<tr>
<td>Corner return length</td>
<td>Not required</td>
<td>24’ Min. (b)</td>
<td>32’ Min. (b)</td>
</tr>
</tbody>
</table>

(a) 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 Basics: BWP Placement

Offset Limitations

- BWP that are counted as part of a BWL must be in line.
- Offsets out-of-plane up to 4’ shall be permitted such that the total out-to-out offset is not more than 8 feet.

R602.10.1.4
Bracing Basics: BWP Placement

A B C

R602.10.1.4
Bracing Basics: BWP Placement

Wind Requirements:
- 25' Centers
- "X" End
- BWP Width

Diagram dimensions:
- 24' length
- 16' width
- 4' and 6' height

R602.10.1.4
Bracing Basics: BWP Placement

BWL

R602.10.1.4
Bracing Basics: T & L Shape Buildings

STEP 1: Divide the structure into rectangular elements.

- Easiest to divide the building in such a way that the “common side” (or shared side) of the two rectangles contains wall segments which can be used for bracing.
Bracing Basics: T & L Shape Buildings

STEP 3: Rejoin Rectangles per Rules

1. The total bracing from both rectangles along the common side must be provided on the common side. One of the corner bracing elements of the two rectangles was moved to illustrate this point.

2. In the example shown above where the wall line for Rectangle 1 extends past the common side, the entire length of the common braced wall line of Rectangle 1 may be used to position the braced wall panels from both rectangles.

3. The wall bracing location provisions of IRC Section R602.10.1.4 must be met along the common side, as well as along the extended wall line.
Bracing Basics: BWP Placement

Does this meet code?
- No, 25' maximum exceeded.
Bracing Basics: BWP Placement

Does this meet code?
- Yes, 25' maximum **not** exceeded.
Bracing Basics: BWP Placement

Does this meet code?
Yes, this meets code

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

12'-6" Max.
25' Max.
48"

R602.10.1.4, Figures R602.10.1.4(1) and R602.10.1.4(2)
Bracing Basics: BWP Placement

Does this meet code?

- No, BWP required to begin no more than 12'-6" from the end of the wall.

Wind

- 25' Centers
- "X" End
- BWP Width
Bracing Basics: BWP Placement

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

Wind & Seismic
- 25' Centers
- "X" End
- ✗ BWP Width

48" 18' 48"
Bracing Basics: BWP Placement

Does this meet code?

- No, placement from the end too far

<table>
<thead>
<tr>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ 25' Centers</td>
</tr>
<tr>
<td>✗ &quot;X&quot; End</td>
</tr>
<tr>
<td>✓ BWP Width</td>
</tr>
</tbody>
</table>

R602.10.1.4
Bracing Basics: BWP Placement

Does the second story meet code?

Wind

- ✔ 25' Centers
- ✗ "X" End
- ✗ BWP Width

R602.10.1.4
Bracing Basics: BWP Placement

Does this meet code for ABW?

- Yes, width requirements are met.
  - 2'-4" (28") required per Table R602.10.3.2 for 8' wall

Wind

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

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

ABW

Equals 4'

Holdowns per R602.10.3.2

R602.10.1.4
Bracing Basics: BWP Placement

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

Wind & Seismic
- 25' Centers
- "X" End
- BWP Width

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

R602.10.1.4 & R602.10.3.3
Bracing Basics: BWP Placement

How many BWL's?
# Bracing Topics

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Getting Started</th>
<th>Bracing Basics</th>
<th>Connections</th>
<th>Other Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Braced Panel Construction
- Intermittent Bracing Methods
- Continuous Bracing Methods
- Mixing Bracing Methods
- BWP Placement
- BWL Spacing
- Required Bracing Length

---

[APA Logo]
# Bracing Basics: Required Bracing Length

## Bracing Length Tables

2009 – Two bracing length tables

- **Wind** Table R602.10.1.2(1)
- **Seismic** Table R602.10.1.2(2)

