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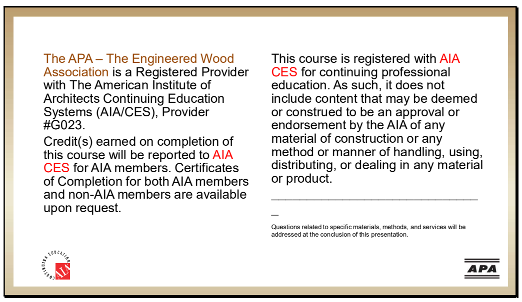
Slide 2



Slide 3

Slide 4

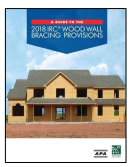
Learning Objectives

- Understand APA resources for IRC wall bracing.
- Develop an understanding of common forces used in designing wall bracing.
- Understand the limits of wall bracing in the IRC.
- Understand the concepts of braced walls and how to apply them.

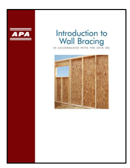
Slide 5

Resources

www.iccsafe.org
- Item no. 7102S12



www.apawood.org
- Form F430

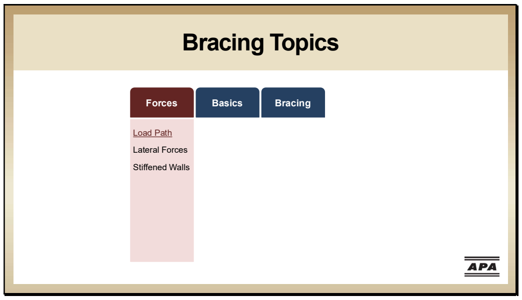


Slide 6

Bracing Topics

Forces	Basics	Bracing
Load Path	Limits	Braced Wall Lines
Lateral Forces	Wind Exposure	Braced Wall Panels
Stiffened Walls		Required Length
		Simplified Wall Bracing
		APA Simplified Wall Bracing
		APA Wall Bracing Calculator

Slide 7



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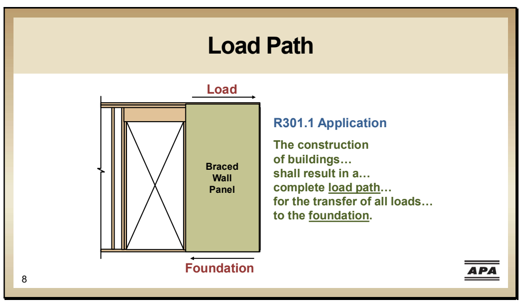

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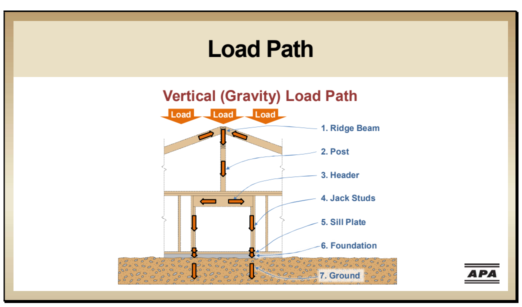

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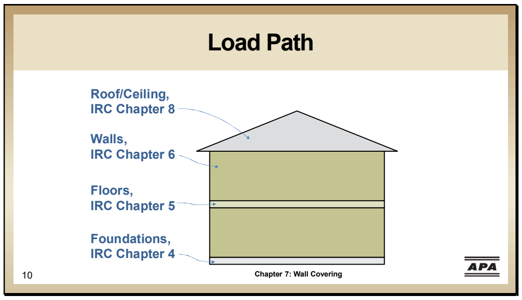

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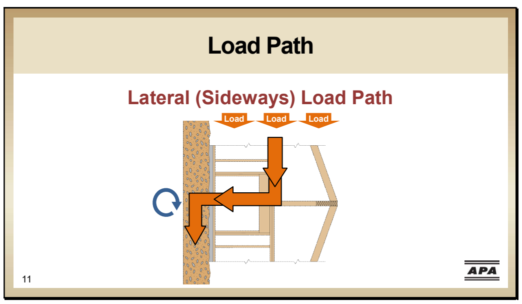

