

WALL BRACING UPDATE

Duane Hubeler
UDC Consultant

Department of Safety & Professional Services

Just when you had wall bracing
under control



Since the first addition of the UDC became effective June 1, 1980, the UDC has required walls to resist a lateral wind load of 20 pounds per square foot of external wall area.

Through availability of engineered wood products came options that were never available, yet sheathing surface area percentage has decreased rapidly.



Everyone Temporarily Braces During Construction To Avoid Wind Issues

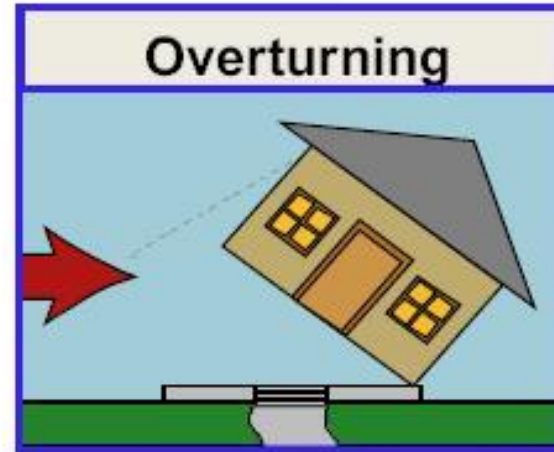
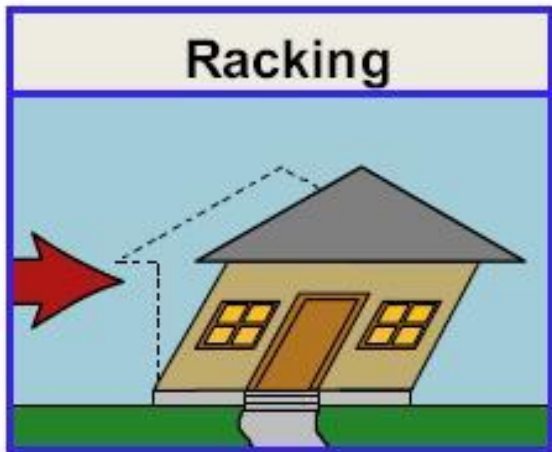
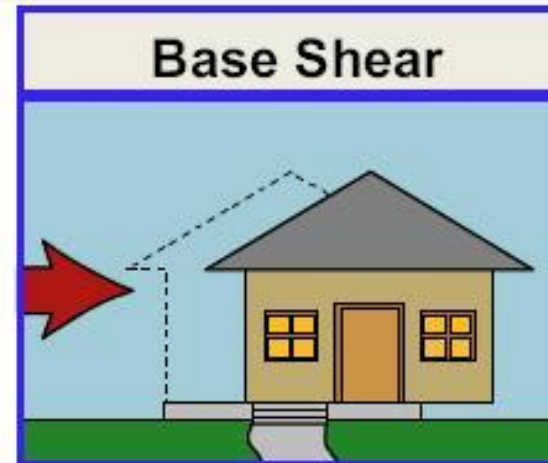
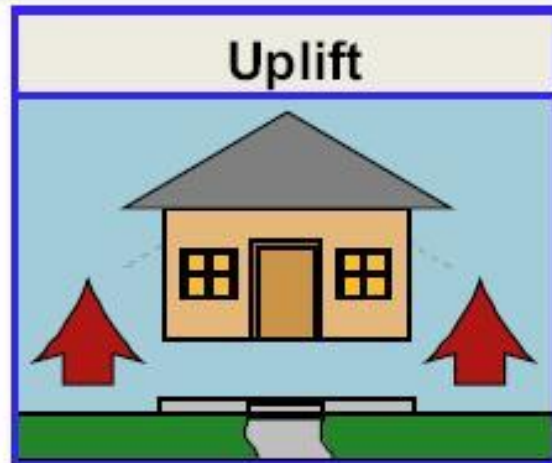


What are the most common wind related structural failures?





General Modes of Failure



Plan Requirements

5) REQUIRED PLANS. The required building plans shall be legible and drawn to scale or dimensioned and shall include all of the following:

(a) *Site plan*. The site plan shall show all of the following:

1. The location of the dwelling and any other buildings, wells, surface waters and dispersal systems on the site with respect to property lines and surface waters adjacent to the site.
2. The areas of land-disturbing construction activity and the location of all erosion and sediment control measures to be employed in order to comply with s. SPS 321.125.
3. The pre-construction ground surface slope and direction of runoff flow within the proposed areas of land disturbance.

(b) *Floor plan*. 1. Floor plans shall be provided for each floor.

2. The following features shall be included on all floor plans:

- a. The size and location of all rooms, doors, windows, structural features, exit passageways and stairs.
- b. The use of each room.
- c. The location of plumbing fixtures, chimneys, heating and cooling appliances, and a heating distribution layout.

d. The location and construction details of wall bracing on each building side and floor level.

(c) *Elevations*. The elevations shall show all of the following:

1. The exterior appearance of the building, including the type of exterior materials.
2. The location, size and configuration of doors, windows, roof, chimneys, exterior grade, footings and foundation walls.

(d) *Storm water management plan*. 1. A storm water management plan shall be prepared for a site where one acre or more of land will be disturbed.

Change in Permanent Rule

- ▣ SPS 320.09 (5) (b) 2. d. The location and
- ▣ construction details of the
- ▣ wall bracing on each building side and floor
- ▣ level.

