

Wall Bracing

This document was prepared for the MBOIA and based on the wind speeds and Seismic Design Categories for Maine and shall only be used as a reference since the Wind Speeds and the Seismic Design Category for Connecticut are different.

The purpose of this document is to give you background information on wall bracing, how to calculate it and what should be shown on the plans.

If you are interested in obtaining an Excel spreadsheet to aid in calculating the required wall bracing, email me and I will forward a copy to you. Keep in mind that the spreadsheet has to be used in conjunction with the 2009 International Residential Code.

2009 IRC Wall Bracing

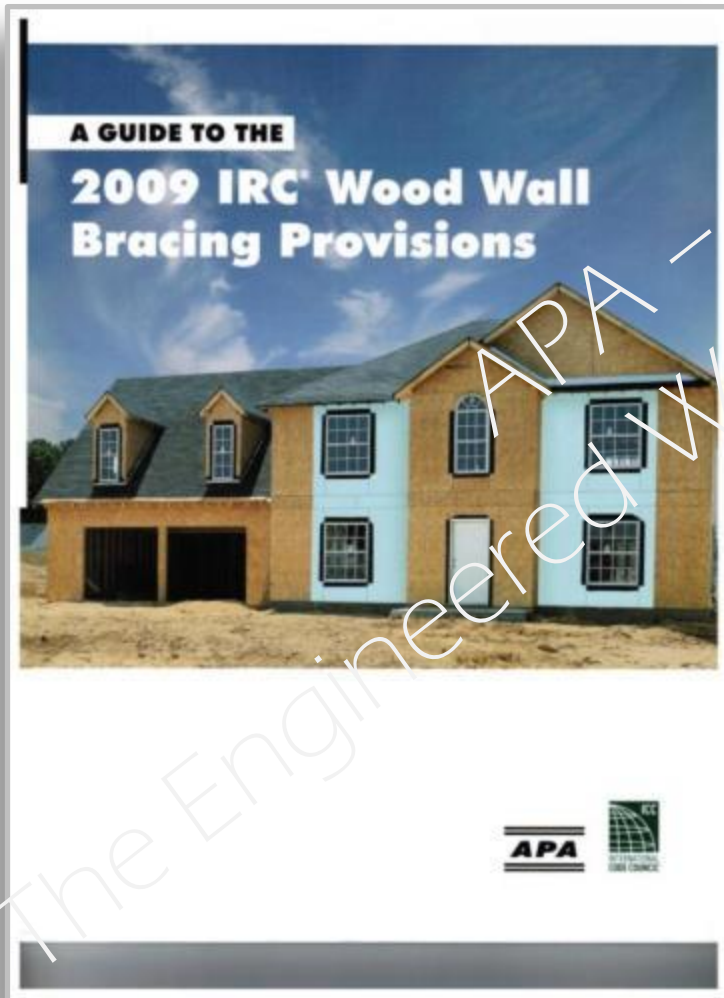


MBOIA

Maine Building Officials and Inspectors Association

Mark Halverson
Manager – Field Services Division
APA – The Engineered Wood Assn.