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

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Braced Wall Line Spacing (ft)</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;= 110 (mph)</td>
<td></td>
<td></td>
<td>10, 10</td>
<td>14.5, 14.5</td>
<td>23, 23</td>
<td>27.5, 27.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30, 18.5</td>
<td>18.5, 18.5</td>
<td>23, 23</td>
<td>27.5, 27.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40, 23</td>
<td>23, 23</td>
<td>23, 23</td>
<td>27.5, 27.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50, 27.5</td>
<td>27.5, 27.5</td>
<td>23, 23</td>
<td>27.5, 27.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60, 10.5</td>
<td>10.5, 10.5</td>
<td>6, 6</td>
<td>10.5, 10.5</td>
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<td></td>
<td></td>
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<td>30, 19</td>
<td>19, 19</td>
<td>19, 19</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40, 36</td>
<td>36, 36</td>
<td>36, 36</td>
<td>27.5, 27.5</td>
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<td></td>
<td>50, 44</td>
<td>44, 44</td>
<td>44, 44</td>
<td>27.5, 27.5</td>
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<tr>
<td></td>
<td></td>
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<td>60, 52.5</td>
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<td>30, 30</td>
<td>27.5, 27.5</td>
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</table>

<table>
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<th>Seismic Design Category (SDC)</th>
<th>Story Location</th>
<th>Braced Wall Line Length (ft)</th>
<th>Method LIB</th>
<th>Methods DWB, SFB, GB, PBS, PCP, HPS</th>
<th>Method WSP</th>
<th>Continuous Sheathing</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDC D_{e} or D_{f}</td>
<td></td>
<td>10</td>
<td>NP</td>
<td>3</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>NP</td>
<td>6</td>
<td>4</td>
<td>3.4</td>
</tr>
<tr>
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<td>30</td>
<td>NP</td>
<td>9</td>
<td>6</td>
<td>5.1</td>
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<tr>
<td></td>
<td></td>
<td>40</td>
<td>NP</td>
<td>12</td>
<td>8</td>
<td>6.8</td>
</tr>
<tr>
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<td></td>
<td>50</td>
<td>NP</td>
<td>15</td>
<td>10</td>
<td>8.5</td>
</tr>
</tbody>
</table>

R602.10.1.2, Table R602.10.1.2(1), Table R602.10.1.2(2) & Table R602.10.1.2(3)
## Bracing Basics: Required Bracing Length

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</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>
</tr>
<tr>
<td>≤ 90 (mph)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>20</td>
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<td>50</td>
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<td>20</td>
<td>10</td>
<td>7</td>
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<td>20</td>
<td>13</td>
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<td></td>
<td>30</td>
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<td>29.5</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>35</td>
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</table>

Table R602.10.1.2(1)
Bracing Basics: Required Bracing Length

Bracing Requirements Based on Wind Speed – Adjustment Factors

Wind bracing adjustment factors found in the footnotes of Table R602.10.1.2(1)

Footnote:
   a) Wind exposure category
   b) Mean roof height
   c) Eave-to-ridge height
   d) Wall height
   e) Number of braced wall lines
   f) Application of gypsum board finish
   g) Single sided Method GB factor
   h) Method LIB gypsum finish board requirement
   i) Reduction factor for tie downs added to each braced wall panel

Table R602.10.1.2(1)
### Bracing Basics: Required Bracing Length

#### Adjustment Factor – Wind Exposure Category, Mean Roof Height

Table R602.10.1.2(1), footnote a, b

<table>
<thead>
<tr>
<th>Number of Stories</th>
<th>Exposure/Height Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposure B</td>
</tr>
<tr>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Getting Started: 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.
Getting Started: 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.
Getting Started: Wind Exposure

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.

