RESIDENTIAL FRAME CONSTRUCTION CR220-00

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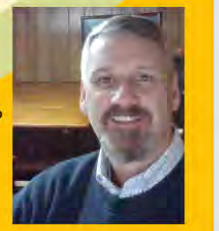
SULLIVAN INSPECTION SERVICES PC

Promoting Safety in Our Built Environment

JIM SULLIVAN MCP



We are a third-party code administration consultant business. Our goal is to assist our customers with developing and maintaining structures to be building/fire code compliant. We assist stakeholders with the navigation of municipal and state regulations. We provide the following services to assist our clients:

- Permit expediting
- Construction documents and plan review
- New construction inspections both commercial and residential
- Project closeout
- Fire safety and property maintenance compliance audits for existing structures
- Continuing education and seminars
- Municipal Support Services

www.linkedin.com/in/buildingsafetysolutions1

Experience:

2016 to 2019. Jim served as the Chief Building Official for Johnson City Tennessee. Jim supervised a staff of 13 building safety professionals and managed a budget of $1 million. Responsible for three groups: New construction plans review and inspections, Code/Zoning enforcement, and Permit administration. This office regulates approximately $150 million of construction activity annually. As the Chief Building Official, Jim was responsible for the development and enforcement of building and zoning regulations in the city. He served as the technical expert and the arbiter of conflicts in the applications of the regulations.

2006 to 2016. Jim served as a Deputy Fire Marshal for the Alexandria Virginia Fire Department. Jim has investigated over 200 incidents of fire or explosion. Jim has investigated and prepared cases for prosecution of; arson, threat to burn, manufacture and possession of explosives and numerous misdemeanor offenses. Jim has conducted thousands of facility inspections in all occupancies and construction types to assist stakeholders with fire prevention and safety compliance.

2010 to present. Jim has worked with third party inspection agencies in the Washington D.C. market assisting clients with inspections, plan review and third-party oversight and quality control. Jim currently assists Core Inspection Services as the Professional in Charge for this third-party inspection agency. Jim has a great deal of experience in navigating the municipal regulatory environment.

2002 to 2006. New construction trades inspector for the Alexandria Virginia Fire Department. Performing trades inspections on large commercial projects and served as supervisor for new construction inspectors.

Certifications/Licenses:

1. International Code Council # 8027199: Tennessee License 2871

- Master Code Professional (MCP)
- Certified Building Official (CBO)
- Fire Inspector I and II
- Accessibility Plans Examiner /Inspector
- AACE Property Maintenance and Housing inspector
- Electrical Inspector (residential and commercial)
- Building Inspector (residential and commercial)
- Plumbing Inspector (residential and commercial)
- Mechanical Inspector (residential and commercial)
- Energy Code Inspector (residential and Commercial)
- Electrical Plans Examiner
- Building Plans Examiner
- Plumbing Plans Examiner
- Mechanical Plans Examiner

2. Fire Marshal Certifications:

- Fire Investigator NFPA 1033.
- Fire Inspector NFPA 1031.
- Public Fire and Life Safety Educator NFPA 1035.

Academics:

- Master of Science; Safety, Security & Emergency Management, 2014. Eastern Kentucky University.
- Certificate; Fire and Emergency Services, 2012. Eastern Kentucky University.
- Bachelor of Science; Business Administration, 1985. Widener University.

Successful Projects of Note:

- United States Patent Trademark Offices; Building Inspector, 2.5 million square feet and over $1 billion in construction cost, 2004
- T.C. Williams High School; Building Inspector, 500,000 square feet of Silver LEED, phased construction, exceeding $100 million in construction cost, 2006
- Wilson High School; Consulting Inspector, renovations to existing school with modernization, $115 million in construction cost, 2011

Associations:

- **Past President** East Tennessee Building Officials Association
- **Board Member** International Code Council Region VIII(ICC)
- **Member** National Association of Fire Investigators (NAFI)

Taking you from plan review to occupancy and everything in between.

Building Safety Solutions, LLC.

Jim Sullivan | ICC Certified MCP
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Promoting safety in our built environment. | Johnson City, TN 37601
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101ST AIRBORNE DIVISION
AIRBORNE
SCREAMING EAGLES

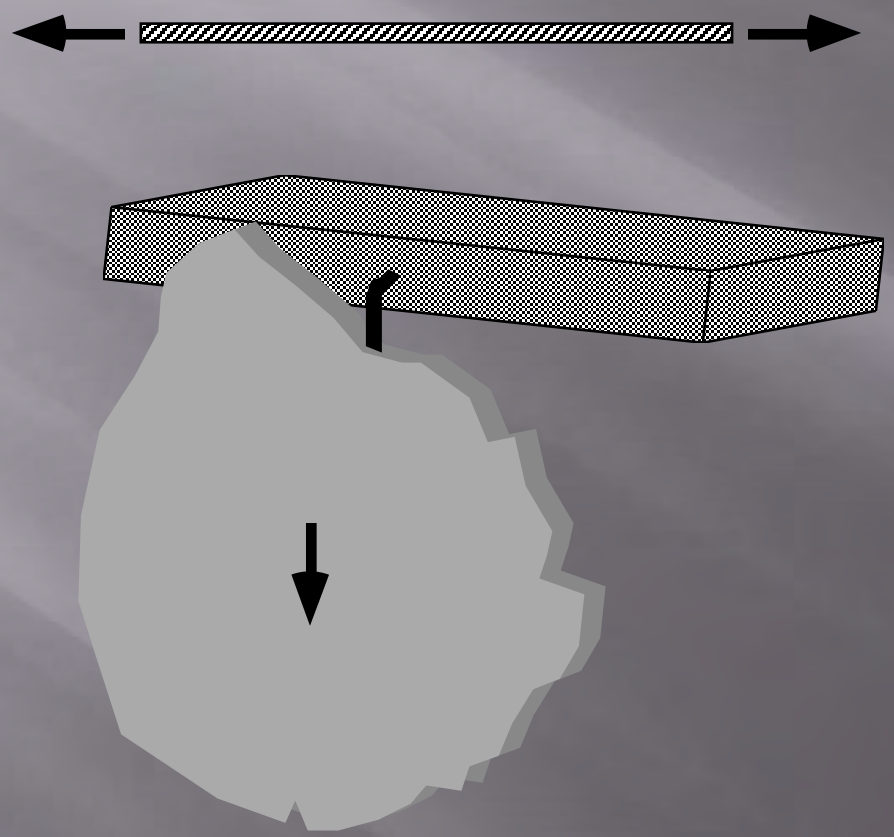

US ARMY 24th MECHANIZED INFANTRY DIVISION
VETERAN

Goals Today

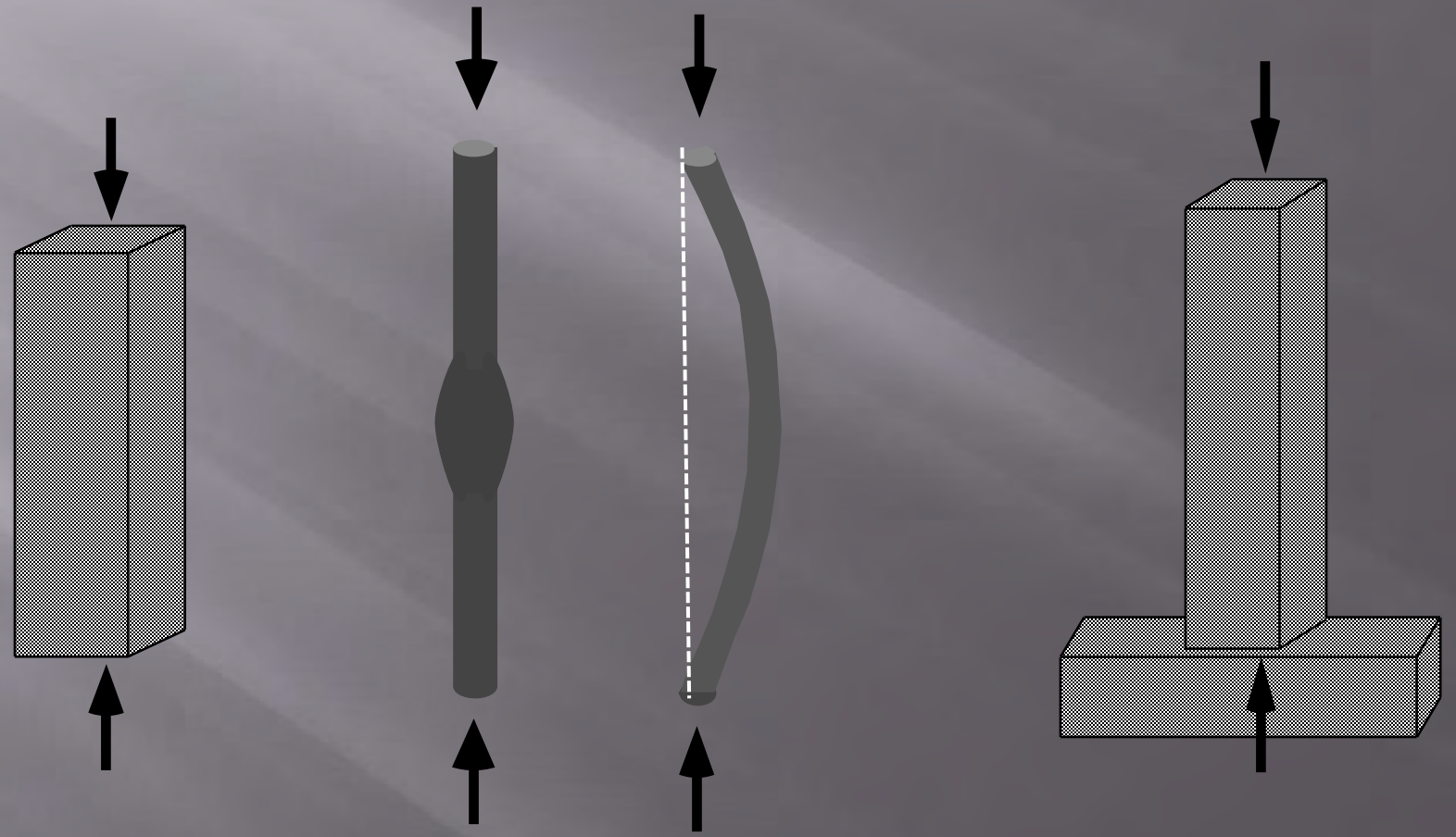
- Structural forces
- Seismic Considerations
- Braced Walls vs. Shear Wall design
- Wind Loads
- Foundations
- Floors
- Walls