Bracing Topics



www.iccsafe.org
Item no. 7102S09

Bracing Topics

Introduction

Getting Started

Bracing Basics

Connections

Other Topics

Lateral Forces

Load Path

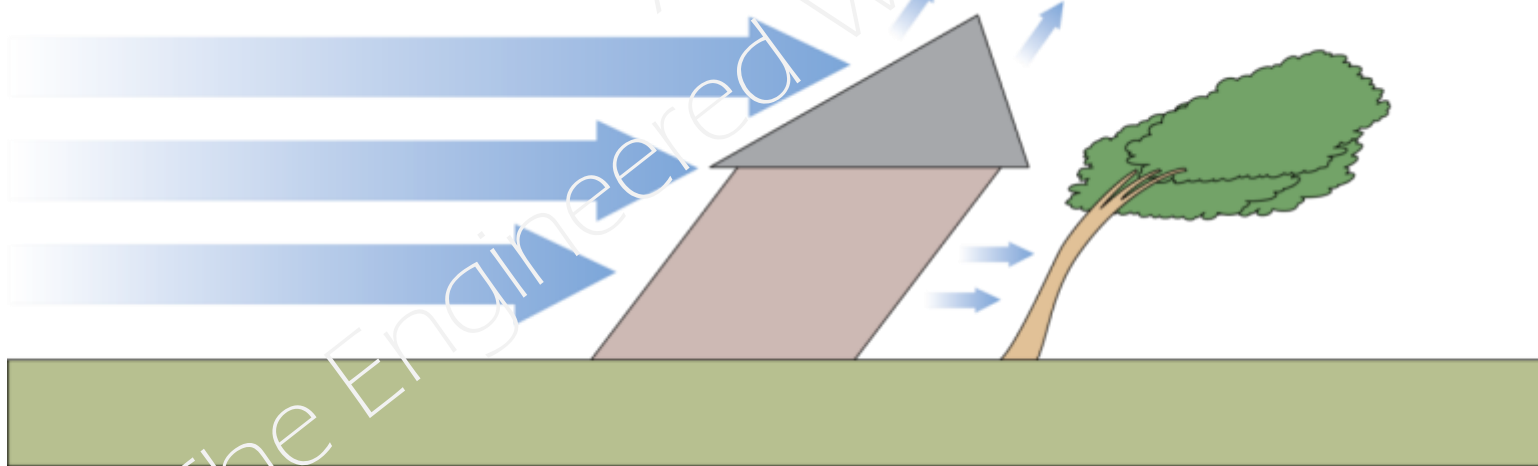
BWP vs.
Shear Walls

Bracing
History

Quiz

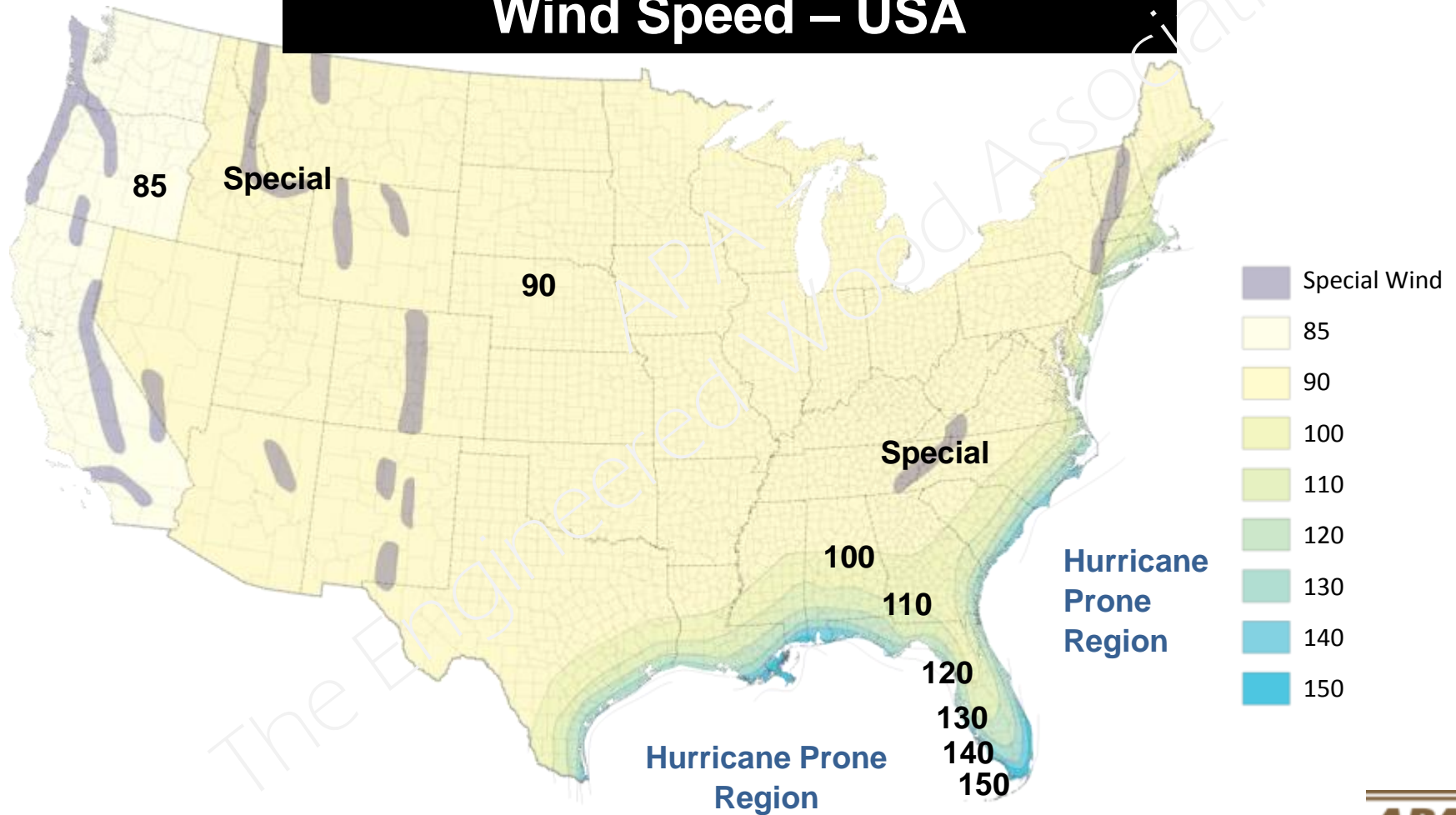
Introduction: Lateral Forces

Wind Speed



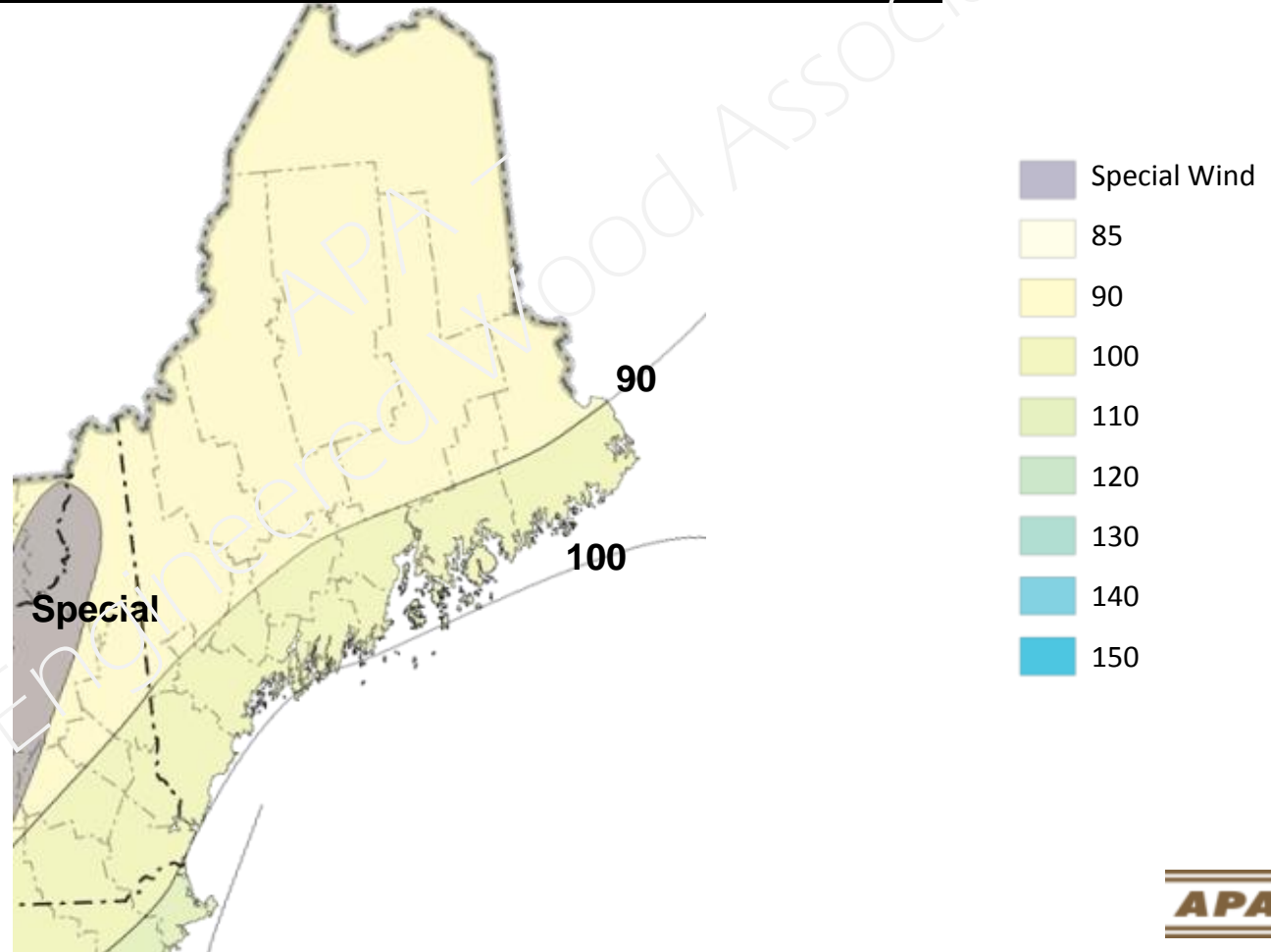
Introduction: Lateral Forces

Wind Speed – USA



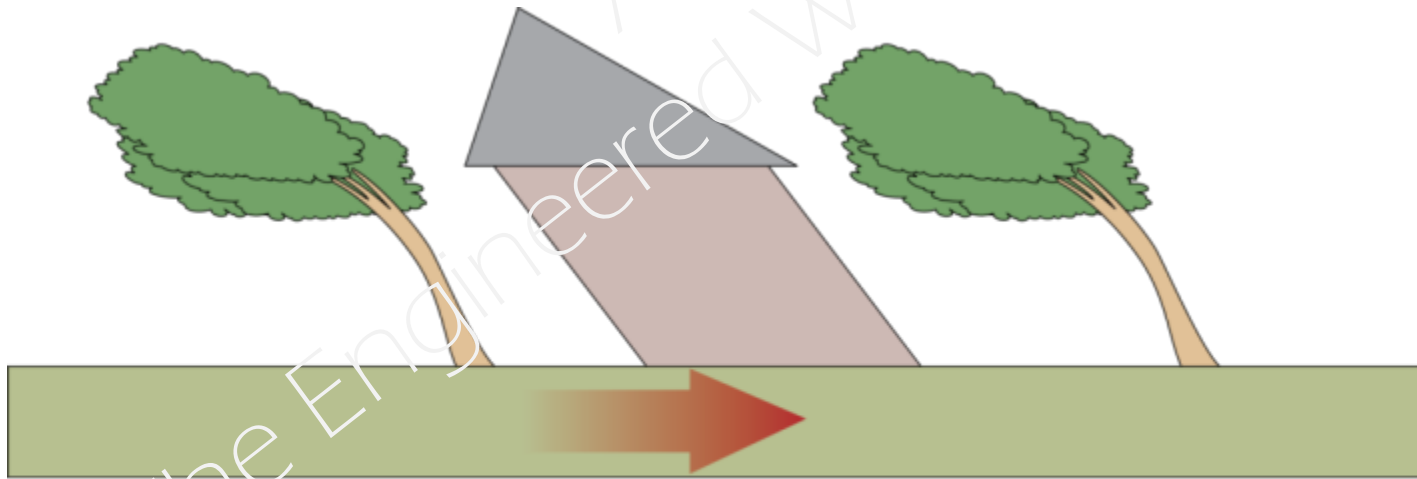
Introduction: Lateral Forces

Wind Speed – New England



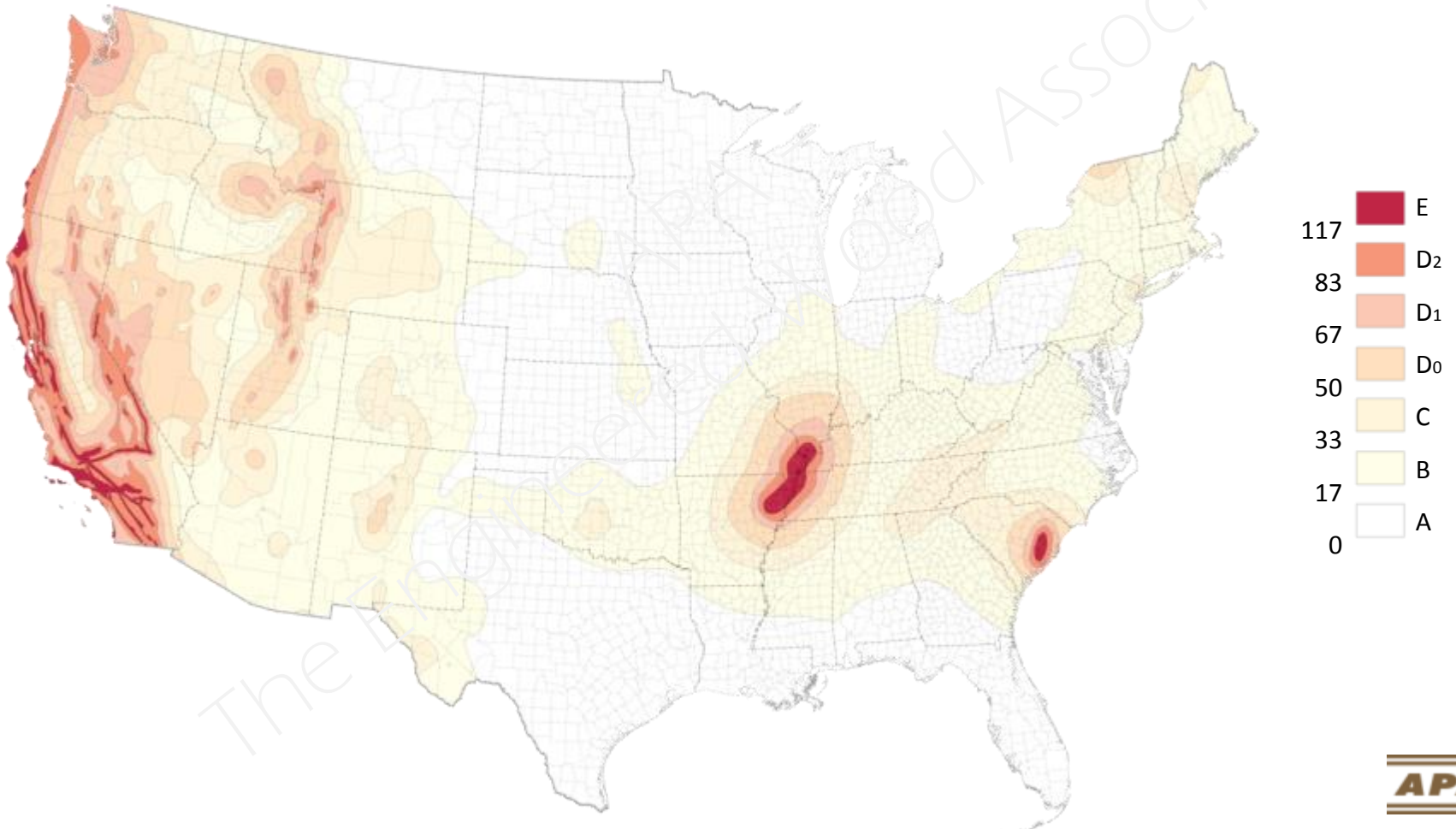
Introduction: Lateral Forces

Earthquake



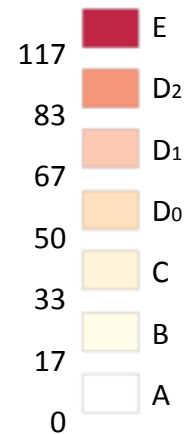
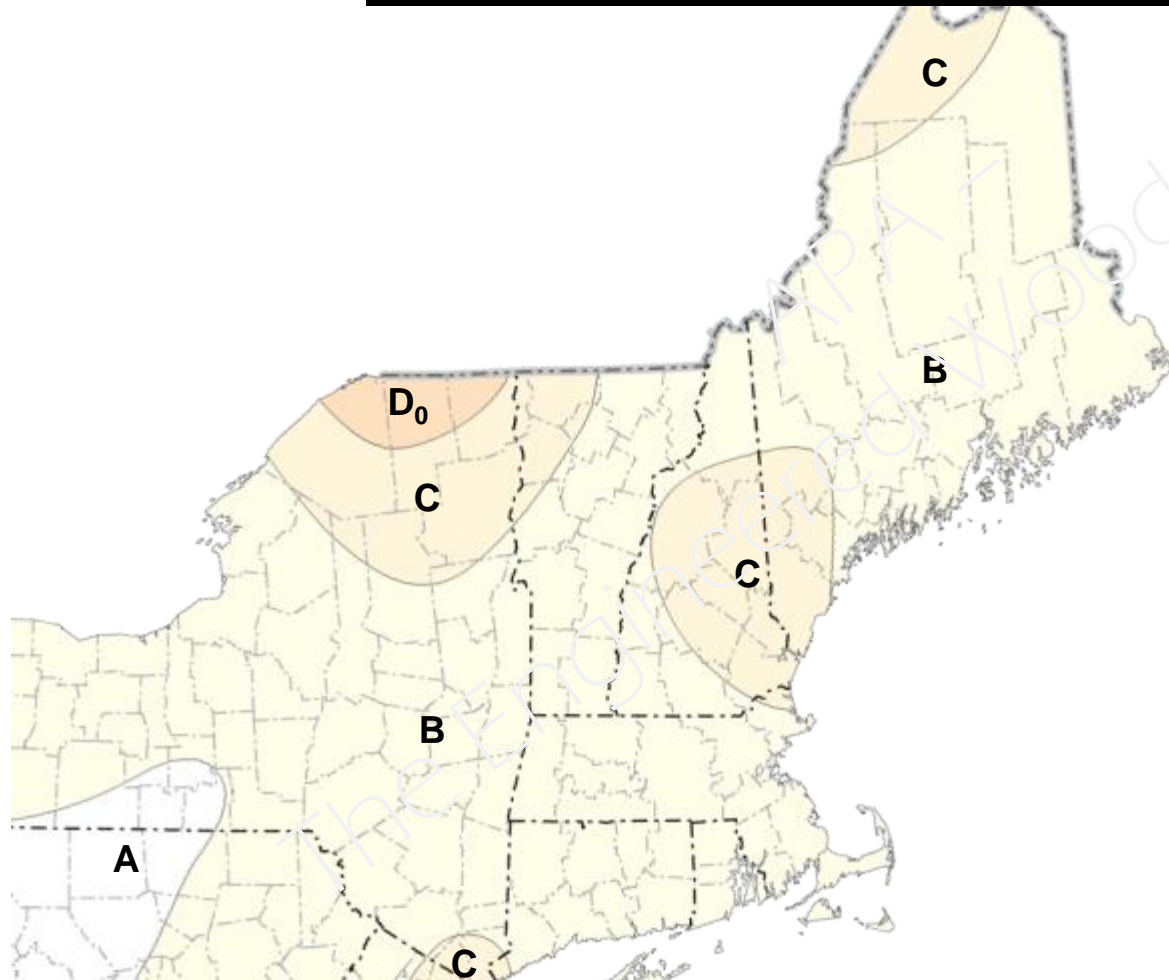
Introduction: Lateral Forces

