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## **Learning Objectives**

- •At the end of this program, participants will have learned:
- 1. All loads (e.g., vertical loads, lateral loads, impact loads, etc.) on a building or structure must be provided with a continuous path to the foundation, connections must also be designed to resist and transfer the applied loads to the foundation. The connections must be adequately designed to transfer all of the loads.
- $2_{ ilde{ }}$  Braced walls are constructed by using prescribed methods and techniques called out in the building codes, SDC C & greater. When wind speeds fall outside the scope of prescriptive codes, engineered shear walls must be used.
- 3. Collector elements serve to transfer forces between floor diaphragms and members of the lateral force resisting system. Connections of adequate size, type, capacity and spacing are required to ensure the continuous load path from the horizontal lateral load-resisting member or system to the vertical lateral load-resisting member or system.
- 4. The reaction at the base of a structure due to an applied lateral load, or sliding force, is the most common structural failure noted after seismic activity. Adequate fastening and connection detailing is critical to avoid compromising the shear wall elements. Horizontal sliding may be resisted by the use of connectors at connection points.

# Agenda

- Background
- Code Review and Explanation
  - SDC A, B, and C Wind < 110</p>
  - Braced Wall Lines
  - Braced Wall Panels
  - Narrow Options
- Designing for the Code
  - Design Strategies
  - Creating Wall Bracing Plans

## What Could Have Prevented This?



### What Causes Shear in a Structure?

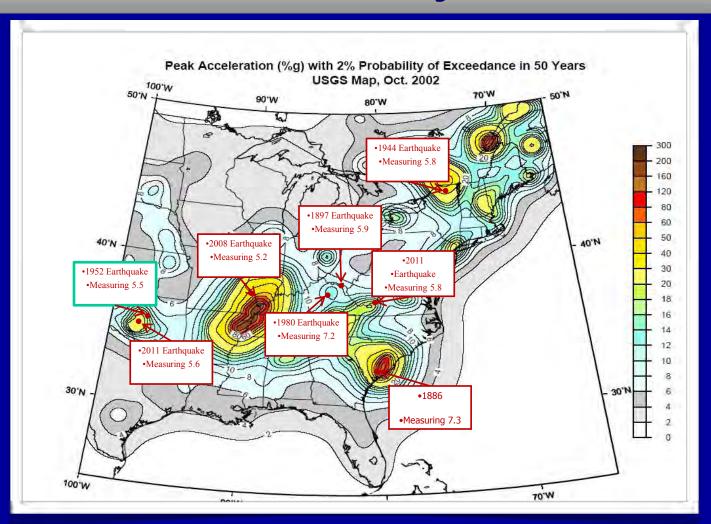
- High Winds (Hurricanes/Tornados Gusts)
  - •In the United States the minimum wind design speed is 90 mph; equivalent to about 25 psf of lateral loads
- Seismic
  - Seismic maps for 2006 IBC increased many SDC in the Southeast.

### Seismic Map Eastern US

SDCC = 33 %g

**SDC D1 = 50 %g** 

SDC D2 = 83 %g



## Basic Wind Speed Map

Eastern US (based on 3-second gusts in mph)



## Result of Shear

- Structural Failure
- Cracked Veneer (Brick or Stucco)
- Cracked Windows or Window
   Frames
- Damaged Drywall

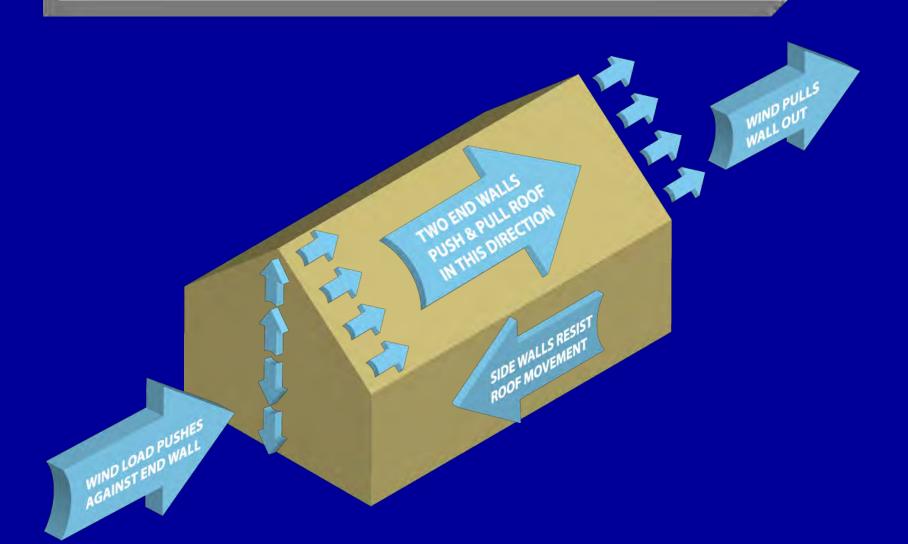
# ALL THESE ITEMS COST \$\$ AND LOST PRODUCTIVITY

## **Building Code**

MMC presentation in DC

- Multihazard Mitigation Council (MMC)
  - Public/Private partnership designed to reduce the societal and economic costs of natural hazards
- Costs:
  - FEMA grants for flood, wind and earthquake mitigation totaled \$3.5 Billion between 1993 and 2003
  - Per analysis; each \$1 spent for mitigation saved \$4 for reconstruction.
  - Similarly, the Building Code is intended to minimize/eliminate reconstruction costs and other related costs of catastrophes.

## Wind Load Path



## Lateral Loads Basics

Components of load



**Sliding** 

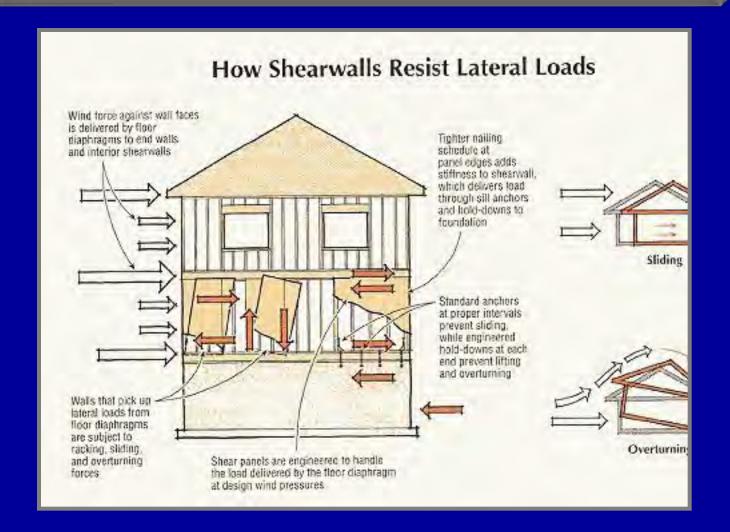
Overturning



**Racking** 

## Lateral Loads Basics

Resistance to Sliding and Overturning



#### Construction Trends

- Smaller footprints
- Larger openings
- More multi-story structures
- Mechanical fasteners

### Result:

• Less wall area to transfer lateral loads in a structure!!