Forces, Material and their Properties

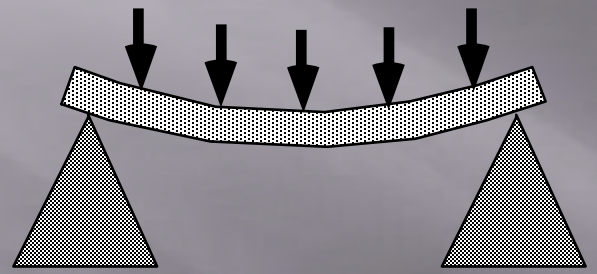
Force Type: Tension

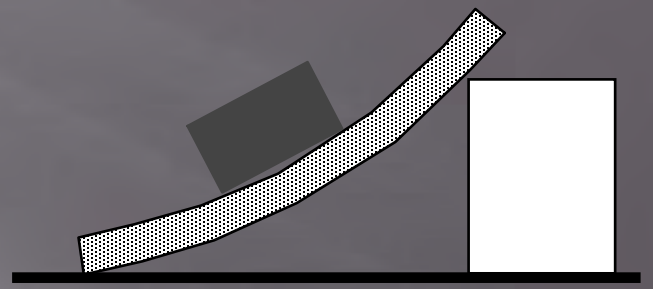


Force Type: Compression

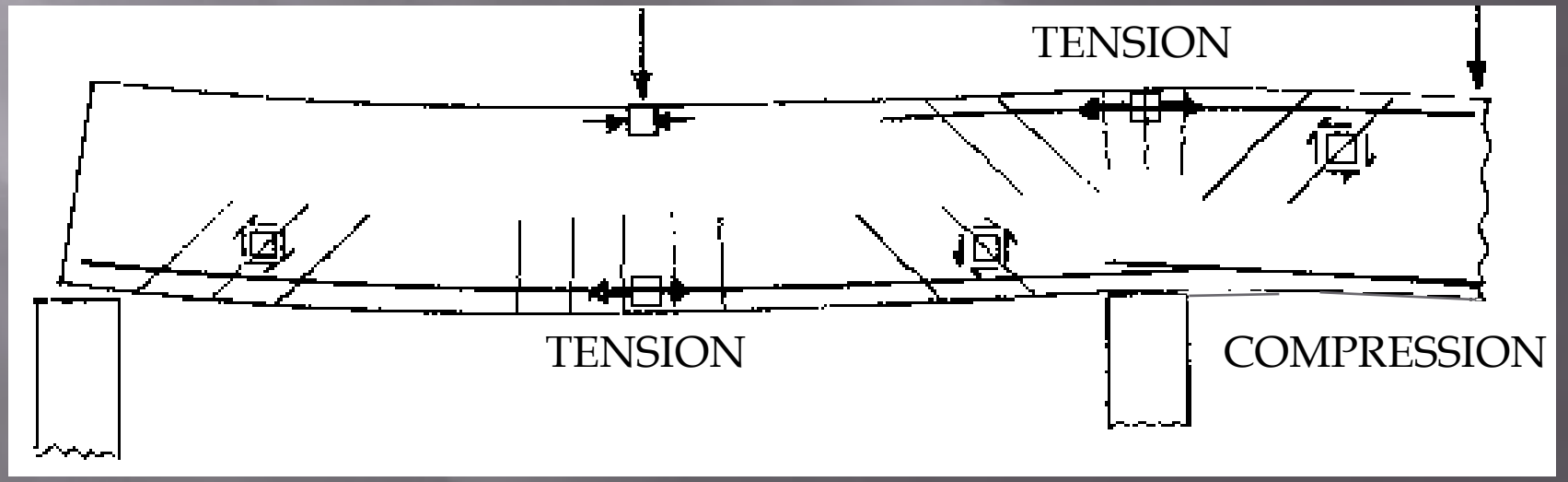


Force Type: Bending

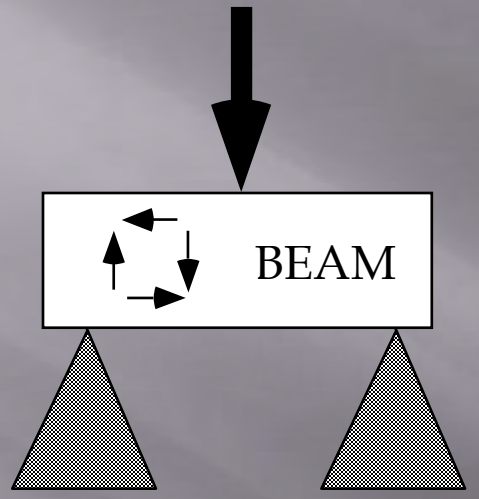


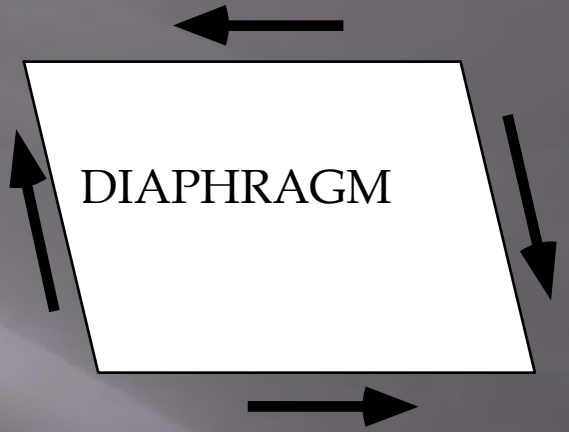


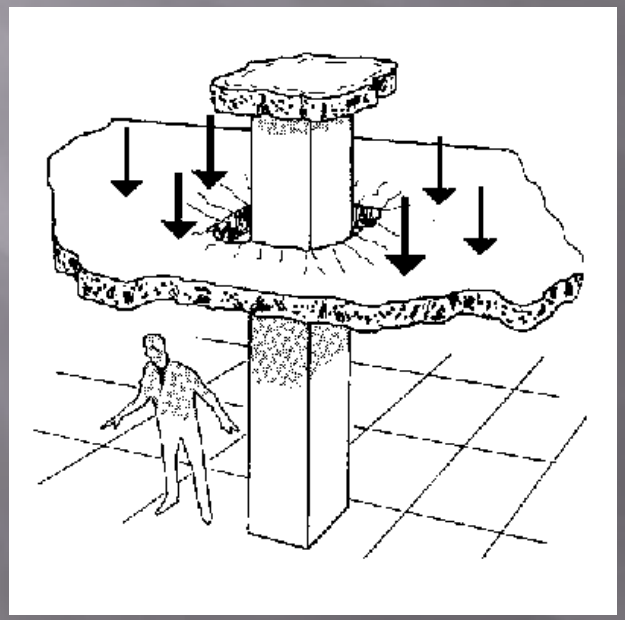
COMPRESSION

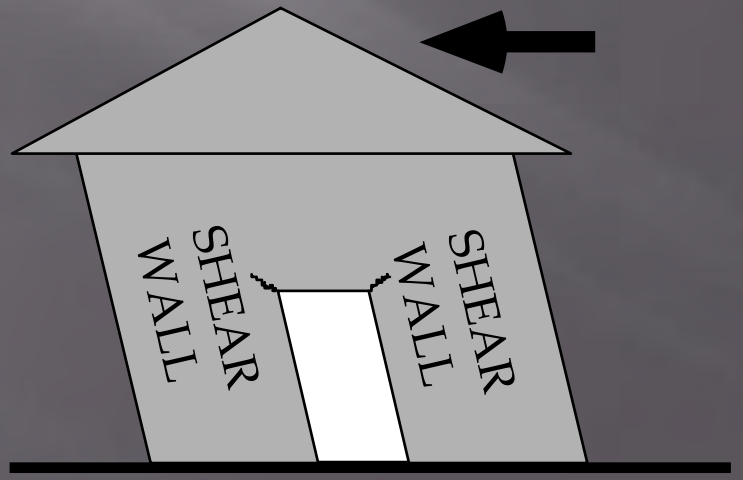


Force Type: Shear



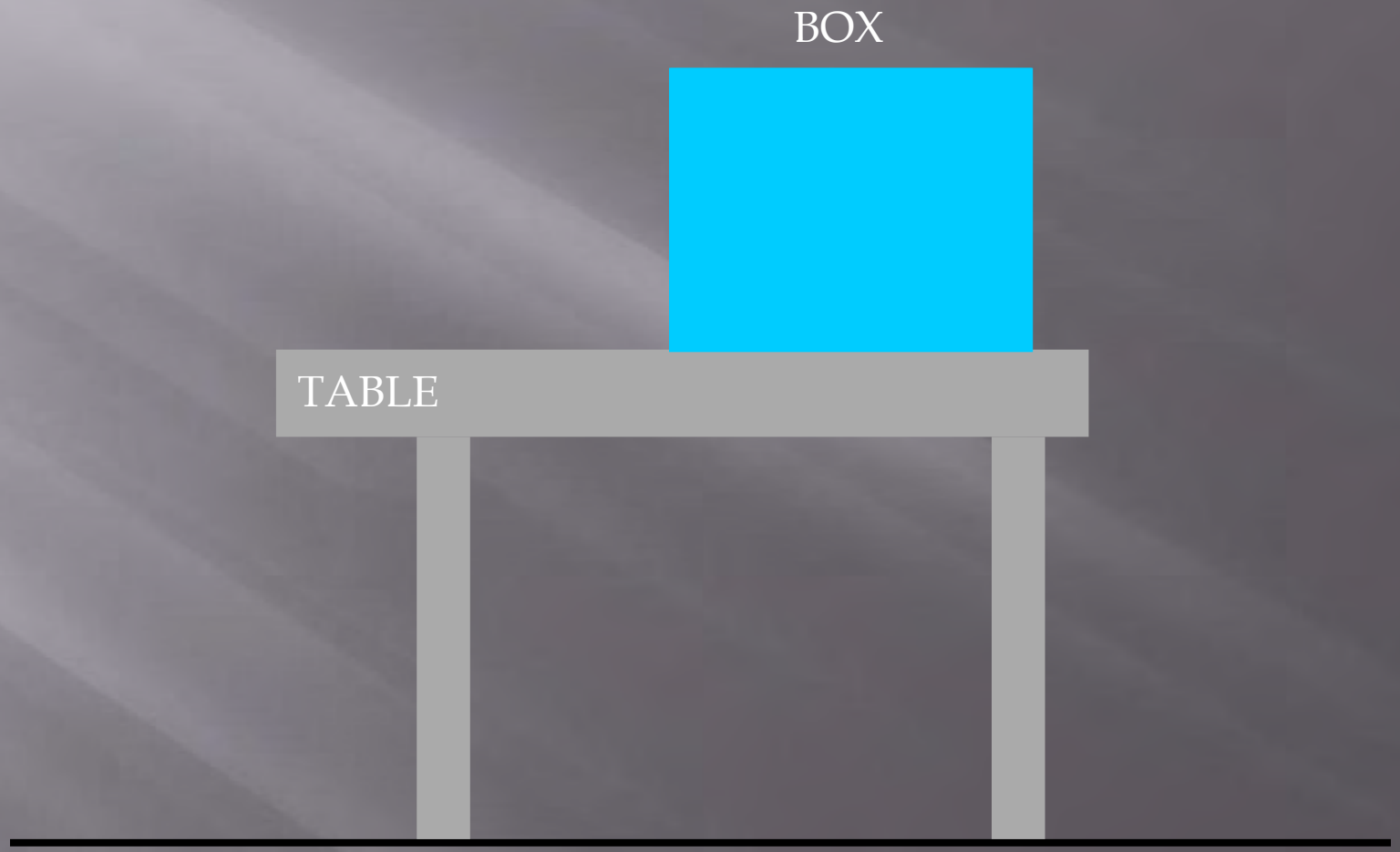




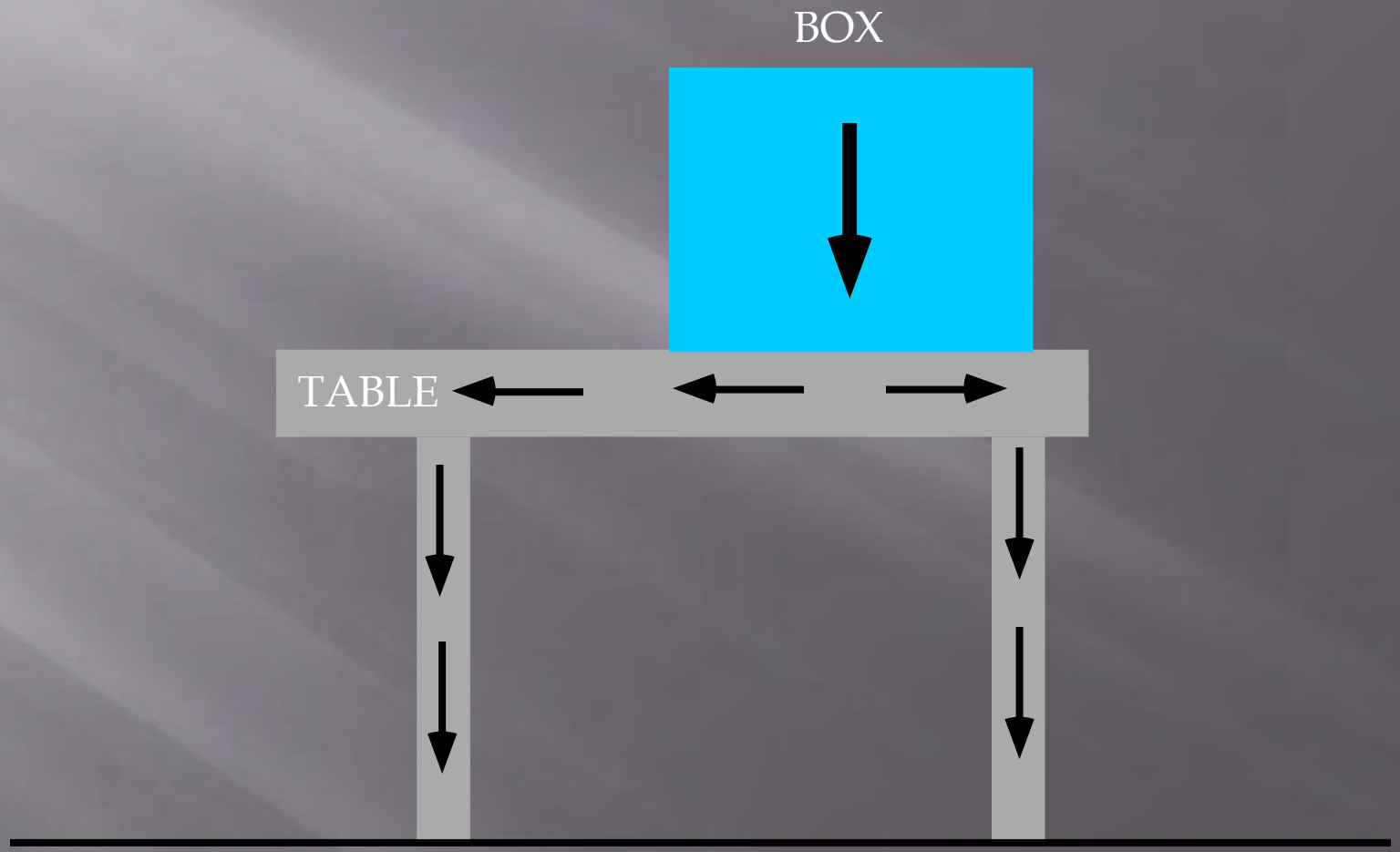


Load Path

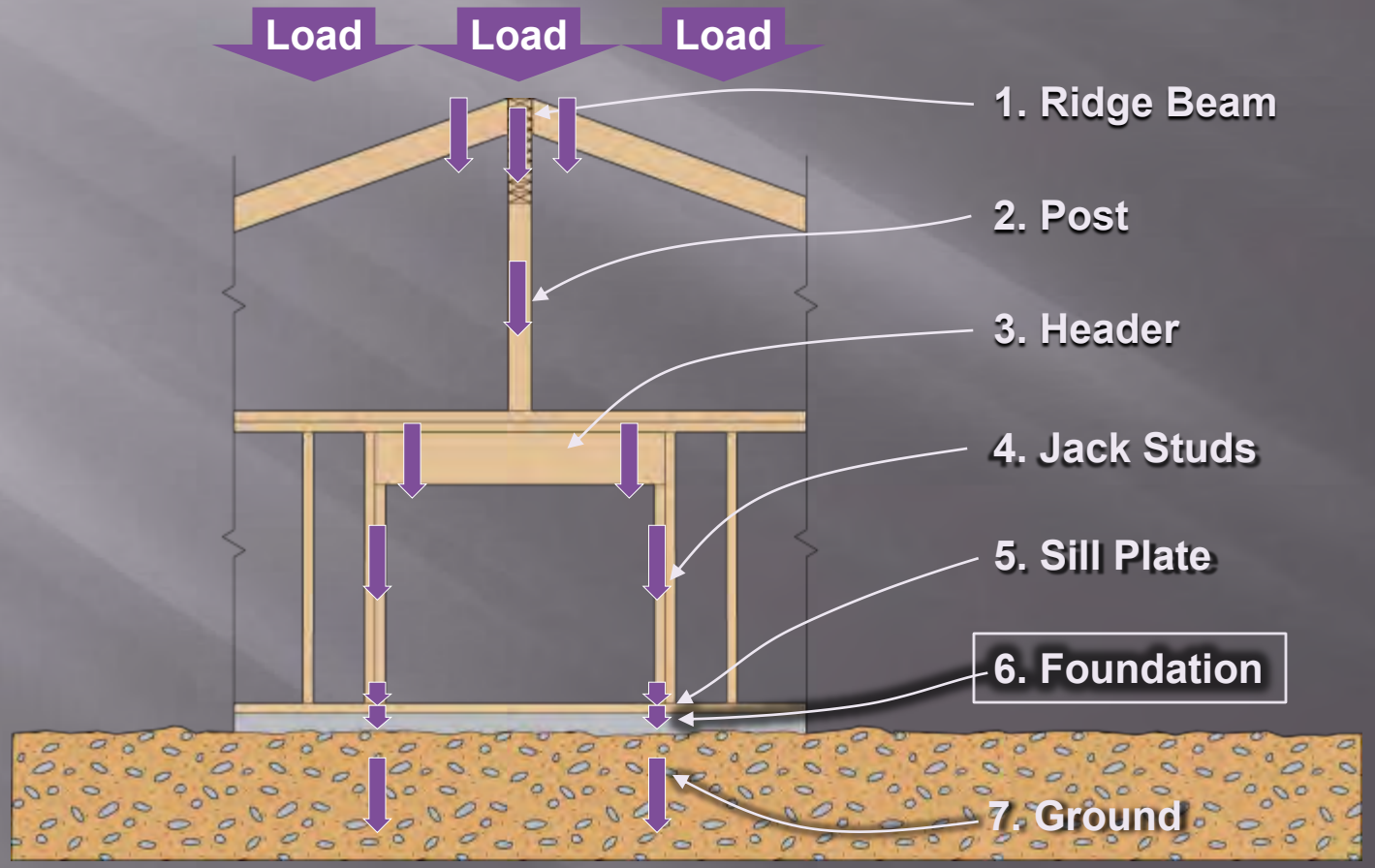
Gravity Load Path Concept



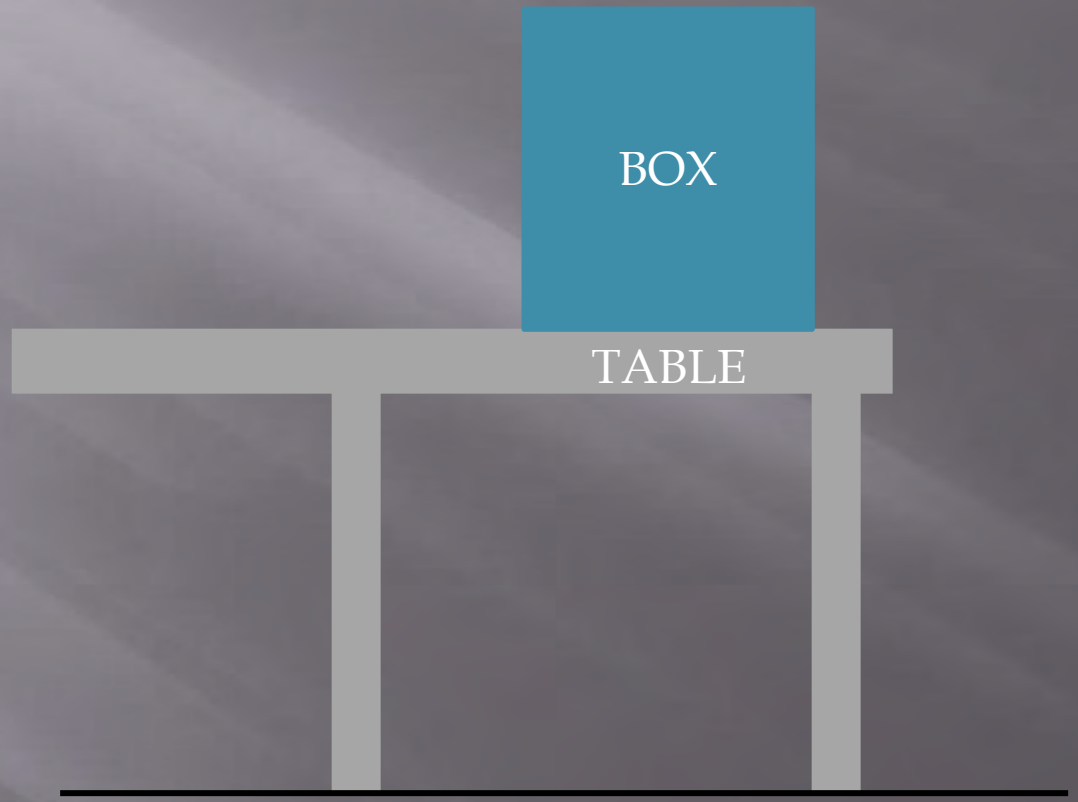
Gravity Load Path Concept



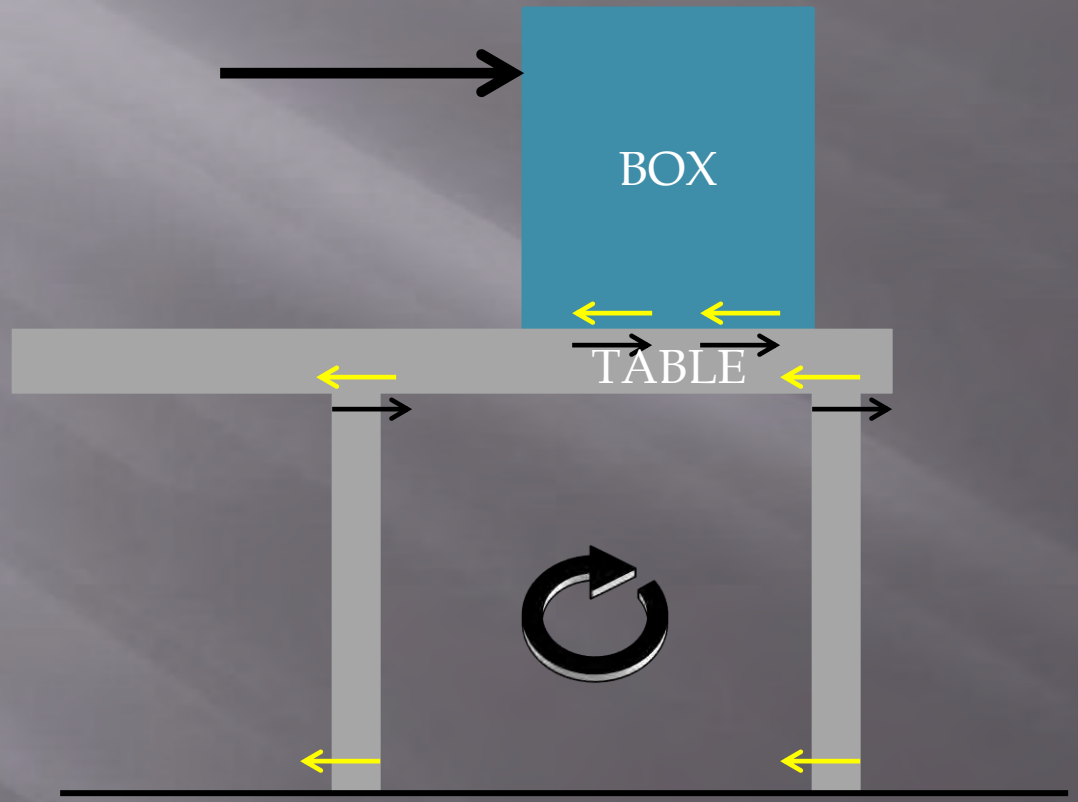
Vertical Load Path



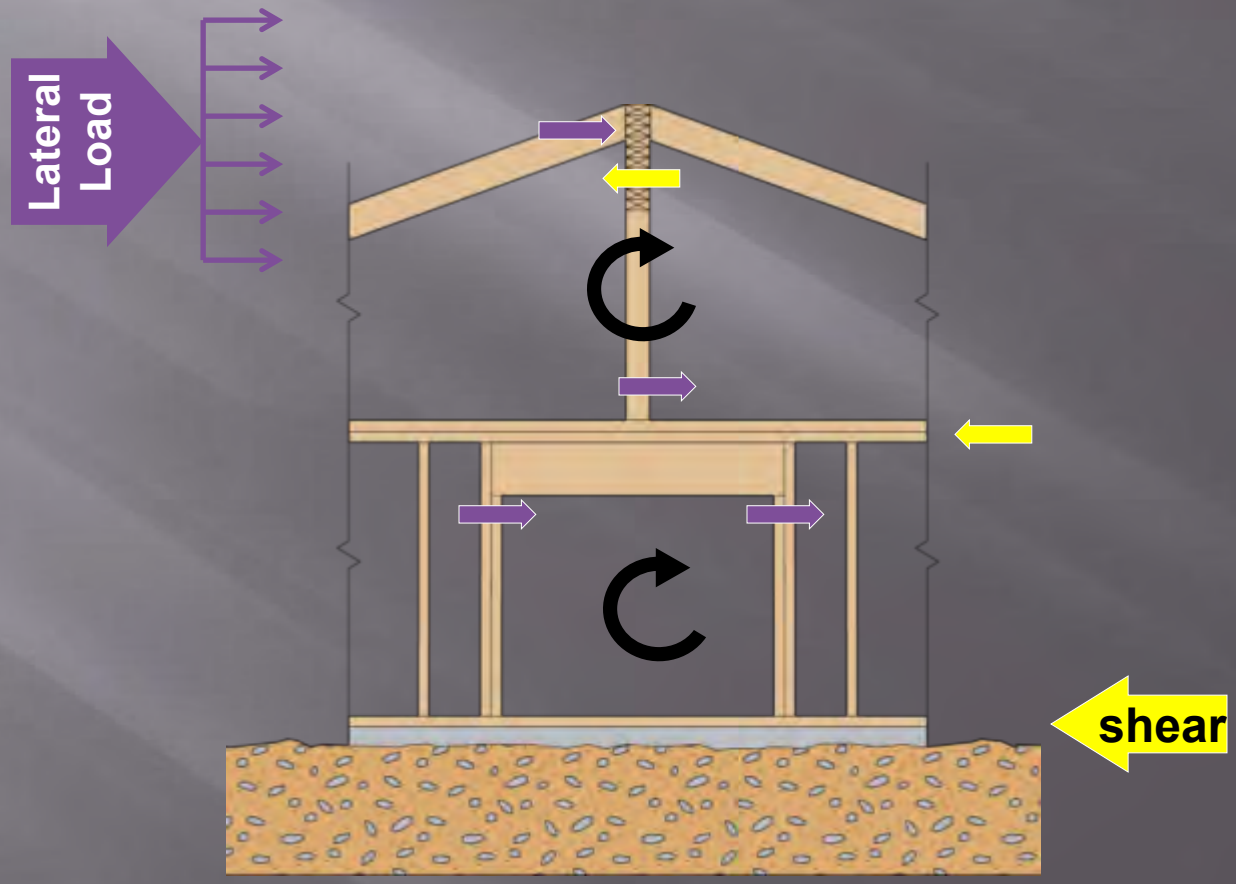
Lateral Load Path Concept



Lateral Load Path Concept

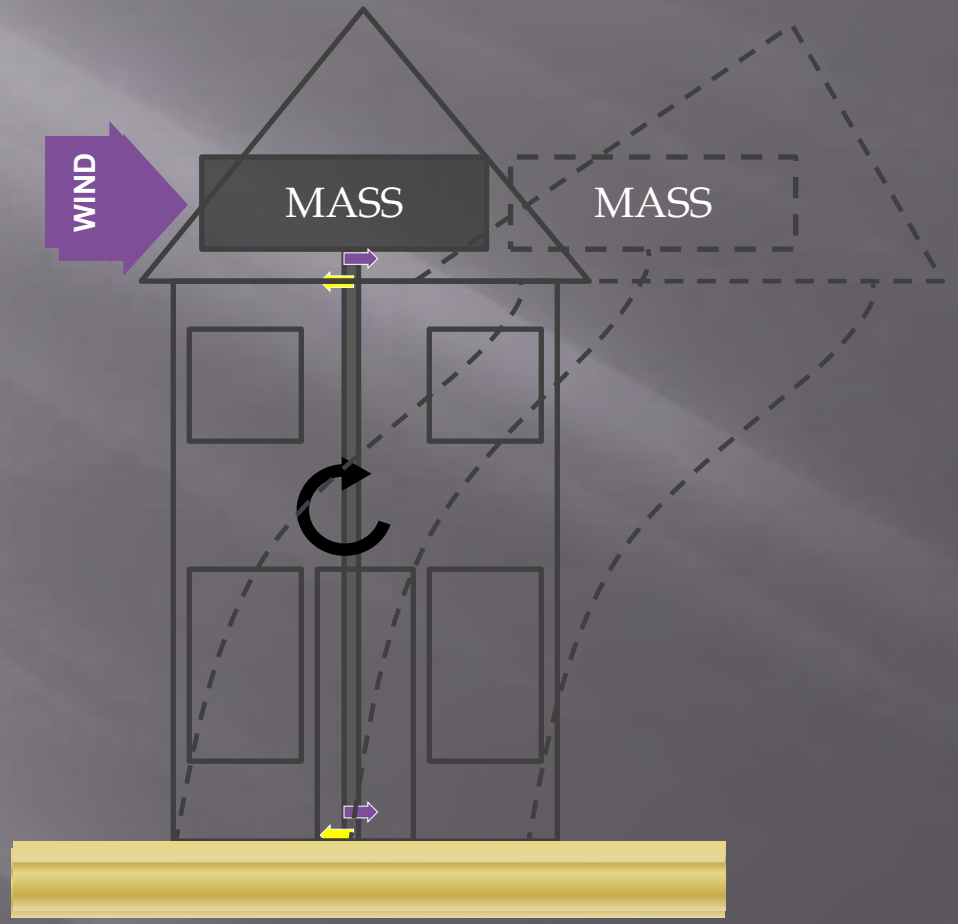


Lateral Load Path

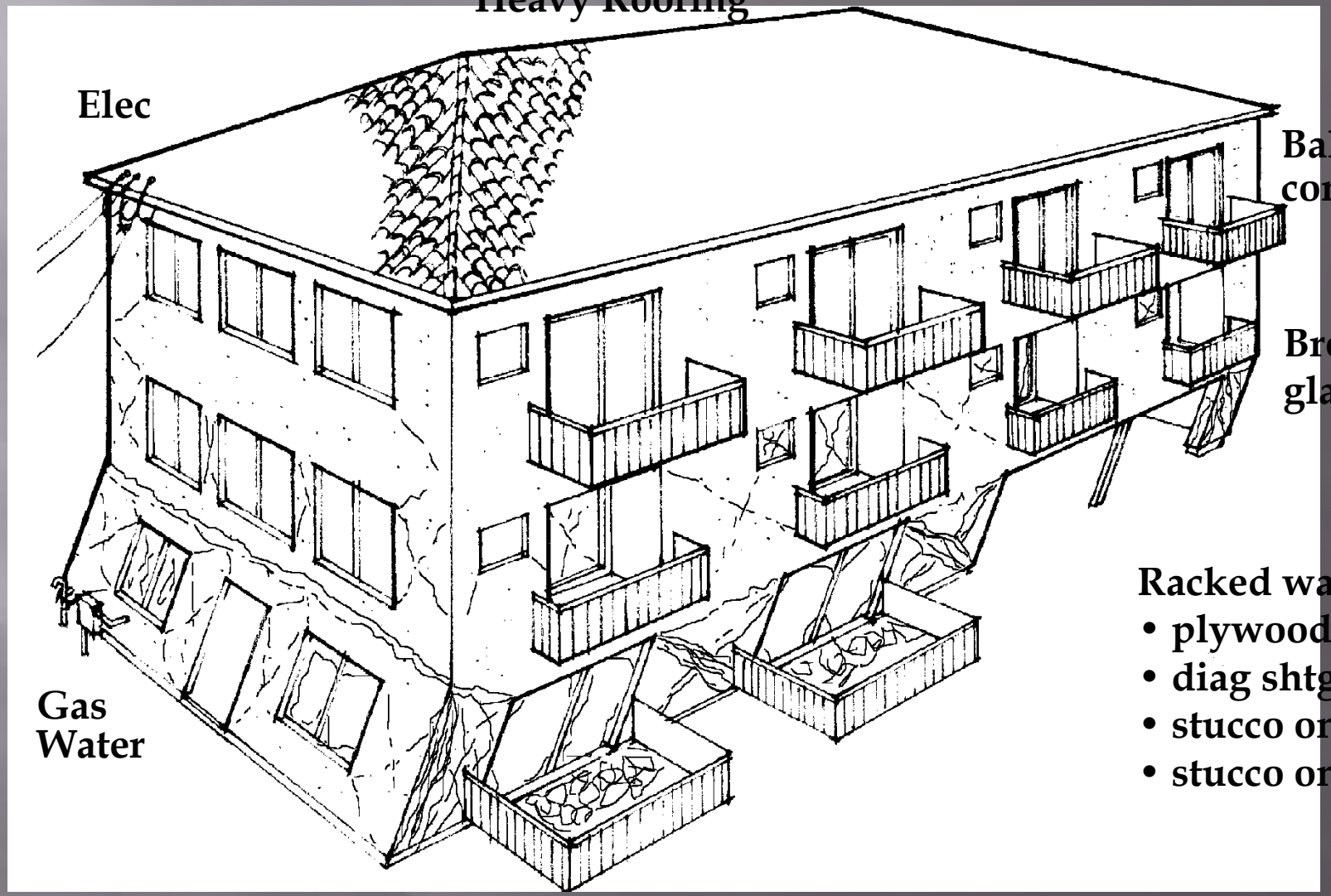


Lateral Forces

WIND



Light Frame - Multi - Story

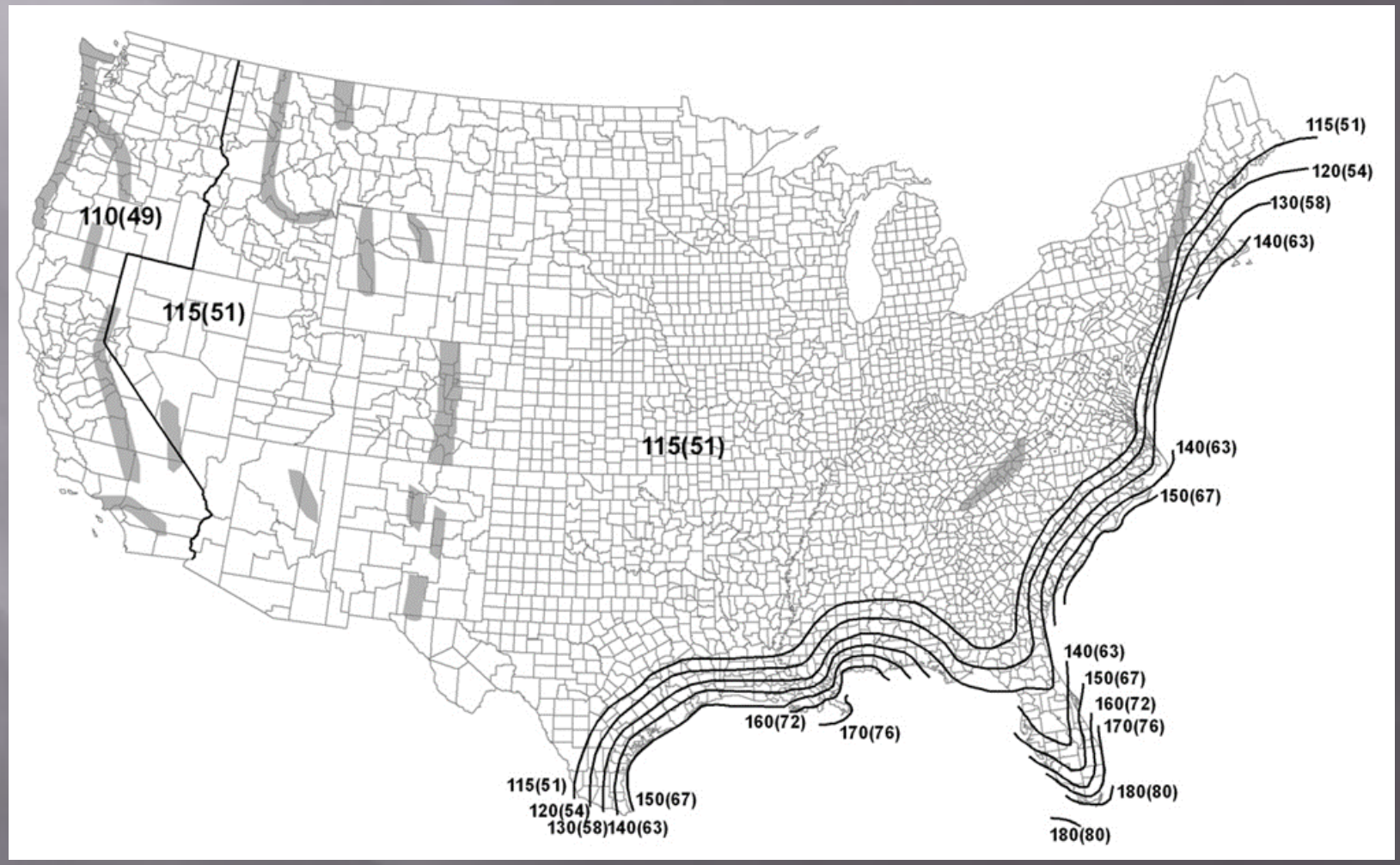


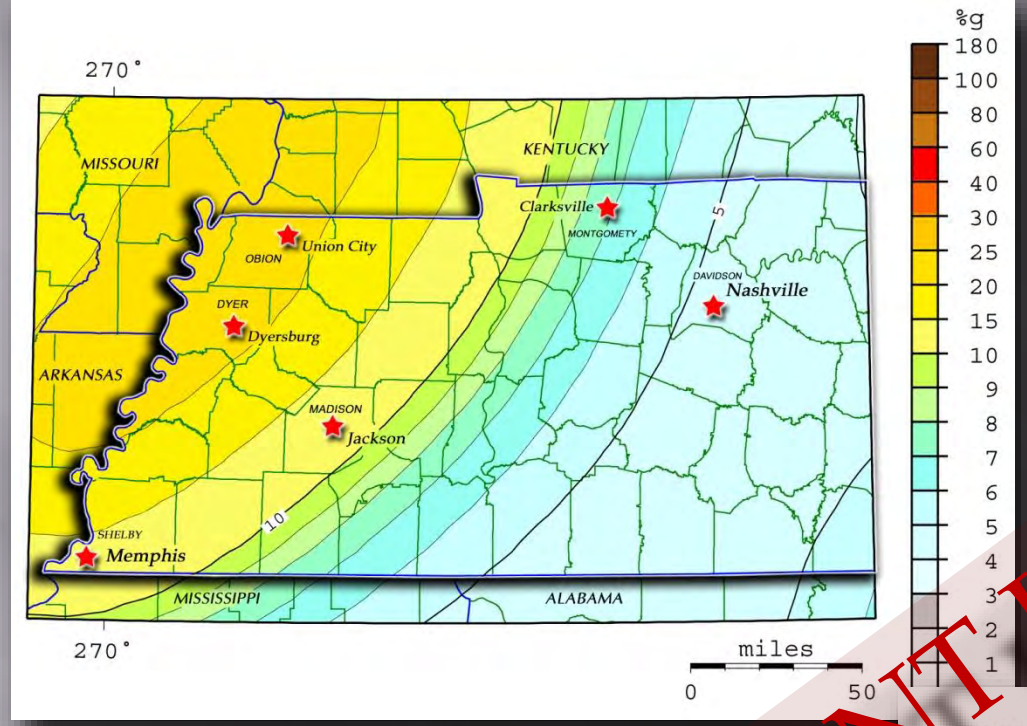
Lateral Forces

Changes from 2012 to 2015 IRC

Wind for all of Tennessee changed from 90 mph to 115 mph in the 2015/2018 IRC. Watch for the special wind region in NE Tennessee

Figure R301.2 (5) A





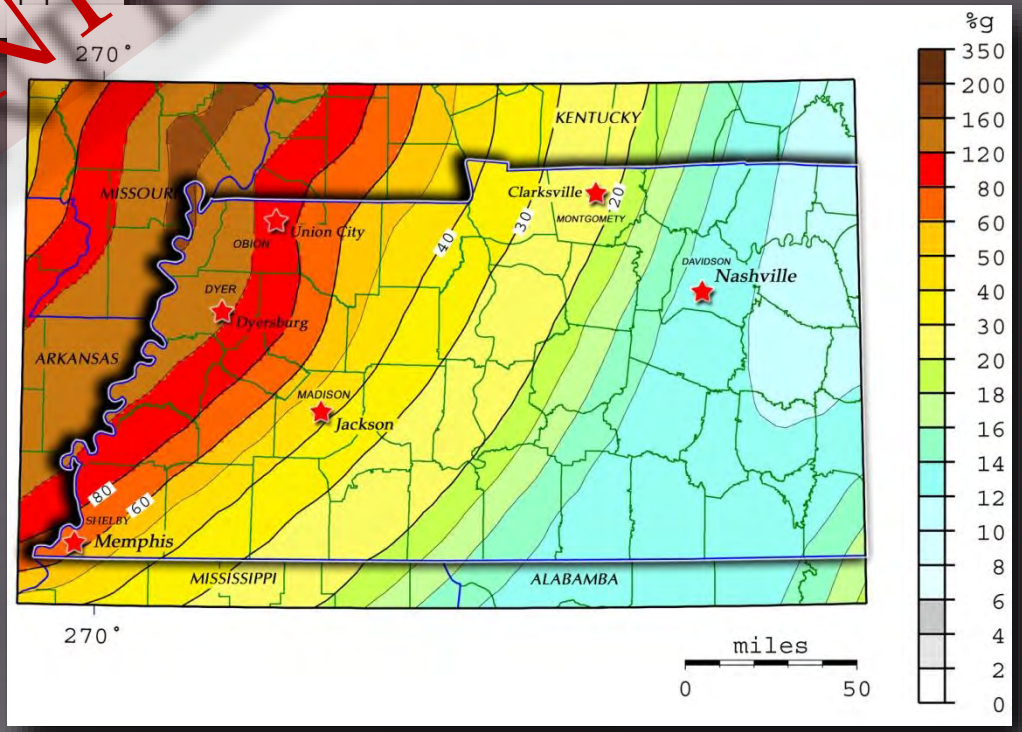
West Tennessee

Traditional – prior to ICC codes

Peak Acceleration (%g) with 10% Probability of Exceedance in 50yr (Recurrence 1 in 500 yrs)

Source: USGS

Traditional hazard prior to IBC/IRC



West Tennessee

Post ICC codes

Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years, (Recurrence 1 in 2500 yrs)

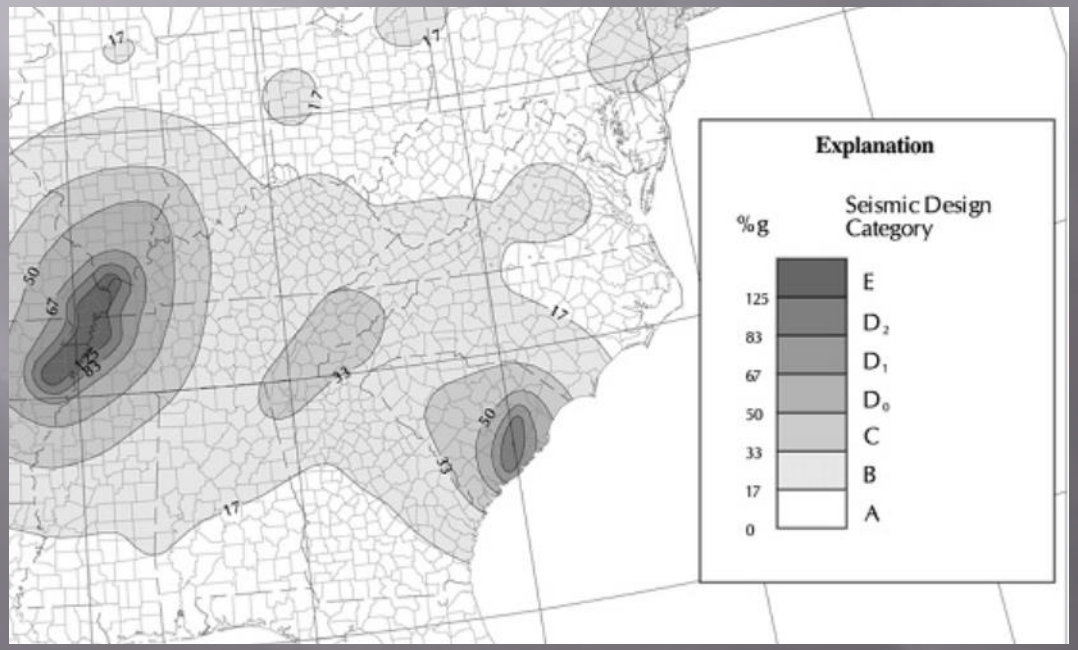
Source: USGS

Risk hazard predicted by IBC/IRC

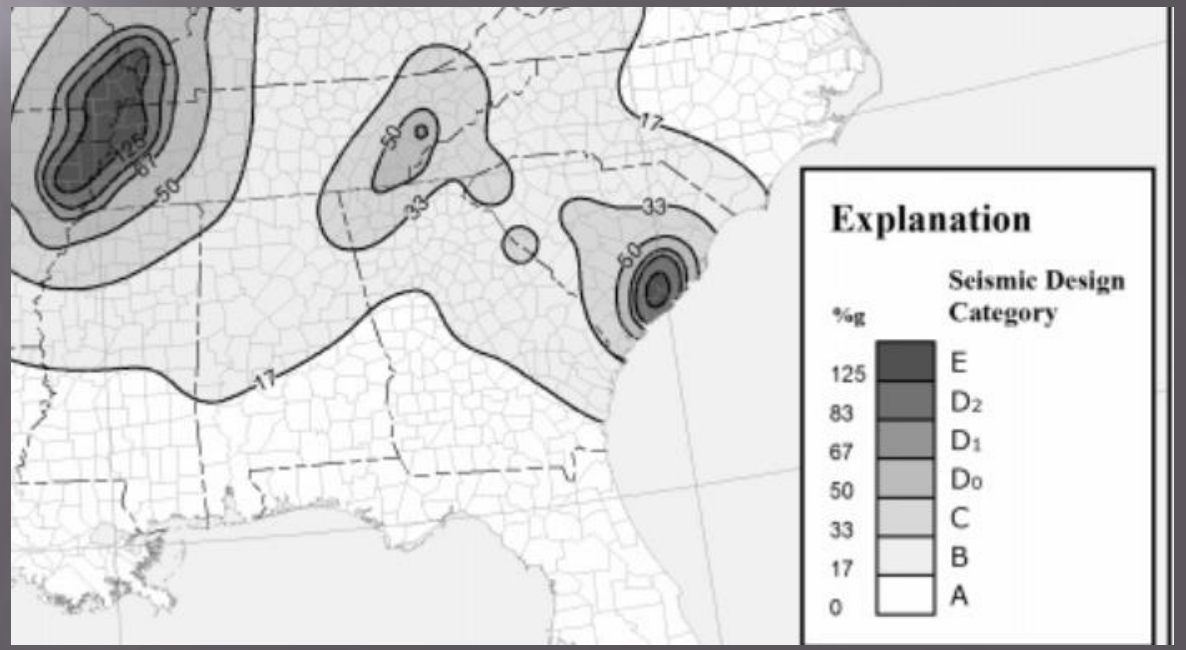
2018 IRC Section R301.2.2 Seismic…

- Figure 301.2(2) updated ….Watch out NE Tennessee…..
- Several language updates here….

2012 IRC



2018 IRC



Bracing History

History - Wall Bracing

Uniform Building Code – 1927

- All exterior walls and partitions shall be thoroughly and effectively angle braced.

Uniform Building Code – 1952

- All exterior walls and partitions shall be thoroughly and effectively angle braced or sheathed with approved panels adequately nailed along all edges.

Bracing History

History - Wall Bracing

Uniform Building Code – 1970

- All exterior walls and main cross stud partitions shall be effectively and thoroughly braced at each end, or as near thereto as possible, and at least every 25 feet of length by one of the following methods:

A. *Nominal 1-inch by 4-inch…*
B. *Wood boards of 5/8-inch…*
C. *Plywood sheathing…*
D. *Fiberboard sheathing…*
E. *Gypsum sheathing…*
F. *Particleboard sheathing…*

Bracing History

History - Wall Bracing

International Residential Code – 2009

- Methods renamed from number designation to abbreviation
- Wall bracing length determined by the greater length requirement from separate wind and seismic bracing length tables
- Intermittent portal frame at garage added
- Continuous sheathing with structural fiberboard added
- Table of effective braced length for braced panels less than 48 in. long added
- Braced panel end distance limit of 12.5 ft cumulative for SDC A-C with intermittent bracing
- Additional bracing requirements for structures with masonry veneer moved to wall bracing section
- Anchorage for masonry foundations with short wall lengths added
- Angled wall lines added
- Imaginary braced wall lines added

R301.1.3 Engineered design

When a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the International Building Code is permitted for all buildings and structures, and parts thereof, included in the scope of this code.

SEISMIC PROVISIONS
RESIDENTIAL CODE
Themes to keep in Mind

1. **Vertical and Lateral Load Path.**
2. **Buildings with Regular Shapes**
3. **F=MxA - Weight Limitations.**
4. **Conventional Light-framing Construction**

The focus is on the effects of ground motion on wood framed structure in moderate and high-seismic regions in the State of Tennessee

Determining Seismic Compliance Requires the following:

- Plans for compliance of building's bracing elements:
  - Number of Stories
  - Story height, wall height, stud size and height.
  - *Brace Wall Lines*.
  - *Braced Wall Panel* Types
  - Total required length of *Brace Wall Panels* for each *Brace Wall Line*.
- Identification of irregularities with suitable engineering remediation.
- Identify hold-downs – engineer's certification for suitability and applicability for engineered products.
- Foundation design for *Alternate Brace Wall* - engineer's certification for suitability and applicability.
- Suitability and applicability of mechanical seismic restraints.

Elements Exceeding the Limits of Section R301

- Elements exceeding weight
  - Roof slopes exceeding ±10:12
  - Tile and slate roofs
  - Heavy floor systems, e.g. Gypsum floor system, tile, etc.
- Non compliant cantilevers, set-backs, and roof hangover
- Irregular Buildings
- Building where SDC = E
- Fireplaces, chimneys and masonry veneer as permitted by this code but masonry and concrete shear walls are considered irregular (R301.2.2.2.5)
- Heavy snow loads > 70 lbs/ft^2
- Aspects of concrete stem walls (R404.1.2.2.1 & R404.1.2.2.2)
- Masonry piers and piles supporting braced wall panels. (R404.1.9.3, R404.1.9.4)

Load Path

R301.1 Application

The construction of buildings… shall result in a… complete load path… for the transfer of all loads… to the foundation.

BWP vs. Shear Walls

BWP (Prescriptive)

- Limitations
  - 3-Stories Maximum
  - Wind ≤140 mph(1)
  - SDC A-D_2
  - Others (see IRC Chap. 3)
- Typically without hold-downs

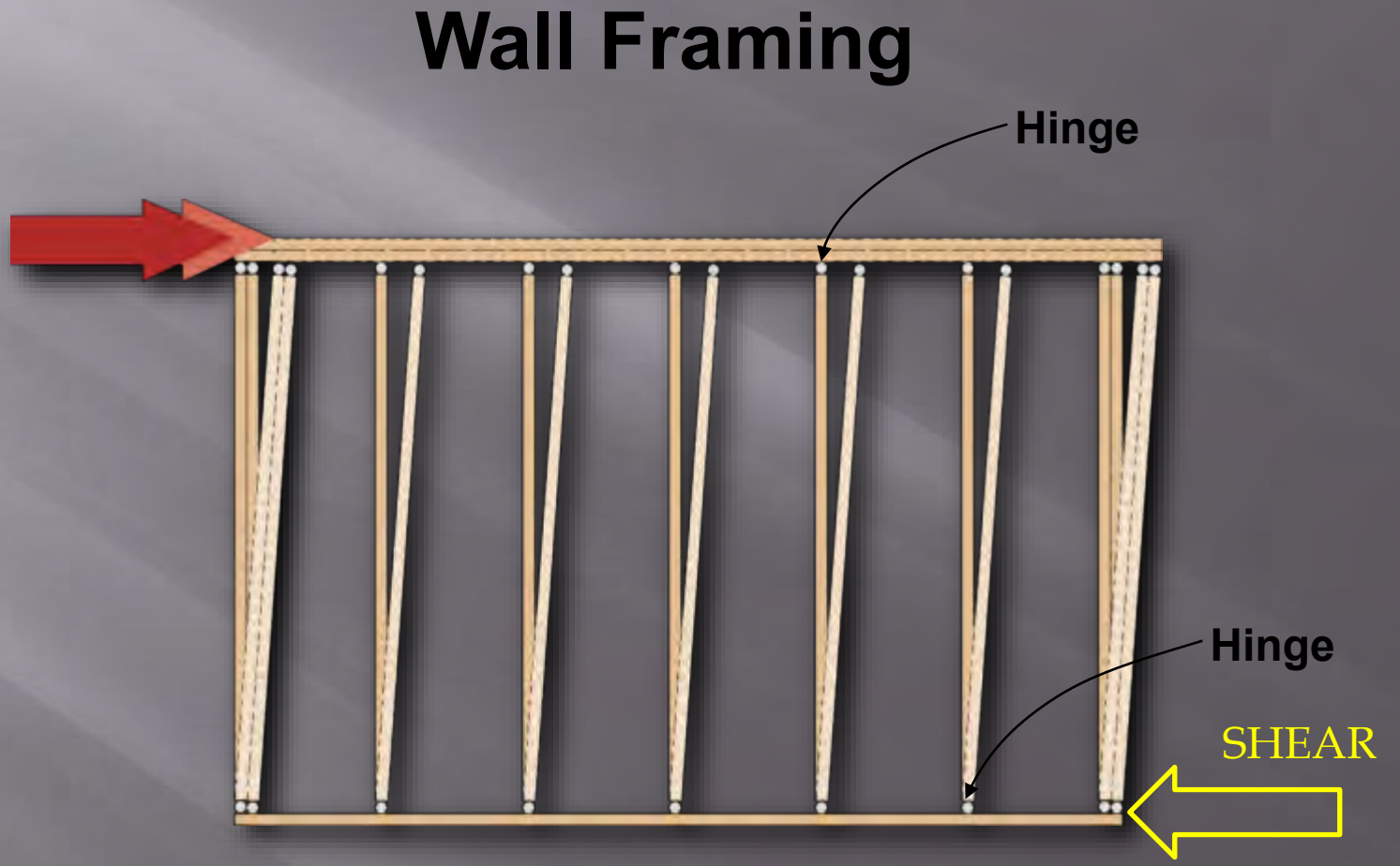
VS.

Shear Walls (Engineered)

- Applications
  - Any building size/shape
  - Wind – no limit
  - SDC – no limit
  - Calculations required
- Typically with hold-downs

(1) Wind ≤ 100 mph in hurricane-prone regions.

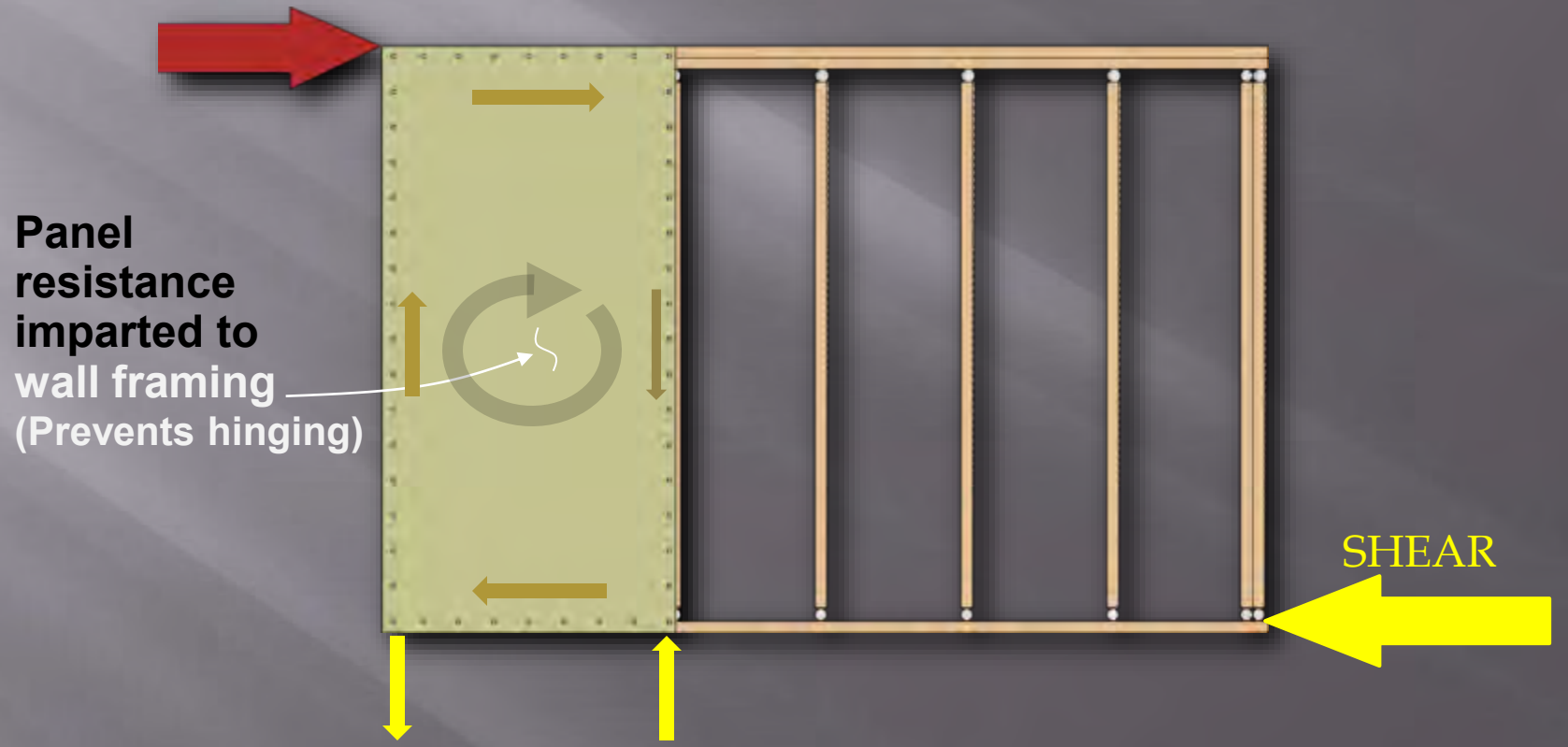
BWP vs. Shear Walls



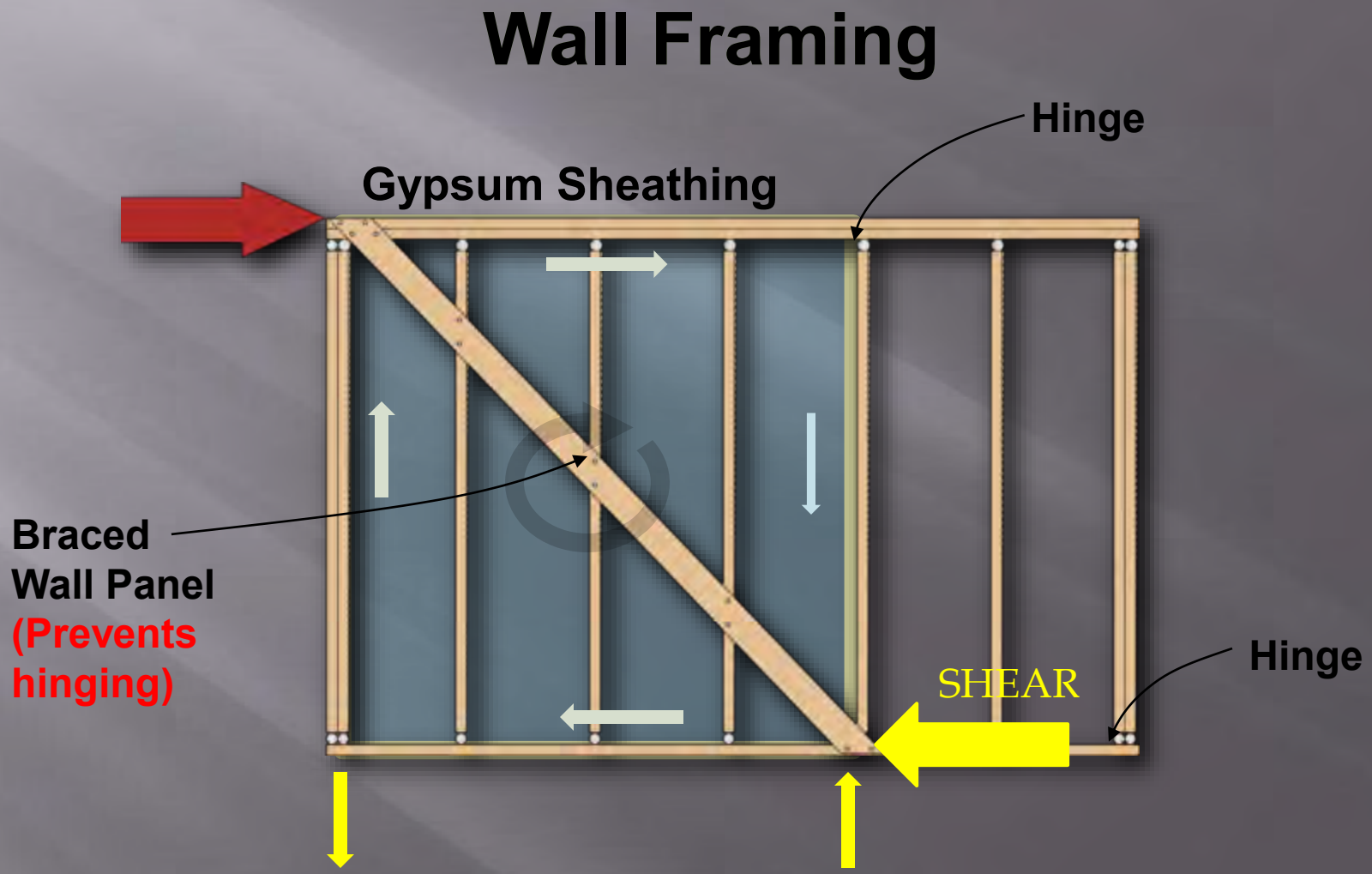
Only small amount transfers

BWP vs. Shear Walls

Wall Framing



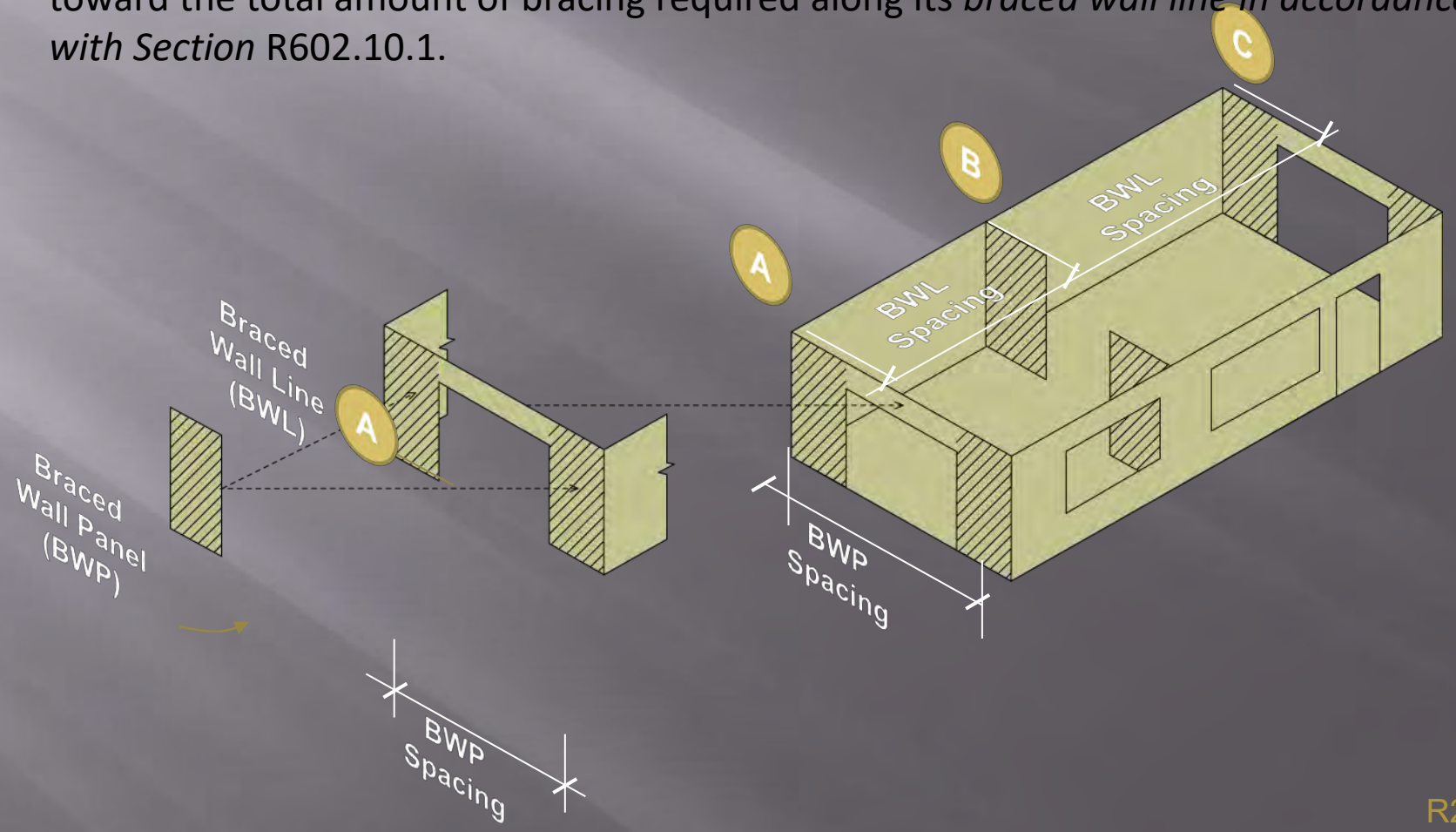
BWP vs. Shear Walls



Terminology

BWP, BWL & Spacing

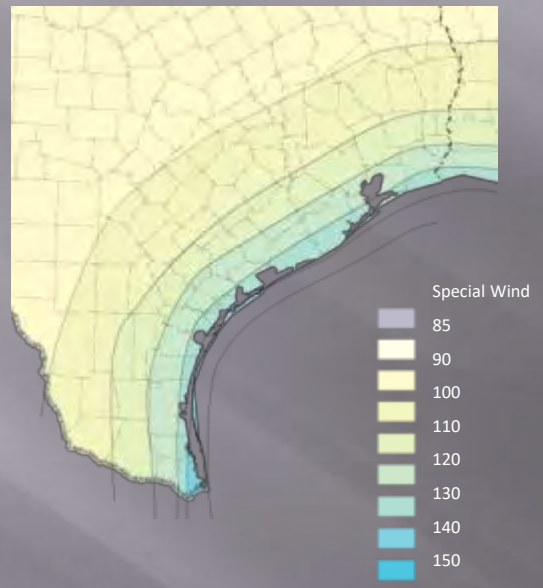
BRACED WALL PANEL. A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material and anchors. The panel's length meets the requirements of its bracing method and contributes toward the total amount of bracing required along its *braced wall line in accordance with Section* R602.10.1.



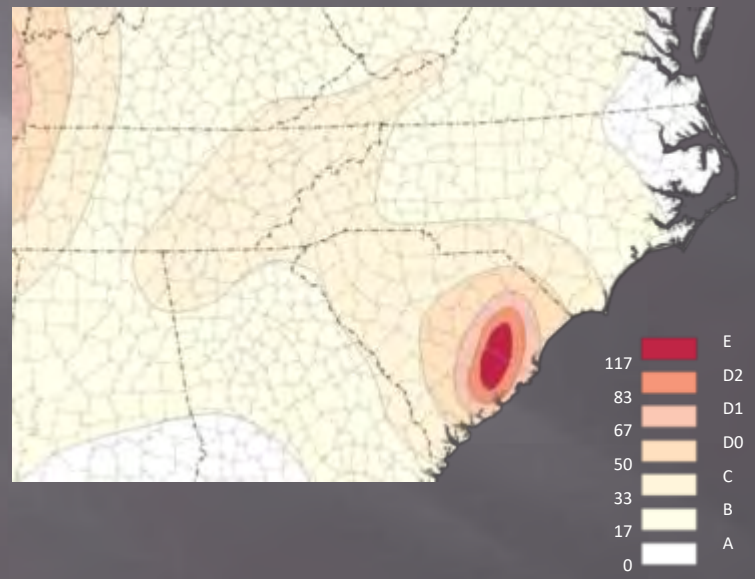
R202

Terminology

Wind Speed



Seismic Risk



Both wind speed and seismic risk must be considered when defining required wall bracing. The required bracing length is the greater of the two bracing lengths.