Permanent Rule Change

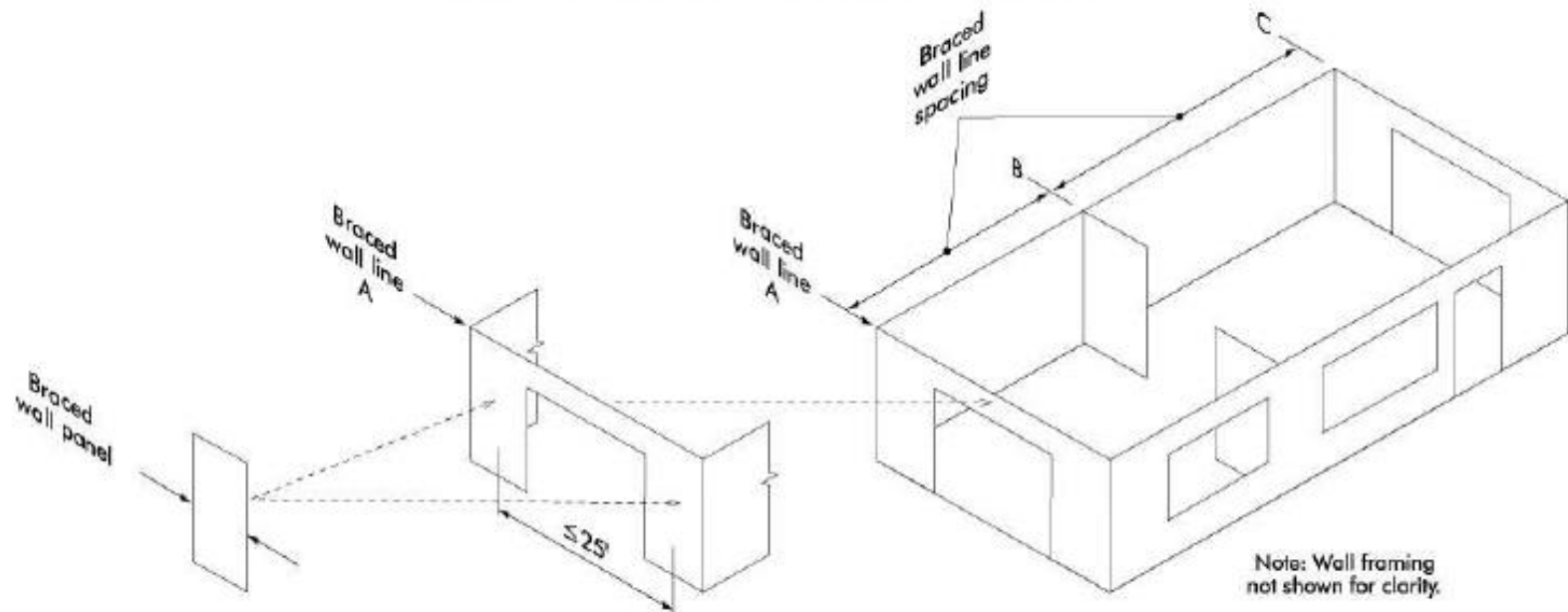
- ▣ Q & A Table 321.25-A The new stud height and spacing table doesn't appear to meet industry standards for deflection limits for some interior and exterior finishes, doors and windows, etc. is this a problem?
- ▣ Yes, while the Table may be used as written in the emergency rules it is advisable to consider the impacts on product warranties, serviceability, durability, etc. which may be impacted by excessive deflection beyond industry standards. The Table has been revised in the permanent rule package.

Change in Permanent Rule

- **Changes to 2X4 Row go away**
- Unless supported by structural analysis, use of stud heights that range from over 10 feet to 12 feet is limited to where all of the following conditions are met: snow loads do not exceed 25 psf; tributary dimensions for floors and roofs do not exceed 6 feet; spans for floors and roofs do not exceed 12 feet; eave projections do not exceed 2 feet; the bending modulus of elasticity is at least 1,600,000 lbf per square inch; the allowable fiber stress in bending for the wood is not less than 1310 psi as determined by multiplying the AF&PA NDS tabular base design value by the repetitive use factor, and by the size factor for all species except southern pine; utility, standard, stud, and No. 3 grade lumber of any species is not used; and the allowable deflection does not exceed whichever of the following are applicable:
 - Interior walls and partitions – span height/180.
 - Exterior walls with plaster or stucco finish – span height/360.
 - Exterior walls with other brittle finishes – span height/240.
 - Exterior walls with flexible finishes – span height/120.
 - Exterior walls with interior gypsum wallboard finish – span height/180.
 - Any manufacturer-specified limits for any included windows or doors.

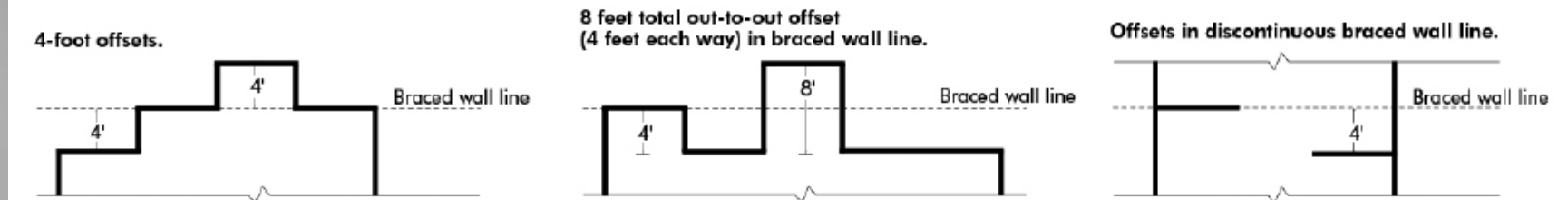
Existing Method for defining braced walls