## What is New?

- Old building codes: SBC
  - 1999 SBC had 2 pages +/-
  - Required engineered connections
  - Min. width of braced wall panel is 4'-0
  - No narrow options
- New building codes: IBC & IRC
  - More intricate requirements
  - IRC 2006 7 pages
  - Narrow options
  - IRC 2012 32 pages

## Braced Walls in the 2012 IRC

- Continuous improvement to the organization of BW requirements
- Reorganized to consolidate BWL length, spacing and orientation into one section
- BWP now allowed to be up to 10ft from end of BWL instead of 12.5ft
- Wind adjustment footnotes have now been consolidated into a table
- Bracing methods consolidated into one section
- Minimum BWP lengths consolidated into one table
- All ABW now consolidated into one section
- Simplified BW section added for low wind and low seismic areas.

# Today's Discussion

- 2006 International Residential Code Section R602.10`
- 2007 Supplement IRC Section R602.10
- A Guide to 2006 Wood Wall Bracing Provisions
- Limiting discussion to SDC A, B, and C

# IRC Chapter 3 Design Limitations

- Wind < 100 mph to < 110 mph in hurricane-prone regions</li>
- Seismic SDC A,B,C,  $D_1,D_2,D_3$
- Snow < 70 psf ground snow load</li>
- 1- and 2- family dwellings
- Maximum 3 Stories
- Height of laterally unsupported (perpendicular) loadbearing stud is 12'-0"
- Seismic provisions weight of materials, irregular buildings
- See Chapter 3 for other design limitations

## Identify Braced Wall Lines SDC A, B, and C

#### General Rule of Thumb:

- All exterior walls should be braced.
- If exterior walls are spaced more than 35' apart, some interior walls should also be braced.
  - Select the interior walls that have fewer openings
  - Select interior walls that begin and end at a Braced Wall Line (implied)

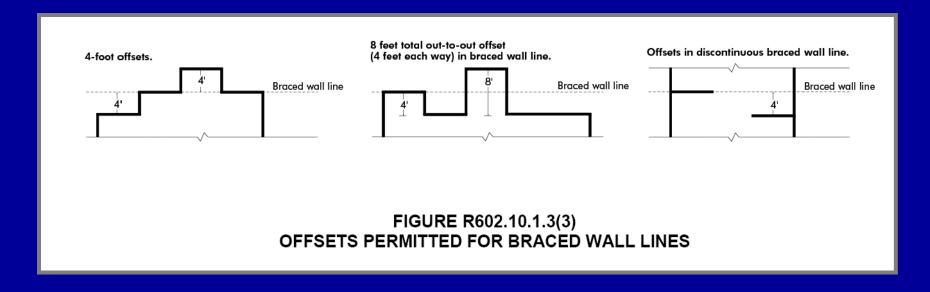
# Spacing of Braced Wall Lines, Cont. SDC A, B, and C

#### Exception:

- Allowable increases in the spacing of braced wall lines up to 50' provided:
  - Length to width ratio of the supporting diaphragm does not exceed 3:1
  - Minimum required wall bracing is increased by a ratio of actual distance between braced wall lines divided by 35'
  - Example: SDC A, wind speed <100 mph, one-story structure: 45' spacing / 35' = 1.29 \* 16% = 21%
- Increasing bracing amounts on exterior walls may be difficult due to openings

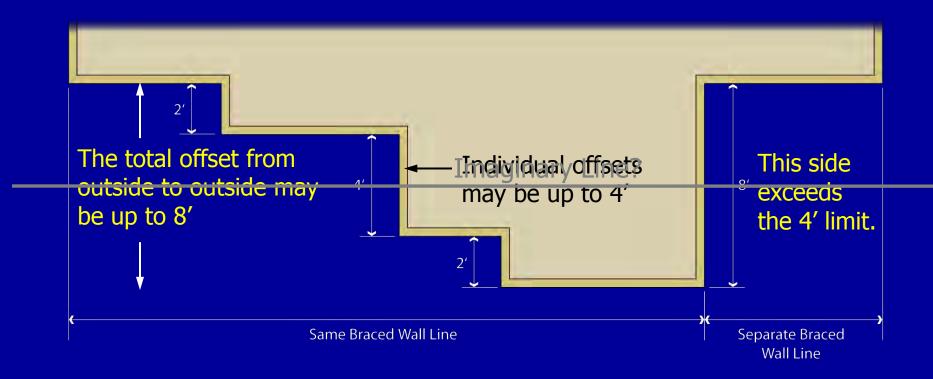
## Braced Wall Lines SDC A, B, and C

• Braced wall panels must line up within a braced wall line. Out-of-plane offsets of up to 4' are permitted provided the total out-of-plane offset does not exceed 8' within any braced wall line.

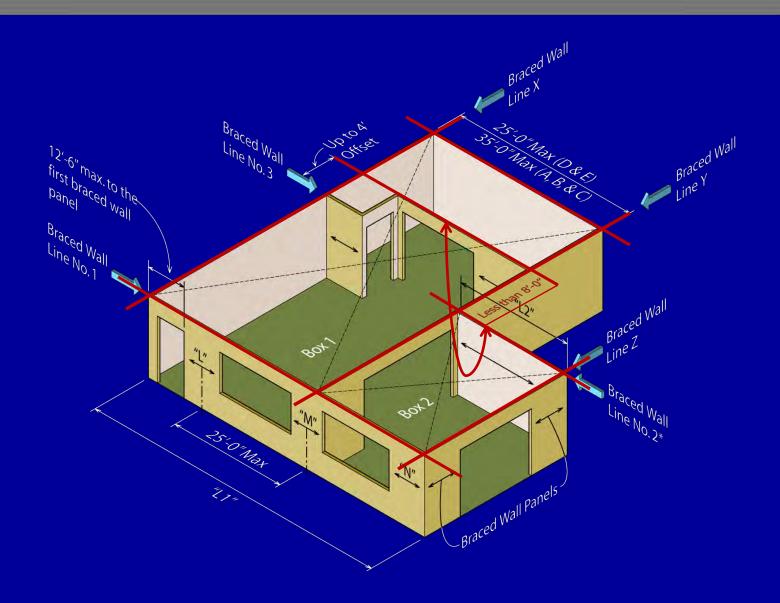


Clarified in 2007 Supplement

## Braced Wall Lines SDC A, B, and C



#### Create a Grid

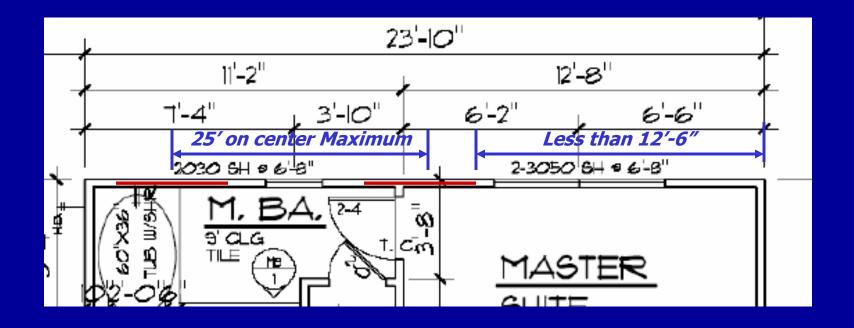


#### **Braced Wall Lines**

- Braced wall lines shall consist of braced wall panels
  - Panels are required at the corner or within 12'-6" from the corner and at least every 25' on center
  - Refer to 2006 Table R602.10.1 or 2007 Table R602.10.1(2) for minimum amounts

#### **Braced Wall Panel Location**

 Braced wall panels shall begin no more than 12.5' from each end of a braced wall line, and repeat every 25' on center.



