Home Innovation
RESEARCH LABS™

ESTIMATED COSTS OF THE 2012 IRC CODE CHANGES

Prepared For

National Association of Home Builders

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ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

AHS	American Housing Survey—national survey conducted biennially by the U.S. Census Bureau in odd years
Avg.	Average
BPS	Builder Practices Survey—national survey conducted annually by Home Innovation Research Labs
Bsmt.	Basement
BWL	Braced wall line
BWP	Braced wall panel
Cap.	Capacity
CFL	Compact fluorescent lamp
CFM	Cubic feet per minute (a measure of flow)
CS-PF	Bracing method consisting of a continuously sheathed portal frame around a large door or window opening
CS-WSP	Bracing method consisting of continuous sheathing with wood structural panel
C.Y.	Cubic yards
CZ	Climate zone, as defined by the International Code Council (ICC)
DWV	Drain, waste, vent [pipes]
EA	Each
EERO	Emergency escape and rescue opening
Eng. Hr.	Professional Engineer's fee, per hour
ERV	Energy recovery ventilator
F.R.	Family room
GB	Gypsum board
GR	Great room
HRV	Heat recovery ventilator
HVAC	Heating, ventilation, and cooling
IBC	International Building Code
ICC	International Code Council
IECC	International Energy Conservation Code
IRC	International Residential Code
LB	Pounds
LF	Linear feet
MAX	Maximum
MEP	Mechanical, electrical, and plumbing
MPH	Miles per hour
OSB	Oriented strand board
PE	Professional Engineer
PF	Portal frame

PFH	Portal frame with hold-downs
PSF	Pounds per square foot
RCD	Residential Cost Data 2014, RSMeans
SDC	Seismic design category
SF	Square feet
SHGC	Solar heat gain coefficient, a measure of the reflectivity versus the absorbed radiation of glass; the lower the SHGC number, the less radiation is absorbed by the glass unit
U-Factor	U-value; a measure of the conductance of building components like windows and doors; the lower the U-Factor the less conductive the component, or the higher the R-value, which is the inverse of U-value
WRB	Water-resistive barrier
WSP	Wood structural panel
XPS	Extruded polystyrene (rigid foam sheathing)

BACKGROUND

The National Association of Home Builders (NAHB) provided a list of code changes approved for the 2012 International Residential Code (2012 IRC).[1] Home Innovation Research Labs (Home Innovation) estimated the expected cost impact of these code changes on construction practices and materials for a number of reference houses sited in various cities nationwide. Cost estimates are aggregated in ranges of high to low based on various methods or components that might be used to comply with the code.

METHODOLOGY

National Construction Cost

Reference houses and their site locations were initially defined in a report titled *Estimated Costs of the 2015 Code Changes.*[2] The four reference houses were selected for their similarity to new home offerings in the six metropolitan areas selected as site locations - Miami, Dallas, Los Angeles, Seattle, New York, and Chicago, and their size proximity to a national average of 2,607 SF.[3] Elevations and floor plans for these reference houses are provided in *Appendices C through F*. These single-family detached houses define the reference or base house that provides the starting point for estimation of the added cost (or savings) of each code change for the 2012 IRC relative to the 2009 IRC or IECC.

Cost impacts in this analysis have been developed primarily with data adapted from the following sources: (1) RSMeans' *Residential Cost Data 2014*;[4] (2) *ASHRAE 1481 RP*[5] and similar reports by Home Innovation; (3) U.S. government reporting from the Census[6] and the Bureau of Labor Statistics;[7] and (4) distributors' or big box retailers' websites. Where a source other than these is used, it is cited in *Appendix A* when applicable to a specific code change.

The square-foot costs for energy efficiency features, which figure prominently in the 2012 IRC changes, have been comprehensively addressed in the May 2012 report, *2012 IECC Cost Effectiveness Analysis*.[8] That report provides the basis for costs related to energy efficiency which are used in this report.

Costs are reported at the national level and can be modified for a region using builders' known bid prices or by applying a location factor adjustment shown in *Appendix B*. Costs reported are the cost to the builder and do not include the builder's gross margin, reported as ranging between 17 to 20% of construction cost per *2014 Cost of Doing Business*[9] and prior year's versions. Therefore, the cost compiled in this report do not reflect the consumer price.

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[1] International Code Council, www.iccsafe.org/Pages/default.aspx

[2] www.homeinnovation.com/trends_and_reports/featured_reports/estimated_costs_of_the_2015_irc_code_changes

[3] Taylor, Heather. 2014. *Cost of Constructing a House*. www.nahb.org/generic.aspx?sectionID=734&genericContentID=221388&channelID=311

[4] http://rsmeans.reedconstructiondata.com

[5] NAHB Research Center, 2009. Economic Database in Support of ASHRAE 90.2 1481 RP. https://www.google.com/#q=ashrae+1481+rp

[6] http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

[7] http://www.bls.gov/oes/current/oes_nat.htm#47-0000

[8] www.homeinnovation.com/trends_and_reports/featured_reports/percent_energy_savings_2012_iecc_analysis

[9] National Association of Home Builders. 2014. Cost of Doing Business Study: 2014 Edition. https://builderbooks.com

Reference House Configurations

The four building designs (see *Appendices C-F)* used in this analysis are based on the data contained in the Census Bureau report, *Characteristics of New Single Family Construction Completed*.[10] The report provides information about building foundation type (Table 1) and number of stories for new single family detached construction over the previous nine year period. (Table 2).

Table 1. New Construction Foundation Types

Slab	54%
Crawlspace	17%
Basement	30%

Table 2. New Construction Number of Stories

One-story	53%
Two-story	43%
Three-story	3%

The Census data supports defining the four reference houses as follows to encompass approximately 85% of the last decade's new single-family construction:

- One-story on slab foundation
- Two-story on slab foundation
- One-story on basement foundation
- Two-story on basement foundation

Table 3 covers the locations where each type of reference house foundation would be pragmatically constructed. All of these selected cities, except Chicago, lie within the top ten states for construction starts in 2013.[11] Chicago was selected to represent a Climate Zone 5 house.

Table 3. Sites for Reference Houses

Reference House	Climate Zone	1	2	3	4
Foundation		**Slab**	**Slab**	**Basement**	**Basement**
Miami	1	X	X		
Los Angeles	3	X	X		X*
Dallas	3	X	X		X*
Seattle	4	X	X	X	X
New York	4	X	X	X	X
Chicago	5			X	X
Fairbanks	8			X	X

*For BWP analysis, only.

To accommodate the results of an extensive wall bracing analysis, which is contained in *Appendix H*, the sites for the reference houses include reference house 4 (a low roof-slope two-story house with basement) sited in both Los Angeles and Dallas.

Based on the data compiled by Home Innovation from the *2013 Builder Practices Survey* (BPS)[12], a nationwide annual survey, the typical Heating, Ventilation, and Cooling (HVAC) systems used in new houses are summarized in Table 4. According to the BPS, 44% of new homes are cooled with a central air

[10] www.census.gov/construction/chars/completed.html

[11] http://www.census.gov/construction/bps/pdf/2013statepiechart.pdf

[12] www.homeinnovation.com/trends_and_reports/data/new_construction

conditioner. These results influenced the selection of a gas furnace with central (electric) air conditioner as the HVAC system in each of the reference houses.

Table 4. Typical HVAC Systems Supplied with New Houses

Feature	Quantity or % of Stock
Furnace or Boiler, natural gas or propane	48%
Central Air Conditioner, electric	44%
Standard Heat Pump with Backup Heat	41%
Geothermal Heat Pump	4%
Electric furnace, baseboard, or radiant	4%
Furnace or Boiler, oil	2%

Reference House Features

The statistics presented in the foregoing tables support reference house features that are detailed in Table 5. These four houses, in compliance with the minimum requirements of the 2009 IRC, will serve as the baseline(s) for adding or subtracting costs to estimate the impact of the code changes approved for the 2012 IRC.

Table 5. Features of the Reference Houses

Reference House	1	2	3	4
Square Feet	2,607	2,607	2,607	2,607
Foundation	Slab	Slab	Basement	Basement
Number of Stories	1	2	1	2
Number of Bedrooms	3	4	3	4
Number of Bathrooms	2	2.5	2	3
Garage, attached	2-car	2-car	2-car	2-car
Heat, Gas Furnace	Yes	Yes	Yes	Yes
Cooling, (Electric) central air	Yes	Yes	Yes	Yes
Hot Water, Gas 50 gallon tank	Yes	Yes	Yes	Yes
9 ft. Ceilings, 1st	Yes	Yes	Yes	Yes
8 ft. Ceilings, 2nd	n/a	n/a	Yes	Yes
Energy Star appliances	Yes	Yes	Yes	Yes
Laundry Room	Yes - Mudroom	Yes	Yes - Mudroom	Yes - Closet
Walls, 2x4 (Zones 1&2)	Yes	Yes	n/a	n/a
Walls, 2x6 (Zones 3 thru 8)	n/a	n/a	Yes	Yes
Bsmt., Conditioned, Unfinished	n/a	n/a	Yes	Yes
Furnace Location	Attic	Attic	Basement	Basement
Water Heater Location	Interior	Garage	Basement	Basement
Window SF/% gross wall	360/18%	315/12%	360/18%	330/12%
Cladding	Brick, 4 sides	Brick, 4 sides	Brick, 4 sides	Stucco
Roof Pitch	12/12	6/12	9/12	4/12

The furnace location has been designated as a platform in the attic for both slab reference houses, a practice that is common in Florida and Texas, where the weather is temperate year round, and thus, the location is practical. A house built on a slab foundation in a cold climate zone would have the HVAC and water heating equipment located within conditioned space.

RESULTS

Estimated Cost of 2012 Code Compliance for Reference Houses by Location

Table 6 summarizes the estimated cumulative impact of the 2012 code changes on the cost of constructing the reference houses. For the purpose of cost aggregation, it was assumed that reference houses were not built in coastal zones or subject to flooding. The aggregated costs are reported in ranges of “High” and “Low” impact based on the applicability of the changes to the features of the reference houses. The results are grouped into four climate zone categories to accommodate the extensive energy efficiency changes in this code edition.

Table 7 summarizes the cost estimates of the code changes that do not apply to the selected reference houses and are not included in the aggregated summary. Those costs can be added to or subtracted from the aggregated costs in Table 6 as applicable to a particular location or a specific building. A detailed analysis of each individual code change is provided in *Appendix A*.

Table 6. Estimated Cost of 2012 Code Compliance

		Selected Cities		Miami, Los Angeles		Dallas, Seattle, New York		Chicago		Fairbanks		
		Climate Zones		1 & 2		3 & 4		5 - 7		8		
		Reference Houses		1 & 2		1, 2, 3, & 4		3 & 4		3 & 4		
Ref #	Code Change	2012 IRC Chapter	2012 IRC Reference	Cost Range								Notes
				High ($)	Low ($)	High ($)	Low ($)	High ($)	Low ($)	High ($)	Low ($)	
R-1	Door leading to house from attached garage must include a self-closing device.	Building Planning	R302.5.1	85	35	85	35	85	35	85	35	All buildings with attached garage
R-2	Window wells to be connected to the building foundation drain system.	Building Planning	R310.2.2	0	0	589	0	589	380	589	0	All buildings except those built on Group 1 soils (R405.1)
R-3	Approved filter membrane material to cover foundation drains	Foundations	R405.1	523	222	552	212	552	212	552	212	All buildings with exterior foundation drains
R-6	Wall bracing, 90 mph wind speed, low seismic	Wall Construction	R602.10.8.2	383	383	544	383	544	544	N/A	N/A	Buildings in wind zone ≤ 90 mph, low seismic
R-8	Requires the addition of flashing at the base of openings in exterior walls	Wall Covering	R703.8	1,082	690	1,141	627	1,141	627	1,141	627	All building openings
R-9	Uplift resistance for roof component/ wall connections	Roof-Ceiling Construction	R802.11	267	19	267	10	155	10	155	10	Buildings in wind speed zones 90 mph or less Buildings with roof spans less than 48'
R-10	Requires more stringent fastening of roof underlayment in wind speed zones of 120 mph or greater	Roof Assemblies	R905.3.3.3	971	394	0	0	0	0	0	0	Buildings located in wind speed zones of 120 mph
R-11	Roof drip edge required at gables and eaves	Roof Assemblies	R905.2.8.5	381	327	381	226	288	226	288	226	All buildings with asphalt shingle roofing
E-1	Compliance with energy efficiency provisions	Energy Efficiency	N1101	3,531	2,302	8,257	5,796	5,231	3,820	7,272	6,926	All buildings
MEP-1	Mechanical Ventilation	Exhaust System	M1507.3	1,500	382	1,500	382	1,500	382	1,500	382	All buildings
MEP-2	Duct joints, seams, and connections comply with SMACNA	Duct System	M1601.1	215	103	314	103	314	232	314	232	All buildings with ducted HVAC systems
MEP-3	Plastic rough plumbing (DWV) systems can no longer be air tested for continuity - a water test at rough-in is required.	Plumbing Administration	P2503.5.1	169	0	169	0	169	0	169	0	All buildings with plastic DWV plumbing systems
	TOTAL ($)			**9,107**	**4,857**	**13,799**	**7,774**	**10,568**	**6,468**	**12,065**	**8,651**	

Table 7. Additional Costs of 2012 Code Compliance not Attributed to the Reference Houses

		Selected Cities		Miami, Los Angeles		Dallas, Seattle, New York		Chicago		Fairbanks		
		Climate Zones		1 & 2		3 & 4		5 - 7		8		
		Reference Houses		1 & 2		1, 2, 3, & 4		3 & 4		3 & 4		
Ref #	Code Change	2012 IRC Chapter	2012 IRC Reference	Cost Range								Notes
				High ($)	Low ($)	High ($)	Low ($)	High ($)	Low ($)	High ($)	Low ($)	
R-4	Option 1 - Open floor assemblies to be provided with a 1/2" gypsum membrane, 5/8" wood, or equivalent on the underside where fire sprinklers are not installed.	Floors	R501.3	0	0	1,981	0	1,981	0	1,981	0	Buildings with basements that do not include a fire sprinkler system with exceptions
	Option 2 – Fire-resistant 14" floor I-joists			0	0	3,050	0	3,050	0	3,050	0	
R-5	Table 602.7.1 added with prescriptive spans for single headers in exterior bearing walls.	Wall Construction	R602.7	(111)	(241)	(111)	(241)	(196)	(196)	(196)	(196)	Allows an alternate header design method for all buildings
R-6	BWP - High wind zone 100/C, SDC A,B	Wall Construction	R602.10.8.2	N/A	N/A	519[a]	300[a]	N/A	N/A	N/A	N/A	Building in 100 mph wind zone
	BWP - Seismic design category D2, 85/B	Wall Construction	R602.10.8.2	356[b]	356[b]	N/A	N/A	N/A	N/A	346	346	Building in seismic D2
R-7	Simplified wall bracing	Wall Construction	R602.12	0	0	40	0	40	0	0	0	Buildings that can use the alternate design method for BWP design
R-10	Requires more stringent fastening of roof underlayment in wind speed zones of 120 mph or greater	Roof Assemblies	R905.3.3.3	971	0	971	0	492	0	492	0	Buildings located in wind speed zones of 120 mph or greater

a. Based on a site located in New York.
b. Based on a site located in Los Angles.

APPENDIX A:
DESCRIPTION AND COST IMPACT OF 2012 IRC CODE CHANGES

R-1

R302.5.1 Opening protection.

Summary of Code Change:

The code change added a requirement for a self-closing mechanism on a door between an attached garage and the residence.

Cost Implication of Code Change:

Replacing standard door hinges with three spring-loaded hinges is the typical practice for complying with the requirement for a self-closing device on the door leading from the garage to the dwelling. The estimated cost impact is summarized in Table R-1.

Table R-1. Cost of Garage Door Spring Hinges

Component	Quantity	Cost ($)	Labor ($)[a]	Total w/20% markup($)
Spring Hinges (option 1)[b]	3	5.98	16	41
Spring Hinges (option 2)[b]	3	9.33	16	53
Safety Spring Door Closer[b]	1	12.98	16	**35**
Medium-duty Door Closer[b]	1	54.98	16	**85**

a. RSM *RCD 2014* for estimated labor cost for 0.5 hours

b. Homedepot.com

R-2

R310.2.2 Drainage.

Summary of Code Change:

This code change adds a new requirement for window wells to be provided with proper drainage via a drainage pipe or drain tile between the stone/gravel base at the bottom of the well and the building foundation drainage system. Consistent with the provisions for foundations in Chapter 4 (Section R405.1), buildings constructed on Group 1 soils are exempt from the new window well drainage requirements.

Cost Implication of Code Change:

Buildings constructed on Group 1 soils will have no additional cost. Buildings built on slab and above-grade crawl space foundations do not have basement windows and will have no additional cost. Buildings with basement walls and windows below grade will have the additional cost of connecting window wells to the exterior perimeter foundation drain. The expense will vary by the number of basement windows and the distance from the bottom of the well to the foundation drain. Therefore, shallow basement windows placed at the top of the basement wall will present the largest expense.

The floor plan of reference house 3 shows the basement has two egress windows and one "hopper" window (3018 hopper window mounted at top of foundation wall). The reference house 4 plan is assumed to have three "hopper" windows and no egress (EERO) windows, as both basements are assumed to be unfinished. Under these assumptions, the range of no expense to $589 in additional expense is provided by Tables R-2-A and R-2-B.

Table R-2-A. Cost to Tie Window Wells To Footing Drain – 3 "Hopper" Windows

Component	Unit	Quantity	Cost ($/Unit)	Total ($)
6" Draintile with Silt Sock[a]	LF	24	14.45	347
Elbow, Tee, Fittings[a]	EA	3	24.50	74
Silt Sock for Fitting[a]	EA	3	4.07	12
Washed Gravel[a]	C.Y.	4	39.00	156
Total ($)				**589**

a. RSM *Site Work and Landscape Cost Data 2014*.

Table R-2-B. Cost to Tie Window Wells to Footing Drain – 1 "Hopper" and 2 Egress (EERO) Windows

Component	Unit	Quantity	Cost ($/Unit)	Total ($)
6" Draintile with Silt Sock[a]	LF	12	14.45	173
Elbow, Tee, Fittings[a]	EA	3	24.50	74
Silt Sock for Fitting[a]	EA	3	4.07	12
Washed Gravel[a]	C.Y.	3	39.00	121
Total ($)				**380**

a. RSM *Site Work and Landscape Cost Data 2014*.

R-3

R405.1 Concrete or masonry foundations.

Summary of Code Change:

This code change adds a requirement for installation of an approved filter membrane along the pipe that is used in the foundation drainage system. Perforated foundation drain tile can either be surrounded with a filter membrane or the filter membrane can be placed over the drainage trench containing the gravel/ stone that surrounds the drainage pipe.

Cost Implication of Code Change:

To establish a range of cost impact, the estimates have been calculated for two scenarios: (1) a geotextile filter "sock" or filter fabric stretched over the drainage pipe (see Table R-3-A), and (2) a geotextile filter fabric placed over the top of the gravel/stone covering the drain tile or perforated pipe (see Table R-3-B). Note that the drainage pipe in Table R-3-A is purchased with the filter sock installed on the pipe, whereas the method in Table R-3-B requires additional labor to lay the approved filter material after the pipe is placed.

Table R-3-A. Cost to Install Foundation Drain Tile with Filter Sock

Component	Unit	Cost ($)	Reference House			
			1	2	3	4
Silt Sock at Fittings[a]	EA	N/A	4	4	4	4
	$/EA	4.07	16	16	16	16
Foundation Perimeter	LF	N/A	216	156	228	148
6" Draintile Silt Sock[a]	$/LF	1.32	285	206	301	195
Total ($)			**301**	**222**	**317**	**212**

a. RSM *Site Work and Landscape Cost Data 2014*.

Table R-3-B. Cost to Install a Building Paper Filter Over Drain Tile

Component	Unit	Cost ($)	Reference House			
			1	2	3	4
Approved Filter Material Trench Cover[a]	LF	N/A	216	156	228	148
	$/LF	2.42	523	378	552	358
Total ($)			**523**	**378**	**552**	**358**

a. RSM *Site Work and Landscape Cost Data 2014*.

R-4

R501.3 Fire protection of floors.

Summary of Code Change:

This code change adds a requirement to provide floor assemblies above unfinished areas in buildings that do not have sprinkler systems with a continuous membrane (e.g., 1/2" gypsum board or 5/8" wood structural panel) on the underside of the floor assembly as fire protection. Exceptions have been provided where floor assemblies are constructed with 2x10 or greater dimension lumber joists, for crawl spaces that do not contain fuel fired equipment or storage space, and for small floor areas (80 square feet or less).

Cost Implication of the Code Change:

These floor assemblies are located above unfinished areas, such as basements. The added cost will impact homes where these floor assemblies are constructed with open web trusses, I-joists, and dimension lumber joists smaller than 2x10.

Dwellings are exempt from the continuous membrane required by this section where whole-house sprinkler systems have been installed. In this case, no additional cost increase will be incurred. (The cost of a whole-house sprinkler system would be higher than the underfloor protection.)

Table R-4 covers the costs associated with compliance for reference houses 3 & 4, the houses with unfinished basements, where the floor assembly is assumed to be constructed with trusses or I-joists and a sprinkler system has not been installed. Two compliance options are evaluated: (1) addition of 1/2-inch gypsum board as a membrane below the floor system and (2) use of wood I-joists with an approved fire protection coating (equivalent compliance). These costs are used to establish a high end for the cost range. For the purpose of cost aggregation in table 7, the option of ½ inch gypsum board is used.

Table R-4. Cost of Fire Protection for Floors above Unfinished Basements without Fire Sprinkler Systems

Fire-Resistant Assembly	Unit	Cost ($/SF)	Reference House			
			3	4	3	4
			Coverage Area (SF)		Total Cost ($)	
1/2" Gypsum Board, Untaped	SF	0.76	2,607	1,393	**1,981**	1,059
14" I-Joists, Fire-Resistant (net of cost for untreated I-Joist)[a]	SF	1.17	2,607	1,393	**3,050**	1,630

a. Weyerhaueser representative estimated the cost of Flak Jacket, a fire-resistant I-joist painted with intumescent paint. The product is available by special order from TJI distributors.

R-5

R602.7 Headers.

Summary of Code Change:

The code change added a prescriptive span table for 2x (dimension lumber) single-ply headers in exterior bearing walls. In contrast, previous codes provided prescriptive options only for multi-ply headers. Single member header spans range from less than 3 feet to over 8 feet based on the number of stories, building configuration, and the header size and material.

Cost Implication of the Code Change:

Single member headers provide an option for optimizing lumber use at openings where multi-ply headers are not required for structural support. In addition, the use of single headers provides space in the wall cavity above openings for insulation, which is included in the cost estimates. To simplify the determination of the cost impact a standard opening height of 6'-8" is assumed and the largest header size required for the dwelling will be used for all openings. This reflects common practice done to save design time and avoid construction errors. Hem-Fir lumber species is selected due to its wide availability nationwide and its load-carrying capacity. A ground snow load of 30 psf is assumed as the load is an adequate design load for all of the locations cited.

Schedules H-2009 and H-2012 indicate the number, width and depth of headers required per the span tables in the codes. Table R-5 contains the Schedule information rolled into linear feet of lumber at the largest dimension required to satisfy the load for each building. (The LVL required in reference houses 1 & 2 has been ignored, as the requirement doesn't change with code editions. Likewise, the engineering design required for house 3 due to long spans is also ignored for the same reason.) The 1-1/2" extruded polystyrene (XPS) foam that is included in the cost estimate is intended to take the space of the second framing member that is not required.

Table R-5. Cost Savings Using Single Member Headers

2009 IRC						
Reference House	**Unit**	**Quantity**	**Material**	**Cost/Unit**	**Total ($)**	**Difference ($)**
1-1st Floor	LF	68	2x10	3.88	264	Baseline
2-1st Floor	LF	76	2x12	4.84	600	
2-2nd Floor	LF	48	2x12	4.84		
4-1st Floor	LF	86	2x8	3.21	469	
4-2nd Floor	LF	60	2x8	3.21		
2012 IRC						
1-1st Floor	LF	34	2x12	3.06	153	**(111)**
1-XPS	SF	34	1.5" XPS[a]	1.43		
2-1st Floor	LF	56	2x12	3.06	359	**(241)**
2-2nd Floor	LF	24	2x12	3.06		
2-XPS	SF	80	1.5" XPS[a]	1.43		
4-1st Floor	LF	59	2x8	2.10	272	**(196)**
4-2nd Floor	LF	30	2x8	2.10		
4-XPS	SF	60	1.5" XPS[a]	1.43		

a. XPS is noted in square feet - both quantity and price.