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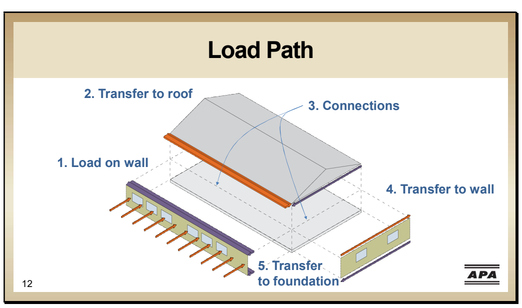

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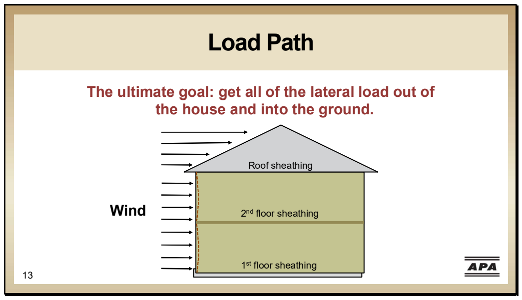

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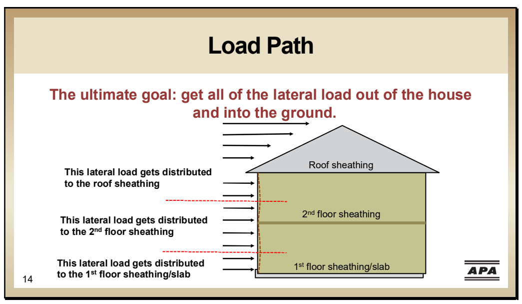

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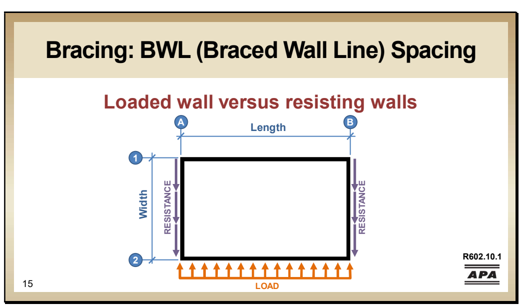

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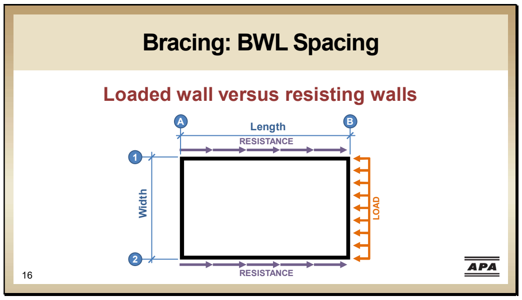

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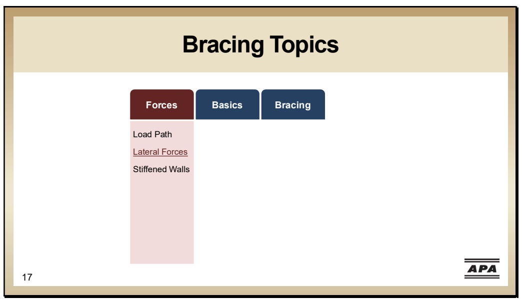

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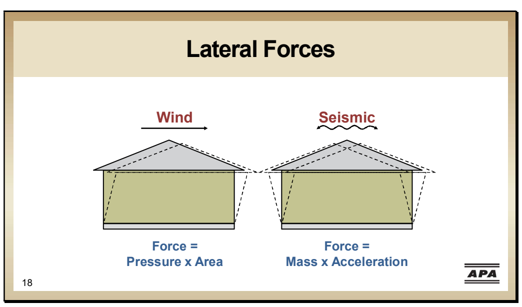

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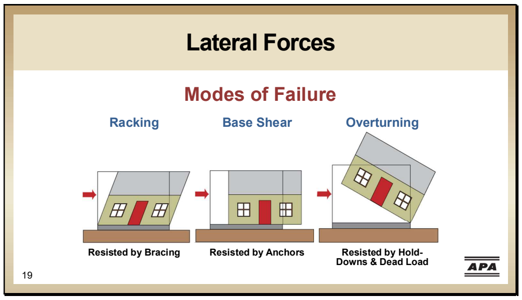