FIGURE 321.25-A
BRACED WALL PANELS AND BRACED WALL LINES

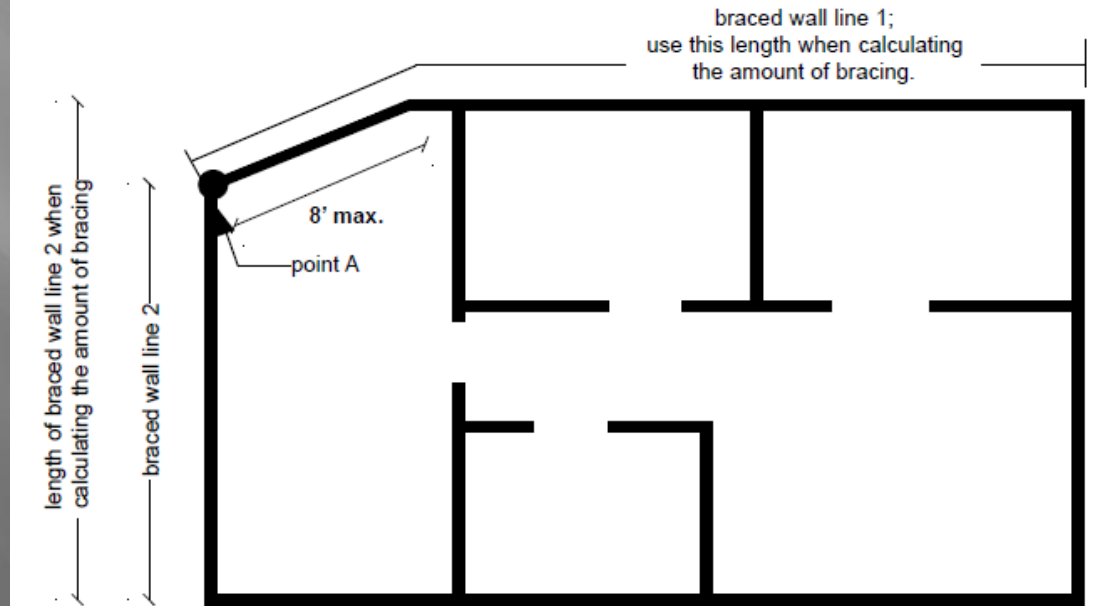


Existing offsets or projections were limited

**FIGURE 321.25-C
PERMITTED OFFSETS**



**FIGURE 321.25-D
ANGLED CORNERS**

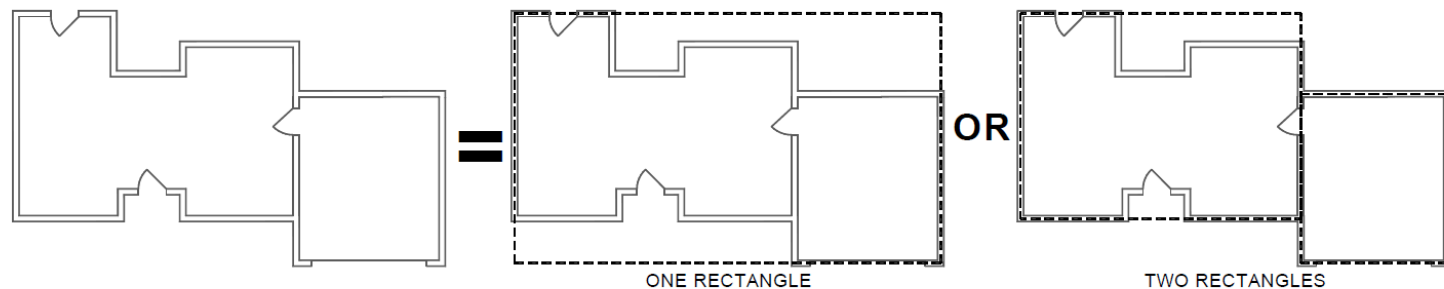


New defined Building Sides

Includes options for walls longer than the 35' length for Panels or 50' for Continuously Sheathed

Figure 321.25-B

Defining Building Sides and Lengths with a Circumscribed Rectangle^{a,b,c}

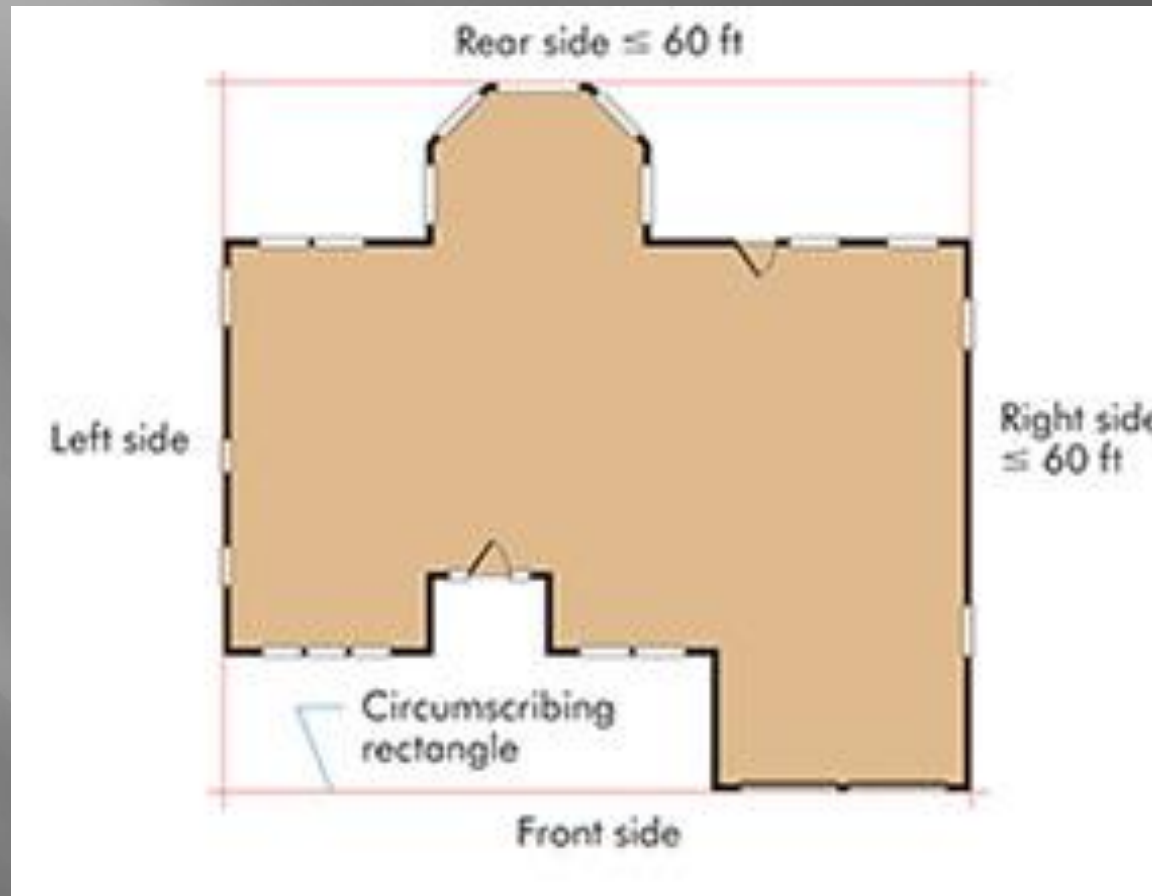


^aEach floor plan level shall be circumscribed with one or more rectangles around the entire floor plan at the floor level under consideration as shown. When multiple rectangles are used, each side shall be braced as though it were a separate building and the bracing amount added together along the common wall where adjacent rectangles overlap.

^bRectangles shall surround all enclosed plan offsets and projections. Chimneys, partial height projections, and open structures, such as carports and decks, shall be excluded from the rectangle.

^cEach rectangle shall have a maximum rectangle length-to-width ratio of 3:1.