Schedule H-2009. Headers per Span Tables

2009		Reference House							
		1		2		3		4	
	Detail	1-Story Slab		2-Story Slab		1-Story Basement		2-Story Basement	
Location	Header Span (ft)	# Openings	Material	# Openings	Material	# Openings	Material	# Openings	Material
1st Floor	3	0	N/A	0	N/A	9	DR[a]	9	2-2x6
	4	4	2-2x6	5	2-2x8	4	DR[a]	4	2-2x8
	6	3	2-2x10	3	2-2x12	3	DR[a]	0	N/A
	12	4	LVL required	1	LVL required	0	DR[a]	0	N/A
2nd Floor	3	N/A		2	2-2x6	N/A		10	2-2x6
	4			3	2-2x6			N/A	N/A
	6			1	2-2x10			N/A	N/A
	12			N/A	N/A			N/A	N/A

a. Engeneering design required

Schedule H-2012. Headers per Span Tables

2012		Reference House							
		1		2		3		4	
	Detail	1-Story Slab		2-Story Slab		1-Story Basement		2-Story Basement	
Location	Header Span (ft)	# Openings	Material	# Openings	Material	# Openings	Material	# Openings	Material
1st Floor	3	0	1-2x10	0		9	DR[a]	9	1-2x8
	4	4	1-2x10	5	1-2x12	4	DR[a]	4	2-2x8
	6	3	1-2x12	3	2-2x12	3	DR[a]	0	N/A
	12	4	LVL required	1	LVL required	0	DR[a]	0	N/A
2nd Floor	3	N/A		2	1-2x8	N/A		10	1-2x8
	4			3	1-2x10			N/A	N/A
	6			1	1-2x12			N/A	N/A
	12			N/A	N/A			N/A	N/A

a. Engeneering design required

R-6

R602.10 Wall bracing.

Summary of Code Change:

A series of further revisions have been introduced in the 2012 IRC wall bracing provisions following a complete overhaul of this part of the code implemented in the 2009 IRC. The key changes introduced in the 2012 IRC that impact braced wall design include:

- Wind limit of 100 mph in hurricane prone regions was removed (<110 mph applies universally), seismic map revised to a risk-targeted (uniform risk) basis reducing expanse of higher seismic design category regions (reduces bracing amounts required in affected regions)
- Hurricane region wind speeds decreased in northeast and gulf coast U.S and increased in southern Florida (decreases or increases bracing requirements and/or code applicability in affected regions)
- Wall bracing provisions completely reformatted with some technical changes (e.g., slightly adjusted wind bracing amounts using new wind load factor in ASCE 7-10 for allowable stress design; braced wall panel end/edge distances revised; etc.)
- Roof uplift requirements re-evaluated with varied impact (will impact bracing uplift load limit and load path detailing where required)

Cost Implication of Code Change:

To develop relevant costs, a matrix of the components for code compliance were developed as summarized in the report titled *Code Comparative Bracing Analysis For Two Representative House Plans* by ARES Consulting (*Appendix H*). The associated costs are compiled in *Table R-6-A through* Table R-6-F by reference house, wind zone/exposure category, and seismic design category. The cost tables show the incremental costs of adding or removing the specified feature relative the baseline construction practice. The cost increase varies between $300 and $544.

Table R-6-A. Change in Braced Wall Line Costs for Reference House 1, 90/B, SDC A/B

BWL#	Component	2009	2012
2 (int)	GB with 7" edge & field fastener spacing (360 sf)		83
B	Engineer's fee[a]		300
	Total ($)	0	383
	Net Effect of Code Change ($)		**383**

a. Fee assumes repetitive use of a standard top-plate collector detail (e.g. minium cost for review.)

Table R-6-B. Change in Braced Wall Line Costs for Reference House 4, 90/B, SDC A/B

BWP#	Component	2009	2012
A	Gypsum Board (187 sf)		142
B	GB with 7" edge & field fastener spacing (144 sf)		33
2	GB with 7" edge & field fastener spacing (295 sf)		68
3	Engineer's fee[a]		300
	Total ($)	0	544
	Net Effect of Code Change ($)		**544**

a. Fee assumes repetitive use of a standard top-plate collector detail (e.g. minium cost for review.)

Table R-6-C. Change in Braced Wall Line Costs for Reference House 1, 100/C, SDC A/B

BWL#	Component	2009	2012
B	Engineer's fee[a]		300
	Total ($)	0	300
	Net Effect of Code Change ($)		**300**

a. Fee assumes repetitive use of a standard top-plate collector detail (e.g. minium cost for review.)

Table R-6-D. Change in Braced Wall Line Costs for Reference House 4, 100/C, SDC A/B

BWP#	Component	2009	2012
B	GB with 7" edge fastener spacing (500 sf)		115
2	GB with 7" edge & field fastener spacing (450 sf)		104
3	Engineer's fee[a]		300
	Total ($)	0	519
	Net Effect of Code Change ($)		**519**

a. Fee assumes repetitive use of a standard top-plate collector detail (e.g. minium cost for review.)

Table R-6-E. Change in Braced Wall Line Costs for Reference House 1, 85/B, SDC D2

BWL#	Component	2009	2012
B (int)	GB with 7" edge & field fastener spacing (288 sf)		66
2 (int)	GB with 7" edge & field fastener spacing (414 sf)		96
3 (int)	GB with 7" edge & field fastener spacing (482 sf)		111
4 (int)	GB with 7" edge & field fastener spacing (360 sf)		83
	TOTAL ($)	0	356
	Net Effect of Code Change ($)		**356**

Table R-6-F. Change in Braced Wall Line Costs for Reference House 4, 85/B, SDC D2

BWP#	Component	2009	2012
B-1st	GB with 7" edge and field fastener spacing (605 sf)		140
B-2nd	GB with 7" edge and field fastener spacing (445 sf)		103
2-2nd	GB with 7" edge and field fastener spacing (448 sf)		103
	Total ($)	0	346
	Net Effect of Code Change ($)		**346**

Table R-6-G. Material Unit Cost

Component	Unit	Material ($)	Labor ($)	O&P ($)	Total ($)
WSF, 7/16", pneumatic nail	SF	0.50	0.29	0.25	1.04
GB, 1/2", glued & screwed	SF	0.30	0.26	0.20	0.76
GB, 7" edge fastener spacing	SF	N/A	0.09	0.03	0.12
GB, 7" edge & field fastener spacing	SF	N/A	0.26	0.09	0.35

(Note: The tables summarizing the change in braced wall line costs show only the cost of the change from the 2009 construction practice to 2012 construction practice, not the total cost for either 2009 or 2012.)

R-7

R602.12 Simplified wall bracing.

Summary of Code Change:

A new optional simplified wall bracing design method was added based on a conservative and limited application of R602.10 provisions. The simplified method strives to streamline the design provisions by allowing the builder to determine bracing amounts based on the overall plan dimensions of the house, without having to define specific braced wall lines, and to then distribute the required number of "bracing units" along the exterior walls. As a trade-off for this simplification, the method is limited in terms of allowable building configuration, available bracing methods, and geographic location based on wind speed and seismic design category. Where this method is utilized, builders may save design time versus applying the full wall bracing provisions, and may gain a reduction in total bracing required due to eliminating braced wall lines passing through the interior of the dwelling, with braced wall panels located within the building footprint.

Cost Implication of Code Change:

To develop relevant costs, a matrix of the components for code compliance were developed as summarized in the report titled *Code Comparative Bracing Analysis For Two Representative House Plans* by ARES Consulting (*Appendix H*). Of the two houses that were analyzed by ARES Consulting, reference house 4 was the only one that could be designed using the simplified method as a result of limitations of the method based on the building's features. In addition, the method was only applicable to a low-hazard location (90/B wind, SDC A/B seismic). The cost impact of using the simplified method was negligible relative to 2009 IRC provisions indicating the primary trade-off between simplification and method limitations. There may be some savings in the time and effort required to implement the simplified analysis but these potential savings cannot be reliably quantified at this time.

Table R-7-A. Braced Wall Line Costs for Reference House 4, 90/B, SDC A/B

BWP#	Component	2009	2012 Simple
A	Gypsum Board		142
B	GB with 7" edge fastener spacing	31	
2	WSP interior wall	33	
2	GB with 7" edge fastener spacing	37	
	Total ($)	102	142
	Net Effect of Code Change ($)		**40**

R-8

R703.8 Flashing

Summary of Code Change:

This code change adds a requirement for flashing at the base of exterior wall openings, i.e., at window sills and door thresholds and that the flashing extend to the water-resistive barrier (WRB) for subsequent drainage.

Code Change Summary:

The code requirement to add flashing at the base of window and door openings results in an added cost to builders who were not already employing industry best practices. Thus, the cost range for this code change starts at zero to recognize that many builders were already employing this practice. Table R-8-A covers the cost to install window and door flashing with flexible flashing in the referenced houses. Tables R-8-B and R-8-C cover alternate approaches with pan flashing.

Table R-8-A. Cost to Install Flexible Sill Flashing

Component	Unit	Cost ($)[a]	Labor ($/LF)[a]	Qty/LF Required Per Reference House			
				1	2	3	4
Sill Corners (set of 2)[b]	EA	1.66		22	23	20	23
Flexible Peel/Stick Flashing - 9"[b]	LF	1.91	4.85	107	116	100	107
Total Cost ($)				**760**	**822**	**709**	**762**

a. RSM *RCD 2014* for sill installation labor. Cost includes O&P at 19.45%

b. Homedepot.com

Table R-8-B. Cost to Install Field Constructed Pan Flashing

Component	Unit	Cost ($)[a]	Labor ($/LF)[a]	Qty/LF Required Per Reference House			
				1	2	3	4
Premolded Pan Flashing[b]	EA	16.14	1.69	22	23	20	23
Flexible Peel/Stick Flashing - 9" (used at pan corners)[b]	LF	1.91	4.85	44	46	40	46
Total Cost ($)				**690**	**721**	**627**	**721**

a. RSM *RCD 2014* for sill installation labor. Cost includes O&P.

b. Homedepot.com (Average cost)

Table R-8-C. Cost to Install Pre-molded Pan Flashing

Component	Unit	Cost ($)[a]	Labor ($/LF)[a]	Qty/LF Required Per Reference House			
				1	2	3	4
Aluminum Flashing Pans - Field Constructed[a]	LF	0.88	10.03	60	66	54	71
Flexible Peel/Stick Flashing - 9" (used at pan corners)[b]	LF	1.91	4.85	44	46	40	46
Total Cost ($)				**999**	**1,082**	**902**	**1,141**

a. RSM *RCD 2014* for sill installation labor. Cost includes O&P.

b. Homedepot.com

R-9

802.11 Roof tie-down.

Summary of Code Change:

This code change revises requirements for rafter and truss uplift connections. The minimum prescriptive connection requirement changed from two 16d box nails to three 16d box nails. Both the format and the level of the threshold for requiring hurricane clips changed in the 2012 IRC. Where the 2009 IRC set the trigger at or above 20 psf wind uplift pressure, the 2012 IRC provisions provide a trigger of 200 lb/ft per joint. In addition, Table R802.11 providing uplift loads for selecting hurricane clips was significantly revised in the 2012 IRC based on the same methodology used to develop uplift loads for the *Wood Frame Construction Manual*.

Cost Implication of Code Change:

The cost impact is estimated for the following two cases: (1) one additional 16d box nail installed pneumatically is added to each truss to wall connection, and (2) an H2A hurricane clip (or similar) with associated nails is provided in lieu of the previously-allowed conventional connection of two (2) 16d box nails. For the purposes of this analysis, it is assumed Table R802.11 in the 2009 IRC either provides an uplift load that will allow the use of toe-nailed connections for all truss-to-wall connections, or provides an uplift load that requires a hurricane clip in all cases in lieu of a toe-nailed connection.

Table R-9. Two Cost Alternatives for Truss Uplift Connections In Wind Speed Zones ≤ 90 MPH

Reference House	# Trusses	Cost/16D nail ($)[a]	Cost/Uplift Connector ($)[b]	Cost ($) Scenario	
				1	2
1	69	0.18	1.94	**25**	**267**
2	54	0.18	1.94	**19**	**209**
3	28	0.18	1.94	**10**	**108**
4	40	0.18	1.94	**14**	**155**
a. RSM *RCD 2014* for estimated labor cost included					
b. RSM *RCD 2014* for estimated labor cost for 20 Ties per hour included					

R-10

R905.2.7.2, R905.3.3.3 Underlayment and high winds.

Summary of Code Change

The code change adds more stringent roof underlayment and associated fastening requirements for regions where the basic wind speed is equal to or exceeds 120 mph. The geographic scope of the change is limited to select islands, outer banks, and immediate shoreline areas along the east coast; southern Florida; and coastal Gulf regions. The new requirements apply to roofs constructed with asphalt shingles, clay or concrete tile shingles, metal roof shingles, mineral surface roll roofing, slate shingles, wood shingles, wood shakes, and metal roof panels.

The new provisions include three categories of more stringent requirements:

- A higher grade underlayment (e.g., No. 30 asphalt felt minimum vs No. 15).
- A minimum lap of 4 inches or more. (Previous provisions for high-wind installations referred to manufacturers' instructions.)
- An increased nailing pattern (6/12-inch grid, cap nails). (Previous provisions for high-wind installations referred to manufacturers' instructions, but required that the fastener spacing did not exceed 36 inches along the overlap.)

Cost Implication of Code Change:

With regard to the reference houses, only the Miami location is impacted by this code change. For the locations and reference houses that are identified in this study as being outside of Miami, the added cost is zero. Table R-10 shows the upper end of the cost range as it pertains to a house built in Miami. The 6/12 nailing grid is consistent with manufacturers' standard recommendations and installation guidelines for roof underlayment.

Table R-10. Cost to Install Roof Underlayment in Wind Zones ≥ 120

Component	Unit	Material ($/SF)	Labor ($/SF)	Cost to Install ($/SF)	Reference House							
					1		2		3		4	
					Qty (SF)	Cost ($)	Qty (SF)	Cost ($)	Qty (SF)	Cost ($)	Qty (SF)	Cost ($)
15# Felt Paper	SF	0.10	0.12	0.22	4,392	971	1,784	394	2,226	492	1,794	396
30# Felt Paper	SF	0.21	0.23	0.44	4,392	1,941	1,784	789	2,226	984	1,794	793
Difference ($)					971		394		492		396	

R-11

R905.2.8.5 Drip edge.

Summary of Code Change:

The code change added a requirement to provide drip edge flashing at roof edges for asphalt shingle roofs. Drip edge overlap, placement, and fastener spacing at 12" are covered in the code.

Cost Implication of Code Change:

The additional requirement for roof edge flashing (drip edge) at both eave and rake (gable end) edges adds a cost that varies with the size and slope of roofs. The cost impact is estimated for the reference homes as summarized in Table R-11.

Table R-11. Cost of Drip Edge at Roof Perimeter

Component	Unit	Reference House			
		1	2	3	4
Roof Edge	LF	249	214	148	188
Drip Edge Cost	$/LF	1.53	1.53	1.53	1.53
Total Cost ($)		**381**	**327**	**226**	**288**

E-1

Summary of Code Change:
A number of code changes significantly increased the stringency of the 2012 IECC and Chapter 11 of the 2012 IRC over the 2009 IECC and Chapter 11 of the 2009 IRC. For the first time, performance testing for whole building tightness was mandated. Other significant changes include:

- Table R402.1.1; window U-value in Climate Zones 5 through 8 changed from U-0.35 to U-0.32
- N1102.1.1; ceiling insulation in Climate Zones 4 and 5 went from R-38 to R-49
- N1102.1.1; wall insulation higher R-values which affected six of the eight climate zones – for example, Climate Zones 3 and 4 went from R-13 to R-20/13+5
- N1102.1.1; basement wall R-value in Climate Zones 5-8 went from R-10/13 to R-15/19
- N1102.4; air seal testing and verification of building air leakage from 7 CFM50 to 5 CFM50 in Climate Zones 1 and 2, and 3 CFM50 in all others
- N1103.5; whole house mechanical ventilation mandatory
- N1103.2.2; HVAC ducting leakage reduction from 8 CFM/100 SF to 4 CFM/100 SF and duct insulation in attic increased to R-8
- N1104.1; lighting requirements were added to the scope of the IECC in 2009 and further increased in 2012 (to 75% high-efficacy lamps).
- N1103.4.2; insulation on hot water pipes in specific locations (e.g. from water heater to kitchen) is required on all pipes exceeding specified lengths (e.g., 3/4" pipe longer than 10')

An itemization of the code changes by climate zone can be accessed in Appendix C of the NAHB Research Center's report, *2012 IECC Cost Effectiveness Analysis*, published in May 2012.[13] Note that the Chapter 11, *Energy Efficiency*, of the International Residential Code (IRC) and Chapter 4, *Residential Energy,* of the International Energy Conservation Code (IECC) contain the same language. The code references in the text of this *Summary* are from the IRC.

Cost Implication of the Code Change:
The cost implications of the code changes for energy efficiency (Chapter 11 of the IRC or Chapter 4 of the IECC) were evaluated in the 2012 NAHB Research Center report using a different reference house from those selected for this analysis. Specifications unique to the reference houses in Appendices C through F have been factored by costs developed in the 2012 report, and as noted in the Table footnotes, to provide a direct basis for comparison. Results are summarized in Table E-1. Schedules A, B, and Window support some line items in the Table, as noted.

[13] www.homeinnovation.com/trends_and_reports/featured_reports/percent_energy_savings_2012_iecc_analysis

Table E-1. Cost of Energy Efficiency 2012 Code Changes

Prescriptive Changes		Reference Location		Miami, Los Angeles		Dallas, Seattle, New York		Chicago		Fairbanks	
		Climate Zones		1 & 2		3 & 4		5-7		8	
		Reference Houses		1 & 2		1, 2, 3, & 4		3 & 4		3 & 4	
				Cost Range							
Code Ref.	Component	Avg. SF/Qty.	Cost Per ($)	High ($)	Low ($)	High ($)	Low ($)	High ($)	Low ($)	High ($)	Low ($)
N1101.12.3(3)	Window SHGC[a]	Sched C	Sched A	96	79	96	67	0	0	0	0
N1101.12.3(1)	Window U-Factor[a]	Sched C	Sched B	1,098	630	960	670	127	121	127	121
N1102.1.1	Ceiling Insulation (R-30 -> 38)	2,011	0.25	503	0	503	336	N/A	N/A	N/A	N/A
N1102.1.1	Ceiling Insulation (R-38 -> 49)	2,011	0.53	N/A	N/A	N/A	N/A	1,066	0	N/A	N/A
N1102.1.1	Wall Insulation (R-13 -> 20)	2,354	1.33	0	0	3,130	3,130	N/A	N/A	N/A	N/A
N1102.1.1	Wall Insulation (R-20 -> 20+5)	2,354	0.20	N/A	N/A	N/A	N/A	471	471	N/A	N/A
N1102.1.1	Wall Insulation (R-21 -> 20+5)	2,354	1.52	N/A	N/A	N/A	N/A	N/A	N/A	3,577	3,577
N1102.1.1	Bsmt. Wall Insulation (R-13 -> 19)	1,448	1.05	N/A	N/A	1,520	N/A	1,520	1,520	1,520	1,520
N1102.4	Leakage Test	1	165.00	165	165	165	165	165	165	165	165
N1102.4	Air Seal (5 & 3 ACH50)	2,607	0.41	1,069	965	1,069	965	1,069	965	1,069	965
N1103.2.2	Sealed Ducts 4cfm/100SF	See MEP-2 for Cost Breakdown									
N1103.2.2	Duct Leakage Testing	1	165.00	165	165	165	165	165	165	165	165
N1103.4.2	Hot Water Pipe Ins.[b]			399	262	613	262	613	377	613	377
N1103.5	Mechanical Ventilation[c]	See MEP-1 for Cost Breakdown									
N1104.1	CFLs (75%)	36	1.00	36	36	36	36	36	36	36	36
Total ($)				**3,531**	**2,302**	**8,257**	**5,796**	**5,231**	**3,820**	**7,272**	**6,926**

a. Cost ranges were established using actual window SF from Schedules A and B.

b. Developed using the report titled *Estimated Costs of the 2015 IRC Code Changes* . http://www.homeinnovation.com/trends_and_reports/featured_reports/estimated_costs_of_the_2015_irc_code_changes

c. Cost developed in Appendix A includes cost from *2012 IECC Cost Effectiveness Analysis* in the range.

Schedule A. Differential Cost of Solar Heat Gain Coefficient Coating on Windows

Component	Unit	Climate Zone	
		1,2,3, & 4	5,6,7, & 8
SHGC	$/SF	0.25	0.00

Schedule B. Differential Window U-Factor Cost

Component	Unit	Climate Zone			
		1	2	3,4	5,6,7&8
U-Factor	$/SF	2.86	2.00	2.50	0.45

Schedule C. Window Layout by Reference House

Window Type	Area (SF)	Perimeter (LF)	Reference House			
			1	2	3	4
			1-Story Slab	2-Story Slab	1-Story Basement	2-Story Basement
2020	4	8			2	
2040	8	12				1
2050	10	14	3	1		1
2060	12	16	6			
3019	5	9			3	4
3040	12	14	1	1		3
3050	15	16	5	8	4	7
3060	18	18	7	11	11	
4040	16	16				7
4050	20	18		1		
4060	24	20		1		
Quantity			22	23	20	23
Area (SF)			315	384	280	289
Perimeter (LF)			358	392	305	328

MEP-1

M1507.3 Whole-house mechanical ventilation system.
Cost reported with Chapter 11 Energy Efficiency

Summary of Code Change:

This code change adds a new set of provisions for design of whole-house mechanical systems. In combination with changes to the Building Planning Chapter (Section R303.4 Mechanical Ventilation) and energy efficiency provisions (Sections N1102.4.1.2 Testing and N1103.5 Mechanical Ventilation), mechanical ventilation is effectively required in all homes.

The ventilation system can be supply-only, exhaust only, or a combination of supply and exhaust (balanced) measures. All systems are required to have controls that provide a manual override (on/off switch). Ventilation can be continuous or intermittent. The minimum ventilation rates are based on the square footage of the dwelling and the number of bedrooms.

Cost Implication of Code Change:

The cost implications depend on the type of ventilation system. Three types of systems are evaluated in this study: (1) exhaust-only, (2) supply-only ducted to the return side of the HVAC system, and (3) balanced systems. For the exhaust-only system, the added costs include sizing and upgrading the bathroom fans to provide exhaust ventilation. For the supply-only system the added costs include an outside air supply duct with a damper and ducting routed to the return side of the air handler. A balanced system would incorporate the components of both of these types of systems, or utilize an energy or heat recovery ventilator (ERV or HRV). Results are summarized in Table MEP-1. The low end of the cost range is the cost estimate that was provided in the *2012 IECC Cost Effectiveness Analysis*, $382.

A balanced system that uses an ERV or an HRV would cost in the range of $1,200 to $1,500, which provides the upper end of the cost range. A standard balanced system can be estimated as the combined cost of an exhaust and supply systems for a total of $765, as itemized in Table MEP-1.

Table MEP-1. Cost to Install Exhaust or Supply Ventilation

Component	Quantity	Cost Each ($)	Ventilation Method	
			Exhaust	Supply
Low Sone 80 CFM Fan	2	154	308	N/A
Controller/Switch	2	80	159	N/A
Credit for Builder Grade Fans/Switches	2	(30)	(60)	N/A
Ducting to Plenum & Damper	1	152	N/A	152
Controller/Switch	1	80	N/A	80
Duct Wall Cap	1	126	N/A	126
Total ($)			**407**	**358**

MEP-2

M1601.4.1 Joints, seams, and connections.
Cost reported with Chapter 11 Energy Efficiency

Summary of Code Change:

The code change required joints, seams, and connections of metallic and nonmetallic ducts to comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Standards.[14] SMACNA standards require ducts to be securely fastened and sealed - a higher standard than the previous code language of "substantially airtight". To achieve compliance with the new requirements, longitudinal seams in metal ducting and flanged seams at duct to equipment connections will require a second method of sealing with UL 181 approved products and methods (i.e., mastic or foil tape).

Cost Implication of Code Change:

The cost implication of sealing horizontal joints in snap-lock metal ducting varies with the HVAC layout and labor costs. The reference houses have been assumed to have a main trunk servicing each story. Branch ducts from the main trunks are assumed to be metal (and snap-lock) when located within the first and second floor framing and insulated flexible ducting (no snap joints) in attics. Table MEP-2 indicates the costs associated with the added sealing of snap-lock seams in the reference houses. The sealant is assumed to be mastic applied with a brush.

At the same time that this change was made to the code, another requiring that ducting be sealed to 4 CFM per 100 SF was also included in the code. The costs that are attributed to that effort, in Table E-1 include the costs developed in Table MEP-2.