R301.2.1.4.3
Exposure D:
Flat, unobstructed areas exposed to wind flowing over open water for at least 1 mile. Extends inland 1,500 feet.
### Bracing Basics: Required Bracing Length

#### Adjustment Factor – Roof Eave-to-Ridge Height

Table R602.10.1.2(1), footnote c

<table>
<thead>
<tr>
<th>Support Condition</th>
<th>Roof Eave-to-Ridge Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 5'</td>
</tr>
<tr>
<td>Roof only</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>
</tbody>
</table>

NP – Not Permitted

---

**Diagram:**
- Eave-to-ridge height
- Roof sail area that contributes to total structure sail area

# Bracing Basics: Required Bracing Length

## Adjustment Factor – Wall Height

Table R602.10.1.2(1), footnote d

<table>
<thead>
<tr>
<th>Wall Height (ft)</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>10'</td>
<td>1.0</td>
</tr>
<tr>
<td>9'</td>
<td>0.95</td>
</tr>
<tr>
<td>8'</td>
<td>0.9</td>
</tr>
<tr>
<td>12'</td>
<td>1.1</td>
</tr>
</tbody>
</table>
## Bracing Basics: Required Bracing Length

### Adjustment Factor – Number of Braced Wall Lines

Table R602.10.1.2(1), footnote e

<table>
<thead>
<tr>
<th>Number of Braced Wall Lines</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<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>

- Braced wall line
- Braced wall line spacing
Bracing Basics: Required Bracing Length

Adjustment Factor – No gypsum finish board applied to interior of wall line

Table R602.10.1.2(1), footnote f

<table>
<thead>
<tr>
<th>Bracing Method</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method LIB</td>
<td>1.8</td>
</tr>
<tr>
<td>Methods DWB, WSP, SFB, PBS, PCP, and HPS</td>
<td>1.4</td>
</tr>
</tbody>
</table>
# Bracing Basics: Required Bracing Length

## Adjustment Factors – Footnotes g, h, and i

<table>
<thead>
<tr>
<th>Table R602.10.1.2(1) Footnote</th>
<th>Methods</th>
<th>Requirements</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>g</td>
<td>GB</td>
<td>Single sided gypsum</td>
<td>2.0</td>
</tr>
<tr>
<td>g</td>
<td>GB</td>
<td>Double sided gypsum when fastened 4” o.c. at panel edges and blocked at horizontal joints</td>
<td>0.7</td>
</tr>
<tr>
<td>h</td>
<td>LIB</td>
<td>Gypsum board must be attached to at least one side using Section R602.10.2 Method GB fastening requirements</td>
<td>1.0</td>
</tr>
<tr>
<td>i</td>
<td>DWB, WSP, SFB, PBS, PCP, and HPS</td>
<td>In one story buildings and top of two or three story buildings, when 800 lb minimum uplift hold-downs are fastened to end studs of each braced wall panel in the braced wall line and to the framing or foundation below.</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Bracing Basics: Required Bracing Length

Bracing Requirements Based on Seismic Design Category

Seismic Bracing Table based on:
- Soil Class D
- Wall height of 10 ft
- Floor dead load of 10 psf
- Roof/ceiling dead load of 15 psf
- Braced wall line spacing ≤ 25 ft

Required bracing length is determined by:
- Seismic design category
- Story location
- Braced wall line length
- Bracing method

<table>
<thead>
<tr>
<th>Seismic Design Category (SDC)</th>
<th>Story Location</th>
<th>Braced Wall Line Length (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>SDC D₀ or D₁</td>
<td>10</td>
<td>NP</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>NP</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>NP</td>
<td>9</td>
</tr>
<tr>
<td></td>
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Table R602.10.1.2(2) & (3)
### Bracing Basics: Required Bracing Length