Terminology
When Considering Bracing

When considering whether wind or seismic requirements control, a number of factors must be considered.

- **Wall bracing length - either wind or seismic may control**
- **Use the longest required length.**
- **Hold-downs, Roof Ties, Limits – if wind or seismic requirements require additional connections or limits, they must be applied regardless of which requirement set controls.**

Wind
•Wall bracing length •Braced wall line spacing •Wall height •Eave to ridge height •Roof ties

Seismic
•Wall bracing length •Braced wall line spacing •Hold-downs •Material weight limits •Irregularity of Building

Terminology

Wind

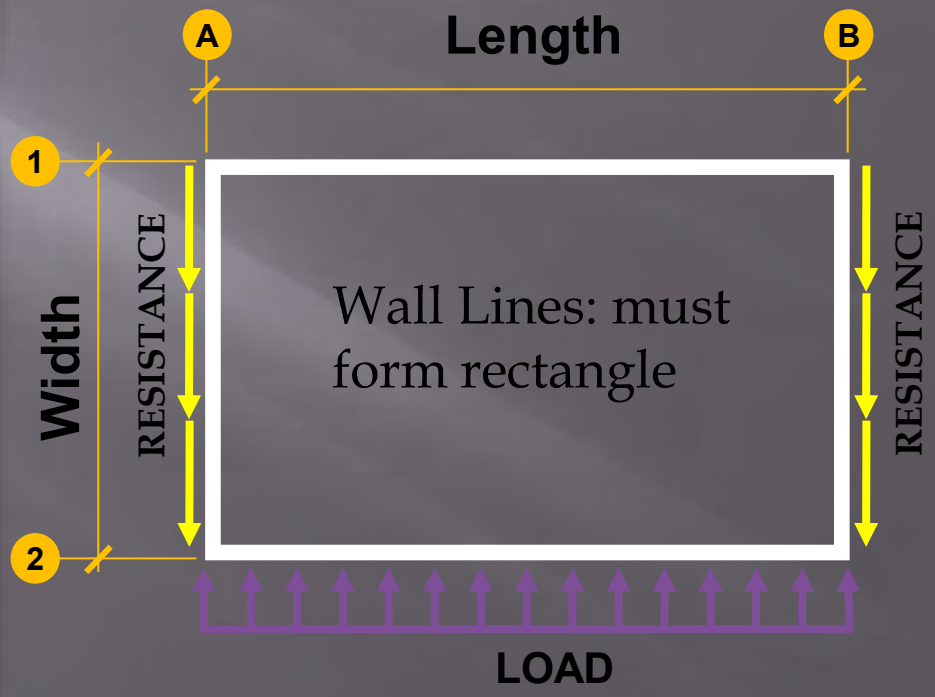
BWL Spacing = 60' max.

Seismic

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

SDC D_0, D_1, & D_2 (all dwellings)
- BWL Spacing = 25' max.
- Permitted to be = 35' max.
  - to accommodate one room not exceeding 900 ft^2
  - L/W < 3:1
  - Increase bracing by factor of 1.4

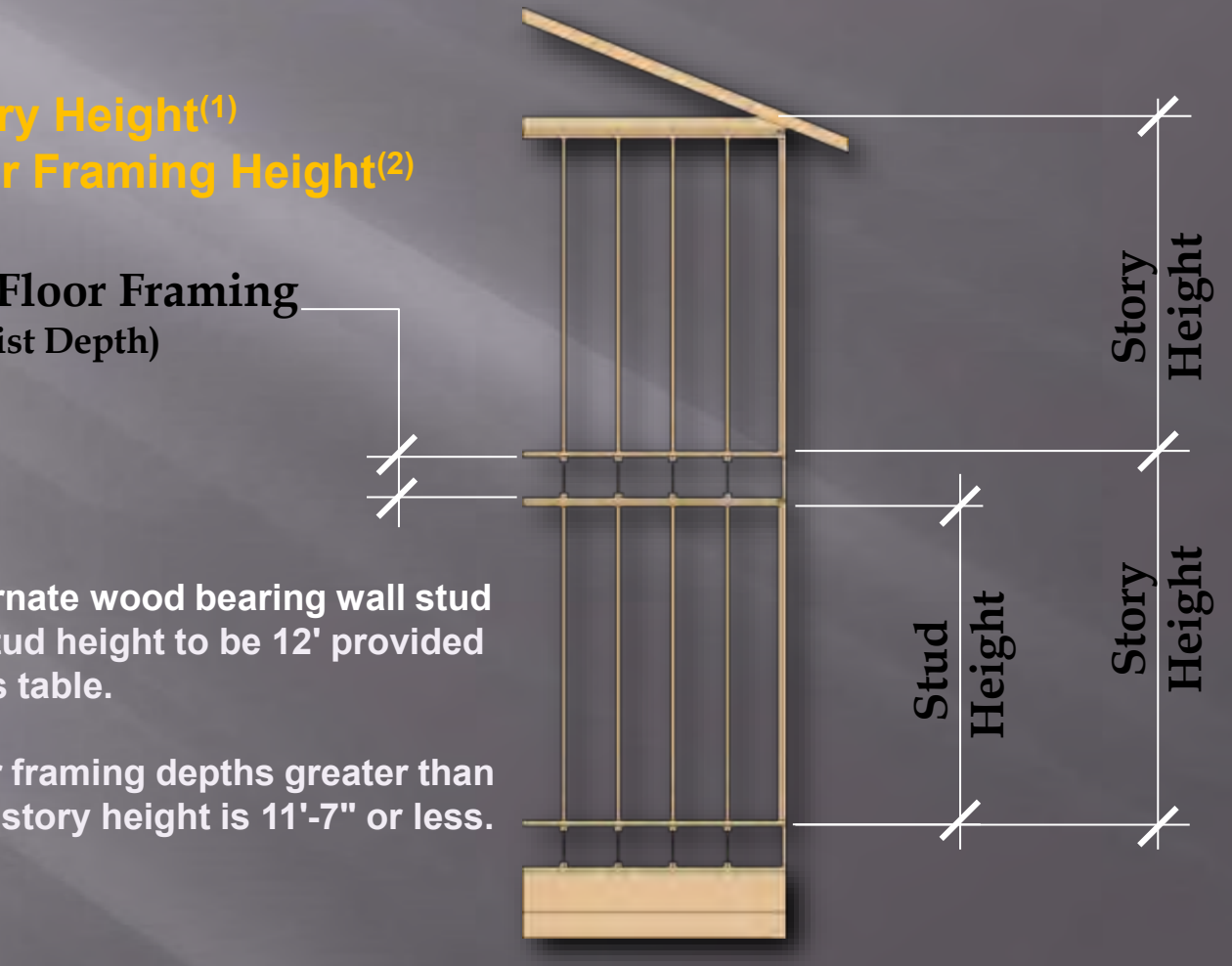
Braced Wall Line



Tables R602.10.1.3(1),(2),(3),
Table R602.10.3.(3) & R602.10.3(4)

Limits

11’7”= Max. Story Height(1)
16" = Max. Floor Framing Height(2)



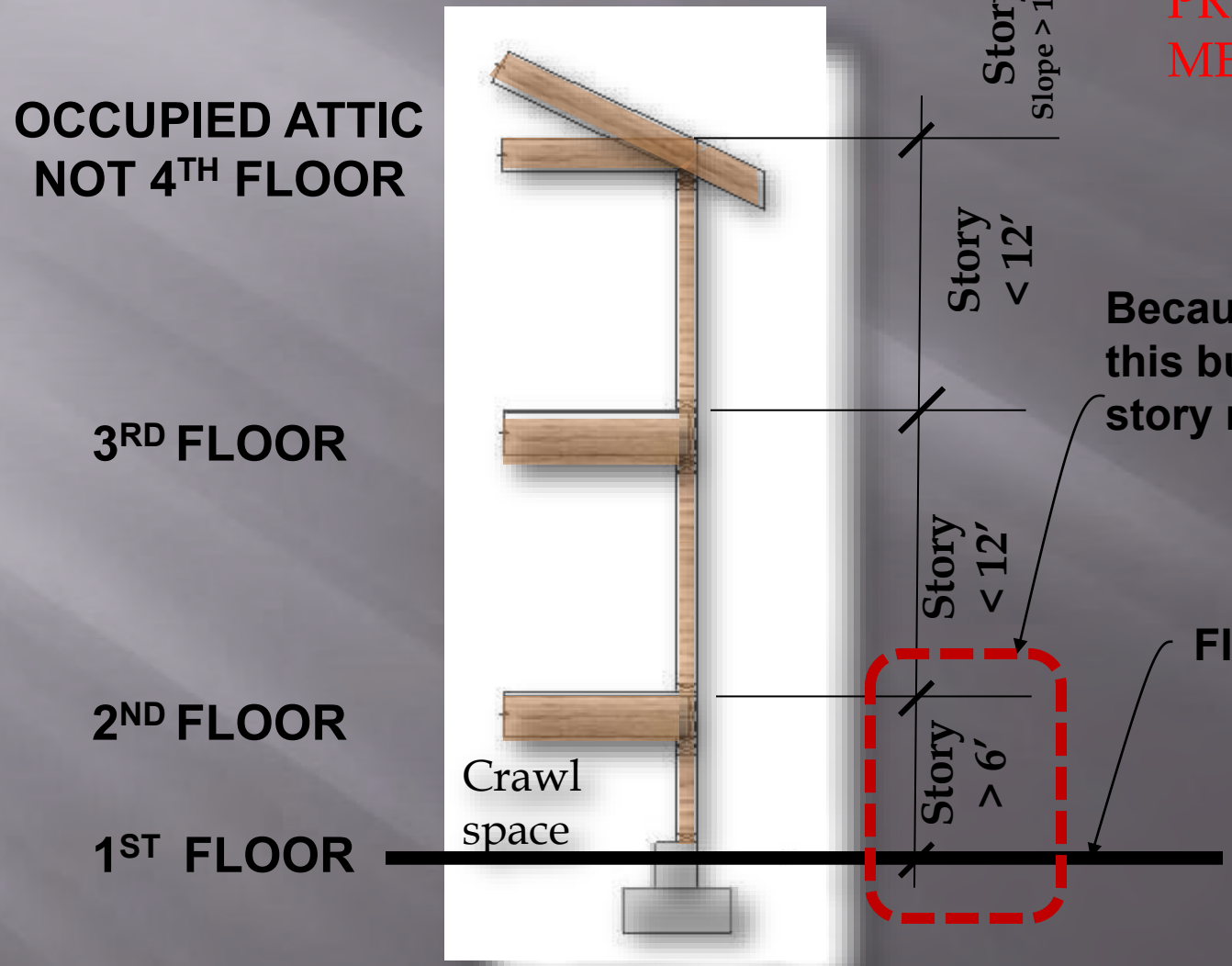
(1) Table R602.3(6) Alternate wood bearing wall stud sizing permits the stud height to be 12' provided compliance with this table.

(2) R301.3 Permits floor framing depths greater than 16" when maximum story height is 11'-7" or less.

R301.3

Limits

NOTE!: ONLY THREE FLOORS ARE PERMITTED USING PRESCIPTIVE METHODS



Limits

STORY: That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above.

STORY ABOVE GRADE PLANE: Any story having its finished surface entirely above grade plane, or in which the finished surface of the floor next above is:

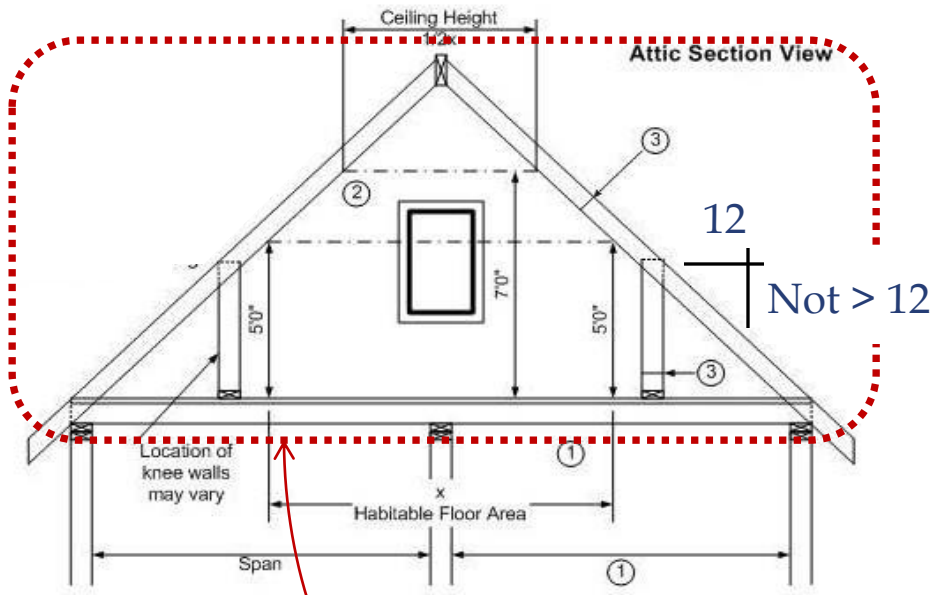
1. More than 6 feet (1829 mm) above grade plane,' or
2. More than 12 feet (3658 mm) above the finished ground level at any point.

Changed from 2006 IRC

ATTIC, HABITABLE: A finished or unfinished area, not considered a *story,* complying with all of the following
requirements:

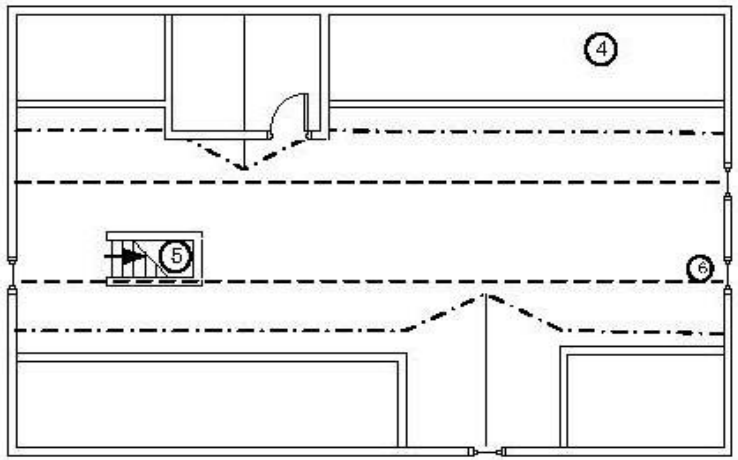
1. The occupiable floor area is at least 70 square feet in accordance with Section R304,
2. The occupiable floor area has a ceiling height in accordance with Section R305, and
3. The occupiable space is enclosed by the roof assembly above, knee walls (if applicable) on the sides and the floor-ceiling assembly below.

Habitable Attic



Watch weight- added gyp. Bd. Adds weight

Attic Floor Plan Showing Ceiling Height

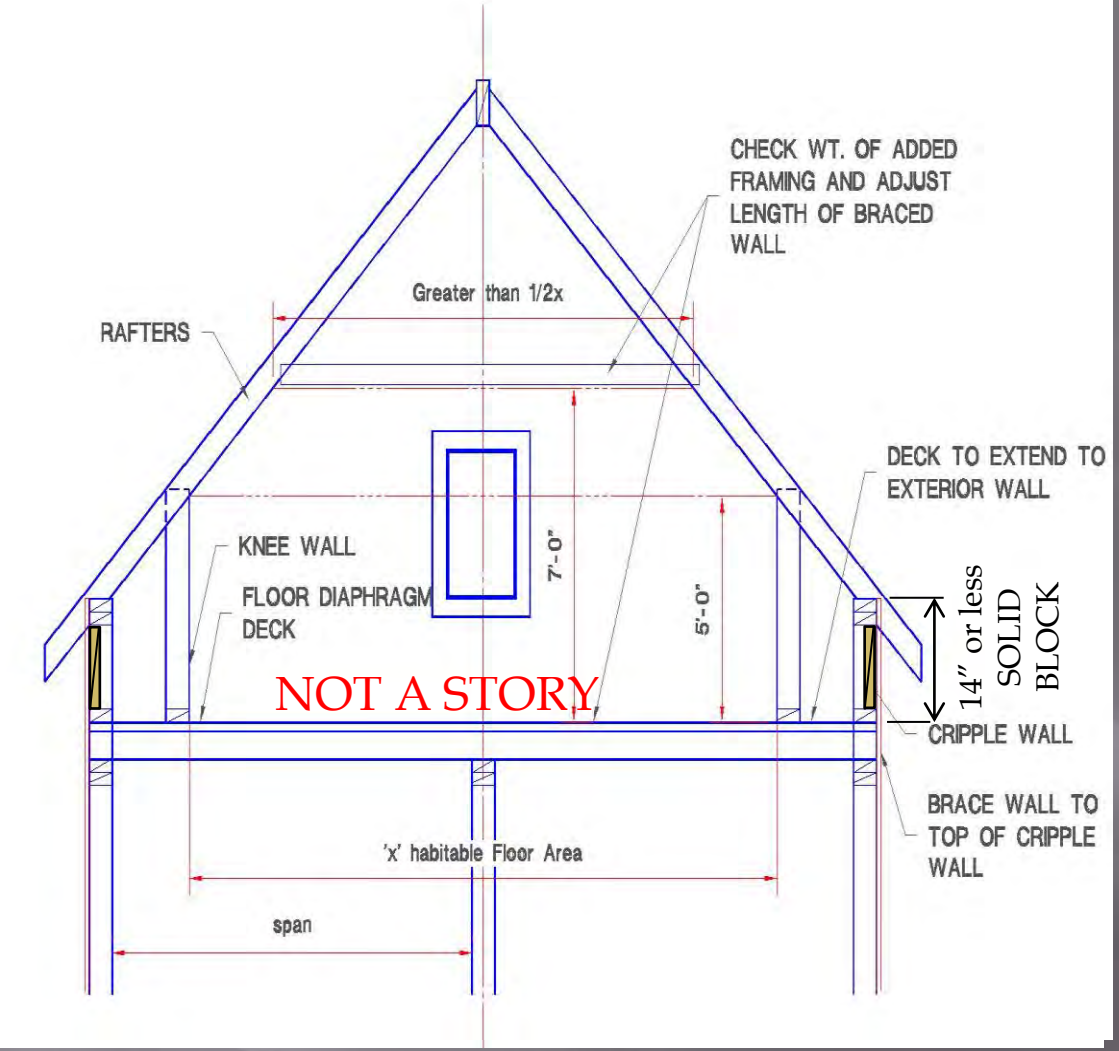


Habitable Attics are defined similarly in the IRC 2006, 2012 and 2015. The IRC 2012 and 2015/2018 do not consider Habitable Attic as a story.

Note: The consensus in the engineering community is that roofs steeper than 12/12 should be considered as walls in the prescriptive provisions of the IRC.

There are no provisions for brace wall lengths with slopes steeper than 12/12

Habitable Attic



Can this condition be made to conform to the prescriptive requirements?

If so how?

Usual Attic framing seen in the industry

Solution:

1. Brace wall to top of cripple wall, solid block. (see **IBC 2308.2 exception**)
2. Consider weight greater than 15lbs but less than 25lbs per sq. ft. of projected area and apply appropriate adjustment factors to brace wall length.
3. If cripple wall is ≤ 14" and solid blocked, calculate required brace wall length based on the habitable attic as NOT being an additional floor.

Limits

When to Apply Seismic Requirements

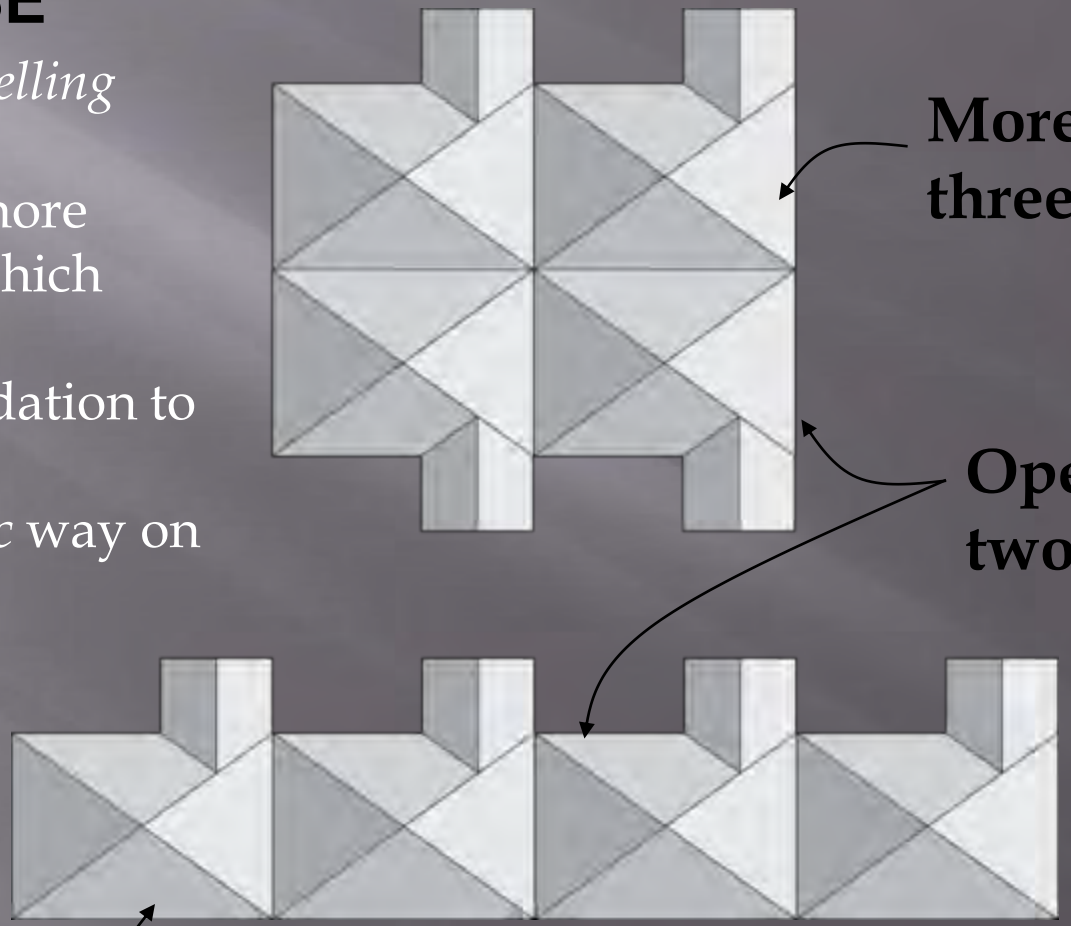
Seismic Design Category	One- and two-family	Townhouses
A & B	Exempt	Exempt
C	Exempt	Apply
D_0	Apply	Apply
D_1	Apply	Apply
D_2	Apply	Apply
E	Apply	Apply

R301.2.2

Loads & Limits

R202 TOWNHOUSE

1. A single-family *dwelling unit constructed*
2. group of three or more attached units in which each unit
3. extends from foundation to roof and
4. with a *yard or public* way on at least two sides.

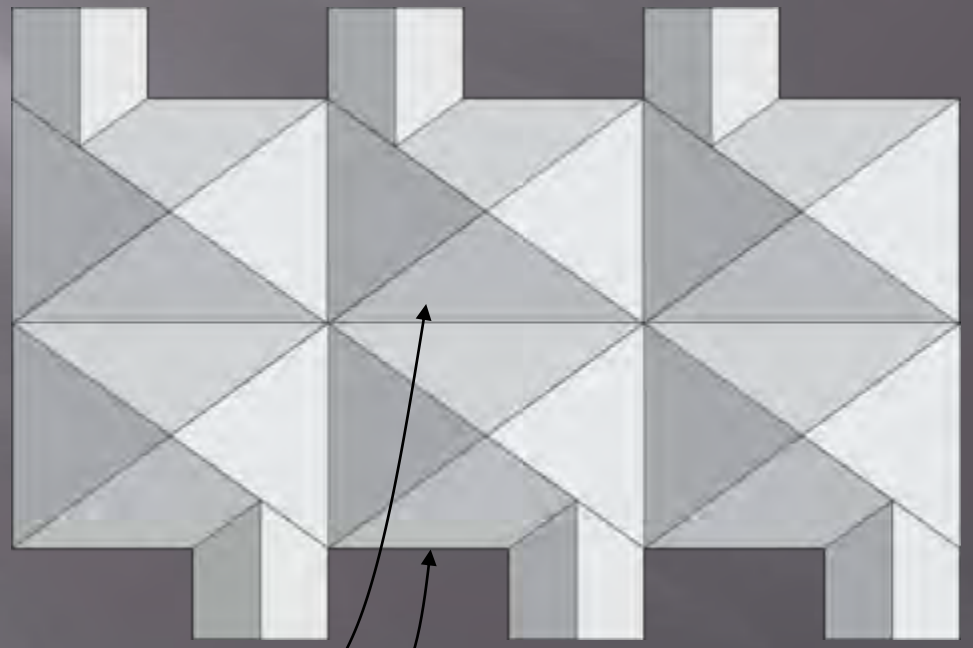


R301.2.2

Limits

R202 TOWNHOUSE

- Three or more attached units
- Units extend from foundation to roof
- Open space on at least two sides



<u>Not</u> open two sides
(therefore, not a townhouse?)

R301.2.2

WEIGHT LIMITATIONS

R301.2.2 Seismic Design Category C: Structures assigned to Seismic Design Category C shall conform to the requirements of this section.

R301.2.2.2 Weights of materials: Average dead loads shall not exceed 15 pounds per square foot (720 Pa) for the combined roof and ceiling assemblies (on a horizontal projection) or 10 pounds per square foot (480 Pa) for floor assemblies, except as further limited by Section R301.2.2. Dead loads for walls above *grade* shall not exceed:

1. Fifteen pounds per square foot (720 Pa) for exterior light-frame wood walls.
2. Fifteen pounds per square foot (670 Pa) for ext walls.
3. s per square foot (480 Pa) for interior l
4. ds per square foot (240 Pa) for interior formed steel walls.
5. Eighty pounds per square foot (3830 Pa) for 8inch thick (203 mm) masonry walls.
6. Eighty-five pounds per square foot (4070 Pa) for 6-inch-thick (152 mm) concrete walls.
7. Ten pounds per square foot (480 Pa) for SIP walls.

Wind Requirements
Weight of materials provisions do not apply

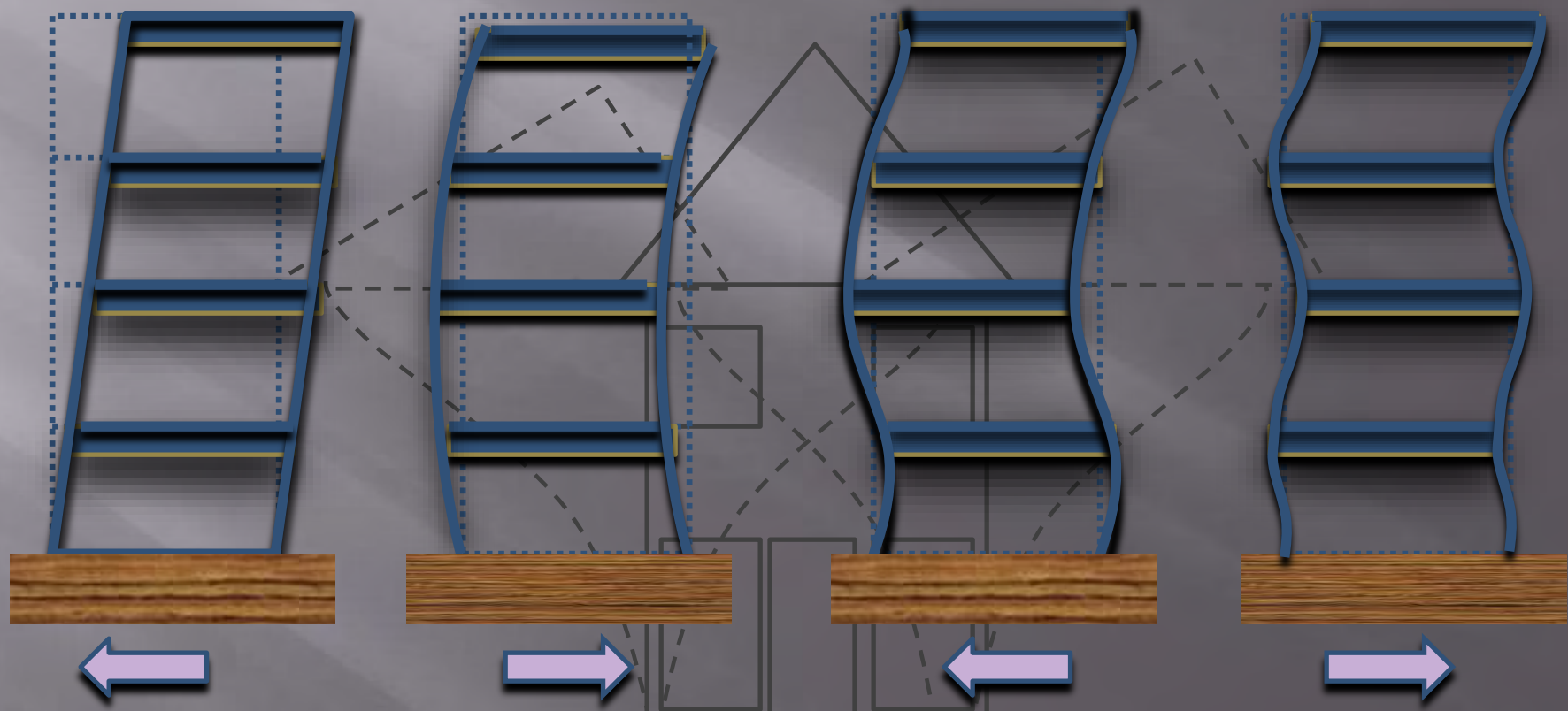
Seismic Requirements
Weight of materials provisions apply

Limits: Weight

About 10:12 max. roof slope based on wt.

LIMITED WEIGHT OF ROOF AND CEILING				
Component		Unit Weight	Weight over Projected Area Slope=9:12	Weight over Projected Area Slope=10:12
Upper floor Ceiling (bottom to top)				
Mechanical Loads (avg.)		0.50		
1/2" attic deck over 1/4 of 2nd floor area		0.38		
Rockwool insulation R-38 (16"deep)		0.68		
2x8 Joists @ 16" o.c. & misc. framing		2.40		
1/2" Gypsum Board		2.20		
Total		6.16	6.16	6.16
Roof (top to bottom)				
Fiberglass shingles		3.00		
15# Felts or membrane		0.15		
1/2" Plywood or OSB Deck		1.5		
2x8 rafters @ 16" o.c. & misc. framing		2.40		
Total		7.05	8.81	9.18
Total Roof + Ceiling		14.32	14.97	15.33

Effect of Lateral Earthquake Forces



Limits: R301.2.2 Seismic provisions

The seismic provisions of this code shall apply as follows:

1. Townhouses in **SDC C, D_0, D_1 and D_2**
2. Detached one- and two-family dwellings in **SDC D_0, D_1 and D_2**

Notice: Seismic provisions do not apply in **SDC C** for detached one- and two-family dwellings

Language changed from 2009

R301.2.2

Limits: R301.2.2 Seismic Provisions

- The seismic design categories and corresponding short period design spectral response accelerations, S_{DS} shown in Figure R301.2(2) are based on soil Site Class D.

- If soil conditions are other than Site Class D, the short period design spectral response accelerations, S_{DS} for a site can be determined according to Section 1613.5 of the *International Building Code.*

- It is permitted to be used to set the seismic design category according to Table R301.2.2.1.1, and to interpolate between values in Tables R602.10.1.2(2), R603.9.2(1) and other seismic design requirements of this code.

Site Classification

ASCE 7-10 Table 20.3-1

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the following characteristics: —Plasticity index $PI > 20$, —Moisture content $w \geq 40\%$, —Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1 ft/s = 0.3048 m/s; 1 lb/ft^2 = 0.0479 kN/m^2.

IRC Based on Site Class D sites

IRC TABLE FOR SD CATEGORY

TABLE R301.2.2.1.1
SEISMIC DESIGN CATEGORY DETERMINATION

CALCULATED S_{DS}	SEISMIC DESIGN CATEGORY
$S_{DS} \leq 0.17g$	A
$0.17g < S_{DS} \leq 0.33g$	B
$0.33g < S_{DS} \leq 0.50g$	C
$0.50g < S_{DS} \leq 0.67g$	D_0
$0.67g < S_{DS} \leq 0.83g$	D_1
$0.83g < S_{DS} \leq 1.17g$	D_2
$1.17g < S_{DS}$	E

http://earthquake.usgs.gov/designmaps/us/application.php

EXAMPLE

DETERMINING SEISMIC DESIGN CATEGORY

TIPTONVILLE, TN

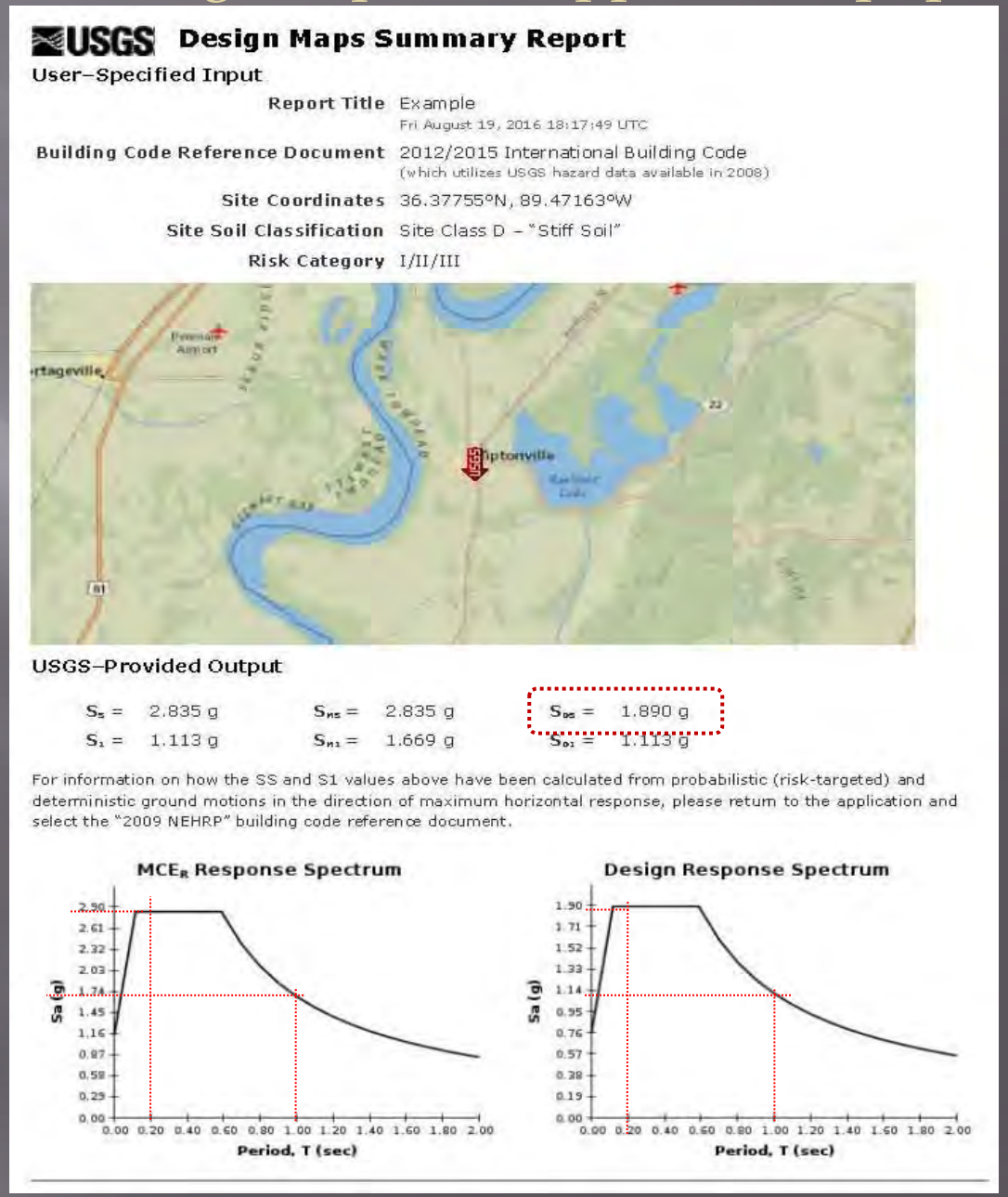
Fri August 19, 2016 18:17:49 UTC

2012/2015 IBC

(which utilizes USGS hazard data available in 2008)

36.37755°N, 89.47163°W

Site Class D – "Stiff Soil" I/II/III



USGS Design Maps Summary Report

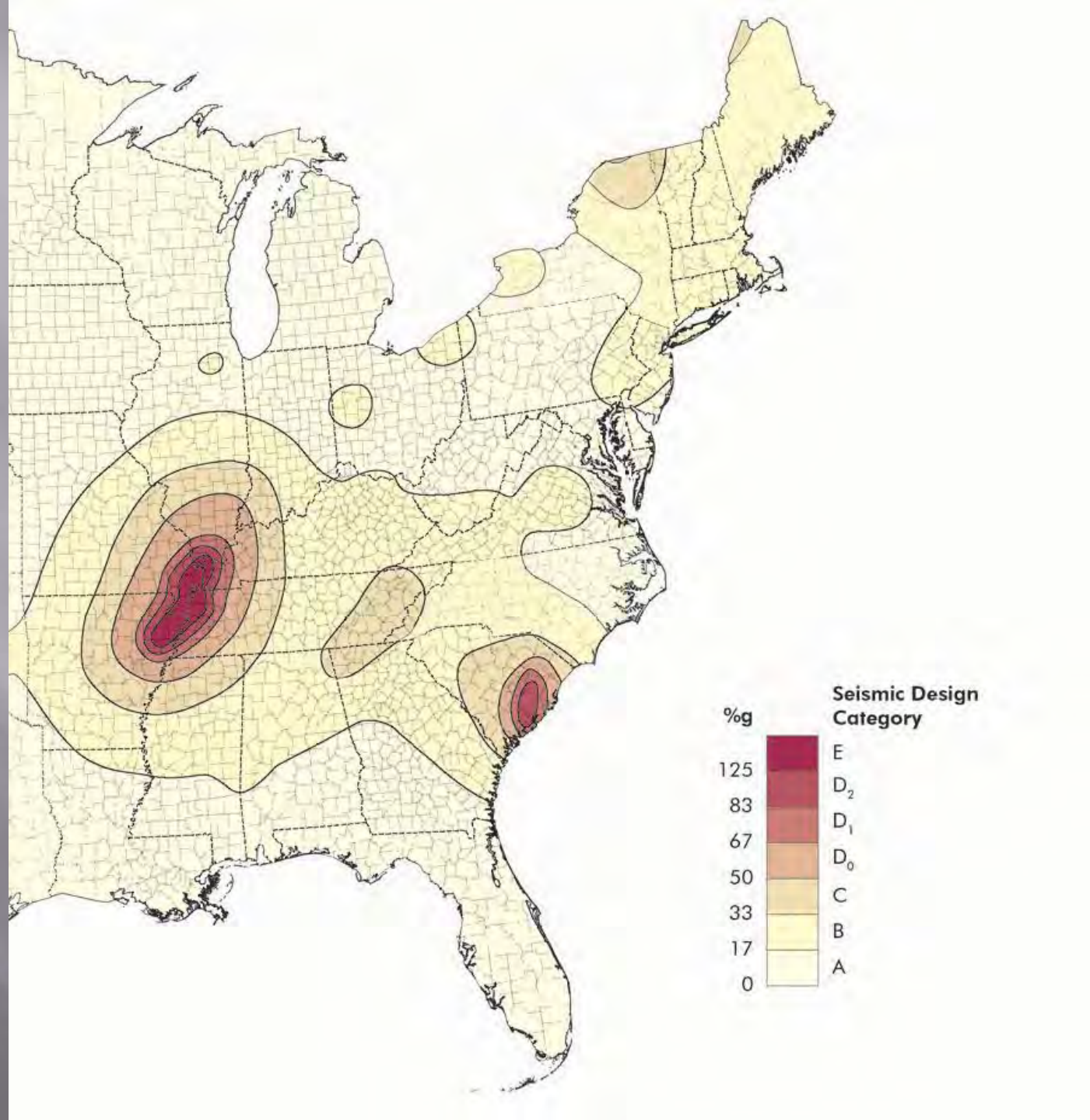
User–Specified Input

Report Title	Example Fri August 19, 2016 18:17:49 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	36.37755°N, 89.47163°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_s =	2.835 g	S_{ms} =	2.835 g	S_{ds} =	1.890 g
S_1 =	1.113 g	S_{m1} =	1.669 g	S_{d1} =	1.113 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.