Table MEP-2. Cost to Seal Snap-Lock Seams in Ducting

Component	Units	Reference House			
		1	2	3	4
6" Branch - Flexible (no seams)	LF	216	180	N/A	N/A
Trunk Line (2)	LF	144	168	128	128
Vertical Supply - seams (2)	LF	14	25	14	20
Return - seams (2)	LF	28	50	28	40
6" Branch - seams - metal (1)	LF	N/A	144	248	378
Subtotal, Duct Seams to Seal	LF	186	387	418	566
Cost to Seal Ducts[a]	$/LF	0.56	0.56	0.56	0.56
Total ($)		**103**	**215**	**232**	**314**

a. RSM *RCD 2014* Sheet Metal Apprentice applying one gallon of mastic/hr. (125 lf/hr.)

[14] www.smacna.org/store/browse/hvac-duct-construction-standards

MEP-3

P2503.5.1 Rough plumbing.

Summary of Code Change:

The code change specifies that drain, waste, and vent (DWV) piping systems made of plastic can no longer be tested for continuity with an air test at the building close-in stage. Therefore polyvinyl chloride (PVC) pipes must be tested for continuity using water.

Cost Implication of the Code Change:

Where site water is available at the time of piping system installation, the use of water for continuity testing of DWV and supply systems will add less cost than at sites where a water supply is not yet available due to concurrent construction of infrastructure. When water for testing is available via a builder's standard temporary water connection or from an adjacent unit's hose bib, no cost is assumed as the test is part of the plumber's contract, and assumed to require equal time as the (air) pressure test that it replaced, thus providing the low end of the range. Where the testing water is trucked to the site a cost has been estimated and provides the high end of the reported cost range, as detailed in Table MEP-3.

Table MEP-3. Cost to Test DWV System with Offsite Water

Component	Hours	Cost ($)	Total ($)
Labor[a]	1	54	54
Truck/Water Hauling[a]	1	115	115
Total ($)			**169**

a. RSM *Site Work & Landscape Cost Data 2014*

APPENDIX B:
LOCATION ADJUSTMENT FACTORS

State	City	Cost Adjustment Factor	State	City	Cost Adjustment Factor
Alabama	Birmingham	0.86	Montana	Billings	0.90
Alabama	Mobile	0.81	Nebraska	Omaha	0.90
Alaska	Fairbanks	1.24	Nevada	Las Vegas	1.03
Arizona	Phoenix	0.86	New Hampshire	Portsmouth	0.97
Arizona	Tucson	0.84	New Jersey	Jersey City	1.13
Arkansas	Little Rock	0.8	New Mexico	Alburquerque	0.83
California	Alhambra	1.08	New York	Long Island City	1.33
California	Los Angeles	1.09	New York	Syracuse	0.98
California	Riverside	1.07	North Carolina	Charlotte	0.86
California	Stockton	1.11	North Carolina	Greensboro	0.85
Colorado	Boulder	0.91	North Carolina	Raleigh	0.86
Colorado	Colorado Springs	0.86	North Dakota	Fargo	0.79
Colorado	Denver	0.89	Ohio	Columbus	0.95
Connecticut	New Haven	1.11	Oklahoma	Oklahoma City	0.82
Deleware	Dover	1.01	Oklahoma	Tulsa	0.78
District of Columbia	Washington, D.C.	0.94	Oregon	Bend	1.00
Florida	Fort Meyers	0.86	Pennsylvania	Norristown	1.10
Florida	Miami	0.86	Pennsylvania	State College	0.91
Florida	Orlando	0.87	Rhode Island	Providence	1.10
Florida	Tampa	0.90	South Carolina	Greenville	0.85
Georgia	Atlanta	0.87	Tennessee	Memphis	0.84
Hawaii	Honolulu	1.22	Texas	Austin	0.78
Idaho	Boise	0.88	Texas	Dallas	0.84
Illinois	Carbondale	1.02	Texas	Houston	0.85
Indiana	Indianapolis	0.93	Texas	San Antonio	0.80
Iowa	Des Moines	0.91	Utah	Ogden	0.79
Kansas	Wichita	0.79	Utah	Provo	0.79
Kentucky	Louisville	0.92	Utah	Salt Lake City	0.80
Louisiana	Baton Rouge	0.82	Vermont	Burlington	0.95
Maine	Portland	0.97	Virginia	Fairfax	1.02
Maryland	Baltimore	0.90	Virginia	Winchester	1.01
Michigan	Ann Arbor	1.03	Washington	Tacoma	1.01
Minnesota	St. Paul	1.11	West Virginia	Charleston	0.97
Mississippi	Biloxi	0.80	Wisconsin	La Crosse	0.96
Missouri	Springfield	0.89	Wyoming	Casper	0.75

Source: RSMeans® *Residential Cost Data 2014*.

APPENDIX C:
ONE-STORY HOUSE WITH SLAB FOUNDATION (REFERENCE HOUSE 1)

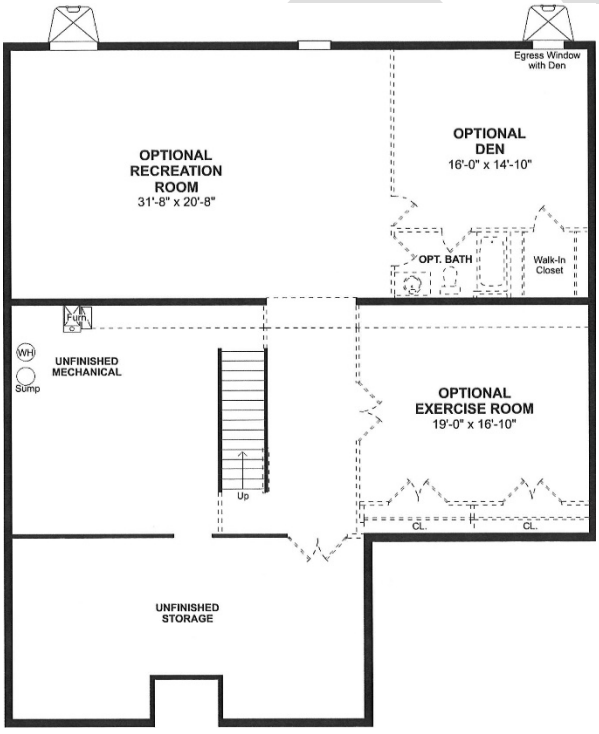
Courtesy: LionsGate Homes at The Creekside

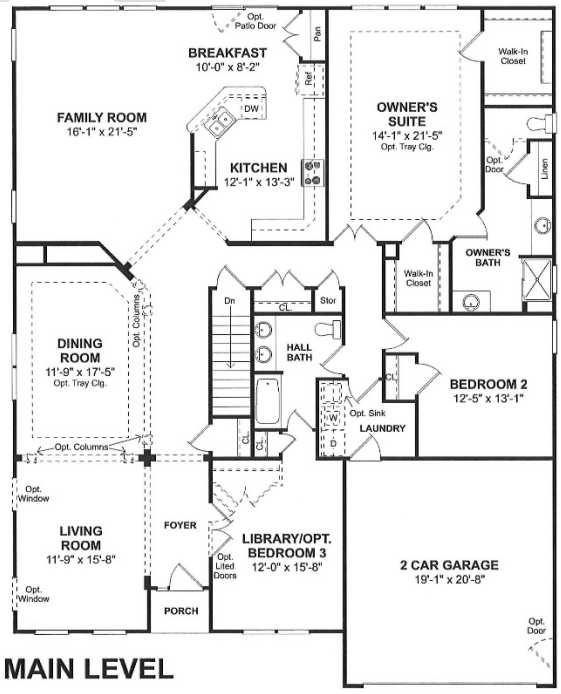
APPENDIX D:
TWO-STORY HOUSE WITH SLAB FOUNDATION (REFERENCE HOUSE 2)

Courtesy: Meritage Homes at Riverstone

APPENDIX E:
ONE-STORY HOUSE WITH BASEMENT FOUNDATION (REFERENCE HOUSE 3)

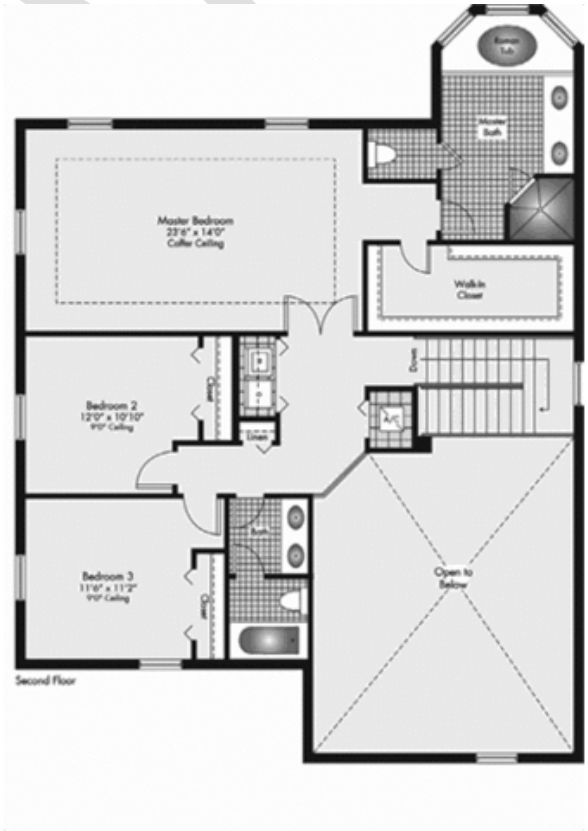
Courtesy: K Hovnanian Four Seasons at New Kent Vineyards





APPENDIX F:
TWO-STORY HOUSE WITH BASEMENT FOUNDATION (REFERENCE HOUSE 4)

Courtesy: Lennar at Sorento Estates



APPENDIX G:
REFERENCES

Home Innovation Research Labs, 2014. *Estimated Costs of the 2015 IRC Code Changes*. www.homeinnovation.com/trends_and_reports/featured_reports/estimated_costs_of_the_2015_irc_code_changes

NAHB Research Center, 2012. *2009 IECC Cost Effectiveness Analysis*. www.homeinnovation.com/trends_and_reports/featured_reports/percent_energy_savings_2009_iecc_analysis

NAHB Research Center, 2012. *2012 IECC Cost Effectiveness Analysis*. www.homeinnovation.com/trends_and_reports/featured_reports/percent_energy_savings_2012_iecc_analysis

RS Means, 2014. *Residential Cost Data (RCD).* *http://rsmeans.reedconstructiondata.com/RSMeans_Cost_Data_eBooks.aspx*

APPENDIX H:
ARES CONSULTING BRACING REPORT

CODE COMPARATIVE BRACING ANALYSIS FOR TWO REPRESENTATIVE HOUSE PLANS

Prepared for
Home Innovation Research Labs
Upper Marlboro, MD

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ARES Consulting
www.aresconsulting.biz

May 4, 2015
FINAL REPORT
(REVISED September 4, 2015 – SDC D2 Analyses Only)

Introduction:

This report provides data in the form of bracing design solutions for two representative house plans. The data is intended to support a cost impact analysis of changes to prescriptive wall bracing provisions in the 2006, 2009, and 2012 editions of the International Residential Code (IRC).

Approach:

The following approach was taken in conducting the bracing analyses for this study:

- Start with 2006 IRC as the "baseline code" and repeat analysis for 2009 and 2012 editions.
- Evaluate intermittent bracing (wood structural panels) as baseline bracing method and progress to continuous bracing method (also with wood structural panels) and then consider other bracing methods (e.g., narrow panel or portal frame methods) as required to addressed plan and design conditions for three representative wind/seismic regions.
- Engineering analysis is used only as necessitated by a condition resulting in a code non-compliance and then is evaluated on the basis of "parts and portions" (e.g., whole building engineering analyses were not performed).
- Report incremental differences in prescriptive bracing designs required for the two representative house plans, including instances where engineering analysis or pre-engineered bracing elements are needed to achieve code compliance (see later section on Summary of Design Solutions and also separately attached analysis files for each plan and design condition specified).

The conditions analyzed as described above are shown in Table 1 for a total of 18 individual prescriptive bracing designs.

Table 1. Bracing Analysis Study Matrix

	2006 IRC			2009 IRC			2012 IRC		
	SDC D2 85B (LA)	90B SDC A/B (Dallas)	100C SDC A/B (NYC)	SDC D2 85B (LA)	90B SDC A/B (Dallas)	100C SDC A/B (NYC)	SDC D2 85B (LA)	90B SDC A/B (Dallas)	100C SDC A/B (NYC)
One-story	X	X	X	X	X	X	X	X	X
Two-story	X	X	X	X	X	X	X	X	X

In addition to the above conditions, an analysis of the 90B, SDC A/B condition for the two-story plan was conducted using the simplified method in Section R602.12 of the 2012 IRC. The one story plan was too large in one plan dimension to qualify for use and the simplified approach excludes the 100/C and SDC D2 design conditions. An assessment of impacts to bracing design was also conducted when using brick veneer in the SDC D2 condition, although detailed analyses were not done for reasons discussed later. For the SDC D2, 85/B condition, two separate analyses (for wind and for seismic bracing) were performed to determine the controlling condition for each braced wall line in each plan.

For the design conditions represented above, the analysis assumed a maximum 15 psf wall dead load, although where appropriate a seismic bracing reduction for 8 psf wall assemblies was applied (e.g., vinyl, wood, or fiber cement siding). The 15 psf wall dead load was applied for cases with brick or stone accents on the front of the building (where the wall dead load on average was still less than 15 psf), such as found on the one-story plan. The two-story plan was assumed to have stucco over wood structural panels (WSP) as shown in the renderings below (e.g., ~15 psf wall assembly). Wall dead load conditions only affect seismic bracing amounts when seismic bracing analysis is required (e.g., SDC D for all homes and SDC C for townhomes). Similarly, the buildings had different roof dead load conditions (e.g., the two story plan had a tile roof) and this affected bracing amounts in the SDC D2 analysis condition. Seismic irregularities were also considered in the SDC D2 condition and in some cases required adjustments or designs to resolve by parts and portions. Other related factors considered included assessment of wind uplift requirements which may be required by roof wind uplift provision, braced wall panel wind uplift provisions added to the 2009 and 2012 editions of the IRC, both or neither. Where uplift requirements were triggered by the bracing uplift limit, this also was considered as a bracing impact. Finally, bracing support and connection conditions were considered.

The analysis relied extensively on the 2006, 2009, and 2012 editions of the International Residential Code. In some cases for design by parts and portions, certain provisions from the Wood Frame Construction Manual (WFCM) were applied (e.g., anchor bolt spacing to resist uplift loads where wall bracing and roof uplift requirements were invoked and were not resolved by dead load prior to reaching the foundation). In other cases, the analysis specifies generic connectors (e.g. straps and hold-downs) based on a rated design capacity. In several cases, design of wall bracing elements was needed, but was not possible using conventional engineering practices such as found in Special Design Provisions for Wind and Seismic (SDPWS) or the IBC. In these cases, pre-engineered manufactured narrow wall bracing panel elements were generically specified based on an equivalency to the number of IRC braced wall panels required. Thus, a design was made possible by parts and portions where needed. Finally, several

aspects of the IRC bracing provisions require interpretation and judgment for specific applications; in these cases, professional judgment was applied. However, local building departments may require different solutions or judgments.

Representative House Plans:

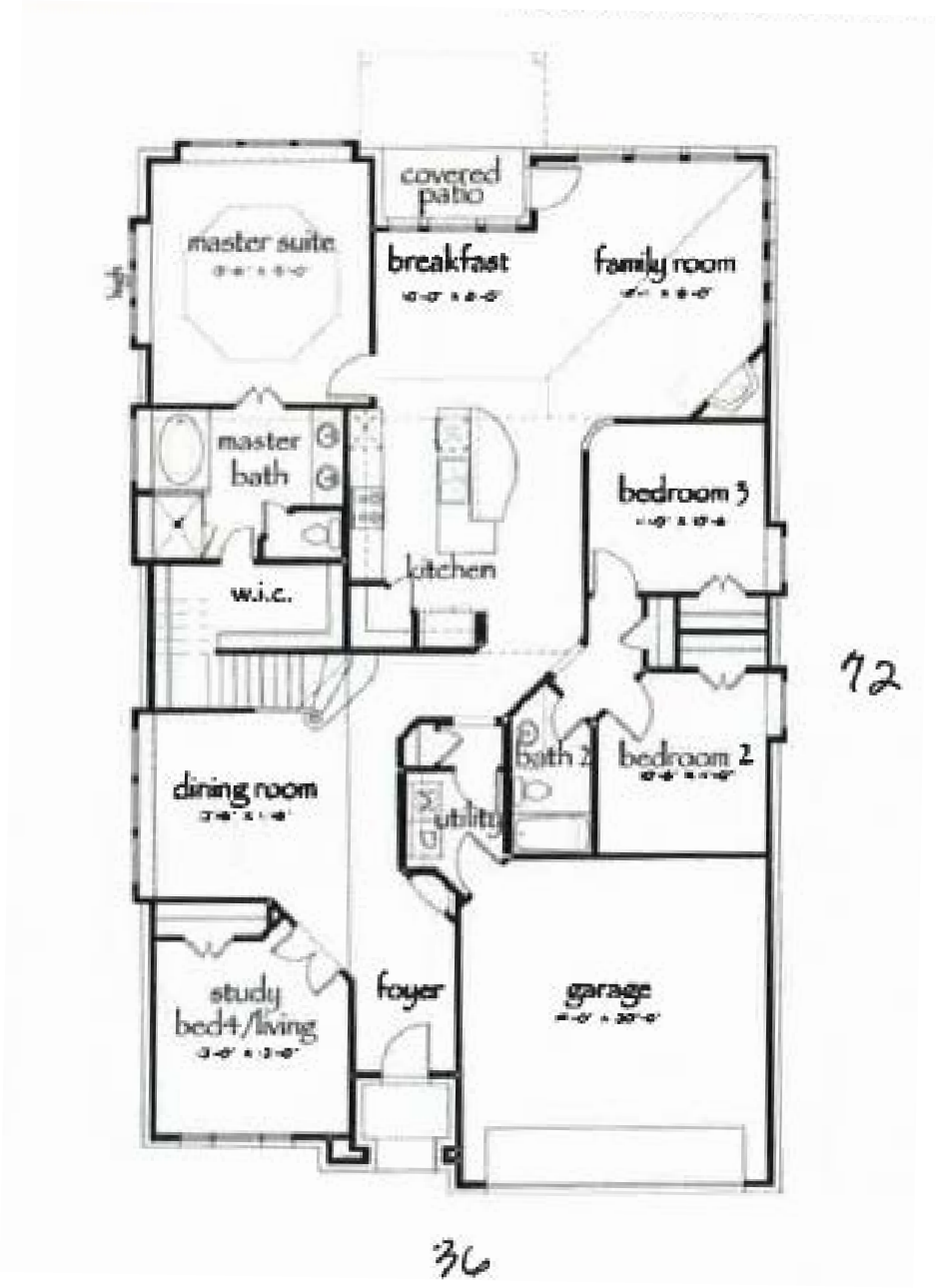
Sample renderings and floor plans for the two representative homes are shown below as provided for this project. Other elevations were not available and are assumed to be typical for the purposes of this analysis.

ONE-STORY HOUSE WITH SLAB FOUNDATION

Courtesy: LionsGate Homes at The Creekside

APPENDIX F:
TWO-STORY HOUSE WITH BASEMENT FOUNDATION

Courtesy: Lennar at Sorento Estates



One Story Plan

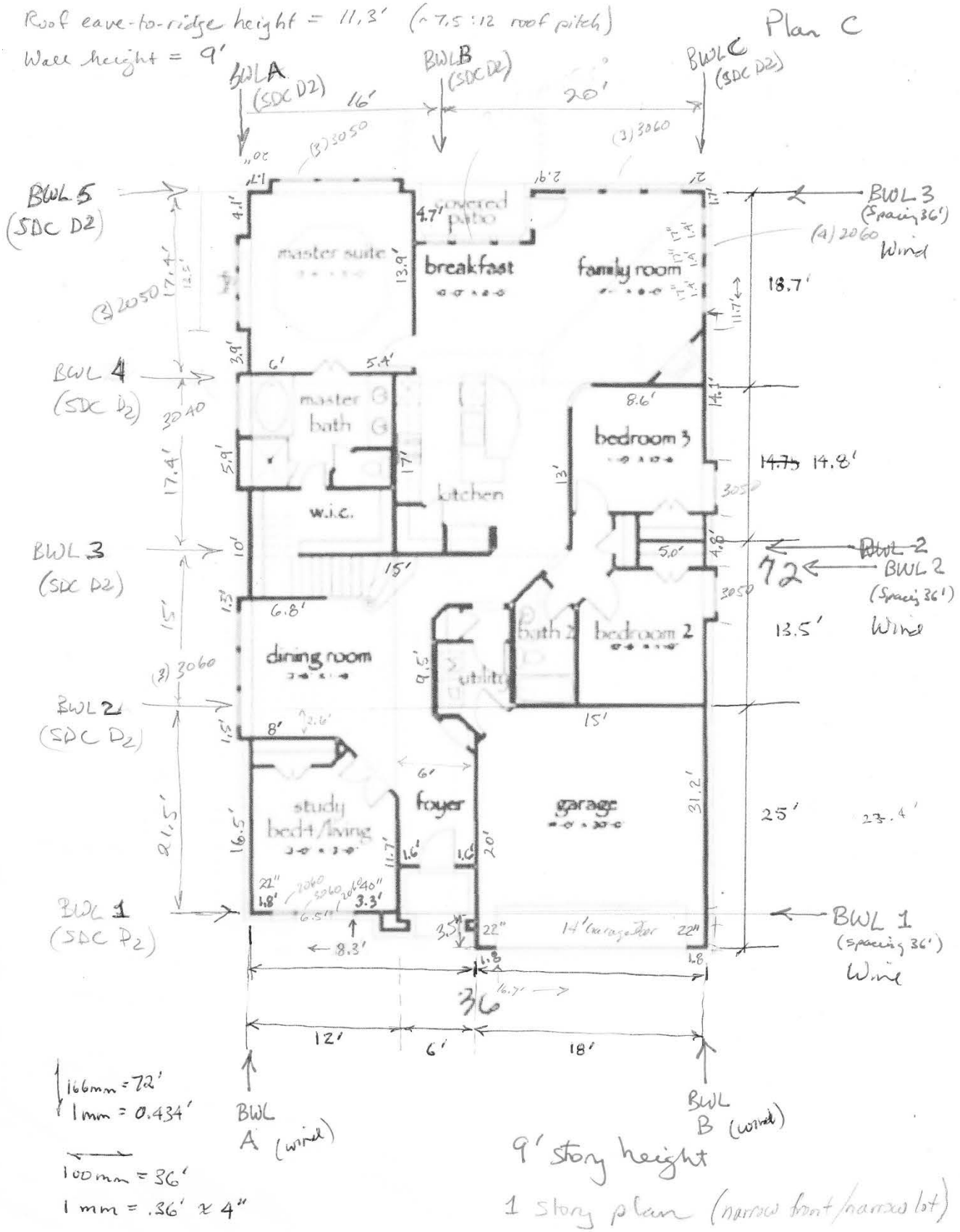
Two Story Plan

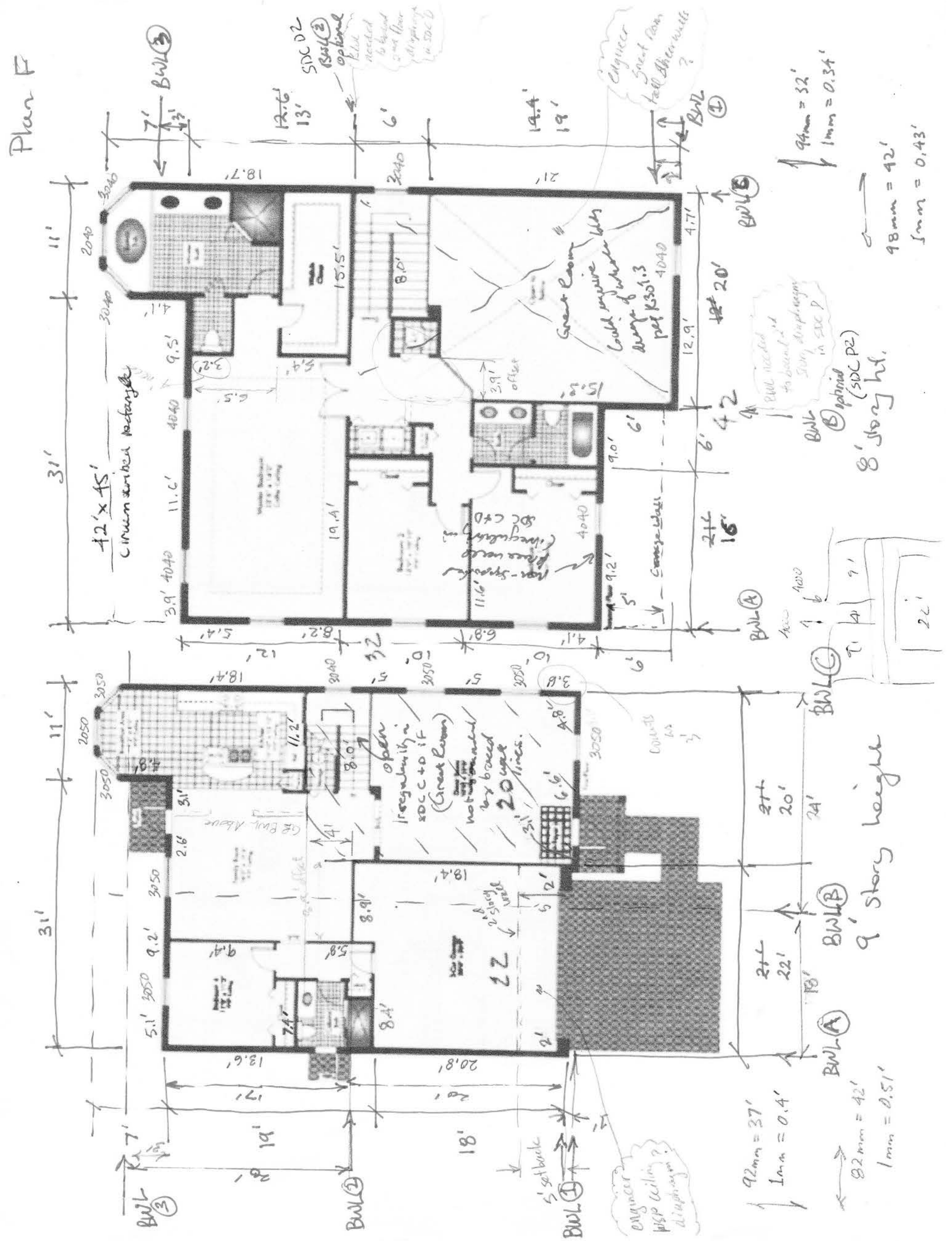
Summary of Design Solutions

Bracing solutions were derived using a detailed analysis template to aid in the implementation the IRC bracing provisions (for each of the three code editions). These templates for each of the 18 specified design conditions (plus the additional 2012 IRC simplified bracing analysis) were provided as separate Word files labelled accordingly. The separate design templates may be referenced for details such as how bracing amounts were determined and other criteria as checked for compliance including a variety of details such as siding types and weights, roofing types and weights, building geometry, adjustment factors for bracing, and a number of other details required to perform an analysis per code. In these detailed templates, comments are added to indicate the cause for needing engineered design solutions or specific oddities regarding the IRC code logic that may place restraint on otherwise applicable solutions (e.g., the requirement in the 2006 IRC that "all walls" be designed with continuous sheathing bracing methods when only one wall may require it based on the analytical bracing requirements).