#### What are Braced Wall Panels?

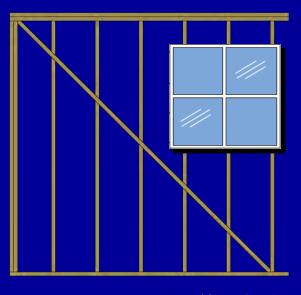
- The construction of BWP's must be in accordance with one of the following methods:
  - 1) LIB 1x4 continuous (let in) diagonal bracing
    - Must be continuous
    - Angle of 45 degrees to 60 degrees from top plate to bottom plate
  - 2) DWB 5/8" Diagonal Wood Boards applied diagonally on studs 24" oc
  - 3) WSP 5/16" min. Wood Structural Panel Sheathing on studs 16" oc or 3/8" min Sheathing on studs 24" oc (Continuously Sheathed Method)
  - 4) SFB Structural Fiberboard Sheathing on studs 16" oc
  - 5) GB Gypsum Board on studs 24" oc
  - 6) PBS Particleboard Wall Sheathing
  - 7) PCP Portland Cement Plaster on studs 16" oc
  - 8) HPS Hardboard Panel Siding

#### Length of Braced Wall Panels

- For Method 1, the length of the wall is governed by the angle of 45-60 degrees and the wall height.
- For Methods 2, 3, 4, 6, 7 and 8 Each BWP must be at least 48" oc covering three stud spaces when studs are 24" oc
- For Method #5 (Gypsum Board), BWP shall be 96" when on one face and 48" when on both faces

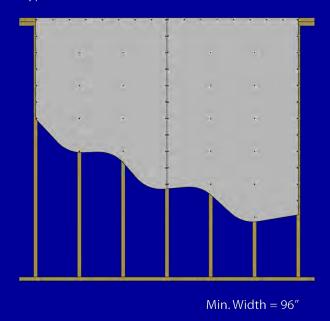
#### **Braced Wall Panel Construction Methods**



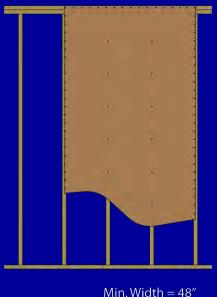


Min. Width = 55'' - 96''

**Gypsum Wall Board** 



Wood Structural Panel



Minimum Width is 4'-0

# Additional Construction Information Sheathed—Type Panels

- Each has a specific nail pattern and material thickness
  - Compare with common practice
- All require ½" Gypsum board on opposite side (2007)
- In SDC A, B, and C some panels over 3' in length may count with a reduced effective length (2007)

## TABLE R602.10.3 EFFECTIVE LENGTHS FOR BRACE WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH (BRACE METHODS 2, 3, 4, 6, 7, AND 8°

	Effective Length of Braced Wall Panel (inches)		
Actual Length of Braced Wall Panel (inches)	8-foot Wall Height	9-foot Wall Height	10-foot Wall Height
48	48	48	48
42	36	36	N/A
36	27	N/A	N/A

For SI: 1 inch = 25.4mm

Interpolation shall be permitted.

# Panel Joints Sheathed—Type Panels

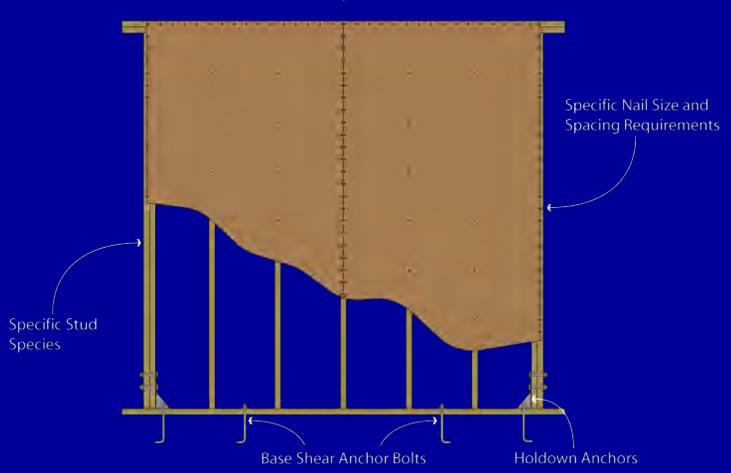
- All Vertical Joints of panel sheathing shall occur over and be fastened to a stud.
- Horizontal Joints must occur over and be fastened to 2x blocking
  - 2006 Exception: SDC A and B and detached dwellings in SDC C do not require blocking at horizontal joints if Method 3 (wood structural panel sheathing) is used.
  - 2007 Exception: Blocking is required at all horizontal joints in segments that are counted as braced wall panels unless percentages are at least twice what is required for the wall (includes wood structural panel sheathing).

## **Braced Wall Panel Support**

- Joists perpendicular to braced wall panels above or below must be blocked for connection to wall plates.
- Joists parallel to braced wall panels, rim joists also must provide a connection to wall plates.
- Braced wall line sills must be anchored to the foundation per R403.1.6.
- Elevated post or pier foundations must be engineered.

#### **Braced Wall Panel Construction Methods**

APA Wood Structural Panels of Specific Grade and Thickness



#### Minimum Bracing Amounts

	TABLE R602.10.1 WALL BRACING					
	SEISMIC DESIGN CATEGORY OR WIND SPEED	CONDITION	TYPE OF BRACE <sup>b, c</sup>	AMOUNT OF BRACING <sup>a, d, e</sup>		
		One story Top of two or three story	Methods 1, 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 16% of braced wall line for Methods 2 through 8.		
ı	Category A and B ( $S_s \le 0.35g$ and $S_{ds} \le 0.33g$ ) or 100 mph or less	First story of two story Second story of three story	Methods 1, 2, 3, 4, 5, 6, 7 or 3	I coated in accordance with Section R602 10 and at least every 25 feet on center but not less than 16% of braced wall line for Method 3 or 25% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.		
		First story of three story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 25% of braced wall line for Method 3 or 35% of		

If stud height is taller than 10' and Located in accordance with Section R602.10 and at least every 25 feet on center but not less then increase quantities by a factor of 1. 16% of braced wall line for Methods 3 or 25% braced wall line for Methods 2, 4, 5, 6, 7 or 8.

If wall lines are more than 35' and Lat least every 25 feet on center but not less than (parallel), increase quantities by a braced wall line for Method 3 or 45% braced wall line for Method 3 or 45% braced wall line for Method 2, 4, 5, 6, 7 or 8. distance (ft) to furthest (parallel) braced wall line divided by 35.

16% of braced wall line for Method 3 or 25% of

braced wall line for Methods 2, 4, 5, 6, 7 or 8

Located in accordance with Section R602.10 and 30% of braced wall line for Method 3 or 45% of

	One story Top of two or three story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 20% of braced wall line for Method 3 or 30% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
Categories $D_0$ and $D_1$ ( $S_s \le 1.25g$ and $S_{ds} \le 0.83g$ ) or less than 110 mph	First story of two story Second story of three story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 45% of braced wall line for Method 3 or 60% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
	First story of three story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 60% of braced wall line for Method 3 or 85% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
	One story Top of two story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 25% of braced wall line for Method 3 or 40% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
Category $D_2$ or less than 110 mph	First story of two story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 55% of braced wall line for Method 3 or 75% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
	Cripple walls	Method 3	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 75% of braced wall line.