- OR -

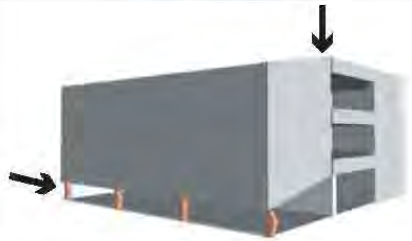
SIMPLY READ THE MAP

Limits
Irregular Structures

R301.2.2.6 Irregular buildings

"Prescriptive construction … shall not be used for irregular structures located in Seismic Design Categories C, D_0, D_1, and D_2. Irregular portions of structures shall be designed … with accepted engineering practice…; design of the remainder of the building shall be permitted to use the provisions of this code."

Wind Requirements	Seismic Requirements
Irregular building provisions do not apply	Irregular building provisions apply SDS C, D_0, D_1, D_2

plan conditions	resulting failure patterns	performance	code remedies
		**P1 Torsional Irregularity: Unbalenced Resistance**	
		Localized damage. Collapse mechanism in extreme instances.	Modal Analysis, +65 foot high in SDC D,E, F. 25% increase to diaphragm connection design forces. Amplified forces to max of X3.
		**P2 Re-entrant Corners**	
		Local damage to diaphragm and attached elements. Collapse mechanism in extreme instances in large buildings.	25% increase in diaphragm connection design forces.
		**P3 Diaphragm Eccentricity and Cutouts**	
		Localized structural damage.	25% increase in diaphragm connection design forces.
		**P4 Nonparallel Lateral Force-Resisting System**	
		Leads to torsion and instability, localised damage.	Combine 100% and 30% of forces in 2 directions, use maximum.
		**P5 Out-of-Plane Offsets: Discontinuous Shearwalls**	
		Collapse mechanism in extreme circumstances.	Modal Analysis, +65 foot high in SDC D,E, F. 25% increase to diaphragm connection design forces.

R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 1

1. When exterior shear wall lines or *braced wall panels are not in one plane vertically from the* foundation to the uppermost *story in which* they are required.

There are Exceptions

R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 • Item 1 *(cont.)*:

a) Floor joists are nominal 2 inches by 10 inches (51 mm by 254 mm) or larger and spaced not more than 16 inches (406 mm) on center.

b) The ratio of the back span to the cantilever is at least 2 to l.

c) Floor joists at ends of *braced wall panels* are doubled.

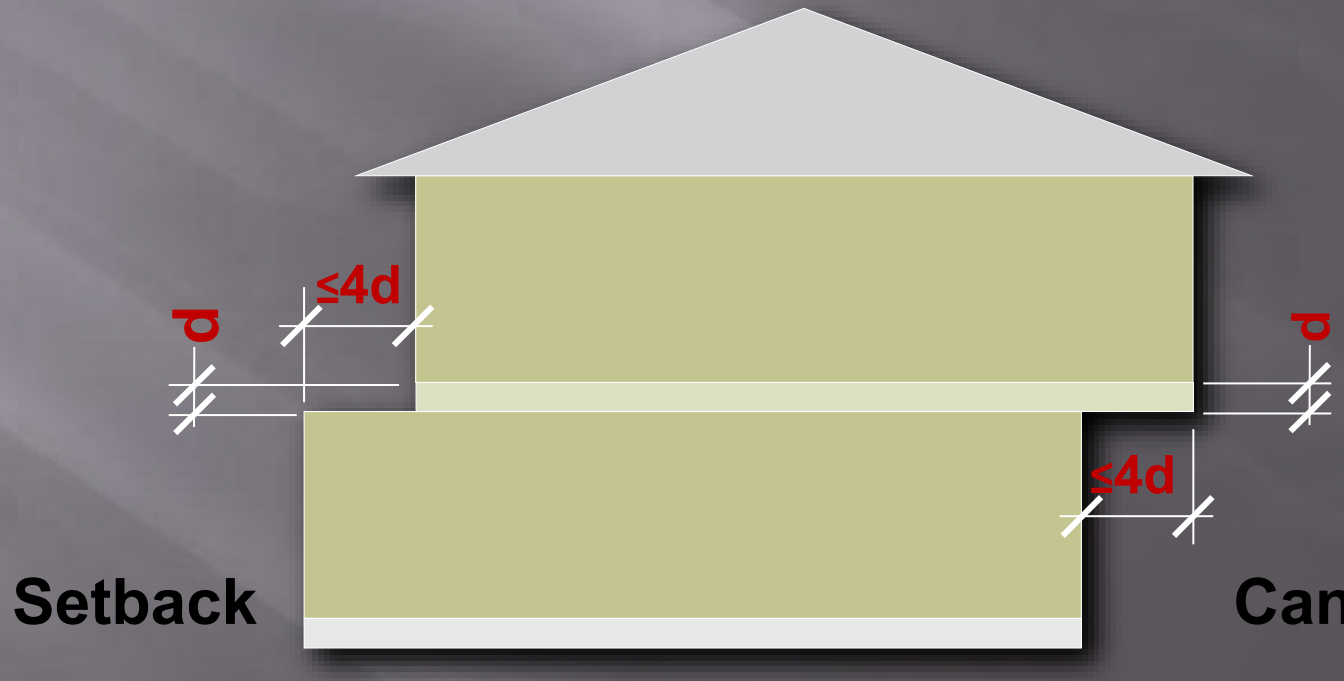
d) For wood-frame construction, a continuous rim joist is connected to ends of all cantilever joists. When spliced, the rim joists shall be spliced using a galvanized metal tie not less than 0.058 inch (16 gage) and 1 1/2 inches wide fastened with six l6d nails on each side of the splice or a block of the same size as the rim joist of sufficient length to fit securely between the joist space at which the splice occurs fastened with eight l6d nails on each side of the splice; and

e) Gravity loads carried at the end of cantilevered joists are limited to uniform wall and roof loads and the reactions from headers having a span of 8 feet or less

R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 • (Item 1 *(cont.)*: exceptions

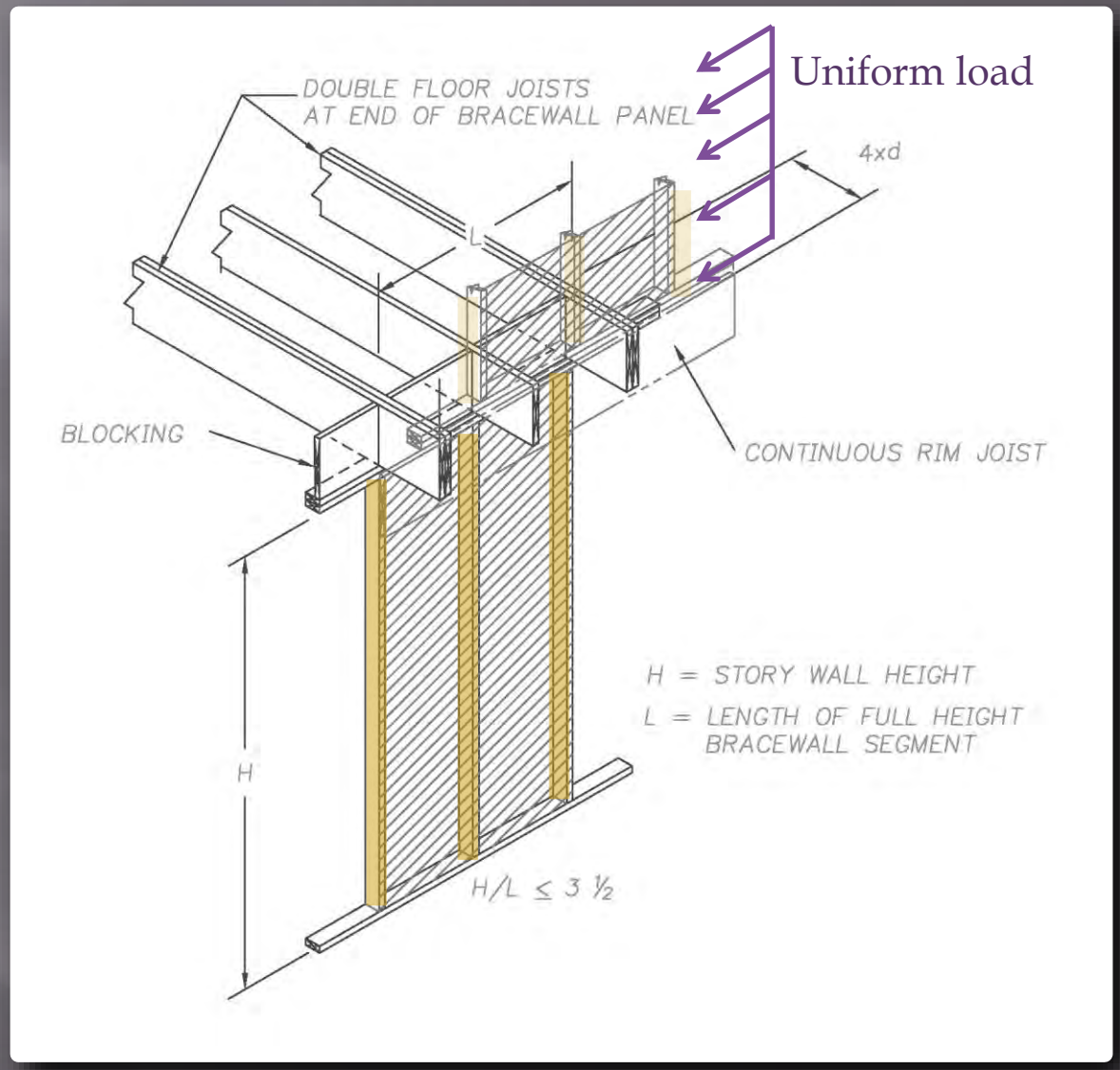
a. Setback or Cantilever 2" x 10“ min. Joists @ 16" Max

b. Back span to cantilever = 2:1



R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 • (Item 1 - exceptions to)

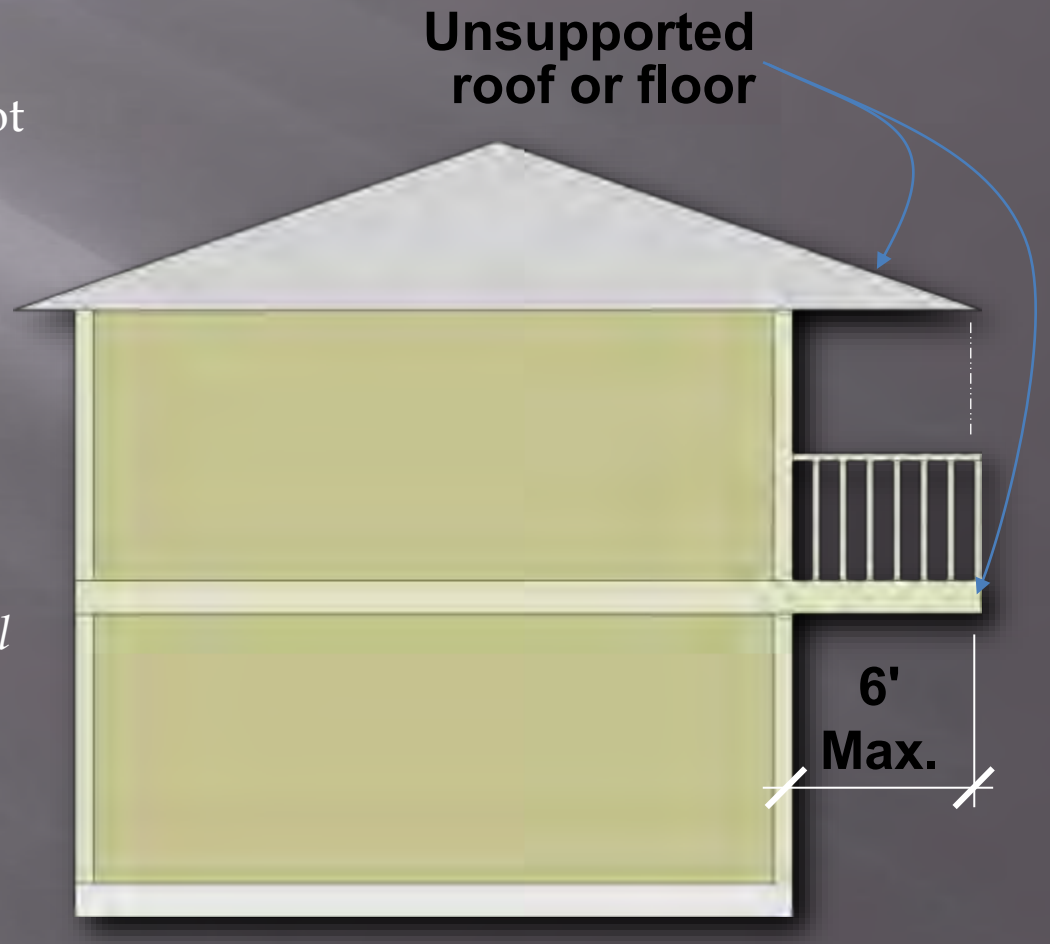
c. **Floor joists at ends of braced wall panels are doubled.**
d. **Continuous rim joist**
e. **Uniform wall and roof loads headers having a span of 8 feet or less**



R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 2

2. When a section of floor or roof is not laterally supported by shear walls or *braced wall lines* on all edges.

Exception: Portions of floors that do not support shear walls or *braced wall panels* above, or roofs, shall be permitted to extend no more than 6 feet (1829 mm) beyond a shear wall or *braced wall line.*



R301.2.2.2.5

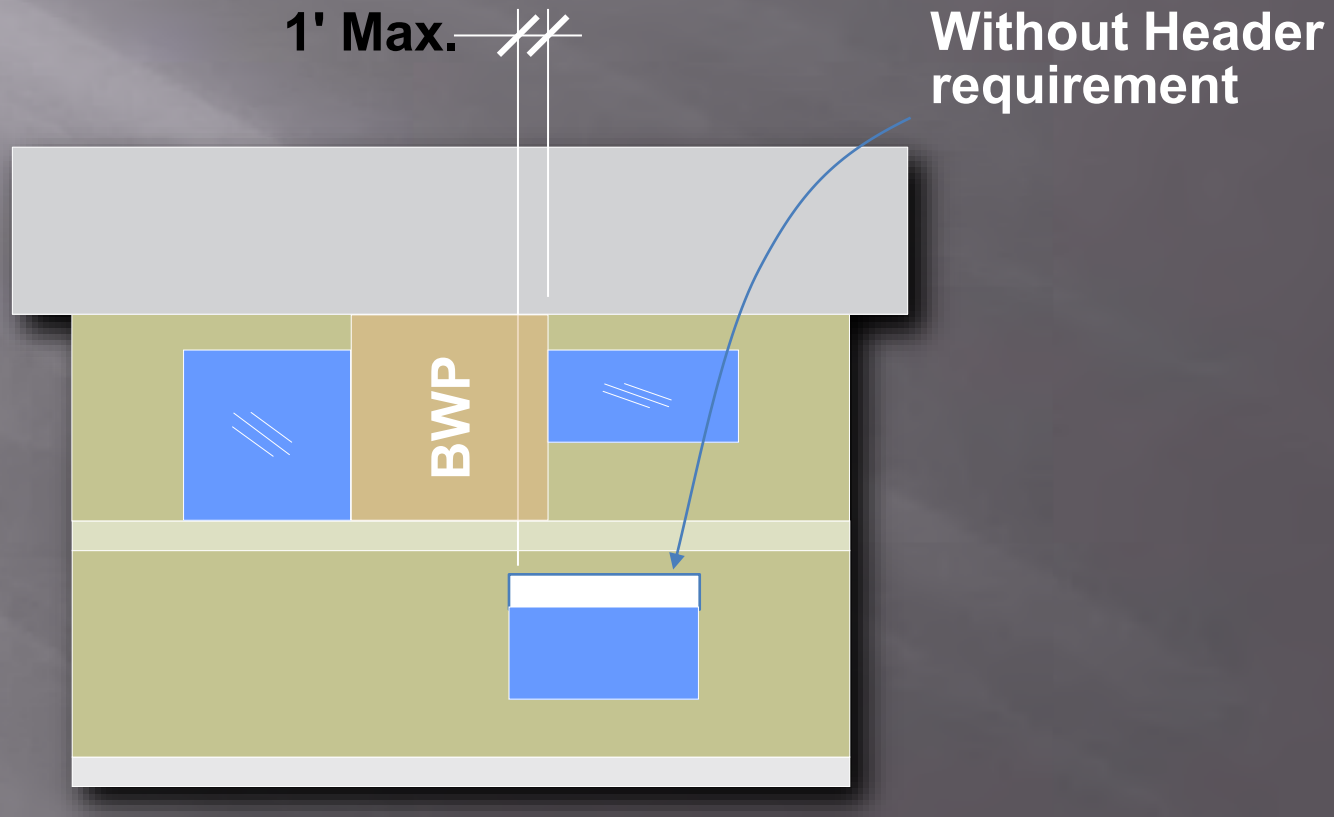
R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 3

3. When the end of a braced wall panel occurs over an opening in the wall below and ends at a horizontal distance greater than 1 foot (305 mm) from the edge of the opening. This provision is applicable to shear walls and braced wall panels offset in plane and to braced wall panels offset out of plane as permitted by the exception to Item 1 above.

Exception: For wood light-frame wall construction, one end of a braced wall panel shall be permitted to extend more than 1 foot (305 mm) over an opening not more than 8 feet (2438 mm) wide in the wall below provided that the opening includes a header in accordance with the following:

1. The building width, loading condition and framing member species limitations of Table R502.5(1) shall apply; and
2. Not less than one 2 x 12 or two 2 x 10 for an opening not more than 4 feet (1219 mm) wide; or
3. Not less than two 2 x 12 or three 2 x 10 for an opening not more than 6 feet (1829 mm) wide; or
4. Not less than three 2 x 12 or four 2 x 10 for an opening not more than 8 feet (2438 mm) wide; and
5. The entire length of the braced wall panel does not occur over an opening in the wall below.

R301.2.2.2.5 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 3 *(cont.)*:

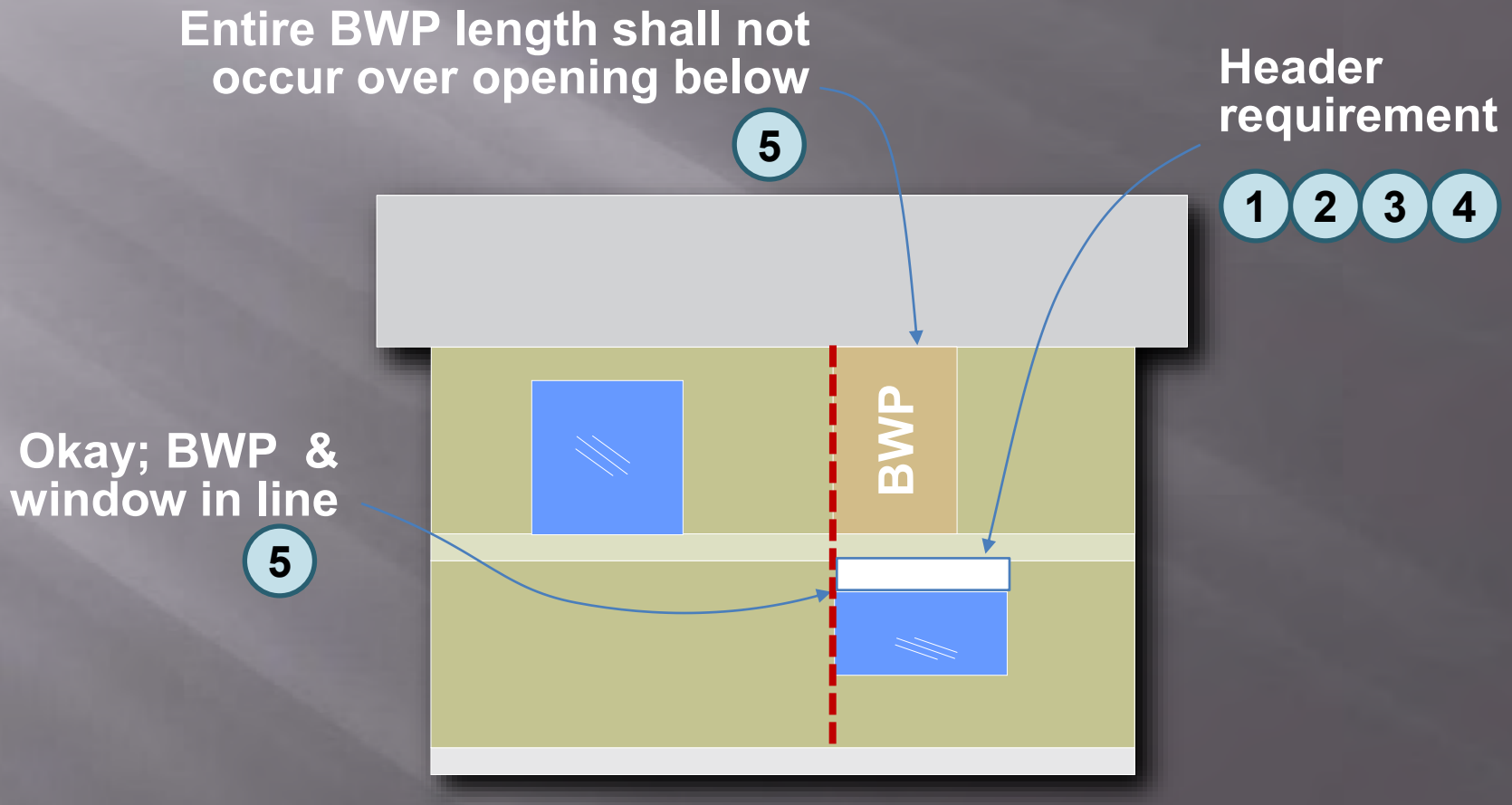


R301.2.2.2.5 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 3 *(cont.)*:

Header Requirements Per Table R502.5(1)		
Maximum Opening length		Minimum Header Requirements
2	4'	Qty 1 – 2" x 12" Qty 2 – 2" x 10"
3	6'	Qty 2 – 2" x 12" Qty 3 – 2" x 10"
4	8'	Qty 3 – 2" x 12" Qty 4 – 2" x 10"

1 Use of these header sizes is conditioned by footnotes in Table R502.5(1)

R301.2.2.2.5 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 3 *(cont.)*:



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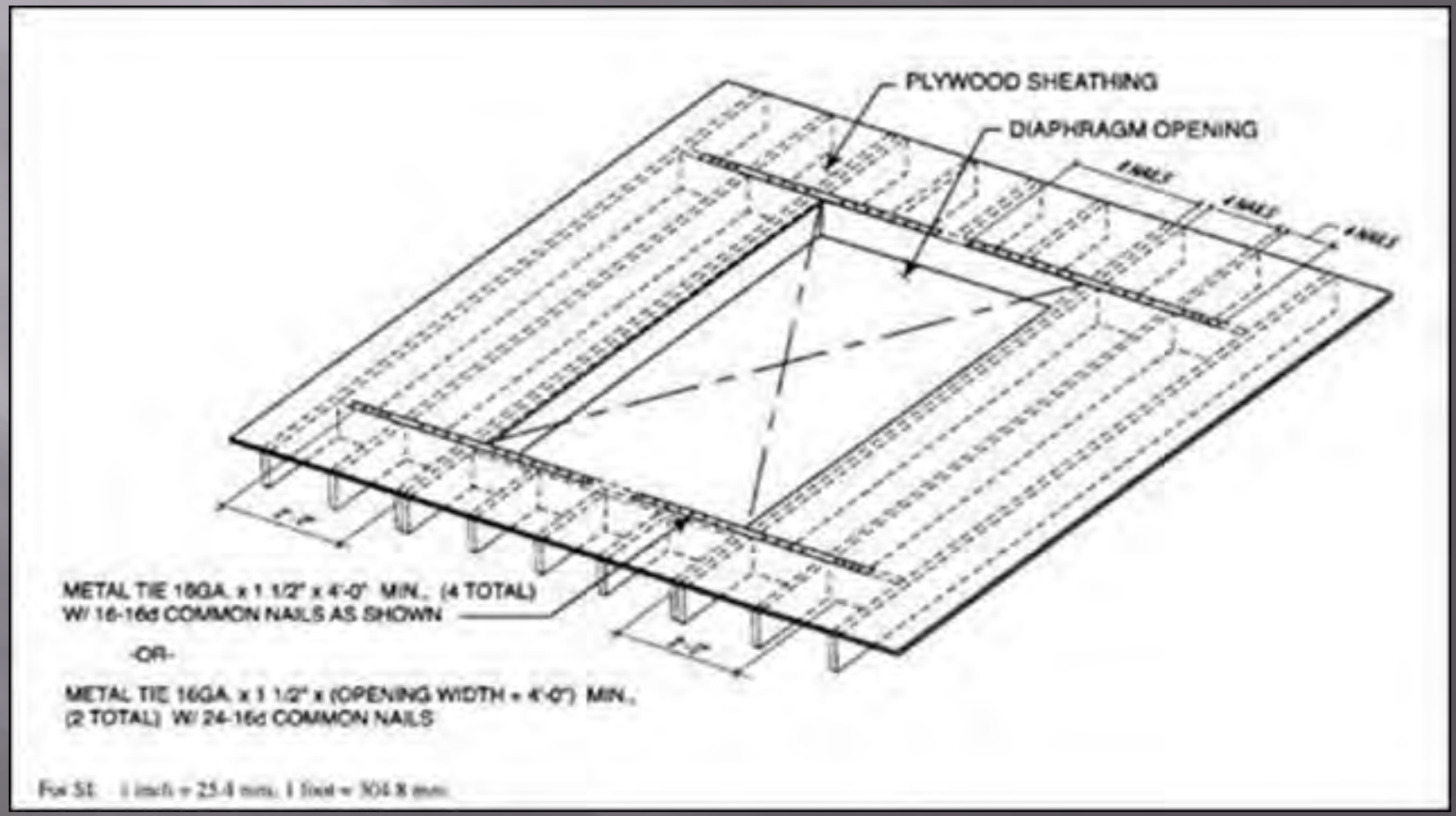
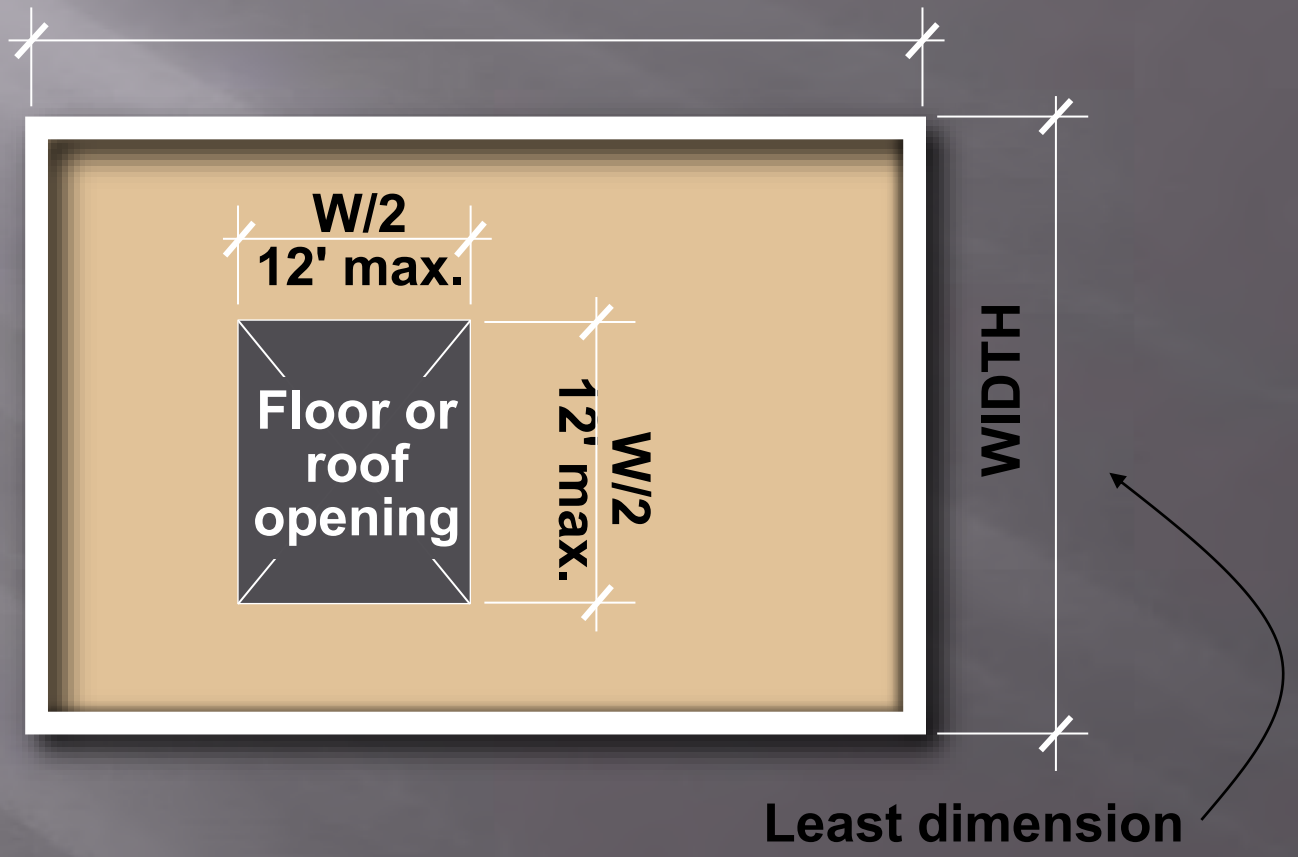
R301.2.2.6Irregular buildings Design Categories C, D_0, D_1, and D_2 • Item 4



R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 • Item 4 *(cont.)*:



Plan View

R301.2.2.2.5

R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 • Item 4 *(cont.)*:

Floor or Roof Opening:

Examples

R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 Items 5

When portions of a floor level are vertically offset.

Exceptions:

a) Framing supported directly by continuous foundations at the perimeter of the building.

b) For wood light-frame construction, floors shall be permitted to be vertically offset when the floor framing is lapped or tied together as required by Section R502.6.1.

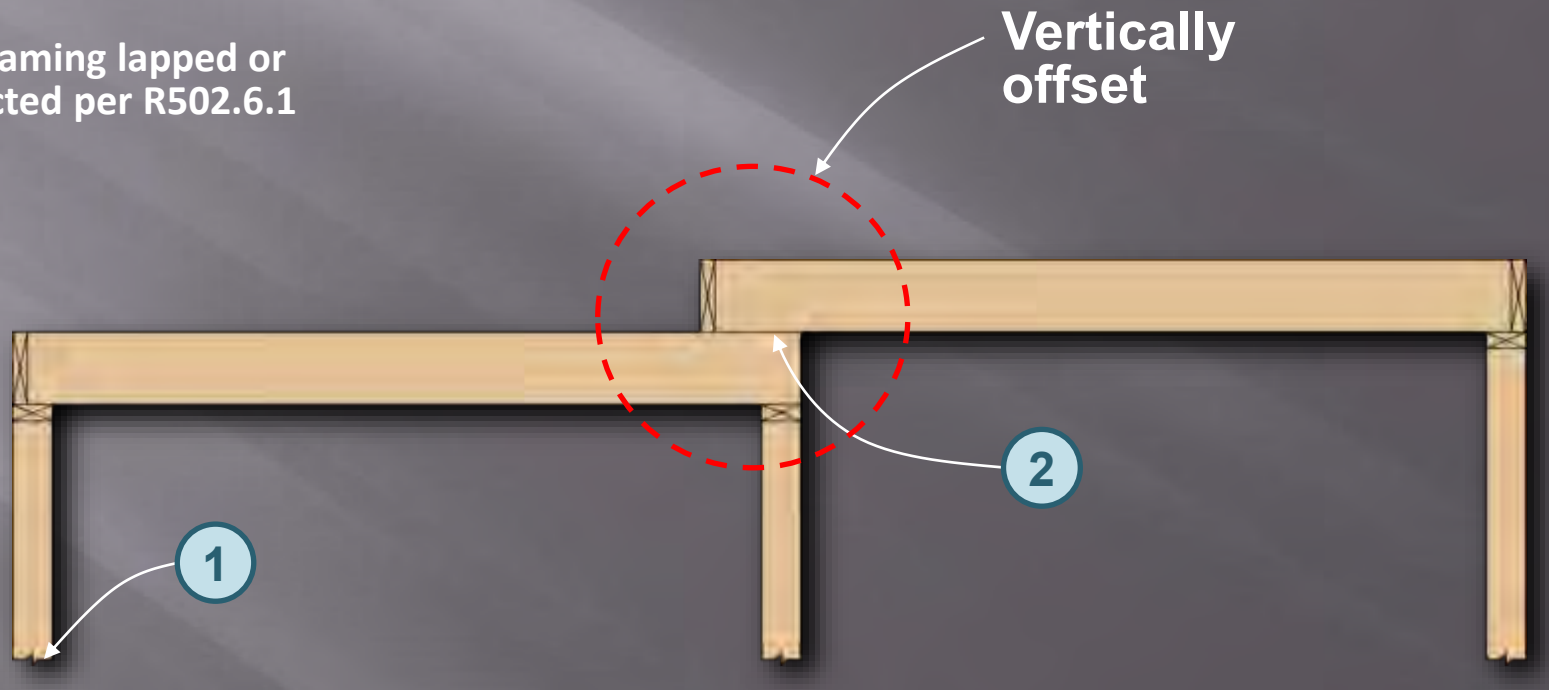
R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 5 *(cont.)*:

Vertical offset permitted if:

1. **Floor framing supported over continuous foundation at building perimeter,**

   or

2. **Floor framing lapped or connected per R502.6.1**

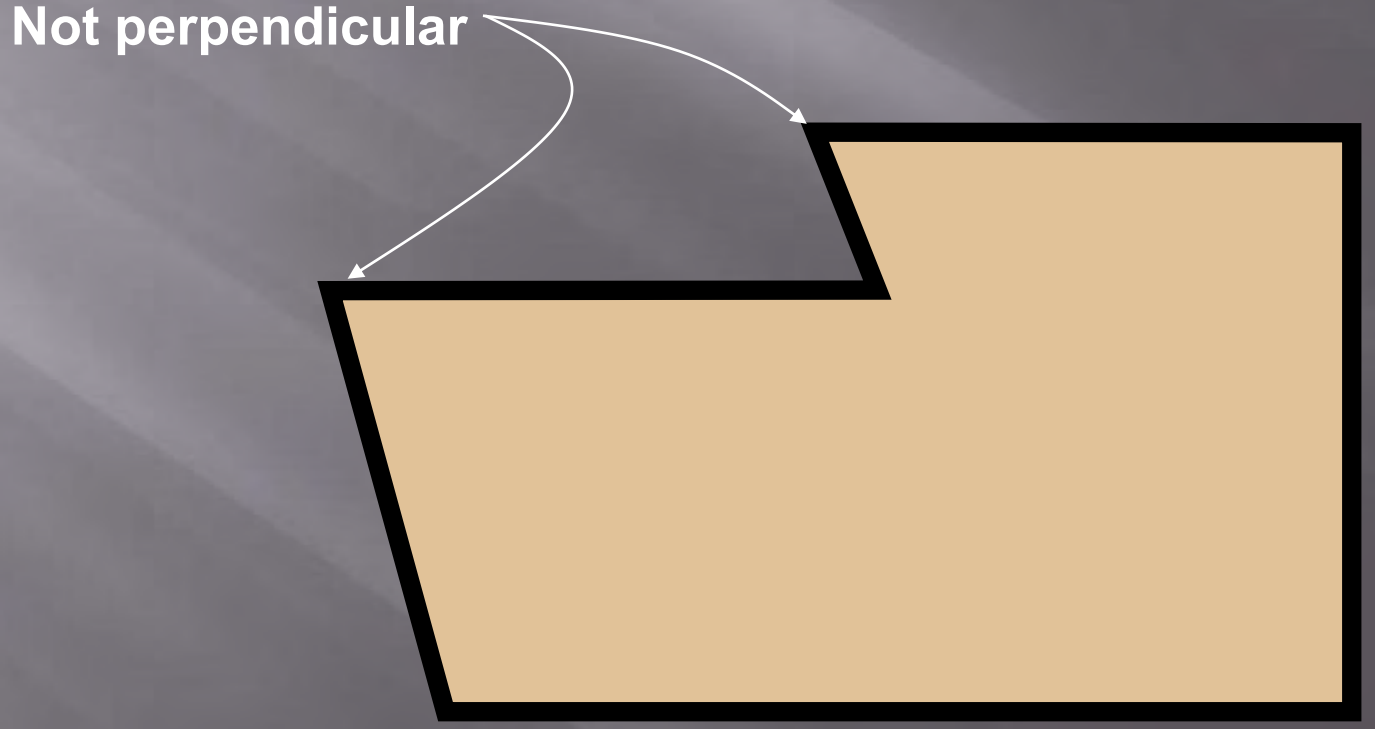


R301.2.2.2.5

R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2

Item 6

6. When shear walls and *braced wall lines do not* occur in two perpendicular directions.

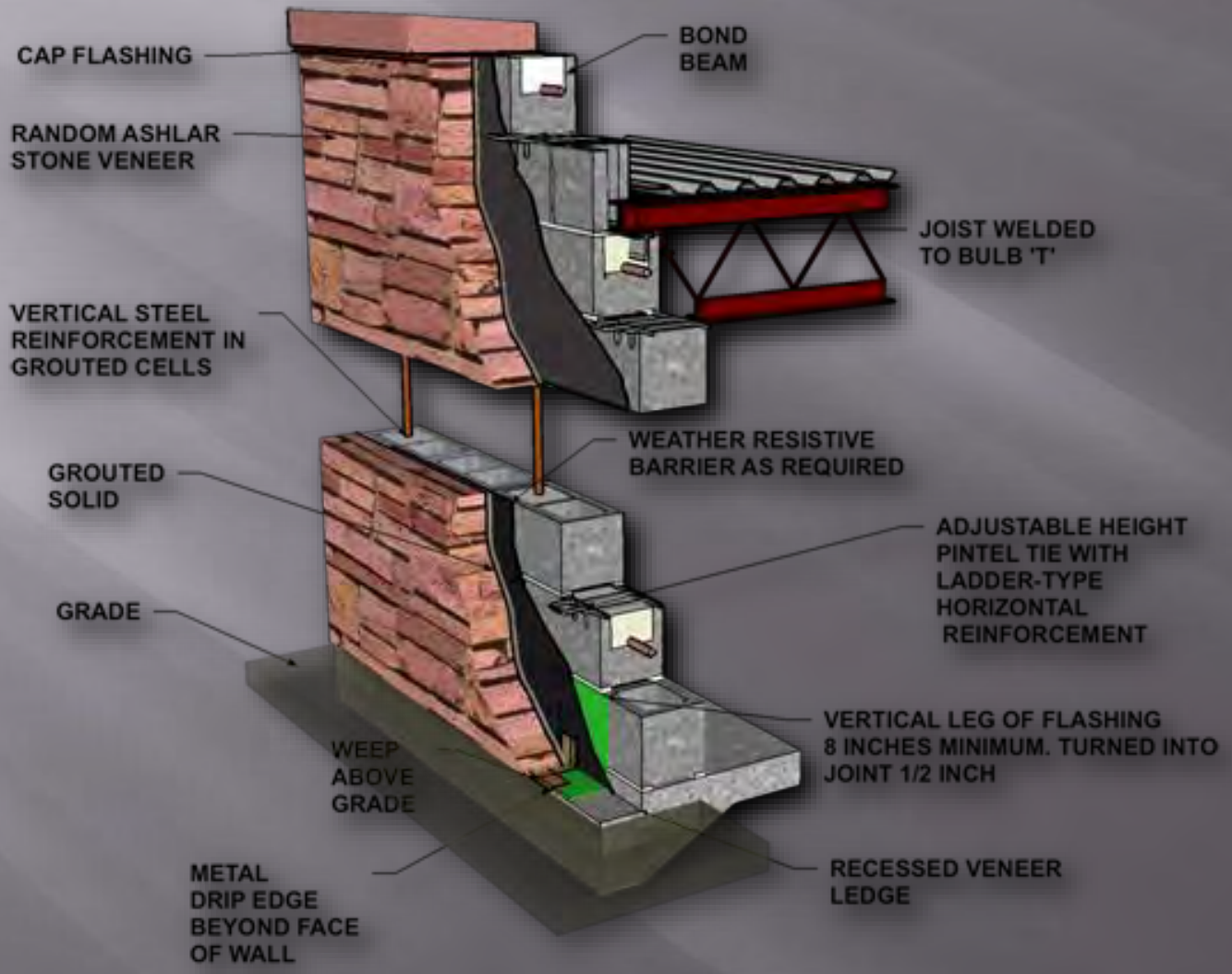


R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2

Item 7

7. When stories above *grade plane partially or* completely braced by wood wall framing in accordance with Section R602 or steel wall framing in accordance with Section R603 include masonry or concrete construction.