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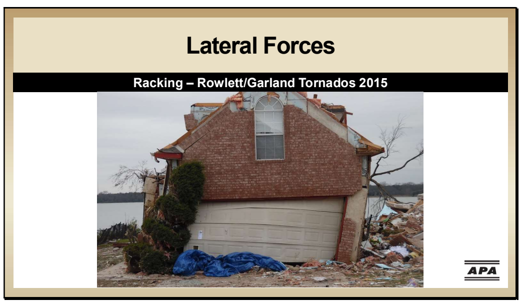

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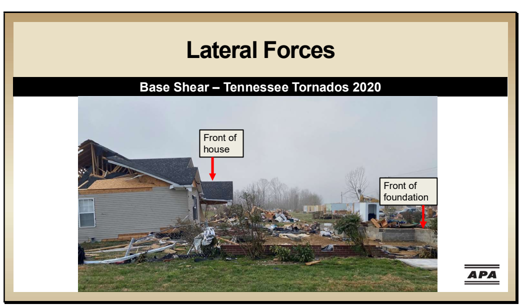

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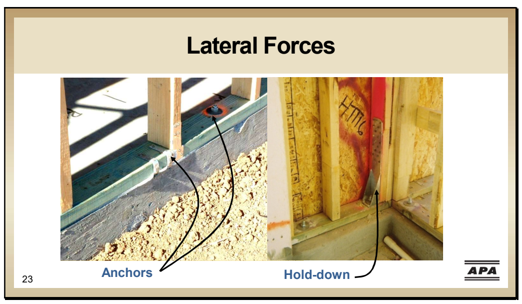

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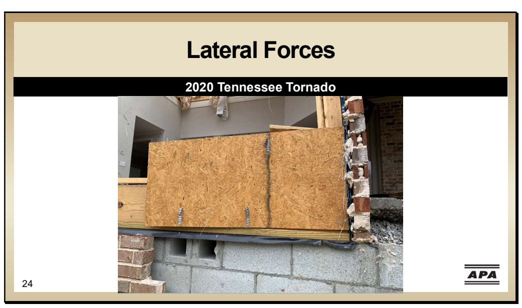

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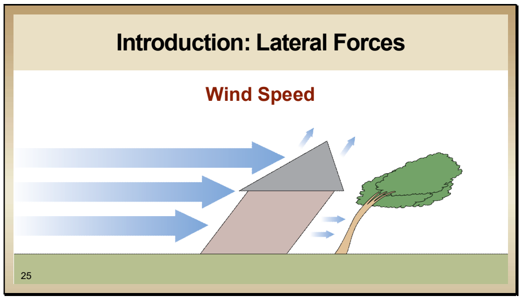

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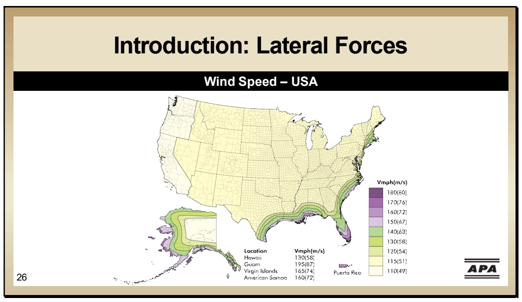

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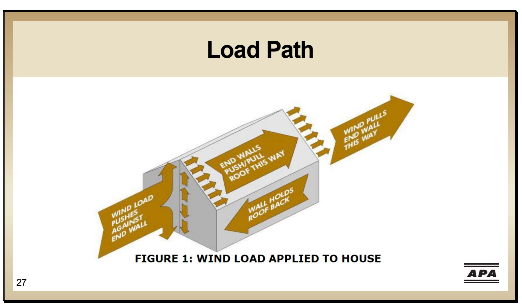