### These are minimums

## Lateral Bracing System

<sub>1 Wall</sub>

#### TABLE R602.10.1 WALL BRACING

	SEISMIC DESIGN CATEGORY OR WIND SPEED	CONDITION	TYPE OF BRACE <sup>b, c</sup>	AMOUNT OF BRACING <sup>a, d, e</sup>
at let	Category A and B ( $S_s \le 0.35g$ and $S_{ds} \le 0.33g$ ) or 100 mph or less	One story Top of two or three story	Methods 1, 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 16% of braced wall line for Methods 2 through 8.
		First story of two story Second story of three story	Methods 1, 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 16% of braced wall line for Method 3 or 25% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
		First story of three story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 25% of braced wall line for Method 3 or 35% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
		One story Top of two or three story	Methods 1, 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 16% of braced wall line for Method 3 or 25% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
	Category C ( $S_s \le 0.6g$ and $S_{ds} \le 0.50g$ ) or less than 110 mph	First story of two story Second story of three story	Methods 2, 3, 4, 5, 6, 7 6 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 30% of braced wall line for Method 3 or 45% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
		First story of three story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 45% of braced wall line for Method 3 or 60% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.

To

### Who has 4'-0"?

- The IRC offers three options that allow for narrower than 4'-0 Bracing
  - Alternate Braced Wall Panel (R602.10.6.1)
  - Alternate Braced Wall Panel Adjacent to a Door or Window Opening (R602.10.6.2)
  - Continuous Wood Structural Sheathing (R602.10.5)
  - Approved Prefabricated Products

### IRC R602.10.6 Alternate BWP Construction Method

- This section allows a reduction from the 48" BWP width described in R602.10.4
- Alternate Braced Wall Panels are permitted to replace each 4' requirement, so an Alternate Braced Wall Panel should be counted as 4' when calculating the BWP percentage that is required by Table R602.10.1
- On Foundation No Upper Story Option

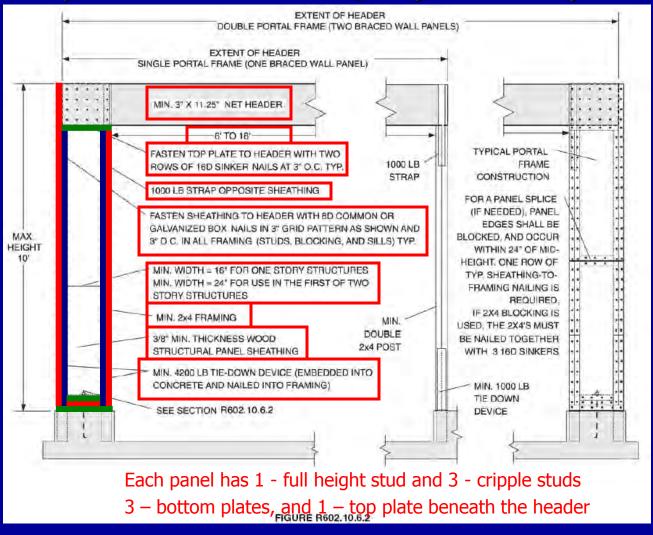
#### Alternate BWP Construction Method

- Single Story
  - Full height stud to full height stud
  - 3/8" Wood Structural Panel Sheathing
  - Anchor bolts
  - Tie-down with min. 1800 lb capacity
  - On foundation
- First Floor of Two Story
  - Same as above, except...
  - More anchor bolts
  - Tie-down capacity min. 3000 lb
  - Sheathing on both sides



### Alternate BWP Construction Method Adjacent to window or door opening

For use adjacent to a window or door opening with a full length header.



#### Alternate BWP Construction Method

Adjacent to window or door opening

- For use adjacent to a window or door opening with a full length header.
- Requires double 2x12 header with spacer on side opposite sheathed face
- Header to extend from full length stud to full length stud.
- Requires 4200 lb tie-down at each end of each panel (4 – tie downs)
- Requires 1000 straps opposite sheathed face
- Cannot be further reduced

### Is this what they had in mind?

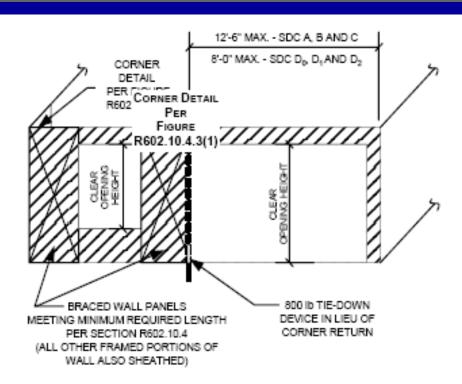


#### Continuous Wood Structural Panel Sheathing

#### **Definition:**

- Wood Structural Panel Sheathing is provided in accordance with Method #3 on all sheathable areas of all exterior braced walls, and interior wall lines, where required.
- 2007 Supplement allows isolated walls to be continuously sheathed provided there is a 2'-0 panel on both sides of corners
- 2007 Supplement also adds an option for replacing the 2'-0 panel with an 800 lb tie-down device

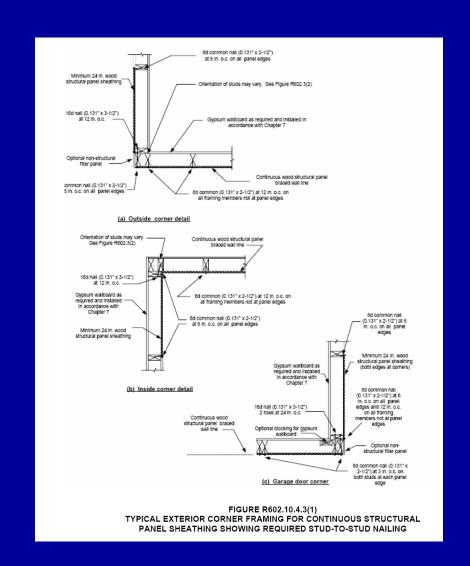
#### Continuous Wood Structural Panel Sheathing



CON JRN

FIGURE R602.10.4.3(4)
CONTINUOUSLY SHEATHED BRACED WALL LINE – FIRST BRACED WALL PANEL AWAY FROM END OF WALL LINE WITH TIE DOWN

### Corner Construction Continuous Wood Structural Panel Sheathing



### Continuous Wood Structural Panel Sheathing Minimum Lengths

 Bracing panel lengths shall be in accordance with Table R602.10.5

	pening Hei	S IN A CONTINUOUSLY SHEATHED WALL <sup>a, b, c</sup>	
	periing men		
	(Inches)	MAXIMUM OPENING HEIGHT NEXT TO THE BRACED WALL PAN	
8-foot wall	9-foot wall	10-foot wall	(% of wall height)

TADI E R602.10.5

8-foot wall	9-foot wall	10-foot wall	MAXIMUM OPENING HEIGHT NEXT TO THE BRACED WALL PANEL (% of wall height)
48 <b>8'-0"</b>	54 <b>9'-0"</b>	60 <b>10'-0"</b>	100
32 <b>6'-9"</b>	36 <b>7'-7"</b>	40 <b>8'-6"</b>	85
24 <b>5'-2"</b>	27 <b>5'-10"</b>	30 <b>6'-6"</b>	65

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound per square foot = 0.0479 kPa.

