Continuous Load Path: Wall Bracing

2009 International Residential Code

This program will look at:

- Building code requirements for wall bracing.
- Their differences from, and similarities to previous codes.
- Sections of code that pertain to building in New England.
- "Continuous load path" provisions of the code directly related to the wall bracing section.
- Common problem areas, such as framing sides of the garage door opening, walls with multiple windows, and two story walls.
- "Engineered solutions" or what to do when your plan falls outside of the *prescriptive* code.
- Software available to help determine the minimum wall bracing length requirements.

Based on 2009 IRC

State of Connecticut
REGULATION
of

NAME OF AGENCY
DEPARTMENT OF CONSTRUCTION SERVICES

Concerning
SUBJECT MATTER OF REGULATION
STATE BUILDING CODE

2013 AMENDMENT TO THE
STATE BUILDING CODE

February 28, 2014

www.ct.gov/dcs

R106.1.1 Information on construction documents

- Where required by the Building Official, the following shall be identified on the construction documents:
- All pertinent information including, but not limited to:
  - Braced wall lines
  - Bracing methods
  - Location and length of brace wall panels
  - Foundation requirements

R301.2.1.1 Design criteria.

In regions where the basic wind speeds from Figure R301.2(4) equal or exceed 100 miles per hour, the design of buildings shall be in accordance with one of the following methods.

DELETE

(Add) **APPENDIX R – WIND SPEEDS and SEISMIC DESIGN CATEGORIES**

Municipality	Basic Wind Speed (3-second gust) (mph)	Seismic Design Category[1]	
		Site Class A-D	Site Class E
Andover	100	B	B
Ansonia	100	B	B
Ashford	100	B	B
Avon	100	B	B
Barkamsted	100	B	B
Beacon Falls	100	B	B
Berlin	100	B	B
Bethany	100	B	B
Bethel	100	B	C
Bethlehem	100	B	B
Bloomfield	100	B	B
Bolton	100	B	B
Bozrah	105	B	B
Branford	100	B	B
Bridgeport	100	B	C
Bridgewater	100	B	C
Bristol	100	B	B
Brookfield	100	B	C
Brooklyn	105	B	B
Burlington	100	B	B

R602.10.1.2.1 Braced wall panel uplift load path.

1. Fastening in accordance with Table R602.3(1) where:
   - 1.1. The basic wind speed does not exceed 90 mph (40 m/s), the wind exposure category is B, the roof pitch is 5:12 or greater, and the roof span is 32 feet (9754 mm) or less, or
   - 1.2. The net uplift value at the top of a wall does not exceed 100 plf. The net uplift value shall be determined in accordance with Section R802.11 and shall be permitted to be reduced by 60 plf (86 N/mm) for each full wall above.

R602.10.1.2.1 Braced wall panel uplift load path.

2. Where the net uplift value at the top of a wall exceeds 100 plf (146 N/mm), installing *approved* uplift framing connectors to provide a continuous load path from the top of the wall to the foundation. The net uplift value shall be as determined in Item 1.2 above.

TABLE R802.11

TABLE R802.11
REQUIRED STRENGTH OF TRUSS OR RAFTER CONNECTIONS TO RESIST WIND UPLIFT FORCES[a,b,c,e,f]
(Pounds per connection)

BASIC WIND SPEED (mph) (3-second gust)	ROOF SPAN (feet)							OVERHANGS[d] (pounds/foot)
	12	20	24	28	32	36	40	
85	-72	-120	-145	-169	-193	-217	-241	-38.55
90	-91	-151	-181	-212	-242	-272	-302	-43.22
100	-131	-218	-262	-305	-349	-393	-436	-53.36
110	-175	-292	-351	-409	-467	-526	-584	-64.56

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 mph = 0.447 m/s, 1 pound/foot = 14.5939 N/m, 1 pound = 0.454 kg.

a. The uplift connection requirements are based on a 30 foot mean roof height located in Exposure B. For Exposures C and D and for other mean roof heights, multiply the above loads by the Adjustment Coefficients in Table R301.2(3).

b. The uplift connection requirements are based on the framing being spaced 24 inches on center. Multiply by 0.67 for framing spaced 16 inches on center and multiply by 0.5 for framing spaced 12 inches on center.

c. The uplift connection requirements are based on a roof dead load of 15 psf. For roof dead loads of 10 psf, multiply the above loads by 0.82 and for roof dead loads of 20 psf, multiply the above loads by 1.18.

d. The uplift connection requirements are based on the tributary area of the overhang being equal to 2 feet multiplied by the horizontal projection of the roof framing members supporting the overhang. Where the overhang supports a roof dead load, a wall dead load or a floor dead load, the uplift connection requirements shall be determined by adding the overhang load found in the table to the uplift load found in the table for the roof framing members supporting the overhang. Where the overhang supports a roof dead load, a wall dead load or a floor dead load, the uplift connection requirements shall be determined by adding the overhang load found in the table to the uplift load found in the table for the roof framing members supporting the overhang and added to the uplift load found in the table for the roof framing members supporting the overhang projection.

e. The uplift connection requirements are based on wind loads acting on all surfaces of a building. The connection value listed is permitted to be reduced by a maximum of 20% of the value listed in the table for connections located on a discontinuous gable end that is not supported by a shear wall, shear panel or diagonal bracing. The connection value listed is permitted to be reduced by a maximum of 40% of the value listed in the table for connections located on a discontinuous gable end that is supported by a shear wall, shear panel or diagonal bracing. The connection value listed is permitted to be reduced by 0.7 and multiplied by the horizontal distance between the connection being considered and the nearest shear wall, shear panel or diagonal bracing.

f. For wall-to-wall and wall-to-foundation connections, the capacity of the uplift connector is permitted to be reduced by 100 pounds for each full wall above. (For example, if a 600-pound rated connector is used on the roof framing, a 500-pound rated connector is permitted at the next floor level down).

Uplift = 135 PLF

TABLE R602.3(1) FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

TABLE R602.3(1)—continued
FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

ITEM	DESCRIPTION OF BUILDING MATERIALS	DESCRIPTION OF FASTENER[b,c,e]	SPACING OF FASTENERS: Edges (inches)[f]	SPACING OF FASTENERS: Intermediate supports[c,e] (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing				
30	⅜" - ½"	6d common (2" × 0.113") nail (subfloor, wall) 8d common (2½" × 0.131") nail (roof)[f]	6	12[g]
31	19/32" - 1"	8d common nail (2½" × 0.131")	6	12[g]

TABLE R602.3(2)
ALTERNATE ATTACHMENTS

NOMINAL MATERIAL THICKNESS (inches)	DESCRIPTION[a,b] OF FASTENER AND LENGTH (inches)	SPACING[c] OF FASTENERS: Edges (inches)	SPACING[c] OF FASTENERS: Intermediate supports (inches)
Wood structural panels subfloor, roof and wall sheathing to framing and particleboard wall sheathing to framing[f]			
up to ½	Staple 15 ga. 1¾	4	8
	0.097 - 0.099 Nail 2¼	3	6

ICC-600

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Standard for Residential Construction in High Wind Regions

307 SPECIAL PROVISIONS FOR WOOD STRUCTURAL PANEL WALL SHEATHING OR SIDING

307.1 Wood Structural Panel Sheathing or Siding Used to Resist Both Shear and Uplift: Wood structural panel sheathing or siding shall be permitted to be used in conjunction with the WFCM to resist shear and uplift simultaneously in accordance with this Section provided the following conditions are met in those areas:

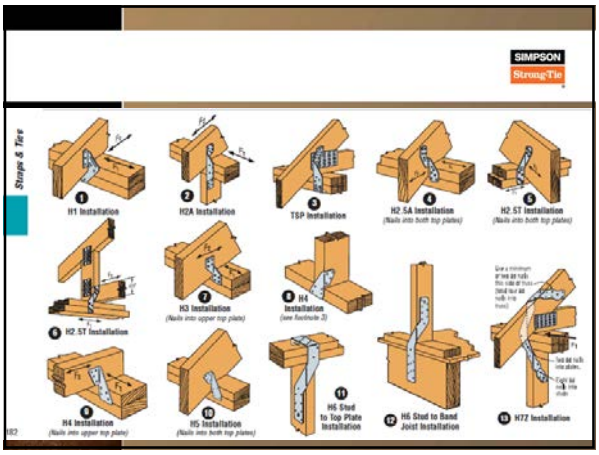
1. Anchor bolt spacing shall be 18" or less on center.
2. 3" x 3" x 0.229 steel washers shall be used at anchor bolt locations.
3. Nails in any single row shall not be spaced closer than 3" on center.

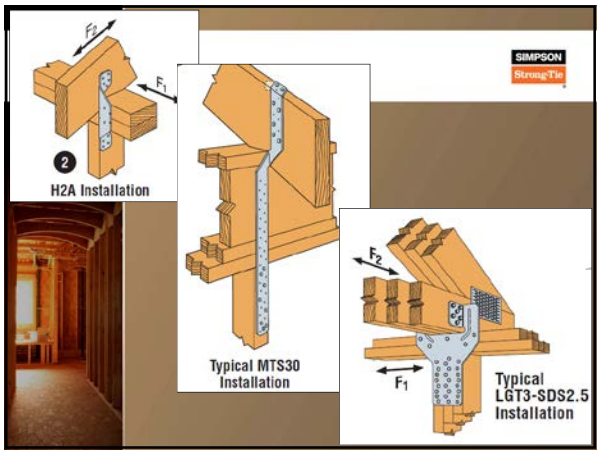
307.1.1. From Tables 3.17A through 3.17E of the WFCM, select a shearwall construction using minimum 7/16" or 15/32" Wood Structural Panel sheathing that will provide required shear capacity.
307.1.2. From Table 2.2A of the WFCM determine the uplift load based on the wind speed and roof span.
307.1.3 From Table 307S1 determine the uplift capacity of the sheathing selected in accordance with 307.1.1. based on the alternate nail spacing in the top and bottom plates.