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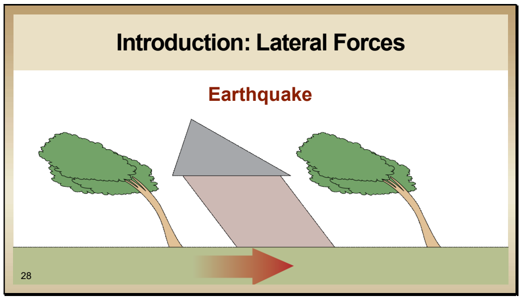

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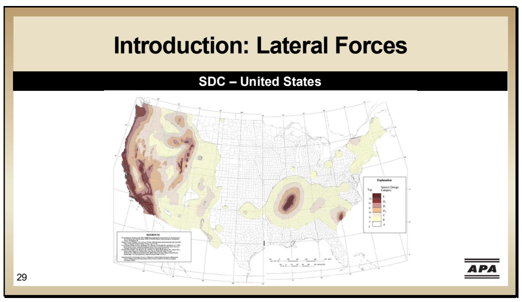

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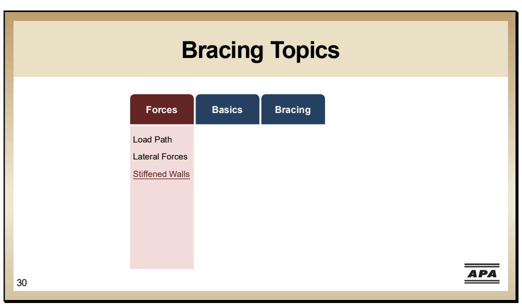

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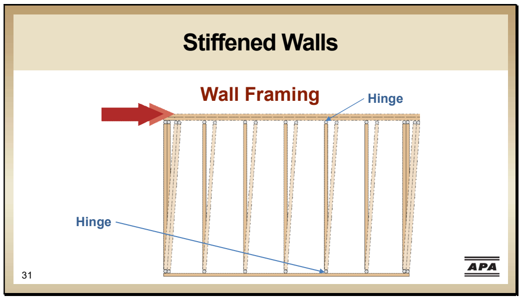

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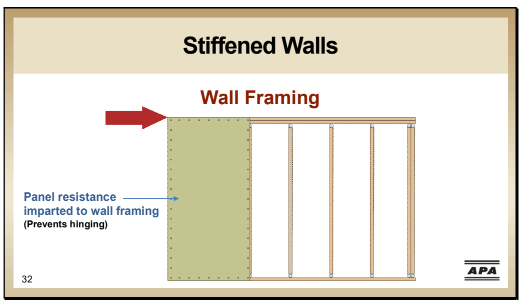

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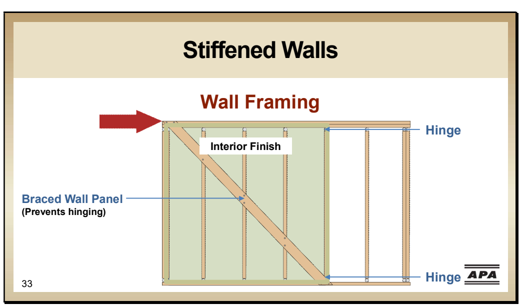

Slide 34

Braced Walls vs. Shear Walls

BWP (Prescriptive)

- Limitations
  - 3-stories maximum
  - Ultimate design wind speed < 140 mph(1)
  - SDC limitations
  - Maximum story height = 11'-7" (R301.3)
  - Townhome configuration
  - Others per Chapter 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

34 (1) Areas requiring wind design in Table R301.2(5)A may not use the IRC for lateral provisions.

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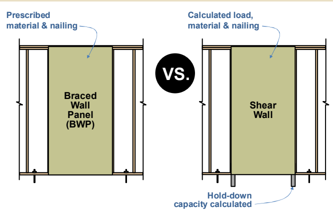
Stiffened Walls



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Wall Bracing

R602.10 Wall Bracing

"Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1."

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History of 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 on 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…
  - The Southern Building Code of 1970 had similar requirements as did the National Building Code by 1984.