- a. Linear interpolation shall be permitted.
- b. Full-height sheathed wall segments to either side of garage openings that support light frame roofs only, with roof covering dead loads of 3 psf or less shall be permitted to have a 4:1 aspect ratio.
- c. Walls on either or both sides of openings in garages attached to fully sheathed dwellings shall be permitted to be built in accordance with Section R602.10.6.2 and Figure R602.10.6.2 except that a single bottom plate shall be permitted and two anchor bolts shall be placed at 1/3 points. In addition, tie-down devices shall not be required and the vertical wall segment shall have a maximum 6:1 height-to-width ratio (with height being measured from top of header to the bottom of the sill plate). This option shall be permitted for the first story of two-story applications in Seismic Design Categories A through C.

### IRC Table R602.10.5 Continuous Wood Structural Panel Sheathing

R602.10.5 Applies only to continuously sheathed (method 3) construction.

Remember that the bracing percentages in Table R602.10.1 still apply.





### Other Approved Solutions

- Substituting prefabricated panels within the requirements of the IRC (Prescriptive method of design)
- Method of design dependent on requirement of local codes and/or requirement of builder



Mont Wickely Assepted and Treats

**ICC-ES Evaluation Report** 

ESR-2089

Reissued September 1, 2010

This report is subject to re-examination in two years.

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DIVISION: 05 00 00—METALS Section: 05 40 00—Cold Formed Metal Framing

DIVISION: 06 00 00-WOOD, PLASTICS AND Section: 06 12 00.19-Shear Wall Panels

REPORT HOLDER:

HARDY FRAMES, INC. 789 SOUTH VICTORIA AVENUE, SUITE 200 VENTURA, CALIFORNIA 93003-5418 www.hardyframe.com david.loop@mil.com

**EVALUATION SUBJECT:** 

Hardy Frame® PANEL, Hardy Frame® BRACE FRAME, Hardy Frame® POST, Hardy Frame® BEARING PLATE, AND Hardy Frame® SADDLE

#### 1.0 EVALUATION SCOPE

- Compliance with the following codes:
- 2009 International Building Code® (2009 IBC)
- 2009 International Residential Code® (2009 IRC)
- 2006 International Building Code® (2006 IBC) ■ 2006 International Residential Code® (2006 IRC)
- 2003 International Building Code® (2003 IBC)
- 2003 International Residential Code® (2003 IRC)

Property evaluated:

Structural

2.0 USES

Hardy Frame® Panel, Hardy Frame® Brace Frame, Hardy Frame® Bearing Plate, and Hardy Frame® Saddle are steel components intended to resist vertical (gravity) loads and horizontal in-plane or out-ofplane wind or earthquake loads in wood-framed or coldformed steel-framed construction. The panels, frames and components are an alternative type of construction to conventional wood frame and cold-formed steel frame construction, permitted in Chapters 22 and 23 of the IBC and Chapter 6 of the IRC. Installations include concrete or masonry foundations, raised or upper wood floors, and portal frames. The *Hardy Frame* Panels and Brace Frames may be used under the IRC when either an engineered design is provided in accordance with Section R301.1.3 of the IRC or installation complice with Section

3.0 DESCRIPTION

3.1 Hardy Frame® Panel and Hardy Frame® Brace

3.1.1 General: The Hardy Frame® Panel and Hardy Frame® Brace Frame are prefabricated vertical and lateral force-resisting products for use in wood and cold-formed steel light-frame construction. Both product types are designed to resist in-plane and out-of-plane lateral wind or earth quake loading while supporting vertical gravity loads. The Hardy Frame® Panel is a one-piece, cold-formed steel (c-fs), C-shaped panel that is enclosed at the top and bottom with c-fs channels as described in the quality documentation. The Hardy Frame® Panel in Balloon Wall applications consists of two Panels in a continuous one pleoe, shop-welded assembly at the top to bottom channel interface. The Hardy Frame Brace Frame is a rectangular c-fs frame with a single diagonal member and c-fs vertical studs spaced at 16 inches (406 mm) on center as described in the quality documentation.

3.1.2 Hardy Frame® Panel and Brace Frame HFX and HFX/S Series: The Hardy Frame® HFX series is intended for single or multi-story wood frame construction with net heights that are equal to standard wood stud height, except for the 9 inch (229 mm) Panel width, which is 11/2 inch (38 mm) greater than a standard wood stud height. The HFX series may be installed over concrete, or masonry foundations, raised wood floors, wood, or steel beams, and may be stacked up to two stories when the lower story is placed on a rigid base, such as a concrete foundation. The 9 Inch (229 mm) Panel widths and Panels in Balloon Wall applications are limited to installation over concrete foundations, masonry foundations or steel beams. The HFX/S series is intended for use in c-fs framing with net heights, that corresponds to standard steel stud heights. HFX/S installations are provided for first floor conditions only over a rigid base, such as a concrete foundation. Model numbers, dimensions, and structural design information for both series are provided in Tables 1.0-1.1A through 4.0, and Figure 1 provides product

#### 3.2 Hardy Frame® Post

3.2.1 General: The Hardy Frame® Post is prefabricated for use in wood or c-fs frame buildings. The Hardy Frame Post is a 31/2-inch-by-31/4-inch (89 mm by 82 mm) c-fs tube that is enclosed at the top and bottom with c-fs channels as described in the quality documentation, and is designed to resist and transfer both axial tension and compression

3.2.2 Hardy Frame® Post HFP Series and Hardy Frame® Post HFP/S Series: The Hardy Frame® Post HFF series is intended for wood-framed construction with net

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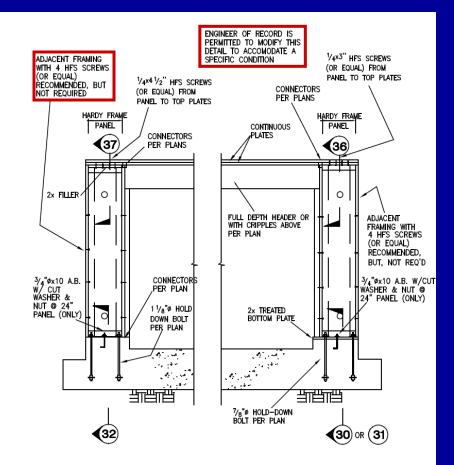


#### Narrow Pre-Fab Shear Wall Solution

- As Narrow as 9"
- Improves Quality
- Shortens Installation Time
- Reduces Job Call Backs
- Builds a Stronger Safer Structure
- Get it right the first time!



Is there enough room for the panel and the cripple studs supporting the header?

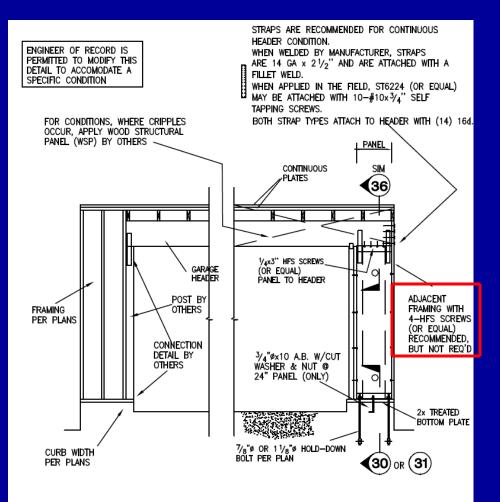


ALL PANELS,  $7_8{''}$  or  $1\,^1\!/_8{''}$  diameter hold down bolts, may be installed on: 1) concrete, see details 5 & 32  $_-$ 

- 2) SUPPORTING NUT & WASHER, OR "DOUBLE NUT", SEE DETAIL 6 & 31
- 3) MUDSILL (PER PLANS, BY OTHERS) SEE DETAIL 30

HARDY FRAME® PANELS AT OPENING BRACE FRAME INSTALLATION SIMILAR

If you don't have room, run the header above the panel.