R301.2.2.6 Irregular buildings Design Categories C, D_0, D_1, and D_2 Item 7(*cont.*):



When this irregularity applies, the entire *story shall be designed in accordance with* accepted engineering practice.

Exception:

Fireplaces, chimneys and masonry veneer as permitted by this code.

R301.2.2.2.5

FOUNDATIONS

FOUNDATIONS

R401.1 Application

Wood foundations in Seismic Design Category Do, D_1, or D_2 shall be designed in accordance with accepted engineering practice.

R403.1.2 Continuous footing in Seismic Design Categories Do, D_1, or D_2

The *braced wall panels* at exterior walls of buildings located in Seismic Design Categories Do, D_1, or D_2 shall be supported by continuous footings. All required interior *braced wall panels* in buildings with plan dimensions greater than 50 feet (15 240 mm) shall also be supported by continuous footings.

2015 IRC CHANGES related to seismic

§R403.1.2, §R602.10.9.1 Continuous Footings in Seismic Design Categories D_0, D_1 and D_2

- In Section R602.10.9.1 (IRC 2012) no specific guidance for D_0, and D_1 to support interior braced wall panels.
- Section R403.1.2 clarifies the foundation requirements under braced wall panels in all high-seismic regions
- All requirements have been moved to R403.1.2 (IRC 2015)

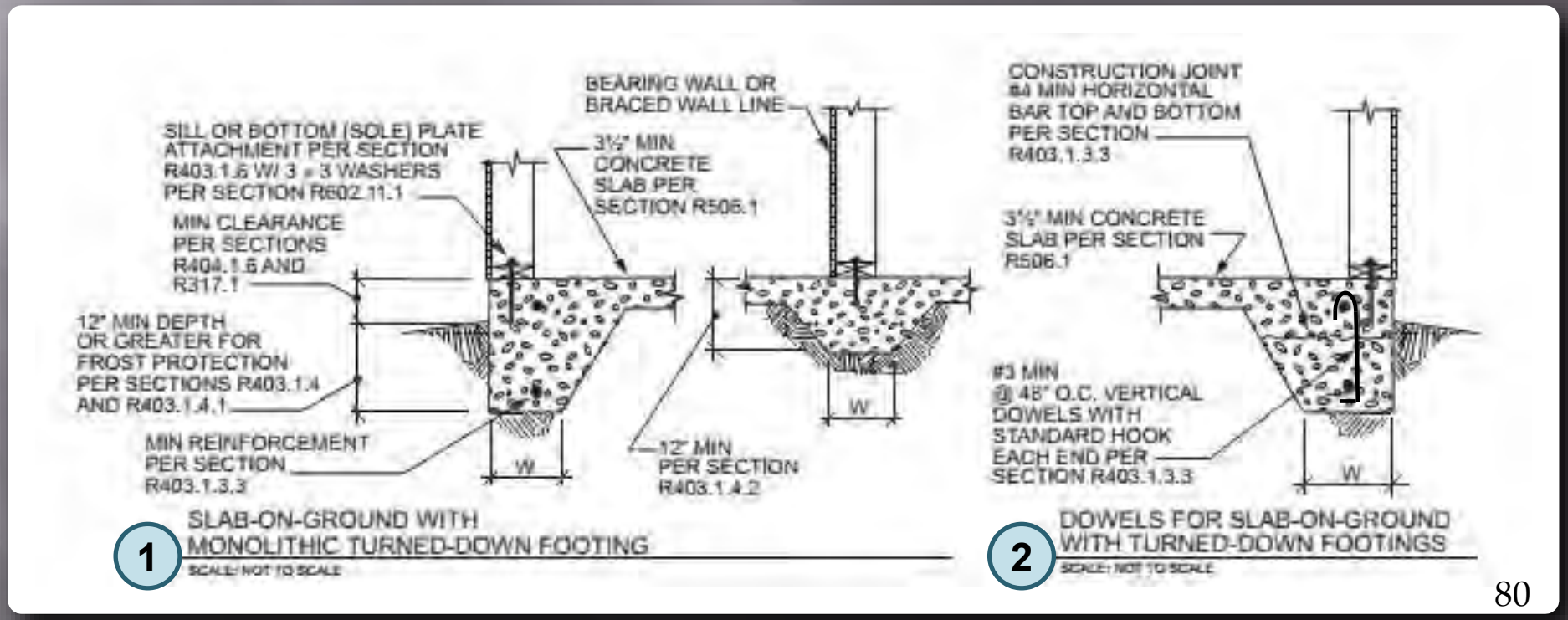
FOUNDATIONS

Continuous Foundation in Hi-Seismic §R403.1.2				
SDC	No. of Stories	Wall Location	Plan Length Dimension	
			Both Dim. ≤ 50 ft.	One or More dim. ≥ 50 ft.
D_0, D_1, D_2	**One Story**	Exterior	Continuous Footing Required	
		Interior	Continuous Ft'g Not Required	Continuous Ft'g required below all interior wall panels
D_0, D_1	**Two Story**	Exterior	Continuous Footing Required	
		Interior	Continuous Ft'g Not Required	Continuous footings are required below all interior braced wall panels with exceptions Section R403.1.2
D_2	**Two Story**	Exterior	Continuous Footing Required	
		Interior	Continuous footings are required below all interior braced wall panels with exceptions Section R403.1.2	Continuous footings are required below all interior braced wall panels with exceptions Section R403.1.2

FOUNDATIONS

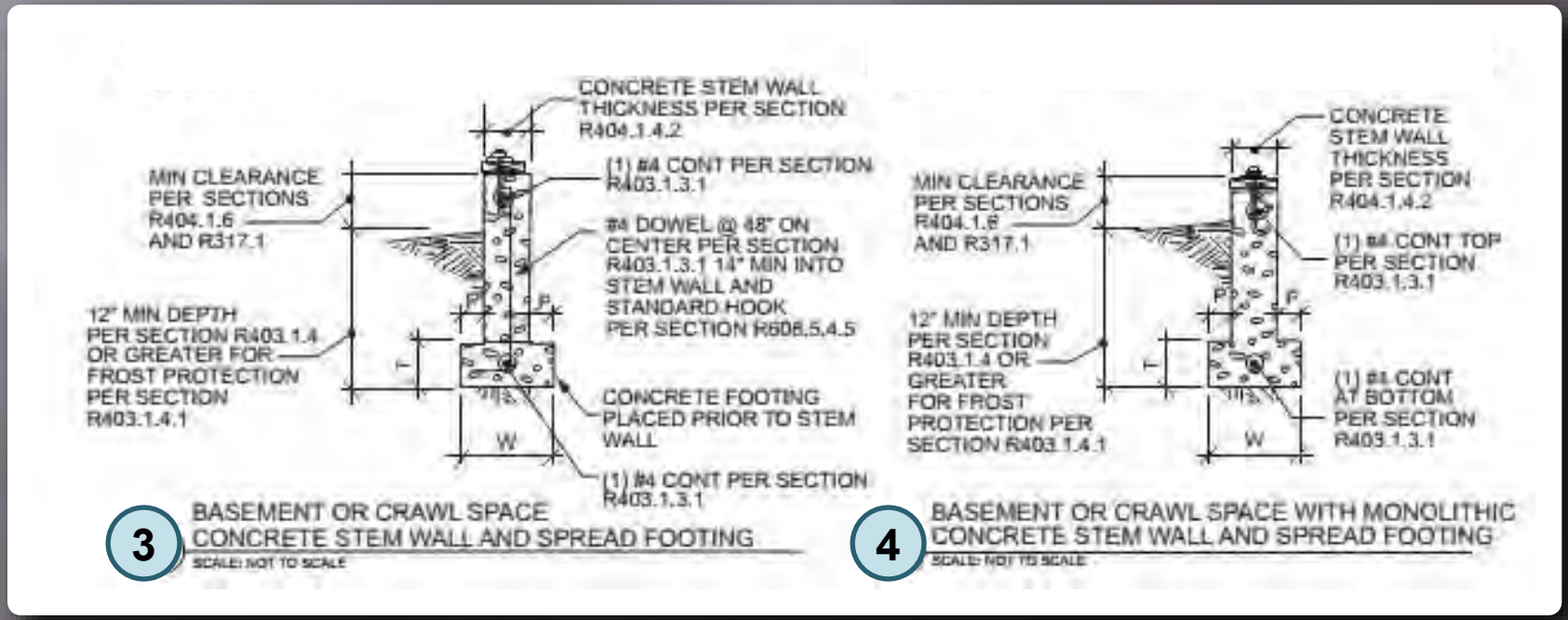
R403.1.3 Seismic reinforcing.

Concrete footings located in Seismic Design Categories Do, D_1 and D2, . . . shall have minimum reinforcement. Bottom reinforcement shall be located a minimum of 3inches clear from the bottom of the footing.



FOUNDATIONS: R403.1.3 Seismic Reinforcing.

In Seismic Design Categories Do, D_1 and D2 where a construction joint is created between a concrete footing and a stem wall, a minimum of one No.4 bar shall be installed at not more than 4 feet on center. . . Extend 14 inches into the stem wall. In Seismic Design Categories Do, D_1 and D2 where a grouted masonry stem wall is supported on a concrete footing and stem wall, a minimum of one No.4 bar shall be installed at not more than 4 feet on center. The vertical bar shall extend to 3 inches clear of the bottom of the footing and have a standard hook.

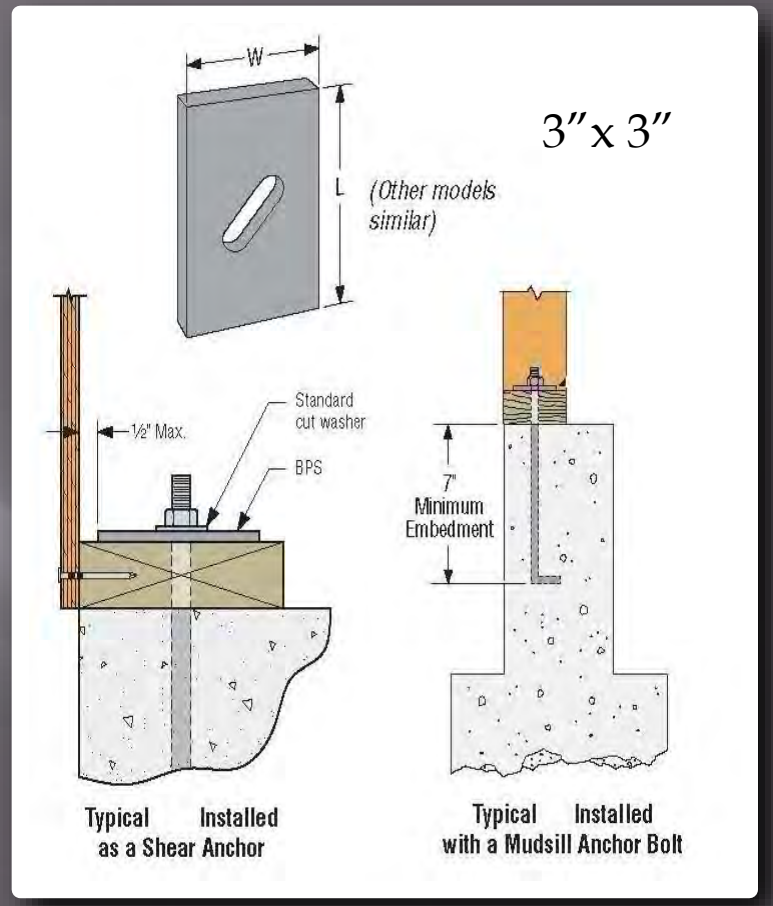


FOUNDATIONS: R403.1.6.1 Foundation Anchorage in SDC C, D_0, D_1, and D_2

In addition to the requirements of Section R403.1.6, the following requirements shall apply to wood light-frame structures in Seismic Design Categories Do, D_1 and D_2 and wood light-frame townhouses in Seismic Design Category C.

1. Plate washers conforming to Section R602.11.1shall be provided for all anchor bolts over the full length of required *braced wall lines* except where *approved* anchor straps are used. Properly sized cut washers shall be permitted for anchor bolts in wall lines not containing *braced wall panels.*

2. Interior braced wall plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located within 12 inches (305 mm) of the ends of each plate section when supported on a continuous foundation



Source: 2015 © 2015 SIMPSON STRONG-TIE COMPANY INC

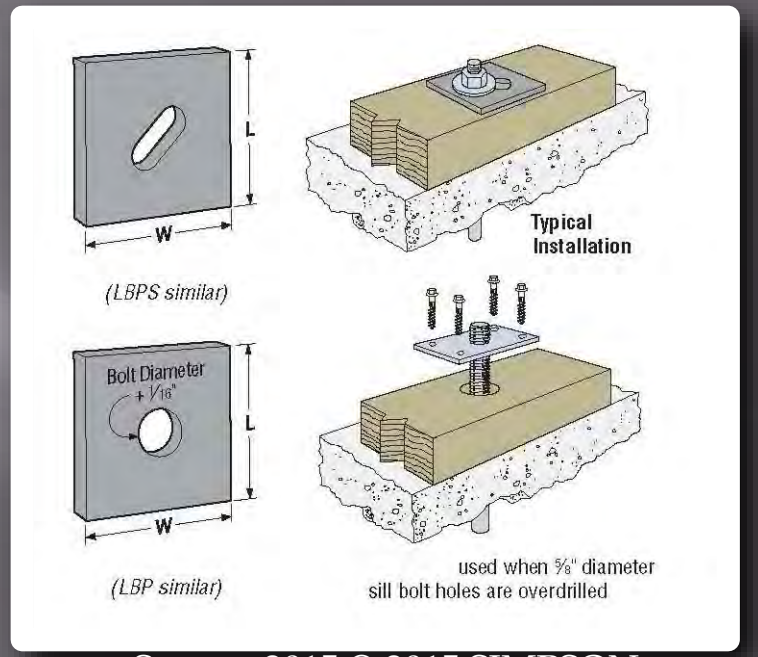
FOUNDATIONS: R403.1.6.1 Foundation Anchorage in SDC C, D_0, D_1, and D_2

3. Interior bearing wall sole plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located within 12 inches (305 mm) of the ends of each plate section when supported on a continuous foundation.

4. The maximum anchor bolt spacing shall be 4 feet (1219 mm) for buildings over two stories in height.

5. Stepped cripple walls shall conform to Section R602.11.2.

6. Where continuous wood foundations in accordance with Section R404.2 are used, the force transfer shall have a capacity equal to or greater than the connections required by Section R602.11.1 or the *braced wall panel* shall be connected to the wood foundations in accordance with the *braced wall panel-to-floor* fastening requirements of Table R602.3(I).



Source: 2015 © 2015 SIMPSON STRONG-TIE COMPANY INC

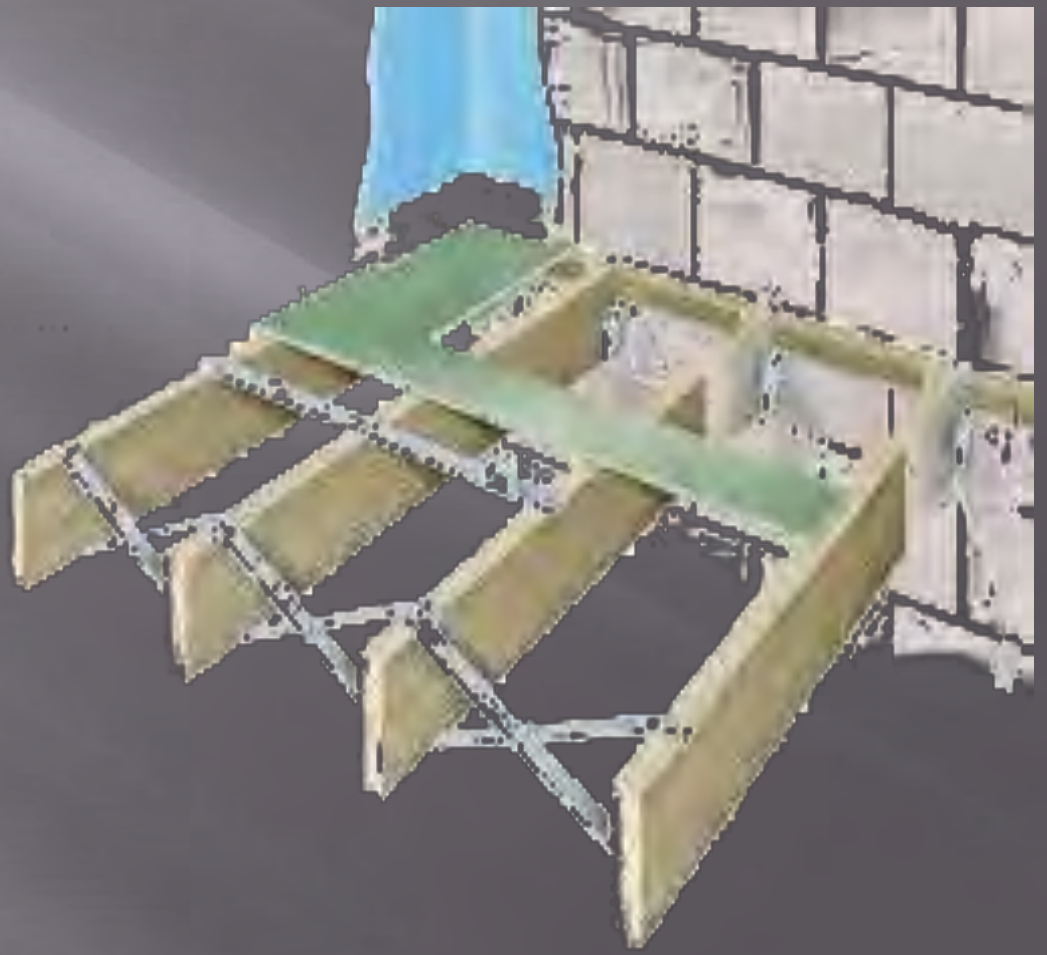
R403.4 Footings for Precast Concrete Foundations.

Crushed stone footing installed in accordance with this section are limited in use to areas of low or moderate seismic hazards.

Footings for precast concrete foundations shall comply with Section R403.4.

R403.4.1 Crushed stone footings. Clean crushed stone shall be free from organic, clayey or silty soils. Crushed stone shall be angular in nature and meet ASTM C 33, with the maximum size stone not to exceed *1/2 inch* and the minimum stone size not to be smaller than 1/16-inch. Crushed stone footings for precast foundations shall be installed in accordance with Figure R403.4(1) and Table R403.4. Crushed stone footings shall be consolidated using a vibratory plate in a maximum of 8-inch lifts. Crushed stone footings shall be limited to Seismic Design Categories A, B and C.

FLOORS



FLOORS

FOR SEISMIC MAINTAIN WEIGHT LIMITS

TABLE R502.3.1(1) NOTE a: Dead load limits for townhouses in Seismic Design Category C and all structures in Seismic Design Categories D_0, D_1, and D_2 shall be determined in accordance with Section R301.2.2.2

TABLE R502.3.1(2) NOTE b: Dead load limits for townhouses in Seismic Design Category C and all structures in Seismic Design Categories D_0, D_1, and D_2 shall be determined in accordance with Section R301.2.2.2

Note: if weights of floor and wall systems exceed those of Section R301.2.2.2 in addition to multiplying wall bracing adjustment factors (R301.2.2.2) it may be necessary to increase joist size.

Cantilever Limits

TABLE R502.3.3(1) NOTE f: See Section R301.2.2.2.5, Item I, for additional limitations on cantilevered floor joists for detached one- and two-family dwellings in Seismic Design Category D_0, D_1, or D_2 and townhouses in Seismic Design Category C, D_0, D_1, or D_2,

R301.2.2.6 Irregular buildings requires that joists are doubled at the end of wall braced panels

R502.7 Lateral restraint at supports. SDC- D_0, D_1, and D_2 also at each intermediate support

DOUBLE JOIST BELOW BEARING WALL AND INTERIOR BRACED WALL PANELS

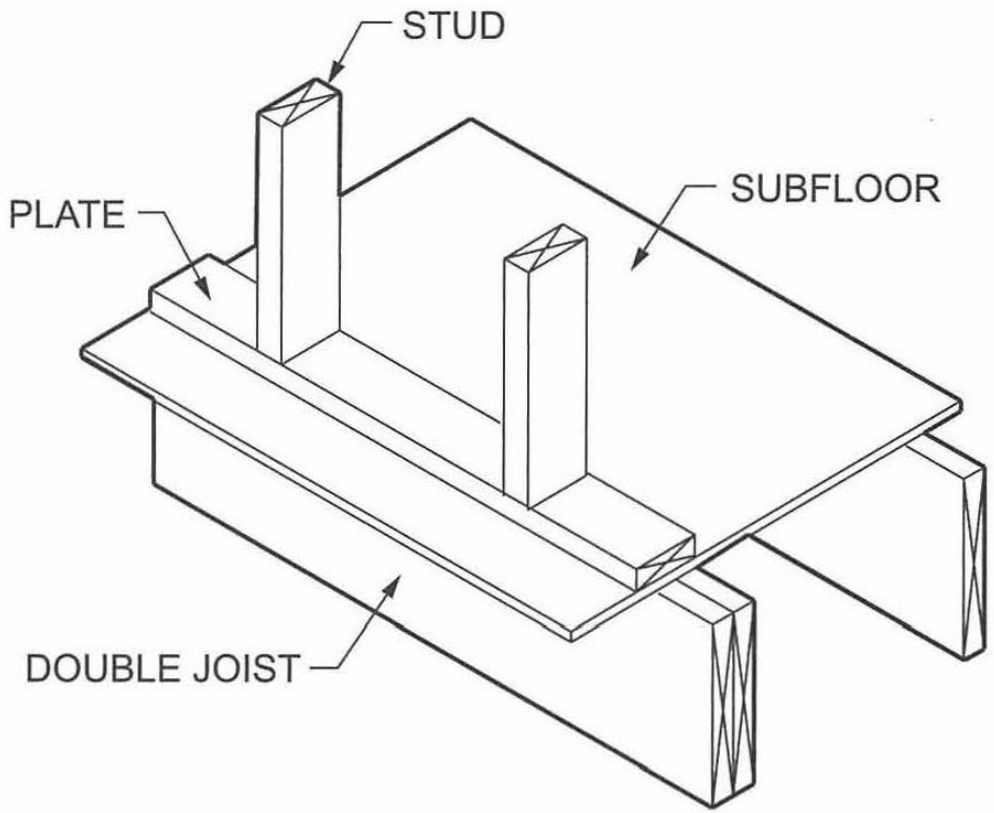


Figure R502.4(1)
DOUBLE JOIST UNDER BEARING PARTITION

R502.4 Joists under bearing partitions. . . Bearing partitions perpendicular to
joists shall not be offset from supporting girders, walls or partitions
more than the joist depth unless such joists are of sufficient
size to carry the additional load.

R403.1.2 Under interior braced wall panels for conventional framing on the ground floor.
See panel 135

R502.7 Lateral restraint at supports.

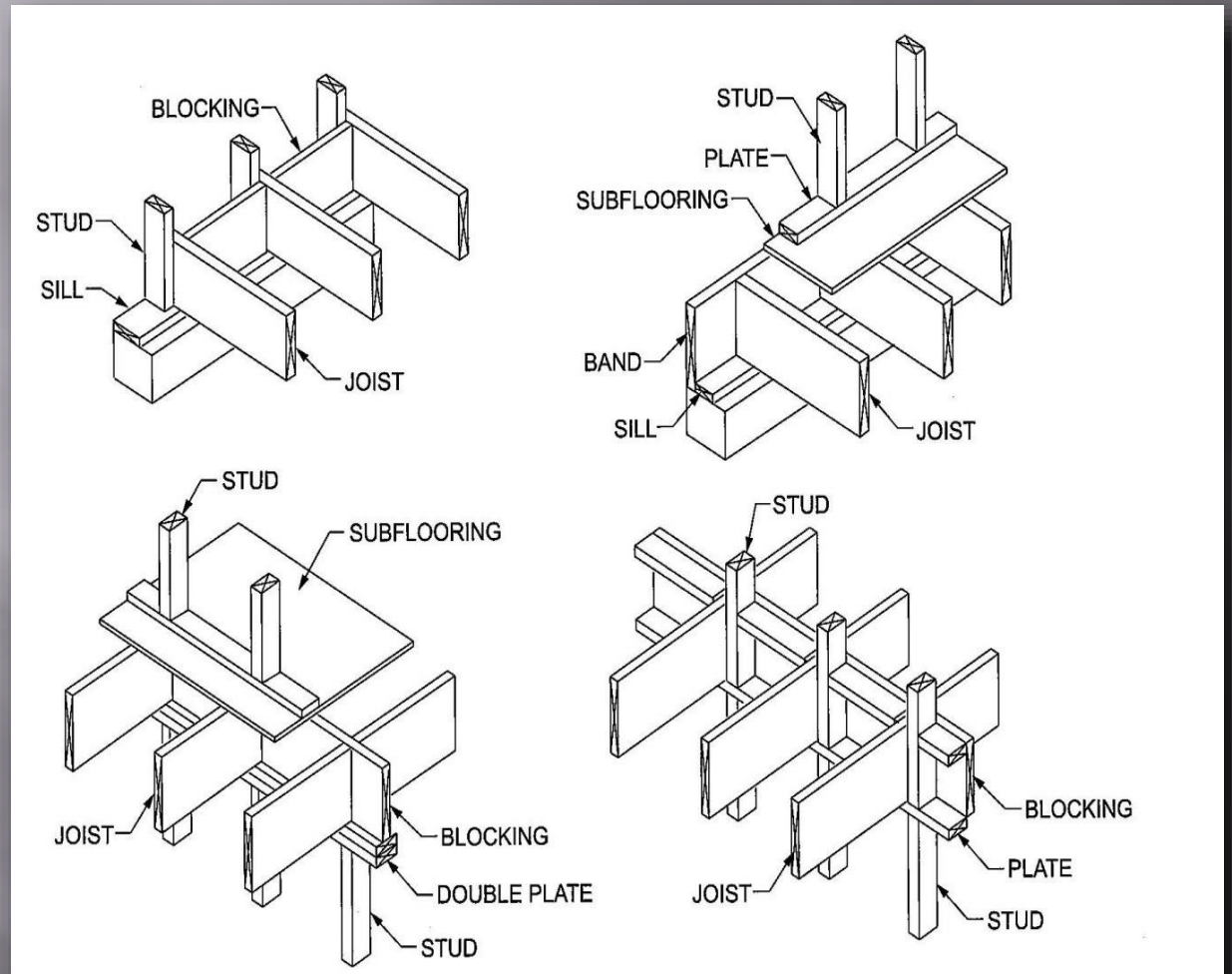


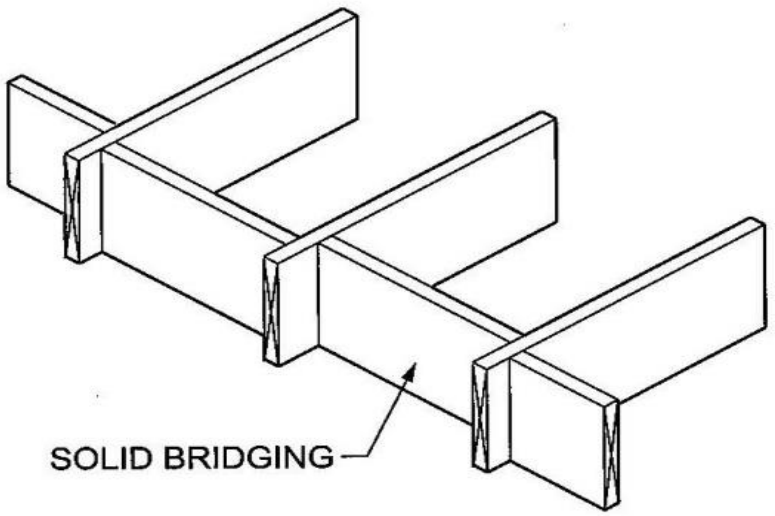
Figure R502.7
BLOCKING OF JOISTS

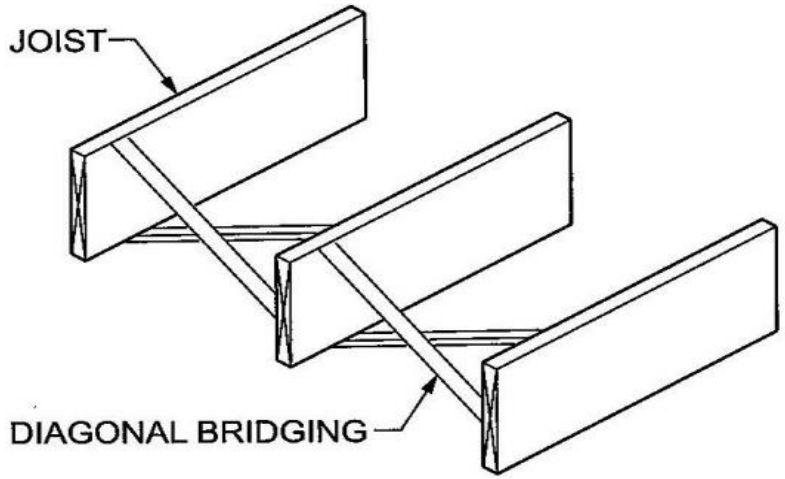
Joists shall be supported laterally at the ends by full-depth solid blocking

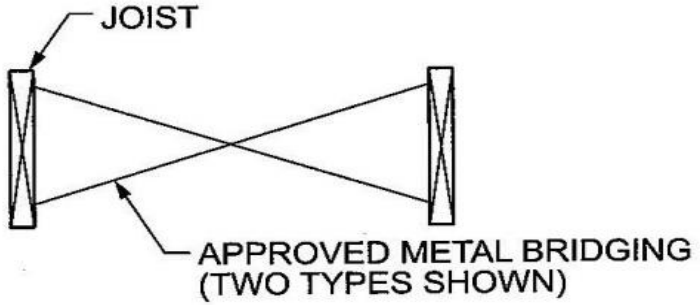
. . . In Seismic Design Categories D_0, D_1, and D_2 , lateral restraint shall also be provided at each intermediate support.

R502.7.1 Bridging

At intervals not exceeding 8 feet







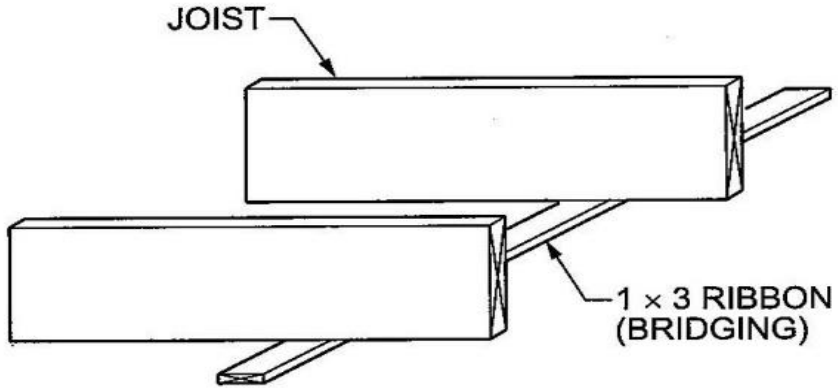
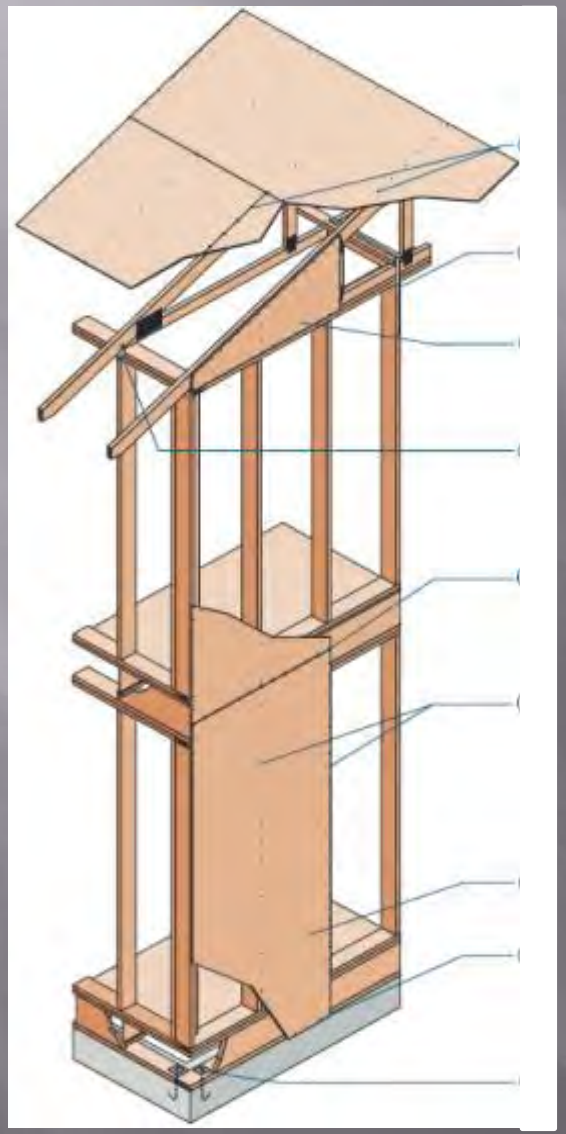


Figure R502.7.1
INTERMEDIATE LATERAL SUPPORT

Fasteners and Connectors



Nail roof sheathing with 8d ring shank nails 4” and 6” on center.

Tie gable end walls back to the structure.

Sheath gable ends with structural wall sheathing.

Use framing anchors to tie wall system to roof system.

Nail upper story and lower story structural wall sheathing to common structural rim board.

Nail wall sheathing with 8d common nails 4” and 6” on center.

Extend structural wall sheathing to lap over the sill plate.

Use continuous structural sheathing over all exterior wall surfaces.