Added Design Flexibility



▣ Go to Pages 7 & 8 in the Permanent Rule Draft

Old Panel Placement Rules

FIGURE 321.25-B
PERMITTED BRACED WALL PANEL DISTANCES
FROM ENDS OF A BRACED WALL LINE

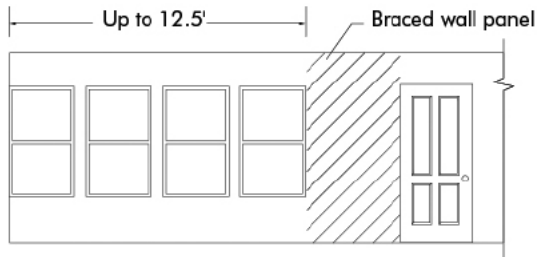


Figure 321.25-H
CONTINUOUSLY-SHEATHED BRACED WALL LINE WITHOUT CORNER RETURN

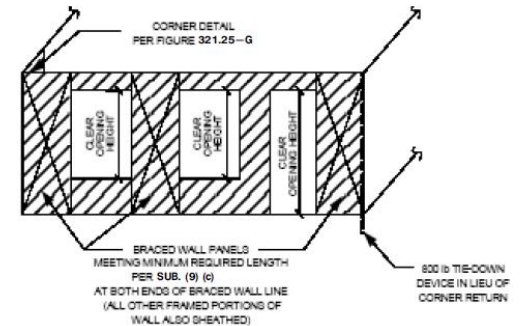


FIGURE 321.25-I
CONTINUOUSLY SHEATHED BRACED WALL LINE — FIRST
BRACED WALL PANEL AWAY FROM END OF WALL LINE WITHOUT TIE DOWN

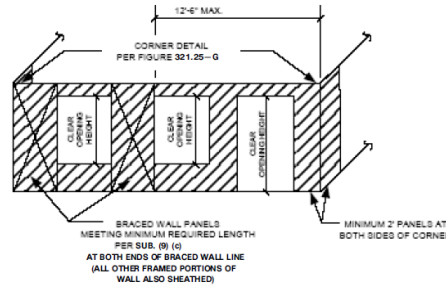


FIGURE 321.25-F
CONTINUOUSLY-SHEATHED BRACED WALL LINE

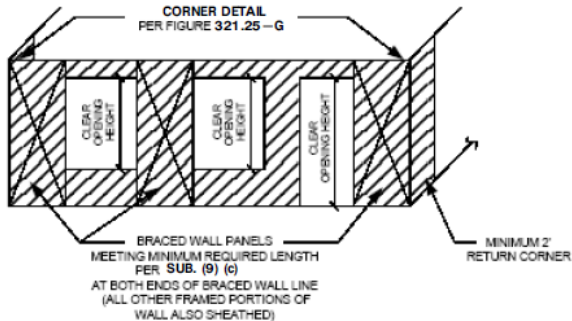
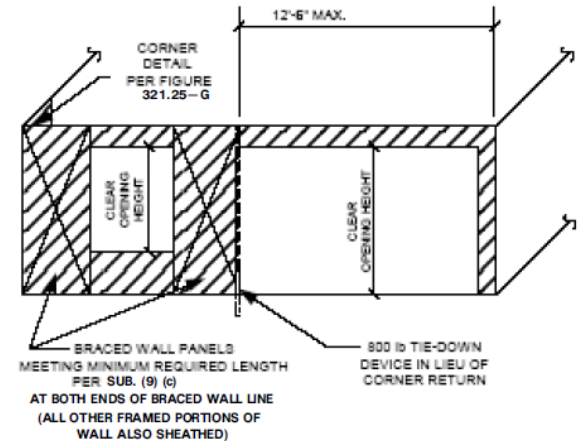
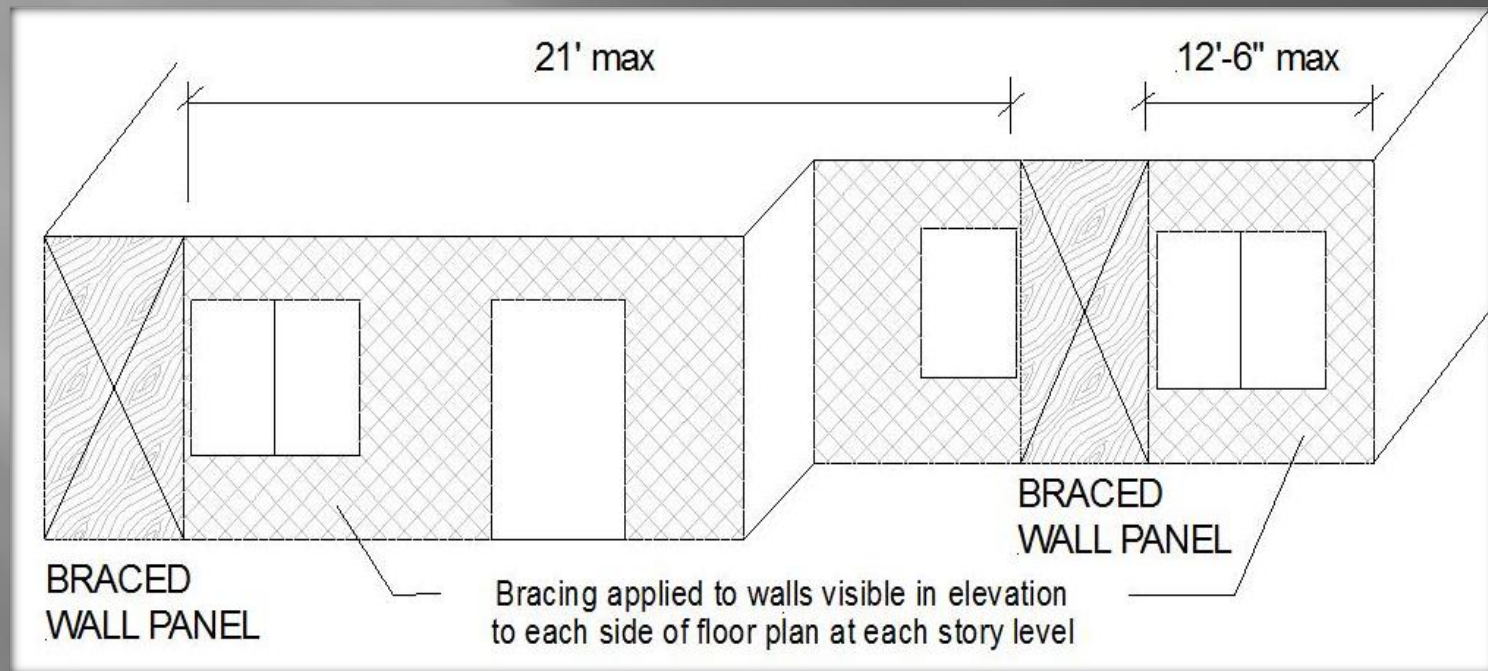


FIGURE 321.25-J
CONTINUOUSLY SHEATHED BRACED WALL LINE — FIRST BRACED
WALL PANEL AWAY FROM END OF WALL LINE WITH TIE DOWN



New flexibility w/out returns

FIGURE 321.25-C
LOCATION OF BRACED WALL PANELS ALONG A BUILDING SIDE^a



^aContinuous sheathing shall be applied to all surfaces of the wall, including areas between brace panels and above and below wall openings.