ALL PANELS 7/8" OR 11/8" DIAMETER HOLD DOWN BOLTS, MAY BE INSTALLED ON:

- 1) CONCRÉTE, SEE DÉTAILS 5 & 32
- 2) SUPPORTING NUT & WASHER, OR "DOUBLE NUT", SEE DETAIL 6 & 31
- 3) MUDSILL, (PER PLANS, BY OTHERS) SEE DETAIL 30

HARDY FRAME® SINGLE PORTAL CONDITION
BRACE FRAME INSTALLATION SIMILAR

### When Should Builders Engineer Their Shear Walls?

- Do your homes "fit" into the parameters of the IRC?
- Are you comfortable with the "cookbook" method of the IRC?
- Do you want the added liability?
- If not, use an engineer.

### Design of Structural Elements

 Where a building, or portion of, does not comply with one or more of the bracing requirements on this section, those portions shall be designed and constructed in accordance with accepted engineering practice.

### Typical Engineered Design

- Load In Load Out Designs
- Calculate lateral loads on building
- Transfer loads through diaphragms to walls
  - Rigid or Flexible
- Distribute lateral loads through a collector
- Resist loads with shearwalls

# WFCM Typical Design

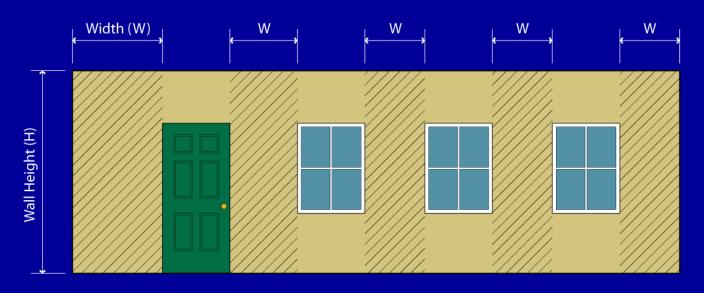
- Provides tables of wind and seismic loads on a wall line
- Provides calculation methods to make adjustments to those loads based on environment or building design
- Offers two methods to determine shear capacities for shearwall materials: segmented or perforated
- Provides tables listing materials, construction parameters, and shear resistance loads per linear foot for each material type.

Minimum lengths of shearwall section is governed by aspect ratio

### Wall Aspect Ratio

Braced wall line and Braced wall panels within the line

### Aspect ratio is a proportion of the height of a wall to the width of a wall panel.



Length requirement of shearwall sections are based on the Aspect ratios. The higher the lateral load, the lower the aspect ratio that is allowed.

# Max. Shear Wall Aspect Ratio IBC Table 2305.3.3 WFCM Table 3.17D

In Structural Design Categories A B, & C the minimum Aspect Ratio is 3 1/2:1 for wood structural panels

For all other materials and in Structural Design Categories D & E the minimum Aspect Ratio is 2:1

Ex.:	3 1/2:1	2:1
Wall Ht.	Min. Width	Min. Width
	(A to C)	(D & E)
8'	2'-3 1/2"	4'-0"
9'	2′-7″	4'-6"
10'	2'-10 1/2"	5′-0″
20'	5'-9"	10'-0

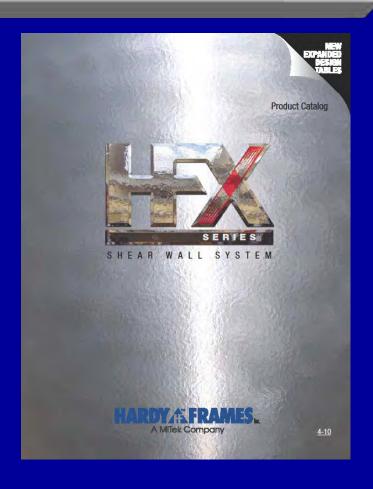
WALLS NARROWER THAN THE MIN. WIDTH
COUNT AS NOTHING

### Prefabricated Shear Walls offer an Engineered Solution

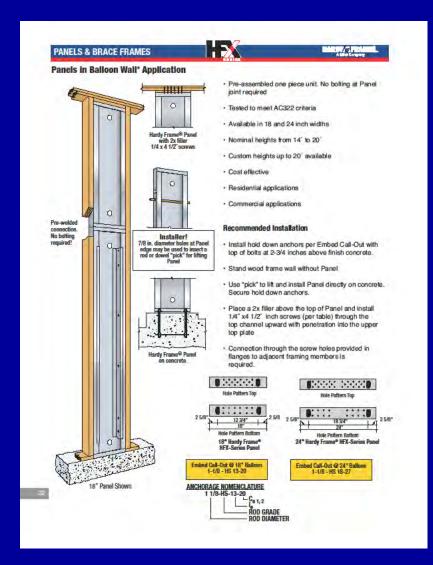
- Higher strength per linear foot
- Aspect ratios do not apply
- May eliminate the need for structural steel
- Proven solution

### Prefabricated Shear Walls offer an Engineered Solution

- Higher strength per linear foot
- Aspect ratios do not apply
- May eliminate the need for structural steel
- Proven solution

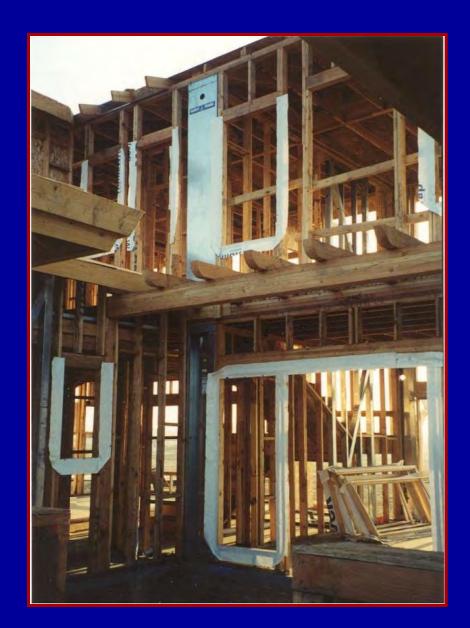


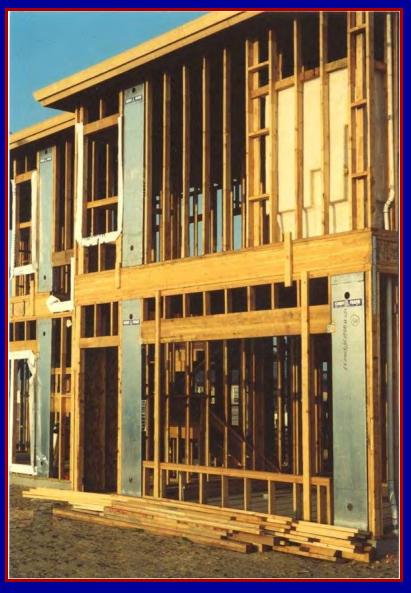
#### Design Safety into Narrow Balloon Walls