**Seismic bracing adjustment factors found in Table R602.10.1.2(3)**

<table>
<thead>
<tr>
<th>Adjustment based on:</th>
<th>Adjustment Factor</th>
<th>Applies To:</th>
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<tbody>
<tr>
<td>Story Height (R301.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤10 ft</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>&gt; 10 ft, ≤12 ft</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Braced wall line spacing – townhouses in SDC C</td>
<td></td>
<td>All bracing methods – R602.10.2, R602.10.4, and R602.10.5</td>
</tr>
<tr>
<td>&lt; 35 ft</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>&gt; 35 ft ≤ 50 ft</td>
<td>1.43</td>
<td></td>
</tr>
<tr>
<td>Wall dead load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 8 lb ≤ 15 lb</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>≤ 8 lb</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Roof /Ceiling dead load for wall supporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof only or Roof + Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 15 psf</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Roof only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 15 psf ≤ 25 psf</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Roof + Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 15 psf ≤ 25 psf</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Walls with stone or masonry veneer in SDC C-D&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td>See R602.12/R703.7</td>
</tr>
<tr>
<td>Cripple Walls</td>
<td></td>
<td>See R602.1.9</td>
</tr>
</tbody>
</table>
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.
Connections: Corners & Collectors

Braced Panel Starting Location

- **Wind**
  - Up to 12.5’ combined (intermittent)
  - Up to 12.5’ each end (continuous)

- **Seismic**
  - 0’ for Non-Method WSP
  - 8’ for Method WSP each end

Distance from Corner

8' to 12'

Corner (end of wall line)

R602.10.1.4
Connections: Corners & Collectors

Engineered Collector

Upper Top Plate

Lower Top Plate or Header

Splice Length (for fastening each side of joint)

Reference:
APA publication TT-102
Collector Design for Bracing in Conventional Construction
Connections: Corners & Collectors

Engineered Collector

Nail all splices beyond BWP
Greater than min. permitted

First bracing panel
Cripple Walls

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

Main Concepts
- Code provisions defined in R602.10.9.
- There are two methods for determining the required braced panel length for cripple walls.
Cripple Walls

Seismic Design Categories A-D₁

Cripple Wall
Supporting One Story

Bracing Length from Table R602.10.1.2(1) or (2) for Roof only

1.15 x Roof only Bracing Length

18' BWP o.c.

or

Redesignated as a Two-story

Bracing Length from Table R602.10.1.2(1) or (2) for Roof only

Roof + Floor Bracing Length

25' BWP o.c.

R602.10.9
Cripple Walls

Seismic Design Categories A-D₁

Cripple Wall Supporting Two Stories

| Bracing Length from Table R602.10.1.2(1) or (2) for Roof only |
| Bracing Length from Table R602.10.1.2(1) or (2) for Roof + 1 Floor |
| 1.15 x Roof + 1 Floor BP Length |

or

Redesignated as a Three Story

| Bracing Length from Table R602.10.1.2(1) or (2) for Roof only |
| Bracing Length from Table R602.10.1.2(1) or (2) for Roof + 1 Floor |
| BP length for Roof + 2 Floors |

18' BWP o.c. 25' BWP o.c.

R602.10.9
Cripple Walls

Stacked framing not permitted
# Bracing Topics

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Getting Started</th>
<th>Bracing Basics</th>
<th>Connections</th>
<th><strong>Other Topics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>Cripple Walls</td>
</tr>
<tr>
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<td>Masonry Veneer</td>
</tr>
<tr>
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<td>Examples</td>
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</table>
Examples: Whole House

Example 1
- Single-family dwelling
- Wind 90 mph
- Method WSP
- 1st of 2 stories

<table>
<thead>
<tr>
<th>WSP 1 of 2</th>
<th>90 mph</th>
<th>BWL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>25’’, 40’’</td>
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</tbody>
</table>
Examples: Whole House

<table>
<thead>
<tr>
<th>Basic Wind Speed</th>
<th>Story Location</th>
<th>Braced Wall Line Spacing (feet)</th>
<th>Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Method LIB(^a)</td>
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<td></td>
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<td>9.5</td>
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<tr>
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<td></td>
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<td>15.5</td>
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<td>18.5</td>
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<tr>
<td>10</td>
<td></td>
<td></td>
<td>7.0</td>
</tr>
<tr>
<td>30</td>
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<td>13.0</td>
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<tr>
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<td>18.5</td>
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<tr>
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<td>24.0</td>
</tr>
<tr>
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<td></td>
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</tr>
<tr>
<td>60</td>
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<td></td>
<td>NP</td>
</tr>
</tbody>
</table>
Examples: Whole House