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History of Bracing: Where did it come from?

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History of Bracing

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History of Bracing

- Uniform Building Code – 1994
  - 32-inch alternate braced wall panel added
- International Residential Code – 2000
  - Bracing percentage requirement added
  - Continuous wood structural panel bracing method added
- International Residential Code – 2006
  - Alternate braced wall panel adjacent to door or window opening added
  - Continuous sheathing 4:1 and 6:1 aspect ratio panels at garage door added

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History of Bracing

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History of 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

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History of Bracing

- International Residential Code – 2009 (continued)
  - 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

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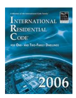
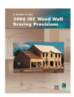
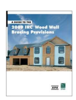
A Guide to the Wood Wall Bracing Provisions





2006 IRC Wall Bracing
- 6 pages on wall bracing
- 157-page guide



2009 IRC Wall Bracing
- 28 pages on wall bracing
- 255-page guide

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History of Bracing

- International Residential Code – 2012
  - Reorganization of wall bracing section
  - Simplification of end distance and distance between braced wall panels
  - Simplification of braced wall line length
  - New method – Simplified Wall Bracing
- International Residential Code – 2015
  - Change to Ultimate Wind Loads
- International Residential Code – 2018
  - Minor clarifications were made
  - No significant cost or design impacts

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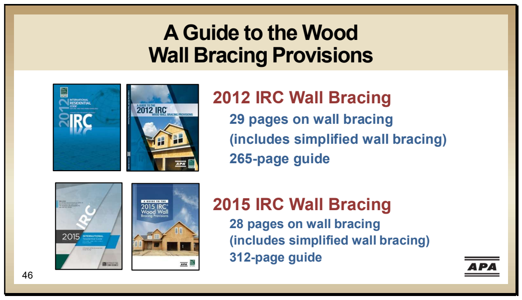

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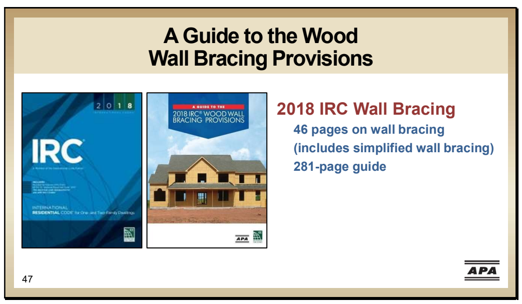

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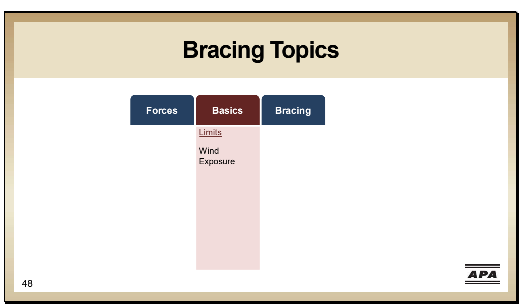

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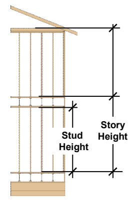
Limits – Story Height

In-plane lateral forces

Requirements for story height exist to limit the wind and seismic provisions

- Story height limit – 11 ft 7 in
- Stud height – 10 ft per Table R602.3(5) – does not include thickness of t/b plates
- Table R602.3(6) allows stud heights up to 12 ft – a lot of restrictions and requirements – read the footnotes and R602.3.1



R301.3

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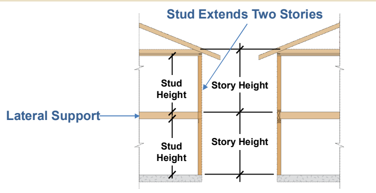
Limits – Story vs Stud Height



Balloon Framing Platform Framing

R301.1.2

APA

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Limits – Seismic

- R301.2.2 Seismic provisions
- The seismic provisions of this code shall apply to…
  - Townhouses in SDC C, D0, D1 and D2
  - Detached one and two family dwellings in SDC D0, D1 and D2