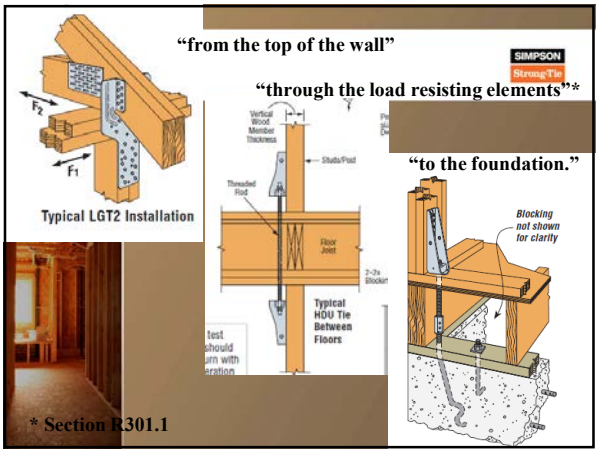
November 2006 130

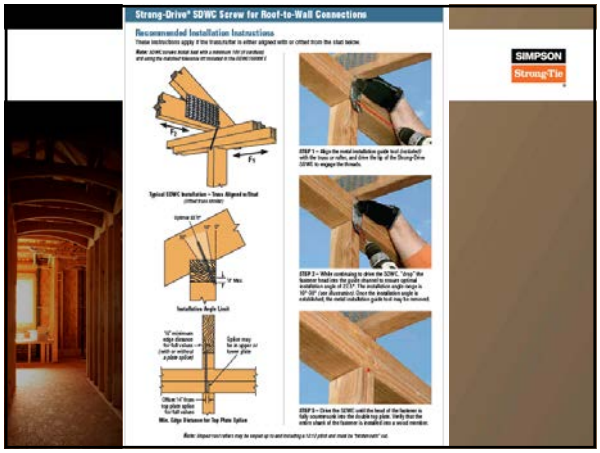
307.1.4 Multiple rows of nails applied at panel ends and edges shall be installed in accordance with Figure 307S1.
307.1.5 Panels shall be of the minimum thickness of 7/16" and be installed as follows:

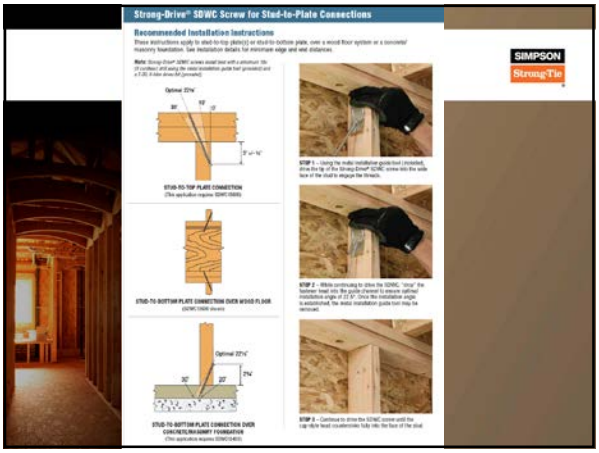
a. Panels shall be installed with strength axis parallel to studs.
b. All horizontal joints shall occur over framing and shall be attached per WFCM 3.2.
c. On single story construction, panels shall be attached to bottom plates and top member of the double top plate. Lowest plate shall be attached to foundation with minimum 5/8" bolts with minimum embedment of 7" or connectors of sufficient capacity to resist the uplift and shear forces developed in the wood structural panel sheathed or sided walls.
d. On two story construction, upper panels shall be attached to the top member of the upper double top plate and to band joist at bottom of panel. Upper attachment of lower panel shall be made to band joist and lower attachment made to lowest plate at first floor framing. Lowest plate of first floor framing shall be attached to foundation with minimum 5/8" bolts with a minimum embedment of 7" or connectors of sufficient capacity to resist the uplift and shear forces developed in the wood structural panel sheathed or sided walls.
e. Where windows and doors interrupt wood structural panel sheathing or siding, framing anchors or connectors shall be used to resist the appropriate uplift loads.









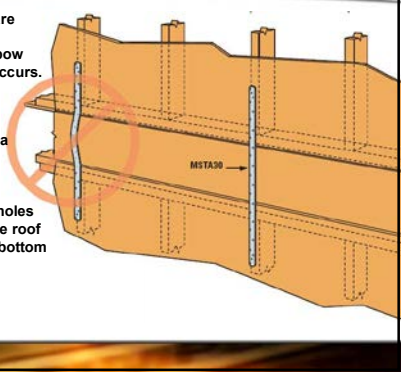


Floor-to-Floor Straps – Solution

Problem: All stud nails are filled before the roof is installed and the straps bow out when compression occurs.

Solution 1: Fill the nail holes in the rim joist area to limit the bowing.

Solution 2: Fill the nail holes to the top stud before the roof is installed and then fill bottom stud nails after.



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Floor-to-Floor Straps – Potential Problem (Bulging Siding)

Wind Uplift Resisting Systems

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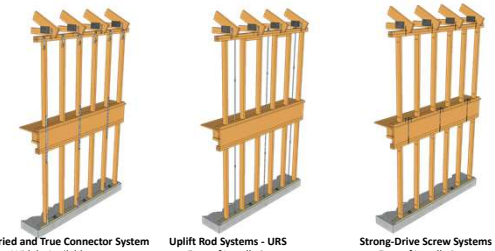

Tried and True Connector System
- Widely Available
- Cost Effective
- Most code listed products available by any mfg.

Uplift Rod Systems - URS
- Ease of Installation
- Cost Effective
- Only code evaluated system available by any mfg.

Strong-Drive Screw Systems
- Ease of Installation
- Framing flexibility
- Most Cost Effective
- Code listed

Braced Walls

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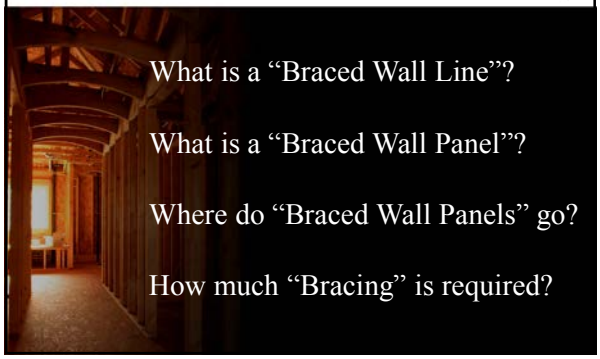


What is a "Braced Wall Line"?

What is a "Braced Wall Panel"?

Where do "Braced Wall Panels" go?

How much "Bracing" is required?

4 Easy Steps

1. Locate the Braced Wall Lines
   1. Maximum 60' O/C
   2. All Braced Wall Panels within 4' of the BWL
2. Determine minimum bracing length required for each line
   1. Determine the Bracing Method.
   2. Determine the BWL spacing
   3. Tables and adjustment factors
3. Locate the Braced Wall Panels within the line.
   1. Start within 12'-6" (total) of end of each Braced Wall Line
   2. Maximum 25' O/C
   3. Minimum Braced Wall Panel Length.
      1. Adjacent to window or door opening
      2. CS-PF, PF-HD, PF-G

4 Easy Steps

- If you do not have enough bracing available:
- **Start all over again!**
  - – Add a Braced Wall Line
  - – Use a different Bracing Method
  - – Use an engineered Solution
  - – Move, or remove windows and doors

R602.10.1 Braced wall lines.

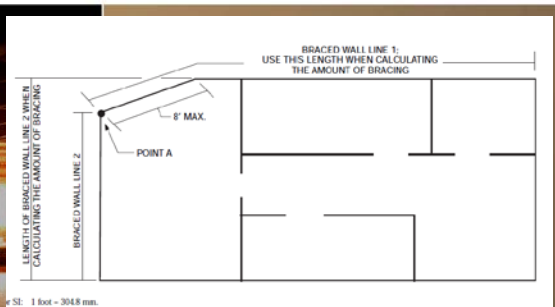


FIGURE R602.10.1.3
ANGLED CORNERS

FIGURE R602.10.1.4(3) OFFSETS PERMITTED FOR BRACED WALL LINES

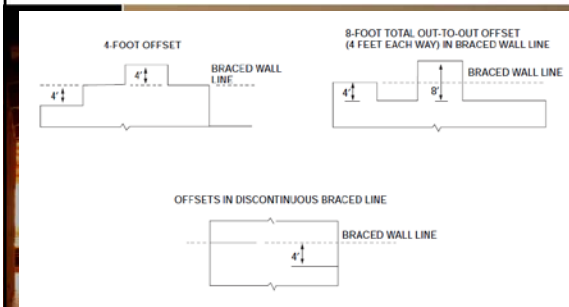


FIGURE R602.10.1.4(3)
OFFSETS PERMITTED FOR BRACED WALL LINES

FIGURE R602.10.1.4(4) BRACED WALL LINE SPACING

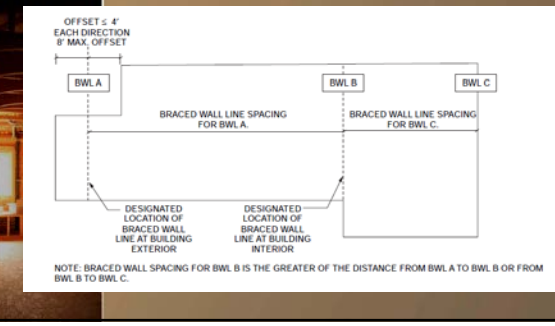
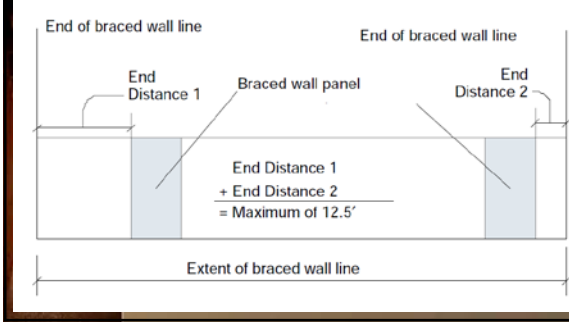


FIGURE R602.10.1.4(2) BRACED WALL PANEL END DISTANCE REQUIREMENTS (SDC A, B AND C)



R602.10.1 Braced wall lines.