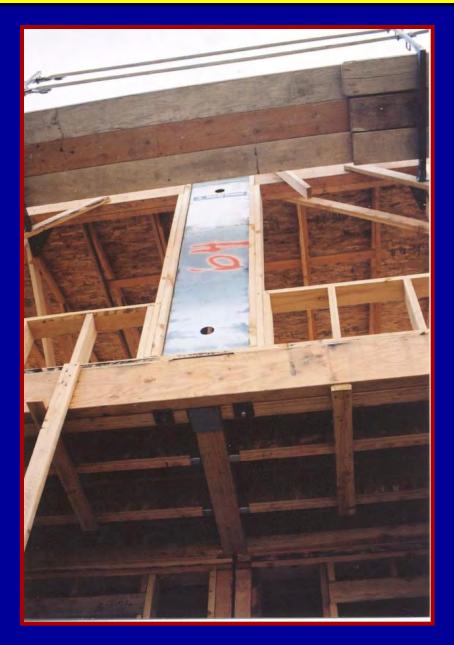
# Narrow Prefabricated Shear Panels for Balloon Wall Applications

### Multi-story applications





### Panels on a Beam



### Applying the Code DESIGN

- Know the capabilities of the trades
- Understand your builders priorities
- Work with your builder to create a flow chart for preferred bracing methods based on those capabilities – include drawings and minimum widths
- Use the 4'-0 offset rule to your advantage
- Utilize interior walls
- Move great rooms away from exterior walls or add covered patios to "laterally support" studs

## Applying the Code IRC602.10 Know the Capabilities of the Trades

#### Method 1 - Over-Cut Studs



### Applying the Code Know the Capabilities of the Trades



### TECHNICAL TOPICS

Form No. TT-012A January 2007

Page 1 of 1

### EFFECT OF OVERDRIVEN FASTENERS ON SHEAR CAPACITY

The following is a suggested guideline for determining if overdriven fasteners will affect the shear capacity of diaphragm or shear wall construction.

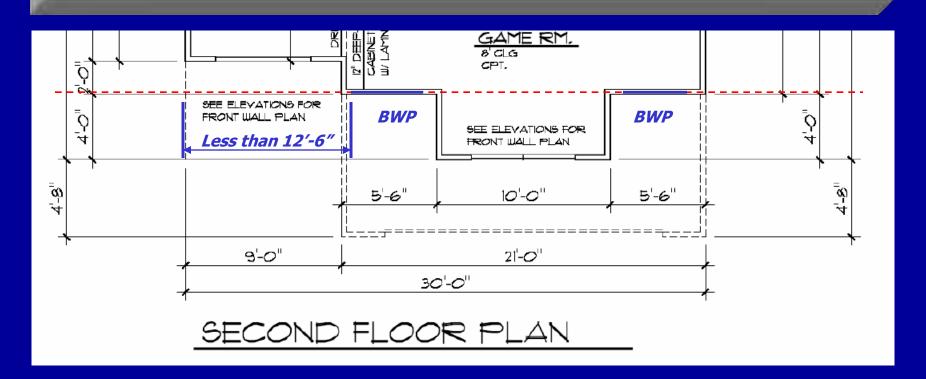
- 1. If any case described below is met, then no reduction in shear capacity needs to be taken.
  - a) If all nails are overdriven into panels by up to 1/16 inch during construction under dry conditions (moisture content less than 16 percent).
  - b) If no more than 20 percent of the fasteners around the perimeter of panels are overdriven by over 1/16 inch up to 1/8 inch, no reduction in shear capacity needs to be taken.
  - c) If all fasteners around the perimeter of panels appear to be overdriven by the same amount, and it appears that panels have been wetted during construction, it can be assumed that the fastener

### Applying the Code Know the Capabilities of your Trades

#### Alternate Braced Wall Panel

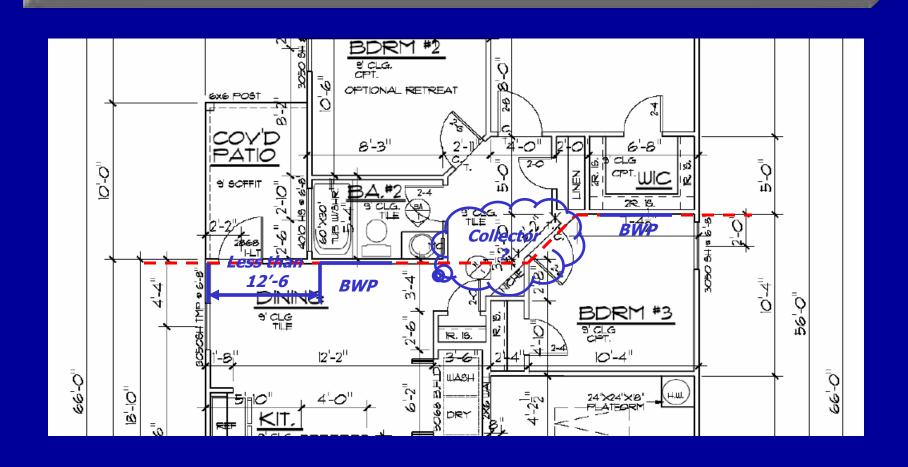
- Tie-Downs
  - Will they be installed at the correct location?
  - Is there a retro-fit?
- Nail Pattern
  - Critical
- Extended Header APA Method
- Plywood on both sides ABWP First Floor of Two Story

#### Applying the Code IRC602.10 Use the 4'-0 Offset Rule to Your Advantage



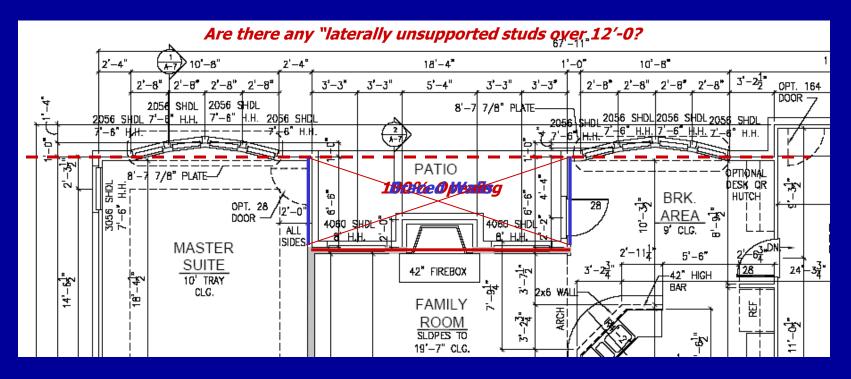
A Well Planned Upper Floor

#### Applying the Code IRC602.10 Utilize Interior Walls



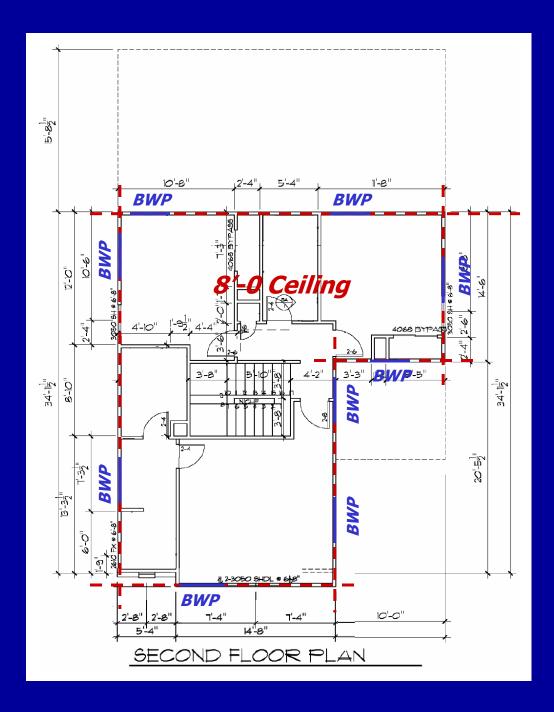
## Applying the Code IRC602.10 Move Great Rooms Away From Exterior Walls