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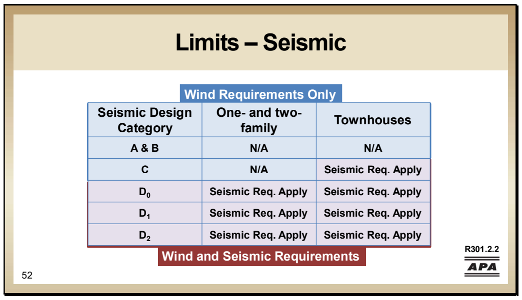

Seismic Design Category	One- and two-family	Townhouses
A & B	N/A	N/A
C	N/A	Seismic Req. Apply
D_0	Seismic Req. Apply	Seismic Req. Apply
D_1	Seismic Req. Apply	Seismic Req. Apply
D_2	Seismic Req. Apply	Seismic Req. Apply

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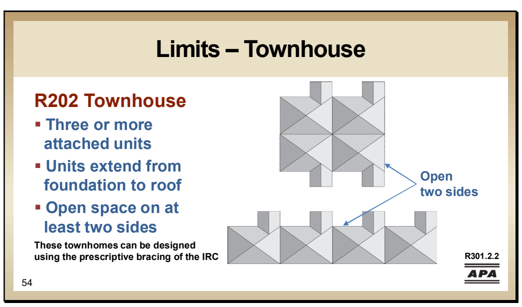

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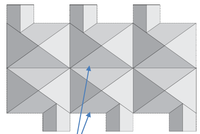
Limits – Townhouse

R202 Townhouse

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

These townhomes cannot be designed using the prescriptive bracing of the IRC



Not open two sides
(therefore, not a townhouse)

R301.2.2

APA

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Limits – Weight

R301.2.2.2.2 Weight of Materials

- Average dead loads shall not exceed:
  - 15 or 25 psf for roofs/ceiling assemblies
  - 10 psf for floor assemblies
  - 15 psf for exterior wall assemblies

Wind Requirements
Weight of materials provisions do not apply

Seismic Requirements
Weight of materials provisions apply

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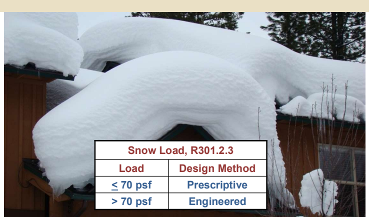
Limits – Weight



Snow Load, R301.2.3	
Load	Design Method
≤ 70 psf	Prescriptive
> 70 psf	Engineered

R301.2.2.3

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Limits: Irregular Buildings

R301.2.2.2.6 Irregular buildings

"The seismic provisions of this code … shall not be used for irregular structures located in Seismic Design Categories C, D0, D1, and D2. 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."

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Limits: Irregular Buildings

R301.2.2.2.6 Irregular buildings

"The seismic provisions of this code … shall not be used for irregular structures located in Seismic Design Categories C, D0, D1, and D2. 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 <u>not</u> apply	Irregular building provisions apply

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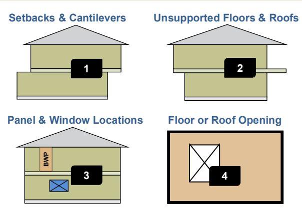
Limits: Irregular Buildings



R301.2.2.2.6

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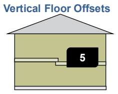
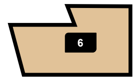
Limits: Irregular Buildings

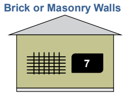
Vertical Floor Offsets



Non-perpendicular Walls



Brick or Masonry Walls



R301.2.2.2.6

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Limits: Wind Exposure

R301.2.1.1 Wind Limitations and Wind Design Required

- When ultimate wind speeds are 140 mph or greater OR
- Special Wind Region per Figure R301.2(5)A
- The following references may be used to design the walls to resist lateral forces:
  - AWC-WFCM
  - ICC 600
  - ASCE-7
  - AISI S230 (steel)
  - IBC

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Limits: Wind Exposure

Figure R301.2(5)A shows where the IRC wall bracing requirements do not apply.

Another code or standard must be used to brace the walls against lateral loads.