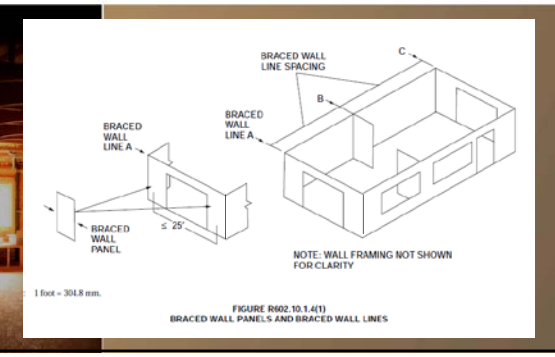


FIGURE R602.10.1.4(1)
BRACED WALL PANELS AND BRACED WALL LINES

R602.10.1.2 Length of bracing.

R602.10.1.2 Length of bracing. The length of bracing along each *braced wall line* shall be the greater of that required by the design wind speed and *braced wall line* spacing in accordance with Table R602.10.1.2(1) as adjusted by the factors in the footnotes or the Seismic Design Category and *braced wall line* length in accordance with Table R602.10.1.2(2) as adjusted by the factors in Table R602.10.1.2(3) or *braced wall panel* location requirements of Section R602.10.1.4. Only Section R602.10.1.3. In no case shall the minimum total length of bracing in a *braced wall line*, after all adjustments have been taken, be less than 48 inches (1219 mm)

TABLE R602.10.1.2(1)[a,b,c,d,e]—continued
BRACING REQUIREMENTS BASED ON WIND SPEED
(as a function of braced wall line spacing)

EXPOSURE CATEGORY B, 30 FT MEAN ROOF HEIGHT, 10 FT EAVE TO RIDGE HEIGHT, 10 FT WALL HEIGHT, 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (feet) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE			
Basic Wind Speed (mph)	Story Location	Braced wall Line Spacing (feet)	Method LIB[f, h]	Method GB (doubled sided)[g]	Method DWB, WSP, SFB, PBS, PCP, HPS[f, i]	Continuous Sheathing
≤ 100 (mph)		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.0	19.0	11.0	9.5
		60	22.5	22.5	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.0	8.0
		30	23.0	23.0	13.0	11.0
		40	29.5	29.5	17.0	14.5
		50	36.5	36.5	21.0	18.0
		60	43.5	43.5	25.0	21.0

TABLE R602.10.1.2(5)[a,b,c,d,e,k]—continued
BRACING REQUIREMENTS BASED ON WIND SPEED
(as a function of braced wall line spacing)

For SI: 1 foot = 304.8 mm, 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 pound/foot = 0.157 kN/m, 1 pound = 4.448 N.

a. Tabulated bracing lengths are based on Wind Exposure Category B, a 30-ft mean roof height, a 10-ft eave to ridge height, a 10-ft wall height, and two braced wall lines sheathing load to a given plan direction on a given story level. Methods of bracing shall be as described in Sections R602.10.2, R602.10.4 and R602.10.5. Interpolation shall be permitted.

b. For other mean roof heights and exposure categories, the required bracing length shall be multiplied by the appropriate factor from the following table:

NUMBER OF STORIES	EXPOSURE/HEIGHT FACTORS		
	Exposure B	Exposure C	Exposure D
1	1.0	1.2	1.5
2	1.0	1.3	1.6
3	1.0	1.4	1.7

c. For other roof-to-eave ridge heights, the required bracing length shall be multiplied by the appropriate factor from the following table; interpolation shall be permitted.

SUPPORT CONDITION	ROOF EAVE-TO-RIDGE HEIGHT			
	5 ft or less	10 ft	15 ft	20 ft
Roof only	0.7	1.0	1.3	1.6
Roof + floor	0.85	1.0	1.15	1.3
Roof + 2 floors	0.9	1.0	1.1	NP

d. For a maximum 9-foot wall height, multiplying the table values by 0.90 shall be permitted. For a maximum 8-foot wall height, multiplying, the table values by 0.80 shall be permitted. For a maximum 12-foot wall height, the table values shall be multiplied by 1.1.

e. For three or more braced wall lines in a given plan direction, the required bracing length on each braced wall line shall be multiplied by the appropriate factor from the following table:

NUMBER OF BRACED WALL LINES	ADJUSTMENT FACTOR
3	1.30
4	1.45
≥ 5	1.60

f. Bracing lengths are based on the application of gypsum board (or equivalent) applied to the inside face of a braced wall panel. When gypsum board finish (or equivalent) is not applied to the inside face of braced wall panels, the tabulated lengths shall be multiplied by the appropriate factor from the following table:

BRACING METHOD	ADJUSTMENT FACTOR
Method LIB	1.8
Methods DWB, WSP, SFB, PBS, PCP, HPS	1.4

g. Bracing lengths for Method GB are based on the application of gypsum board on both faces of a braced wall panel. When Method GB is provided on only one side of the wall, the required bracing amounts shall be doubled. When Method GB braced wall panels installed in accordance with Section R602.10.2 are fastened at 4 inches on center at panel edges, no bolting top and bottom plates, and are blocked at all horizontal joints, multiply tag the required bracing percentage for wind loading by 0.7 shall be permitted.

h. Method LIB bracing shall have gypsum board attached to at least one side according to the Section R602.10.2 Method GB requirements.

i. Required bracing length for Methods DWB, WSP, SFB, PBS, PCP and HPS in braced wall lines located in one-story buildings and in the top story of two or three story buildings shall be permitted to be multiplied by 0.80 when an approved hold-down device with a minimum uplift design value of 800 pounds is fastened to the

R602.10.3 Minimum length of braced panels.

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R602.10.3 Minimum length of braced panels. For Methods DWB, WSP, SFB, PBS, PCP and HPS, each *braced wall panel* shall be at least 48 inches (1219 mm) in length, cover-

Exceptions:

1. Lengths of *braced wall panels* for continuous sheathing methods shall be in accordance with Table R602.10.4.2.
2. Lengths of Method ABW panels shall be in accordance with Sections R602.10.3.2.
3. Length of Methods PFH and PFG panels shall be in accordance with Section R602.10.3.3 and R602.10.3.4 respectively.

R602.10.4 Continuous sheathing.

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R602.10.4.1 Continuous sheathing braced wall panels. Continuous sheathing methods require structural panel sheathing to be used on all sheathable surfaces on one side of a *braced wall line* including areas above and below openings and gable end walls. *Braced wall panels* shall be constructed in accordance with one of the methods listed in Table R602.10.4.1. Different bracing methods, other than those listed in Table R602.10.4.1, shall not be permitted along a *braced wall line* with continuous sheathing.

R602.10.4.1.1 Continuous portal frame.

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R602.10.4.1.1 Continuous portal frame. Continuous portal frame *braced wall panels* shall be constructed in accordance with Figure R602.10.4.1.1. The number of continuous portal frame panels in a single *braced wall line* shall not exceed four. For purposes of resisting wind pressures acting perpendicular to the wall, the requirements of Figure R602.10.4.1.1 and Table R602.10.4.1.1 shall be met. There shall be a maximum of two braced wall segments per header and header length shall not exceed 22 feet (6706 mm). Tension straps shall be installed in accordance with the manufacturer's recommendations.

FIGURE R602.10.4.2
BRACED WALL PANELS WITH CONTINUOUS SHEATHING

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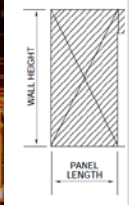


TABLE R602.10.4.2
LENGTH REQUIREMENTS FOR BRACED WALL PANELS WITH CONTINUOUS SHEATHING[a] (inches)

METHOD	ADJACENT CLEAR OPENING HEIGHT (inches)	WALL HEIGHT (feet)				
		8	9	10	11	12
CS-WSP	64	24	27	30	33	36
	68	26	27	30	—	—
	72	28	27	30	—	—
	76	29	30	30	—	—
	80	31	33	30	—	—
	84	33	36	33	—	—
	88	39	39	36	—	—
	92	44	42	39	—	—
	96	48	45	42	—	—
	100	—	48	45	—	—
	104	—	51	48	—	—
	108	—	54	51	—	—
	112	—	—	54	44	—
	116	—	—	57	—	—
	120	—	—	60	—	—
	122	—	—	—	—	48
	132	—	—	—	66	—
	144	—	—	—	—	75
CS-G	≤ 120	24	27	30	—	—
CS-PF	≤ 120	16	18	20	—	—