Example 1

- Single-family dwelling
- Wind 90 mph
- Method WSP
- 1st of 2 stories

Required Wall Bracing (Table R602.10.1.2(1))

BWL Spacing A & B 40’ = 14’
BWL Spacing 1 & 2 25’ (roundup to 30’) = 10.5’
BWL 1: \((8+4) = 12 > 10.5'\) OK
BWL 2: \((4+4+4) = 12 > 10.5'\) OK
BWL A: (4'+6') = 10' < 14' NG
BWL B: (5'+5') = 10' < 14' NG

Try Continuous Sheathing (CS-WSP) on BWL A&B
Examples: Whole House

**Example 1**

- Method CS-WSP (BWL A & B)
- 1st of 2 stories
- 9’ wall height

Required Wall Bracing (Table R602.10.1.2(1))

BWL Spacing A & B 40’ = 12’

For the CS-WSP method:

1. All sheathable areas of the BWL must be sheathed in WSPs (includes above and below openings)
2. BWPs must meet length requirements of Table R602.10.4.2
   - Wall Height = 9’, Windows are 6’=72”, BWP must be > 27”
3. Must meet 2’ return at corners or use hold-downs.
Examples: Whole House

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Braced Wall Line Spacing (feet)</th>
<th>Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Method LIB&lt;sup&gt;4,9&lt;/sup&gt;</td>
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<td>3.5</td>
<td>7.0</td>
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<td>9.5</td>
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<tr>
<td>60</td>
<td></td>
<td>NP</td>
<td>52.0</td>
</tr>
</tbody>
</table>
BWL A: (3+4+6) = 13 > 12' OK
BWL B: (3+5+5) = 13 > 12' OK
Examples: Whole House

Example 1, Continued

- Single-family dwelling
- Wind 90 mph
- Method WSP
- 2nd of 2 stories

Required Wall Bracing (Table R602.10.1.2(1))
BWL Spacing A&B 40’ = 7.5’
BWL Spacing 1&2 25’ (roundup to 30’) = 5.5’
Examples: Whole House

**TABLE R602.10.1.2(1)**

<table>
<thead>
<tr>
<th>Basic Wind Speed (mph)</th>
<th>Story Location</th>
<th>Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Braced Wall Line Spacing (feet)</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
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<td>≤ 90 (mph)</td>
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<td>NP</td>
<td>44.0</td>
</tr>
<tr>
<td>60</td>
<td>NP</td>
<td>52.0</td>
</tr>
</tbody>
</table>
BWL 1: \((4’+4’) = 8’ > 5.5’\) OK
BWL 2: \((4’+4’) = 8’ > 5.5’\) OK

End spacing \(\leq 12.5\) is violated!  Old code said \(\leq 12.5’\) either end
New code says (combined spacing from each end) \(\leq 12.5’\)
BWL 1: \(9’+7’=16’\) and BWL 2: \(9’+10’=19’\)
BWL 1: (4'+4') = 8’ > 5.5’ OK
BWL 2: (4'+4') = 8’ > 5.5’ OK

End spacing <= 12.5 is ok
BWL 1: 9’<=12.5’ and BWL 2: 9’<=12.5’
BWL A: (4'+4') = 8’ > 7.5’ OK
BWL B: (4'+4') = 8’ > 7.5’ OK

<table>
<thead>
<tr>
<th>WSP</th>
<th>90 mph</th>
<th>BWL</th>
</tr>
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<tbody>
<tr>
<td>2 of 2</td>
<td>40’, 30’</td>
<td></td>
</tr>
</tbody>
</table>
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