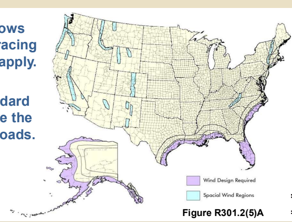

Figure R301.2(5)A

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Limits: Wind Exposure

R301.2.1 Wind Design Criteria

- Component and cladding loads for wall coverings, windows, etc. per Table R301.2(2) and adjusted per Table R301.2(3) shall be used…

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Limits: Wind Exposure

R301.2.1.1 Wind Limitations

Cladding Failure

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Bracing Topics

Forces	Basics	Bracing	Examples
	Limits Wind Exposure		

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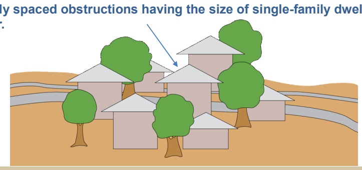
Wind Exposure

Exposure B:
Urban and suburban areas, wooded areas or other terrain with many closely spaced obstructions having the size of single-family dwellings or larger.



R301.2.1.4

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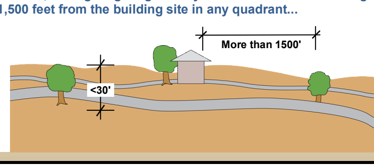
Wind Exposure

Exposure C (1 of 2):
Open with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet extending more than 1,500 feet from the building site in any quadrant...



R301.2.1.4

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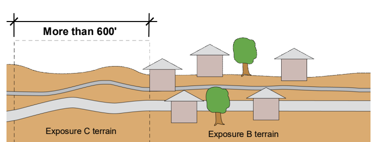
Wind Exposure

Exposure C (2 of 2):
Within Exposure B terrain, but located directly adjacent to open areas of Exposure C for a distance of more than 600 ft.



R301.2.1.4

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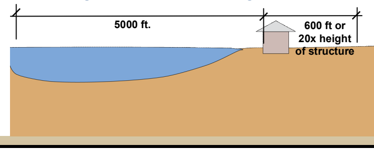
Wind Exposure

Exposure D:

Flat, unobstructed areas exposed to wind flowing over open water, smooth mud flats, salt flats and unbroken ice for a distance of not less than 5000 ft. Extends inland the greater of 600 ft. or 20x height of structure.



R301.2.1.4

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Bracing Topics

Forces | Basics | Bracing

- Braced Wall Lines
- Braced Wall Panels
- Required Length
- Simplified Wall Bracing
- APA Simplified Wall Bracing
- APA Wall Bracing Calculator

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Important Basics

- Braced Wall Lines R602.10.1
  - Straight
  - Run in each plan direction
  - Required on each floor
  - 4' offset each side of BWL allowed
  - BWL not required to align with physical walls
  - Angled walls allowed

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Important Basics: BWL vs. BWP

- The IRC defines a BWL as a series of BWPs in a single story
- The code (R602.10.2) defines a Braced Wall Panel (BWP) as a full height section of a Braced Wall Line (BWL) with no vertical or horizontal offsets.

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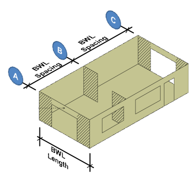
Bracing: BWL Spacing



R202, R602.10.1, R602.10.2

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Bracing: BWL Spacing

Table R602.10.1.3

Wind
Seismic
SDC C (only applies to townhouses) BWL Spacing = 35' max. Permitted to be = 50' max. when bracing length increased per R602.10.3(4).
2. When required length of bracing is adjusted per R602.10.3(4)

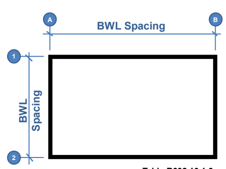

Table R602.10.1.3

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Bracing: BWL Spacing

R602.10.1

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Bracing: BWL Spacing

Wall Lines with BWP Offset Limitations

- Wall lines with BWP that are counted as part of a BWL must be parallel to the BWL
- Offsets out-of-plane up to 4' are permitted for any wall line
- There is an angle wall exception which will be discussed later