SDC – United States

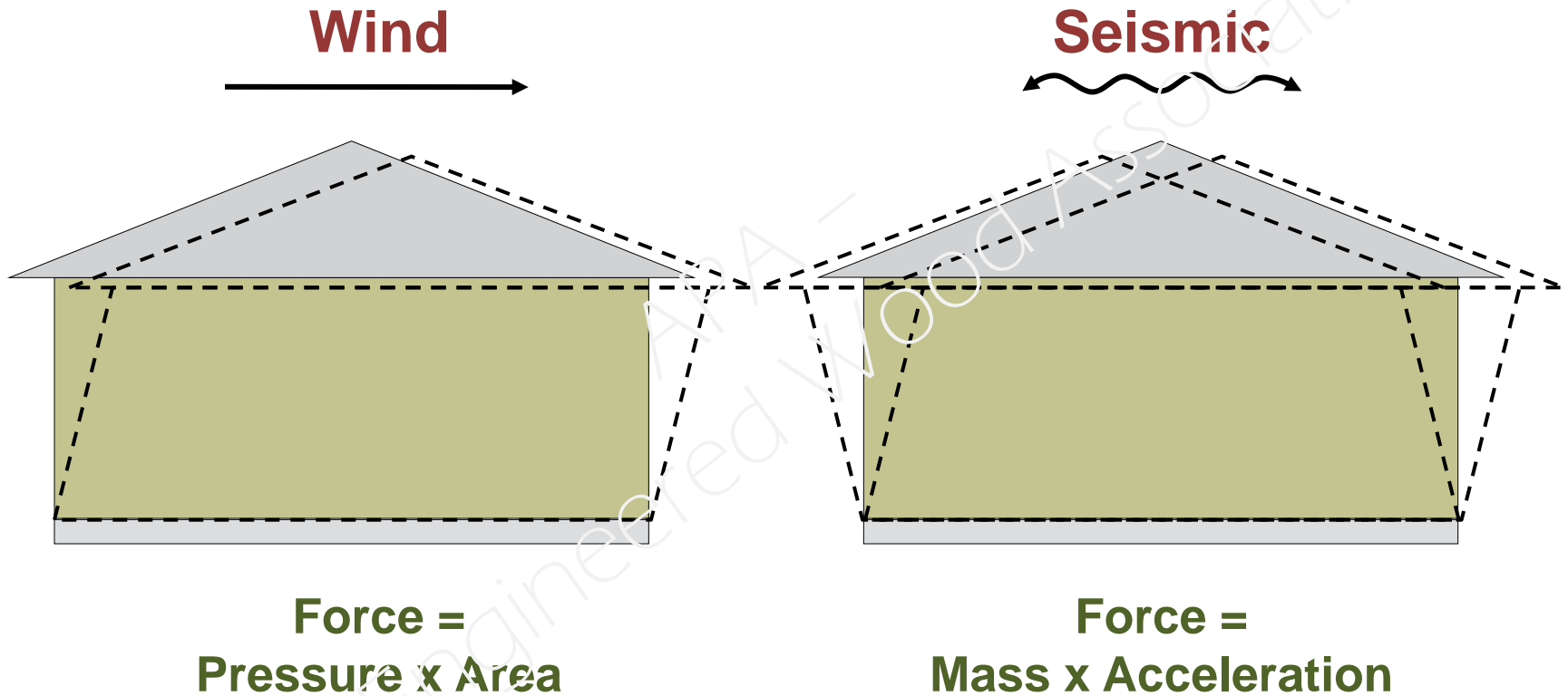


Introduction: Lateral Forces

SDC – Northeast USA



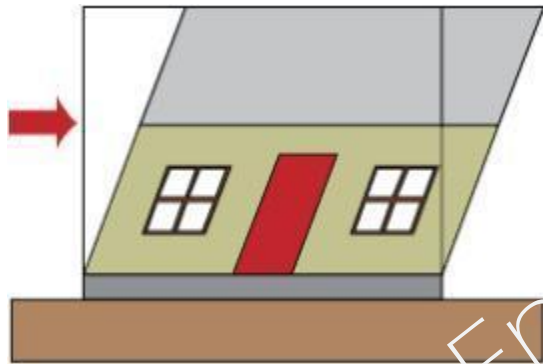
Introduction: Lateral Forces



Introduction: Lateral Forces

Effects of Forces

Racking



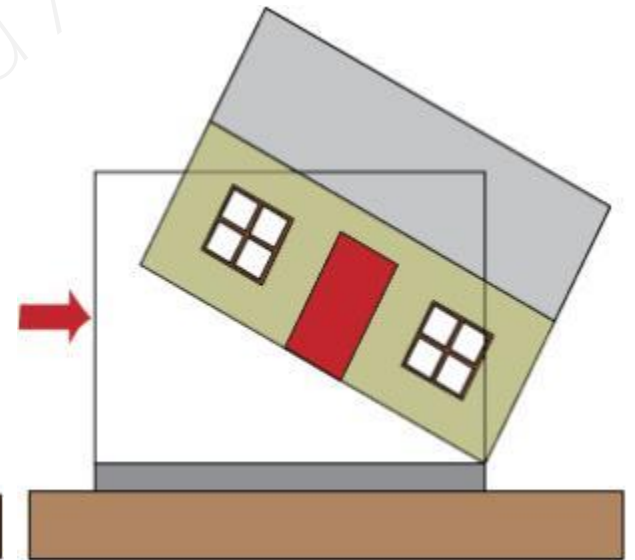
Resisted by Bracing

Base Shear



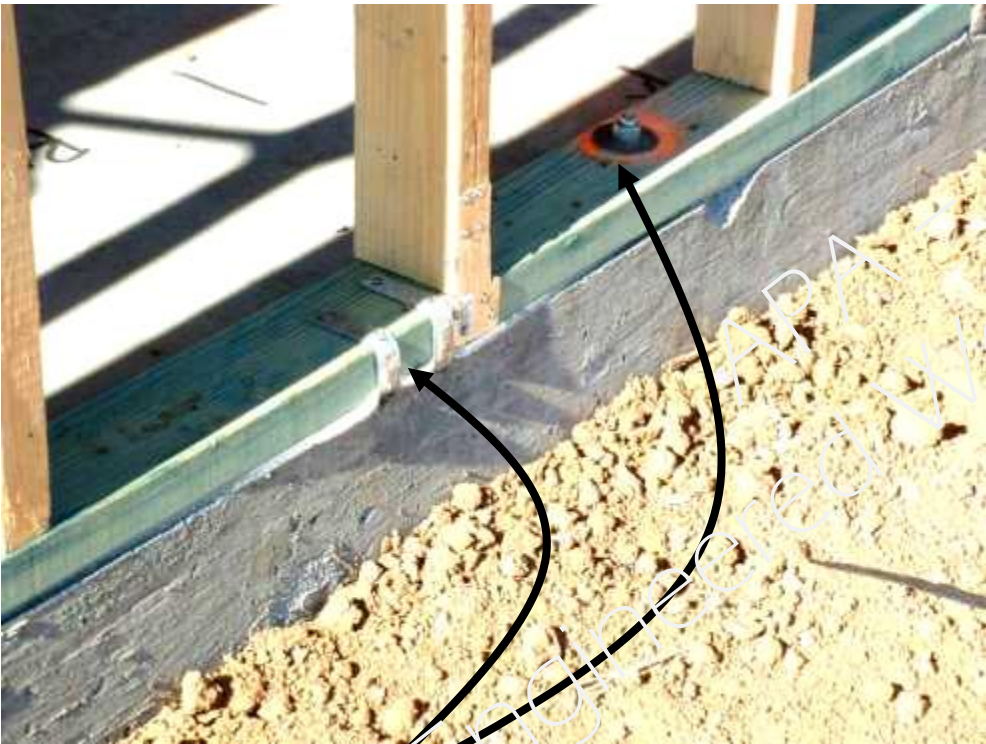
Resisted by Anchors

Overturning



Resisted by hold-downs
& Dead Load

Introduction: Lateral Forces



Anchors



hold-down

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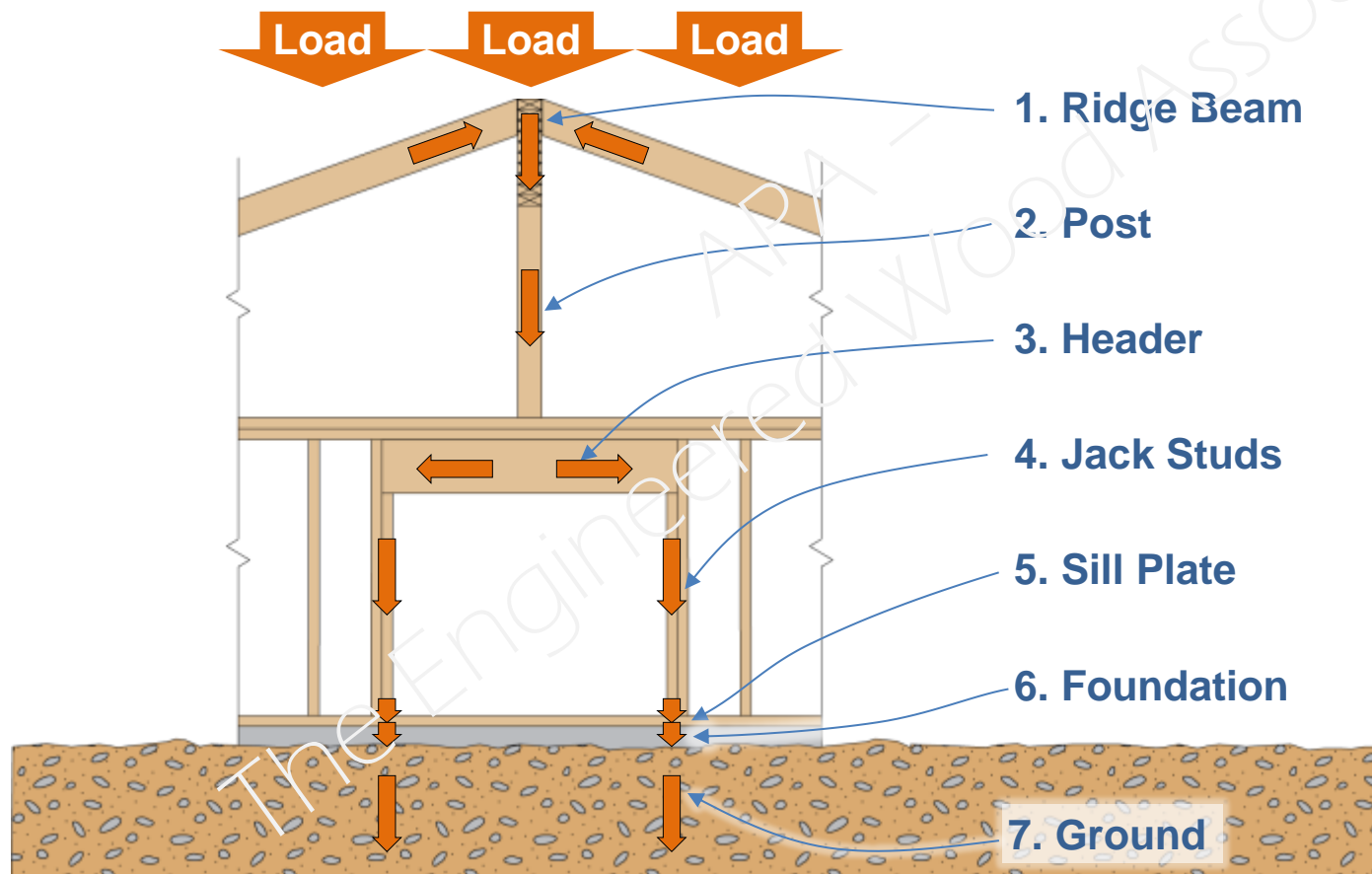
BWP vs.
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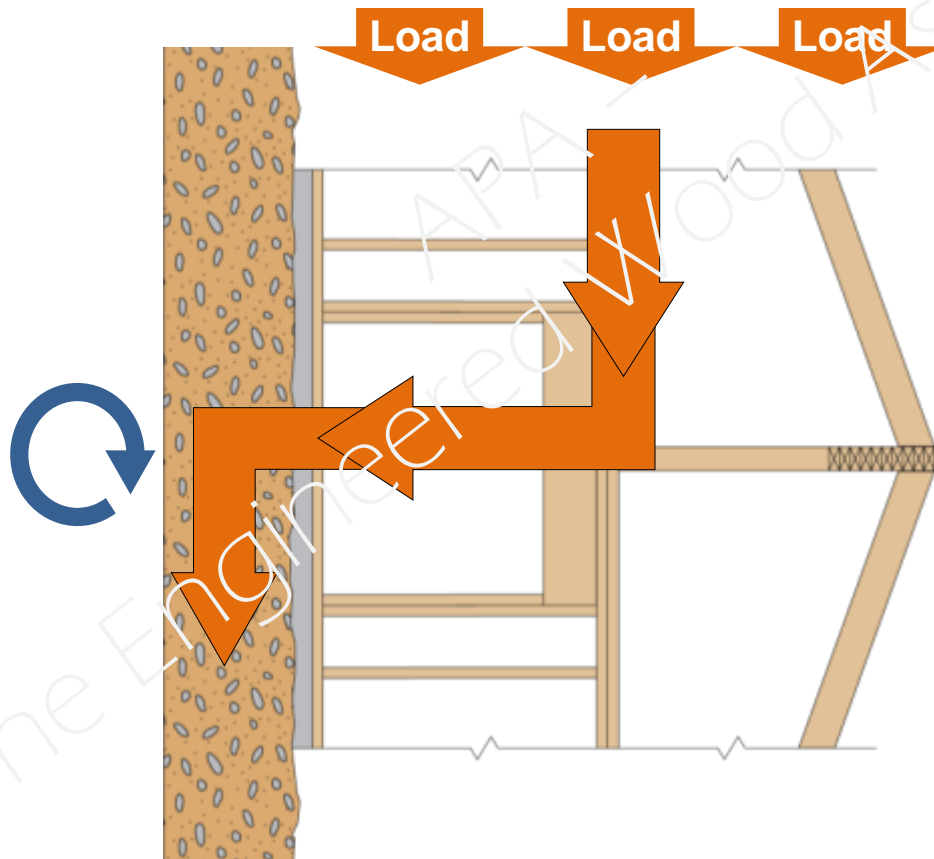
Introduction: Load Path

Vertical (Gravity) Load Path

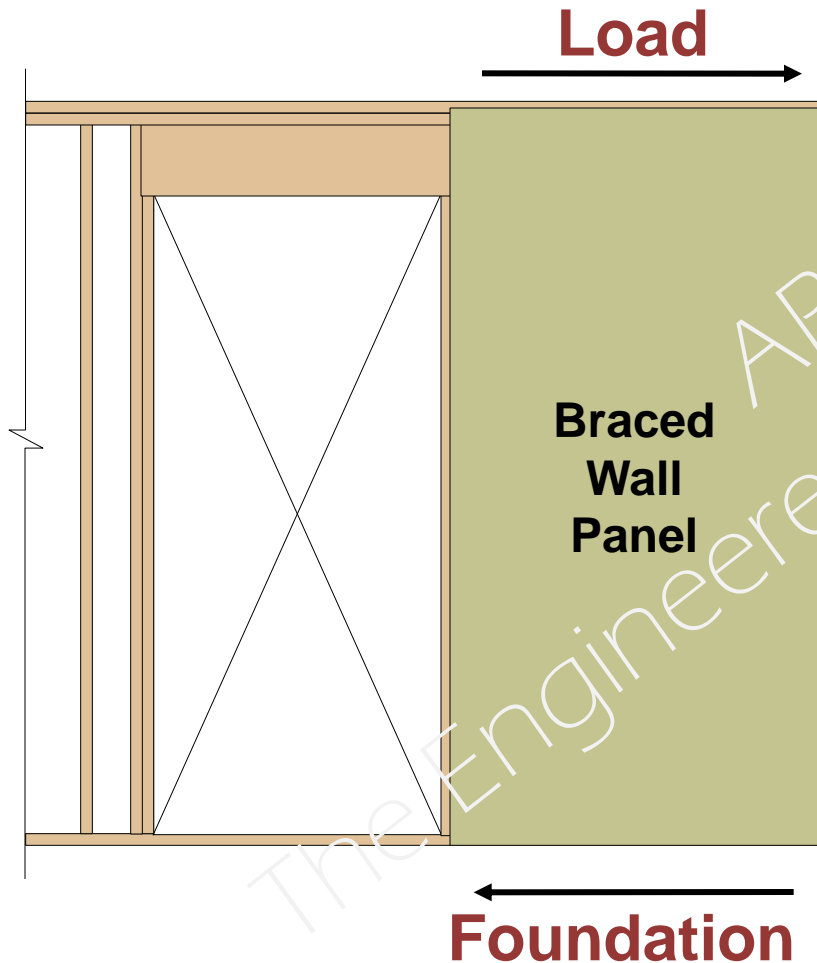


Introduction: Load Path

Lateral (Sideways) Load Path



Introduction: 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.

Bracing Topics

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Introduction: BWP vs. Shear Walls

BWP (Prescriptive)

- **Limitations**
 - 3-Stories Maximum
 - Wind ≤ 110 mph⁽¹⁾
 - SDC A-D₂
 - Others (see IRC Chap. 3)
- Typically without hold-downs

VS.