Space ½” anchor bolts 32” to 48” on center with 3”x3” plate washers

Fasteners and Connectors

2015 IRC

Changes to Table R602.3(1) provide additional options for fasteners

TABLE R602.3(1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a,b,c]	SPACING AND LOCATION
	Roof		
1	Blocking between ceiling joists or rafters to top plate	4-8d box (2½" × 0.113") or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Toe nail
2	Ceiling joists to top plate	4-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Sections R802.3.1, R802.3.2 and Table R802.5.1(9)]	4-10d box (3" × 0.128"); or 3-16d common (3½" × 0.162"); or 4-3" × 0.131" nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Sections R802.3.1 and R802.3.2 and Table R802.5.1(9)]	Table R802.5.1(9)	Face nail
5	Collar tie to rafter, face nail or 1¼" × 20 ga. ridge strap to rafter	4-10d box (3" × 0.128"); or 3-10d common (3" × 0.148"); or 4-3" × 0.131" nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box nails (3½" × 0.135"); or 3-10d common nails (3" × 0.148"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2" ridge beam	4-16d (3½" × 0.135"); or 3-10d common (3½" × 0.148"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	Toe nail
		3-16d box 3½" × 0.135"); or 2-16d common (3½" × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	End nail
8	Stud to stud (not at braced		
9	Stud to stud and abutting st (at braced wall panels)		
10	Built-up header (2" to 2" he		
11	Continuous header to stud		
12	Top plate to top plate	10d box (3" × 0.128"); or 3" × 0.131" nails	12" o.c. face nail
13	Double top plate splice for SDCs A-D_2 with seismic braced wall line spacing < 25′	8-16d common (3½" × 0.162"); or 12-16d box (3½" × 0.135"); or 12-10d box (3" × 0.128"); or 12-3" × 0.131" nails	Face nail on each side of end joint (minimum 24" lap splice length each side of end joint)
	Double top plate splice SDCs D_0, D_1, or D_2; and braced wall line spacing ≥ 25′	12-16d (3½" × 0.135")	

(continued)

13	Double top plate splice for SDCs A-D_2 with seismic braced wall line spacing < 25′	8-16d common (3½" × 0.162"); or 12-16d box (3½" × 0.135"); or 12-10d box (3" × 0.128"); or 12-3" × 0.131" nails	Face nail on each side of end joint (minimum 24" lap splice length each side of end joint)
	Double top plate splice SDCs D_0, D_1, or D_2; and braced wall line spacing ≥ 25′	12-16d (3½" × 0.135")	

Fasteners and Connectors

TABLE R602.3(1)—continued
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
14	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common ($3^1/_2$″ × 0.162″)	16″ o.c. face nail
		16d box ($3^1/_2$″ × 0.135″); or 3″ × 0.131″ nails	12″ o.c. face nail
15	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	3 each 16″ o.c. face nail 2 each 16″ o.c. face nail 4 each 16″ o.c. face nail
16	Top or bottom plate to stud	4-8d box ($2^1/_2$″ × 0.113″); or 3-16d box ($3^1/_2$″ × 0.135″); or 4-8d common ($2^1/_2$″ × 0.131″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box ($3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail
17	Top plates, laps at corners and intersections	3-10d box (3″ × 0.128″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-3″ × 0.131″ nails	Face nail
18	1″ brace to each stud and plate	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples $1^3/_4$″	Face nail
19	1″ × 6″ sheathing to each bearing	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 2-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$″ long	Face nail
20	1″ × 8″ and wider sheathing to each bearing	3-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3 staples, 1″ crown, 16 ga., $1^3/_4$″ long	Face nail
		Wider than 1″ × 8″ 4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 4 staples, 1″ crown, 16 ga., $1^3/_4$″ long	
	Floor		
21	Joist to sill, top plate or girder	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
22	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d box ($2^1/_2$″ × 0.113″)	4″ o.c. toe nail
		8d common ($2^1/_2$″ × 0.131″); or 10d box (3″ × 0.128″); or 3″ × 0.131″ nails	6″ o.c. toe nail
23	1″ × 6″ subfloor or less to each joist	3-8d box ($2^1/_2$″ × 0.113″); or 2-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 2 staples, 1″ crown, 16 ga., $1^3/_4$″ long	Face nail

(continued)

2015 IRC

Changes to Table R602.3(1) provide additional options for fasteners

Fasteners and Connectors

TABLE R602.3.2
SINGLE TOP-PLATE SPLICE CONNECTION DETAILS

CONDITION	TOP-PLATE SPLICE LOCATION			
	Corners and intersecting walls		Butt joints in straight walls	
	Splice plate size	Minimum nails each side of joint	Splice plate size	Minimum nails each side of joint
Structures in SDC A-C; and in SDC D_0, D_1 and D_2 with braced wall line spacing less than 25 feet	3″ × 6″ × 0.036″ galvanized steel plate or equivalent	(6) 8d box (2½″ × 0.113″) nails	3′ × 12″ × 0.036″ galvanized steel plate or equivalent	(12) 8d box (2½″ × 0.113″) nails
Structures in SDC D_0, D_1 and D_2, with braced wall line spacing greater than or equal to 25 feet	3″ × 8″ by 0.036″ galvanized steel plate or equivalent	(9) 8d box (2½″ × 0.113″) nails	3′ × 16″ × 0.036″ galvanized steel plate or equivalent	(18) 8d box (2½″ × 0.113″) nails

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

2015 IRC
Added Table R602.3.2 Single plate splice.

Fasteners and Connectors

TABLE R602.3(2)
ALTERNATE ATTACHMENTS TO TABLE R602.3(1)

NOMINAL MATERIAL THICKNESS (inches)	DESCRIPTION[a, b] OF FASTENER AND LENGTH (inches)	SPACING[c] OF FASTENERS	
		Edges (inches)	Intermediate supports (inches)
Wood structural panels subfloor, roof[g] and wall sheathing to framing and particleboard wall sheathing to framing[f]			
Up to 1/2	Staple 15 ga. 1 3/4	4	8
	0.097 - 0.099 Nail 2 1/4	3	6
	Staple 16 ga. 1 3/4	3	6
19/32 and 5/8	0.113 Nail 2	3	6
	Staple 15 and 16 ga. 2	4	8
	0.097 - 0.099 Nail 2 1/4	4	8
23/32 and 3/4	Staple 14 ga. 2	4	8
	Staple 15 ga. 1 3/4	3	6
	0.097 - 0.099 Nail 2 1/4	4	8
	Staple 16 ga. 2	4	8
1	Staple 14 ga. 2 1/4	4	8
	0.113 Nail 2 1/4	3	6
	Staple 15 ga. 2 1/4	4	8
	0.097 - 0.099 Nail 2 1/2	4	8
NOMINAL MATERIAL THICKNESS (inches)	DESCRIPTION[a, b] OF FASTENER AND LENGTH (inches)	SPACING[c] OF FASTENERS	
		Edges (inches)	Body of panel[d] (inches)
Floor underlayment; plywood-hardboard-particleboard[f]-fiber-cement[h]			
Fiber-cement			
1/4	3d, corrosion-resistant, ring shank nails (finished flooring other than tile)	3	6
	Staple 18 ga., 7/8 long, 1/4 crown (finished flooring other than tile)	3	6
	1 1/4 long × .121 shank × .375 head diameter corrosion-resistant (galvanized or stainless steel) roofing nails (for tile finish)	8	8
	1 1/4 long, No. 8 × .375 head diameter, ribbed wafer-head screws (for tile finish)	8	8
Plywood			
1/4 and 5/16	1 1/4 ring or screw shank nail-minimum 12 1/2 ga. (0.099") shank diameter	3	6
	Staple 18 ga., 7/8, 3/16 crown width	2	5
11/32, 3/8, 15/32, and 1/2	1 1/4 ring or screw shank nail-minimum 12 1/2 ga. (0.099") shank diameter	6	8[e]
19/32, 5/8, 23/32 and 3/4	1 1/2 ring or screw shank nail-minimum 12 1/2 ga. (0.099") shank diameter	6	8
	Staple 16 ga. 1 1/2	6	8
Hardboard[f]			
0.200	1 1/2 long ring-grooved underlayment nail	6	6
	4d cement-coated sinker nail	6	6
	Staple 18 ga., 7/8 long (plastic coated)	3	6
Particleboard			
1/4	4d ring-grooved underlayment nail	3	6
	Staple 18 ga., 7/8 long, 3/16 crown	3	6
3/8	6d ring-grooved underlayment nail	6	10
	Staple 16 ga., 1 1/8 long, 3/8 crown	3	6
1/2, 5/8	6d ring-grooved underlayment nail	6	10
	Staple 16 ga., 1 5/8 long, 3/8 crown	3	6

(continued)

2015 IRC

Changes to Table R602.3(2) provide additional options for fasteners

Fasteners and Connectors

TABLE 602.3(1)
FASTENING SCHEDULE—continued

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
	Floor		
24	2″ subfloor to joist or girder	3-16d box (3½″ × 0.135″); or 2-16d common (3½″ × 0.162″)	Blind and face nail
25	2″ planks (plank & beam—floor & roof)	3-16d box (3½″ × 0.135″); or 2-16d common (3½″ × 0.162″)	At each bearing, face nail
26	Band or rim joist to joist	3-16d common (3½″ × 0.162″) 4-10 box (3″ × 0.128″), or 4-3″ × 0.131″ nails; or 4-3″ × 14 ga. staples, 7/16″ crown	End nail
27	Built-up girders and beams, 2-inch lumber layers	20d common (4″ × 0.192″); or	Nail each layer as follows: 32″ o.c. at top and bottom and staggered.
		10d box (3″ × 0.128″); or 3″ × 0.131″ nails	24″ o.c. face nail at top and bottom staggered on opposite sides
		And: 2-20d common (4″ × 0.192″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Face nail at ends and at each splice
28	Ledger strip supporting joists or rafters	4-16d box (3½″ × 0.135″); or 3-16d common (3½″ × 0.162″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	At each joist or rafter, face nail
29	Bridging to joist	2-10d (3″ × 0.128″)	Each end, toe nail

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING OF FASTENERS	
			Edges (inches)[h]	Intermediate supports[c, e] (inches)
	Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel *exterior* wall sheathing to wall framing]			
30	3/8″ – 1/2″	6d common (2″ × 0.113″) nail (subfloor, wall)[i] 8d common (2½″ × 0.131″) nail (roof)	6	12[f]
31	19/32″ – 1″	8d common nail (2½″ × 0.131″)	6	12[f]
32	1⅛″ – 1¼″	10d common (3″ × 0.148″) nail; or 8d (2½″ × 0.131″) deformed nail	6	12
	Other wall sheathing[g]			
33	1/2″ structural cellulosic fiberboard sheathing	1½″ galvanized roofing nail, 7/16″ head diameter, or 1″ crown staple 16 ga., 1¼″ long	3	6
34	25/32″ structural cellulosic fiberboard sheathing	1¾″ galvanized roofing nail, 7/16″ head diameter, or 1″ crown staple 16 ga., 1¼″ long	3	6
35	1/2″ gypsum sheathing[d]	1½″ galvanized roofing nail; staple galvanized, 1½″ long; 1¼″ screws, Type W or S	7	7
36	5/8″ gypsum sheathing[d]	1¾″ galvanized roofing nail; staple galvanized, 1⅝″ long; 1⅝″ screws, Type W or S	7	7
	Wood structural panels, combination subfloor underlayment to framing			
37	3/4″ and less	6d deformed (2″ × 0.120″) nail; or 8d common (2½″ × 0.131″) nail	6	12
38	7/8″ – 1″	8d common (2½″ × 0.131″) nail; or 8d deformed (2½″ × 0.120″) nail	6	12
39	1⅛″ – 1¼″	10d common (3″ × 0.148″) nail; or 8d deformed (2½″ × 0.120″) nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

(continued)

2015 IRC

Changes to Table R602.3(1) provide additional options for fasteners.

Fasteners and Connectors

R317.3 Fasteners and connectors in contact with preservative-

Treated or Fire-retardant-treated Wood – Galvanized in accordance with ASTM A 153. Ref. R317.3.1 R317.3.2 R317.3.3 R317.3.4 or in accordance with manufacturer's recommendations.

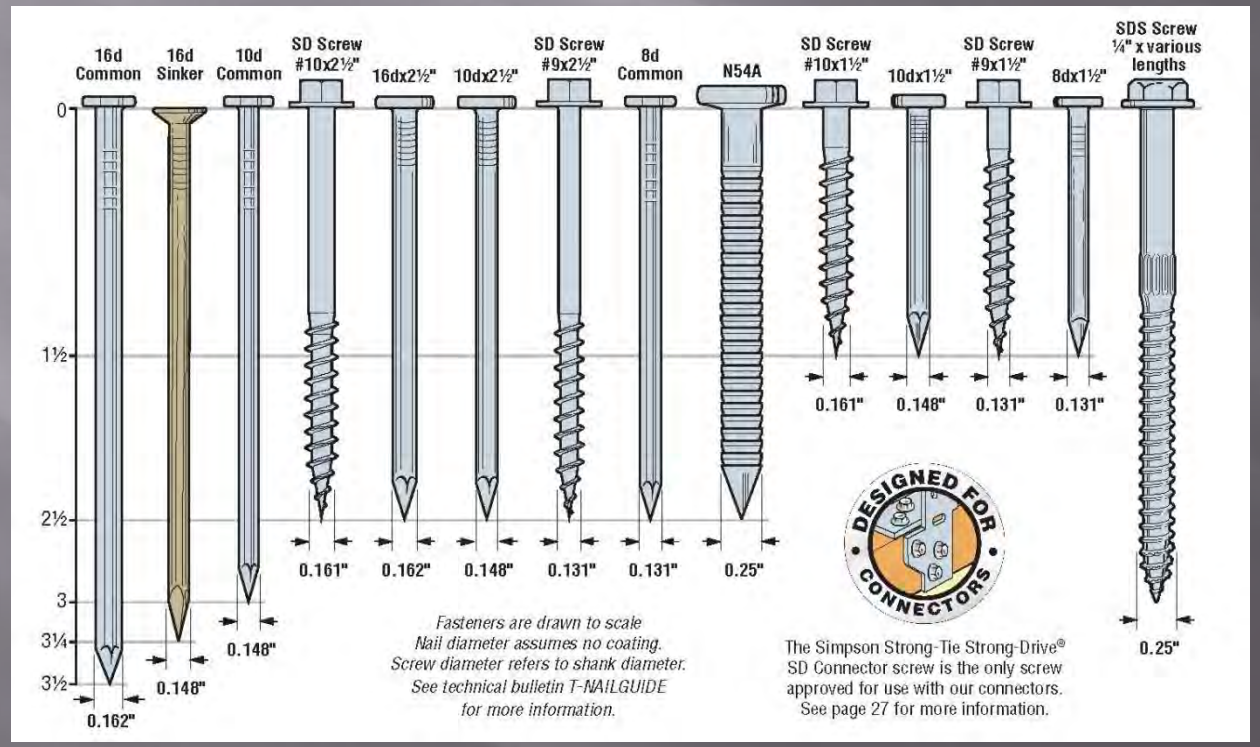


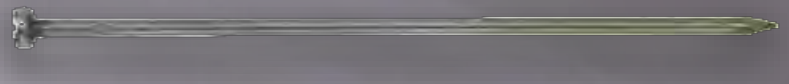
TABLE R703.4
WEATHER-RESISTANT SIDING ATTACHMENT AND MINIMUM THICKNESS

SIDING MATERIAL		NOMINAL THICKNESS[a] (inches)	JOINT TREATMENT	WATER-RESISTIVE BARRIER REQUIRED	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS[b, c, d]					
					Wood or wood structural panel sheathing into stud	Fiberboard sheathing into stud	Gypsum sheathing into stud	Foam plastic sheathing into stud	Direct to studs	Number or spacing of fasteners
Horizonal aluminum[e]	Without insulation	0.019[f] 0.024	Lap	Yes	0.120 nail 1½″ long	0.120 nail 2″ long	0.120 nail 2″ long	0.120 nail[y]	Not allowed	Same as stud spacing
			Lap	Yes	0.120 nail 1½″ long	0.120 nail 2″ long	0.120 nail 2″ long	0.120 nail[y]	Not allowed	
	With insulation	0.019	Lap	Yes	0.120 nail 1½″ long	0.120 nail 2½″ long	0.120 nail 2½″ long	0.120 nail[y]	0.120 nail 1½″ long	
Anchored veneer: brick, concrete, masonry or stone		2	Section R703	Yes	See Section R703 and Figure R703.7[g]					
Adhered veneer: concrete, stone or masonry[w]		—	Section R703	Yes Note w	See Section R703.6.1[g] or in accordance with the manufacturer's instructions.					
Hardboard[k] Panel siding-vertical		7/16	—	Yes	Note m	Note m	Note m	Note m	Note m	6″ panel edges 12″ inter. sup.[n]
Hardboard[k] Lap-siding-horizontal		7/16	Note p	Yes	Note o	Note o	Note o	Note o	Note o	Same as stud spacing 2 per bearing
Steel[h]		29 ga.	Lap	Yes	0.113 nail 1¾″ Staple-1¾″	0.113 nail 2¾″ Staple-2½″	0.113 nail 2½″ Staple-2¼″	0.113 nail[v] Staple[v]	Not allowed	Same as stud spacing
Particleboard panels		3/8 - 1/2	—	Yes	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	6d box nail (2″ × 0.099″)	box nail[v]	6d box nail (2″ × 0.099″), 3/8 not allowed	6″ panel edge, 12" inter. sup.
		5/8	—	Yes	6d box nail (2″ × 0.099″)	8d box nail (2½″ × 0.113″)	8d box nail (2½″ × 0.113″)	box nail[v]	6d box nail (2″" × 0.099″)	
Wood structural panel[f] ANSI/APA-PRP 210 siding[i] (exterior grade)		3/8 - 1/2	Note p	Yes	0.099 nail-2″	0.113 nail-2½″	0.113 nail-2 1/2″	0.113 nail[v]	0.099 nail-2″	6″ panel edges, 12″ inter. sup.
Wood structural panel lapsiding		3/8 - 1/2	Note p Note x	Yes	0.099 nail-2″	0.113 nail-2½″	0.113 nail-2 1/2″	0.113 nail[x]	0.099 nail-2″	8″ along bottom edge
Vinyl siding[l]		0.035	Lap	Yes	0.120 nail (shank) with a 0.313 head or 16-gage staple with 3/8 to 1/2-inch crown[y, z]	0.120 nail (shank) with a 0.313 head or 16-gage staple with 3/8 to 1/2-inch crown[y]	0.120 nail (shank) with a 0.313 head or 16-gage staple with 3/8 to 1/2-inch crown[y]	0.120 nail (shank) with a 0.313 head per Section R703.11.2	Not allowed	16 inches on center or specified by the manufacturer instructions or test report
Wood[j] rustic, drop	3/8 Min	Lap	Yes	Fastener penetration into stud-1″					0.113 nail-2½″ Staple-2″	Face nailing up to 6″ widths, 1 nail per bearing; 8″ widths and over, 2 nails per bearing

Fasteners

ALL FASTENERS ARE TO COMPLY WITH ASTM F1667-05

ASTM F1667 - Designation



F 1667 NL SK D 34

- F 1667 → ASTM IDENTIFIER
- NL → NAIL
- SK → SINKER
- D 34 → DASH NO.

SIGNIFIES A SINKER NAIL WITH A LENGTH OF 3.5″ A DIA. OF 0.162″ AND A DIAMOND POINT

Dash No.	L	D	S	No./lb	Dash No.	L	D	S	No./lb
01	3/8	0.035	...	9520	21	1 3/4	0.062	...	670
02	1/2	0.035	...	7060	22	1 3/4	0.080	...	400
03	1/2	0.048	...	3990	23	1 3/4	0.099	5d	270
04	5/8	0.035	...	5680	24	2	0.062	...	580
05	5/8	0.048	...	3200	25	2	0.080	...	350
06	3/4	0.035	...	4800	26	2	0.113	6d	180
07	3/4	0.048	...	2620	27	2 1/4	0.080	...	320
08	3/4	0.062	...	1550	28	2 1/4	0.113	7d	160
09	7/8	0.035	...	4220	29	2 1/2	0.080	...	290
10	7/8	0.048	...	2220	30	2 1/2	0.131	8d	110
11	7/8	0.062	...	1280	31	2 3/4	0.131	9d	97
12	1	0.054	...	1500	32	3	0.148	10d	70
13	1	0.062	...	1120	33	3 1/4	0.148	12d	65
14	1	0.072	...	904	34	3 1/2	0.162	16d	50
15	1 1/4	0.054	...	1210	35	4	0.192	20d	31
16	1 1/4	0.062	...	940	36	4 1/2	0.207	30d	24
17	1 1/4	0.080	3d	560	37	5	0.225	40d	18
18	1 1/2	0.054	...	1040	38	5 1/2	0.244	50d	14
19	1 1/2	0.080	...	470	39	6	0.262	60d	11
20	1 1/2	0.099	4d	320	...	...	...	...	...

[A] All dimensions are given in inches.

Fastener Resistance

Nail Specification Table

Finish	USP Stock No.	Ref. No.	Description (in)	Metric (mm)		Factored Shear Resistance[3]			
						DF-L		S-P-F	
				Dia	Length	Lbs	kN	Lbs	kN
HDG	NA11	N8	8d (0.131) x 1-1/2	3.33	38.1	178	0.79	163	0.72
	NA9D	N10	10d (0.148) x 1-1/2	3.76	38.1	200	0.89	184	0.82
	N10C	10DHDG	10d (0.148) x 3	3.76	76.2	218	0.97	201	0.90
	NA16D	N16, N16EG	16d (0.162) x 2-1/2	4.11	63.5	250	1.11	230	1.02
	N16C	16DHDG	16d (0.162) x 3-1/2	4.11	88.9	250	1.11	230	1.02
	NA20D	-- --	20d (0.192) x 2-1/2	4.88	63.5	323	1.44	296	1.32
GC	N8-GC	-- --	8d (0.131) x 1-1/2	3.33	38.1	178	0.79	163	0.72
	N10-GC	-- --	10d (0.148) x 1-1/2	3.76	38.1	200	0.89	184	0.82
	N10C-GC	-- --	10d (0.148) x 3	3.76	76.2	218	0.97	201	0.90
	N16C-GC	-- --	16d (0.162) x 3-1/2	4.11	88.9	250	1.11	230	1.02
SS	SSNA8D	SSN8	8d (0.131) x 1-1/2	3.33	38.1	178	0.79	163	0.72
	SSNA10D	SSN10	10d (0.148) x 1-1/2	3.76	38.1	200	0.89	184	0.82
	SSN8C	SS8D	8d (0.131) x 2-1/2	3.33	63.5	181	0.81	168	0.75
	SSN10C	SS10D	10d (0.148) x 3	3.76	76.2	218	0.97	201	0.90
	SSN16C	SS16D	16d (0.162) x 3-1/2	3.76	82.6	250	1.11	230	1.02
Bright	8d Common	-- --	8d (0.131) x 2-1/2	3.33	63.5	181	0.81	168	0.75
	10d Common	-- --	10d (0.148) x 3	3.76	76.2	218	0.97	201	0.90
	16d Sinker	-- --	16d (0.148) x 3-1/4	3.76	82.6	218	0.97	201	0.90
	NA16D-RS	-- --	16d (0.148) x 3-1/2 Ring Shank	3.76	88.9	218	0.97	201	0.90
	16d Common	-- --	16d (0.162) x 3-1/2	4.11	88.9	250	1.11	230	1.02
	20d Common	-- --	20d (0.192) x 4	4.88	101.6	323	1.44	296	1.32
	2-1/2" Common Spiral	-- --	8d (0.110) x 2-1/2 Spiral Shank	2.77	63.5	139	0.62	130	0.58
	3" Common Spiral	-- --	10d (0.122) x 3 Spiral Shank	3.10	76.20	163	0.73	151	0.67
	3-1/4" Common Spiral	-- --	12d (0.122) x 3-1/4 Spiral Shank	3.10	82.60	163	0.73	151	0.67
	3-1/2" Common Spiral	-- --	16d (0.152) x 3-1/2 Spiral Shank	3.86	88.9	227	1.01	209	0.93

1) Factored shear resistance values determined in accordance with CSA O86-09 Clause 10.9.
2) Factored shear resistance values apply to DF-L: Douglas Fir-Larch (SG=0.49, fv=1.9 MPa) and S-P-F: Spruce-Pine-Fir (SG=0.42, fv=1.5 MPa).
3) Fastener values shown in this table are for 16Ga steel side member with Fu=45,000 psi and design metal thickness of 0.058 inch (1.47mm).
Approximate fastener values for other steel thicknesses can be determined as follows:
For 18Ga steel (0.046 inch, 1.17mm), multiply table values by 0.91
For 14Ga steel (0.074 inch, 1.88mm), multiply table values by 1.05
For 12Ga steel (0.104 inch, 2.64mm), multiply table values by 1.05
4) Fastener values shown are based on standard-term load duration of $K_D = 1.00$. Values may be adjusted for other load durations.
5) HDG = Hot-Dip Galvanized; SS = Stainless Steel; GC = Gold Coat; Bright = No Finish.
6) Bright finish common, sinker, and spiral nails are listed for reference only. USP does not stock these type nails.

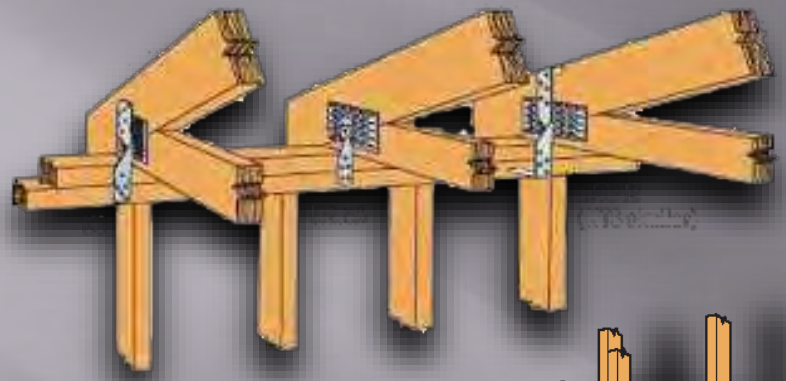
NOTES

1. Many nail guns use fasteners smaller than the common nail size specified with USP product, factored resistance must be reduced accordingly.
2. Drive through pre-punched nail holes only
3. Do not over drive
4. Recommend the use of guns featuring hole-locating mechanisms

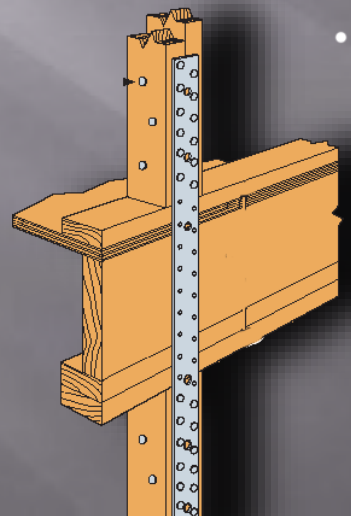
USP STRUCTURAL CONNECTORS

ALSO SEE HANDOUT: ESR-1539

ENGINEERED PRODUCTS



ES REPORTS REQUIRE DESIGN PROFESSIONAL TO PROVIDE PROPER FOUNDATION OR SUBSTRATE FOR THESE PRODUCTS.



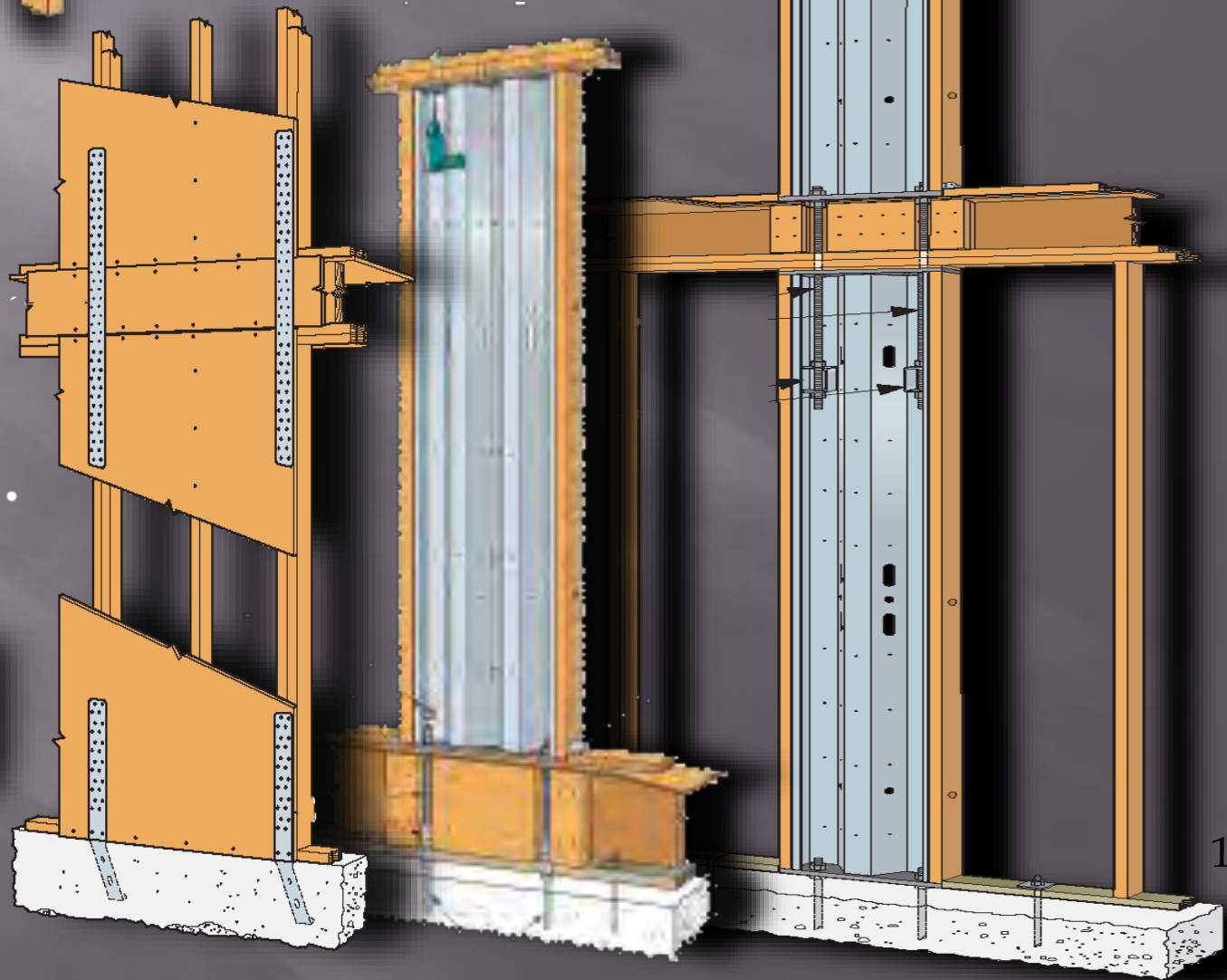
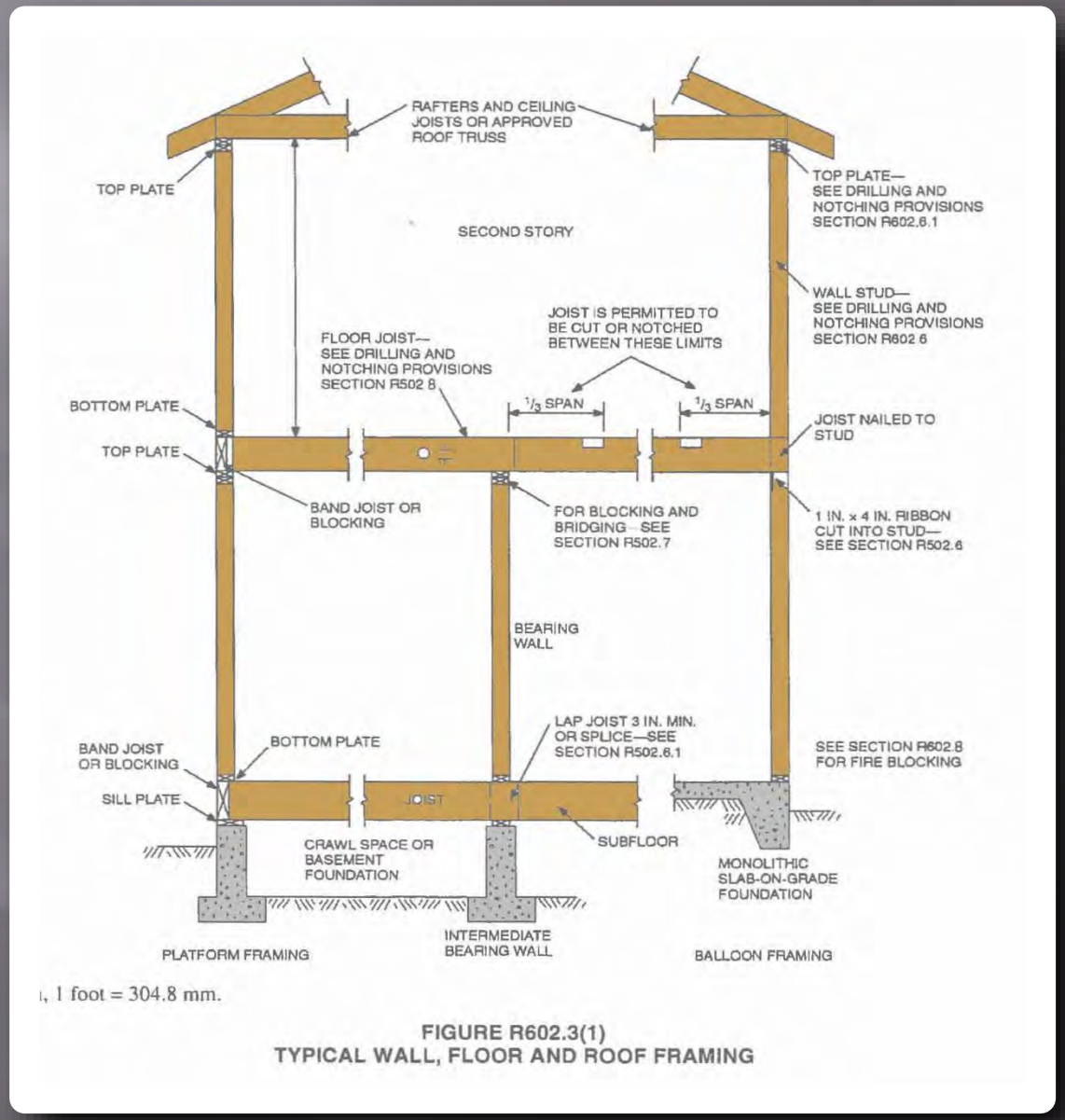


FIGURE R602.3(1)



, 1 foot = 304.8 mm.

FIGURE R602.3(1)
TYPICAL WALL, FLOOR AND ROOF FRAMING

Table R602.3(5)

Size, Height and Spacing of Wood Studs

2018 IRC

TABLE R602.3(5)
SIZE, HEIGHT AND SPACING OF WOOD STUDS[a]

STUD SIZE (inches)	BEARING WALLS					NONBEARING WALLS	
	Laterally unsupported stud height[a] (feet)	Maximum spacing when supporting a roof-ceiling assembly or a habitable attic assembly, only (inches)	Maximum spacing when supporting one floor, plus a roof-ceiling assembly or a habitable attic assembly (inches)	Maximum spacing when supporting two floors, plus a roof-ceiling assembly or a habitable attic assembly (inches)	Maximum spacing when supporting one floor height[a] (inches)	Laterally unsupported stud height[a] (feet)	Maximum spacing (inches)
							
2 × 3[b]	—	—	—	—	—	10	16
2 × 4	10	24[c]	16[c]	—	24	14	24
3 × 4	10	24	24	16	24	14	24
2 × 5	10	24	24	—	24	16	24
2 × 6	10	24	24	16	24	20	24

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

a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Bearing walls shall be sheathed on not less than one side or bridging shall be installed not greater than 4 feet apart measured vertically from either end of the stud. Increases in unsupported height are permitted where in compliance with Exception 2 of Section R602.3.1 or designed in accordance with accepted engineering practice.

b. Shall not be used in exterior walls.

c. A habitable attic assembly supported by 2 × 4 studs is limited to a roof span of 32 feet. Where the roof span exceeds 32 feet, the wall studs shall be increased to 2 × 6 or the studs shall be designed in accordance with accepted engineering practice.

TABLE R602.3.1

MAXIMUM ALLOWABLE LENGTH OF WOOD WALL STUDS EXPOSED TO WIND SPEEDS OF 100 MPH OR LESS IN SEISMIC DESIGN CATEGORIES A, B, C, D_o, D_1, and D_2

Table omitted in 2015 IRC

HEIGHT	ON-CENTER SPACING (inches)			
ft.	24"	16"	12"	8"
Supporting a roof only				
>10	2x4	2x4	2x4	2x4
12	2x6	2x4	2x4	2x4
14	2x6	2x6	2x6	2x4
16	2x6	2x6	2x6	2x4
Supporting one floor and a roof				
>10	2x6	2x4	2x4	2x4
12	2x6	2x6	2x6	2x4
14	2x6	2x6	2x6	2x6
16	NA[a]	2x6	2x6	2x6
Supporting two floors and a roof				
> 10	2x6	2x6	2x4	2x4
12	2x6	2x6	2x6	2x6
14	2x6	2x6	2x6	2x6
16	NA[a]	NA[a]	2x6	2x6

IRC 2012
Limiting Stud Size also means limiting span of horizontal elements

footnote b:

Applicability of this table assumes the following: . . . tributary dimensions for floors and roofs not exceeding 6 feet, maximum span for floors and roof not exceeding 12 feet, eaves not over 2 feet in dimension and exterior sheathing. Where the conditions are not within these parameters, design is required.

2015 IRC
R602.3.1 Stud size, height and spacing.

The size, height and spacing of studs shall be in accordance with Table R602.3.(5).

Exceptions:

I. Utility grade studs shall not be spaced more than 16 inches on center, shall not support more than a roof and ceiling, and shall not exceed 8 feet in height for exterior walls and load-bearing walls or 10 feet for interior non load-bearing walls.

2. Where snow loads are less than or equal to 25 pounds per square foot, and the ultimate design wind speed is less than or equal to 130 mph, 2-inch by 6-inch studs supporting a roof load with not more than 6 feet of tributary length shall have a maximum height of 18 feet (5486 mm) where spaced at 16 I niches on center, or 20 feet where spaced at 12 inches on center. Studs shall be minimum No. 2 grade lumber.

Limits – Stud Size, Spacing and max Height (Seismic and Wind)

Table R602.3.1, (see footnote b)

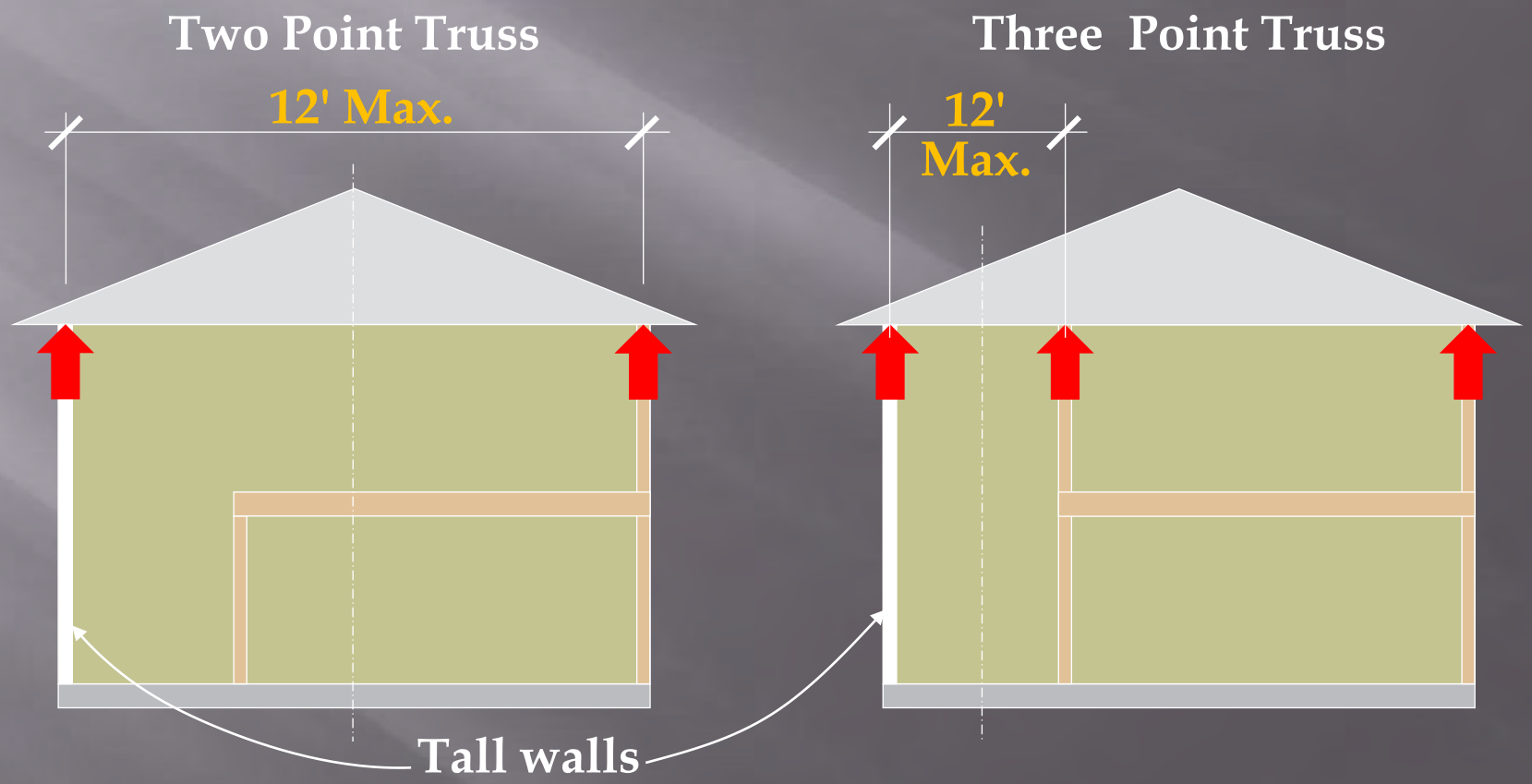


Table R602.3.1

R202
CRIPPLE WALL and PONEY WALL

CRIPPLE WALL: A framed wall extending from The top of the foundation to the underside of the floor framing of the first story above grade plane.

PONY WALL: not defined. Understood to be a framed wall resting on top of header or the top plate a wall below extending its height to support ceiling or rafters.

R602.9 Cripple walls.

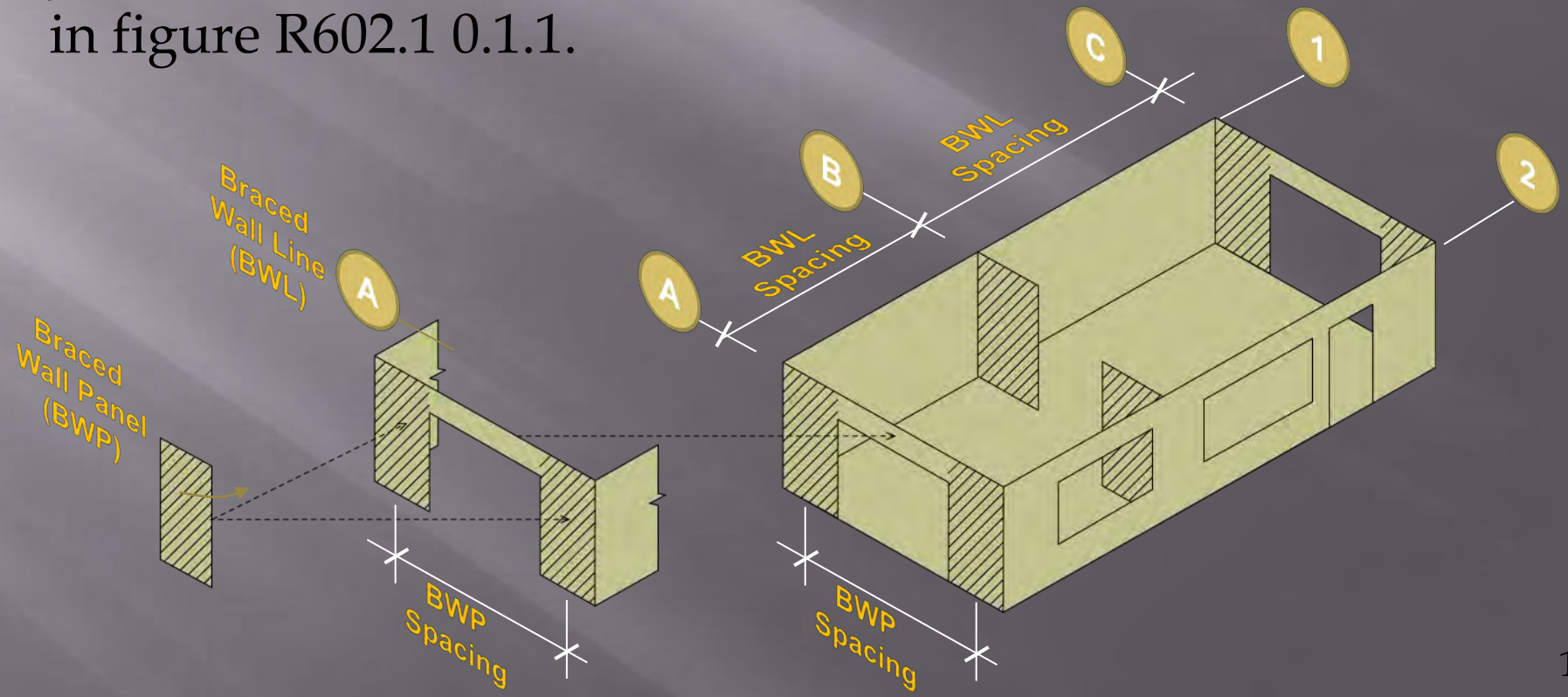
Foundation cripple walls shall be framed of studs not smaller than the studding above. When exceeding 4 feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional *story.*

Cripple walls with a stud height less than 14 inches shall be continuously sheathed on one side with wood structural panels fastened to both the top and bottom plates in accordance with Table R602.3(I), or the cripple walls shall be constructed of solid blocking.