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

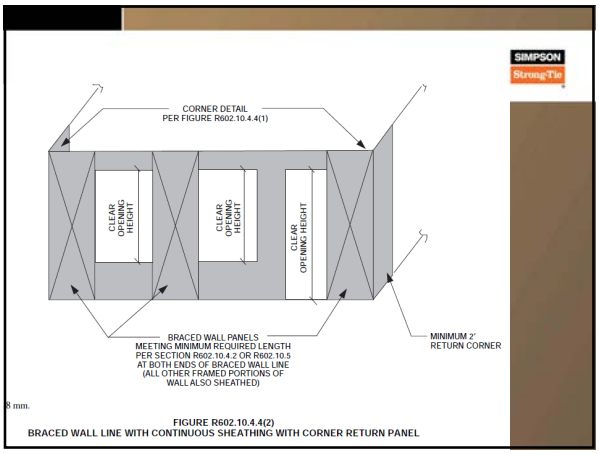


FIGURE R602.10.4.4(2)
BRACED WALL LINE WITH CONTINUOUS SHEATHING WITH CORNER RETURN PANEL

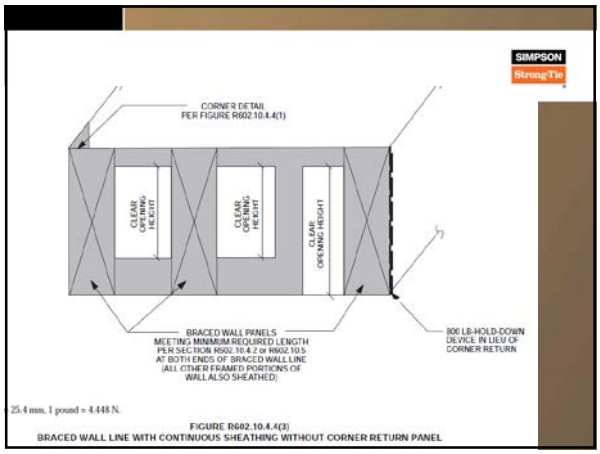


FIGURE R602.10.4.4(3)
BRACED WALL LINE WITH CONTINUOUS SHEATHING WITHOUT CORNER RETURN PANEL

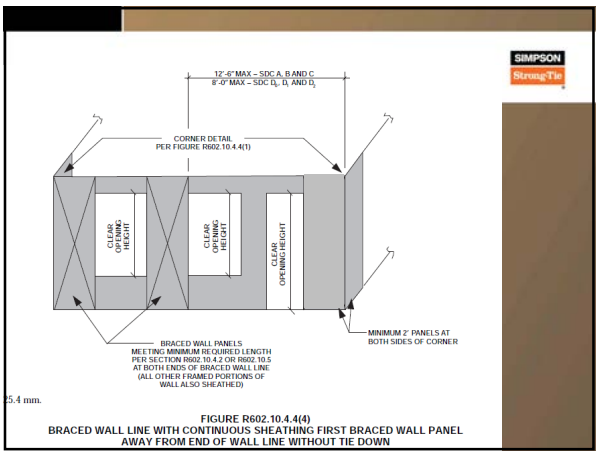


FIGURE R602.10.4.4(4)
BRACED WALL LINE WITH CONTINUOUS SHEATHING FIRST BRACED WALL PANEL AWAY FROM END OF WALL LINE WITHOUT TIE DOWN

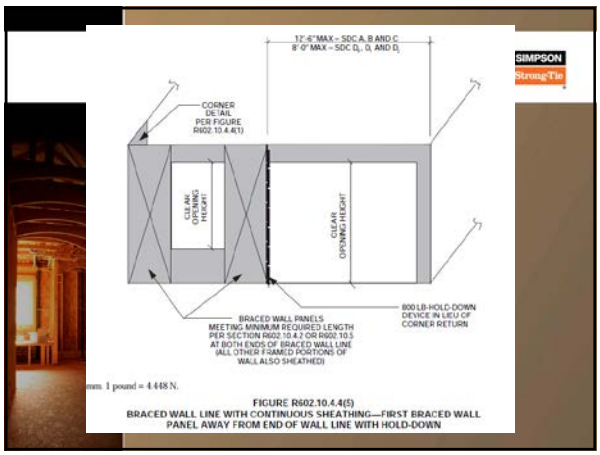


FIGURE R602.10.4.4(5)
BRACED WALL LINE WITH CONTINUOUS SHEATHING—FIRST BRACED WALL PANEL AWAY FROM END OF WALL LINE WITH HOLD-DOWN

TABLE R602.10.4.1
CONTINUOUS SHEATHING METHODS

SIMPSON StrongTie

METHOD	MATERIAL	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA
CS-WSP	Wood structural panel	3/8"		6d common (2" × 0.113") nails at 6" spacing (panel edges) and at 12" spacing (intermediate supports) or 16 ga. × 1 1/2" staples at 3" spacing (panel edges) and 6" spacing (intermediate supports)
CS-G	Wood structural panel adjacent to garage openings and supporting roof load only[a,b]	3/8"		See Method CS-WSP
CS-PF	Continuous portal frame	See Section R602.10.4.1.1		See Section R602.10.4.1.1

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 47.89 lb.
a. Applies to one wall of a garage only.
b. Roof covering dead loads shall be 3 psf or less.

FIGURE R602.10.4.4(1)
TYPICAL EXTERIOR CORNER FRAMING FOR CONTINUOUS SHEATHING

SIMPSON StrongTie

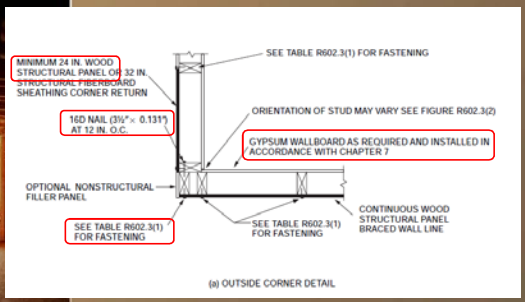


FIGURE R602.10.4.4(1)
TYPICAL EXTERIOR CORNER FRAMING FOR CONTINUOUS SHEATHING

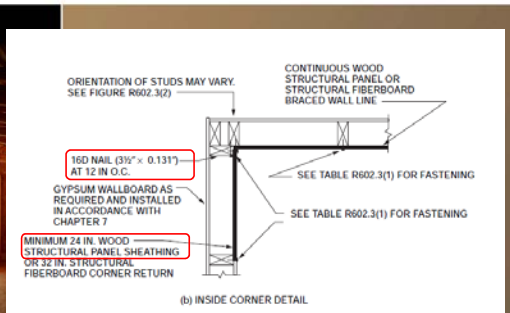
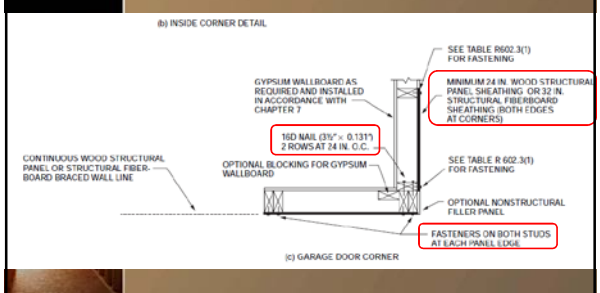


FIGURE R602.10.4.4(1)
TYPICAL EXTERIOR CORNER FRAMING FOR CONTINUOUS SHEATHING



Prescriptive Wall Bracing Methods – Narrow Alternatives
Continuous Sheathing for a Portal Frame – CS-PF

Similar to International Residential Code® -'06, R602.10.6.2-Alternate BWP Method
Table R602.10.2 Intermittent Bracing Methods (Method – CS-PF, R602.10.4.1.1)-'09;

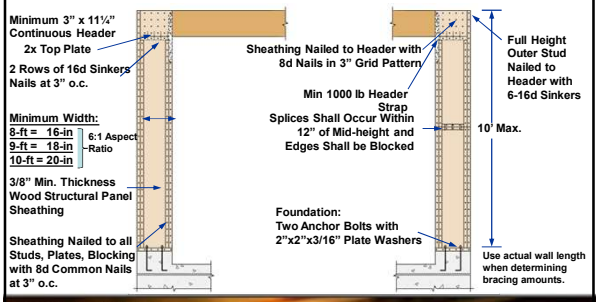
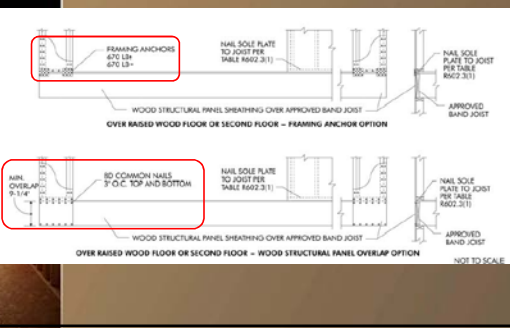


TABLE R602.10.4.1.1
TENSION STRAP CAPACITY REQUIRED FOR RESISTING WIND PRESSURES PERPENDICULAR TO 6:1 ASPECT RATIO WALLS[a,b]

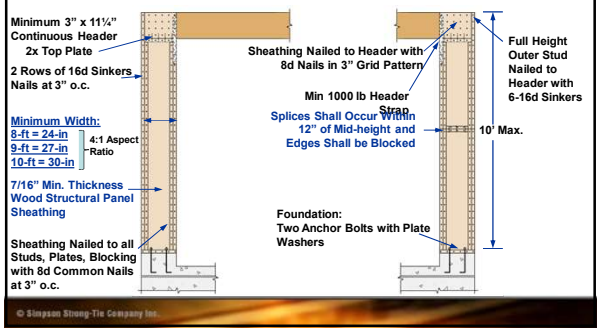
MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM P/WF WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (Feet)	BASIC WIND SPEED (mph) 85 Exposure B	90 Exposure B	100 Exposure B	85 Exposure C	90 Exposure C	100 Exposure C
				Tension strap capacity required (lbs)[a,c]					
2×4 No. 2 Grade	0	10	18	1000	1000	1000	1000	1000	1000
	1	10	9	1000	1000	1000	1000	1000	1275
			16	1000	1000	1750	1800	2325	3500
			18	1000	1200	2100	2175	2725	DR
	2	10	9	1000	1000	1925	1975	1550	2500
			16	1525	2025	3125	3200	3900	DR
			18	1875	2400	3575	3700	DR	DR
	2	12	9	1000	1200	2075	2125	2750	4000
			16	2600	3200	DR	DR	DR	DR
			18	3175	3850	DR	DR	DR	DR
	4	12	9	1775	2350	3500	3550	DR	DR
			16	4175	DR	DR	DR	DR	DR
2×6 Stud Grade	2	12	9	1000	1000	1325	1375	1750	2550
			16	1650	2050	2905	3000	3550	DR
			18	2025	2450	3425	3500	4100	DR
	4	12	9	1125	1500	2225	2275	2775	3800
			16	2650	3150	DR	DR	DR	DR
			18	3125	3675	DR	DR	DR	DR