New Fastener Table



Bracing installed in a saw kerf

Table 321.25-G BRACING METHODS^a

| Method | Minimum Brace Material Thickness or Size | Maximum Nominal Wall Height ^b | Minimum Braced Wall Panel Width or Brace Angle | Connection Criteria | |
|--|--|--|--|---|---|
| | | | | Minimum Fasteners | Maximum Spacing |
| Intermittent Bracing Methods | | | | | |
| LIB ^c Let-in bracing | 1x4 wood brace (or approved metal brace installed per manufacturer instructions) | 10' | 45° angle and maximum 16" o.c. stud spacing ^b | 2-8d common nails or 3-8d box nails (2-1/2" long x 0.113" diameter) | Per stud and top and bottom plates ^e |
| DWB Diagonal wood boards | 3/4" (1" nominal) for maximum 24" o.c. stud spacing | 10' | 48" | 2-8d box nails (2-1/2" long x 0.113" diameter) or 2 - 1-3/4" long 16 gage staples | Per stud and top and bottom plates ^e |
| WSP Wood structural panel | 3/8" for maximum 16" o.c. stud spacing; 7/16" for maximum 24" o.c. stud spacing | 10' | 48" | 6d common nail or 8d box nail (2-1/2" long x 0.113" diameter) or 7/16" crown 16 gage staples, 1-1/4" long | 6" edges, 12" field (nails) 3" edges, 6" field (staples) |
| SFB Structural fiberboard sheathing | 1/2" for maximum 16" o.c. stud spacing | 10' | 48" | 1-1/2" long x 0.120" diameter galvanized roofing nails or 1" crown 16 gage staples, 1-1/4" long | 3" edges, 6" field |
| GB Gypsum board (installed on both sides of wall) | 1/2" for maximum 24" o.c. stud spacing | 10' | 96" | 5d cooler nails, or #6 screws | 7" edges, 7" field (including top and bottom plates) |
| PCP Portland cement plaster | 3/4" for maximum 16" o.c. stud spacing | 10' | 48" | 1-1/2" long, 11 gage, 7/16" diameter head nails or 7/8" long, 16 gage staples | 6" o.c. on all framing members |
| Continuous Sheathed Bracing Methods | | | | | |
| CS-WSP ^d Continuous sheathed WSP | 3/8" for maximum 16" o.c. stud spacing; 7/16" for maximum 24" o.c. stud spacing | 12' | Refer to Table 321.25-H | Same as WSP | Same as WSP |
| CS-SFB ^d Continuous sheathed SFB | 1/2" for maximum 16" o.c. stud spacing | | | Same as SFB | Same as SFB |
| Narrow Panel Bracing | | | | | |
| PF Portal frame | 7/16" | 12' | Refer to Figure 321.25-A | Refer to Figure 321.25-A | Refer to Figure 321.25-A |

^aThe interior side of all exterior walls shall be sheathed minimum 1/2" gypsum wall board. All edges of panel-type wall bracing, except horizontal joints in GB bracing, shall be attached to framing or blocking.

^bThe actual measured wall height shall include stud height and thickness of top and bottom plates. The actual wall height shall be permitted to exceed the listed nominal values by not more than 4 inches. Tabulated bracing amounts in s. SPS 321.25 (8) (c) are based on a 10-foot nominal wall height for all bracing methods and shall be permitted to be adjusted to other nominal wall heights not exceeding 12 feet in accordance with footnotes to Table 321.25-I or Table 321.25-J.

^cMethod LIB may not be permitted for walls supporting a roof and two floors. Two LIB braces installed at a 60° angle from horizontal shall be permitted to be substituted for each 45° angle LIB brace.

^dBracing methods CS-WSP and CS-SFB shall have sheathing installed on all sheathable surfaces above, below, and between wall openings.

^eShall be attached to the top and bottom plates and any intermediate studs, in one continuous length.

Exception to 12 foot wall height

- ▣ 6. Balloon-frame walls may be no longer than 21 feet and shall have a maximum height of two floors unless constructed in accordance with an approved design. Wall framing shall be continuous from the lowest floor to the wall top plate at the roof. All edges of sheathing shall be supported on and fastened to blocking or framing. Braced wall panels may not be required on the balloon-frame wall portion provided the bracing amount and brace spacing requirement are satisfied for the building side. Where brace panels are located on the balloon-frame wall portion, they shall have a height-to-width ratio of not more than 2.5:1.

Exception to 12 foot wall height

- ▣ 7. For a gable end wall, if the brace-panel height does not exceed 12 feet at the highest portion and if the 12½-foot and 21-foot spacing requirements in Figure 321.25–C are met, the wall is adequately braced. Where a brace panel exceeds 12 feet in height, it shall have a height-to-width ratio of not more than 2.5:1, and comply with Figure 21.25–C.

Algebra 101

Ratio of 2.5:1

- ▣ For 14' high: $14/2.5 = x/1$
- ▣ Divide both sides
- ▣ $X = 5.6$ feet - round up to 6 feet

- ▣ So a 14 ' high gable end brace panel must be 6 feet wide. (18' = 7.2')

Existing Continuously Sheathed table in %'s

Calculator needed in apron for changes on site

Table 321.25-J

LENGTH REQUIREMENTS FOR BRACED WALL PANELS IN A CONTINUOUSLY SHEATHED WALL¹

| Minimum Length of Braced Wall Panel (inches) | | | Maximum Opening Clear Height Next to the Braced Wall Panel (% of wall height) | Braced Wall Panel Height to Width Ratio |
|--|-------------|--------------|---|---|
| 8-foot wall | 9-foot wall | 10-foot wall | | |
| 48 | 54 | 60 | 100% | 2:1 |
| 32 | 36 | 40 | 85% | 3:1 |
| 24 | 27 | 30 | 67% | 4:1 ² |

¹Interpolation is permitted.

²For a garage supporting a roof only, a 4:1 aspect ratio is permitted for full-height sheathed wall segments on either side of the garage openings.