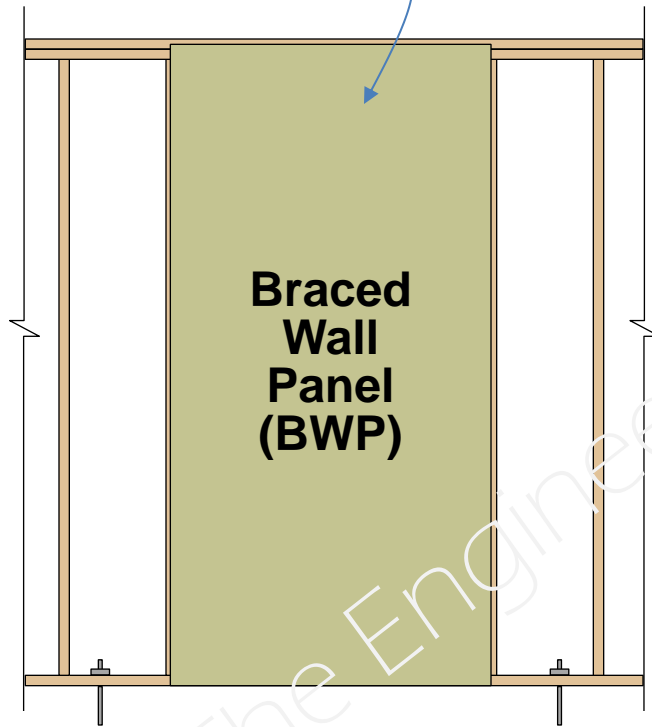
Shear Walls (Engineered)

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

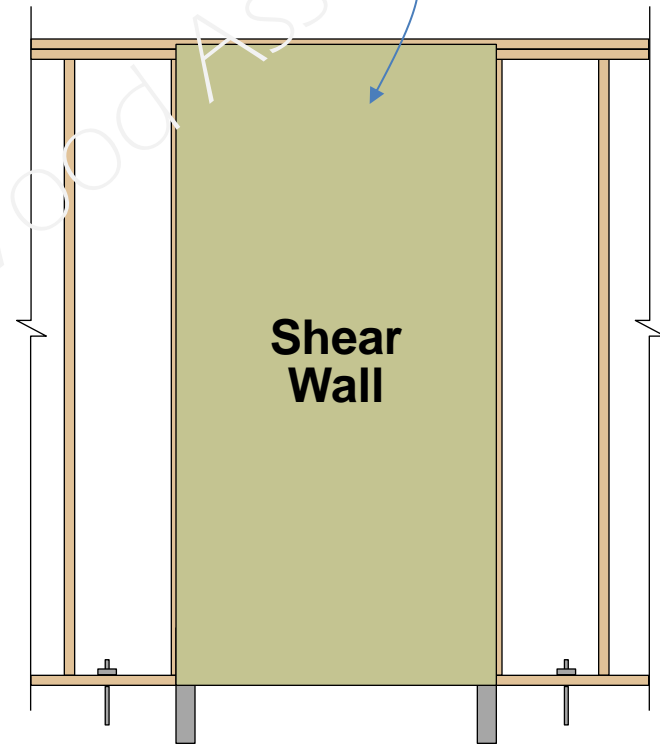
(1) Wind ≤ 100 mph in hurricane-prone regions.

Introduction: BWP vs. Shear Walls

Prescribed
material & nailing



Calculated load,
material & nailing



VS.

Hold-down
capacity calculated

Introduction: BWP vs. Shear Walls

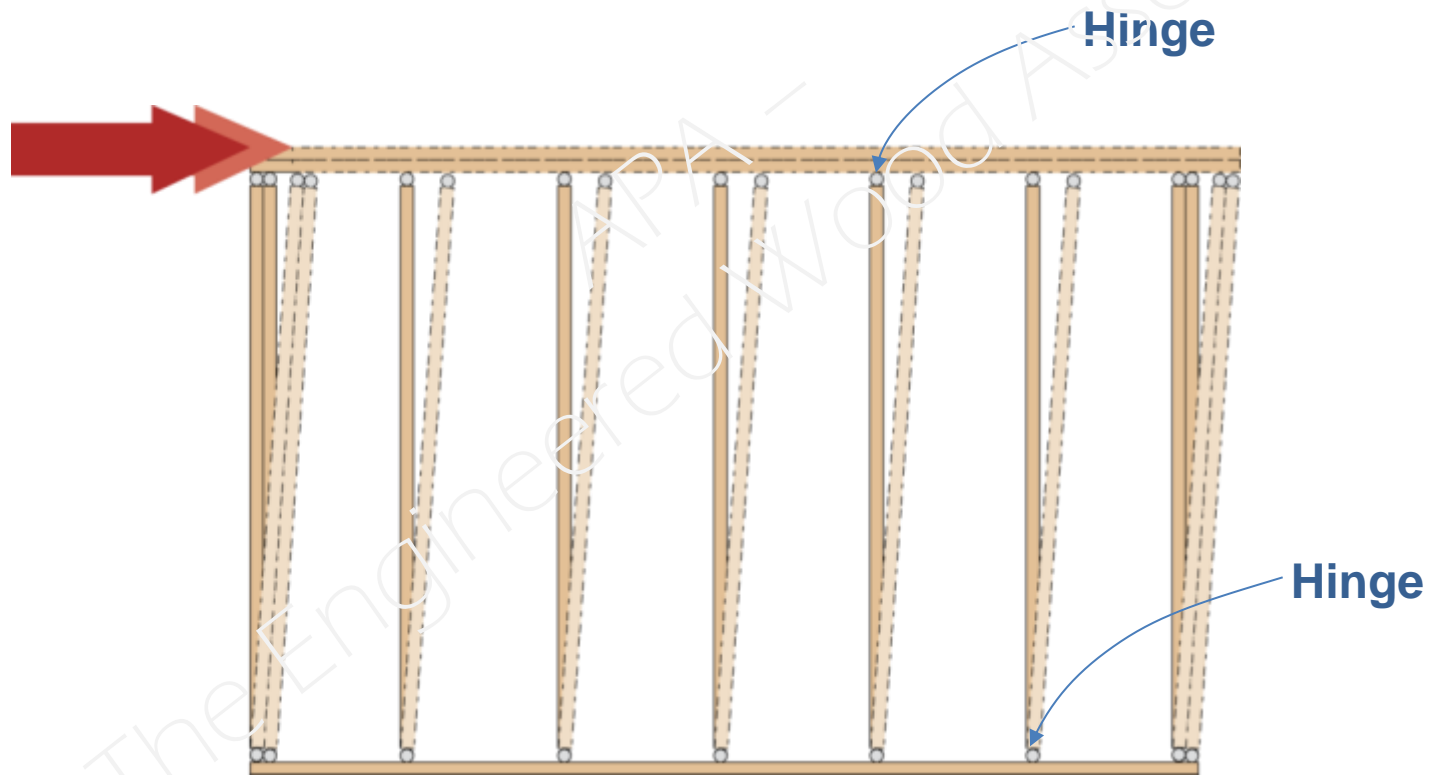
R602.10 Wall Bracing

"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."



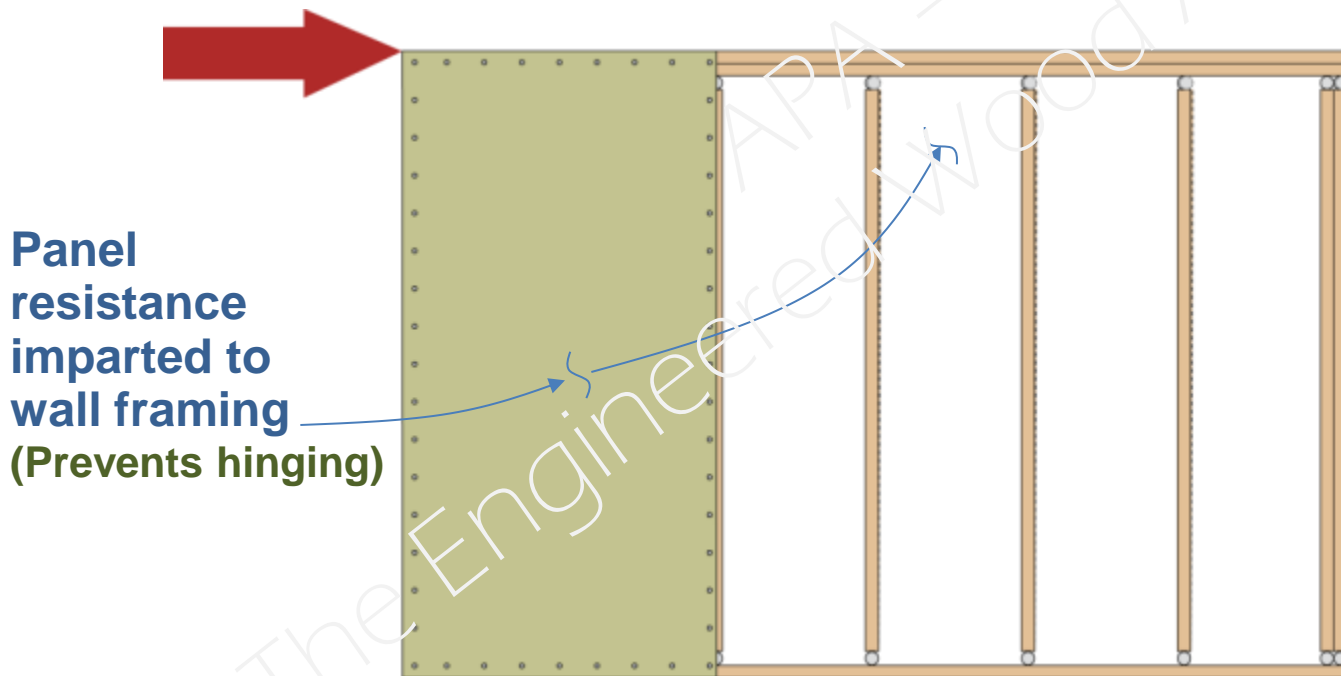
Introduction: BWP vs. Shear Walls

Wall Framing



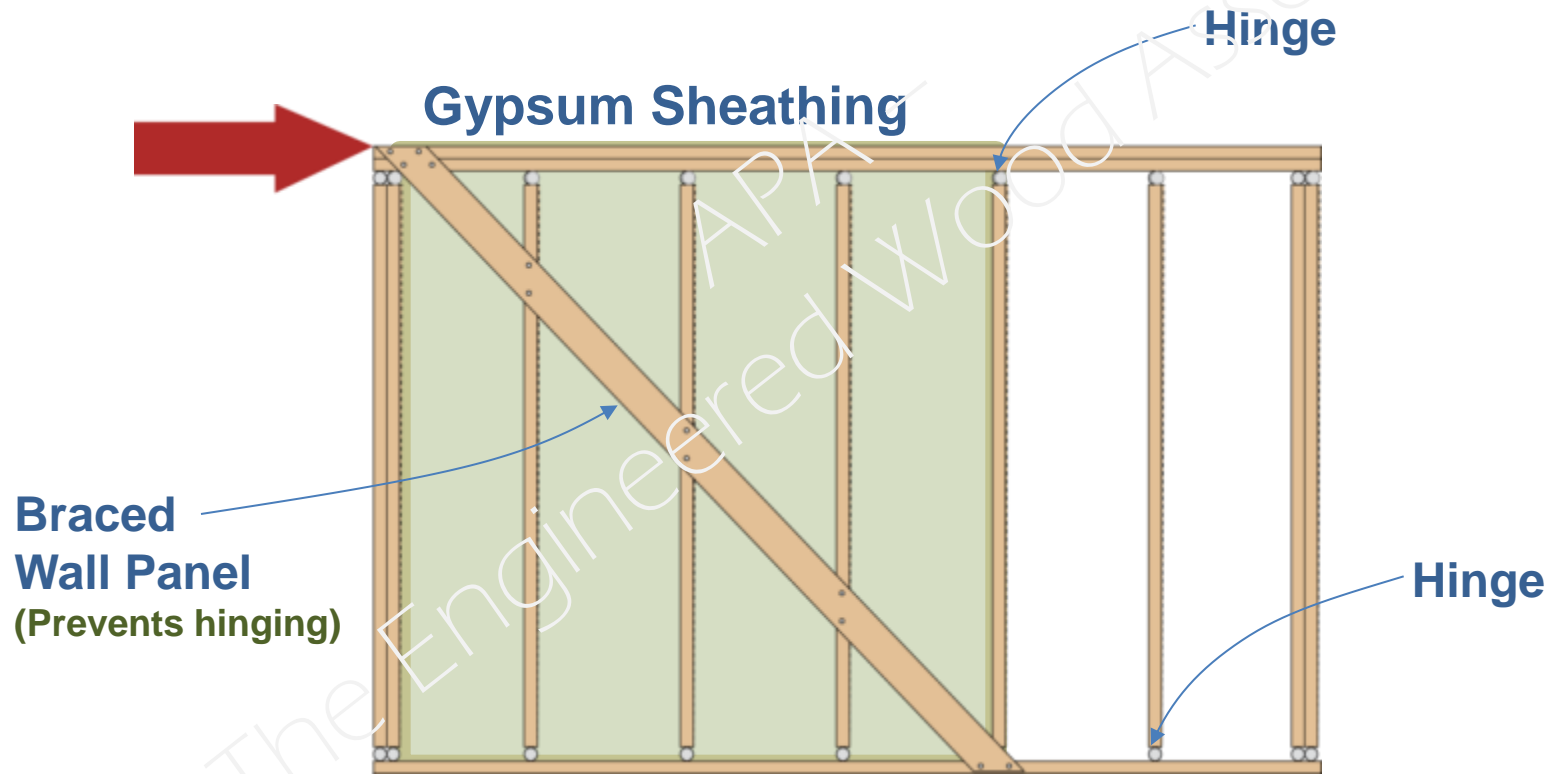
Introduction: BWP vs. Shear Walls

Wall Framing



Introduction: BWP vs. Shear Walls

Wall Framing



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Introduction: Bracing History