To aid in understanding the design solutions and how they apply to the two representative plans, it is first important to understand the layout of braced wall lines (BWL) for the two plans. For the one-story plan, two different braced wall line layouts are shown in the image below because additional interior braced wall lines were required in the SDC D2 design condition to comply with BWL spacing limits. This added significantly to the number interior braced wall lines on the one-story plan. For the two-story plan, three braced wall lines were used for both stories; however, for wind bracing design purposes (90/B and 100/C conditions) the interior braced wall lines on the 2nd story were not required. These BWL layouts and individual wall segment dimensions and other dimensioning necessary to conduct the analysis were scaled from the plan renderings provided using the overall plan dimensions noted on the images as provided for this study. Thus, the dimensioning of elements on these plans is approximate.

The BWL layouts are as follows:


Roof eave-to-ridge height = 11.3' (~7.5:12 roof pitch)
Wall height = 9'
Plan C
BWL A (SDC D2)
BWL B (SDC D2)
BWL C (SDC D2)
16'
20'
(3) 3050
(3) 3060
BWL 5 (SDC D2)
BWL 4 (SDC D2)
BWL 3 (SDC D2)
BWL 2 (SDC D2)
BWL 1 (SDC P2)
BWL 3 (Spacing 36')
(4) 2060 Wind
BWL 2 (Spacing 36')
Wind
BWL 1 (spacing 36')
Wind
(2) 2050
(3) 3060
3040
3050
3060
master suite
breakfast
covered patio
family room
master bath
kitchen
w.i.c.
bedroom 3
bedroom 2
bath 2
dining room
utility
study bedr/living
foyer
garage
14' garage door
18.7'
14.8'
25'
23.4'
31.2'
36
12'
6'
18'
166mm = 72'
1mm = 0.434'
100mm = 36'
1mm = .36' x 4"
BWL A (wind)
BWL B (wind)
9' story height
1 story plan (narrow front/narrow lot)


Plan F
9' story height
8' story ht.
Great Room
42' x 45' circumscribed rectangle

The following tables summarize the bracing design solutions derived from the separately attached detailed analysis templates (roof uplift impacts related to bracing uplift limitations are presented separately later):

NOTE: There may be slightly different wording describing the same solution given that each solution was individually analyzed over the course of several different iterations for each plan. In addition, it is important to recognize that many solutions look similar (e.g., the 2009 and 2012 IRC bracing design are generally identical). However, some differences in these codes (such as the change in braced wall panel end distance) may trigger an additional solution such as a collector or inclusion of an additional segment of wall as a BWP that was before not required. Thus, a careful reading is advised to pick up substantive differences that may otherwise be lost in all the similarities.

One Story Plan (90/B, SDC A/B)

BWL	2006 IRC	2009 IRC	2012 IRC
A (left)	*OSB fully sheathed ["All walls" due to BWL 1 & 3]*	*(4) 4' OSB panels (56' infill panels)*	*(4) 4' OSB panels (56' infill panels)*
B (Right)	*OSB fully sheathed [Garage can be unfinished]*	*(4) 4' OSB panels (56' infill panels)*	*(4) 4' OSB panels (56' infill panels) + engr fee for collector design at 4-gang windows (BWP>10' from corner)*
1 (front)	*OSB fully sheathed [use portal frame @ garage w/o hold-downs per note 'c' Table R602.10.5, shift window set 2"from corner]*	*OSB fully sheathed [increased 3 panels by 3" ea. to reach 2' min. – may affect window sizes, foyer width, or plan width] (Garage must be finished)*	*OSB fully sheathed [increased 3 panels by 3" ea. to reach 2' min. – may affect window sizes, foyer width, or plan width] (garage must be finished)*
2 (int.)	*OSB fully sheath one-side of two interior walls at closet and stairway/kitchen (no impact to door jambs); overlay with GWB int. finish*	*GB double side interior walls with 7"oc fastening at edges of GB panels (two interior wall segments)*	*GB double side interior walls with 7"oc fastening at edges and field (two interior wall segments)*
3 (rear)-option 1	*OSB fully sheathed [requires all rear windows to be max. 28" instead of 30" wide]*	*OSB fully sheathed [requires all rear windows to be max. 28" instead of 30" wide]*	*OSB fully sheathed [requires all rear windows to be max. 28" instead of 30" wide]*
3 (rear)-option 2	*OSB fully sheath plus PFH portal frame with hold-downs and strapping at Master Suite window set(no change to window sizes, but extra PFH header in attic may interfere with roof framing require detailing)*	*OSB fully sheath plus 4 CS-PF panels at both opening sets, in one case an extra CS-PF header must be placed in attic which may affect roof framing if perp.)*	*OSB fully sheath plus 4 CS-PF panels at both opening sets, in one case an extra CS-PF header must be placed in attic which may affect roof framing if perp.)*
3 (rear)-option 3	*Use two narrow shear wall engr. panels: 1.7' & 2.9' wide with 4 hold-downs per manuf. design (equivalent to 1.5 4' WSP BWPs)*	*Use three narrow shear wall engr. panels: 1.7', 2.9', and 2' wide with 6 hold-downs per manuf. design (equivalent to 2.3 4' WSP BWPs)*	*Use three narrow shear wall engr. panels: 1.7', 2.9', and 2' wide with 6 hold-downs per manuf. design (equivalent to 2.3 4' WSP BWPs)*

Two Story Plan (90/B, SDC A/B)

BWL	2006 IRC	2009 IRC	2012 IRC	2012 IRC - Simple
First Story (Bottom)				
A (left)	*Fully sheath OSB; req'd all walls due to BWL 1 & 3 (garage can be unfinished)*	*Use (3) 4' OSB panels (25' infill); (garage may be unfinished)*	*Use (3) 4' OSB panels (25' infill); garage assumed to have ½" GWB*	*Fully sheath OSB (selected due to BWL 3 and GR tall wall at BWL C and thus simplified method requires "all walls") (garage must be finished with simplified method)*
B (interior)	*Fully sheath OSB int. walls (one side) through middle of building; BWL not req'd by code but included due to GR (to avoid design req'd by bldg. dept.)*	*7"oc edge fasten int. GWB both sides for 8' along two int. walls adjoining front and rear ext. walls*	*7"oc edge & field fasten int. GWB both sides for 8' along two int. walls adjoining front and rear ext. walls*	*Int. BWL not permitted*
C (right)	*Fully sheath OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)*	*Use (3) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**	*Use (3) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd for permit)*	*Fully sheath OSB (use two 9,000 lb holddowns at ends of GR wall portion if required to engr for permit)*
1 (front)	*OSB fully-sheath + 1 PFH panel at garage corner + hdr + straps + 2 hold-downs*	*OSB fully-sheath + 2 CS-PF panels at garage supporting offset 2nd story BWL*	*OSB fully-sheath + 2 CS-PF panels at garage supporting offset 2nd story BWL*	*OSB fully-sheath + 2 CS-PF panels at garage supporting offset 2nd story BWL*
2 (interior)	*OSB fully sheathing int. walls one side at 9' int.wall btwn garage & F.R. and 8' int. wall between stairs*	*7"oc edge fasten int. GWB both sides at 9' int. wall btwn garage & F.R. and 8' wall between stairs*	*7"oc edge & field fasten int. GWB both sides at 8.4'wall btwn garage & bath/tub and 8' wall between stairs*	*Int. BWL not permitted*
3 (rear)	*OSB fully-sheath*	*OSB fully-sheath [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*	*OSB fully-sheath + engr collector for BWP>10' from end of BWL [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*	*OSB fully-sheath*
Second Story (Top)				
A (left)	*Fully sheath OSB (WSP would work but BWL 1 & 3 req CS-WSP and thus "all walls" per R602.10.5)*	*(3) 4' OSB panels*	*(3) 4' OSB panels*	*Fully-sheath OSB (due to "all walls" invoked by conditions on 1st story; otherwise WSP would work)*
B (interior)	*BWL not used in SDC A/B, 90/B*	*BWL not used in SDC A/B, 90/B*	*BWL not used in SDC A/B, 90/B*	*Int. BWL not permitted*
C (right)	*Fully sheath OSB*	*(3) 4' OSB panels*	*(3) 4' OSB panels*	*Fully-sheath OSB*
1 (front)	*Fully sheath OSB*	*(3) 4' OSB panels*	*(3) 4' OSB panels*	*Fully-sheath OSB*
2 (interior)	*BWL not used in SDC A/B, 90/B*	*BWL not used in SDC A/B, 90/B*	*BWL not used in SDC A/B, 90/B*	*Int. BWL not permitted*
3 (rear)	*Fully sheath OSB*	*(3) 4' OSB panels*	*(3) 4' OSB panels + engr collector for BWP>10' from end of BWL*	*Fully-sheath OSB*

One Story Plan (100/C, SDC A/B)

BWL	2006 IRC	2009 IRC	2012 IRC
A (left)	*OSB fully sheathed ["All walls" due to BWL 1 & 3]*	*(4) 4' OSB panels (56' infill panels)*	*(4) 4' OSB panels (56' infill panels)*
B (Right)	*OSB fully sheathed [Garage can be unfinished]*	*(4) 4' OSB panels (56' infill panels) [garage can be unfinished front and side wall]*	*(4) 4' OSB panels (56' infill panels) + engr fee for collector design at 4-gang windows (BWP>10' from corner)*
1 (front)	*OSB fully sheathed [use portal frame @ garage w/o hold-downs per note 'c' Table R602.10.5, shift window set 2"from corner]*	*Use four narrow shear wall engr. panels: 1.8', 3.3', 1.8', and 1.8' wide max. with 8 hold-downs per manuf. design (equiv. to 3.4 4' WSP BWPs) [garage can be unfinished front and side wall]*	*Use four narrow shear wall engr. panels: 1.8', 3.3', 1.8', and 1.8' wide max. with 8 hold-downs per manuf. design (equiv. to 3.4 4' WSP BWPs) [garage can be unfinished front and side wall]*
2 (int.)	*OSB fully sheath one-side of two interior walls at closet and stairway/kitchen (no impact to door jambs); overlay with GWB int. finish*	*GB double side interior walls with 7"oc fastening at edges of GB panels (3 interior wall segments)*	*GB double side interior walls with 7"oc fastening at edges and field of GB panels (3 interior wall segments)*
3 (rear)-option 1	*OSB fully sheathed [requires all rear windows to be max. 28" instead of 30" wide]*	*NG*	*NG*
3 (rear)-option 2	*OSB fully sheath plus PFH portal frame with hold-downs and strapping at Master Suite window set(no change to window sizes, but extra PFH header in attic may interfere with roof framing require detailing)*	*NG*	*NG*
3 (rear)-option 3	*Use two narrow shear wall engr. panels: 1.7' & 2.9' wide with 4 hold-downs per manuf. design (equivalent to 1.5 4' WSP BWPs)*	*Use four narrow shear wall engr. panels: 1.7', 1.33', 2.9', and 2' wide with 8 hold-downs per manuf. design (equivalent to 3.4 4' WSP BWPs)*	*Use four narrow shear wall engr. panels: 1.7', 1.33', 2.9', and 2' wide with 8 hold-downs per manuf. design (equivalent to 3.4 4' WSP BWPs)*

NG = "no good" (option does not work)

Two Story Plan (100/C, SDC A/B)

BWL	2006 IRC	2009 IRC	2012 IRC
First Story (Bottom)			
A (left)	*Fully sheath OSB; req'd all walls due to BWL 1 & 3 (garage can be unfinished)*	*Use (3) 4' OSB panels (25' infill); garage assumed to have ½" GWB*	*Use (3) 4' OSB panels (25' infill); garage assumed to have ½" GWB*
B (interior)	*Fully sheath OSB int. walls (one side) through middle of building; BWL not req'd by code but included due to GR (to avoid design req'd by bldg. dept.)*	*7"oc edge fasten int. GWB both sides for 18.4' garage wall along G.R. and 9.4' Bdrm Wall at F.R. (front and rear of plan)*	*7"oc edge & field fasten int. GWB both sides for 18.4' garage wall along G.R. and 9.4' Bdrm Wall at F.R. (front and rear of plan)*
C (right)	*Fully sheath OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**	*Use (4) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**	*Use (4) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**
1 (front)	*OSB fully-sheath + 1 PFH panel at garage corner + hdr + straps + 2 hold-downs*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*
2 (interior)	*OSB fully sheathing int. walls one side at 9'int.wall btwn garage & F.R. and 8' int. wall between stairs*	*7"oc edge fasten int. GWB both sides at 8'wall btwn garage and bath, 9'wall btwn garage & F.R. and 8' wall between stairs*	*7"oc edge & field fasten int. GWB both sides at 8'wall btwn garage and bath, 9' wall btwn garage and F.R. and 8'wall btwn stairs*
3 (rear)	*OSB fully-sheath*	*OSB fully-sheath [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*	*OSB fully-sheath + engr collector for BWP>10' from end of BWL [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*
Second Story (Top)			
A (left)	*Fully sheath OSB (WSP would work but BWL 1 & 3 req CS-WSP and thus "all walls" per R602.10.5)*	*(3) 4' OSB panels*	*(3) 4' OSB panels*
B (interior)	*BWL not used in SDC A/B, 100/C*	*BWL not used in SDC A/B, 100/C*	*BWL not used in SDC A/B, 100/C*
C (right)	*Fully sheath OSB*	*(3) 4' OSB panels*	*(3) 4' OSB panels*
1 (front)	*Fully sheath OSB*	*(3) 4' OSB panels*	*(3) 4' OSB panels*
2 (interior)	*BWL not used in SDC A/B, 100/C*	*BWL not used in SDC A/B, 100/C*	*BWL not used in SDC A/B, 100/C*
3 (rear)	*Fully sheath OSB*	*(3) 4' OSB panels*	*(3) 4' OSB panels + engr collector for BWP>10' from end of BWL*

One Story Plan (85/B, SDC D2)

BWL	2006 IRC	2009 IRC	2012 IRC
A (left)	*(4) 4' OSB panels (56' infill panels) with 3"x3" plate washers on anchor bolts at 6'oc to sill plate*	*Engr Req'd due to wall length >50' + Fully sheath OSB ("all ext. walls" due to BWLs 1 & 5) anchor bolts at 6'oc with 3"x3" plate washers*	*Engr Req'd due to wall length >50' + Fully sheath OSB ("all ext. walls" due to BWLs 1 & 5) anchor bolts at 6'oc with 3"x3" plate washers*
B (interior)	*GB double side interior walls with 7"oc fastening at edges of GB panels (13.9', 17', 9.5', and 20' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*	*Engr Req'd due to wall length >50' + GB double side interior walls with 7"oc fastening at edges of GB panels (4 4' interior wall segments) anchor bolts 6'oc with 3"x3" plate washers + 8" thick slab at BWP locations for anchor bolts*	*Engr Req'd due to wall length >50' + GB double side interior walls with 7"oc fastening at edges and field of GB panels (4-4' interior wall segments) anchor bolts 6'oc with 3"x3" plate washers + 8" thick slab at BWP locations for anchor bolts*
C (right)	*(4) 4' OSB panels (56' infill panels) with 3"x3" plate washers on anchor bolts at 6'oc to sill plate + 1800# hold down at end of wall next to windows at rear and 16-16d nails at top plate splice in this region*	*Engr Req'd due to wall length >50' + Fully sheath OSB ("all ext. walls" due to other BWLs) anchor bolts at 6'oc with 3"x3" plate washers*	*Engr Req'd due to wall length >50' + Fully sheath OSB ("all ext. walls" due to other BWLs) anchor bolts at 6'oc with 3"x3" plate washers*
1 (front)	*Use three 16" PFH panels (2 at garage and one at left corner) with two 4200# hold-downs each panel and strapping and sheathing per FigR602.10.6.2 [remainder of wall OSB sheath]*	*OSB fully sheathed [increased 2 panels by 5" ea. to reach 27" min. and corner panel by 3" to reach 24"min– may affect window sizes, foyer width, or plan width; Garage must be finished; use 3"x3" plate washers on anchor bolts at 6'oc*	*OSB fully sheathed [increased 2 panels by 5" ea. to reach 27" min. and corner panel by 3" to reach 24"min– may affect window sizes, foyer width, or plan width; Garage must be finished; use 3"x3" plate washers on anchor bolts at 6'oc*
2 (interior)	*GB double side interior walls with 7"oc fastening at edges of GB panels (8' and 15' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*	*GB double side interior wall segments with 7"oc fastening at edges (8' and 15' walls, garage and dining room) on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*	*GB double side interior wall segments with 7"oc fastening at edges and field (8' and 15' walls, garage and dining room) on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*
3 (interior)	*GB double side interior walls with 7"oc fastening at edges of GB panels (5', 15', and 6.8' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*	*GB double side interior wall segments with 7"oc fastening at edges (6.8',15', and 5.0' walls) at D.R., stairway, and dbl closet on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*	*GB double side interior wall segments with 7"oc fastening at edges and field (6.8',15', and 5.0' walls) at D.R., stairway, and dbl closet on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*
4 (interior)	*GB double side interior walls with 7"oc fastening at edges of GB panels (6', 5.4 and 8.6' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*	*GB double side interior walls with 7"oc fastening at edges of GB panels (6', 5.4 and 8.6' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*	*GB double side interior walls with 7"oc fastening at edges and field of GB panels (6', 5.4 and 8.6' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*
5 (rear)	*Use three 16" PFH panels (one at each corner and one at door) with two 4200# hold-downs each panel and strapping and sheathing per FigR602.10.6.2 [remainder of wall OSB sheath]*	*OSB fully sheathed + 2 CS-PF panels, one at each rear corner; use 3"x3" plate washers on anchor bolts at 6'oc*	*OSB fully sheathed + 2 CS-PF panels, one at each rear corner; use 3"x3" plate washers on anchor bolts at 6'oc*

NOTES:

1. Where a BWP is bearing directly on a slab or foundation, 3x3" plate washers required on sill anchor bolts in SDC D2 (all codes) and the slab or footing must be reinforced per code.
2. For interior walls, blocking must be provided in floor/roof framing above and below (all codes).
3. For 2009 and 2012 IRC codes, roof eave blocking or lateral force transfer detail is needed (e.g., if truss or rafter heel height is 9.25" or less then partial height blocking can be used; if taller, then refer to code for details).

Two Story Plan (85/B, SDC D2)

BWL	2006 IRC	2009 IRC	2012 IRC
First Story (Bottom)			
A (left)	*Fully sheath OSB; req'd all walls due to BWL 3 (garage can be unfinished); anchor bolts at 6'oc with 3"x3" plate washers*	*Fully sheath OSB (caused by "all walls" due to BWL C, 1, and 3); use 3"x3" washers on anchor bolts @ 6'oc (garage can be unfinished)*	*Fully sheath OSB (caused by "all walls" due to BWL C, 1, and 3); use 3"x3" washers on anchor bolts @ 6'oc (garage can be unfinished)*
B (interior)	*Fully sheath OSB int. walls (one side) through middle of building; blocking between joists below and anchors at 6'oc with 3"x3" plate washers to foundation at garage.*	*7"oc edge fasten int. GWB both sides for two int. walls adjoining front and rear ext. walls; blocking below wall at family room; 6'oc with 3"x3" plate washers to foundation at garage.*	*7"oc edge and field fasten int. GWB both sides for two int. walls adjoining front and rear ext. walls; blocking below wall at family room; 6'oc with 3"x3" plate washers to foundation at garage.*
C (right)	*Fully sheath OSB (may require engr. due to tall walls at G.R., but prescriptive design works due to min. openings and sizes; local official may disagree – engr fee may be req'd)*	*Fully Sheath OSB w/ two 9,000# holddowns to dbl. tall studs at ends of great room wall portion (engr. Fee may be req'd); 3"x3" washers on anchor bolts at 6'oc*	*Fully Sheath OSB w/ two 9,000# holddowns to dbl. tall studs at ends of great room wall portion (engr. Fee may be req'd); 3"x3" washers on anchor bolts at 6'oc*
1 (front)	*Use 3 or more engr narrow brace wall panels (no more than 2' wide each) for total equivalence to 5.8 WSP BWPs*	*Use 3 or more engr narrow brace wall panels (no more than 2' wide each) for total equivalence to 5.8 WSP BWPs*	*Use 3 or more engr narrow brace wall panels (no more than 2' wide each) for total equivalence to 5.8 WSP BWPs*
2 (interior)	*OSB fully sheathing int. walls at back of garage and between stairwell and kitchen*	*OSB fully sheathing int. walls at back of garage and between stairwell and kitchen; 3"x3" plate washers on anchor bolts @ 6'oc along garage walls*	*OSB fully sheathing int. walls at back of garage and between stairwell and kitchen; 3"x3" plate washers on anchor bolts @ 6'oc along garage walls*
3 (rear)	*Use 3 or more engr narrow brace wall panels (no more than 2.6' wide each) for total equivalence to 5.8 WSP BWPs also 1000# strap from top plate or band to doubled floor joist over breakfast nook for collector*	*Use 3 or more engr narrow brace wall panels (no more than 2.6' wide each) for total equivalence to 5.8 WSP BWPs also 1000# strap from top plate or band to doubled floor joist over breakfast nook for collector*	*Use 3 or more engr narrow brace wall panels (no more than 2.6' wide each) for total equivalence to 5.8 WSP BWPs also 1000# strap from top plate or band to doubled floor joist over breakfast nook for collector*
Second Story (Top)			
A (left)	*Fully sheath OSB (required due to CS-WSP needed for BWL 3 in 1st story per "all walls", R602.10.5)*	*Fully-sheath OSB ("all ext. walls" SDC D2 caused by BWLs 1 & 3 on 1st story)*	*Fully-sheath OSB ("all ext. walls" SDC D2 caused by BWLs 1 & 3 on 1st story)*
B (interior)	*Fully sheath OSB (15.3', 5.4', and 3.2' interior walls)*	*7"oc edge fasten int. GWB both sides along GR wall and MBdr closet (15.3', 5.4', and 4' at toilet wall & increase wall 9"); extra joist below wall line aligned*	*7"oc edge & field fasten int. GWB both sides along GR wall and MBdr closet (15.3', 5.4', and 4' at toilet wall & increase wall 9"); extra joist below wall line aligned*
C (right)	*Fully sheath OSB*	*Fully sheath with OSB (part of GR CS-WSP wall design for story below)*	*Fully sheath with OSB (part of GR CS-WSP wall design for story below)*
1 (front)	*Fully sheath OSB (design required for BWP support over garage: use doubled floor joist beneath with 1000# straps to stud in first story garage walls and hold-down to foundation; OSB ceiling diaphragm 5' wide to wall at garage opening)*	*Fully sheath OSB (design support below with double joist at garage ceiling and strap ends at bearing to double studs in 1st story wall anchored to garage foundation with 1000# holdowns) and OSB sheath garage ceiling 5' wide to garage opening wall*	*Fully sheathing with OSB (design support below with double joist at garage ceiling and strap ends at bearing to double studs in 1st story wall anchored to garage foundation with 1000# holdowns) and OSB sheathing garage ceiling 5' wide to garage opening wall*
2 (interior)	*Fully sheath OSB (mis-alignment with int brace wall below is within four joist thicknesses, OK)*	*7"oc edge fasten int. GWB both sides along stairway and Mbrm (15.5' and 19.4'); blocking btwn joists below 19.4' wall)*	*7"oc edge & field fasten int. GWB both sides along stairway and Mbrm (15.5' and 19.4'); blocking btwn joists below 19.4' wall)*
3 (rear)	*Fully sheath OSB also 1000# strap from top plate to ceiling joist over breakfast nook for collector 4' OSB sheath to roof rafter.*	*(3) 4' OSB panels double ceiling joist collector over bath bump-out attach to top plate or band above walls with 1000# strap/connector*	*Fully-sheath OSB panels + ceiling joist collector over bath bump-out attach to top plate or band above walls with 1000# strap/connector*

NOTES:

1. Where BWP is bearing on slab or foundation (e.g., along garage walls supported on a foundation and not the 1st floor deck), 3x3" plate washers required on sill anchor bolts in SDC D2 (all codes) and the slab or footing must be reinforced per code.
2. For interior walls, blocking must be provided in floor/roof framing above and below (all codes).