FIGURE R602.10.4.1.1
METHOD CS-PF: CONTINUOUS PORTAL FRAME PANEL CONSTRUCTION



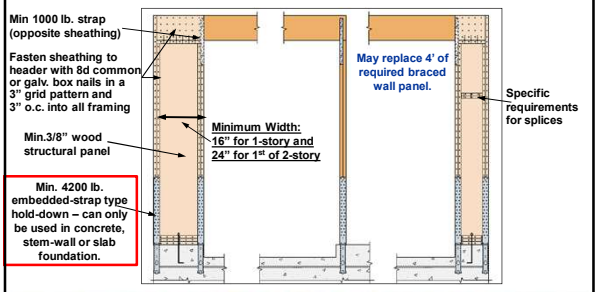
Prescriptive Wall Bracing Methods – Narrow Alternatives
Portal Frame at the Garage - PFG

Table R602.10.2 Intermittent Bracing Methods (Method – PFG, R602.10.3.4)-'09;



Prescriptive Wall Bracing Methods – Narrow Alternatives Portal Frame with Hold-Downs – PFH

Figure R602.10.6.2 similar (minor differences)/2308.9.3.2 – (2006-2009),
Table R602.10.2 Intermittent Bracing Methods (Method – PFH, R602.10.3.3) (2009);



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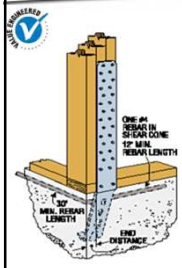
Overturning-Holdowns – Cast-in Place (STHD)



- Built in tab
  - Allows proper distance from form board
  - Keeps the hook from slipping, reduces spalling
- Countersunk nail holes
  - Less reveal
- Holes in the embedded area
  - Allows for more concrete cover
- Wider strap and staggered nail hole pattern
  - Allows proper nailing to double 2x's
- The curl on the sides of the hook makes the hook more rigid
  - Strap yields for the bend at the proper place
  - Reduces spalling at the top of the concrete
- The STHD14 meets the code requirement of a 4,200 lbs. embedded strap tie-down device.

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R602.10.6 Braced wall panel connections.

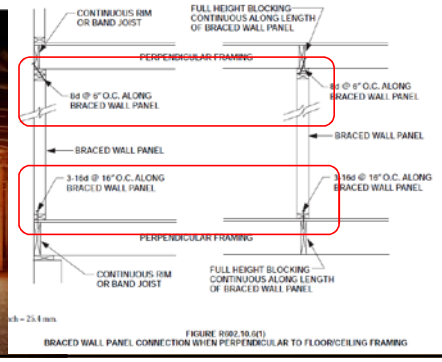


FIGURE R602.10.6(1)
BRACED WALL PANEL CONNECTION WHEN PERPENDICULAR TO FLOOR/CEILING FRAMING

R602.10.6 Braced wall panel connections.

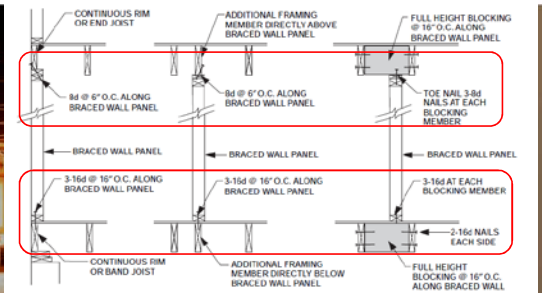
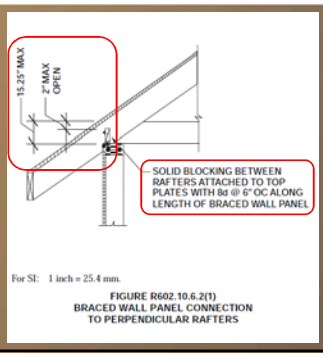


FIGURE R602.10.6(2)
BRACED WALL PANEL CONNECTION WHEN PARALLEL TO FLOOR/CEILING FRAMING

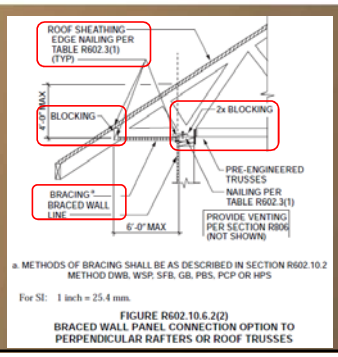
R602.10.6.2 Connections to roof framing.



For SI: 1 inch = 25.4 mm.

FIGURE R602.10.6.2(1)
BRACED WALL PANEL CONNECTION TO PERPENDICULAR RAFTERS

R602.10.6.2 Connections to roof framing.



a. METHODS OF BRACING SHALL BE AS DESCRIBED IN SECTION R602.10.2 METHOD DWB, WSP, SFB, GB, PBS, PCP OR HPS

For SI: 1 inch = 25.4 mm.

FIGURE R602.10.6.2(2)
BRACED WALL PANEL CONNECTION OPTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES

R602.10.6.2 Connections to roof framing.

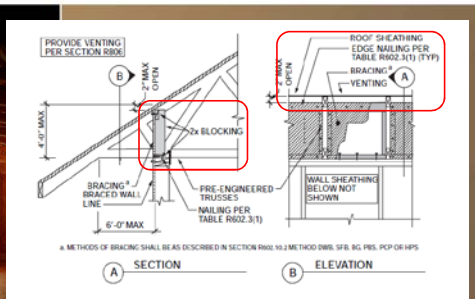


FIGURE R602.10.6.2(3)
BRACED WALL PANEL CONNECTION OPTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES

R602.10.8 Panel joints.

R602.10.8 Panel joints. All vertical joints of panel sheathing shall occur over, and be fastened to common studs. Horizontal joints in *braced wall panels* shall occur over, and be fastened to common blocking of a minimum $1^1/_2$ inch (38

Exceptions:

1. Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels*.
2. Where the bracing length provided is at least twice the minimum length required by Tables R602.10.1.2(1) and R602.10.1.2(2) blocking at horizontal joints shall not be required in *braced wall panels* constructed using Methods WSP, SFB, GB, PBS or HPS.

TECHNICAL BULLETIN

Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®

Table 1: Holdowns Attaching to Anchor Bolt

Holdown	Anchor Bolt Diameter (in.)	Min Wood Member Thickness[2] (in.)	Allowable Tension (lbs.) DF/SP	Allowable Tension (lbs.) SPF/HF
DTT2Z	½	1.5	1825	1890
DTT2Z-SDS2.5	½	3	2145	2195
HDU2-SDS2.5	⅝	3	3075	2215
HTT4	¾	3	3610	3105
HTT5	⅞	3	4360	3740
HDU4-SDS2.5	⅞	3	4565	3285
HDU5-SDS2.5	1	3	5545	4065

1. Allowable loads have been increased for wind or earthquake load durations with no further increase allowed.
2. Designer must specify anchor bolt type, length, and embedment. Refer to our *Wood Construction Connectors Catalog* for Simpson Strong-Tie SB, SSTB, and PAB anchor bolt options.
3. Post may consist of multiple members provided they are connected independently of the holdown fasteners.

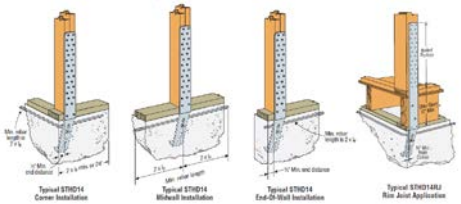
TECHNICAL BULLETIN

Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®

Table 2: Embedded Strap-Style Holdowns

Holdown	Min Wood Member Thickness[2] (in.)	Tension (lbs.) (DF/SP/SPF/HF)[3,4,5] Midwall/Corner	Endwall
LSTHD8/LSTHD8RJ	3.5	2700	2230
STHD10/STHD10RJ	3.5	4120	3145
STHD14/STHD14RJ	3.5	5345	4210

1. Allowable loads have been increased for wind or earthquake with no further increase allowed.
2. Post may consist of multiple members provided they are connected independently of the holdown fasteners.
3. Tension values apply to uncracked concrete in wind and low-seismic regions (any structure in seismic design categories A and B and detached one- and two-family dwellings in seismic design category C). For allowable load information for other applications, refer to current *Wood Construction Connectors* catalog.
4. Tension values apply to minimum concrete strength, f'c of 2500 psi, and minimum stemwall width of 8". For values with minimum stemwall width of 6" refer to current *Wood Construction Connectors* catalog.
5. Refer to the current *Wood Construction Connectors* catalog for installation requirements.



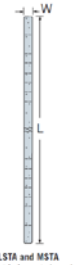
TECHNICAL BULLETIN

Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®

Table 3: Straight Straps

Strap	Fasteners (Total)	Dimensions (in.) W	Dimensions (in.) L	Capacity (lbs.) (DF/SP/SPF/HF)
LSTA21	(16) 10d	1 ¼	21	1235
LSTA30	(22) 10d	1 ¼	30	1540
MSTA30	(22) 10d	1 ¼	30	1820
(2) LSTA30[3]	(44) 10d	1 ¼	30	3280
(2) MSTA30[3]	(44) 10d	1 ¼	30	3640

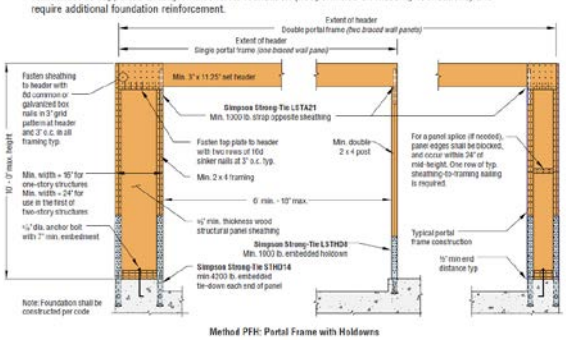
1. Allowable loads have been increased for wind or earthquake load durations with no further increase allowed.
2. Double jack stud required; one strap installed per stud.
3. Use half the nails in each member being connected to achieve the listed loads.
4. 10dx1½" nails may be substituted where 10d are specified at 100% of the table loads except where installed over sheathing.