History of Wall Bracing

Uniform Building Code – 1927

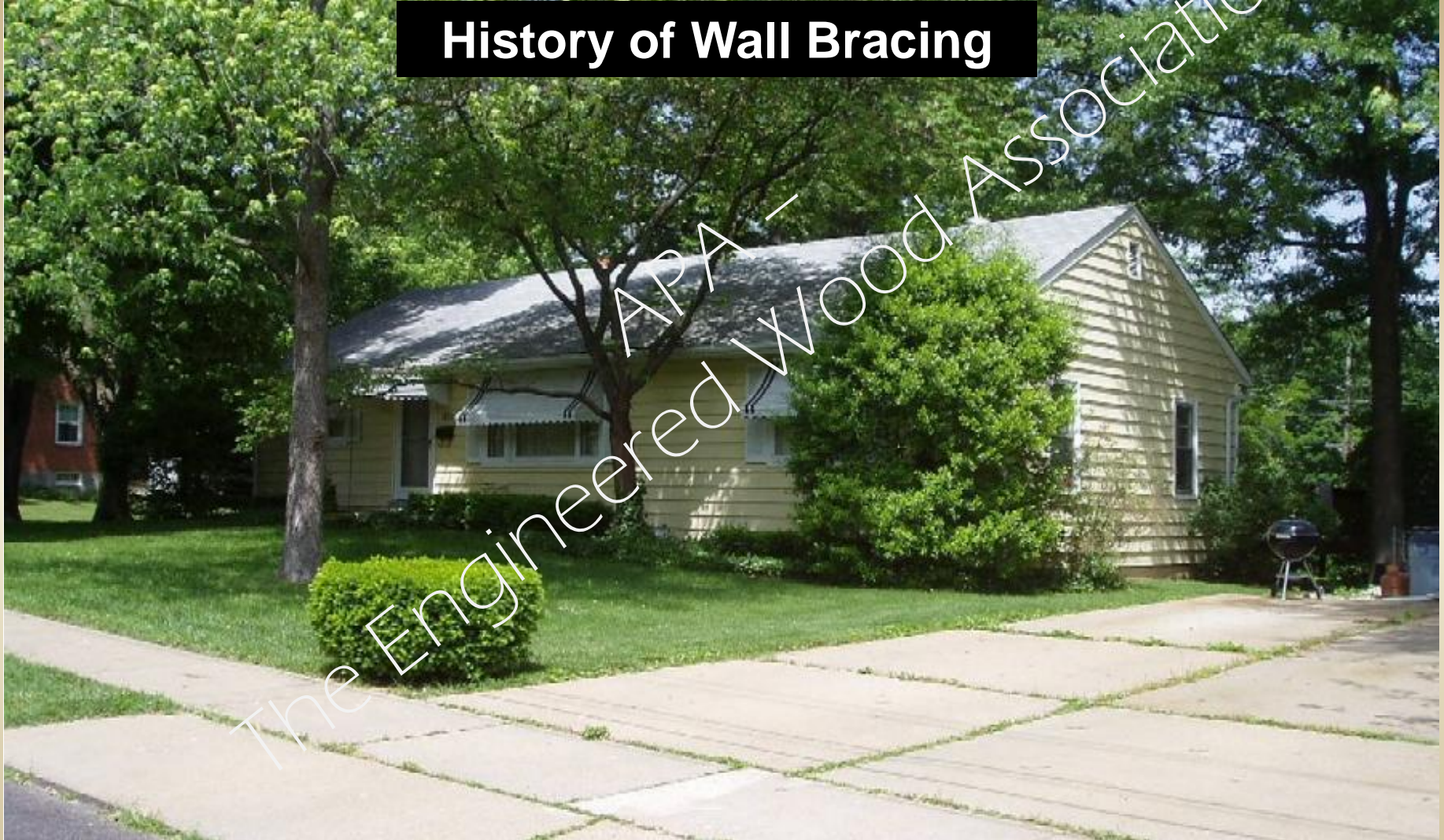
- All exterior walls and partitions shall be thoroughly and effectively angle braced.

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.

Introduction: Bracing History

History of Wall Bracing



Introduction: Bracing History

History of 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 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...*

Introduction: Bracing History

History of Wall 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

Introduction: Bracing History

History of 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

Introduction: Bracing History

History of Wall Bracing



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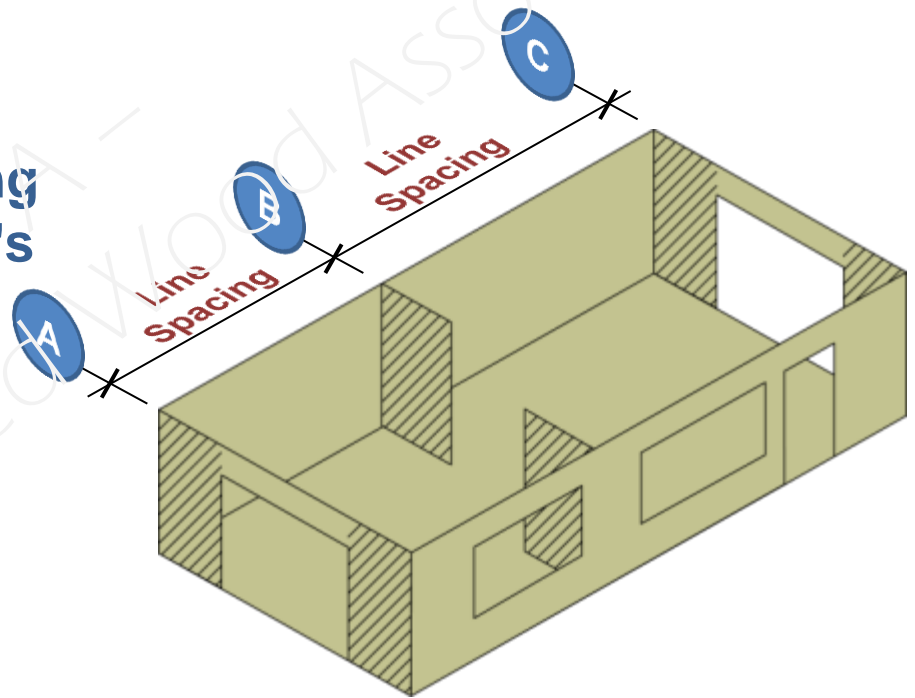
Introduction: Quiz

1. What is the maximum offset in a BWL?

4' per side, 8' total

2. What is the maximum spacing between the centers of BWP's within a BWL?

25'



Introduction: Quiz

3. What is the minimum length of a Method WSP BWP?

4'

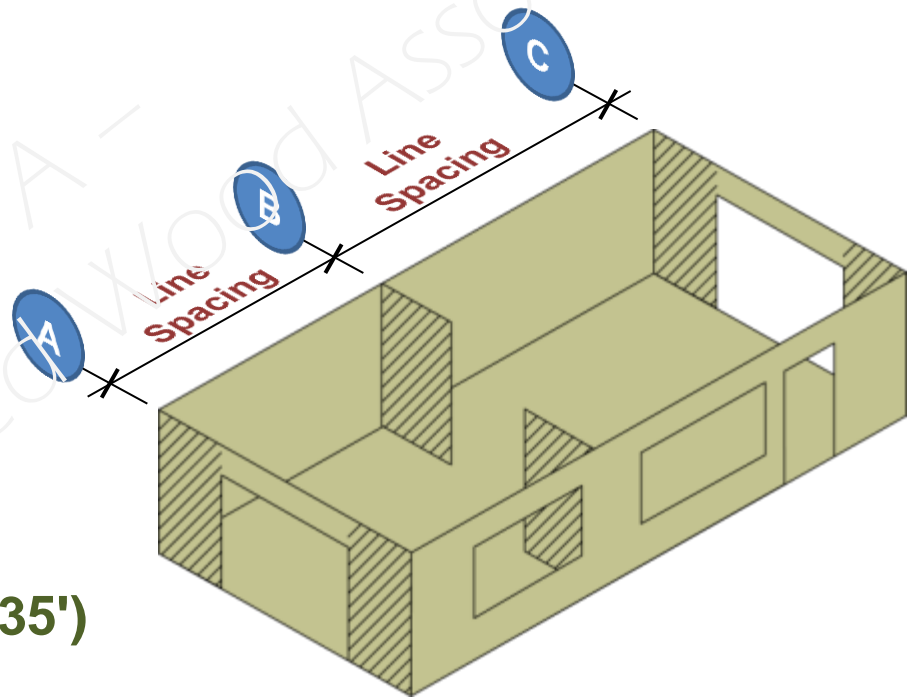
4. What is the minimum length of a continuous BWP?

24" (or 16")

5. What is the max. spacing between centers of BWL's?

Wind Design = 60'

Seismic Design = 25' (or 35')



Introduction: Quiz

6. Can a bracing panel be less than 48" long?

Yes. Most intermittent - 36"

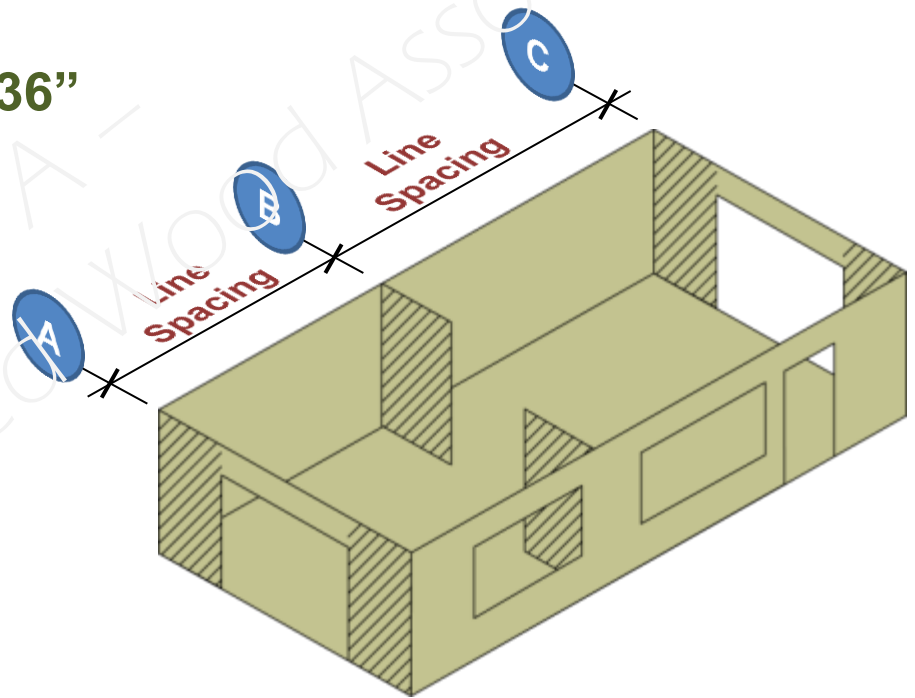
CS-WSP - 16"

7. Is more bracing needed for steeper roofs?

Yes

> 10' < 15' ridge = + 15%

> 15' < 20' ridge = + 30%



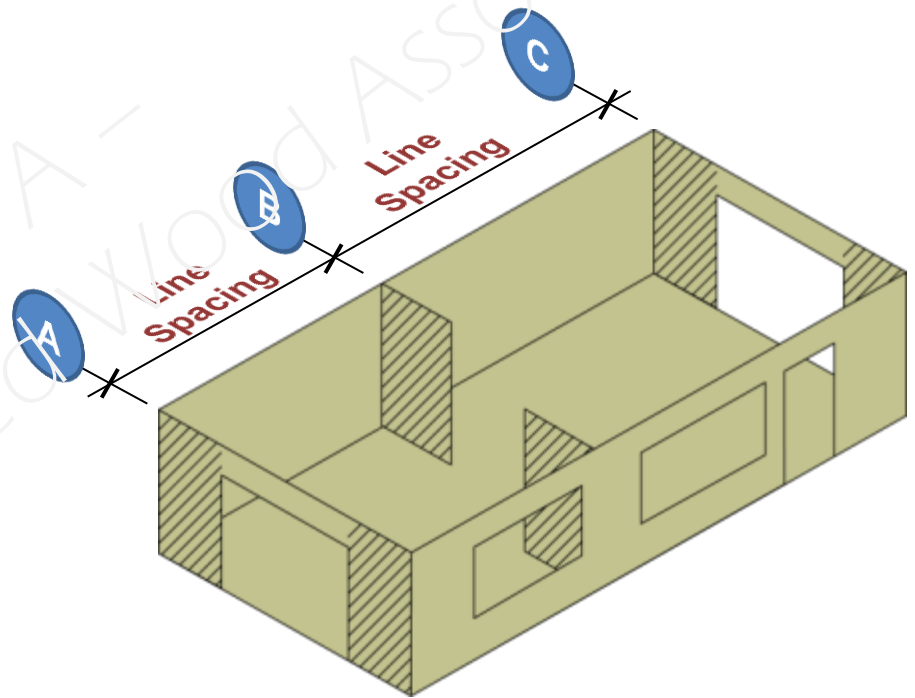
Introduction: Quiz

8. Are the BWP placement requirements the same for interior and exterior BWL's?

SDC A-C = Yes

Int. = 12.5' end dist.

Ext. = 12.5' end dist.