New easy to read table incorporates percentages

The actual measured wall height shall include stud height and thickness of top and bottom plates. The actual wall height shall be permitted to exceed the listed nominal values by not more than 4.5 inches.

Table 321.25-H
MINIMUM WIDTHS OF METHOD CS-WSP AND CS-SFB BRACED WALL PANELS

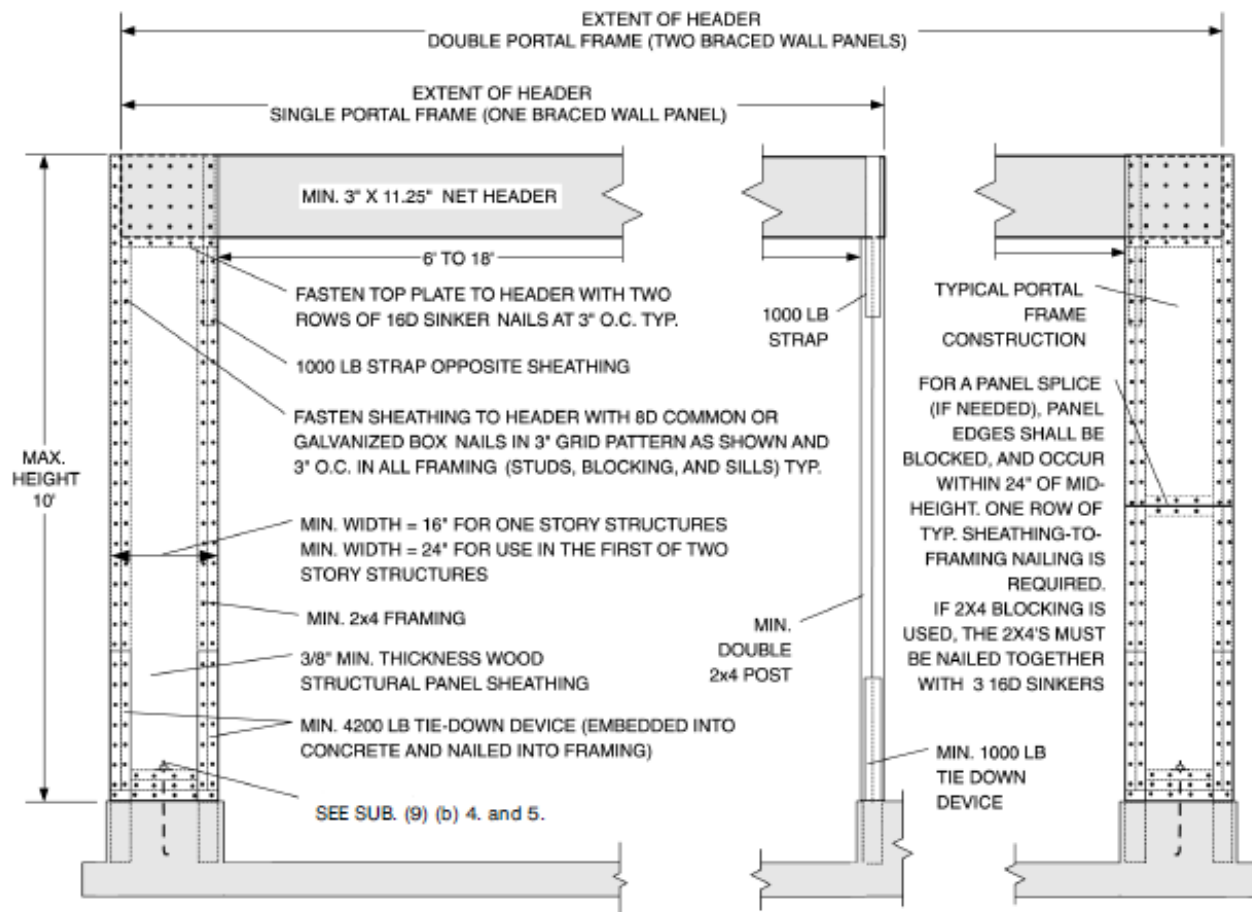
| Maximum Opening Height Adjacent to Braced Wall Panel | Minimum Length of Braced Wall Panel (inches) | | | |
|---|---|---------------------|----------------------|----------------------|
| | 8' tall wall | 9' tall wall | 10' tall wall | 12' tall wall |
| Up to 5' – 4" | 24 | 27 | 30 | 36 |
| Up to 6' – 8" | 32 | 30 | 30 | 36 |
| Up to 8' | 48 | 41 | 38 | 36 |
| Up to 9' | - | 54 | 46 | 41 |
| Up to 10' | - | - | 60 | 48 |
| Up to 12' | - | - | - | 72 |

What about Extended Headers?