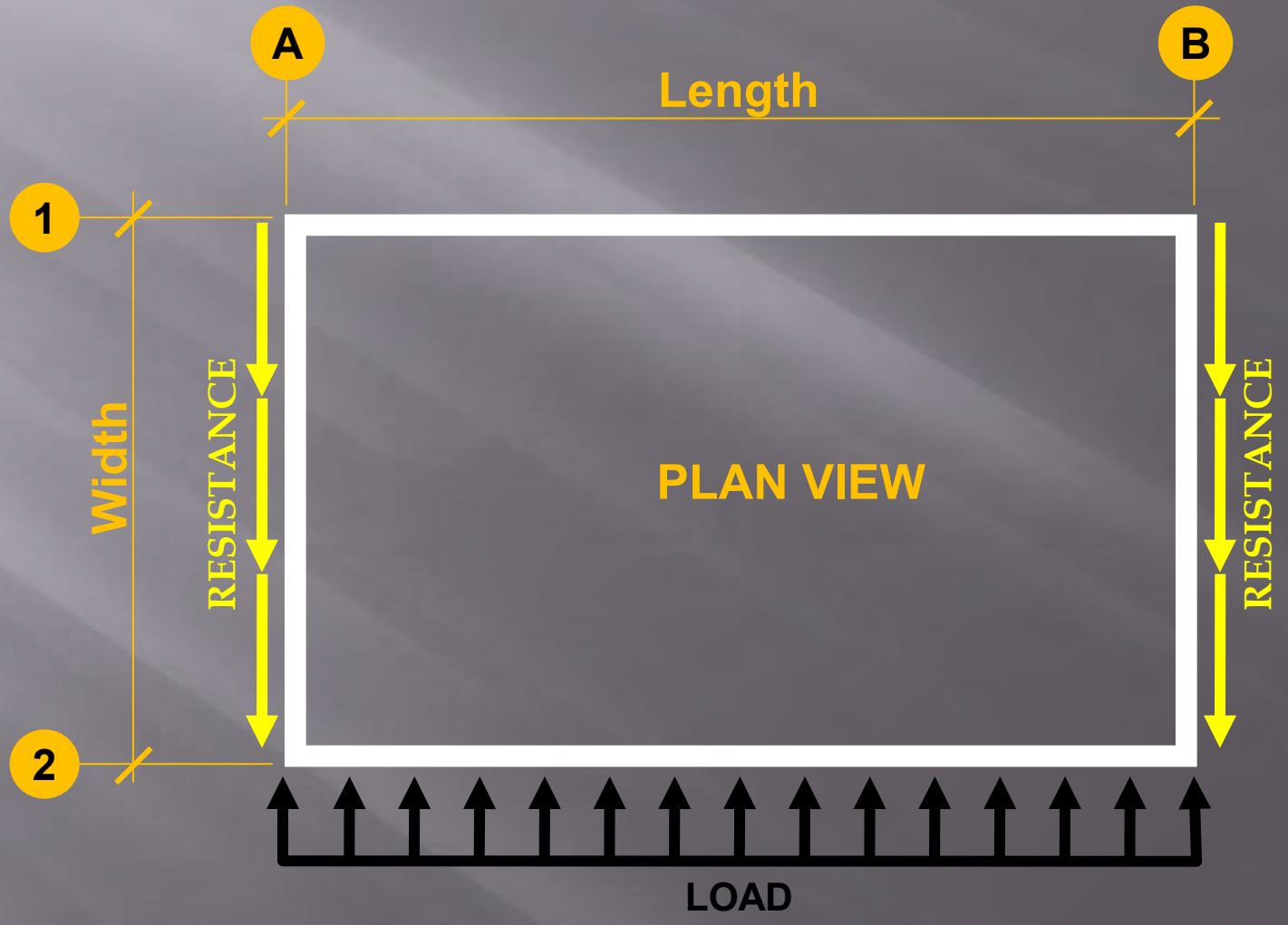
All cripple walls shall be supported on continuous foundations.

R602.10.1 Length of Braced wall lines.

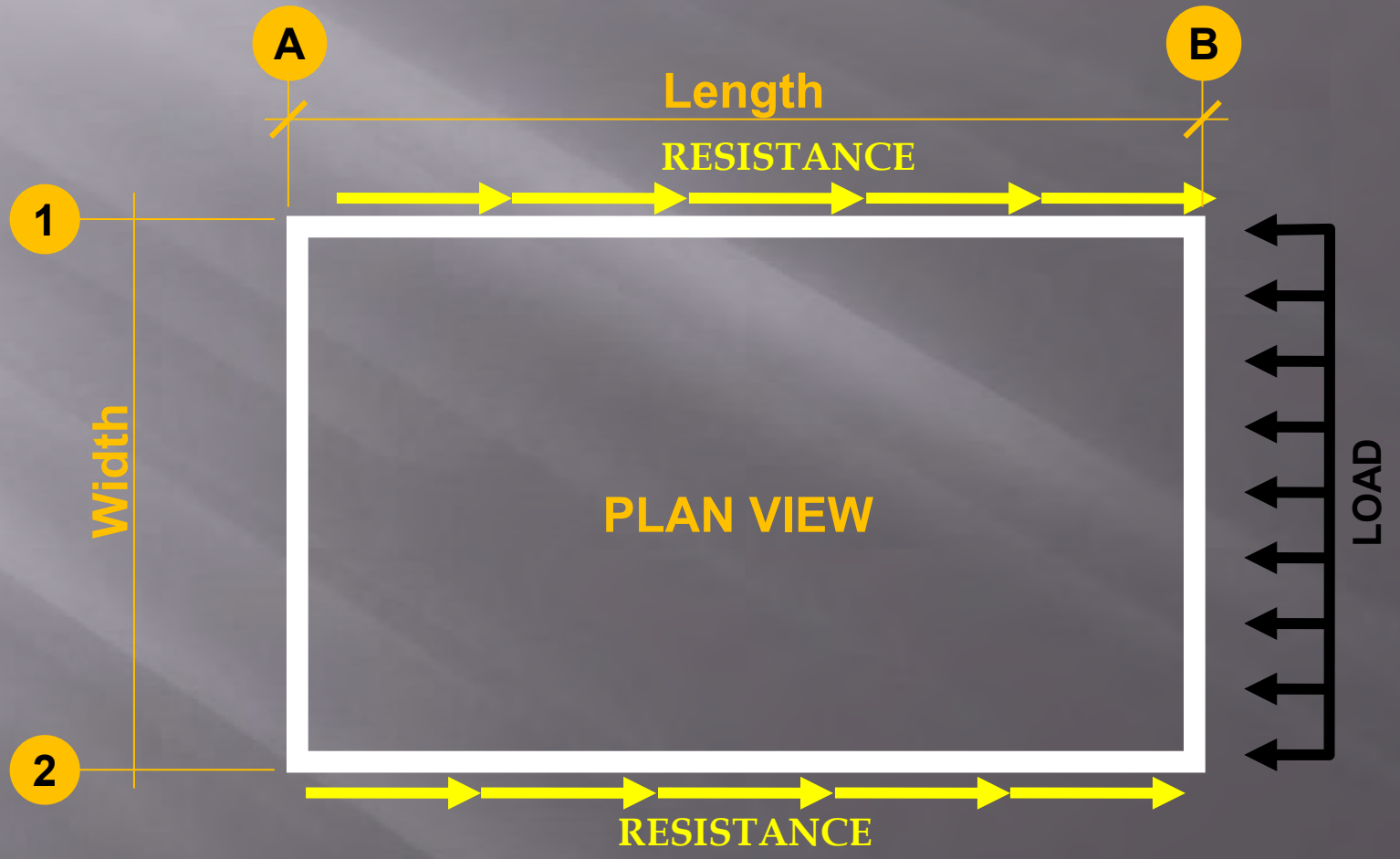
The length of a *braced wall line shall be the distance between its* ends. The end of a *braced wall line shall be the intersection* with a perpendicular *braced wall line, an* angled *braced wall line as permitted in Section* R602.10.1.4 or an exterior wall as shown in figure R602.1 0.1.1.



Brace Walls Resisting EQ. Forces



Brace Walls Resisting EQ. Forces

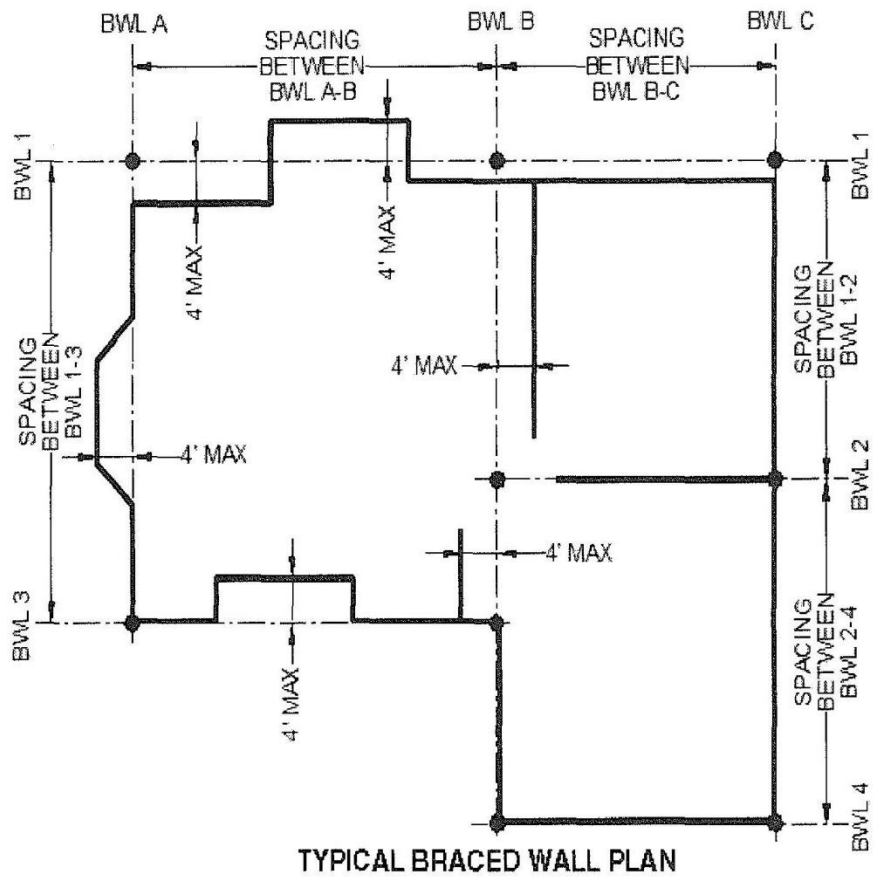


OFFSETS AND PARALLEL SPACING OF BRACED WALL LINE.

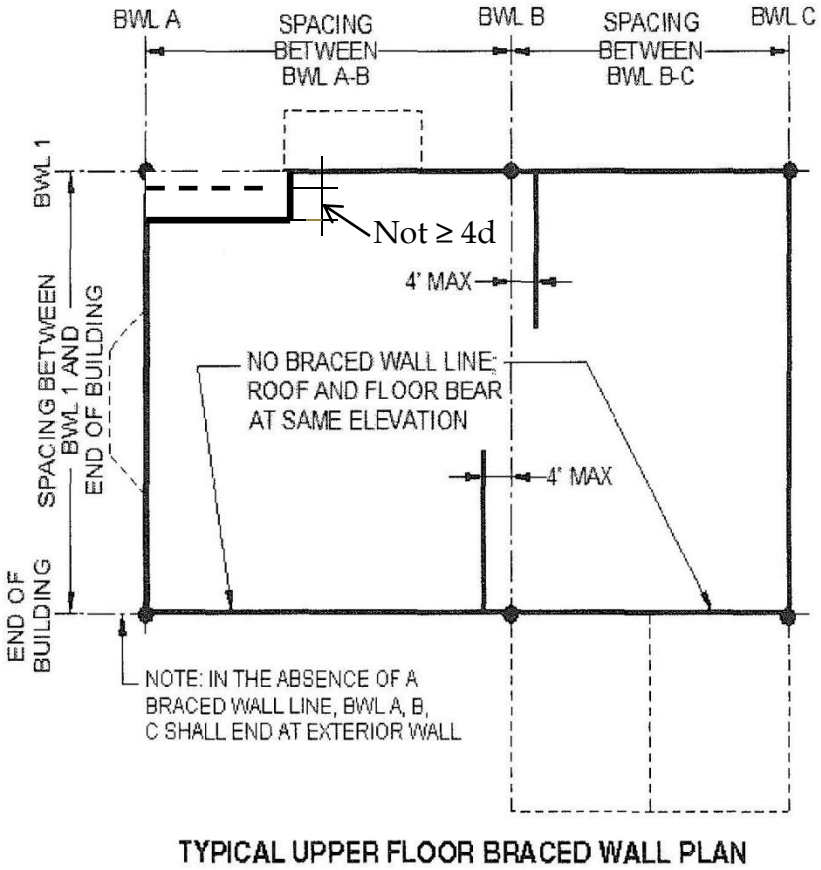
R602.10.1.2 Offsets along a braced wall line. All exterior walls parallel to a *braced wall line shall be offset* not more than 4 feet from the designated *braced wall line location as shown Figure R602.10.1.1.* Interior walls used as bracing shall be offset not more than 4 feet from a *braced wall line through* the interior of the building as shown in Figure R602.10.1.1.

R602.10.1.3 Spacing of braced wall lines. The spacing between parallel *braced lines shall be in accordance* with Table R602.10.1.3. Intermediate *braced wall lines through the interior of the building shall be* permitted.

BRACED WALL LINES (BWL)
FIGURE R602.10.1.1



TYPICAL BRACED WALL PLAN



TYPICAL UPPER FLOOR BRACED WALL PLAN

For SI: 1 foot = 304.8 mm.

FIGURE R602.10.1.1
BRACED WALL LINES

LET'S LOOK AGAIN

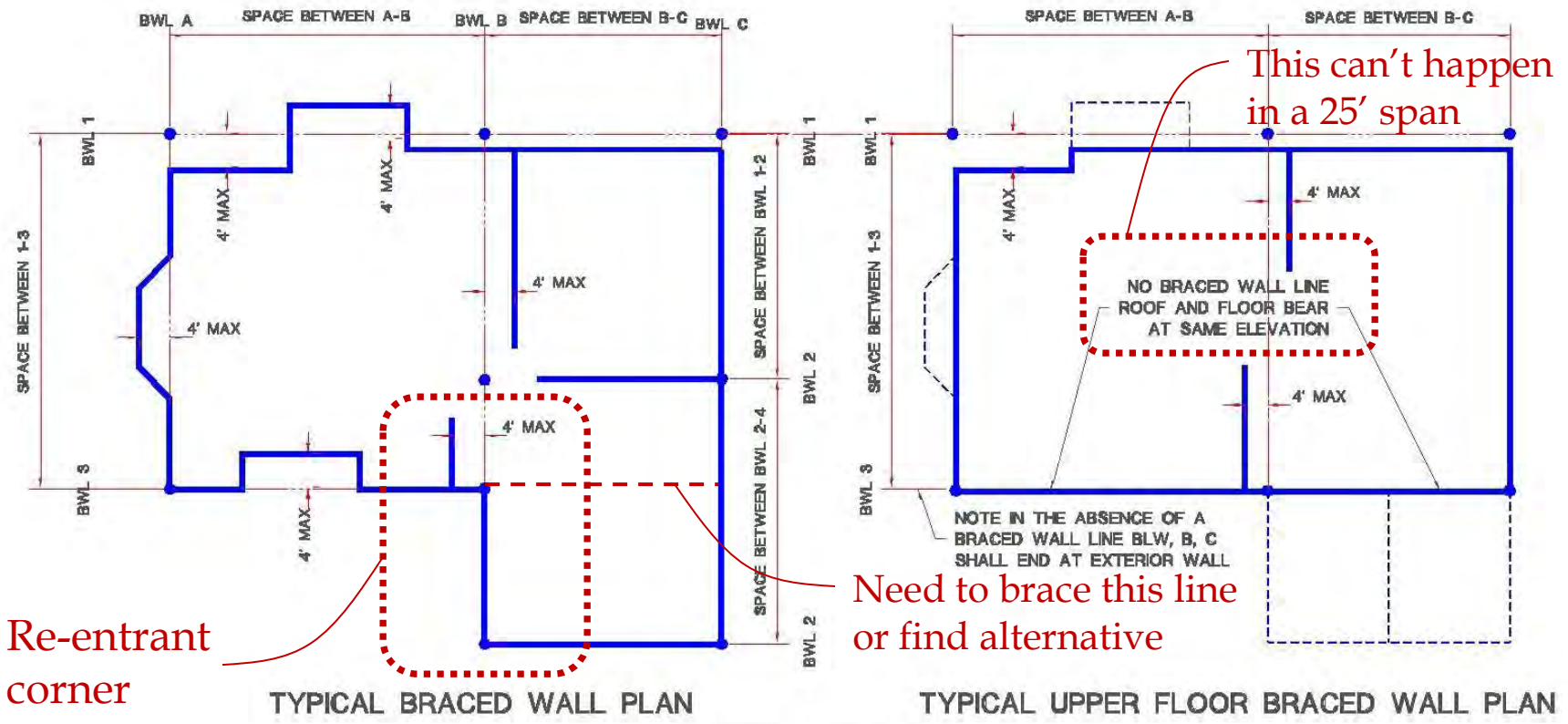
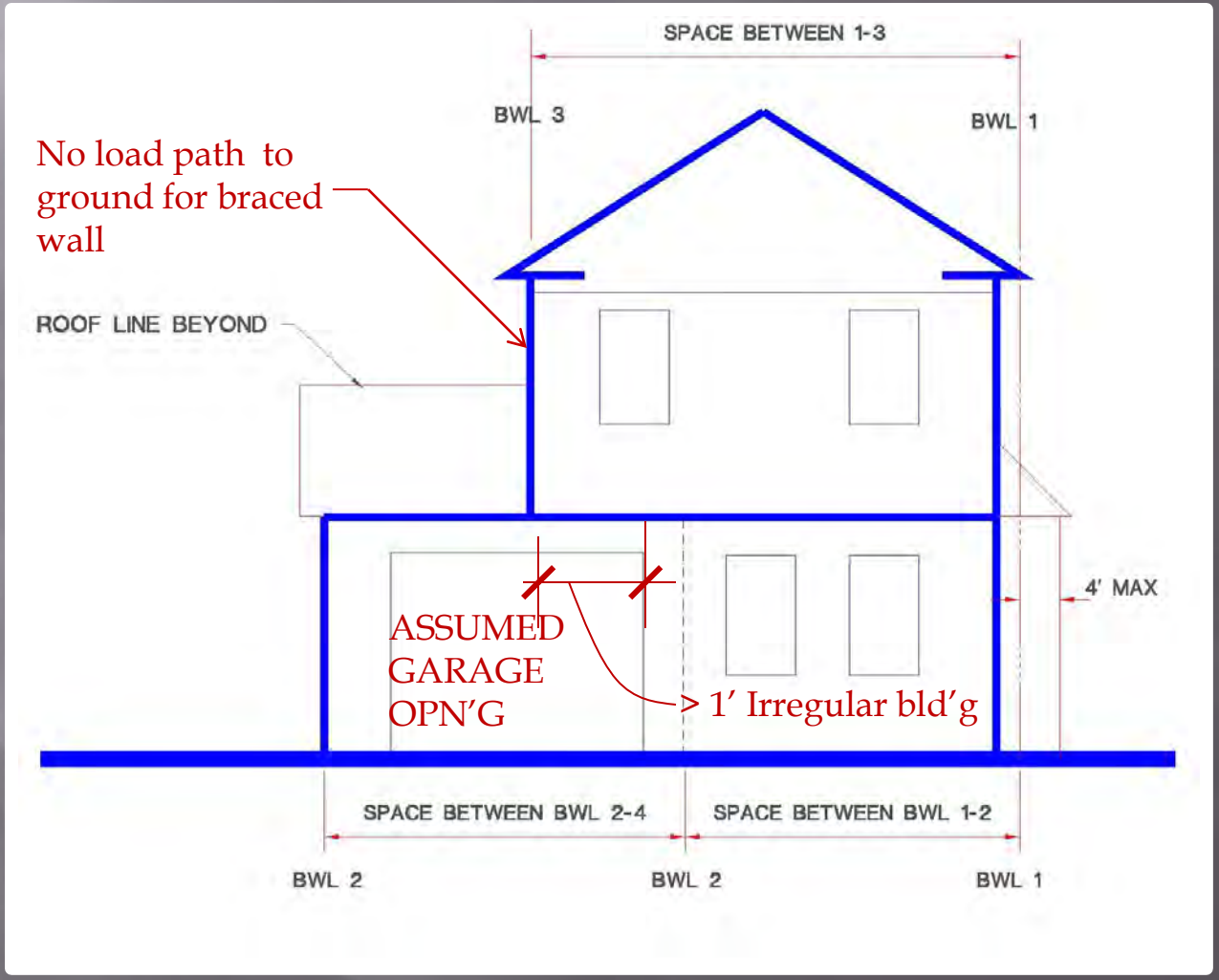


FIGURE R602.10.1.1
BRACED WALL LINES

ELEVATED VIEW



R602.10.1.3 SPACING OF BRACED WALL LINES

The spacing between parallel *braced wall lines shall be in accordance* with Table R602.10.1.3. Intermediate *braced wall lines through the interior of the building shall be* permitted.

TABLE R602.10.1.3
BRACED WALL LINE SPACING CRITERIA

APPLICATION	CONDITION	BUILDING TYPE	BRACED WALL LINE SPACING CRITERIA	
			Max. Spacing	Exception to Maximum Spacing
Wind bracing	85 mph to < 110 mph	Detached, townhouse	60 feet	None
Seismic Bracing	SDC A-C	Detached	Use wind bracing	
	SDC A-B	Townhouse	Use wind bracing	
	SDC C	Townhouse	35 feet	Up to 50 conditionally (1)
	SDC D_0 D_1 D_2	Detached, townhouses, one- and two-story only	25 feet	Up to 35 feet conditionally (1)
	SDC D_0 D_1 D_2	Detached townhouse	25 feet	Up to 35 feet conditionally (1)

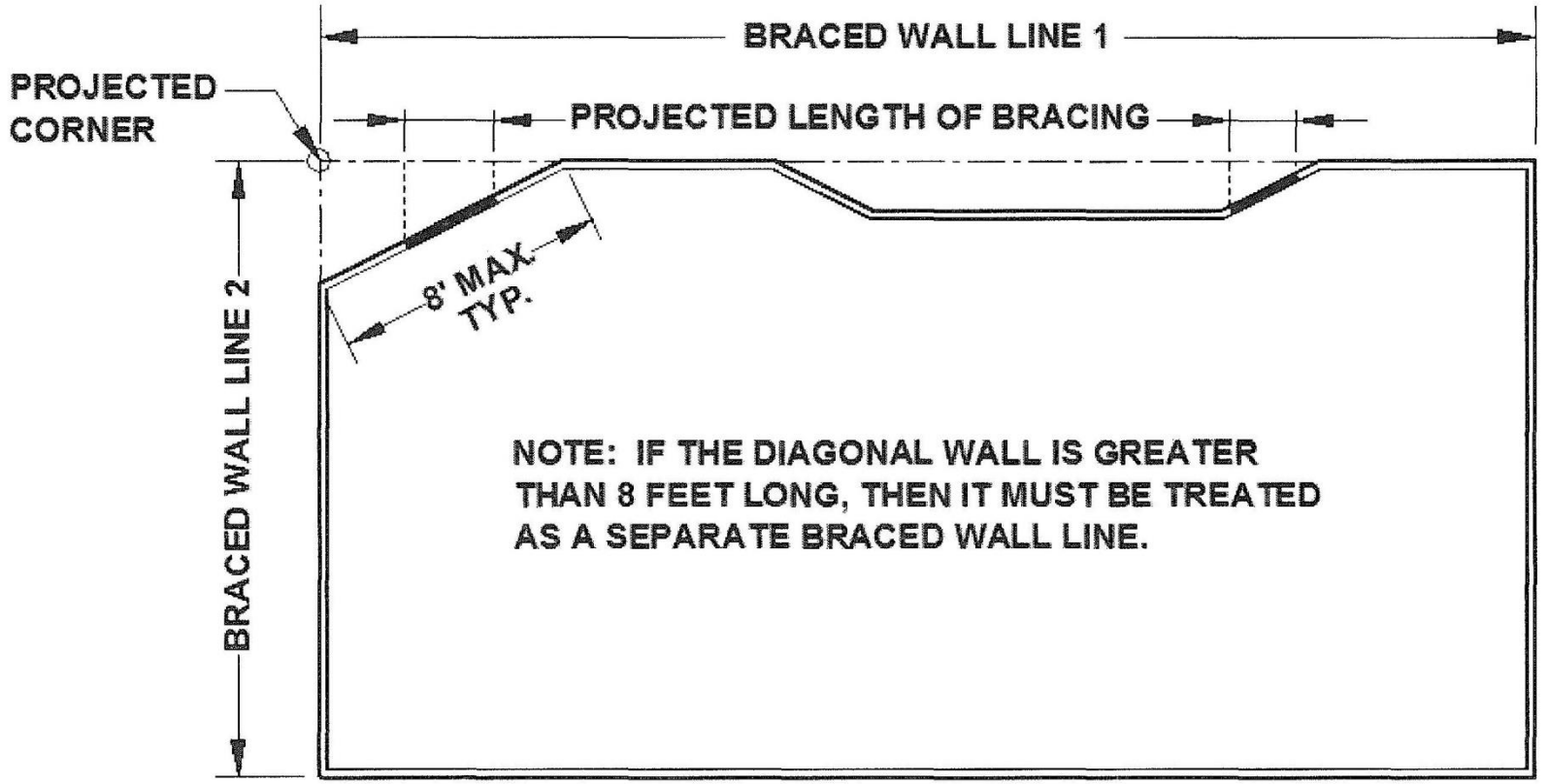
Tables R602.10.1.2(1),(2),(3), Table R602.10.1.5, & R602.10.1.5

(1) See Tables R602.10.3(3) & Table R602.10.3(4).

R602.10.1.4 ANGLED WALLS

Any portion of a wall along a *braced wall line shall be permitted to angle out of* plane for a maximum diagonal length of 8 feet. Where the angled wall occurs at a corner, the length of the *braced wall line shall be measured from* the projected corner as shown in Figure R602.10.1.4. Where the diagonal length is greater than 8 feet , it shall be considered a separate *braced wall line* and shall be braced in accordance with Section
R602.10.1.

Figure R602.10.1.4



For SI: 1 foot = 304.8 mm.

FIGURE R602.10.1.4
ANGLED WALLS

R602.10.2.2 LOCATIONS OF BRACED WALL PANELS

A *braced wall panel shall begin within 10 feet* from each end of a *braced wall line as determined in* Section R602.10.1.1.

Distance between adjacent edges of *braced wall panels along a braced wall line* shall be no greater than 20 feet

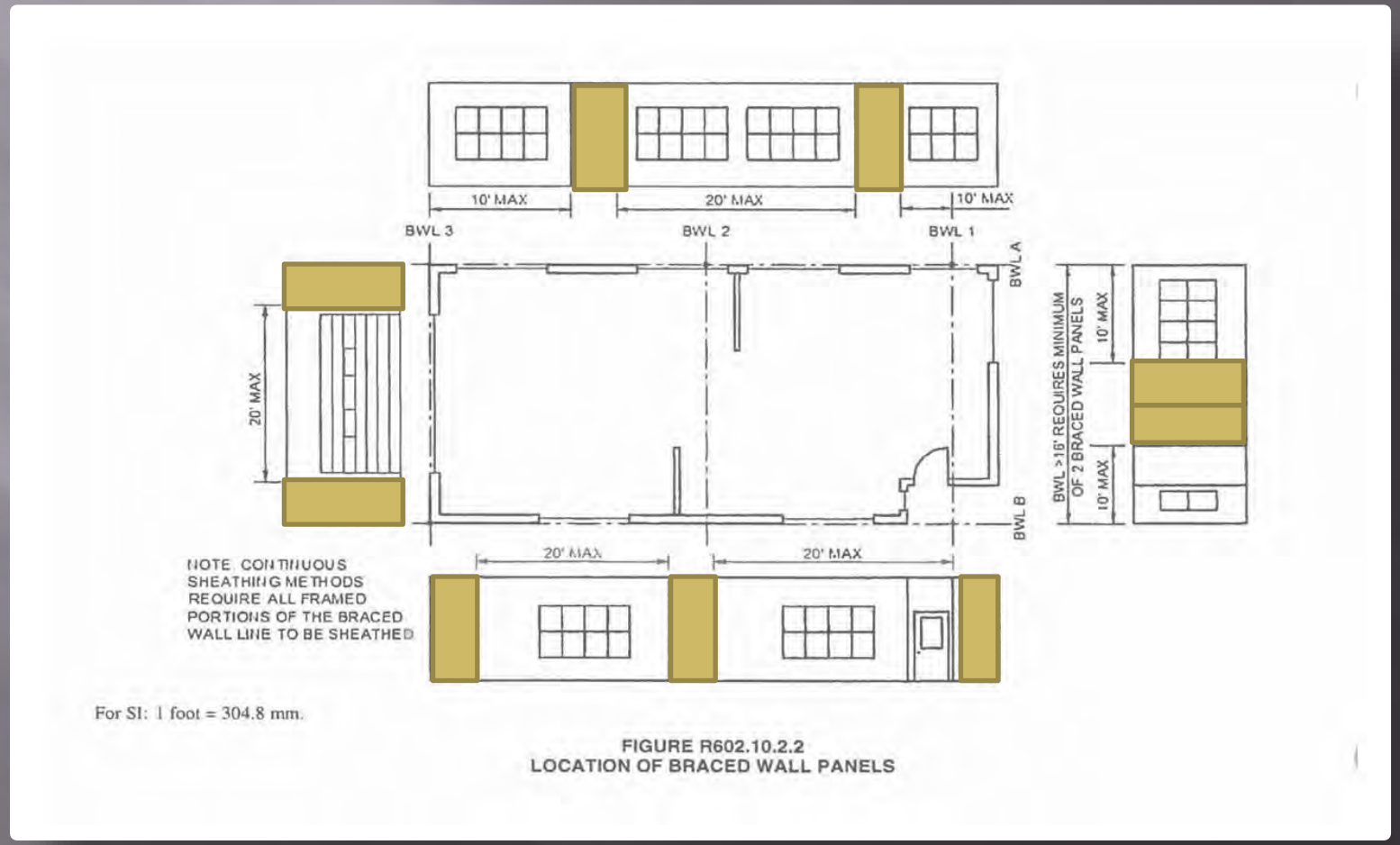


FIGURE R602.10.2.2
LOCATION OF BRACED WALL PANELS

R602.10.2.2.1 Location of braced wall panels in SDC D_0, D_1 and D_2

Except

May be 10 feet from end of BWL provided

Braced wall panels shall be located at each end of a braced wall line.
Or

Minimum Panel width

24" Methods WSP, BV-WSP, CS-WSP, CS-G, and CS-PF

32" Method CS-SFB [See Figure R602.10.7 Condition 4]

Or

Hold-down at end of BWP nearest end of braced wall line. [See Figure R602.10.7 Condition 5]

Or

Method BV-WSP per Table R602.10.6.5 at EACH braced wall panel

R602.10.2.3 MINIMUM NUMBER OF BRACED WALL PANELS

Braced wall lines with a length of 16 feet or less shall have a minimum of two braced wall panels of any length or one braced wall panel equal to 48 inches or more. Braced wall lines greater than 16 feet shall have a minimum of two braced wall panels.

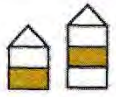
R602.10.3 REQUIRED LENGTH OF BRACING.

Only *braced wall panels* parallel to the *braced wall line* shall contribute toward the required length of bracing of that *braced wall line*. *Braced wall panels* along an angled wall meeting the minimum length requirements of Tables R602.10.5 and R602.l0.5.2 shall be permitted to contribute its projected length toward the minimum required length of bracing for the *braced wall line* as shown in Figure R602.10.1.4. Any *braced wall panel* on an angled wall at the end of a *braced wall line* shall contribute its projected length for only one of the *braced wall lines* at the projected corner.

Exception: The length of wall bracing for dwellings in Seismic Design Categories Do, D_1, and D_2 with stone or masonry veneer installed per Section R703.7 and exceeding the first-story height shall be in accordance with Section R602.l0.6.5

TABLE R602.10.3(3)
BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY

- SOIL CLASS D[b]
- WALL HEIGHT = 10 FEET
- 10 PSF FLOOR DEAD LOAD
- 15 PSF ROOF/CEILING DEAD LOAD
- BRACED WALL LINE SPACING ≤ 25 FEET

Seismic Design Category	Story Location	Braced Wall Line Length (feet)	MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]				
			Method LIB[c]	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB[d]	Method WSP	Methods CS-WSP, CS-G
C (townhouses only)		10	2.5	2.5	2.5	1.6	1.4
		20	5.0	5.0	5.0	3.2	2.7
		30	7.5	7.5	7.5	4.8	4.1
		40	10.0	10.0	10.0	6.4	5.4
		50	12.5	12.5	12.5	8.0	6.8
		10	NP	4.5	4.5	3.0	2.6
		20	NP	9.0	9.0	6.0	5.1
		30	NP	13.5	13.5	9.0	7.7
		40	NP	18.0	18.0	12.0	10.2
		50	NP	22.5	22.5	15.0	12.8
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1
D_0		10	NP	2.8	2.8	1.8	1.6
		20	NP	5.5	5.5	3.6	3.1
		30	NP	8.3	8.3	5.4	4.6
		40	NP	11.0	11.0	7.2	6.1
		50	NP	13.8	13.8	9.0	7.7
		10	NP	5.3	5.3	3.8	3.2
		20	NP	10.5	10.5	7.5	6.4
		30	NP	15.8	15.8	11.3	9.6
		40	NP	21.0	21.0	15.0	12.8
		50	NP	26.3	26.3	18.8	16.0
		10	NP	7.3	7.3	5.3	4.5
		20	NP	14.5	14.5	10.5	9.0
		30	NP	21.8	21.8	15.8	13.4
		40	NP	29.0	29.0	21.0	17.9
		50	NP	36.3	36.3	26.3	22.3

(continued)

TABLE R602.10.3(3)

THERE IS NO SIGNIFICANT DIFFERENCE BETWEEN 2012 IRC AND 2015 IRC

NOTES 'C' AND 'F' ARE DIFFERENT

TABLE R602.10.3(3)—continued
BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY

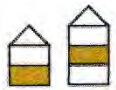
• SOIL CLASS D[b] • WALL HEIGHT = 10 FEET • 10 PSF FLOOR DEAD LOAD • 15 PSF ROOF/CEILING DEAD LOAD • BRACED WALL LINE SPACING ≤ 25 FEET			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a]				
Seismic Design Category	Story Location	Braced Wall Line Length (feet)	Method LIB[c]	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB[d]	Method WSP	Methods CS-WSP, CS-G
D_1		10	NP	3.0	3.0	2.0	1.7
		20	NP	6.0	6.0	4.0	3.4
		30	NP	9.0	9.0	6.0	5.1
		40	NP	12.0	12.0	8.0	6.8
		50	NP	15.0	15.0	10.0	8.5
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1
		10	NP	8.5	8.5	6.0	5.1
		20	NP	17.0	17.0	12.0	10.2
		30	NP	25.5	25.5	18.0	15.3
		40	NP	34.0	34.0	24.0	20.4
		50	NP	42.5	42.5	30.0	25.5
D_2		10	NP	4.0	4.0	2.5	2.1
		20	NP	8.0	8.0	5.0	4.3
		30	NP	12.0	12.0	7.5	6.4
		40	NP	16.0	16.0	10.0	8.5
		50	NP	20.0	20.0	12.5	10.6
		10	NP	7.5	7.5	5.5	4.7
		20	NP	15.0	15.0	11.0	9.4
		30	NP	22.5	22.5	16.5	14.0
		40	NP	30.0	30.0	22.0	18.7
		50	NP	37.5	37.5	27.5	23.4
		10	NP	NP	NP	NP	NP
		20	NP	NP	NP	NP	NP
		30	NP	NP	NP	NP	NP
		40	NP	NP	NP	NP	NP
		50	NP	NP	NP	NP	NP
	Cripple wall below one- or two-story dwelling	10	NP	NP	NP	7.5	6.4
		20	NP	NP	NP	15.0	12.8
		30	NP	NP	NP	22.5	19.1
		40	NP	NP	NP	30.0	25.5
		50	NP	NP	NP	37.5	31.9

TABLE R602.10.3(3)

THERE IS NO SIGNIFICANT DIFFERENCE BETWEEN 2012 IRC AND 2015 IRC

NOTES 'C' AND 'F' ARE DIFFERENT

TABLE R602.10.3(3) (IN %)

- BETTER OR EQ. SOIL CLASS D
- WALL HIGHT = 10'
- 15 PSF ROOF/CEILING D.L.
- BRACED WALL LINE ≤ 25 FT.

WHEN NOT MET SEE TABLE R602.10.3(4) SEISMIC ADJUSTMENT FACTORS

MINIMUM TOTAL LENGTH OF BRACED WALL LINE REQUIRED ALONG EA. BRACED WALL LINE
(in % of BRACE WALL LENGTH)

FOOTNOTES
1. USE 40% FOR 1ST 10'
2. FORCE = LBS
3. NP = NOT PERMITTED
4. NA= NOT APPLICABLE
5. Table R602.10.6.5 INCLUDED

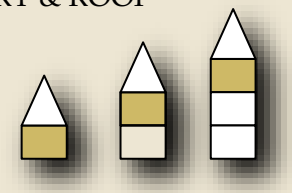
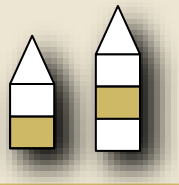
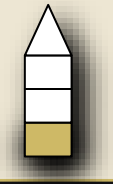
Story Location	Design Category	METHOD OF BRACING							
		LIB	GB	DWB, SFB, PCP, CS-SFB	WSP	CS-WSP, CS-G	BRICK VENEER		
							BV-WSP	STRY HOLD-DWN	TOTAL HD FORCE[2]
1 STORY & ROOF 	C	25	25	25	16	14	NA[4]	NA	NA
	D_0	NP[3]	28	28	18	16	40/35[1]	1900	---
	D_1	NP	30	30	20	17	45	2100	---
	D_2	NP	40	40	25	21	55	2300	---
2 STORY & ROOF 	C	NP	45	45	30	26	NA	NA	NA
	D_0	NP	53	53	38	32	45	3500	5400
	D_1	NP	60	60	45	38	45	3700	5800
	D_2	NP	75	75	55	47	55	3900	6200
3 STORY & ROOF 	C	NP	60	60	45	38	NA	NA	NA
	D_0	NP	73	73	53	45	60	3500	8900
	D_1	NP	85	85	60	51	60	3700	9500
	D_2	NP	NP	NP	NP	NP	NP	NA	NA

TABLE R602.10.3(4) 2015 IRC

THERE IS NO SIGNIFICANT DIFFERENCE BETWEEN 2012 IRC AND 2015 IRC

NOTES 'C' AND 'F' ARE DIFFERENT

TABLE R602.10.3(4)
SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING

ITEM NUMBER	ADJUSTMENT BASED ON:	STORY	CONDITION	ADJUSTMENT FACTOR[a,b] [Multiply length from Table R602.10.3(3) by this factor]	APPLICABLE METHODS
1	Story height (Section 301.3)	Any story	≤ 10 feet	1.0	All methods
			> 10 feet and ≤ 12 feet	1.2	
2	Braced wall line spacing, townhouses in SDC C	Any story	≤ 35 feet	1.0	
			> 35 feet and ≤ 50 feet	1.43	
3	Braced wall line spacing, in SDC D_0, D_1, D_2[c]	Any story	> 25 feet and ≤ 30 feet	1.2	
			> 30 feet and ≤ 35 feet	1.4	
4	Wall dead load	Any story	> 8 psf and < 15 psf	1.0	
			< 8 psf	0.85	
5	Roof/ceiling dead load for wall supporting	1-, 2- or 3-story building	≤15 psf	1.0	
		2- or 3-story building	> 15 psf and ≤ 25 psf	1.1	
		1-story building	> 15 psf and ≤ 25 psf	1.2	
6	Walls with stone or masonry veneer, townhouses in SDC C[d,e]		1.0		All methods
			1.5		
			1.5		
7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D_0 – D_2[f]	Any story	See Table R602.10.6.5		BV-WSP
8	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation shall be permitted.

b. The total length of bracing required for a given wall line is the product of all applicable adjustment factors.

c. The length-to-width ratio for the floor/roof *diaphragm* shall not exceed 3:1. The top plate lap splice nailing shall be in accordance with Table R602.3(1), Item 13.

d. Applies to stone or masonry veneer exceeding the first story height.

e. The adjustment factor for stone or masonry veneer shall be applied to all exterior *braced wall lines* and all *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supported concealed walls.

f. See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.