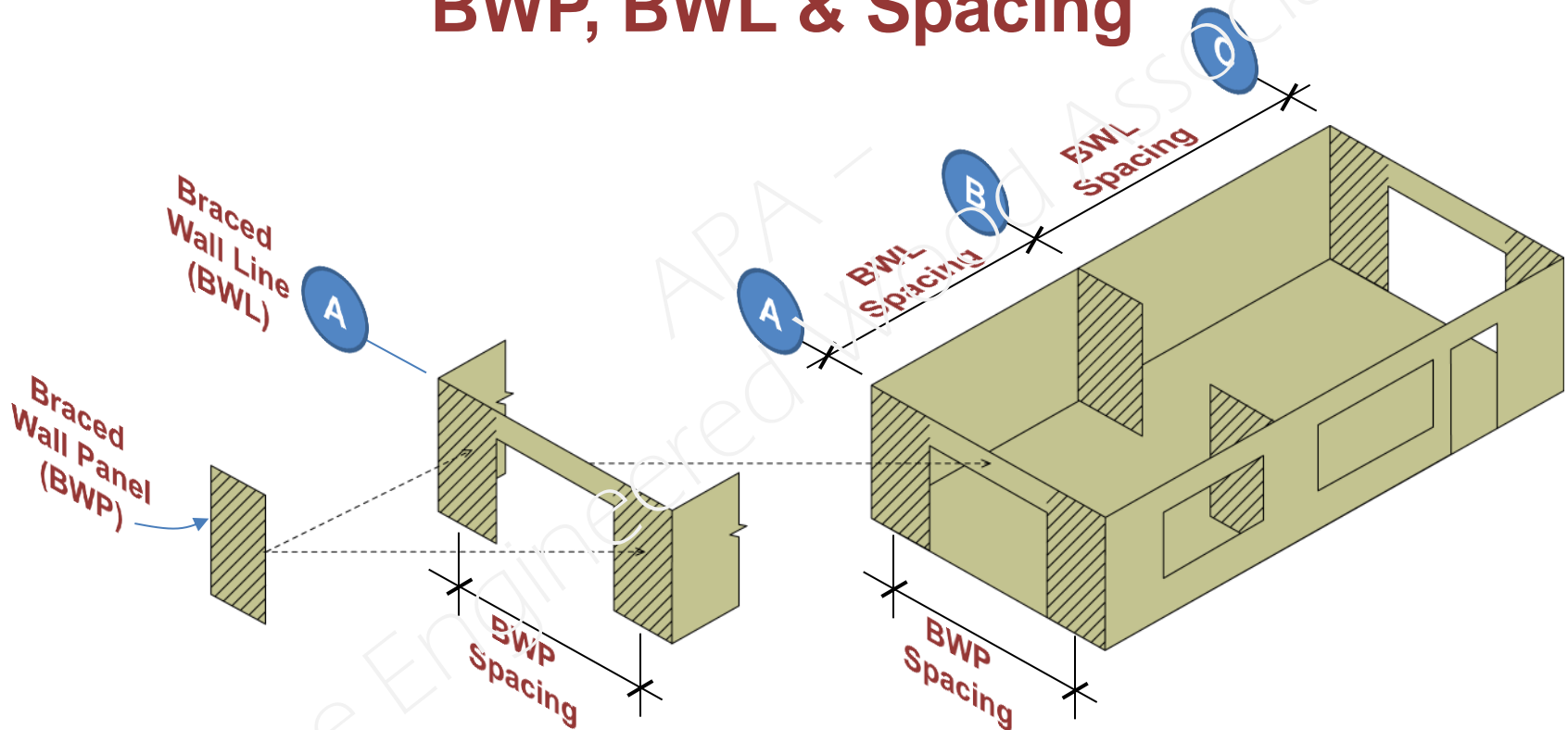


Bracing Topics

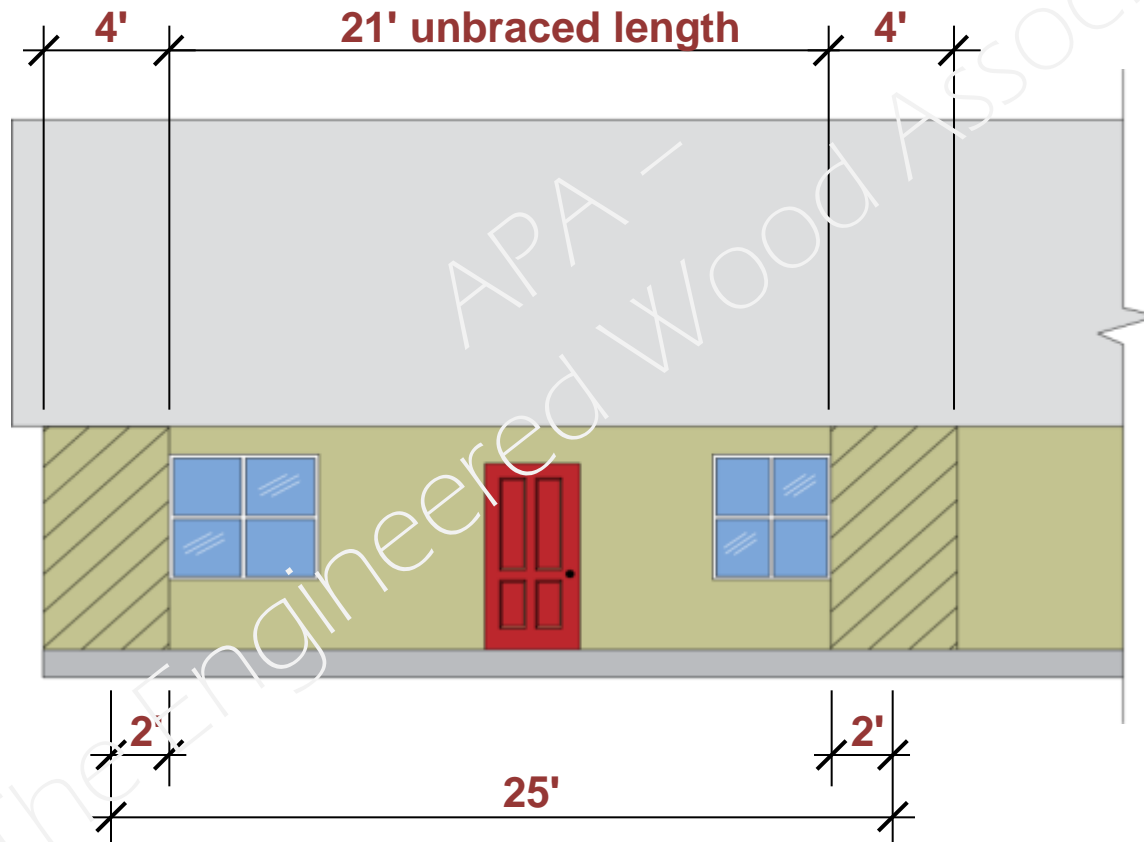
Introduction	Getting Started	Bracing Basics	Connections	Other Topics
	<p><u>Terminology</u></p> <p>Loads & Limits</p> <p>Irregular Buildings</p> <p>Wind Exposure</p> <p>Connecting the systems</p>			