Existing Extended Header was limited to a 10' Height

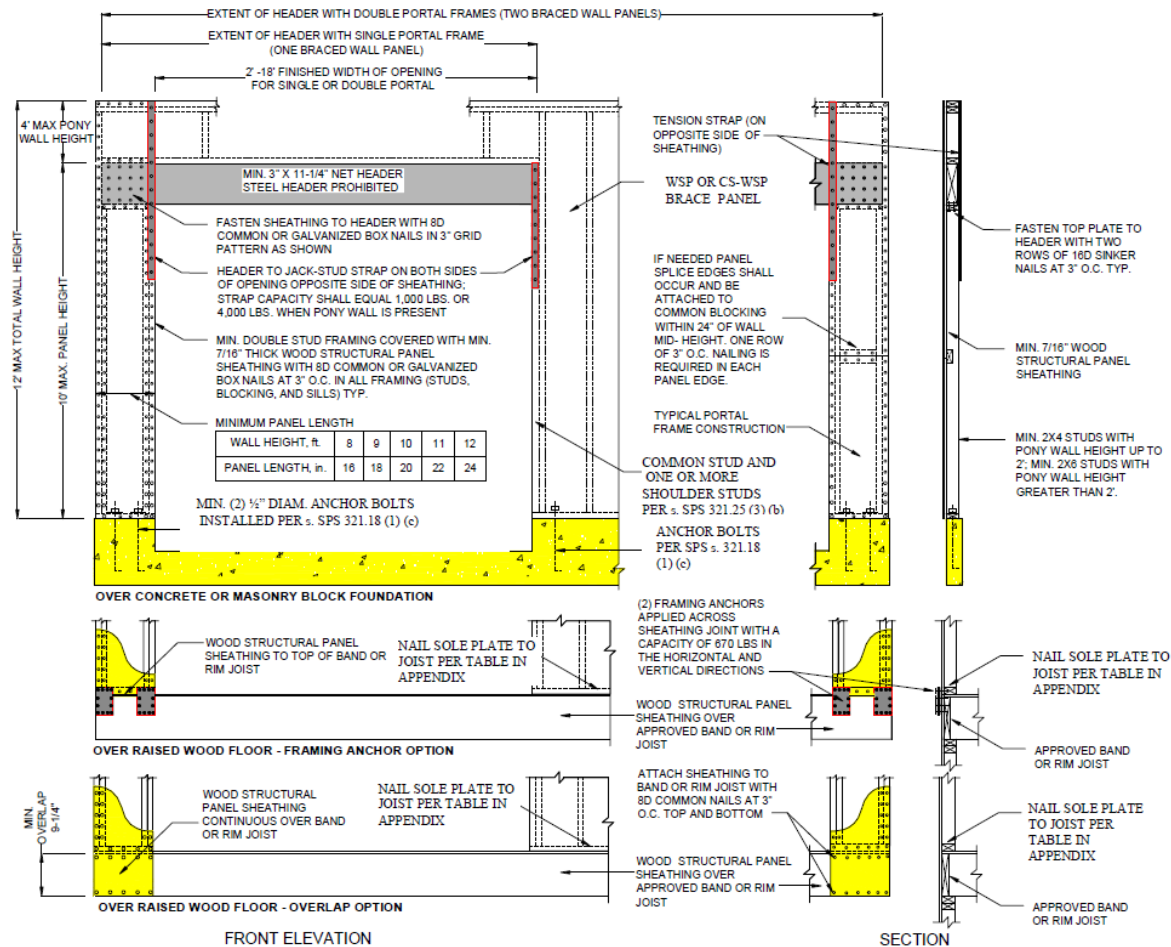
Figure 321.25-E
ALTERNATE BRACING METHOD WITH EXTENDED HEADER AND TIE DOWNS



New Portal Frame Method has 12' Ht. option and updated easy to follow details

Figure 321.25-A

Method PF – Portal Frame Brace Construction



Q & A Clarification

- ▣ Tables 321.25-G and SPS 321.25 (8) (c) 6. require the interior side of all exterior walls to be sheathed with a minimum 1/2" gypsum wall board. Since portal frame wall panel are listed under Table 321.25-G, is it the intent to require drywall on the interior of Portal Frame braced panels?
- ▣ No. That is not the intent. Figure 321.25-A as referenced in Table 321.25-G for Portal Frame method in the cross section and construction details does not show 1/2" drywall on the interior of the Portal Frame braced panels. The intent for the PF is to follow the same exception as in Section R602.10.4 (exception 1) in the 2012 IRC.

How Much Sheathing is needed at each Building Side?

Used to be based on Percentage of Wall Lengths

Table 321.25-H
MINIMUM REQUIRED BRACING AMOUNTS FOR WALLS

| Wall Supporting: | Amount of Bracing Per Wall Line ^{4, 5} Braced segments shall be located at least every 25'-fr o.c. but not less than the following percentages: | |
|------------------------|---|---|
| | Wood Structural Panel Sheathing [Sub. (8) (b) 4. and (9) (b) and (c)] | Other Methods Permitted [Sub. (8) (b) 1., 2., 3., 5. and 6.] |
| Roof only ¹ | 16% | 16% ² |
| Floor and roof | 16% | 25% ² |
| Two floors and roof | 25% | 35% ³ |

¹The 'Roof only' condition also applies to one braced wall line of wood frame construction on the ground floor where all other exterior walls on the ground floor are constructed of masonry or concrete in accordance with s. SPS 321.18.

²Wood and metal let in bracing exempt from % bracing requirement, but not spacing requirement.

³Wood and metal let in bracing not permitted as a bracing method.




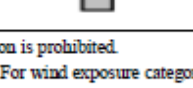
⁴Maximum wall heights equal 12 feet. For wall heights over 10 feet, increase percent bracing requirement an additional 20%.

⁵For continuous sheathing method with wood structural panels, percent requirement may be decreased 10% when openings on the wall line do not exceed 85% of wall height and may be decreased 20% when openings do not exceed 67% of wall height. See Table 321.25-K.

Tables & Illustrations for each Method

Intermittent Panels

Table 321.25-I
REQUIRED NUMBER OF INTERMITTENT BRACED WALL PANELS
ON EXTERIOR WALLS PARALLEL TO EACH RECTANGLE SIDE
AT EACH FLOOR LEVEL^{a,b,c,d,e,f,g,h}

| Wall Supporting: |  | Required Number of Brace Panels on a Building Side | | |
|------------------------------|--|--|-----|-----|
| | | Length of Perpendicular Side (feet) | | |
| | | ≤25' | 50' | 75' |
| Roof and ceiling only |  | 1 | 2 | 3 |
| One floor, roof and ceiling |  | 2 | 4 | 6 |
| Two floors, roof and ceiling |  | 3 | 6 | 9 |

^aInterpolation shall be permitted. Extrapolation is prohibited.

^bTable applies to wind exposure category B. For wind exposure category C or D, multiply number of braced wall panels required by 1.3 or 1.6, respectively.

Wind exposure category B is comprised of urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. Exposure B shall be assumed unless the site meets the definition of another type exposure.

Wind exposure category C is comprised of flat, open country and grasslands with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet extending more than 1,500 feet from the building site in any quadrant. This exposure also applies to any building located within Exposure B type terrain where the building is directly adjacent to open areas of Exposure C type terrain in any quadrant for a distance of more than 600 feet.

Wind exposure category D is comprised of flat, unobstructed areas exposed to wind flowing over open water for a distance of at least 1 mile. This exposure applies only to those buildings and other structures exposed to the wind coming from over the water. Exposure D extends inland from the shoreline a distance of 1,500 feet or 10 times the height of the building or structure, whichever is greater.

^cTabulated values are based on a nominal wall height of 10 feet. For nominal wall heights other than 10 feet and not more than 12 feet, multiply the required number of brace panels by the following factors: 0.9 for 8 feet, 0.95 for 9 feet, 1.15 for 11 feet, or 1.3 for 12 feet.

^dTabulated values are based on a roof eave-to-ridge height of 10 feet. For roof eave-to-ridge heights other than 10 feet, multiply the required number of brace panels by the following factors for each floor level support condition:

Roof only – 0.7 for 5 feet, 1.3 for 15 feet, or 1.6 for 20 feet

Roof + 1 Floor – 0.85 for 5 feet, 1.15 for 15 feet, or 1.3 for 20 feet

Roof + 2 Floors – 0.9 for 5 feet or 1.1 for 15 feet.