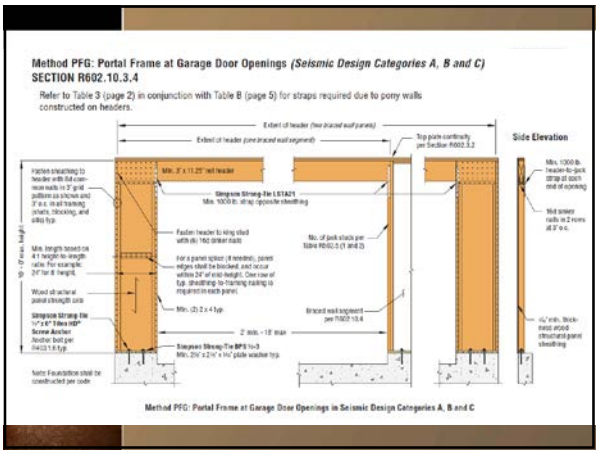
LSTA and MSTA
(Pilot holes not shown)

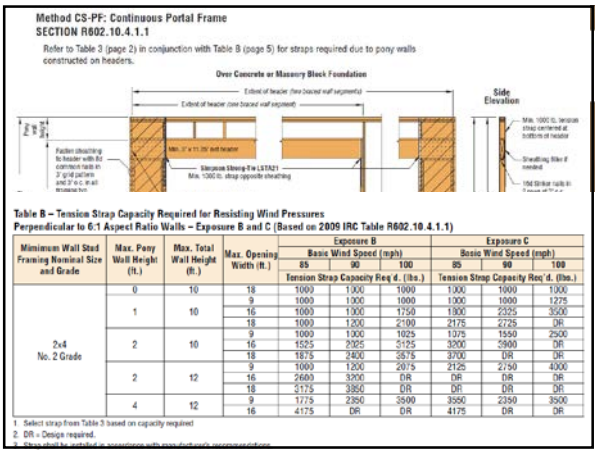
Method PFH: Portal Frame with Holdowns SECTION R602.10.3.3

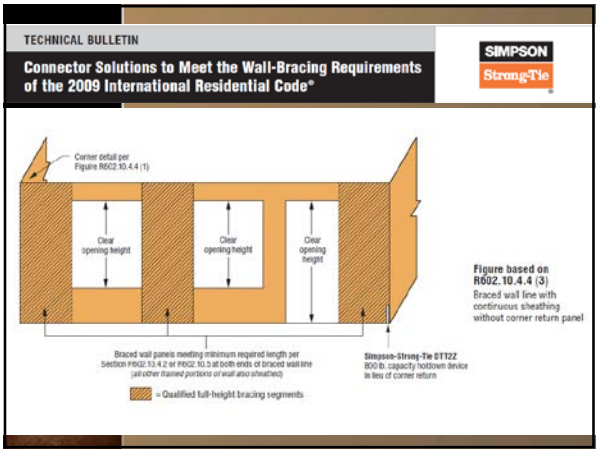
Walls must be supported directly on a concrete foundation *(not permitted on masonry foundations)* and require additional foundation reinforcement.

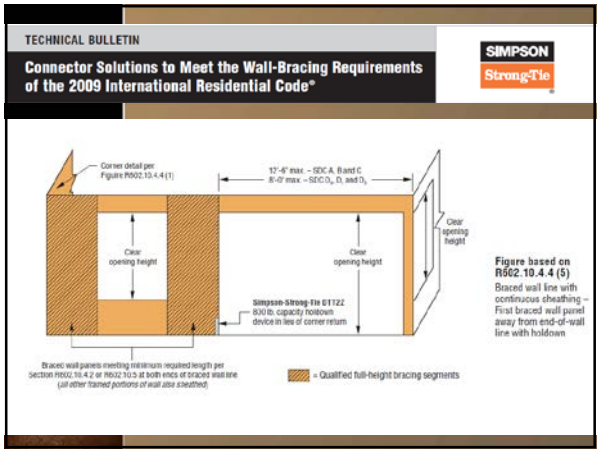


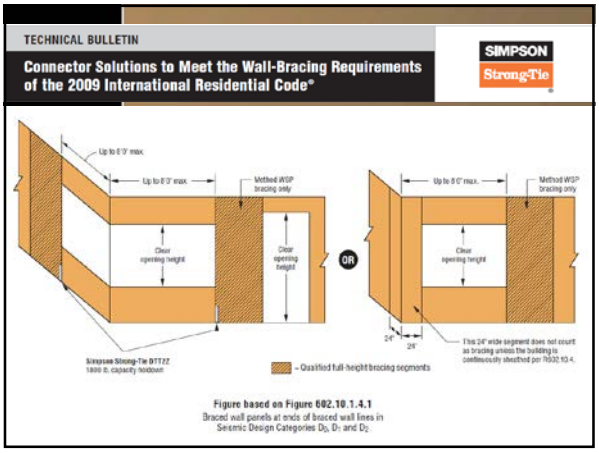
Method PFH: Portal Frame with Holdowns

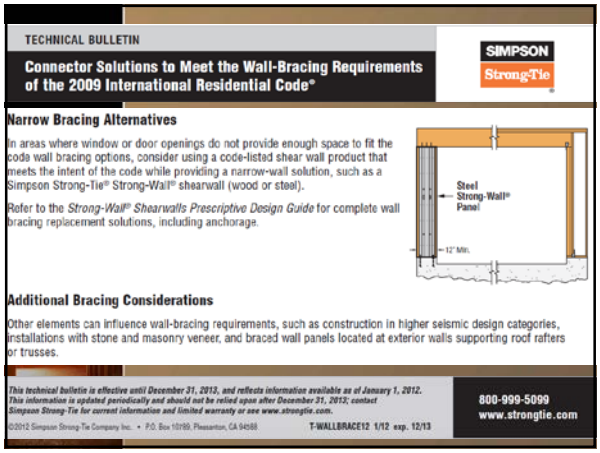

Method PFG: Portal Frame at Garage Door Openings (Seismic Design Categories A, B and C)
SECTION R602.10.3.4
Refer to Table 3 (page 2) in conjunction with Table B (page 5) for straps required due to pony walls constructed on headers.
Side Elevation
Method PFG: Portal Frame at Garage Door Openings in Seismic Design Categories A, B and C


Method CS-PF: Continuous Portal Frame
SECTION R602.10.4.1.1
Refer to Table 3 (page 2) in conjunction with Table B (page 5) for straps required due to pony walls constructed on headers.
Over Concrete or Masonry Block Foundation
Side Elevation
Table B – Tension Strap Capacity Required for Resisting Wind Pressures
Perpendicular to 6:1 Aspect Ratio Walls – Exposure B and C (Based on 2009 IRC Table R602.10.4.1.1)
Minimum Wall Stud Framing Nominal Size and Grade
Max. Pony Wall Height (ft.)
Max. Total Wall Height (ft.)
Max. Opening Width (ft.)
Exposure B
Exposure C
Basic Wind Speed (mph)
85
90
100
Tension Strap Capacity Req'd. (lbs.)
2x4 No. 2 Grade
1. Select strap from Table 3 based on capacity required
2. DR = Design required.


TECHNICAL BULLETIN
Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®
SIMPSON Strong-Tie
Corner detail per Figure R602.10.4.4 (1)
Clear opening height
Figure based on R602.10.4.4 (3)
Braced wall line with continuous sheathing without corner return panel
Braced wall panels meeting minimum required length per Section R602.10.4.2 or R602.10.5 at both ends of braced wall line (all other framed portions of wall also sheathed)
Simpson Strong-Tie DTT2Z 800 lb. capacity holdown device in lieu of corner return
= Qualified full-height bracing segments


TECHNICAL BULLETIN
Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®
SIMPSON Strong-Tie
Corner detail per Figure R602.10.4.4 (1)
12'-6" max. – SDC A, Band C
8'-0" max. – SDC D0, D1 and D2
Clear opening height
Simpson Strong-Tie DTT2Z 800 lb. capacity holdown device in lieu of corner return
Figure based on R602.10.4.4 (5)
Braced wall line with continuous sheathing – First braced wall panel away from end-of-wall line with holdown
Braced wall panels meeting minimum required length per Section R602.10.4.2 or R602.10.5 at both ends of braced wall line (all other framed portions of wall also sheathed)
= Qualified full-height bracing segments


TECHNICAL BULLETIN
Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®
SIMPSON Strong-Tie
Up to 8'-0" max.
Method WSP bracing only
Clear opening height
OR
Simpson Strong-Tie DTT2Z 1800 lb. capacity holdown
= Qualified full-height bracing segments
Figure based on Figure R602.10.1.4.1
Braced wall panels at ends of braced wall lines in Seismic Design Categories D0, D1 and D2


TECHNICAL BULLETIN
Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®
SIMPSON Strong-Tie
Narrow Bracing Alternatives
In areas where window or door openings do not provide enough space to fit the code wall bracing options, consider using a code-listed shear wall product that meets the intent of the code while providing a narrow-wall solution, such as a Simpson Strong-Tie® Strong-Wall® shearwall (wood or steel).
Refer to the Strong-Wall® Shearwalls Prescriptive Design Guide for complete wall bracing replacement solutions, including anchorage.
Steel Strong-Wall® Panel
12" Min.
Additional Bracing Considerations
Other elements can influence wall-bracing requirements, such as construction in higher seismic design categories, installations with stone and masonry veneer, and braced wall panels located at exterior walls supporting roof rafters or trusses.
This technical bulletin is effective until December 31, 2013, and reflects information available as of January 1, 2012. This information is updated periodically and should not be relied upon after December 31, 2013; contact Simpson Strong-Tie for current information and limited warranty or see www.strongtie.com.
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TECHNICAL BULLETIN

Connector Solutions to Meet the Wall-Bracing Requirements of the 2009 International Residential Code®

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Continuous Narrow Braced Wall Panel Methods

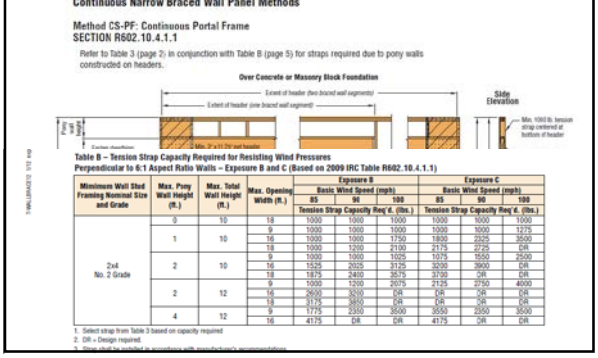
Method CS-PF: Continuous Portal Frame
SECTION R602.10.4.1.1

Refer to Table 3 (page 2) in conjunction with Table B (page 5) for straps required due to pony walls constructed on headers.