Getting Started: Terminology

BWP, BWL & Spacing

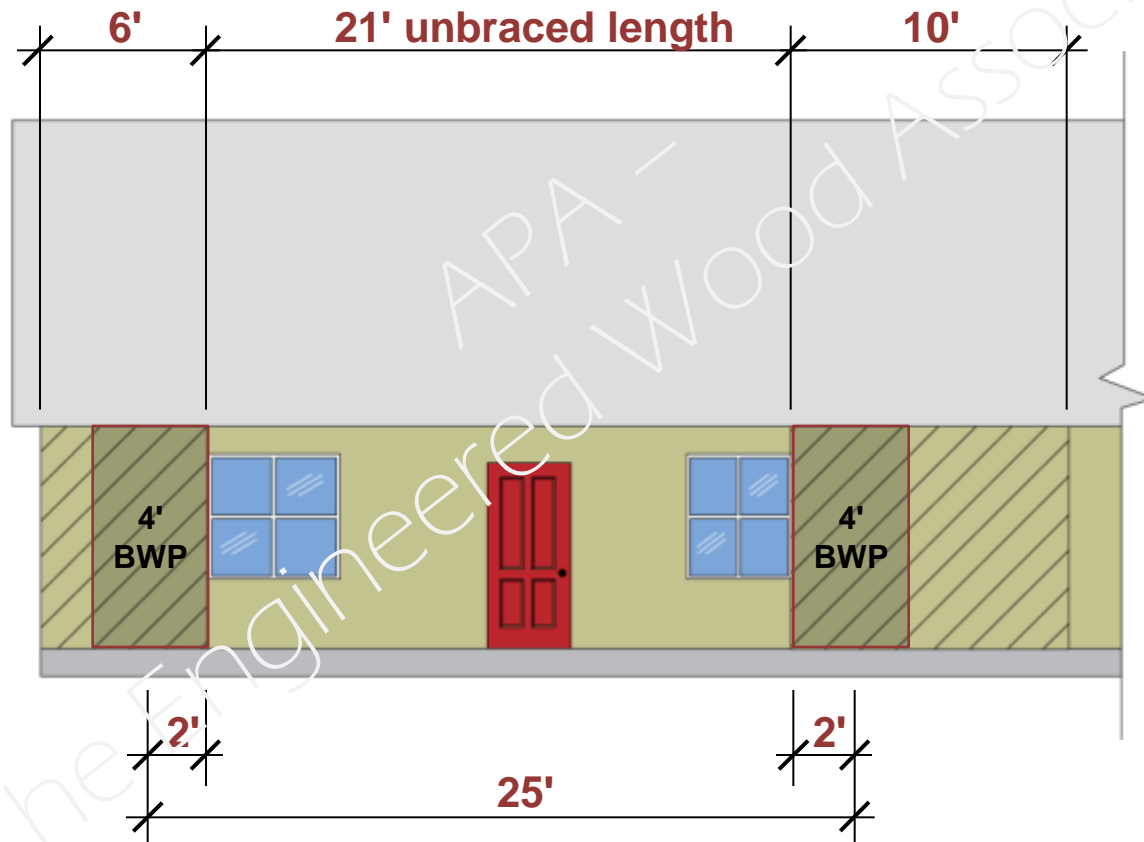


Getting Started: Terminology



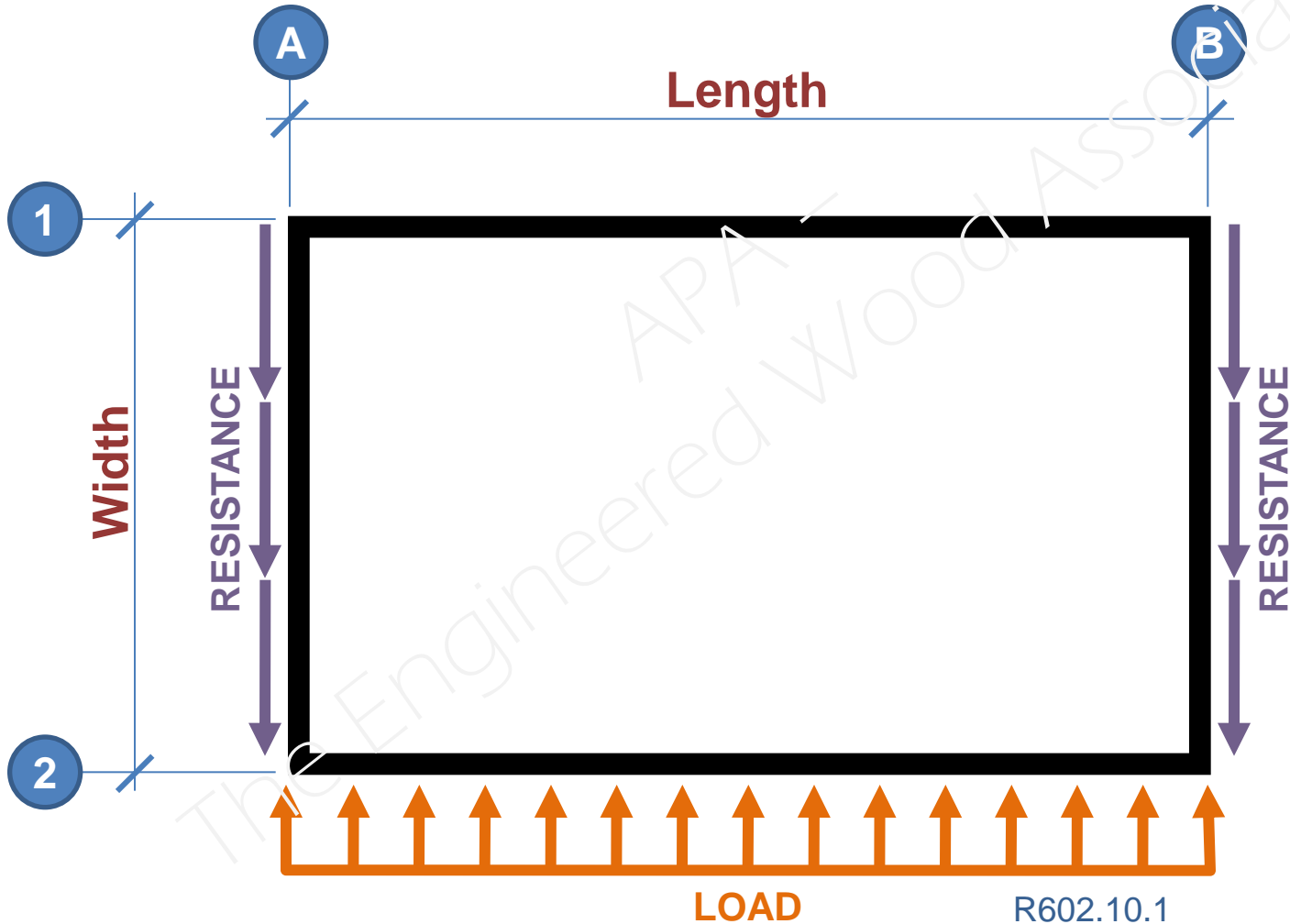
R602.10.1.4

Getting Started: Terminology

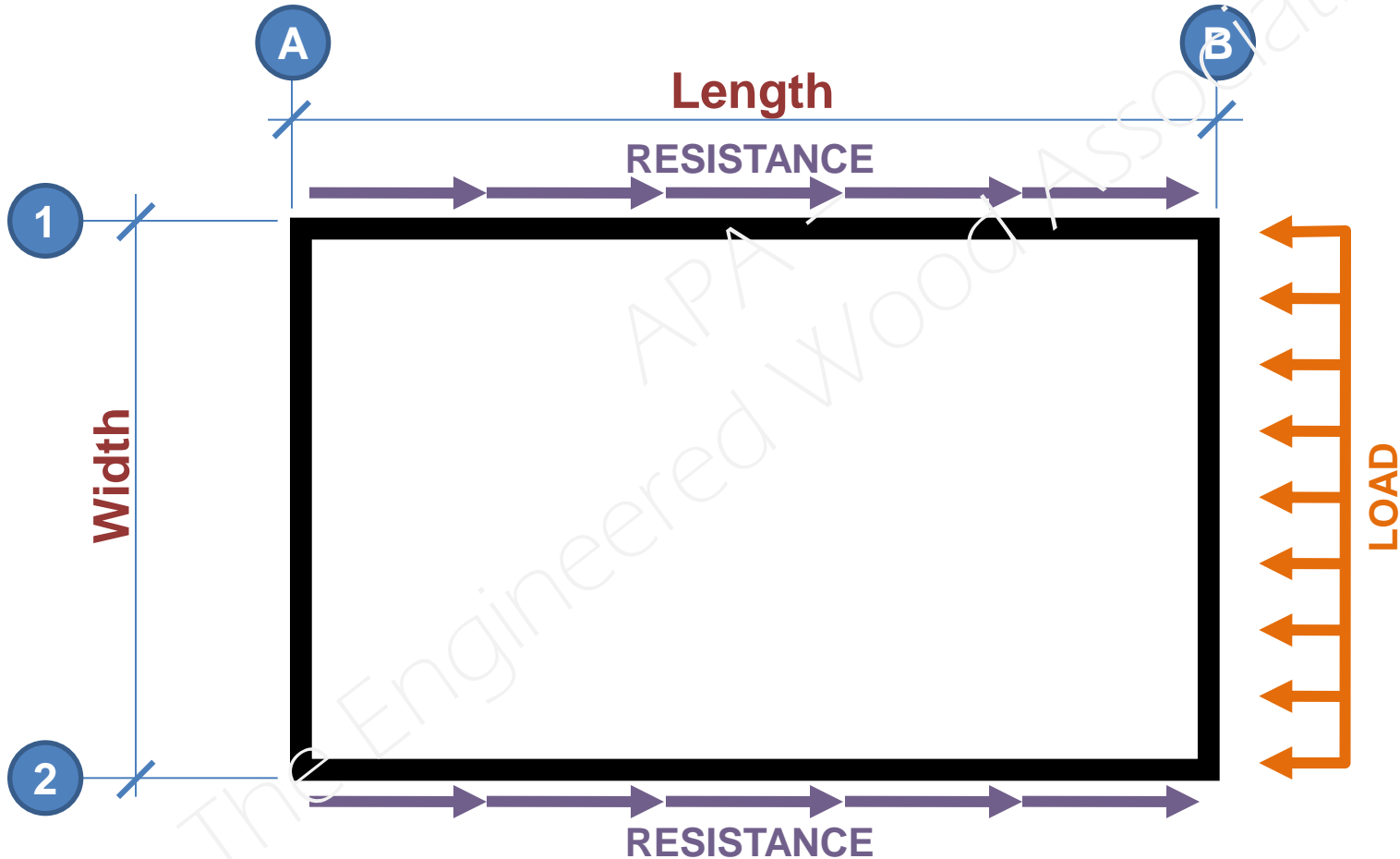


R602.10.1.4

Getting Started: Terminology



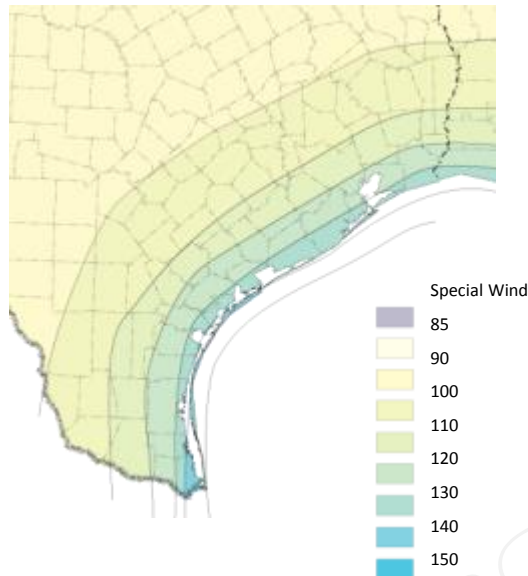
Getting Started: Terminology



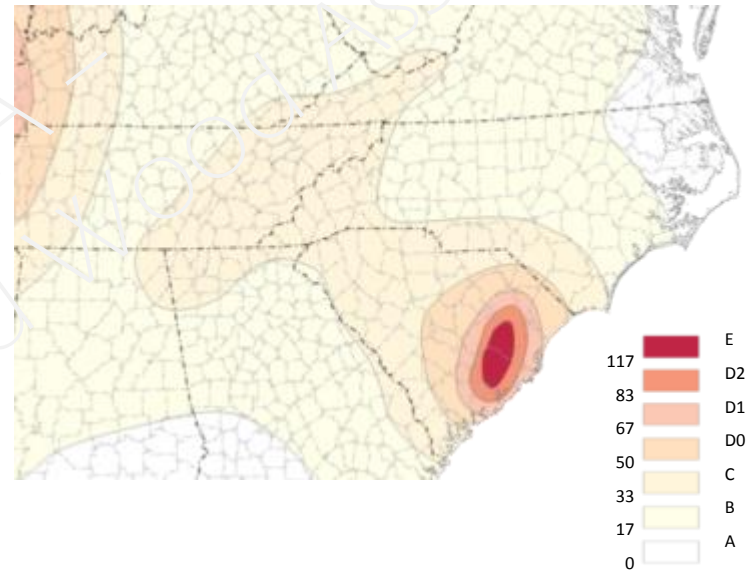
R602.10.1

Getting Started: 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.

Getting Started: Terminology

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

- **Wall bracing length** - either wind or seismic requirements 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 Requirements

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

Seismic Requirements

- Wall bracing length
- Braced wall line spacing
- Hold-downs
- Material weight limits

Getting Started: Terminology

Wind

BWL Spacing = 60' max.

Seismic

SDC C (only applies to townhouses)

BWL Spacing = 35' max.

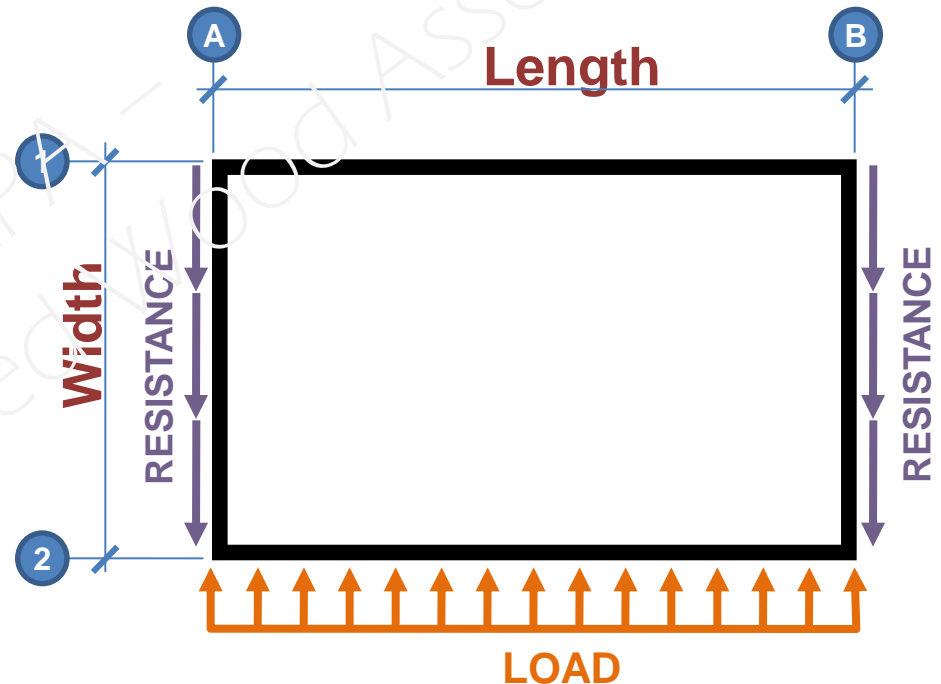
Permitted to be = 50' max.

SDC D₀, D₁, & D₂ (all dwellings)

BWL Spacing = 25' max.

Permitted to be = 35' max.

- to accommodate one room not exceeding 900 ft²
- $L/W < 3:1$
- Increase bracing by factor of 1.4



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

Bracing Topics

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	<p>Terminology</p> <p><u>Loads & Limits</u></p> <p>Irregular Buildings</p> <p>Wind Exposure</p> <p>Connecting the Systems</p>			

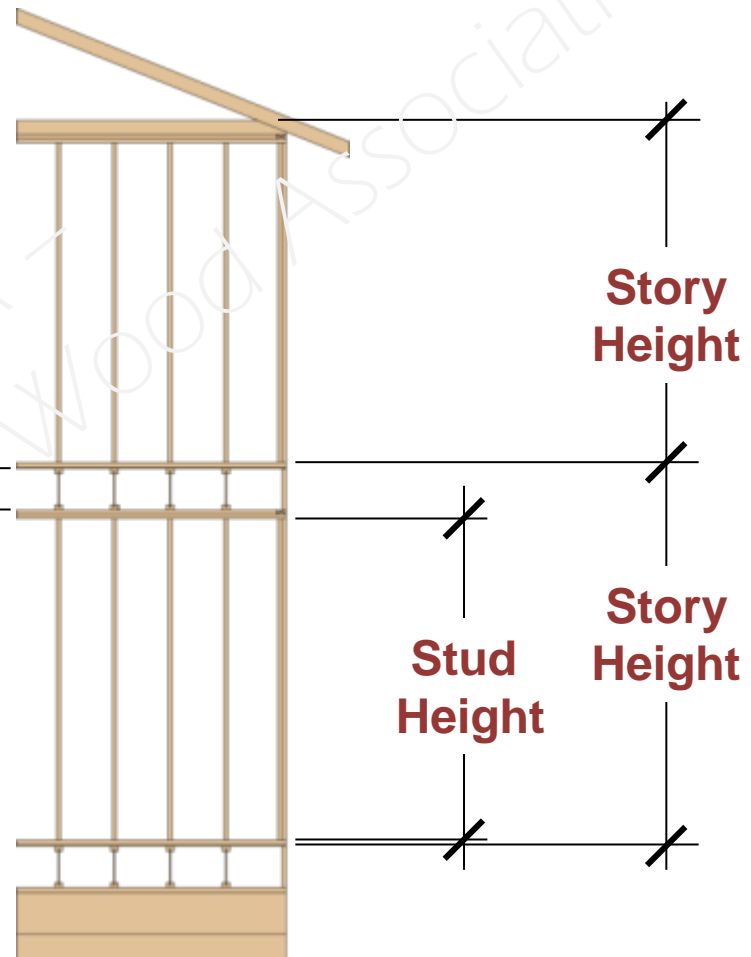
Getting Started: Loads & Limits

10' = Max. Stud Height⁽¹⁾
16" = Max. Floor Framing Height⁽²⁾

**16" Max Floor Framing
(Joist Depth)**

(1) R301.3 – Item 1, Exception permits the stud height to be 12' provided bracing length is increased by a factor of 1.2.