^eWhere minimum 1/2" gypsum wall board is not included on the interior side of the wall, multiply the number of braced wall panels by 1.7 for LIB bracing or 1.4 for all other bracing methods.

^fAdjustments in footnotes b-d apply cumulatively. Fractions of panels shall be rounded to the nearest one-half braced wall panel.

^gThe following braced wall panel conditions shall be permitted to be counted as one-half a braced wall panel toward meeting the required number of panels: (1) one 60 degree LIB; (2) one 48" GB or one 96" GB with gypsum wall board on one side; (3) one 36" WSP, SFB, or PCP braced wall panel for wall heights not more than 9 feet; (4) a 48" WSP or SFB braced wall panel where there is no more than one unblocked horizontal joint; or (5) one PF brace panel complying with Figure 321.25-A.

Continuous Bracing on Exterior Walls

Table 321.25-J
REQUIRED LENGTH OF CONTINUOUS BRACING ON EXTERIOR WALLS
PARALLEL TO EACH RECTANGLE SIDE AT EACH FLOOR LEVEL^{a,b,c,d,e}

| Eave-to-Ridge Height (feet) | Wall Supporting: [*] | | Required Length (feet) of Bracing on Any Side of Rectangle | | | | | | | |
|-----------------------------|-------------------------------|---|--|------|------|------|------|------|------|------|
| | | | Length of perpendicular side (feet) [*] | | | | | | | |
| | | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| 10 | Roof and ceiling only |  | 2.0 | 3.5 | 5.0 | 6.0 | 7.5 | 9.0 | 10.5 | 12.0 |
| | One floor, roof and ceiling |  | 3.5 | 6.5 | 9.0 | 12.0 | 14.5 | 17.0 | 19.8 | 22.6 |
| | Two floors, roof and ceiling |  | 5.0 | 9.5 | 13.5 | 17.5 | 21.5 | 25.5 | 29.2 | 33.4 |
| 15 | Roof and ceiling only |  | 2.6 | 4.6 | 6.5 | 7.8 | 9.8 | 11.7 | 13.7 | 15.7 |
| | One floor, roof and ceiling |  | 4.0 | 7.5 | 10.4 | 13.8 | 16.7 | 19.6 | 22.9 | 26.2 |
| | Two floors, roof and ceiling |  | 5.5 | 10.5 | 14.9 | 19.3 | 23.7 | 27.5 | 32.1 | 36.7 |
| 20 | Roof and ceiling only |  | 2.9 | 5.2 | 7.3 | 8.8 | 11.1 | 13.2 | 15.4 | 17.6 |
| | One floor, roof and ceiling |  | 4.5 | 8.5 | 11.8 | 15.6 | 18.9 | 22.1 | 25.8 | 29.5 |
| | Two floors, roof and ceiling |  | 6.2 | 11.9 | 16.8 | 21.8 | 27.3 | 31.1 | 36.3 | 41.5 |

^aInterpolation shall be permitted; extrapolation shall be prohibited.

^bTable applies to wind exposure category B. For wind exposure category C or D, multiply number of braced wall panels required by 1.3 or 1.6, respectively. Wind exposure categories are as defined in Table 321.25-I footnote b.

^cTabulated values are based on a nominal wall height of 10 feet. For nominal wall heights other than 10 feet, multiply the required length of bracing by the following factors: 0.90 for 8 feet, 0.95 for 9 feet, 1.05 for 11 feet, or 1.10 for 12 feet.

^dWhere minimum 1/2" gypsum wall board interior finish is not provided, the required bracing amount for the affected rectangle side shall be multiplied by 1.40.

^ePerpendicular sides to the front and rear sides are the left and right sides. Perpendicular sides to the left and right sides are the front and rear sides. See Figure 321.25-B.

“Adjustments apply cumulatively”

- ▣ (Footnote f in intermittent table, footnote e in continuous table)
- ▣ Small (25'x50') 1-story house on open grassland
- ▣ Wind category: C – 1.3
- ▣ Bearing wall height: 8 ft – 0.9
- ▣ Eave to ridge height: <5 ft – 0.7
- ▣ No interior drywall: 1.4

- ▣ $1.3 \times 0.9 \times 0.7 \times 1.4 = 1.15$

Assuming Intermittent Method

- ▣ The two 50' sides (perpendicular side is 25')
- ▣ $1 \times 1.15 = 1.15$
- ▣ Round to 2 (Minimum of 2 per side)

- ▣ The two 25' sides
- ▣ $2 \times 1.15 = 2.3$
- ▣ Round up to 3 = 12'

Adjustment Factors for CS

- ▣ Small (25'x50') 1-story house on open grassland
- ▣ Wind category: C – 1.3
- ▣ Bearing wall height: 8 ft – 0.9
- ▣ No interior drywall: 1.4

- ▣ $1.3 \times 0.9 \times 1.4 = 1.64$

Assuming Continuous Method

- ▣ The two 50' sides (perpendicular side is 25')
- ▣ $3.5 + 5.0 / 2 = 4.25'$
- ▣ $4.25 \times 1.64 = 7'$ or 84" of full height bracing

- ▣ Assume max opening height – 6'8"
- ▣ Need 32" wide panels on either side of door.
- ▣ Need three – 32" panels = 96". Code requirement is met with all remaining sheathable surfaces sheathed.

Assuming Continuous Method

(cont.)

- ▣ The two 25' sides
- ▣ $7.5'$ (direct from table) $\times 1.64 = 12.3'$ or 148" of full height bracing

- ▣ Assume max opening of 5'4" or less
- ▣ Need 24" wide panels on either side of window
- ▣ A total of six – 24" panels will meet code with all remaining sheathable surfaces sheathed.

How large of a hole can I cut into a required panel?

The max dimension of the hole should not be greater than 10% of the least dimension of the panel. Thus, for a 48" panel, the max size hole would be 4.8" x 4.8". Thus, for a 16" portal frame panel that has high load but narrow width, the max hole size would be 1.6" x 1.6" (really just enough for a pipe or to pull a wire, but not a gang box). In these locations it would be necessary to use a shallow surface mounted box where needed.

Online Resources

- ▣ <http://www.dsps.wi.gov/Programs/Industry-Services/Industry-Services-Programs/One-and-Two-Family-UDC>
- ▣ Video
- ▣ Compliance Worksheet
- ▣ How-to guide

Thank You For Your Time!