R602.10.1.2

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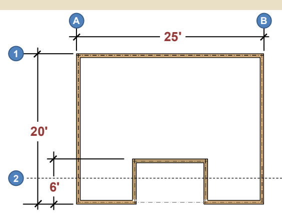
Bracing: BWL Spacing



R602.10.1.2

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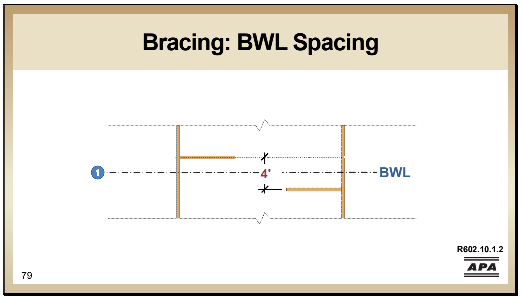

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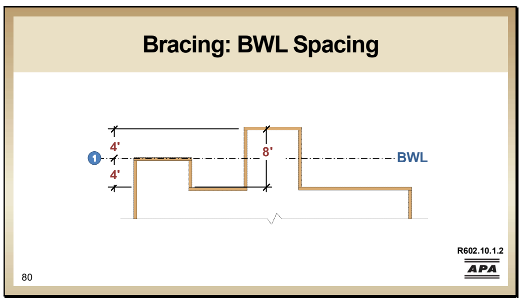

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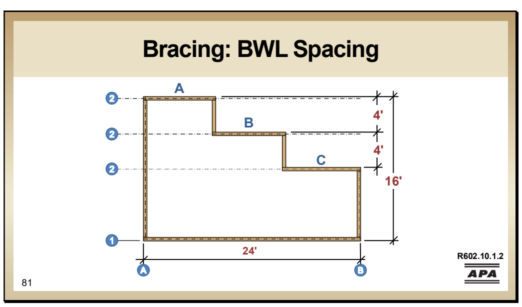

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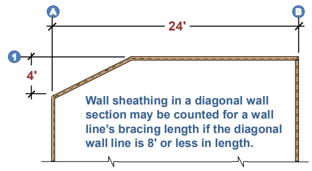
Bracing: BWL Spacing

R602.10.1.4 Angled Corners



R602.10.1.4

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Bracing: BWL Spacing

R602.10.1.4 Angled Walls

Angle from BWL (degrees)	Projected BWL Length from Angled Wall Line (ft)		
	Angled Wall Line Length		
	4 ft	6 ft	8 ft
15	3.9	5.8	7.8
30	3.5	5.2	7.0
45	2.9	4.3	5.7

R602.10.1.4

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Bracing Topics

Forces | Basics | Bracing

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Braced Wall Panels

- 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…
  1. Refers to any of the 16 bracing Methods in the IRC
  2. Can be offset as far as 4 ft. from a Braced Wall Line
  3. No vertical or horizontal offsets
  4. Must be parallel with the BWL it is associated with – unless it meets the angled wall requirements
  5. The length of a BWP is measured parallel to the BWL
  6. Connections must resist uplift loads (R602.10.2.1)

R602.10.2

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2018 IRC Wall Bracing

Questions?

Matthew Brown
Find your Local Field Services Representative
www.apawood.org/field-services
help@apawood.org
www.apawood.org

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APA Update Newsletter
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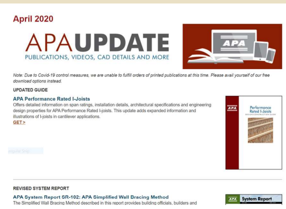

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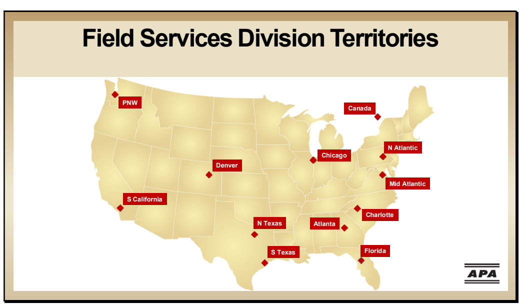

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