Table B – Tension Strap Capacity Required for Resisting Wind Pressures Perpendicular to 6:1 Aspect Ratio Walls – Exposure B and C (Based on 2009 IRC Table R602.10.4.1.1)

Minimum Wall Stud Framing Nominal Size and Grade	Max. Pony Wall Height (ft.)	Max. Total Wall Height (ft.)	Max. Opening Width (ft.)	Exposure B Basic Wind Speed (mph) 85	90	100	Exposure C Basic Wind Speed (mph) 85	90	100
				Tension Strap Capacity Req'd. (lbs.)			Tension Strap Capacity Req'd. (lbs.)		
2x4 No. 2 Grade	0	10	18	1000	1000	1000	1000	1000	1000
	1	10	9	1000	1000	1000	1000	1000	1275
			16	1000	1000	1750	1800	2325	3500
	2	10	18	1000	1200	2100	2175	2725	DR
			9	1000	1000	1025	1075	1550	2500
			16	1525	2025	3125	3200	3900	DR
	2	12	18	1875	2400	3575	3700	DR	DR
			9	1000	1200	2075	2125	2750	4000
			16	2600	3200	DR	DR	DR	DR
	4	12	18	3175	3850	DR	DR	DR	DR
			9	1775	2350	3500	3550	2350	3500
			16	4175	DR	DR	4175	DR	DR

1. Select strap from Table 3 based on capacity required
2. DR = Design required.
3. Straps shall be installed in accordance with manufacturer's recommendations.



R104.11 Alternative materials, design and methods of construction

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- The code is not intended to prohibit any method of construction
- Alternatives shall be approved where the Building Official finds:
  - The proposed design complies with the intent of the code
  - Is at least equivalent to the code

R106.1.2 Manufacturer's instructions

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- Manufacturer's installation instructions, as required by this code, shall be available on the job site at the time of inspection.

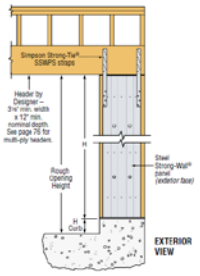
Shear Walls – Overturning

What other options do you have when you have limited space for site built shearwalls due to large openings from garage fronts, great rooms, morning rooms, conservatories, large entry ways, walls with large or numerous windows or tuck-under parking applications?

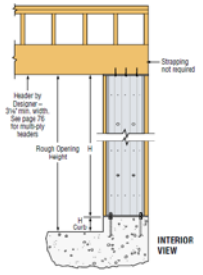
Steel Strong-Wall®: Garage-Front Application

SIMPSON Strong-Tie

STEEL STRONG-WALL® – GARAGE PORTAL
See pages 76-77 for installation information.



STEEL STRONG-WALL® – GARAGE FRONT (NON PORTAL)
See pages 76-77 for installation information.



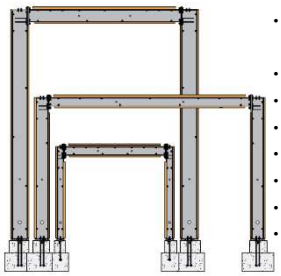
STEEL STRONG-WALL® PORTAL MODELS

STEEL STRONG-WALL® STANDARD MODELS

Shear Walls – Overturning
Strong-Frame™ Ordinary Moment Frame

SIMPSON Strong-Tie

Use when Strong-Wall panels do not work because SW panels are too wide, don't provide enough capacity or result in anchor tension loads that are too high.



- Pre-designed moment frame solutions
  - Sizes up to 16' wide and 19' tall
- 100% bolted connections
- Pre-installed wood nailers
- Frames fit in a standard 2x6 wall
- Pre-drilled holes for utilities
- Greater quality control
- Convenient to store, ship and handle
- Strong-Frame Selector software

© Simpson Strong-Tie Company Inc.

Introduction to the Strong-Frame Ordinary Moment Frame

SIMPSON Strong-Tie

WALL-BRACING REPLACEMENTS FOR JOBSITE CATEGORY

Wind

Wall Selection and Anchorage Classification:

GARAGE-FRONT APPLICATIONS (7' to 8' Tall)

Wind

Equivalent Wall-Bracing Length (ft)	Wall Model	Single-Story Application – Base Material Under Wall: Concrete	Single-Story Application – Base Material Under Wall: CMU	1st Story of 2- or 3-Story Application – Base Material Under Wall: Concrete	1st Story of 2- or 3-Story Application – Base Material Under Wall: CMU
6	SSW12x7 w/SSWP-KT	C	NS	NS	NS
	SSW15x7 w/SSWP-KT	B	C	D	NS
	SSW18x7 w/SSWP-KT	B	B	C	NS
	SSW12x8 w/SSWP-KT	C	NS	NS	NS
	SSW15x8 w/SSWP-KT	C	C	D	NS
	SSW18x8 w/SSWP-KT	B	B	D	NS
	SSW12x7	D	NS	NS	NS
	SSW15x7	C	C	D	NS
	SSW18x7	B	B	D	NS
	SSW21x7	B	B	C	C
	SSW12x8	D	NS	NS	NS
	SSW15x8	C	NS	NS	NS
	SSW18x8	B	C	D	NS
	SSW21x8	B	B	D	D
	SSW24x8	B	B	C	C
	SW16x7x4	B	B	D	NS
	SW16x7x6	B	B	D	NS
	SW22x7x4	A	A	B	NS
	SW22x7x6	A	A	B	B
	SW16x8x4	C	C	D	NS
	SW16x8x6	C	C	D	NS

ANCHORAGE SOLUTIONS FOR

Concrete Stemwall *(Anchorage into Wall)* – Garage Front

SIMPSON Strong-Tie

STEEL STRONG-WALL®: 15" AND WIDER MODELS (1" DIAMETER ANCHOR)

Minimum Concrete Strength, f'_c (psi)	Anchorage Classification	Cast-in-Place Anchor: Anchor Bolt Type	Stemwall Width, W (in)	Minimum Stemwall Length, L (in)	Minimum Embedment Depth, d_a (in)	Post-Installed Anchor (Adhesive): Minimum Stemwall Length, L (in)	Embedment Depth, d_a (in) – Garage Front Installation: SET-XP™/SET	AT
2500	A	SSWAB1	8	18	12	24	12	12
		SB1x30	8	36	24			
	B	SSWAB1	8	36	24	24	16	16
		SB1x30	8	36	24			
	C	SSWAB1	8	46	31	24	20	20
		SB1x30	8	36	24			
3000	A	SSWAB1	8	15	10	24	12	12
		SB1x30	8	36	24			
	B	SSWAB1	8	33	22	24	16	16
		SB1x30	8	36	24			
	C	SSWAB1	8	45	30	24	20	20
		SB1x30	8	36	24			
3500	A	SSWAB1	8	9	6	24	12	12
		SB1x30	8	36	24			
	B	SSWAB1	8	27	18	24	12	16
		SB1x30	8	36	24			
	C	SSWAB1	8	42	28	24	20	20
		SB1x30	8	36	24			

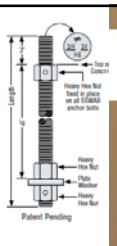
STEEL STRONG-WALL® – SSWAB ANCHOR BOLTS

SSWAB anchor bolts in ¾" and 1" diameters offer flexibility to meet specific project demands. Inspection is easy; the head is stamped with a "No Equal" symbol for identification, bolt length, bolt diameter, and optional "HS" for High Strength if specified.

MATERIAL: ASTM F1554 Grade 36; High Strength (HS) ASTM A449

FINISH: None. May be ordered hot-dip galvanized; contact Simpson Strong-Tie.

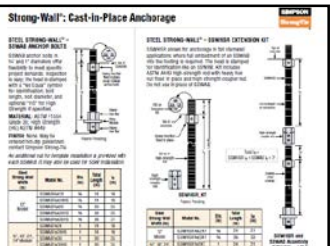
An additional nut for template installation is provided with each SSWAB. It may also be used for SSW installation.

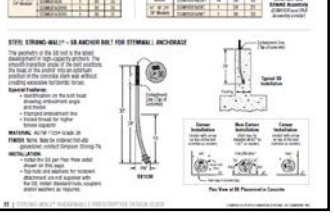


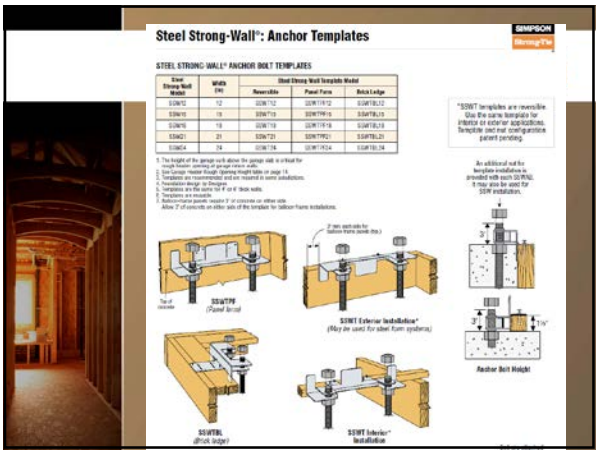
Steel Strong-Wall Width (in)	Model No.	Dia. (in)	Total Length (in)	l_e (in)
12" Model	SSWAB¾x24	¾	24	19
	SSWAB¾x24HS	¾	24	19
	SSWAB¾x30	¾	30	25
	SSWAB¾x30HS	¾	30	25
	SSWAB¾x36HS	¾	36	31
15", 18", 21", 24" Models	SSWAB1x24	1	24	19
	SSWAB1x24HS	1	24	19
	SSWAB1x30	1	30	25
	SSWAB1x30HS	1	30	25
	SSWAB1x36HS	1	36	31