3. For 2009 and 2012 IRC codes, roof eave blocking or lateral force transfer detail is needed (e.g., if truss or rafter heel height is 9.25" or less then partial height blocking can be used; if taller, then refer to code for details).

Discussion on Brick Veneer in SDC D2:

A cursory evaluation of the above plans for use of brick veneer (full height of exterior walls) yielded some problematic findings that would require a complete re-engineering of the plans to accommodate the load of the brick veneer (using the conventional engineering assumption that it adds dead load without any ability to resist seismic forces itself). The following are offered as observations:

1. The walls with large door/window opening areas and small walls segment widths provide insufficient room to accommodate the prescriptive BV-WSP brace panels (2012 IRC). These panels are similarly detailed and required in all three codes. They each require a pair of hold-down brackets and must be a minimum of 48 wide for up to a 10' tall wall. Sheathing is fastened at 4"oc on the edges with 8d common nails.

2. The amount of bracing length required for the BV-WSP brace panels significantly exceeds that required for other wall systems addressed in the IRC due to the added mass of the brick veneer. For all three codes a bracing amount of 55% of the BWL length is required for both interior and exterior wall lines.

3. Using these BV-WSP panels for required interior braced wall lines in SDC D2 for the two plans evaluated would excessively disrupt the interior space. Furthermore, on the basement plan of the two story home, panels and hold-downs would need to be added to the basement for force transfer; yet, the code does not give guidance on this load path issue (e.g., it could be assumed that the same first story panels could be repeated in the basement or engineered)

4. The 2006 IRC does not clearly exempt 1-story brick construction, but the 2009 and 2012 codes include a statement that exempts 1-story brick from requiring with the BV-WSP provisions of the code.

5. By way of example, and assuming that the BV-WSP panels could be fit into the 2-story house plan (which it can't without major floor plan and wall opening changes), it would require the following:

    a. 24 BV-WSP panels per story (including 12 more in the basement, 6 in each plan direction)
    b. 48 – 2,300 lb tension ties on the upper story BV-WSP panels
    c. 48 – 2,300 lb tension ties on the top of the lower story BV-WSP panels.
    d. 48 – 6,200 lb hold-down brackets to the foundation at the lower story BV-WSP panels.
    e. 24 – 6,200 tension ties to BV-WSP panels in the basement.
    f. 24 – 6,200 lb hold-down brackets to two reinforced grade beams extending in both directions across the basement slab.

If the engineering analysis that substantiates the above requirements in the IRC is representative of the design that results from conventional, code-compliant engineering practice, then there is not much opportunity for brick veneer on wood-frame two-story homes in SDC D2 (and probably any SDC D condition). Instead, it would appear that a steel moment frame type of assembly would be more

efficient. Certainly, a better prescriptive solution is needed if brick veneer is an important home-building feature in SDC D conditions.

Roof Uplift Conditions Related to BWP Requirements:

The following represent observations regarding roof uplift provisions in the evaluated codes:

1. For both plans and all design conditions, the 2006 code did not invoke roof uplift requirements (due to the 20 psf roof uplift pressure criteria not being exceeded).

2. For the 2009 and 2012 plans, a new braced wall panel wind uplift limit of 100 plf was initiated (with some exceptions that did not trigger with these plans). Thus, in some cases the wall bracing triggers an uplift load path at BWP locations only and the roof uplift provisions elsewhere in the code (Section R802.11) may or may not be similarly triggered.

3. The 2009 IRC retains the 20 psf roof pressure criteria from the 2006 IRC, so uplift requirements are isolated to braced wall panels where they are triggered by the 100 plf limit, since none of the design conditions exceed the 20 psf roof pressure criteria.

4. The 2012 IRC revised the roof uplift provisions and removed the 20 psf criteria and instead uses a 200 lb force limit for applicability of conventional connections (with exceptions that were not triggered by these plans). Thus, for the 2012 IRC, there are cases where, when the wall bracing uplift is triggered, the roof uplift lift provisions for the remainder of the exterior wall portions, may or may not be triggered. In reality, this would create an awkward design to isolate uplift load path to BWPs only, but from a costing standpoint this does represent a distinction in costs to comply with the code.

The following are specific uplift requirements as determined for the 2009 and 2012 IRC evaluation of the two plans.

85/B Condition

Code/Plan:	One-story	Two-story
2006 IRC	*Use conventional fastening requirements.*	*Use conventional fastening requirements.*
2009 IRC	*AT BWP LOCATIONS ONLY: Provide roof uplift connectors 185#/ea 16"oc, stud to sill plate straps at 120#/ea 16"oc, and sill anchor bolts at 6'oc with 3"sq washers (per WFCM 2001).*	*AT BWP LOCATIONS ONLY: Provide roof uplift connectors 205#/ea 16"oc and studs to top plate; 140#/ea straps at 16"oc studs to 1st floor band joist and to studs below at 16"oc; 75#/ea straps at 16"oc 1st story studs (or 150# straps every other) to band on foundation. Slant nail band to foundation sill per code.*
2012 IRC	*Use conventional fastening requirements.*	*AT BWP LOCATIONS ONLY: Provide roof uplift connectors 140#/ea 16"oc and studs to top plate; 140#/ea straps at 16"oc studs to 1st floor band joist; remainder of connections per conventional fastening.*

90/B Condition

Code/Plan:	One-story	Two-story
2006 IRC	*Use conventional fastening requirements.*	*Use conventional fastening requirements.*
2009 IRC	*AT BWP LOCATIONS ONLY: Provide roof uplift connectors 225#/ea 16"oc, stud to sill plate straps at 165#/ea 16"oc, and sill anchor bolts at 6'oc with 3"sq washers (per WFCM 2001)*	*AT BWP LOCATIONS ONLY: Provide roof uplift connectors 250#/ea 16"oc and studs to top plate; 185#/ea straps at 16"oc studs to 1st floor band joist and to studs below at 16"oc; 120#/ea straps at 16"oc 1st story studs to band on foundation and band to sill. Slant nail band to foundation sill per code.*
2012 IRC	*Use conventional fastening requirements.*	*AT BWP LOCATIONS ONLY: Use roof uplift connectors 190#/ea 16"oc and studs to top plate and 110# straps to 2nd floor band and band to studs below and 1st floor studs to floor band; connect band to sill and sill to foundation per conventional connections.*

100/C Condition

Code/Plan:	One-story	Two-story
2006 IRC	*Use conventional fastening requirements.*	*Use conventional fastening requirements.*
2009 IRC	*AT BWP LOCATIONS ONLY: Provide roof uplift connectors 360#/ea 16"oc, stud to sill plate straps at 295#/ea 16"oc, and sill anchor bolts at 4'oc with 3"sq washers (per WFCM 2001)*	*AT BWP LOCATIONS ONLY: Provide roof uplift connectors 440#/ea 16"oc and studs to top plate; 375#/ea straps from studs to 2nd floor band joist and band joist to studs below at 16"oc; 310#/ea straps from studs to 1st floor band and band to sill plate at 16"oc; sill anchor bolts at 48"oc with 3x3 plate washers.*
2012 IRC	*ALL EXT. WALLS: Use roof uplift connectors 280#/ea 16"oc and stud to top plate straps at 16"oc; use #200 lb stud to sill plate straps; use sill anchor bolts at 48"oc with 3"x3" plate washers (per WFCM).*	*ALL EXT. WALLS: Use roof uplift connectors 525#/ea 16"oc and studs to top plate; 445#/each straps studs to 2nd floor band and to studs below; 365#/ea straps from studs to 1st floor band and band to sill; 48"oc anchor bolts and 3"x3" plate washers sill to foundation.*

General Observations:

Several general observations made during the analyses are as follows:

1. The 2009 and 2012 IRC bracing provisions significantly increase design time and cost, particularly in cases where both wind and seismic provisions are invoked requiring a dual analysis.
2. Other cost impacts may include the addition of wall bracing construction documentation requirements in Chapter 1 of the codes (particularly the 2012 and perhaps also the 2009). There are costs associated with including this information and details on plans. However, with the added complexity of the code, this seems necessary from an installer and inspector standpoint for code compliance.
3. Where special design by "parts and portions" is indicated in this study, there would typically be an engineering fee in addition to any construction cost impact. The fee will vary depending on the complexity of the design or whether or not a "standard detail" can be applied.
4. Other options exist to address roof uplift conditions together with bracing. For example, using a sheathing uplift approach (as recently introduced to reference standards such as the WFCM and ICC 600) may provide a viable option. However, this still doesn't avoid special detailing of sheathing connections and for straps at points of load concentration, e.g., edges of openings.

Thus, the sheathing uplift approach may work best for walls that have substantial solid area (e.g., few windows and doors). Using the sheathing for uplift purposes reduces its capacity for bracing and thus increases bracing amounts needed, all other factors equal. Never the less, a simplified sheathing uplift approach may prove useful prescriptively. The cost of designing the method (even using prescriptive approaches) may currently offset the cost of using a conventional strap load path when required, which was the approach taken in this work.

5. Bracing location requirements such as 12.5' from the corner, now 10' from the corner in the 2012 IRC, trigger design requirements that are probably not needed, particularly in lower hazard conditions. In addition, it is questionable if the 20' (prior 25'oc) BWP spacing is really necessary for performance. Other factors, such as the maximum 4' BWL offset are also problematic. There were several instances where these considerations triggered a design problem or very nearly so. Other plans may have had more or less problem with these arbitrary requirements in the code. The code could be significantly simplified if these requirements were removed and replaced with a more performance-based and simplified logic for prescriptive bracing. For example, efficient bracing amounts could be determined for each story level of a building and then basic rules established for ensuring a balanced distribution of bracing in each story, thus avoiding arbitrary rules regarding placement of braced wall lines, offsets, etc.
6. In the 2012 IRC, Section R301.1, a requirement to consider open areas in an Exposure B wind condition could kick many more designs into a higher wind condition, thus triggering wind uplift requirements and increasing bracing. More work into the impacts of exposure and shielding may yield benefits for more efficient design.
7. For seismic bracing design, adjustments are given for a range of wall and roof system weights. However, for floor systems, the weight is given as 10 psf average. If there are substantial areas with tile flooring, then this could kick some designs out of the prescriptive bracing provisions entirely if not except from the seismic provisions (e.g., not in SDC A/B/C, excluding townhouses in SDC C).
8. The treatment of great-room (two-story) walls for bracing is not clearly enabled in the IRC and, thus, may be subject to varied interpretations from code compliance, engineering, and enforcement perspectives.
9. Finally, the 2009 and 2012 IRC seismic bracing approach differs from the 2006 IRC seismic bracing approach in that bracing amounts are determined in a table based on a range of brace wall lengths of 10 to 50 feet. In the 2006 IRC, brace wall lengths were simply multiplied by a percentage to determine the bracing amount required, without limit to brace wall lines with lengths of 50 feet or less. The 50-foot brace wall line length limit in the 2009 and 2012 IRC table format appears arbitrary and it will unnecessarily require an engineering fee that was not required in the 2006 IRC for any brace wall line that is over 50 feet in length.

APPENDIX I:
PLAN CHECK WORKSHEETS

IRC 2009 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan C, One story, 36'x72', slab-on-grade)

GIVEN:
Wind Speed/Exposure: 90/B *(no topographic effects)*
Seismic SDC: A/B *(exempt)*
Roof eave-to-ridge hgt.: 11.3'
Wall Hgt.: 9'
Roof/Ceiling DL: ≤15psf avg. (shingles)
Wall DL: ≤15psf avg. (incl. stone veneer accents on front)
Floor DL: n/a (slab on grade)
Roof Span: 36' (mean roof ht. = 15')

BWL Configuration Used:
BWL Layout: 2 BWLs & 3 BWLs for two plan axes
BWL Spacing: A,B (36'); 1,2,3 (36') – see plan

BWP Location and Minimum Bracing:
max 12.5' cumulative edge distance from ends of BWLs
max 25' oc BWP spacing (R602.10.1.4)
min. 48" bracing amount per BWL (R602.10.1.2)

Mixing Bracing Methods (R602.10.1.1):
Generally permitted except R602.10.4 requires "all ext. walls" in SDC D if CS method is required on any one wall at any story level.

Wind Bracing Length Adjustment Factors (Table R602.10.1.2(1) footnotes)
(b) Exposure B: 1.0
(c) Ridge-to-eave hgt.: 1.1
(d) Wall Hgt.: 0.95
(e) BWL Factor: 1.0 (A,B); 1.3 (1,2,3)
(f) No int. gyp.: n/a
(g) GB one-sided: n/a (All GB BWLs double sided were used)

Seismic Bracing Length Adjustment Factors (Table R602.10.1.2(3)) – *N/A*

Seismic Irregularities (R301.2.2.5) – *N/A*

Load Path Detailing (R602.10.1.2, R602.10.6 through R602.10.9, R602.11)

- *Roof uplift load >100 plf per code (R602.10.1.2.1 & R802.11); AT BWP LOCATIONS ONLY: Provide roof uplift connectors 225#/ea 16"oc, stud to sill plate straps at 165#/ea 16"oc, and sill anchor bolts at 6'oc with 3"sq washers (per WFCM 2001); – Alternate design per ICC600(2008) uses sheathing as uplift and bracing requiring fully sheathed all walls + special details/connectors at edges of openings + anchors at 16"oc, etc.; ICC600 (2008) also references WFCM(2001) for other provisions (for determining shear wall amount, etc.).*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.6)*
- *Provide BWP support per code at floor cantilevers and masonry piers (R602.10.7)- N/A*
- *Block BWP horizontal joints (except GB) per code unless bracing lengths doubled (R602.10.8)*
- *Brace foundation cripple walls per code (R02.10.9) – N/A*
- *BWL sills anchored to concrete/masonry per code (R602.11)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition Roof only Roof+1 floor Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*6.7'*	*6.7'x1.1xx0.95 = 7.0'*	***40.4'***	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
B (right)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*6.7'*	*6.7'x1.1x 0.95 = 7.0'*	*50.1'*	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
1 (front)	*OK*	*Roof only*	*36'*	*36'*	*CS-WSP CS-G*	*5.6'*	*5.6'x1.1x 0.95x1.3 = 7.6'*	*3.3' (CS-WSP) 2'+2' = 4' (CS-G) w/4" credit for 3 narrow segments*	*OK*	*OK*	*OK*	*OSB fully sheathed [increased 3 panels by 3" ea. to reach 2' min. – may affect window sizes, foyer width, or plan width] (Garage must be finished)*
2 (int.)	*OK*	*Roof only*	*36'*	*36'*	*GB*	*11.3'*	*11.3'x1.1x0.95x 1.3 = 15.4'*	*5'+15'= 20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (two interior wall segments)*
3-0pt1 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-WSP*	*5.6'*	*5.6'x1.1x 0.95x1.3 = 7.6'*	*2.3'+3.1' +2.3' = 7.7'*	*OK (barely)*	*OK*	*OK*	*OSB fully sheathed [requires all rear windows to be max. 28" instead of 30" wide]*
3-Opt2 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-PF*	*5.6'*	*5.6x1.1x 0.95x1.3 = 7.6'*	*1.7'+1.3' 2.9'+2' = 7.9'*	*OK (barely)*	*OK*	*OK*	*OSB fully sheath plus 4 CS-PF panels at both opening sets, in one case an extra CS-PF header must be placed in attic which may affect roof framing if perp.)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition Roof only Roof+1 floor Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
3-Opt3 (rear)	*OK*	*Roof only*	*36'*	*36'*	*WSP*	*6.7'*	*6.7'x1.1x 0.95x1.3 = 9.1' (equivalent to 2.3-4' WSP panels)*	*0 (engr req'd)*	*NG*	*OK*	*OK*	*Use three narrow shear wall engr. panels: 1.7', 2.9', and 2' wide with 6 hold-downs per manuf. design (equivalent to 2.3 4' WSP BWPs)*
Second Story Braced Wall Lines												
n/a												
Detached Garage or Other Portions												
n/a												

IRC 2012 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan C, One story, 36'x72', slab-on-grade)

GIVEN:
Wind Speed/Exposure: 90/B* *(no topographic effects)*
Seismic SDC: A/B *(exempt)*
Roof eave-to-ridge hgt.: 11.3'
Wall Hgt.: 9'
Roof/Ceiling DL: ≤15psf avg. (shingles)
Wall DL: ≤15psf avg. (incl. stone veneer accents on front)[1]
Floor DL: n/a (slab on grade)[2]
Roof Span: 36' (mean roof ht. = 15')

**Note: 2012 IRC R301.2.1.4 added new requirement for buildings in exposure B but directly adjacent to open areas of Exposure C measuring at least 600ft in expanse. This could kick some buildings previously in exposure B into exposure C.*

BWL Configuration Used:
BWL Layout: 2 BWLs & 3 BWLs for two plan axes
BWL Spacing: A,B (36'); 1,2,3 (36') – see plan[3]

BWP Location and Minimum Bracing:
max 10' edge distance from ends of BWLs
max 20' between BWPs
min. bracing amount per R602.10.2.3 (min. 2 BWPs per BWL or one BWP min. 48" wide for BWL 16' or less in length)

Wind Bracing Length Adjustment Factors (Table R602.10.3(2))
Exposure: 1.0 (B)
Eave-to-ridge hgt.: 1.1
Wall Hgt.: 0.95
BWL Factor: 1.0 (A,B); 1.3 (1,2,3)
800# strap Factor: n/a (not used)
No int. gyp.: n/a (int. GWB used all ext. walls)
GB fastening: n/a (std. 7"oc edge fastening for GB used)

Seismic Bracing Length Adjustment Factors (Table R602.10.3(4)) – *N/A*

Seismic Irregularities (R301.2.2.5) – *N/A*

Load Path Detailing
- *Roof uplift load path at BWPs (R602.3.5, R802.11) – <100 plf limit on BWP and <200 lbs per connection; use conventional fastening*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.8)*
- *Provide connection/blocking at roof eaves above BWPs per code (R602.10.8.2)*
- *Provide BWP support per code at floor cantilevers and masonry & concrete piers (R602.10.9)- N/A (assume concrete pier size supporting garage opening BWPs not requiring reinforcement)*
- *Block BWP horizontal joints (except GB horizontal) or double required bracing length per code (R602.10.10)*
- *Brace foundation cripple walls per code (R602.10.11) – N/A*
- *BWL sills anchored to concrete/masonry using plate washers per code (R602.11) – SDC D only*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition Roof only Roof+1 floor Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*6.7'*	*6.7'x1.1x0.95 = 7.0'*	***40.4'***	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
B (right)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*6.7'*	*6.7'x1.1x 0.95 = 7.0'*	*50.1'*	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels) + engr fee for collector design at 4-gang windows (BWP>10' from corner)*
1 (front)	*OK*	*Roof only*	*36'*	*36'*	*CS-WSP CS-G*	*5.6'*	*5.6'x1.1x 0.95x1.3 = 7.6'*	*3.3' (CS-WSP) 2'+2' = 4' (CS-G)*	*OK (w/4" credit for 3 narrow segments)*	*OK*	*OK*	*OSB fully sheathed [increased 3 panels by 3" ea. to reach 2' min. – may affect window sizes, foyer width, or plan width] (garage must be finished)*
2 (int.)	*OK*	*Roof only*	*36'*	*36'*	*GB*	*11.3'*	*11.3'x1.1x0.95x 1.3 = 15.4'*	*5'+15'= 20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges and field (two interior wall segments)*
3-0pt1 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-WSP*	*5.6'*	*5.6'x1.1x 0.95x1.3 = 7.6'*	*2.3'+3.1' +2.3' = 7.7'*	*OK (barely)*	*OK*	*OK*	*OSB fully sheathed [requires all rear windows to be max. 28" instead of 30" wide]*
3-Opt2 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-PF*	*5.6'*	*5.6x1.1x 0.95x1.3 = 7.6'*	*1.7'+1.3' 2.9'+2' = 7.9'*	*OK (barely)*	*OK*	*OK*	*OSB fully sheath plus 4 CS-PF panels at both opening sets, in one case an extra CS-PF header must be placed in attic which may affect roof framing if perp.)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition Roof only Roof+1 floor Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution*
3-Opt3 (rear)	*OK*	*Roof only*	*36'*	*36'*	*WSP*	*6.7'*	*6.7'x1.1x 0.95x1.3 = 9.1' (equivalent to 2.3-4' WSP panels)*	*0 (engr req'd)*	*NG*	*OK*	*OK*	*Use three narrow shear wall engr. panels: 1.7', 2.9', and 2' wide with 6 hold-downs per manuf. design (equivalent to 2.3 4' WSP BWPs)*
Second Story Braced Wall Lines												
n/a												
Detached Garage or Other Portions												
n/a												

NOTES:

1. *Where brick/stone veneer is used in SDC D, it will affect the veneered wall and perpendicular BWL design per code (e.g., more bracing and use of hold-downs at ends of BWPs required). Does not apply to brick on first story only. See R602.10.6.5.*
2. *The code has no bracing adjustment factor for cases where average floor DL is greater than 10 psf. In Seismic SDC C and D, this could cause the seismic bracing design to be kicked completely into engineering only (since the diaphragm will cause this load increase all wall lines)*
3. *Where there are multiple braced wall lines, the BWL spacing for the interior BWLs is always taken as the average of the spacing to the two adjacent parallel BWLs.*

IRC 2009 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan F, Two story, 42'x38', basement)