R602.10.4 Construction Methods for Wall Brace Panels.

1. Intermittent Braced Wall Panels
   a) Individual Braced Wall Panels meeting required widths and heights
   b) Sum of individual Braced Wall Panels meeting required length requirements for Braced Wall Lines in TABLE R602.10.3(3)
2. Continuously Sheathed Braced Wall Panels
   a) Sheathing methods require structural panel sheathing to be used on all sheathable. See R602.10.4.2
   b) On one side of a braced wall line.
   c) Areas above and below openings and gable end walls and shall meet the requirements of Section R602.10.7.
3. Refer to Table R602.10.4

R602.10.4.1 Mixing methods

1. Mixing intermittent bracing and continuous sheathing methods from story to story shall be permitted.

2. Mixing intermittent bracing methods from *braced wall line* to *braced wall line* within a story shall be permitted.
   a) SDC A, B and C, basic wind speed ≤ 100 mph mixing of intermittent bracing and continuous sheathing methods from *braced wall line* to *braced wall line* within a story shall be permitted.

3. SDC A and B, and detached dwellings in SDC C, mixing intermittent bracing methods along a *braced wall line* permitted provided the length of required bracing meets lengths Table R602.10.3(1) or R602.1 0.3(3) (highest value of all intermittent bracing methods used).

4. Mixing of continuous sheathing methods CS-WSP, CS-G and CS-PF along a *braced wall line* shall be permitted.

5. SDC A and B, and for detached one- and two-family dwellings in Seismic Design Category C, mixing of intermittent bracing methods along the interior portion of a *braced wall line* with continuous sheathing methods CS-WSP, CS-G and CS-PF along the exterior portion of the same *braced wall line* is permitted. (Use highest value from Table R602.1 0.3(1) or R602.1 0.3(3) as adjusted by Tables R602.10.3(2) and R602.10.3(4), respectively. The requirements of Section R602.1 0. 7 shall .

BRACE WALL PANELS - TABLE R602.10.4 (INTERMITTENT)

Symbol	Description
	Diagonal let-in brace
	Diagonal wood boards
	Wood structural panel
	Wood Structural Panels with Stone or Masonry Veneer (See R602.10.6.5)
	SFB Structural fiberboard
	GB Gypsum wallboard
	PBS Particleboard

SEE TABLE R602.10.4

MINIMUM LENGTH of PANEL TABLE R602.10.5

footnotes to follow

2015 IRC

2012 IN RED

TABLE R602.10.5
MINIMUM LENGTH OF BRACED WALL PANELS

METHOD (See Table R602.10.4)		MINIMUM LENGTH[a] (Inches)					CONTRIBUTING LENGTH (Inches)
		Wall Height					
		8 feet	9 feet	10 feet	11 feet	12 feet	
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP		48	48	48	53	58	Actual[b]
GB		48	48	48	53	58	Double sided = Actual Single sided = 0.5 × Actual
LIB		55	62	69	NP	NP	Actual[b]
ABW	SDC A, B and C, ultimate design wind speed < 140 mph	28	32	34	38	42	48
	SDC D_0, D_1 and D_2, ultimate design wind speed < 140 mph	32	32	34	NP	NP	
PFH	Supporting roof only	16	16	16	18[c]	20[c]	48
	Supporting one story and roof	24	24	24	27[c]	29[c]	48
PFG		24	27	30	33[d]	36[d]	1.5 × Actual[b]
CS-G		24	27	30	33	36	Actual[b]
CS-PF	SDC A, B and C	16	18	20	22[e]	24[e]	1.5 × Actual[b]
	SDC D_0, D_1 and D_2	16	18	20	22[e]	24[e]	Actual[b]
CS-WSP, CS-SFB	Adjacent clear opening height (inches)						
	≤ 64	24	27	30	33	36	Actual[b]
	68	26	27	30	33	36	
	72	27	27	30	33	36	
	76	30	29	30	33	36	
	80	32	30	30	33	36	
	84	35	32	32	33	36	
	88	38	35	33	33	36	
	92	43	37	35	35	36	
	96	48	41	38	36	36	
	100	—	44	40	38	38	
	104	—	49	43	40	39	
	108	—	54	46	43	41	
	112	—	—	50	45	43	
	116	—	—	55	48	45	
	120	—	—	60	52	48	
	124	—	—	—	56	51	
	128	—	—	—	61	54	
	132	—	—	—	66	58	
	136	—	—	—	—	62	
	140	—	—	—	—	66	
	144	—	—	—	—	72	

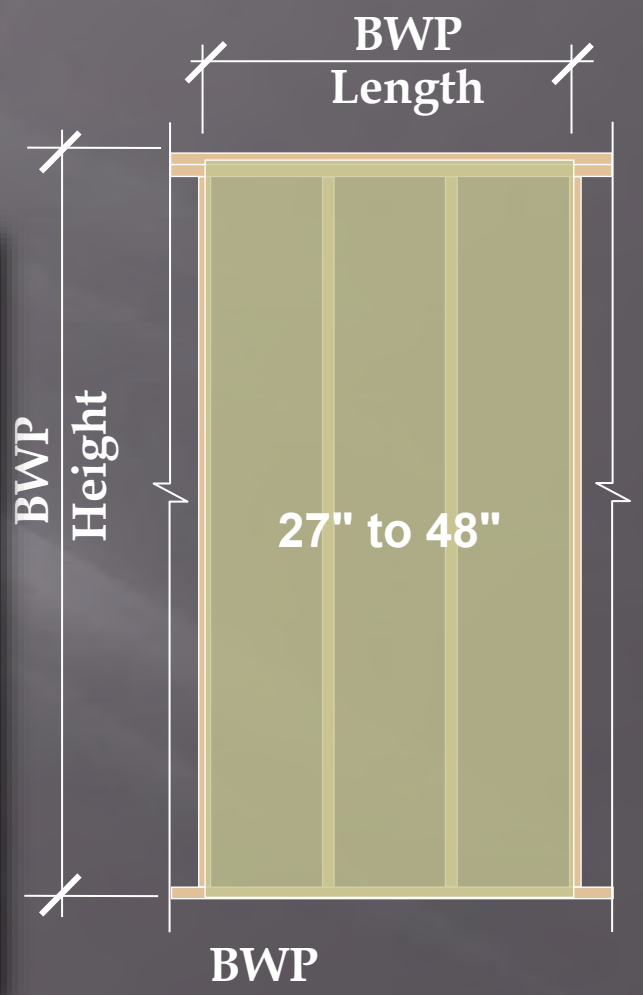
Intermittent Bracing

Minimum Braced Panel Length

Table R602.10.5.2 Effective length of braced panels less than 48"

TABLE R602.10.5.2
PARTIAL CREDIT FOR BRACED WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH

Actual Length	CONTRIBUTING LENGTH OF BRACED WALL PANEL (inches)[a]	
	8′ wall hgt.	9′ wall hgt.
48"	48″	48″
42"	36"	36"
36"	27"	N/A



a. **Linear interpolation shall be permitted**

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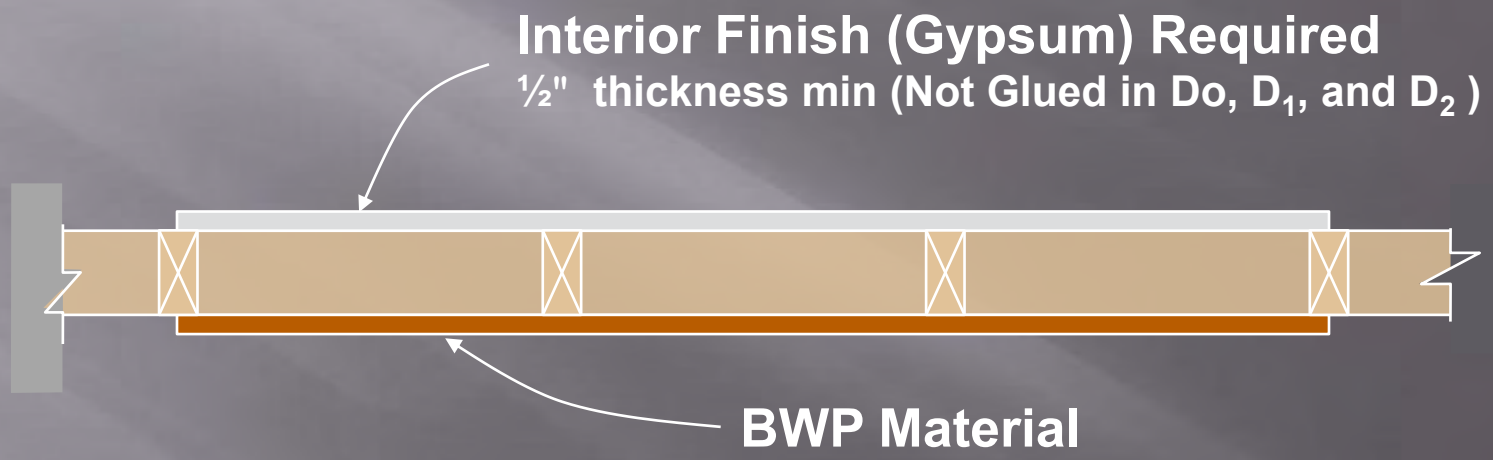
Braced Panel Construction

R602.10.4.3 Braced Wall Panel Interior Finish Material



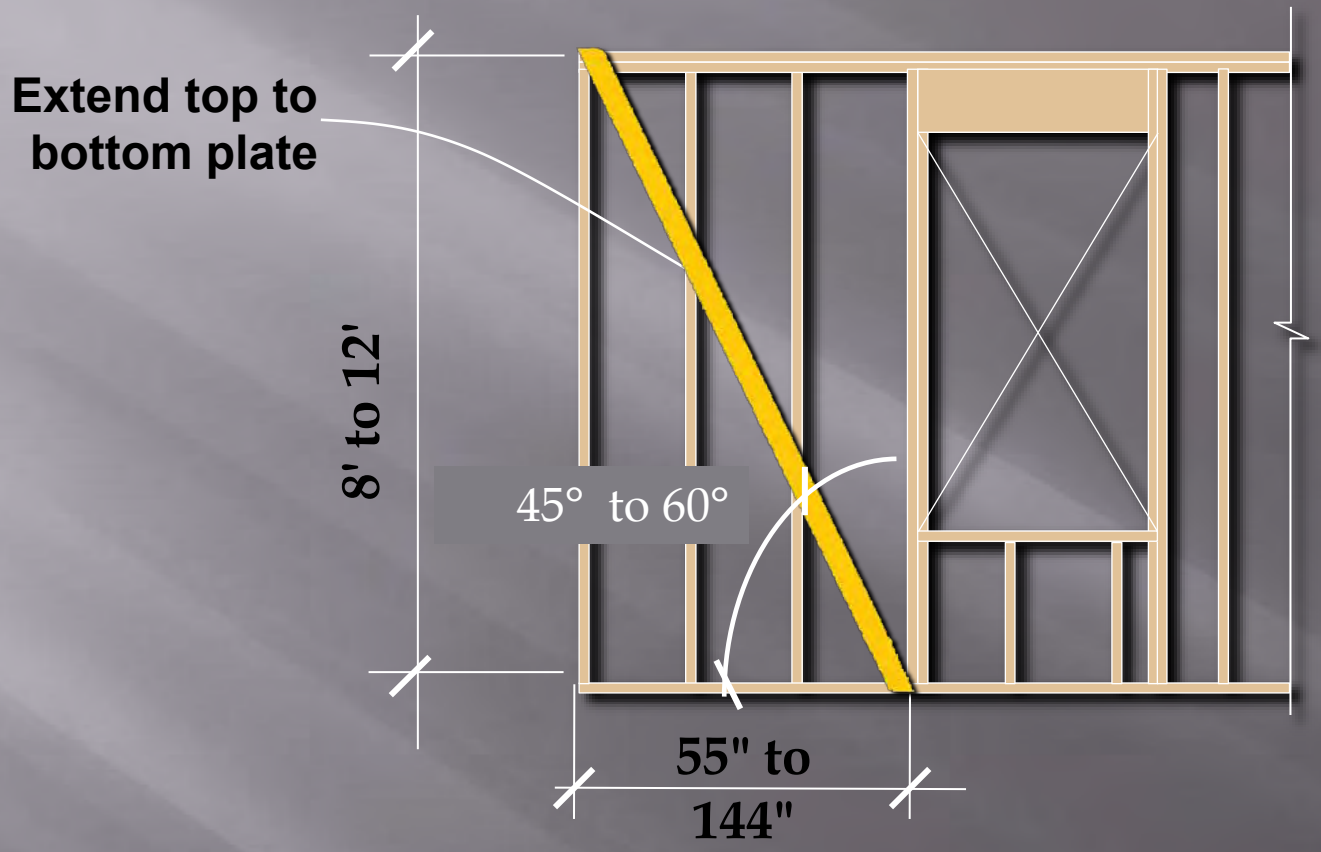
Exceptions:

Wall panels braced with Methods GB, BV-WSP, ABW, PFH, PFG and CS-PF.

1. **For Methods DWB, WSP, SFB, PBS, PCP and HPS, omitting gypsum wall board is permitted if not otherwise required by Section R302.6**
2. **When an *approved interior finish material with* an in-plane shear resistance equivalent to gypsum board is installed.**
3. **LIB when length is adjusted**

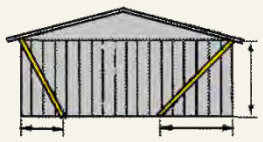
Intermittent Bracing

Method LIB – Let-in Brace



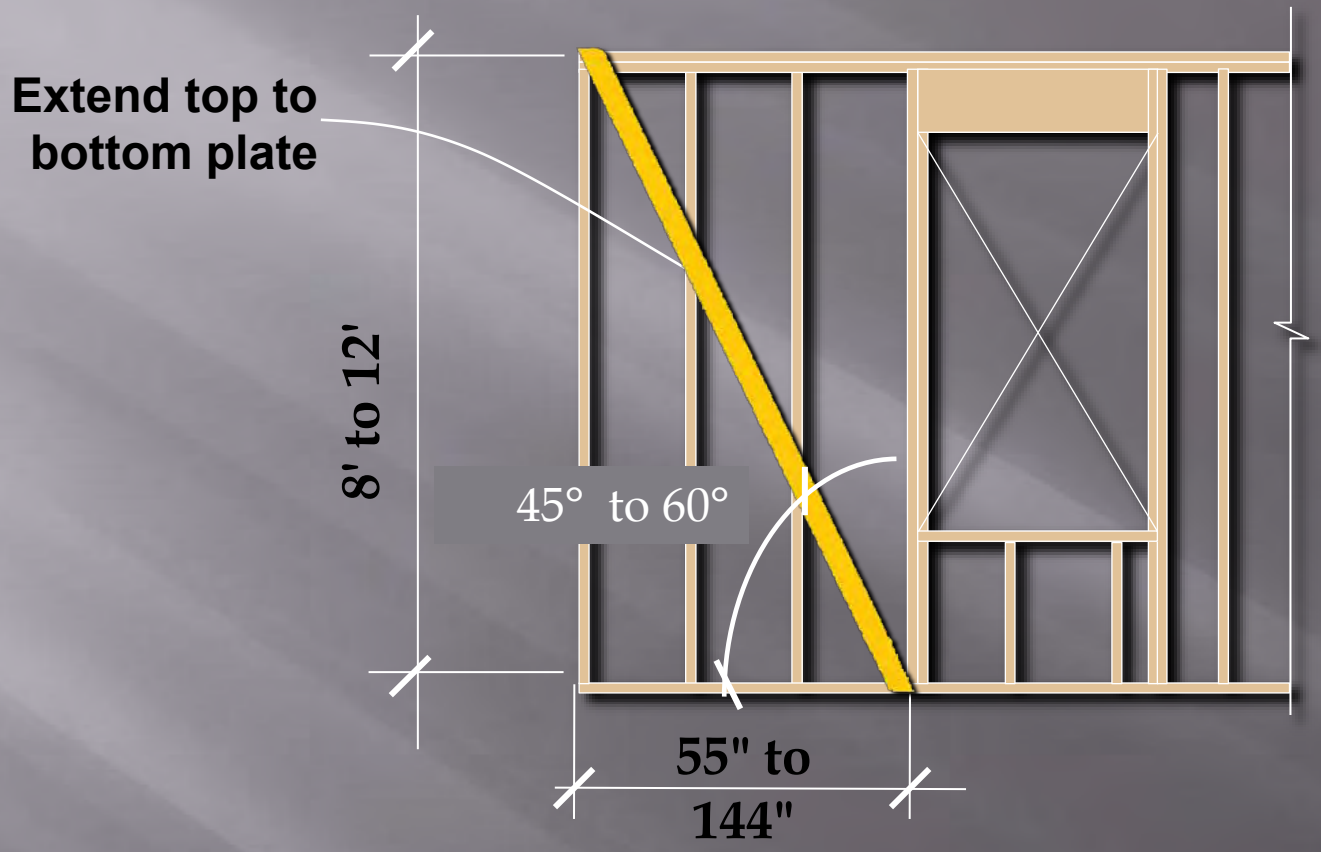
Method LIB
Let-in Brace

- Angled 45 to 60 degrees from horizontal
- Extends continuously from bottom plate to top plate
- 1x4 lumber or approved metal strap

Method Material	Minimum Thickness	Figure/Symbol	Connection Criteria	
			Fasteners	Spacing
LIB Let-in bracing	1X4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing	 LIB	Wood: 2-8d nail or 3-8d (2 ½″ long x 0.113 dia.) nails	Wood: per stud and top and bottom plates
			Metal strap: per manufacturer	Metal per Manufacturer

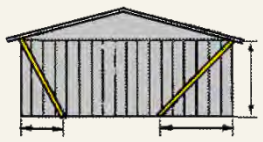
Intermittent Bracing

Method LIB – Let-in Brace



Method LIB
Let-in Brace

- Angled 45 to 60 degrees from horizontal
- Extends continuously from bottom plate to top plate
- 1x4 lumber or approved metal strap

Method Material	Minimum Thickness	Figure/Symbol	Connection Criteria	
			Fasteners	Spacing
LIB Let-in bracing	1X4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing	 LIB	Wood: 2-8d nail or 3-8d (2 ½″ long x 0.113 dia.) nails	Wood: per stud and top and bottom plates
			Metal strap: per manufacturer	Metal per Manufacturer

Intermittent Bracing

LIB

Method LIB – Let-in Brace

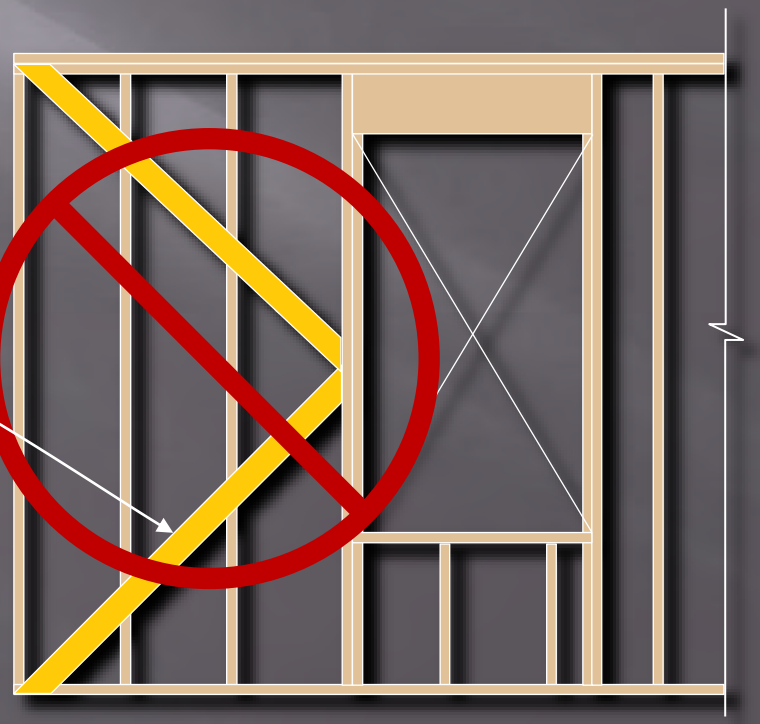
Application limited

1st and 2nd story in SDC A & B

1st story in SDC C

Not permitted in SDC D_0 D_1 and D_2

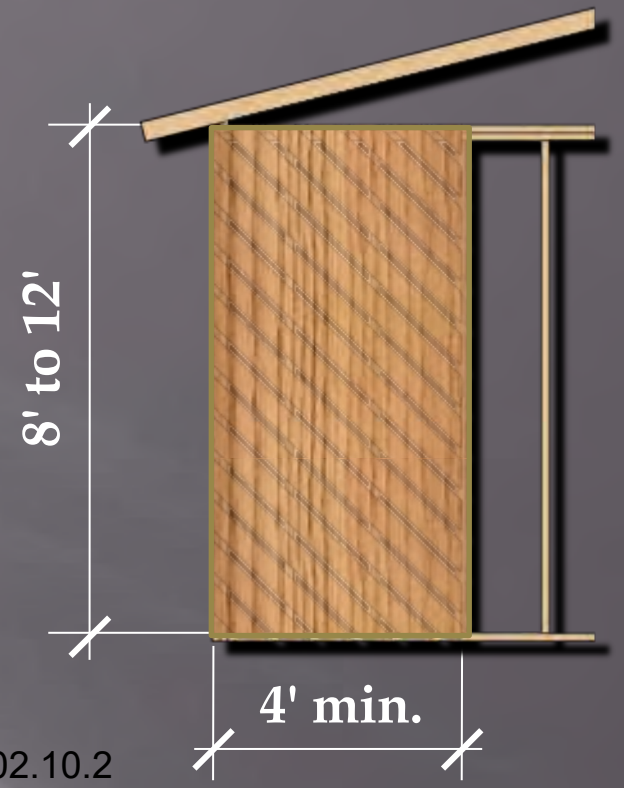
Must extend continuously from bottom plate to top plate



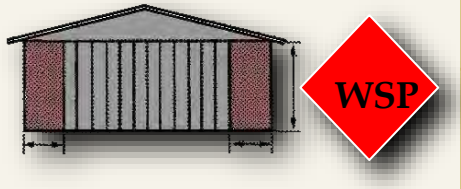
Intermittent Bracing

Method WSP – Wood Structural Panel

3/8" min. thickness Wood structural panel defined in R604.1: Identification and grade.
Wood structural panels shall conform to DOC PS 1, DOC PS 2 or ANSI/APA PRP 210 or, when manufactured in Canada, CSA 0437 or CSA 0325. All panels shall be identified by a grade mark or certificate of inspection issued by an *approved agency*.



R602.10.2

Method Material	Minimum Thickness	Figure/Symbol	Connection Criteria	
			Fasteners	Spacing
WSP Structural pane l (See Section R604)	3/8″ plywood or 7/16″ Structural OSB See R602.12.2 and R604		Sheathing per Table R602.3(3)	6″panel edge 12″ field
			Interior sheathing per Table R602.3(1) or R602.3(3)	Varies fastener

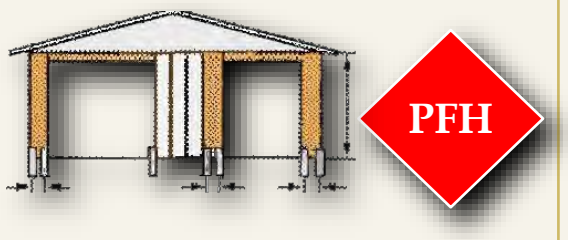
Intermittent Bracing

R602.10.6.2 Method PFH

R602.10.6.2 Method PFH: Portal frame with hold downs. Method PFH *braced wall panels shall be constructed* in accordance with Figure R602.10.6.2.

Limited to 2 Story maximum . Hgt. of panel includes header height

1 or 2-Story		
Height	Min. length Roof Only	Min. length Roof + 1-Story
8'	16"	24″
9'	16"	24″
10'	16"	24″
11′	18″	27″
12′	20″	30″

Method Material	Minimum Thickness	Figure/Symbol	Connection Criteria	
			Fasteners	Spacing
PFH Portal frame with hold-downs	3/ 8″		See Section R602.10.6.2	See Section R602.1 0.6.2

Intermittent Bracing

PFH

Method PFH – Intermittent Portal with Hold Downs

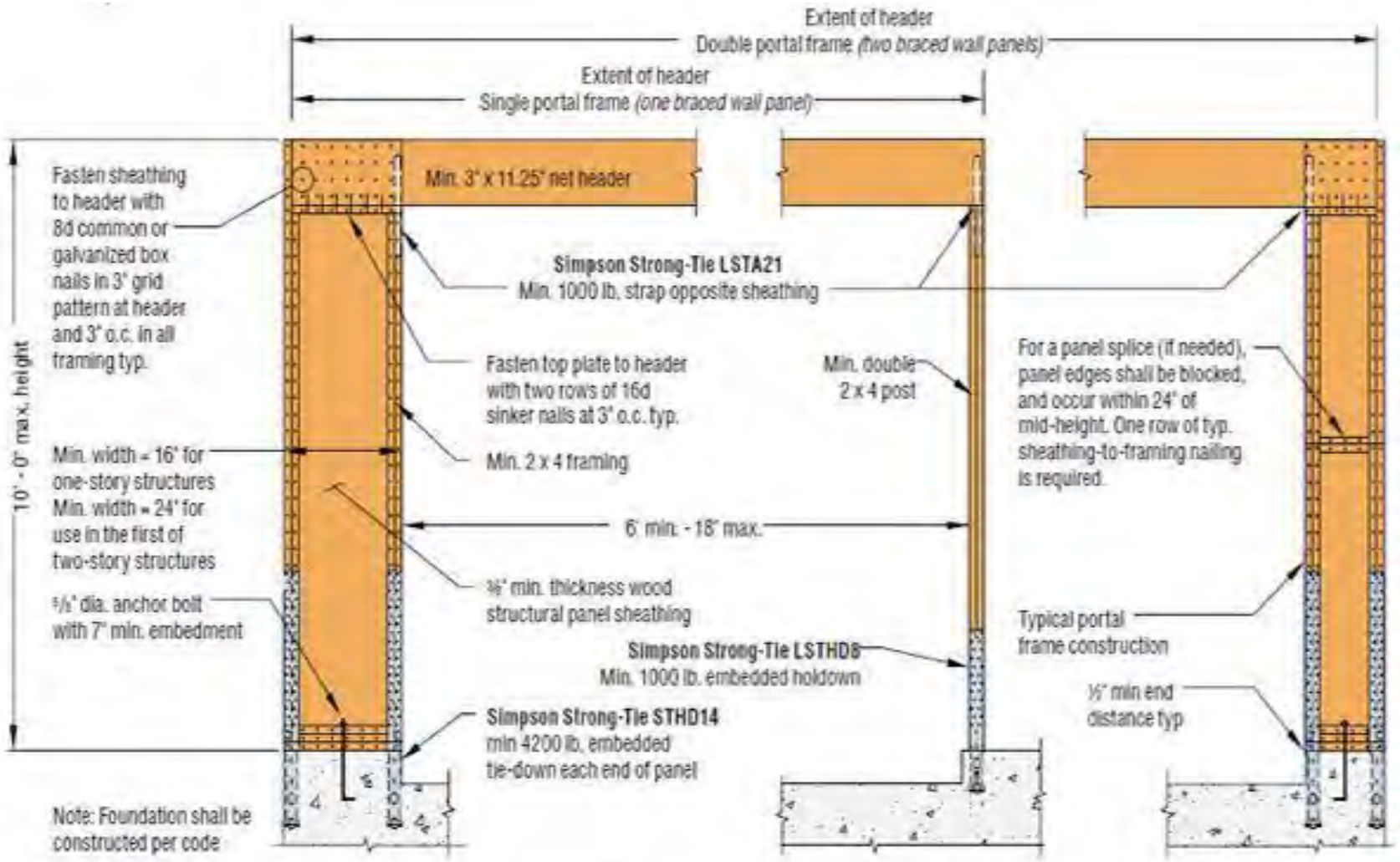


Figure R602.10.6.2 Method PFH: Portal Frame with Holdowns

R602.10.3.4

R602.10.6.3 Method PFG:

Portal frame at garage door openings in Seismic Design Categories A, B and C. Where supporting a roof or one story and a roof, a Method PFG *braced wall panel constructed in* accordance with Figure R602.10.6.3 shall be permitted on either side of garage door openings.

1 or 2-Story	
Wall Height	Min. length
8'	24"
9'	27"
10'	30"
11′	33″
12′	36″

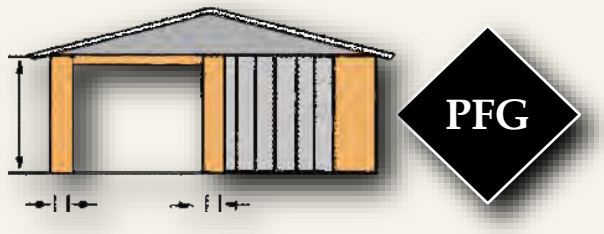
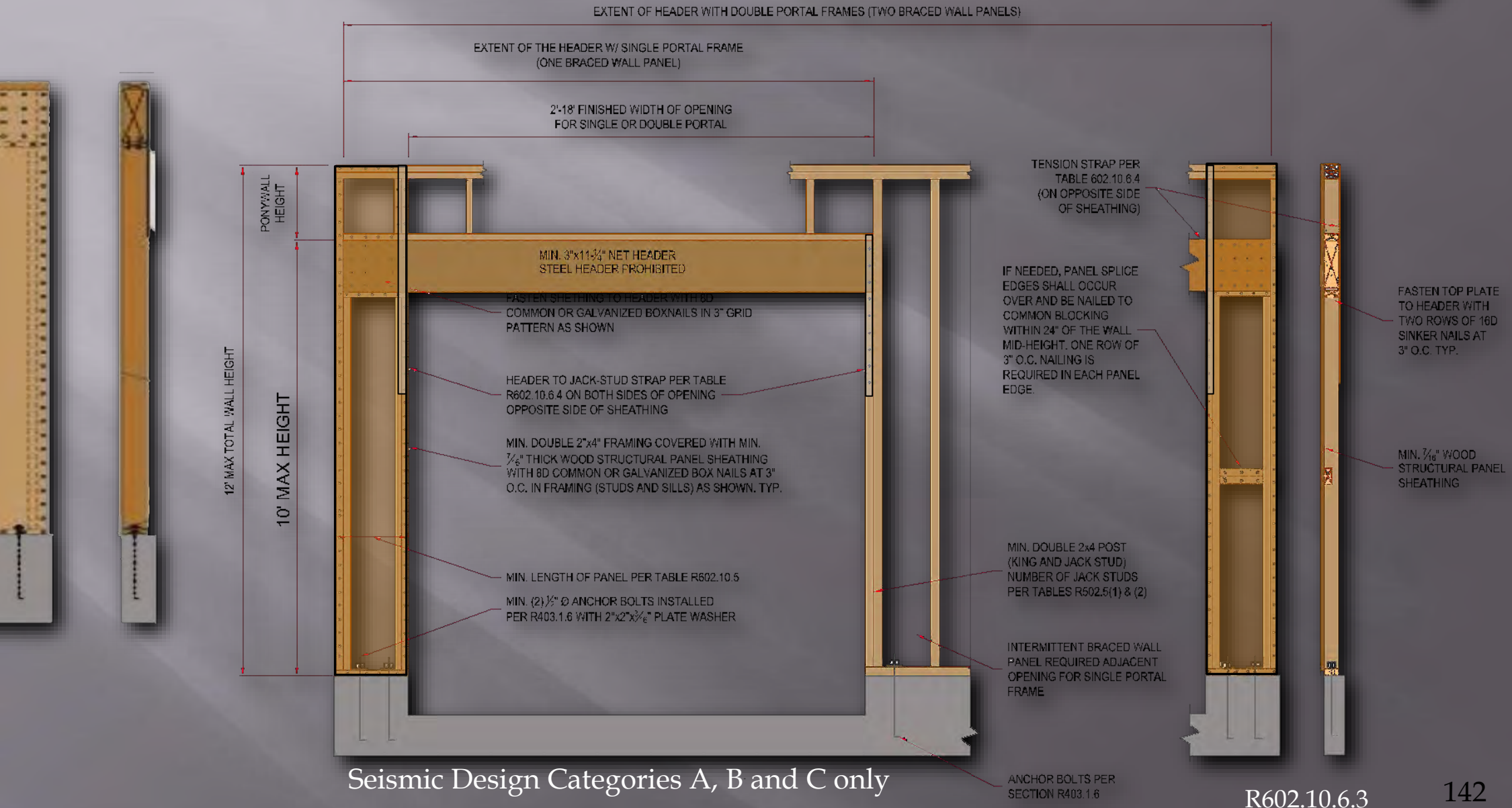
Method Material	**Minimum Thickness**	**Figure/Symbol**	**Connection Criteria**	
			Fasteners	Spacing
PFG Portal frame at garage	7/16″		See Section R602.10.6.3	See Section R602.10.6.3

Figure R602.10.6.3

Method PFG – Intermittent Portal Frame at Garage

PFG



Seismic Design Categories A, B and C only

R602.10.6.3

R602.10.6.4 Method CS-PF

Continuously sheathed portal frame. Continuously sheathed portal frame *braced wall panels shall be constructed in accordance* with Figure R602.10.6.4 and Table 602.10.6.4. The number of continuously sheathed portal frame panels in a single *braced wall line shall not exceed four.*

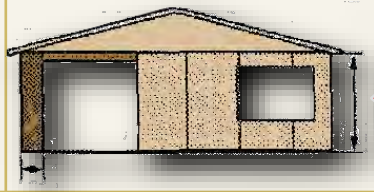
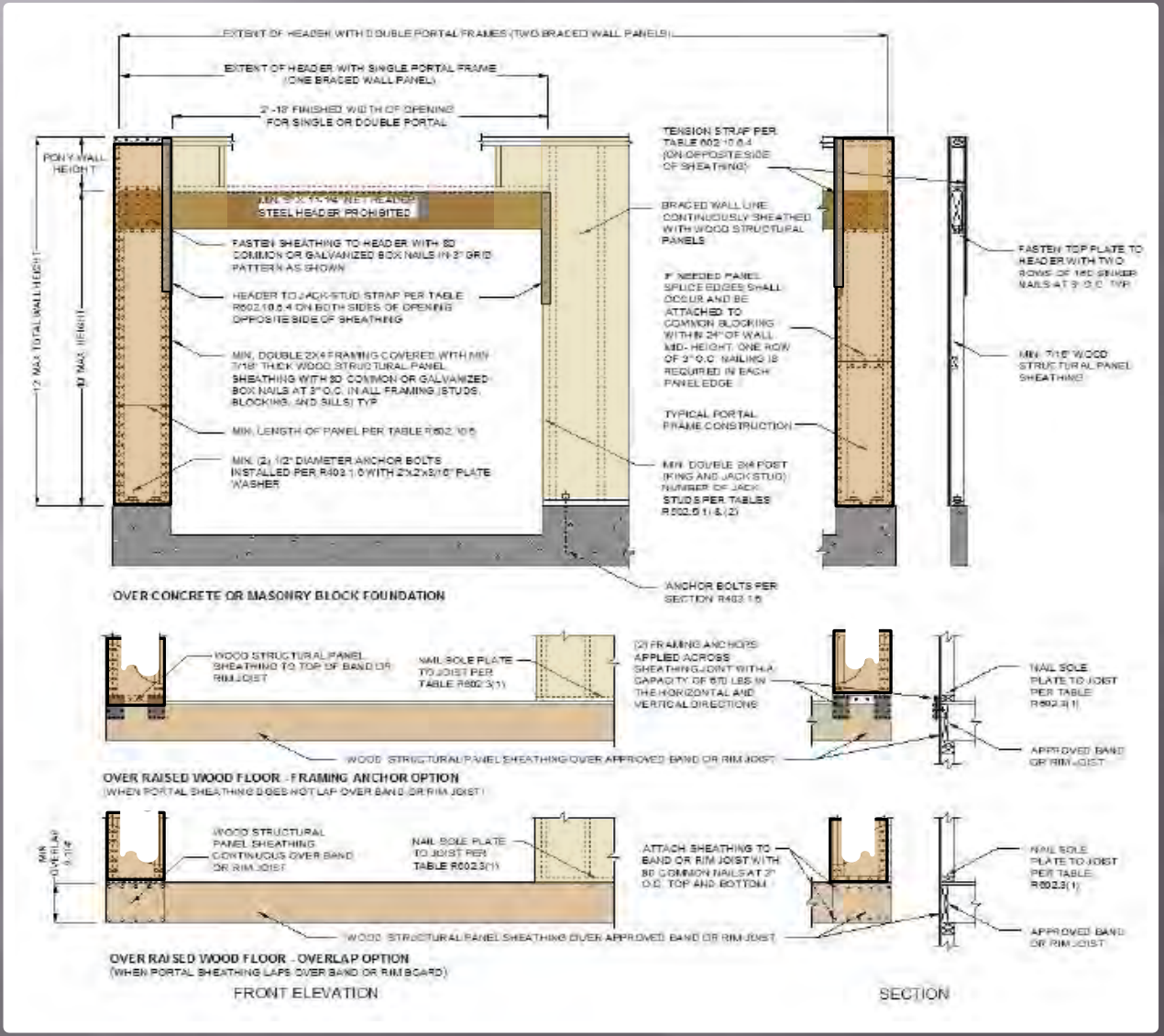
Method Material	**Minimum Thickness**	**Figure/Symbol**	**Connection Criteria**	
			Fasteners	Spacing
CS-PF Continuously sheathed portal frame	7/16"	 CS-PF	See Section R602.10.6.4	See Section R602.10.6.4

Figure R602.10.6.4

Method CS-PF – Intermittent Portal Frame at Garage



CS-PF

1 or 2-Story	
Wall Height	Min. length
8'	16"
9'	18"
10'	20"
11’	22”
12’	24”

R602.10.4.1 Mixing Methods.

- Mixing intermittent bracing and continuous sheathing methods from story to story shall be permitted.

- Mixing intermittent bracing methods from *braced wall line to braced wall line within a story* - permitted. SDC A thru D_2

- Mixing intermittent bracing and continuous sheathing methods from *braced wall line to braced wall line within a story* - permitted. SDC A, B and C or in regions where the basic wind speed is less than or equal to 100 mph (IRC 2015 130mph)

- Mixing intermittent bracing methods along a b*raced wall line shall be permitted in SDC* A and B and SDC C single family – permitted provided length of required bracing is in accordance with Table R602.10.3(1) or R602.1 0.3(3) is the highest value of all intermittent bracing methods used.

Masonry Veneers Have Special Brace Panel Needs

- Thank You!!!