#### Covered Patio?



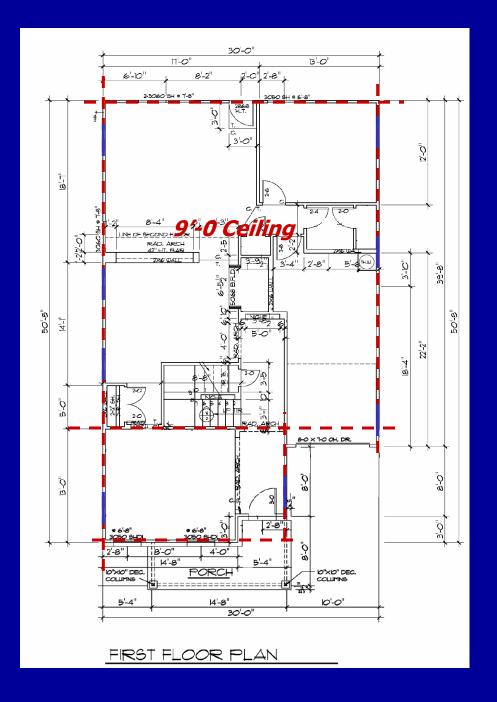
### **Bracing Plans**

- Assume SDC B
- Not continuously sheathed
- Prefer to use Thermo-Ply on exterior and double-sided drywall on interior walls
- Base on 4' sections
  - 16% upper story
  - 25% bottom story
- Begin with the Upper Floor
- Identify Braced Wall Lines
  - Begin with the Exterior
  - Interior?
- Confirm Plate Heights
- Determine Qty of BWP's
- Locate Braced Wall Panels

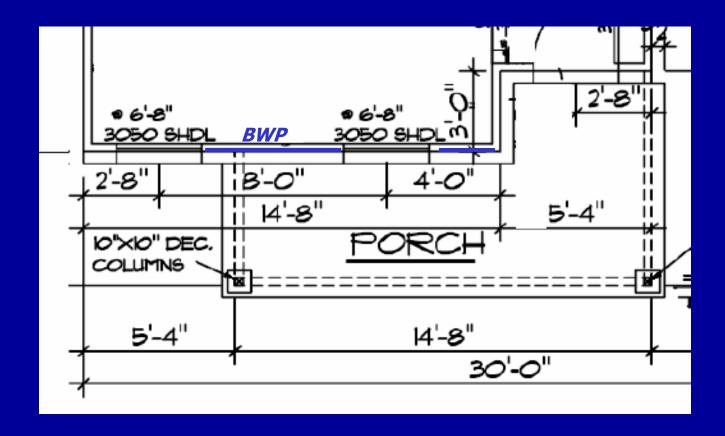


### **Bracing Plans**

- Identify Braced Wall Lines
  - Exterior
  - Interior
- Confirm Plate Height
- Determine Qty of BWP'sDistance Between Walls
- Locate BWP's



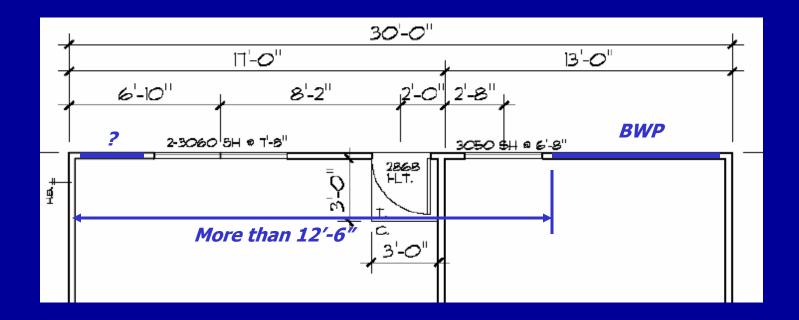
### **Bracing Plan**



Feel better by adding another BWP?
• Calculation: Methods 2-8, 20' x 25% = 5'-0"

• Calculation: Method 3, 20' x 16% = 3'-3"

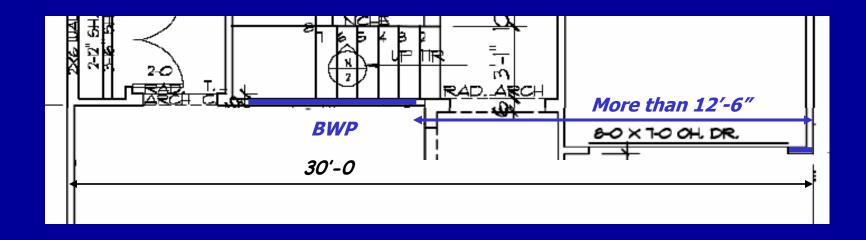
### **Bracing Plan**



- Optionation: Methods 2-8, 30' x 25% x 38'/35' = 8'-2"
   Alternate Braced Wall Panel (sheathed both sides)
- \*42" BWH with metroffestive length of 38" (New 2007)

  Move the window or door to allow for a 48" Panel
- •12" Prefabricated Panel (Add another window?)

### **Bracing Plan**



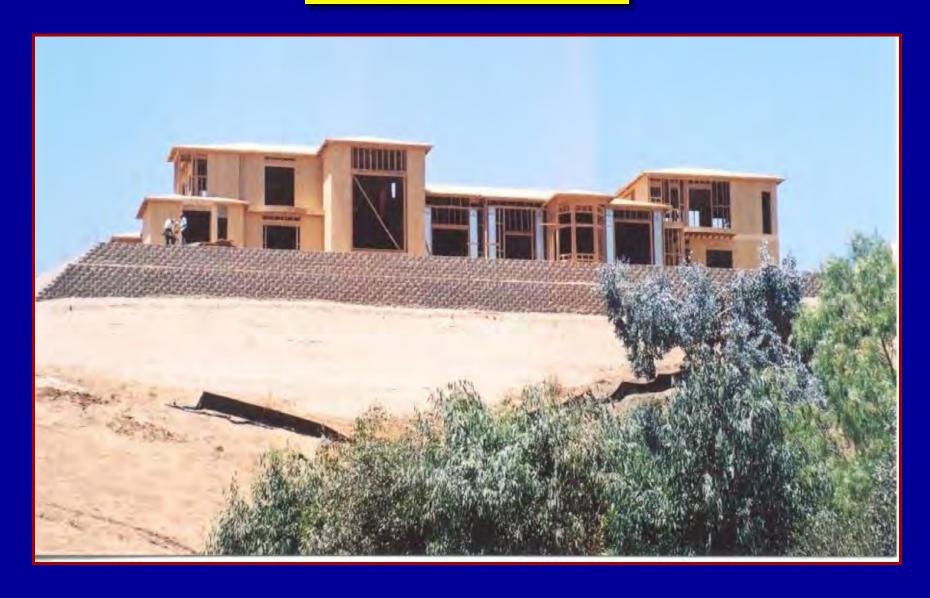
• Calculation: Methodicader 30' & 250% 9" 38' 135' = 8'-2"

Prefabricated Shear Panel
• Calculation: Method 3, 30' x 16% x 38'/35' = 5'-3"

#### Prefabricated Shear Walls

# The Best Solution For Narrow Applications

### Thank You



### HARDY FRAMES

A MiTek Company



### • THERE IS NO COMPARISON!

The Original Steel Shear Wall System