GIVEN: ***Wind Speed/Exposure: 90/B*** *(no topographic effects)* ***Seismic SDC: A/B*** *(exempt)* *Roof eave-to-ridge hgt.: 7.0'* *Wall Hgt.: 9'(1st); 8' (2nd)* *Roof/Ceiling DL: 25 psf max. (clay tile, typical)* *Wall DL: 15psf (stucco)* *Floor DL: ≤10 psf (avg)-limited areas with tile (~10%)* *Roof Span: 42' (mean roof ht = 22')* *BWL Configurations Used:* *BWL Layout: 3 BWLs each plan direction (1st story);* *2 or 3 BWLs each plan direction (2nd story)* *BWL Spacing: varies, see analysis below and floor plan[4]* *BWP Location and Minimum Bracing:* *max 12.5' cumulative edge distance from ends of BWLs* *max 25' oc BWP spacing (R602.10.1.4)* *min. 48" bracing amount per BWL (R602.10.1.2)*	*Wind Bracing Length Adjustment Factors (Table R602.10.1.2(1) footnotes)* *(b) Exposure B: 1.0* *(c) Ridge-to-eave hgt.: 0.9(1st); 0.8(2nd)* *(d) Wall Hgt.: 0.95 (both stories)* *(e) BWL Factor: 1.3 (1st story), 1.0 or 1.3 (2nd story per 2 or 3 BWLs)* *(f) No int. gyp.: n/a* *(g) GB one-sided: n/a (all GB BWLs double sided where used)* *Seismic Bracing Length Adjustment Factors (Table R602.10.1.2(3))* – *N/A* *Seismic Irregularities (R301.2.2.5)* – *N/A* *Load Path Detailing (R602.10.1.2, R602.10.6 through R602.10.9, R602.11)* - *Uplift load > 100 plf at roof/wall (R602.10.1.2.1 & R802.11); AT BWP LOCATIONS ONLY: Provide roof uplift connectors 250#/ea 16"oc and studs to top plate; 185#/ea straps at 16"oc studs to 1st floor band joist and to studs below at 16"oc; 120#/ea straps at 16"oc 1st story studs to band on foundation and band to sill. Slant nail band to foundation sill per code. – Alternate design per ICC600(2008) uses sheathing as uplift and bracing requiring fully sheathed all walls + special details/connectors at edges of openings + anchors at 16"oc, etc.; ICC600 (2008) also references WFCM(2001) for other provisions (for determining shear wall amount, etc.).* - *Provide blocking or parallel member above/below BWPs per code (R602.10.6)* - *Provide BWP support per code at floor cantilevers and masonry piers (R602.10.7)- N/A* - *Block BWP horizontal joints (except GB) per code unless bracing lengths doubled (R602.10.8)* - *Brace foundation cripple walls per code (R02.10.9) – N/A* - *BWL sills anchored to concrete/masonry per code (R602.11)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*6.8'*	*6.8'x0.9x0.95x 1.3 = 7.6'*	*34.4'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB panels (25' infill); (garage may be unfinished)*
B (int.)	*OK*	*Roof +1 floor*	*21'*	*41'*	*GB*	*13.6'*	*13.6'x0.9x0.95x 1.3 = 15.1'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides for 8' along two int. walls adjoining front and rear ext. walls*
C (right)	*OK*	*Roof +1 floor*	*24'*	*41'*	*WSP**	*8.7'*	*8.7'x0.9x0.95x 1.3 = 9.7'*	*32.0'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**
1 (front)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP CS-PF*	*7.5'*	*7.5'x0.9x0.95x 1.3 = 8.3'*	*18.5'*	*OK*	*OK*	*OK*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*
2 (int.)	*OK*	*Roof +1floor*	*20'*	*42'*	*GB*	*13'*	*13'x0.9x0.95x 1.3 = 14.4'*	*25.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides at 9'wall btwn garage & F.R. and 8' wall between stairs*
3 (rear)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP*	*7.5'*	*7.5'x0.9x0.95x 1.3 = 8.3'*	*17.4'*	*OK*	*OK*	*OK*	*OSB fully-sheath [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
Second Story Braced Wall Lines (N/A)												
A (left)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*7.8'*	*7.8'x0.8x0.95 x1.0 = 5.9'*	*24.5'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
B (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 90/B*
C (right)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*7.8'*	*7.8'x0.8x0.95 x1.0 = 5.9'*	*39.7'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
1 (front)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*7.7'*	*7.7'x0.8x0.95 x1.0 = 5.9'*	*35.8'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
2 (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 90/B*
3 (rear)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*7.7'*	*7.7'x0.8x0.95 x1.0 = 5.9'*	*25.0'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
Detached Garage or Other Portions												
n/a												

IRC 2012 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan F, Two story, 42'x38', basement)

GIVEN:
Wind Speed/Exposure: 90/B* *(no topographic effects)*
Seismic SDC: A/B *(exempt)*
Roof eave-to-ridge hgt.: 7.0'
Wall Hgt.: 9'(1st); 8' (2nd)
Roof/Ceiling DL: 25 psf max. (clay tile, typical)
Wall DL: 15psf (stucco)
Floor DL: ≤10 psf (avg)-limited areas with tile (~10%)
Roof Span: 42' (mean roof ht = 22')

**Note: 2012 IRC R301.2.1.4 added new requirement for buildings in exposure B but directly adjacent to open areas of Exposure C measuring at least 600ft in expanse. This could kick some buildings previously in exposure B into exposure C.*

BWL Configurations Used:
BWL Layout: 3 BWLs each plan direction (1st story);
2 or 3 BWLs each plan direction (2nd story)
BWL Spacing: varies, see analysis below and floor plan

BWP Location and Minimum Bracing:
max 10' edge distance from ends of BWLs
max 20' between BWPs
min. bracing amount per R602.10.2.3 (min. 2 BWPs per BWL or one BWP min. 48" wide for BWL 16' or less in length)

Wind Bracing Length Adjustment Factors (Table R602.10.3(2))
Exposure: 1.0 (B)
Eave-to-ridge hgt.: 0.9 (1st); 0.8 (2nd)
Wall Hgt.: 0.95 (both stories)
BWL Factor: 1.3 (1st story); 1.0 or 1.3 (2nd story per 2 or 3 BWLs)
800# strap Factor: n/a (not used)
No int. gyp.: n/a (int. GWB used all ext. walls)
GB fastening: n/a (std. 7"oc edge fastening for GB used)

Seismic Bracing Length Adjustment Factors (Table R602.10.3(4)) – *N/A*

Seismic Irregularities (R301.2.2.5) – *N/A*

Load Path Detailing
- *Roof uplift load path at BWPs (R602.3.5, R802.11) – 100 plf limit on BWP uplift exceeded (143 plf, but < 200 lbs/joint); AT BWP LOCATIONS ONLY: Use roof uplift connectors 190#/ea 16"oc and studs to top plate and 110# straps to 2nd floor band and band to studs below and 1st floor studs to floor band; connect band to sill and sill to foundation per conventional connections.*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.8)*
- *Provide connection/blocking at roof eaves above BWPs per code (R602.10.8.2)*
- *Provide BWP support per code at floor cantilevers and masonry & concrete piers (R602.10.9)- N/A (assume concrete pier size supporting garage opening BWPs not requiring reinforcement)*
- *Block BWP horizontal joints (except GB horizontal) or double required bracing length per code (R602.10.10)*
- *Brace foundation cripple walls per code (R602.10.11) – N/A*
- *BWL sills anchored to concrete/masonry using plate washers per code (R602.11) – SDC D only*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution & Comments*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*6.8'*	*6.8'x0.9x0.95x 1.3 = 7.6'*	*34.4'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB panels (25' infill); garage assumed to have ½" GWB*
B (int.)	*OK*	*Roof +1 floor*	*21'*	*41'*	*GB*	*13.6'*	*13.6'x0.9x0.95x 1.3 = 15.1'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge & field fasten int. GWB both sides for 8' along two int. walls adjoining front and rear ext. walls*
C (right)	*OK*	*Roof +1 floor*	*24'*	*41'*	*WSP**	*8.7'*	*8.7'x0.9x0.95x 1.3 = 9.7'*	*32.0'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**
1 (front)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP CS-PF*	*7.5'*	*7.5'x0.9x0.95x 1.3 = 8.3'*	*18.5'*	*OK*	*OK*	*OK*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*
2 (int.)	*OK*	*Roof +1floor*	*20'*	*42'*	*GB*	*13'*	*13'x0.9x0.95x 1.3 = 14.4'*	*25.3'*	*OK*	*OK*	*OK*	*7"oc edge & field fasten int. GWB both sides at 8.4'wall btwn garage & bath/tub and 8' wall between stairs*
3 (rear)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP*	*7.5'*	*7.5'x0.9x0.95x 1.3 = 8.3'*	*17.4'*	*OK*	*OK*	*OK*	*OSB fully-sheath + engr collector for BWP>10' from end of BWL [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution & Comments*
Second Story Braced Wall Lines (N/A)												
A (left)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*7.8'*	*7.8'x0.8x0.95 x1.0 = 5.9'*	*24.5'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
B (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 90/B*
C (right)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*7.8'*	*7.8'x0.8x0.95 x1.0 = 5.9'*	*39.7'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
1 (front)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*7.7'*	*7.7'x0.8x0.95 x1.0 = 5.9'*	*35.8'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
2 (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 90/B*
3 (rear)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*7.7'*	*7.7'x0.8x0.95 x1.0 = 5.9'*	*25.0'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels + engr collector for BWP>10' from end of BWL*
Detached Garage or Other Portions												
n/a												

IRC 2012 Wall Bracing Design and Plan Check Worksheet - SIMPLIFIED

Project: NAHB (Plan F, Two story, 42'x38', basement)

GIVEN:
Wind Speed/Exposure: 90/B* *(no topographic effects)*
Seismic SDC: A/B *(exempt)*
Roof eave-to-ridge hgt.: 7.0'
Wall Hgt.: 9'(1st); 8' (2nd)
Roof/Ceiling DL: 25 psf max. (clay tile, typical)
Wall DL: 15psf (stucco)
Floor DL: ≤10 psf (avg)-limited areas with tile (~10%)
Roof Span: 42' (mean roof ht = 22')

Meets 8 criteria (R602.12): Yes
Circumscribed Rectangle Size: 42'x45' (OK < 60'max)
Max. heel height (R602.12.7): 9.25" (top plate to roof sheathing unless blocked per R602.10.8.2)

Allowed Bracing Methods: WSP (1 BU per 3' panel length)
SFB (1 BU per 4' panel length)

Allowed Narrow Panels:
CS-G (0.5 BU per panel)
CS-PF (0.5 BU per panel, max 4 per side of bldg)
PFH (1.0 BU per panel)
PFG (0.75 BU per panel)
**CS-G and CS-PF only permitted if all ext. walls fully-sheathed*

Bracing Unit (BU) Minimum Length: 3' (CS-WSP or CS-SFB)
4' (intermittent WSP or SFB)

BWL Configurations Used:
Simplified method only applies to exterior walls defined as parallel to the sides of the circumscribed rectangle

BWP Location/Distribution (R602.12.5):
max 12' edge distance from any wall corner
max 20' between adjacent edges of BWPs
Ext. wall segments > 8feet shall have a minimum of one bracing unit.

Wind Bracing Length Adjustment Factors (Table R602.10.3(2)) – N/A

Seismic Bracing Length Adjustment Factors (Table R602.10.3(4)) – N/A

Seismic Irregularities (R301.2.2.5) – N/A

Load Path Detailing
- *Roof uplift load path at BWPs (R602.3.5, R802.11) – 100 plf limit on BWP uplift exceeded (143 plf, but < 200 lbs/joint); AT BWP LOCATIONS ONLY: Use roof uplift connectors 190#/ea 16"oc and studs to top plate and 110# straps to 2nd floor band and band to studs below and 1st floor studs to floor band; connect band to sill and sill to foundation per conventional connections.*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.8) – N/A (simplified method only addresses exterior walls)*
- *Provide connection/blocking at roof eaves above BWPs per code (R602.10.8.2) – N/A (heel height assumed 9.25" or less; partial height blocking or other detailing only required in 100 mph or greater and SDC D conditions)*
- *Provide BWP support per code at floor cantilevers and masonry & concrete piers (R602.10.9)- N/A (assume concrete pier size supporting garage opening BWPs not requiring reinforcement)*
- *Block BWP horizontal joints (except GB horizontal) or double required bracing length per code (R602.10.10) – N/A*
- *Brace foundation cripple walls per code (R602.10.11) – N/A*
- *BWL sills anchored to concrete/masonry using plate washers per code (R602.11) – N/A only*

NOTE: The BU Table R602.12.4 does not allow interpolation of BU's and this creates a significant whole-number round up conservatism. However, the simplified method is given some advantages, such as use of a 12' corner distance for BU's. But the BU per 8' wall segment and the "all walls" provision when any one wall requires continuous sheathing, pushes the user toward continuous sheathing on the entire building with this method.

STEP 1 Braced Wall Line ID	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 3 Selected Bracing Method (s)	STEP 4 No. of Bracing Units Required Table R602.12.4 (no interpolate)	STEP 4 *No. of BUs available on BWL (min. 3' WSP or 4' SFB)*	STEP 5 Is Value in Column G ≥ Value in Column F?	STEP 6 All 8' wall segments have BU?	STEP 7 Is BU edge distance from ends of BWL ≤ 12'?	STEP 7 Do BUs comply with maximum 20' spacing btwn BWPs?	*Solution & Comments*
FIRST STORY									
A (left) 45'side	*Roof +1floor*	*CS-WSP**	*5*	*11*	*OK*	*OK*	*OK*	*OK*	*Fully sheath OSB *(selected due to BWL 3 and GR tall wall at BWL C and thus simplified method requires "all walls") (garage must be finished with simplified method)*
B (int.)	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*Int. BWL not permitted*
C (right) 45'side	*Roof +1 floor*	*CS-WSP*	*5*	*10*	*OK*	*OK*	*OK*	*OK*	*Fully sheath OSB (use two 9,000 lb holddowns at ends of GR wall portion if required to engr for permit)*
1 (front) 42'side	*Roof +1floor*	*CS-WSP* *CS-PF*	*5*	*5.8*	*OK (barely)*	*OK*	*OK*	*OK*	*OSB fully-sheath + 2 CS-PF panels at garage supporting offset 2nd story BWL*
2 (int.)	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*Int. BWL not permitted*
3 (rear) 42'side	*Roof +1floor*	*CS-WSP*	*5*	*5.8*	*OK (barely)*	*OK*	*OK*	*OK*	*OSB fully-sheath*
SECOND STORY									
A (left) 45'side	*Roof only*	*WSP*	*3*	*8*	*OK*	*OK*	*OK*	*OK*	*Fully-sheath OSB (due to "all walls" invoked by conditions on 1st story; otherwise WSP would work)*
B (int.)	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*Int. BWL not permitted*
C (right) 45'side	*Roof only*	*WSP*	*3*	*13*	*OK*	*OK*	*OK*	*OK*	*Fully-sheath OSB*
1 (front) 42'side	*Roof only*	*WSP*	*3*	*11*	*OK*	*OK*	*OK*	*OK*	*Fully-sheath OSB*
2 (int.)	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*Int. BWL not permitted*
3 (rear) 42'side	*Roof only*	*WSP*	*3*	*8*	*OK*	*OK*	*OK*	*OK*	*Fully-sheath OSB*

IRC 2009 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan C, One story, 36'x72', slab-on-grade)

GIVEN:
Wind Speed/Exposure: 100/C *(no topographic effects)*
Seismic SDC: A/B *(exempt)*
Roof eave-to-ridge hgt.: 11.3'
Wall Hgt.: 9'
Roof/Ceiling DL: ≤15psf avg. (shingles)
Wall DL: ≤15psf avg. (incl. stone veneer accents on front)
Floor DL: n/a (slab on grade)
Roof Span: 36' (mean roof ht. = 15')

BWL Configuration Used:
BWL Layout: 2 BWLs & 3 BWLs for two plan axes
BWL Spacing: A,B (36'); 1,2,3 (36') – see plan

BWP Location and Minimum Bracing:
max 12.5' cumulative edge distance from ends of BWLs
max 25' oc BWP spacing (R602.10.1.4)
min. 48" bracing amount per BWL (R602.10.1.2)

Mixing Bracing Methods (R602.10.1.1):
Generally permitted except R602.10.4 requires "all ext. walls" in SDC D if CS method is required on any one wall at any story level.

Wind Bracing Length Adjustment Factors (Table R602.10.1.2(1) footnotes)
(b) Exposure: 1.2 (C, 1-story)
(c) Ridge-to-eave hgt.: 1.1
(d) Wall Hgt.: 0.95
(e) BWL Factor: 1.0 (A,B); 1.3 (1,2,3)
(f) No int. gyp.: n/a
(g) GB one-sided: n/a (All GB BWLs double sided were used)

Seismic Bracing Length Adjustment Factors (Table R602.10.1.2(3)) – *N/A*

Seismic Irregularities (R301.2.2.5) – *N/A*

Load Path Detailing (R602.10.1.2, R602.10.6 through R602.10.9, R602.11)
- *Roof uplift load >100 plf per code (R602.10.1.2.1 & R802.11), but less than 20psf criteria; AT BWP LOCATIONS ONLY: Provide roof uplift connectors 360#/ea 16"oc, stud to sill plate straps at 295#/ea 16"oc, and sill anchor bolts at 4'oc with 3"sq washers (per WFCM 2001); – Alternate design per ICC600(2008) uses sheathing as uplift and bracing requiring fully sheathed all walls + special details/connectors at edges of openings + anchors at 16"oc, etc.; ICC600 (2008) also references WFCM(2001) for other provisions (for determining shear wall amount, etc.).*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.6)*
- *Provide BWP support per code at floor cantilevers and masonry piers (R602.10.7)- N/A*
- *Block BWP horizontal joints (except GB) per code unless bracing lengths doubled (R602.10.8)*
- *Brace foundation cripple walls per code (R02.10.9) – N/A*
- *BWL sills anchored to concrete/masonry per code (R602.11)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition Roof only Roof+1 floor Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*8.2'*	*8.2'x1.2x1.1x 0.95 = 10.3'*	***40.4'***	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
B (right)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*8.2'*	*8.2'x1.2x1.1x 0.95 = 10.3'*	*50.1'*	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels) [garage can be unfinished front and side wall]*
1 (front)	*OK*	*Roof only*	*36'*	*36'*	*WSP*	*8.2'*	*8.2'x1.2x1.1x 0.95x1.3 = 13.4' (equiv. to 3.4 4'BWPs)*	*0 (engr req'd)*	*NG*	*OK*	*OK*	*Use four narrow shear wall engr. panels: 1.8', 3.3', 1.8', and 1.8' wide max. with 8 hold-downs per manuf. design (equiv. to 3.4 4' WSP BWPs) [garage can be unfinished front and side wall]*
2 (int.)	*OK*	*Roof only*	*36'*	*36'*	*GB*	*14.1'*	*14.1'x1.2x1.1x 0.95x1.3 = 23.0'*	*5'+15'+6.8' = 26.8'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (3 interior wall segments)*
3-0pt1 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-WSP*	*6.9'*	*6.9'x1.2x1.1x 0.95x1.3 =11.2'*	*2.3'+3.1'+2 .3' = 7.7'*	*NG*	*OK*	*OK*	*NG*
3-Opt2 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-PF*	*6.9'*	*6.9'x1.2x1.1x 0.95x1.3 =11.2'*	*1.7'+1.3'2. 9'+2' = 7.9'*	*NG*	*OK*	*OK*	*NG*
3-Opt3 (rear)	*OK*	*Roof only*	*36'*	*36'*	*WSP*	*8.2'*	*8.2'x1.2x1.1x 0.95x1.3 = 13.4' (equiv. to 3.4 4'BWPs)*	*0 (engr req'd)*	*NG*	*OK*	*OK*	*Use four narrow shear wall engr. panels: 1.7', 1.33', 2.9', and 2' wide with 8 hold-downs per manuf. design (equivalent to 3.4 4' WSP BWPs)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
Second Story Braced Wall Lines												
n/a												
Detached Garage or Other Portions												
n/a												

IRC 2012 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan C, One story, 36'x72', slab-on-grade)

GIVEN: ***Wind Speed/Exposure: 100/C*** *(no topographic effects)* ***Seismic SDC: A/B*** *(exempt)* *Roof eave-to-ridge hgt.: 11.3'* *Wall Hgt.: 9'* *Roof/Ceiling DL: ≤15psf avg. (shingles)* *Wall DL: ≤15psf avg. (incl. stone veneer accents on front)* *Floor DL: n/a (slab on grade)* *Roof Span: 36' (mean roof ht. = 15')* *BWL Configuration Used:* *BWL Layout: 2 BWLs & 3 BWLs for two plan axes* *BWL Spacing: A,B (36'); 1,2,3 (36') – see plan* *BWP Location and Minimum Bracing:* *max 10' edge distance from ends of BWLs* *max 20' between BWPs* *min. bracing amount per R602.10.2.3 (min. 2 BWPs per BWL or one BWP min. 48" wide for BWL 16' or less in length)*	*Wind Bracing Length Adjustment Factors (Table R602.10.3(2))* *Exposure: 1.2 (C, 1-story)* *Eave-to-ridge hgt.: 1.1* *Wall Hgt.: 0.95* *BWL Factor: 1.0 (A,B); 1.3 (1,2,3)* *800# strap Factor: n/a (not used)* *No int. gyp.: n/a (int. GWB used all ext. walls)* *GB fastening: n/a (std. 7"oc edge fastening for GB used)* *Seismic Bracing Length Adjustment Factors (Table R602.10.3(4))* – *N/A* *Seismic Irregularities (R301.2.2.5)* – *N/A* *Load Path Detailing* - *Roof uplift load path at BWPs (R602.3.5, R802.11) – 100 plf limit on BWP uplift exceeded (301 plf and >200 plf per joint at 16"oc); ALL EXT. WALLS: Use roof uplift connectors 280#/ea 16"oc and stud to top plate straps at 16"oc; use #200 lb stud to sill plate straps; use sill anchor bolts at 48"oc with 3"x3" plate washers (per WFCM).* - *Provide blocking or parallel member above/below BWPs per code (R602.10.8)* - *Provide connection/blocking at roof eaves above BWPs per code (R602.10.8.2)* - *Provide BWP support per code at floor cantilevers and masonry & concrete piers (R602.10.9)- N/A (assume concrete pier size supporting garage opening BWPs not requiring reinforcement)* - *Block BWP horizontal joints (except GB horizontal) or double required bracing length per code (R602.10.10)* - *Brace foundation cripple walls per code (R602.10.11) – N/A* - *BWL sills anchored to concrete/masonry using plate washers per code (R602.11) – SDC D only*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*8.2'*	*8.2'x1.2x 1.1x0.95 = 10.3'*	***40.4'***	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
B (right)	*OK*	*Roof only*	*36'*	*72'*	*WSP*	*8.2'*	*8.2'x1.2x 1.1x0.95 = 10.3'*	*50.1'*	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels) + engr fee for collector design at 4-gang windows (BWP>10' from corner)*
1 (front)	*OK*	*Roof only*	*36'*	*36'*	*WSP*	*8.2'*	*8.2'x1.2x 1.1x0.95x1.3 = 13.4'*	*0 (engr req'd)*	*NG*	*OK*	*OK*	*Use four narrow shear wall engr. panels: 1.8', 3.3', 1.8', and 1.8' wide max. with 8 hold-downs per manuf. design (equiv. to 3.4 4' WSP BWPs) [garage can be unfinished front and side wall]*
2 (int.)	*OK*	*Roof only*	*36'*	*36'*	*GB*	*14.1'*	*14.1'x1.2x1.1x 0.95x1.3 = 23.0'*	*5'+15'+6. 8'= 26.8'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (3 interior wall segments)*
3-0pt1 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-WSP*	*6.9'*	*6.9'x1.2x1.1x 0.95x1.3 =11.2'*	*2.3'+3.1' +2.3' = 7.7'*	*NG*	*OK*	*OK*	*NG*
3-Opt2 (rear)	*OK*	*Roof only*	*36'*	*36'*	*CS-PF*	*6.9'*	*6.9'x1.2x1.1x 0.95x1.3 =11.2'*	*1.7'+1.3' 2.9'+2' = 7.9'*	*NG*	*OK*	*OK*	*NG*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0'or8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution*
3-Opt3 (rear)	*OK*	*Roof only*	*36'*	*36'*	*WSP*	*8.2'*	*8.2'x1.2x1.1x 0.95x1.3 = 13.4' (equiv. to 3.4 4'BWPs)*	*0 (engr req'd)*	*NG*	*OK*	*OK*	*Use four narrow shear wall engr. panels: 1.7', 1.33', 2.9', and 2' wide with 8 hold-downs per manuf. design (equivalent to 3.4 4' WSP BWPs)*
Second Story Braced Wall Lines												
n/a												
Detached Garage or Other Portions												
n/a												

IRC 2009 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan F, Two story, 42'x38', basement)