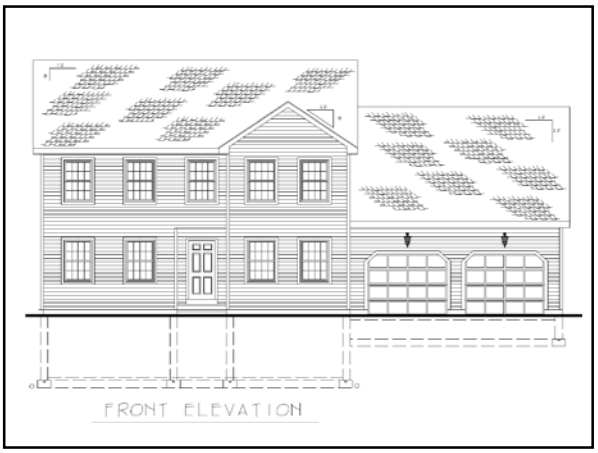
Strong-Wall®: Cast-in-Place Anchorage

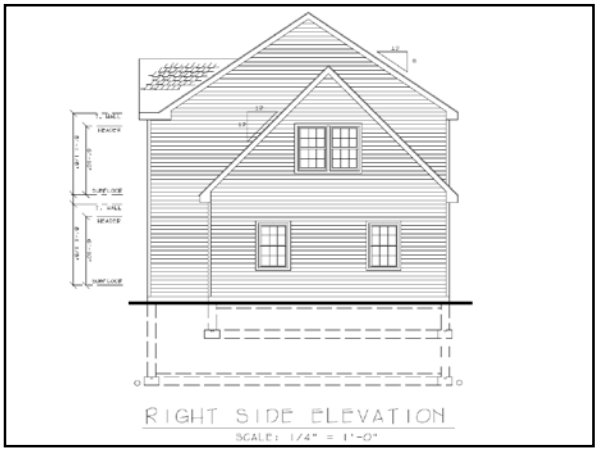
SIMPSON Strong-Tie

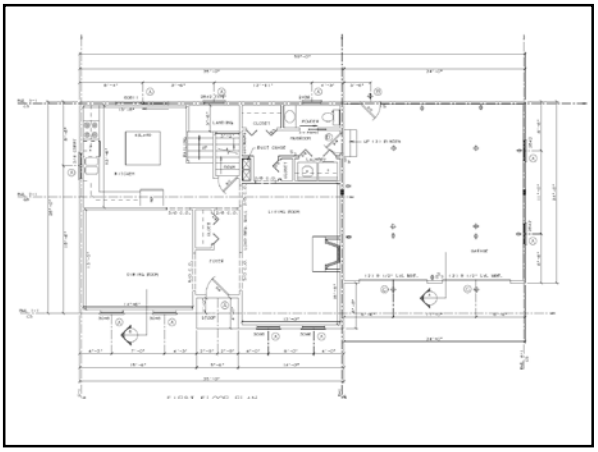












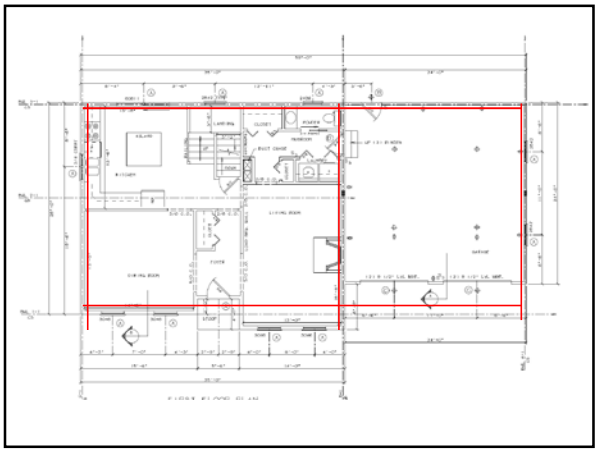


TABLE R602.10.1.2(1)[a, b, c, d, e]
BRACING REQUIREMENTS BASED ON WIND SPEED
(as a function of braced wall line spacing)

SIMPSON Strong-Tie

EXPOSURE CATEGORY B, 30 FT MEAN ROOF HEIGHT, 10 FT EAVE TO RIDGE HEIGHT, 10 FT WALL HEIGHT, 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (feet) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE			
Basic Wind Speed (mph)	Story Location	Braced wall Line Spacing (feet)	Method LIB[f, h]	Method GB (doubled sided)[g]	Method DWB, WSP, SFB, PBS, PCP, HPS[f, i]	Continuous Sheathing
≤ 100 (mph)		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.0	19.0	11.0	9.5
		60	22.5	22.5	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.0	8.0
		30	23.0	23.0	13.0	11.0
		40	29.5	29.5	17.0	14.5
		50	36.5	36.5	21.0	18.0
		60	43.5	43.5	25.0	21.0

TABLE R602.10.1.2(1)[a, b, c, d, e]—continued
BRACING REQUIREMENTS BASED ON WIND SPEED
(as a function of braced wall line spacing)

SIMPSON StrongTie

For SI: 1 foot = 304.8 mm, 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 pound force = 4.448 N.

a. Tabulated bracing lengths are based on Wind Exposure Category B, a 30-ft mean roof height, a 10-ft eave to ridge height, a 10-ft wall height, and two braced wall lines sharing load in a given plan direction on a given story level. Methods of bracing shall be as described in Sections R602.10.2, R602.10.4 and R602.10.5. Interpolation shall be permitted.

NUMBER OF STORIES	EXPOSURE/HEIGHT FACTORS		
	Exposure B	Exposure C	Exposure D
1	1.0	1.2	1.5
2	1.0	1.2	1.5

c. For other roof to eave ridge heights, the required bracing length shall be multiplied by the appropriate factor from the following table: interpolation shall be permitted.

SUPPORT CONDITION	ROOF EAVE-TO-RIDGE HEIGHT			
	5 ft or less	10 ft	15 ft	20 ft
Roof only	0.7	1.0	1.3	1.6
Roof + floor	0.85	1.0	1.15	1.3
Roof + 2 floors	0.9	1.0	1.1	NP

d. For a maximum 9-foot wall height, multiplying the table values by 0.95 shall be permitted. For a maximum 8-foot wall height, multiplying the table values by 0.90 shall be permitted. For a maximum 12-foot wall height, the table values shall be multiplied by 1.1.

e. For three or more braced wall lines in a given plan direction, the required bracing length on each braced wall line shall be multiplied by the appropriate factor from the following table:

NUMBER OF BRACED WALL LINES	ADJUSTMENT FACTOR
3	1.30
4	1.45
≥ 5	1.60

TABLE R602.10.4.2
LENGTH REQUIREMENTS FOR BRACED WALL PANELS WITH CONTINUOUS SHEATHING[a] (inches)

METHOD	ADJACENT CLEAR OPENING HEIGHT (inches)	WALL HEIGHT (foot)				
		8	9	10	11	12
CS-WSP	64	24	27	30	33	36
	68	26	27	30	—	—
	72	28	27	30	—	—
	76	29	30	30	—	—
	80	31	33	30	—	—
	84	35	36	33	—	—
	88	39	39	36	—	—
	92	44	42	39	—	—
	96	48	45	42	—	—
	100	—	48	45	—	—
	104	—	51	48	—	—
	108	—	54	51	—	—
	112	—	—	54	44	—
	116	—	—	57	—	—
	120	—	—	60	—	—
	122	—	—	—	—	48
	132	—	—	—	66	—
	144	—	—	—	—	75
CS-G	≤ 120	24	27	30	—	—
CS-PF	≤ 120	16	18	20	—	—

Wall Bracing Schedule

Wind Speed	Braced Wall Line #	Braced Wall Line Spacing	Method	Minimum Length Req'd. T602.10.1.2(1)	Adjustment Factors				Adjusted Minimum Length	Bracing Length Provided	800# Hold Down Y/N	Blocking Needed Y/N
					b. Exposure	c. Ridge Height	d. Wall Height	e. number of BWL's				
100	1	16.58'	CS	6.803 LF	(B)1	(15') 1.15	(9') .95	(3) 1.3	9.66 LF	14'-11"	Y, 1	Y
	2	36.33'	CS	13.2155 LF	"	"	"	"	18.77 LF	29'-7"	N	Y
	3	36.33'	CS	13.2155 LF	"	"	"	"	18.77 LF	21'-3"	Y, 1	Y
	A*	21.42'	WSP	9.568 LF	"	"	(10') 1	(4) 1.45	15.95 LF	0'		
	B	23.08'	CS	8.924 LF	"	"	(9') .95	"	14.14 LF	17 LF	N	Y
	C	23.08'	WSP	10.232 LF	"	"	"	"	16.21 LF	16'-7"	Y, 1,800#	Y
	D	13.5'	CS	5.725 LF	"	"	"	"	9.07 LF	12'-7"	N	Y

*BWL "A" does not meet the minimum requirements to satisfy any of the code prescribed methods, including the "Portal Frame" methods. This wall must use an engineered solution. This can be a system analyzed and designed by an engineer for this specific building on this specific address, or a pre-manufactured shear wall system that meets or exceeds the requirements.

———————— = Braced Wall Line #

////////////////////////// = Braced Wall Panel Location

* = 800# or 1,800# Hold Down Device

Did we cover all these points?

- Building code requirements for wall bracing.
- Their differences from, and similarities to previous codes.
- Sections of code that pertain to building in New England.
- "Continuous load path" provisions of the code directly related to the wall bracing section.
- Common problem areas, such as framing sides of the garage door opening, walls with multiple windows, and two story walls.
- "Engineered solutions" or what to do when your plan falls outside of the *prescriptive* code.
- Software available to help determine the minimum wall bracing length requirements.

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Wall Bracing
Thank You