GIVEN: ***Wind Speed/Exposure: 100/C*** *(no topographic effects)* ***Seismic SDC: A/B*** *(exempt)* *Roof eave-to-ridge hgt.: 7.0'* *Wall Hgt.: 9'(1st); 8' (2nd)* *Roof/Ceiling DL: 25 psf max. (clay tile, typical)* *Wall DL: 15psf (stucco)* *Floor DL: ≤10 psf (avg)-limited areas with tile (~10%)* *Roof Span: 42' (mean roof ht = 22')* *BWL Configurations Used:* *BWL Layout: 3 BWLs each plan direction (1st story);* *2 or 3 BWLs each plan direction (2nd story)* *BWL Spacing: varies, see analysis below and floor plan* *BWP Location and Minimum Bracing:* *max 12.5' cumulative edge distance from ends of BWLs* *max 25' oc BWP spacing (R602.10.1.4)* *min. 48" bracing amount per BWL (R602.10.1.2)*	*Wind Bracing Length Adjustment Factors (Table R602.10.1.2(1) footnotes)* *(b) Exposure: 1.3 (C, 2-story)* *(c) Ridge-to-eave hgt.: 0.9(1st); 0.8(2nd)* *(d) Wall Hgt.: 0.95 (both stories)* *(e) BWL Factor: 1.3 (1st story), 1.0 or 1.3 (2nd story per 2 or 3 BWLs)* *(f) No int. gyp.: n/a* *(g) GB one-sided: n/a (all GB BWLs double sided where used)* *Seismic Bracing Length Adjustment Factors (Table R602.10.1.2(3))* – *N/A* *Seismic Irregularities (R301.2.2.5)* – *N/A* *Load Path Detailing (R602.10.1.2, R602.10.6 through R602.10.9, R602.11)* - *Uplift load > 100 plf at roof/wall (R602.10.1.2.1 & R802.11), but barely less than 20psf criteria; AT BWP LOCATIONS ONLY: Provide roof uplift connectors 440#/ea 16"oc and studs to top plate; 375#/ea straps from studs to 2nd floor band joist and band joist to studs below at 16"oc; 310#/ea straps from studs to 1st floor band and band to sill plate at 16"oc; sill anchor bolts at 48"oc with 3x3 plate washers. Alternate design per ICC600(2008) uses sheathing as uplift and bracing requiring fully sheathed all walls + special details/connectors at edges of openings + anchors at 16"oc, etc.; ICC600 (2008) also references WFCM(2001) for other provisions (for determining shear wall amount, etc.).* - *Provide blocking or parallel member above/below BWPs per code (R602.10.6)* - *Provide BWP support per code at floor cantilevers and masonry piers (R602.10.7)- N/A* - *Block BWP horizontal joints (except GB) per code unless bracing lengths doubled (R602.10.8)* - *Brace foundation cripple walls per code (R02.10.9) – N/A* - *BWL sills anchored to concrete/masonry per code (R602.11)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*8.2'*	*8.2'x1.3x0.9x 0.95x 1.3 = 11.8'*	*34.4'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB panels (25' infill); garage assumed to have ½" GWB*
B (int.)	*OK*	*Roof +1 floor*	*21'*	*41'*	*GB*	*16.7'*	*16.7'x1.3x0.9x 0.95x1.3 = 24.1'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides for 18.4' garage wall along G.R. and 9.4' Bdrm Wall at F.R. (front and rear of plan)*
C (right)	*OK*	*Roof +1 floor*	*24'*	*41'*	*WSP**	*10.6'*	*10.6'x1.3x0.9x 0.95x 1.3 = 15.3'*	*32.0'*	*OK*	*OK*	*OK*	*Use (4) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**
1 (front)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP CS-PF*	*8.0'*	*8.0'x1.3x0.9x 0.95x 1.3 = 11.6'*	*18.5'*	*OK*	*OK*	*OK*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*
2 (int.)	*OK*	*Roof +1floor*	*20'*	*42'*	*GB*	*16.0'*	*16.0'x1.3x0.9x 0.95x 1.3 = 23.1'*	*25.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides at 8'wall btwn garage and bath, 9'wall btwn garage & F.R. and 8' wall between stairs*
3 (rear)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP*	*8.0'*	*8.0'x1.3x0.9x 0.95x 1.3 = 11.6'*	*17.4'*	*OK*	*OK*	*OK*	*OSB fully-sheath [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.1.2 (1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.1.2(1) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 12.5? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
Second Story Braced Wall Lines (N/A)												
A (left)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*9.4'*	*9.4'x1.3x0.8 x0.95x1.0 = 9.3'*	*24.5'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
B (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 100/C*
C (right)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*9.4'*	*9.4'x1.3x0.8 x0.95x1.0 = 9.3'*	*39.7'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
1 (front)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*9.2'*	*9.2'x1.3x0.8 x0.95x1.0 = 9.1'*	*35.8'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
2 (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 100/C*
3 (rear)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*9.2'*	*9.2'x1.3x0.8 x0.95x1.0 = 9.1'*	*25.0'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
Detached Garage or Other Portions												
n/a												

IRC 2012 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan F, Two story, 42'x38', basement)

GIVEN:
Wind Speed/Exposure: 100/C *(no topographic effects)*
Seismic SDC: A/B *(exempt)*
Roof eave-to-ridge hgt.: 7.0'
Wall Hgt.: 9'(1st); 8' (2nd)
Roof/Ceiling DL: 25 psf max. (clay tile, typical)
Wall DL: 15psf (stucco)
Floor DL: ≤10 psf (avg)-limited areas with tile (~10%)
Roof Span: 42' (mean roof ht = 22')

BWL Configurations Used:
BWL Layout: 3 BWLs each plan direction (1st story);
2 or 3 BWLs each plan direction (2nd story)
BWL Spacing: varies, see analysis below and floor plan

BWP Location and Minimum Bracing:
max 10' edge distance from ends of BWLs
max 20' between BWPs
min. bracing amount per R602.10.2.3 (min. 2 BWPs per BWL or one BWP min. 48" wide for BWL 16' or less in length)

Wind Bracing Length Adjustment Factors (Table R602.10.3(2))
Exposure: 1.3 (C, 2-story)
Eave-to-ridge hgt.: 0.9 (1st); 0.8 (2nd)
Wall Hgt.: 0.95 (both stories)
BWL Factor: 1.3 (1st story); 1.0 or 1.3 (2nd story per 2 or 3 BWLs)
800# strap Factor: n/a (not used)
No int. gyp.: n/a (int. GWB used all ext. walls)
GB fastening: n/a (std. 7"oc edge fastening for GB used)

Seismic Bracing Length Adjustment Factors (Table R602.10.3(4)) – *N/A*

Seismic Irregularities (R301.2.2.5) – *N/A*

Load Path Detailing
- *Roof uplift load path at BWPs (R602.3.5, R802.11) – 100 plf limit on BWP uplift exceeded (394 plf and > 200 lbs/joint at 16"oc); ALL EXT. WALLS: Use roof uplift connectors 525#/ea 16"oc and studs to top plate; 445#/each straps studs to 2nd floor band and to studs below; 365#/ea straps from studs to 1st floor band and band to sill; 48"oc anchor bolts and 3"x3" plate washers sill to foundation.*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.8)*
- *Provide connection/blocking at roof eaves above BWPs per code (R602.10.8.2)*
- *Provide BWP support per code at floor cantilevers and masonry & concrete piers (R602.10.9)- N/A (assume concrete pier size supporting garage opening BWPs not requiring reinforcement)*
- *Block BWP horizontal joints (except GB horizontal) or double required bracing length per code (R602.10.10)*
- *Brace foundation cripple walls per code (R602.10.11) – N/A*
- *BWL sills anchored to concrete/masonry using plate washers per code (R602.11) – SDC D only*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution & Comments*
First Story Braced Wall Lines												
A (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*8.2'*	*8.2'x1.3x0.9x 0.95x 1.3 = 11.8'*	*34.4'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB panels (25' infill); garage assumed to have ½" GWB*
B (int.)	*OK*	*Roof +1 floor*	*21'*	*41'*	*GB*	*16.7'*	*16.7'x1.3x 0.9x0.95x1.3 = 24.1'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge & field fasten int. GWB both sides for 8' along two int. walls adjoining front and rear ext. walls*
C (right)	*OK*	*Roof +1 floor*	*24'*	*41'*	*WSP**	*10.6'*	*10.6'x1.3x0.9x 0.95x 1.3 = 15.3'*	*32.0'*	*OK*	*OK*	*OK*	*Use (4) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**
1 (front)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP CS-PF*	*8.0'*	*8.0'x1.3x0.9x0. 95x 1.3 = 11.6'*	*18.5'*	*OK*	*OK*	*OK*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*
2 (int.)	*OK*	*Roof +1floor*	*20'*	*42'*	*GB*	*16.0'*	*16.0'x1.3x0.9x 0.95x 1.3 = 23.1'*	*25.3'*	*OK*	*OK*	*OK*	*7"oc edge & field fasten int. GWB both sides at 8'wall btwn garage and bath, 9' wall btwn garage and F.R. and 8'wall btwn stairs*
3 (rear)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP*	*8.0'*	*8.0'x1.3x0.9x0. 95x 1.3 = 11.6'*	*17.4'*	*OK*	*OK*	*OK*	*OSB fully-sheath + engr collector for BWP>10' from end of BWL [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Table R602.10.3(1) (feet)	STEP 4 Adjusted Bracing Length per Table R602.10.3(2) footnotes (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP edge distance from ends of BWL ≤ 10'? (0' or 8' SDC D)	STEP 7 Do BWPs comply with maximum 20' spacing btwn BWPs?	*Solution & Comments*
Second Story Braced Wall Lines (N/A)												
A (left)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*9.4'*	*9.4'x1.3x0.8x 0.95x1.0 = 9.3'*	*24.5'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
B (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 100/C*
C (right)	*OK*	*Roof only*	*42'*	*41'*	*WSP*	*9.4'*	*9.4'x1.3x0.8x 0.95x1.0 = 9.3'*	*39.7'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
1 (front)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*9.2'*	*9.2'x1.3x0.8x 0.95x1.0 = 9.1'*	*35.8'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
2 (int.)	*n/a*	*Roof only*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*BWL not used in SDC A/B, 100/C*
3 (rear)	*OK*	*Roof only*	*41'*	*42'*	*WSP*	*9.2'*	*9.2'x1.3x0.8x 0.95x1.0 = 9.1'*	*25.0'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels + engr collector for BWP>10' from end of BWL*
Detached Garage or Other Portions												
n/a												

IRC 2009 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan C, One story, 36'x72', slab-on-grade)

GIVEN:
Wind Speed/Exposure: 85/B *(no topographic effects)*
Seismic SDC: D2
Roof eave-to-ridge hgt.: 11.3'
Wall Hgt.: 9'
Roof/Ceiling DL: ≤15psf avg. (shingles)
Wall DL: ≤15psf avg. (incl. stone veneer accents on front)[1]
Floor DL: n/a (slab on grade)[2]
Roof Span: 36' (mean roof ht. = 15')

BWL Configuration Used (Wind):
BWL Layout: 2 BWLs & 3 BWLs for two plan axes
BWL Spacing: A,B (36'); 1,2,3 (36') – see plan[3]

BWL Configuration Used (Seismic, D):
*BWL Layout: 3 BWLs & 5 BWLs for two plan axes**
BWL Spacing: varies – see plan
**BWL Spacing = max 25' with exception for 35' for one room not more than 900sqft (R602.10.1.5)*

BWP Location and Minimum Bracing (Wind):
max 12.5' cumulative edge distance from ends of BWLs
max 25'oc BWP spacing (R602.10.1.4)
min. 48" bracing amount per BWL (R602.10.1.2)

BWP Location and Minimum Bracing (Seismic, D2):
max 0' edge distance (8' allowed if 2' corner panels or 1800# hold-down at edge closest to corner)
max 25'oc BWP spacing
minimum bracing 48" total per BWL (R602.10.1.2)

Mixing Bracing Methods (R602.10.1.1):
Generally permitted except R602.10.4 require "all ext. walls" in SDC D if CS method is required on any one wall at any story level.

Wind Bracing Length Adjustment Factors (Table R602.10.1.2(1) footnotes)
(b) Exposure B: 1.0
(c) Ridge-to-eave hgt.: 1.1
(d) Wall Hgt.: 0.95
(e) BWL Factor: 1.3 (A,B,C); 1.6 (1,2,3,4,5)
(f) No int. gyp.: n/a
(g) GB one-sided: n/a (All GB BWLs double sided were used)

Seismic Bracing Length Adjustment Factors (Table R602.10.1.2(3))
Story height: 1.0
BWL spacing: n/a (SDC A-C only)
Wall Dead Load: 0.85 (all but front wall with brick/stone accents)
Roof/ceiling DL: 1.0
Walls w/stone or masonry: see Section R602.10.12 (n/a)
Cripple walls: see Section R602.10.9 (n/a)

Seismic Irregularities (R301.2.2.5)
Contains no irregularities

Load Path Detailing (R602.10.1.2, R602.10.6 through R602.10.9, R602.11)
- *Roof uplift load >100 plf per code (R602.10.1.2.1 & R802.11); AT BWP LOCATIONS ONLY: Provide roof uplift connectors 185#/ea 16"oc, stud to sill plate straps at 120#/ea 16"oc, and sill anchor bolts at 6'oc with 3"sq washers (per WFCM 2001).*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.6)*
- *Provide BWP support per code at floor cantilevers and masonry piers (R602.10.7)*
- *BWP support on continuous foundations (R602.10.7.1 – SDC D2)*
- *Block BWP horizontal joints (except GB) per code unless bracing lengths doubled (R602.10.8)*
- *Brace foundation cripple walls per code (R02.10.9.1, SDC D2) – N/A*
- *BWL sills anchored to concrete/masonry per code (R602.11)*

NOTE: Even while SDC D2 controls BWL spacing and BWP end distance and sometime allowed bracing method and anchorage, 85/B wind conditions still controls bracing amounts in some cases (mainly because of a large #BWL factor when there are 3 or more BWLs because of SDC D2 BWL spacing limits). Sometimes, however, the BWP spacing controls bracing amount anyway.

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition Roof only Roof+1 floor Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
First Story Braced Wall Lines												
A-wind (left)	*OK*	*Roof only*	*16'*	*72'*	*WSP*	*2.9'*	*2.9'x1.1x0.95 x1.3 = 3.9' (min. 4.0')*	***40.4'***	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
A-seis (left)	*OK*	*Roof only*	*16'*	*72'*	*WSP*	*Engr., 25%x72'=18'*	*18'x0.85'= 15.3'*	***40.4'***	*OK*	*OK*	*OK*	*Engr. Fee + Fully sheath OSB ("all ext. walls" due to BWLs 1 & 5) anchor bolts at 6'oc with 3"x3" plate washers*
B-wind (int.)	*OK*	*Roof only*	*18'avg*	*72'*	*GB*	*5.5'*	*5.5'x1.1x 0.95x1.3 = 7.5'*	*60.4'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (4 4' interior wall segments)*
B-seis (int.)		*Roof only*	*20'max*	*72'*	*GB*	*Engr., 40%x72'=28. 8'*	*28.8'x1.0 = 28.8'*	*60.4'*	*OK*	*OK*	*OK*	*Engr. Fee + GB double side interior walls with 7"oc fastening at edges of GB panels (4 4' interior wall segments) anchor bolts 6'oc with 3"x3" plate washers + 8" thick slab at BWP locations for anchor bolts*
C-wind (right)	*OK*	*Roof only*	*20'*	*72'*	*WSP*	*3.5'*	*3.5'x1.1x 0.95x1.3 =4.8'*	*50.1'*	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
C-seis (right)	*OK*	*Roof only*	*20'*	*72'*	*WSP*	*Engr., 25%x72'=18'*	*18'x0.85=15.3'*	*50.1*	*OK*	*OK*	*OK*	*Engr. + Fully sheath OSB ("all ext. walls" due to BWLs 1 & 5) anchor bolts at 6'oc with 3"x3" plate washers*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
1 - wind (front)	*OK*	*Roof only*	*21.5'*	*36'*	*CS-WSP CS-G*	*3.2'*	*3.2'x1.1x 0.95x1.6 =5.4'*	*3.3' (CS-WSP) 2'+2' = 4' (CS-G) w/4" credit for 3 narrow segments*	*OK*	*OK*	*OK*	*OSB fully sheathed [increased 3 panels by 3" ea. to reach 2' min. – may affect window sizes, foyer width, or plan width] (Garage must be finished)*
1-seis (front)	*OK*	*Roof only*	*21.5'*	*36'*	*CS-WSP CS-G*	*7.6'*	*7.6'x1.0= 7.6'*	*3.3' (CS-WSP) & 2.3'+2.3' = 4.6' (CS-G)*	*OK*	*OK*	*OK*	*OSB fully sheathed [increased 2 panels by 5" ea. to reach 27" min. and corner panel by 3" to reach 24"min – may affect window sizes, foyer width, or plan width] (Garage must be finished) use 3"x3" plate washers on anchor bolts at 6'oc*
2-wind (int.)	*OK*	*Roof only*	*18.3'avg*	*36'*	*GB*	*5.6'*	*5.6'x1.1x 0.95x1.6 =9.4'*	*23'*	*OK*	*OK*	*OK*	*GB double side interior wall segments with 7"oc fastening at edges (two 8' segments, garage and dining room)*
2-seis (int.)	*OK*	*Roof only*	*21.5' max*	*36'*	*GB*	*14,4'*	*14.4'x0.85 = 12.2'*	*23'*	*OK*	*OK*	*OK*	*GB double side interior wall segments with 7"oc fastening at edges (8' and 15' walls, garage and dining room) on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
3-wind (int.)	*OK*	*Roof only*	*16.2'avg*	*36'*	*GB*	*5.1'*	*5.1'x1.1x0.95 x1.6 = 8.5'*	*5'+15'= 20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (5' and 15' interior walls)*
3-seis (int.)	*OK*	*Roof only*	*17.4' max*	*36'*	*GB*	*14.4'*	*14.4'x0.85 = 12.2'*	*5'+15'+ 6.8' = 26.8'*	*OK*	*OK*	*OK*	*GB double side interior wall segments with 7"oc fastening at edges (6.8',15', and 5.0' walls) at D.R., stairway, and dbl closet on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*
4-wind (int.)	*OK*	*Roof only*	*17.4'avg*	*36'*	*GB*	*5.4'*	*5.4'x1.1x0.95 x1.6 = 9.0'*	*20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (6', 5.4', and 8.6' interior walls)*
4-seis (int.)	*OK*	*Roof only*	*17.4' max*	*36'*	*GB*	*14.4'*	*14.4'x0.85 = 12.20'*	*20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (6', 5.4 and 8.6' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
5-wind (rear)	*OK*	*Roof only*	*17.4'*	*36'*	*CS-WSP + CS-PF*	*2.6'*	*2.6'x1.1x 0.95x1.6 = 4.3'*	*1.7'+2.9' = 4.6'*	*OK*	*OK*	*OK*	*OSB fully sheathed + 1 CS-PF panel at left rear corner*
5-seis (rear)	*OK*	*Roof only*	*17.4'*	*36'*	*CS-WSP + CS-PF*	*7.6'*	*7.6'x0.85 = 6.5'*	*2.0+1.7'+ 2.9' = 4.6'*	*OK*	*OK*	*OK*	*OSB fully sheathed + 2 CS-PF panels, one at each rear corner; use 3"x3" plate washers on anchor bolts at 6'oc*
Second Story Braced Wall Lines												
n/a												
Detached Garage or Other Portions												
n/a												

IRC 2012 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan C, One story, 36'x72', slab-on-grade)

GIVEN:
Wind Speed/Exposure: 85/B *(no topographic effects)*
Seismic SDC: D2
Roof eave-to-ridge hgt.: 11.3'
Wall Hgt.: 9'
Roof/Ceiling DL: ≤15psf avg. (shingles)
Wall DL: ≤15psf avg. (incl. stone veneer accents on front)
Floor DL: n/a (slab on grade)
Roof Span: 36' (mean roof ht. = 15')

BWL Configuration Used (Wind):
BWL Layout: 2 BWLs & 3 BWLs for two plan axes
BWL Spacing: A,B (36'); 1,2,3 (36') – see plan

BWL Configuration Used (Seismic, D):
*BWL Layout: 3 BWLs & 5 BWLs for two plan axes**
BWL Spacing: varies – see plan
**BWL Spacing = max 25' with exception for 35' for one room not more than 900sqft*

BWP Location and Minimum Bracing (Wind):
max 10' edge distance from ends of BWLs
max 20' between BWPs
min. bracing amount per R602.10.2.3 (min. 2 BWPs per BWL or one BWP min. 48' wide for BWL 16' or less in length)

BWP Location (Seismic, D2):
max 0' edge distance (10' allowed if 2' corner panels or 1800# hold-down at edge closest to corner)

Mixing Bracing Methods (R602.10.4.1):
Various "permissions" given, but in SDC D it is implied that mixing is not permitted if CS methods used on exterior wall, must be used on all ext. walls (interpretation based on 2009 IRC).

Wind Bracing Length Adjustment Factors (Table R602.10.3(2))
Exposure: 1.0 (B)
Eave-to-ridge hgt.: 1.1
Wall Hgt.: 0.95
BWL Factor: 1.3 (A,B,C); 1.6 (1,2,3,4,5)
800# strap Factor: n/a (not used)
No int. gyp.: n/a (int. GWB used all ext. walls)
GB fastening: n/a (std. 7"oc edge/field fastening for GB used)

Seismic Bracing Length Adjustment Factors (Table R602.10.3(4))
Story height: 1.0
BWL spacing: 1.0 (all BWL spacing 25' or less)
Wall Dead Load: 0.85 (all but front wall with brick/stone accents and BWL B)
Roof/ceiling DL: 1.0
Walls w/stone or masonry: see Table R602.10.3(4) (n/a)
Interior Gyp omitted: 1.0 (n/a) (gyp included unless noted otherwise)

Seismic Irregularities (R301.2.2.5)
Contains no irregularities

Load Path Detailing
- *Roof uplift load <100 plf and force less than 200# (R602.3.5 & R802.11); Use conventional fastening requirements.*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.8)*
- *Provide connection/blocking at roof eaves above BWPs per code (R602.10.8.2)*
- *Provide BWP support per code at floor cantilevers and masonry & concrete piers (R602.10.9)*
- *Block BWP horizontal joints (except GB horizontal) or double required bracing length per code (R602.10.10)*
- *Brace foundation cripple walls per code (R02.10.11) – N/A*
- *BWL sills anchored to concrete/masonry using plate washers per code (R602.11) – SDC D only*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
First Story Braced Wall Lines												
A-wind (left)	*OK*	*Roof only*	*16'*	*72'*	*WSP*	*2.9'*	*2.9'x1.1x0.95 x1.3 = 3.9' (min. 4.0')*	***40.4'***	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
A-seis (left)	*OK*	*Roof only*	*16'*	*72'*	*WSP*	*Engr., 25%x72'=18'*	*18'x0.85'= 15.3'*	***40.4'***	*OK*	*OK*	*OK*	*Engr. Fee + Fully sheath OSB ("all ext. walls" due to BWLs 1 & 5) anchor bolts at 6'oc with 3"x3" plate washers*
B-wind (int.)	*OK*	*Roof only*	*18'avg*	*72'*	*GB*	*5.5'*	*5.5'x1.1x 0.95x1.3 = 7.5'*	*60.4'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (4- 4' interior wall segments)*
B-seis (int.)		*Roof only*	*20'max*	*72'*	*GB*	*Engr., 40%x72'=28. 8'*	*28.8'x1.0 = 28.8'*	*60.4'*	*OK*	*OK*	*OK*	*Engr. Fee + GB double side interior walls with 7"oc fastening at edges of GB panels (4 4' interior wall segments) anchor bolts 6'oc with 3"x3" plate washers + 8" thick slab at BWP locations for anchor bolts*
C-wind (right)	*OK*	*Roof only*	*20'*	*72'*	*WSP*	*3.5'*	*3.5'x1.1x 0.95x1.3 =4.8'*	*50.1'*	*OK*	*OK*	*OK*	*(4) 4' OSB panels (56' infill panels)*
C-seis (right)	*OK*	*Roof only*	*20'*	*72'*	*WSP*	*Engr., 25%x72'=18'*	*18'x0.85=15.3'*	*50.1*	*OK*	*OK*	*OK*	*Engr. + Fully sheath OSB ("all ext. walls" due to BWLs 1 & 5) anchor bolts at 6'oc with 3"x3" plate washers*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition Roof only Roof+1 floor Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
1 - wind (front)	*OK*	*Roof only*	*21.5'*	*36'*	*CS-WSP CS-G*	*3.2'*	*3.2'x1.1x 0.95x1.6 =5.4'*	*3.3' (CS-WSP) 2'+2' = 4' (CS-G) w/4" credit for 3 narrow segments*	*OK*	*OK*	*OK*	*OSB fully sheathed [increased 3 panels by 3" ea. to reach 2' min. – may affect window sizes, foyer width, or plan width] (Garage must be finished)*
1-seis (front)	*OK*	*Roof only*	*21.5'*	*36'*	*CS-WSP CS-G*	*7.6'*	*7.6'x1.0= 7.6'*	*3.3' (CS-WSP) & 2.3'+2.3' = 4.6' (CS-G)*	*OK*	*OK*	*OK*	*OSB fully sheathed [increased 2 panels by 5" ea. to reach 27" min. and corner panel by 3" to reach 24"min – may affect window sizes, foyer width, or plan width] (Garage must be finished) use 3"x3" plate washers on anchor bolts at 6'oc*
2-wind (int.)	*OK*	*Roof only*	*18.3'avg*	*36'*	*GB*	*5.6'*	*5.6'x1.1x 0.95x1.6 =9.4'*	*23'*	*OK*	*OK*	*OK*	*GB double side interior wall segments with 7"oc fastening at edges (two 8' segments, garage and dining room)*
2-seis (int.)	*OK*	*Roof only*	*21.5' max*	*36'*	*GB*	*14,4'*	*14.4'x0.85 = 12.2'*	*23'*	*OK*	*OK*	*OK*	*GB double side interior wall segments with 7"oc fastening at edges (8' and 15' walls, garage and dining room) on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
3-wind (int.)	*OK*	*Roof only*	*16.2'avg*	*36'*	*GB*	*5.1'*	*5.1'x1.1x0.95 x1.6 = 8.5'*	*5'+15'= 20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (5' and 15' interior walls)*
3-seis (int.)	*OK*	*Roof only*	*17.4' max*	*36'*	*GB*	*14.4'*	*14.4'x0.85 = 12.2'*	*5'+15'+ 6.8' = 26.8'*	*OK*	*OK*	*OK*	*GB double side interior wall segments with 7"oc fastening at edges (6.8',15', and 5.0' walls) at D.R., stairway, and dbl closet on 12"x16" reinforced thick slab footing and 3"x3" plate washers on anchor bolts at 6'oc*
4-wind (int.)	*OK*	*Roof only*	*17.4'avg*	*36'*	*GB*	*5.4'*	*5.4'x1.1x0.95 x1.6 = 9.0'*	*20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (6', 5.4', and 8.6' interior walls)*
4-seis (int.)	*OK*	*Roof only*	*17.4' max*	*36'*	*GB*	*14.4'*	*14.4'x0.85 = 12.20'*	*20'*	*OK*	*OK*	*OK*	*GB double side interior walls with 7"oc fastening at edges of GB panels (6', 5.4 and 8.6' interior walls) on 12"x16" reinforced thick slab footings with anchor bolts and 3"x3" washers at 6'oc*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D) w/ except	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution*
5-wind (rear)	*OK*	*Roof only*	*17.4'*	*36'*	*CS-WSP + CS-PF*	*2.6'*	*2.6'x1.1x 0.95x1.6 = 4.3'*	*1.7'+2.9' = 4.6'*	*OK*	*OK*	*OK*	*OSB fully sheathed + 1 CS-PF panel at left rear corner*
5-seis (rear)	*OK*	*Roof only*	*17.4'*	*36'*	*CS-WSP + CS-PF*	*7.6'*	*7.6'x0.85 = 6.5'*	*2.0+1.7'+ 2.9' = 4.6'*	*OK*	*OK*	*OK*	*OSB fully sheathed + 2 CS-PF panels, one at each rear corner; use 3"x3" plate washers on anchor bolts at 6'oc*
Second Story Braced Wall Lines												
n/a												
Detached Garage or Other Portions												
n/a												

IRC 2009 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan F, Two story, 42'x38', basement)

GIVEN:
Wind Speed/Exposure: 85/B *(no topographic effects)*
Seismic SDC: D2
Roof eave-to-ridge hgt.: 7.0'
Wall Hgt.: 9'(1st); 8' (2nd)
Roof/Ceiling DL: 25 psf max. (clay tile, typical)
Wall DL: 15psf (stucco)
Floor DL: ≤10 psf (avg)-limited areas with tile (~10%)
Roof Span: 42' (mean roof ht = 22')

BWL Configurations Used (Wind):
BWL Layout: 3 BWLs each plan direction (1st story);
2 or 3 BWLs each plan direction (2nd story)
BWL Spacing: varies, see analysis below and floor plan

BWL Configuration Used (Seismic, D):
*BWL Layout: 3 BWLs each plan direction (both stories)**
BWL Spacing: varies – see plan
**BWL Spacing = max 25' with exception for 35' for one room not more than 900sqft (R602.10.1.5)*

BWP Location and Minimum Bracing (Wind):
max 12.5' cumulative edge distance from ends of BWLs
max 25' oc BWP spacing (R602.10.1.4)
min. 48" bracing amount per BWL (R602.10.1.2)

BWP Location and Minimum Bracing (Seismic, D2):
max 0' edge distance (8' allowed if 2' corner panels or 1800# hold-down at edge closest to corner)
max 25'oc BWP spacing
minimum bracing 48" total per BWL (R602.10.1.2)

Mixing Bracing Methods (R602.10.1.1):
Generally permitted except R602.10.4 require "all ext. walls" in SDC D if CS method is required on any one wall at any story level.

Wind Bracing Length Adjustment Factors (Table R602.10.1.2(1) footnotes)
(b) Exposure B: 1.0
(c) Ridge-to-eave hgt.: 0.9(1st); 0.8(2nd)
(d) Wall Hgt.: 0.95 (both stories)
(e) BWL Factor: 1.3 (both stories, both directions)
(f) No int. gyp.: n/a
(g) GB one-sided: n/a (all GB BWLs double sided where used)

Seismic Bracing Length Adjustment Factors (Table R602.10.1.2(3))
Story height: 1.0
BWL spacing: n/a (SDC A-C only)
Wall Dead Load: 1.0 (stucco over WSP)
Roof/ceiling DL: 1.2 (top story), 1.1 (bottom story) (NOTE: These two factors were reversed in 2009 IRC and have been corrected here.)
Walls w/stone or masonry: see Section R602.10.12 (n/a)
Cripple walls: see Section R602.10.9 (n/a)

Seismic Irregularities (R301.2.2.5)
OK- 2nd floor diaphragm is bounded by braced walls at great room.
OK- 2nd-story brace wall set back above garage opening – design load path required
OK- 2nd-story BWPs above garage opening end on beam in ceiling/floor above garage (technically not an opening with header below) – design load path required

Load Path Detailing (R602.10.1.2, R602.10.6 through R602.10.9, R602.11)
- *Uplift load > 100 plf at roof/wall (R602.10.1.2.1 & R802.11); AT BWP LOCATIONS ONLY: Provide roof uplift connectors 205#/ea 16"oc and studs to top plate; 140#/ea straps at 16"oc studs to 1st floor band joist and to studs below at 16"oc; 75#/ea straps at 16"oc 1st story studs (every other) to band on foundation. Slant nail band to foundation sill per code.*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.6)*
- *Provide BWP support per code at floor cantilevers and masonry piers (R602.10.7)*
- *BWP support on continuous foundations (R602.10.7.1 – SDC D2)*
- *Block BWP horizontal joints (except GB) per code unless bracing lengths doubled (R602.10.8)*
- *Brace foundation cripple walls per code (R02.10.9.1, SDC D2) – N/A*
- *BWL sills anchored to concrete/masonry per code (R602.11)*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
First Story Braced Wall Lines												
A-wind (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*5.9'*	*5.4'x0.9x0.95x 1.3 = 6.6'*	*34.4'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB panels (25' infill); (garage may be unfinished)*
A-seis (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*22.8'*	*22.8'x1.1 =25.1'*	*34.4'*	*OK*	*OK*	*OK*	*Fully sheath OSB (caused by "all walls" due to BWL C, 1, and 3); use 3"x3" washers on anchor bolts @ 6'oc (garage can be unfinished)*
B-wind (int.)	*OK*	*Roof +1 floor*	*21'*	*41'*	*GB*	*12.0'*	*12.0'x0.9x0.95x 1.3 = 13.3'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides for 8' along two int. walls adjoining front and rear ext. walls*
B-seis (int.)	*OK*	*Roof +1floor*	*24' max*	*41'*	*GB*	*30.8'*	*30.8'x1.1 = 33.9'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides for two int. walls adjoining front and rear ext. walls; blocking below wall at family room.*
C-wind (right)	*OK*	*Roof +1 floor*	*24'*	*41'*	*WSP**	*7.7'*	*7.7'x0.9x0.95x 1.3 = 8.6'*	*32.0'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**
C-seis (right)	*OK*	*Roof +1floor*	*24'*	*41'*	*CS-WSP (engr.)*	*19.4'*	*19.4'x1.1 = 21.3'*	*32.0'*	*OK*	*OK*	*OK*	*Fully Sheath OSB w/ two 9,000# holddowns to dbl. tall studs at ends of great room wall portion; 3"x3" washers on anchor bolts at 6'oc*
1-wind (front)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP CS-PF*	*5.5'*	*5.5'x0.9x0.95x 1.3 = 6.1'*	*18.5'*	*OK*	*OK*	*OK*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
1-seis (front)	*OK*	*Roof+1floor*	*20'*	*42'*	*WSP* (equiv)*	*23.1'*	*23.1'x1.1 = `25.4'*	*18.5'*	*NG*	*OK*	*OK*	*Use 3 or more engr. Narrow brace wall panels (no more than 2' wide each) for total equivalence to 5.8 WSP BWPs*
2-wind (int.)	*OK*	*Roof +1floor*	*20'*	*42'*	*GB*	*11.5'*	*11.5'x0.9x0.95x 1.3 = 12.8'*	*25.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides at 9'wall btwn garage & F.R. and 8' wall between stairs*
2-seis (int.)	*OK*	*Roof+1floor*	*20'*	*42'*	*WSP*	*23.1'*	*23.1'x1.1 = 25.4'*	*25.3'*	*OK*	*OK*	*OK*	*OSB fully sheath int. walls at back of garage and btwn stairwell and kitchen ; 3"x3" plate washers on anchor bolts @ 6'oc along garage walls*
3-wind (rear)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP*	*5.5'*	*5.5'x0.9x0.95x 1.3 = 6.1'*	*17.4'*	*OK*	*OK*	*OK*	*OSB fully-sheath [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*
3-seis (rear)	*OK*	*Roof+1floor*	*20'*	*42'*	*WSP* (equiv.)*	*23.1*	*23.1'x1.1 = `25.4'*	*17.4'*	*NG*	*NG (engr req'd)*	*OK*	*Use 3 or more engr. Narrow brace wall panels (no more than 2.6' wide each) for total equivalence to 5.8 WSP BWPs; double floor joist collector over brkfst nook attach to top plate or band above walls with 1000# strap/connector*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
Second Story Braced Wall Lines (N/A)												
A-wind (left)	*OK*	*Roof only*	*22'*	*41'*	*WSP*	*3.8'*	*3.8'x0.8x0.95 x1.3 = 3.8' (4' min.)*	*24.5'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
A-seis (left)	*OK*	*Roof only*	*22'*	*41'*	*WSP*	*10.3'*	*10.3'x1.2=12.4'*	*24.5'*	*OK*	*OK*	*OK*	*Fully sheath OSB (CS-WSP required due to other ext. BWLs)*
B-wind (int.)	*OK*	*Roof only*	*21'avg*	*41'*	*GB*	*6.3'*	*6.3'x0.8x0.95 x1.3 = 6.2'*	*23.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along GR wall and MBdr closet (15.3' and 5.4')*
B-seis (int.)	*OK*	*Roof only*	*22'max*	*41'*	*GB*	*16.4'*	*16.4'x1.2= 19.7'*	*23.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along GR wall and MBdr closet (15.3', 5.4', and 4' at toilet wall & increase wall 9"); extra joist below wall line aligned*
C-wind (right)	*OK*	*Roof only*	*20'*	*41'*	*WSP*	*3.5'*	*3.5'x0.8x0.95 x1.3 = 3.5' (4' min.)*	*39.7'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
C-seis (right)	*OK*	*Roof only*	*20'*	*41'*	*WSP*	*10.3'*	*10.3'x1.2=12.4'*	*39.7'*	*OK*	*OK*	*OK*	*Fully sheath with OSB (part of GR CS-WSP wall design for story below)*
1-wind (front)	*OK*	*Roof only*	*23'*	*42'*	*WSP*	*4.0'*	*4.0'x0.8x0.95 x1.3 = 4.0'*	*35.8'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
1-seis (front)	*OK*	*Roof only*	*23'*	*42'*	*WSP*	*10.5'*	*10.5'x1.2=12.6'*	*35.8'*	*OK*	*OK*	*OK*	*Fully sheath OSB (design support below with double joist at garage*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.1.2 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.1.2 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
												ceiling and strap ends at bearing to double studs in 1st story wall anchored to garage foundation with 1000# holdowns) and OSB sheath garage ceiling 5' wide to garage opening wall
2-wind (int.)	*n/a*	*Roof only*	*22'avg*	*42'*	*GB*	*6.5'*	*6.5'x0.8x0.95 x1.3 = 6.4'*	*34.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along stairway and Mbrm (15.5' and 19.4')*
2-seis (int.)	*OK*	*Roof only*	*23'max*	*42'*	*GB*	*16.8'*	*16.8'x1.2= 20.2'*	*34.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along stairway and Mbrm (15.5' and 19.4'); blocking btwn joists below 19.4' wall)*
3-wind (rear)	*OK*	*Roof only*	*22'*	*42'*	*WSP*	*3.8'*	*3.8'x0.8x0.95 x1.3 = 5.9'*	*25.0'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
3-seis (rear)	*OK*	*Roof only*	*22'*	*42'*	*WSP*	*10.5'*	*10.5'x1.2=12. 6'*	*25.0'*	*OK*	*NG (engr req'd)*	*OK*	*(3) 4' OSB panels double ceiling joist collector over bath bump-out attach to top plate or band above walls with 1000# strap/connector*
Detached Garage or Other Portions												
n/a												

IRC 2012 Wall Bracing Design and Plan Check Worksheet

Project: NAHB (Plan F, Two story, 42'x38', basement)

GIVEN:
Wind Speed/Exposure: 85/B *(no topographic effects)*
Seismic SDC: D2
Roof eave-to-ridge hgt.: 7.0'
Wall Hgt.: 9'(1st); 8' (2nd)
Roof/Ceiling DL: 25 psf max. (clay tile, typical)
Wall DL: 15psf (stucco)
Floor DL: ≤10 psf (avg)-limited areas with tile (~10%)
Roof Span: 42' (mean roof ht = 22')

BWL Configurations Used (Wind):
BWL Layout: 3 BWLs each plan direction (1st story);
2 or 3 BWLs each plan direction (2nd story)
BWL Spacing: varies, see analysis below and floor plan

BWL Configuration Used (Seismic, D):
*BWL Layout: 3 BWLs each plan direction (both stories)**
BWL Spacing: varies – see plan
**BWL Spacing = max 25' with exception for 35' for one room not more than 900sqft*

BWP Location and Minimum Bracing (Wind):
max 10' edge distance from ends of BWLs
max 20' between BWPs
min. 48" bracing amount per R602.10.2.3 (min. 2 BWPs per BWL or one BWP min. 48" wide for BWL 16' or less in length)

BWP Location (Seismic, D2):
max 0' edge distance (10' allowed if 2' corner panels or 1800# hold-down at edge closest to corner)

Mixing Bracing Methods (R602.10.4.1):
Various permissions given, but in SDC D it is implied that mixing is not permitted if CS methods are used on exterior wall, must be used on all ext. walls (interpretation based on 2009 IRC)

Wind Bracing Length Adjustment Factors (Table R602.10.3(2))
Exposure B: 1.0
Eave-to-Ridge hgt.: 0.9(1st); 0.8(2nd)
Wall Hgt.: 0.95 (both stories)
BWL Factor: 1.3 (both stories, both directions)
800# strap factor: n/a (not used)
No int. gyp.: n/a (int. GWB used all ext. walls)
GB fastening: n/a (std. 7"oc edge/field fastening for GB used)

Seismic Bracing Length Adjustment Factors (Table R602.10.3(4))
Story height: 1.0
BWL spacing: 1.0 (all BWL spacing 25' or less)
Wall Dead Load: 1.0 (stucco over WSP)
Roof/ceiling DL: 1.2 (top story), 1.1 (bottom story)
Walls w/stone or masonry: see Section R602.10.12 (n/a)
Int. Gyp omitted: 1.0 (n/a) (gyp included unless noted otherwise)

Seismic Irregularities (R301.2.2.2.5)
OK- 2nd floor diaphragm is bounded by braced walls at great room.
OK- 2nd-story brace wall set back above garage opening – design load path required
OK- 2nd-story BWPs above garage opening end on beam in ceiling/floor above garage (technically not an opening with header below) – design load path required

Load Path Detailing
- *Uplift load > 100 plf at roof/wall and <200 lbs per joint at 16"oc (R602.3.5 & R802.11); AT BWP LOCATIONS ONLY: Provide roof uplift connectors 140#/ea 16"oc and studs to top plate; 140#/ea straps at 16"oc studs to 1st floor band joist; remainder of connections per conventional fastening.*
- *Provide blocking or parallel member above/below BWPs per code (R602.10.8)*
- *Provide connection/blocking at roof eaves above BWPs per code (R602.10.8.2)*
- *Provide BWP support per code at floor cantilevers and masonry & concrete piers (R602.10.9)*
- *BWP support on continuous foundations (R602.10.7.1 – SDC D2)*
- *Block BWP horizontal joints (except GB horizontal) or double required bracing length per code (R602.10.10)*
- *Brace foundation cripple walls per code (R02.10.11) – N/A*
- *BWL sills anchored to concrete/masonry per code (R602.11) – SDC D only*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
First Story Braced Wall Lines												
A-wind (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*5.9'*	*5.9'x0.9x0.95x 1.3 = 6.6'*	*34.4'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB panels (25' infill); (garage may be unfinished)*
A-seis (left)	*OK*	*Roof +1floor*	*18'*	*41'*	*WSP*	*22.8'*	*22.8'x1.1 =25.1'*	*34.4'*	*OK*	*OK*	*OK*	*Fully-sheath OSB ("all ext. walls" SDC D2 caused by BWLs 1 & 3) anchor bolts at 6'oc with 3"x3" plate washers (garage may be unfinished)*
B-wind (int.)	*OK*	*Roof +1 floor*	*21'*	*41'*	*GB*	*12.0'*	*12.0'x0.9x0.95x 1.3 = 13.3'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides for 8' along two int. walls adjoining front and rear ext. walls*
B-seis (int.)	*OK*	*Roof +1floor*	*24' max*	*41'*	*GB*	*30.8'*	*30.8'x1.1 = 33.9'*	*37.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides for two int. walls adjoining front and rear ext. walls; blocking below wall at family room.*
C-wind (right)	*OK*	*Roof +1 floor*	*24'*	*41'*	*WSP**	*7.7'*	*7.7'x0.9x0.95x 1.3 = 8.6'*	*32.0'*	*OK*	*OK*	*OK*	*Use (3) 4' OSB (or use engr CS-WSP w/2 hold-downs due to GR if design req'd)**
C-seis (right)	*OK*	*Roof +1floor*	*24'*	*41'*	*CS-WSP (engr.)*	*19.4'*	*19.4'x1.1 = 21.3'*	*32.0'*	*OK*	*OK*	*OK*	*Fully Sheath OSB w/ two 9,000# holddowns to dbl. tall studs at ends of great room wall portion; 3"x3" washers on anchor bolts at 6'oc*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
1-wind (front)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP CS-PF*	*5.5'*	*5.5'x0.9x0.95x 1.3 = 6.1'*	*18.5'*	*OK*	*OK*	*OK*	*OSB fully-sheath + CS-PF at garage supporting offset 2nd story BWL*
1-seis (front)	*OK*	*Roof+1floor*	*20'*	*42'*	*WSP* (equiv)*	*23.1'*	*23.1'x1.1 = `25.4'*	*18.5'*	*NG*	*OK*	*OK*	*Use 3 or more engr. Narrow brace wall panels (no more than 2' wide each) for total equivalence to 5.8 WSP BWPs*
2-wind (int.)	*OK*	*Roof +1floor*	*20'*	*42'*	*GB*	*11.5'*	*11.5'x0.9x0.95x 1.3 = 12.8'*	*25.3'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides at 9'wall btwn garage & F.R. and 8' wall between stairs*
2-seis (int.)	*OK*	*Roof+1floor*	*20'*	*42'*	*WSP*	*23.1'*	*23.1'x1.1 = 25.4'*	*25.3'*	*OK*	*OK*	*OK*	*OSB fully sheath int. walls at back of garage and btwn stairwell and kitchen ; 3"x3" plate washers on anchor bolts @ 6'oc along garage walls*
3-wind (rear)	*OK*	*Roof +1floor*	*20'*	*42'*	*CS-WSP*	*5.5'*	*5.5'x0.9x0.95x 1.3 = 6.1'*	*17.4'*	*OK*	*OK*	*OK*	*OSB fully-sheath [WSP method, (3) 4' OSB panels OK if one panel next to door increased to 43" vs. 37" wide]*
3-seis (rear)	*OK*	*Roof+1floor*	*20'*	*42'*	*WSP* (equiv.)*	*23.1*	*23.1'x1.1 = `25.4'*	*17.4'*	*NG*	*NG (engr req'd)*	*OK*	*Use 3 or more engr. Narrow brace wall panels (no more than 2.6' wide each) for total equivalence to 5.8 WSP BWPs; double floor joist collector over brkfst nook attach to top plate or band above walls with 1000# strap/connector*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
Second Story Braced Wall Lines												
A-wind (left)	*OK*	*Roof only*	*22'*	*41'*	*WSP*	*3.8'*	*3.8'x0.8x0.95 x1.3 = 3.8' (4' min.)*	*24.5'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
A-seis (left)	*OK*	*Roof only*	*22'*	*41'*	*WSP*	*10.3'*	*10.3'x1.2=12. 4'*	*24.5'*	*OK*	*OK*	*OK*	*Fully-sheath OSB ("all ext. walls" SDC D2 caused by BWLs 1 & 3 on 1st story) anchor bolts at 6'oc with 3"x3" plate washers*
B-wind (int.)	*OK*	*Roof only*	*21'avg*	*41'*	*GB*	*6.3'*	*6.3'x0.8x0.95 x1.3 = 6.2'*	*23.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along GR wall and MBdr closet (15.3' and 5.4')*
B-seis (int.)	*OK*	*Roof only*	*22'max*	*41'*	*GB*	*16.4'*	*16.4'x1.2= 19.7'*	*23.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along GR wall and MBdr closet (15.3', 5.4', and 4' at toilet wall & increase wall 9"); extra joist below wall line aligned*
C-wind (right)	*OK*	*Roof only*	*20'*	*41'*	*WSP*	*3.5'*	*3.5'x0.8x0.95 x1.3 = 3.5' (4' min.)*	*39.7'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
C-seis (right)	*OK*	*Roof only*	*20'*	*41'*	*WSP*	*10.3'*	*10.3'x1.2=12. 4'*	*39.7'*	*OK*	*OK*	*OK*	*Fully sheath with OSB (part of GR CS-WSP wall design for story below)*
1-wind (front)	*OK*	*Roof only*	*23'*	*42'*	*WSP*	*4.0'*	*4.0'x0.8x0.95 x1.3 = 4.0'*	*35.8'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*

STEP 1 Braced Wall Line ID	STEP 1 Maximum BWP Offset from BWL ≤ 4'?	*STEP 2 BWL Support Condition* *Roof only* *Roof+1 floor* *Roof+2 floors*	STEP 2 BWL Spacing (feet)	Length of BWL (feet) (see plan for actual wall lengths)	STEP 3 Selected Bracing Method (s)	STEP 4 Tabulated Bracing Length Tables R602.10.3 (feet)	STEP 4 Adjusted Bracing Length per Tables R602.10.3 (inches)	STEP 5 Bracing Length Available with Allowed Panel Widths (inches)	STEP 6 Is Value in Column G ≥ Value in Column F?	STEP 7 Is BWP cumulative distance from ends of BWL ≤ 0' (SDC D)	STEP 7 Do BWPs comply with maximum 25'oc spacing along BWP?	*Solution & Comments*
1-seis (front)	*OK*	*Roof only*	*23'*	*42'*	*WSP*	*10.5'*	*10.5'x1.2=12.6'*	*35.8'*	*OK*	*OK*	*OK*	*Fully sheathing with OSB (design support below with double joist at garage ceiling and strap ends at bearing to double studs in 1st story wall anchored to garage foundation with 1000# holdowns) and OSB sheathing garage ceiling 5' wide to garage opening wall*
2-wind (int.)	*n/a*	*Roof only*	*22'avg*	*42'*	*GB*	*6.5'*	*6.5'x0.8x0.95 x1.3 = 6.4'*	*34.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along stairway and Mbrm (15.5' and 19.4')*
2-seis (int.)	*OK*	*Roof only*	*23'max*	*42'*	*GB*	*16.8'*	*16.8'x1.2= 20.2'*	*34.9'*	*OK*	*OK*	*OK*	*7"oc edge fasten int. GWB both sides along stairway and Mbrm (15.5' and 19.4'); blocking btwn joists below 19.4' wall)*
3-wind (rear)	*OK*	*Roof only*	*22'*	*42'*	*WSP*	*3.8'*	*3.8'x0.8x0.95 x1.3 = 5.9'*	*25.0'*	*OK*	*OK*	*OK*	*(3) 4' OSB panels*
3-seis (rear)	*OK*	*Roof only*	*22'*	*42'*	*WSP*	*10.5'*	*10.5'x1.2=12.6'*	*25.0'*	*OK*	*NG (engr req'd)*	*OK*	*Fully-sheath OSB panels + ceiling joist collector over bath bump-out attach to top plate or band above walls with 1000# strap/connector*
Detached Garage or Other Portions												
n/a												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