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



R301.3



Getting Started: Loads & Limits

Table R602.3(5)
Size, Height and Spacing of Wood Studs

Stud Size (Inches)	BEARING WALLS					NONBEARING WALLS	
	Laterally unsupported stud height (feet)	Maximum spacing when supporting roof-ceiling assembly or habitable attic, only (inches)	Maximum spacing when supporting one floor, plus a roof-ceiling assembly or habitable attic (inches)	Maximum spacing when supporting two floors, a roof-ceiling assembly or habitable attic (inches)	Maximum spacing when supporting one floor height (inches)	Laterally unsupported stud height (feet)	Maximum spacing (inches)
2 x 3	--	--	--	--	--	10	16
2 x 4	10	24	16	--	24	14	24
3 x 4	10	24	24	16	24	14	24
2 x 5	10	24	24	--	24	16	24
2 x 6	10	24	24	16	24	20	24

Getting Started: Loads & Limits

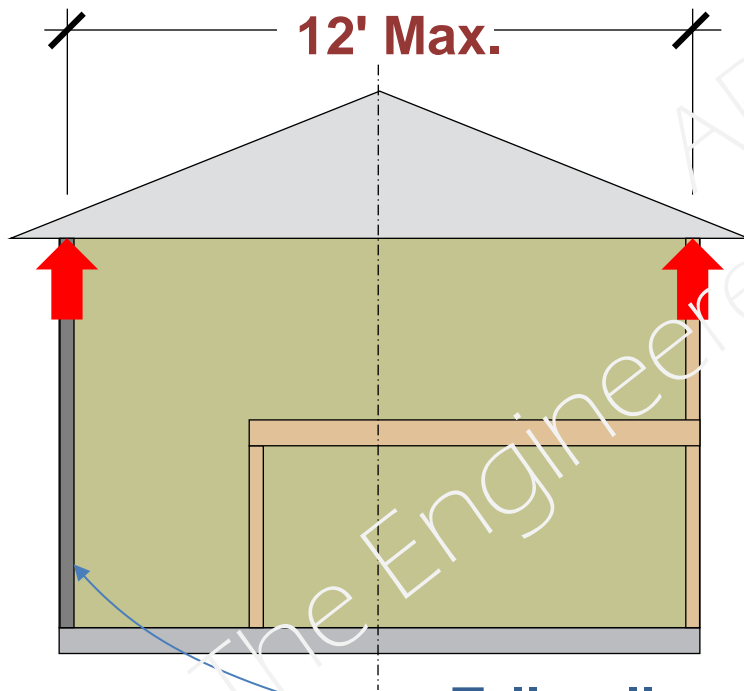
Table R602.3.1
Maximum Allowable Length of Wood Wall Studs Exposed to
Wind Speeds of 100 mph or Less in SDC A-D₂

Height (feet)	On-Center Spacing (inches)			
	24	16	12	8
Supporting a roof only				
>10	2 x 4	2 x 4	2 x 4	2 x 4
12	2 x 6	2 x 4	2 x 4	2 x 4
14	2 x 6	2 x 6	2 x 6	2 x 4
16	2 x 6	2 x 6	2 x 6	2 x 4
18	N/A	2 x 6	2 x 6	2 x 6
20	N/A	N/A	2 x 6	2 x 6
24	N/A	N/A	N/A	2 x 6

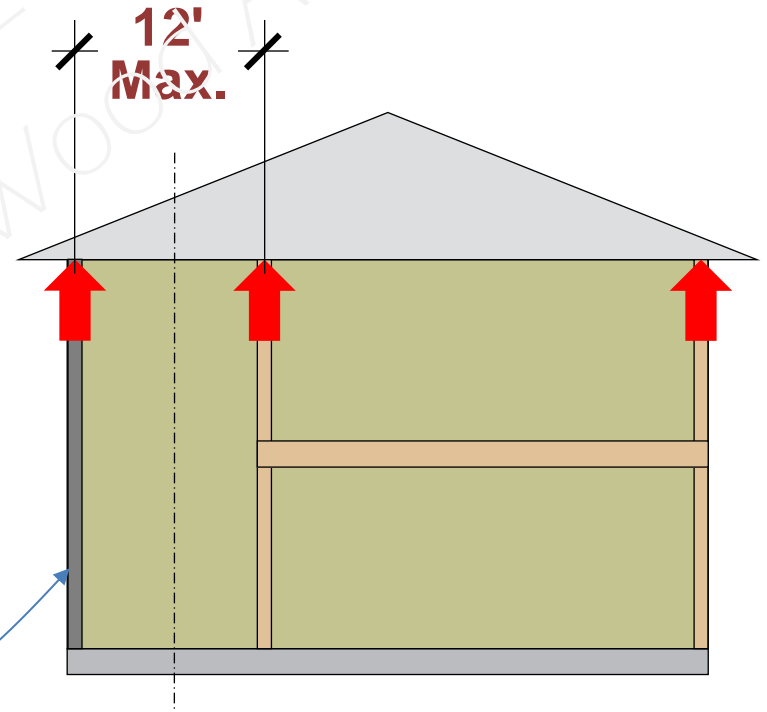
Getting Started: Loads & Limits

Table R602.3.1, footnote b

Two Point Truss



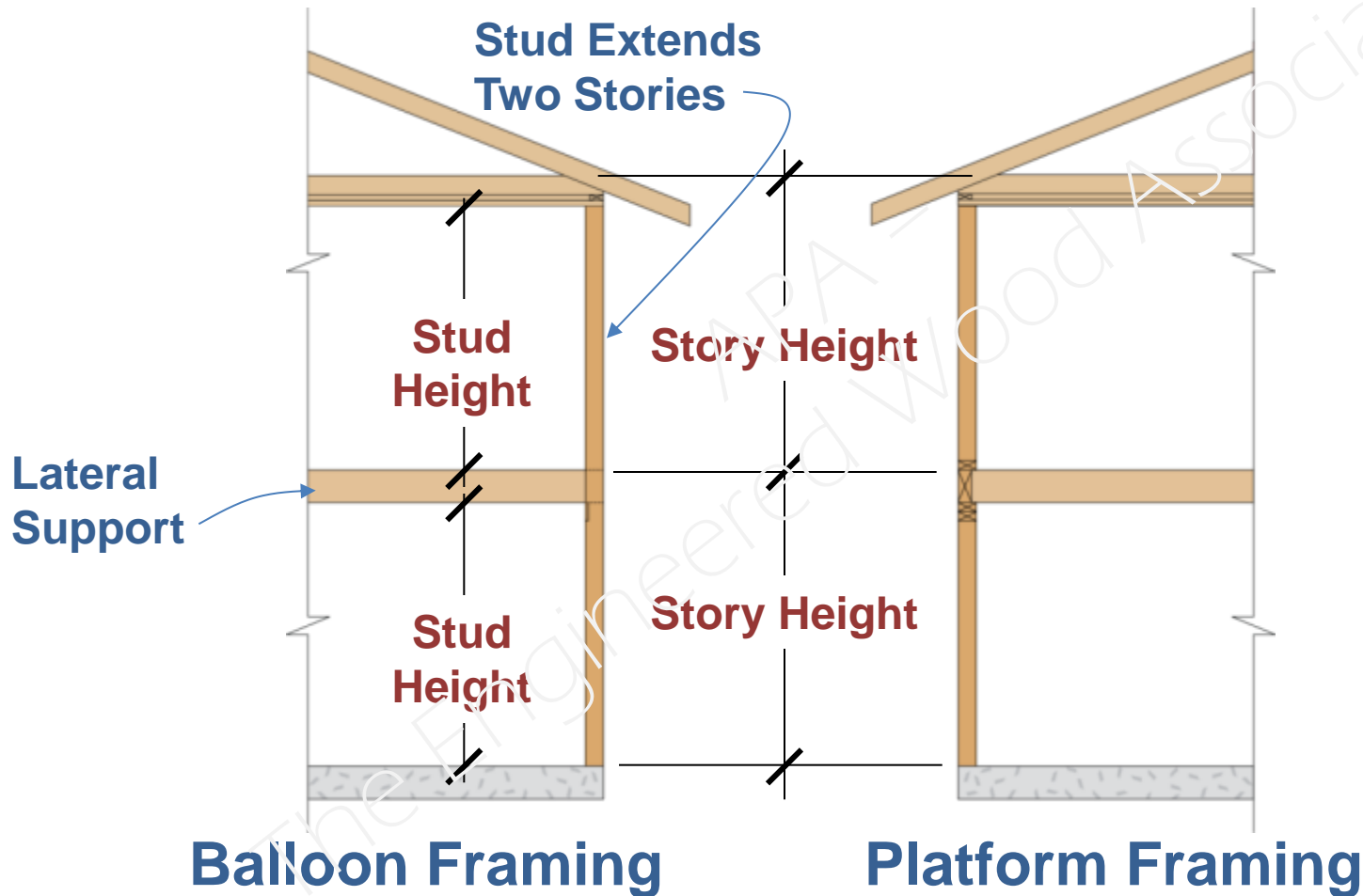
Three Point Truss



Tall walls

Table R602.3.1

Getting Started: Loads & Limits



R301.1.2



Getting Started: Loads & Limits

R301.2.2 Seismic provisions.

The seismic provisions of this code shall apply to...
SDC C, D₀, D₁ and D₂...

Exception:

Detached one- and two-family dwellings located in Seismic Design Category C are exempt from the seismic requirements of this code.

Getting Started: Loads & Limits

Wind Requirements Only

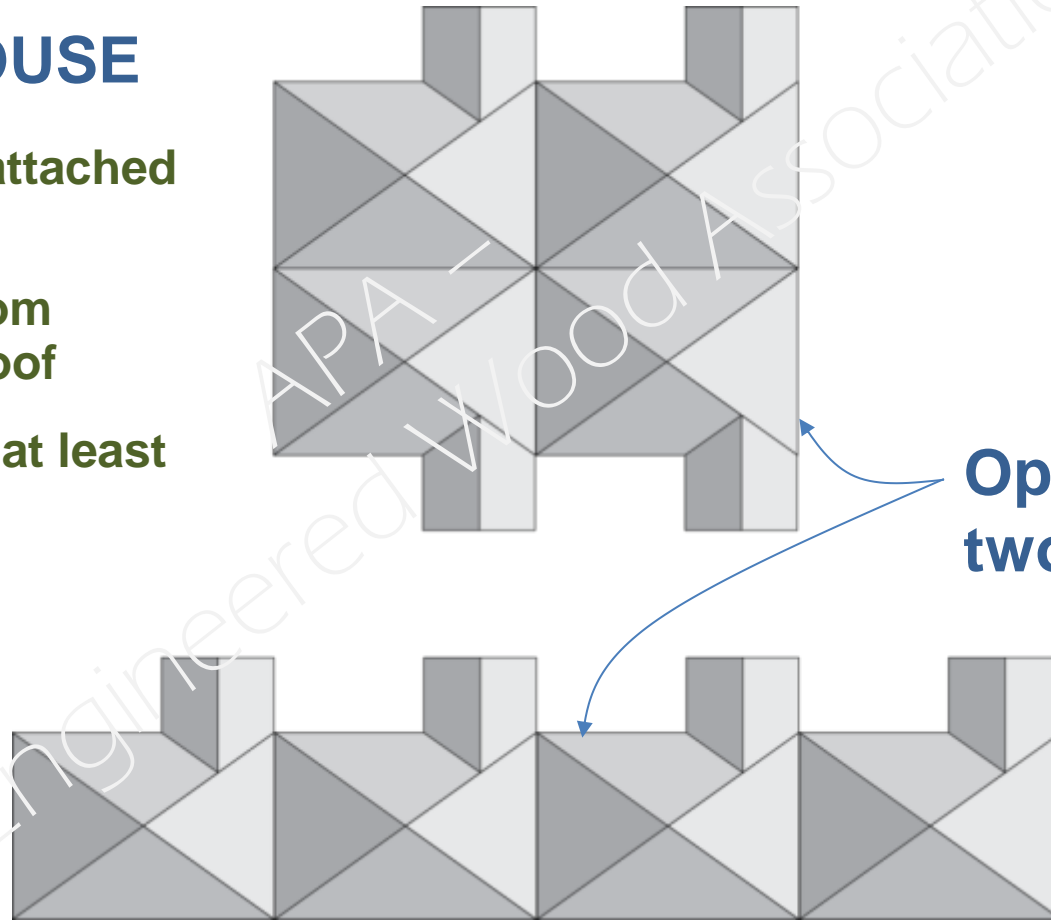
Seismic Design Category	One- and two-family	Townhouses
A & B	N/A	N/A
C	Exempt	Seismic Req. Apply
D ₀	Seismic Req. Apply	Seismic Req. Apply
D ₁	Seismic Req. Apply	Seismic Req. Apply
D ₂	Seismic Req. Apply	Seismic Req. Apply

Wind and Seismic Requirements

Getting Started: Loads & Limits

R202 TOWNHOUSE

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

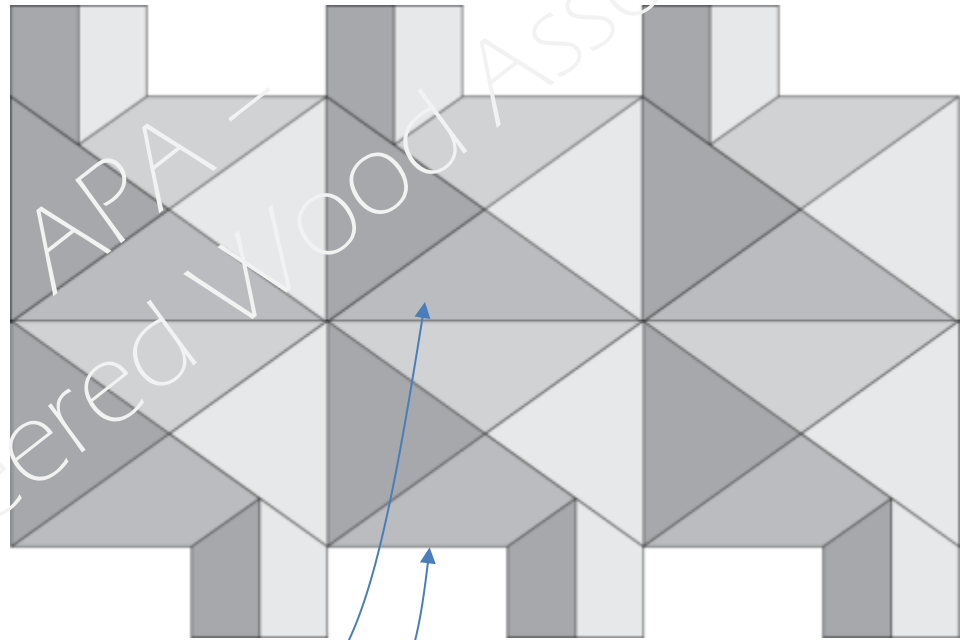


R301.2.2

Getting Started: Loads & Limits

R202 TOWNHOUSE

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



Not open two sides
(therefore, not a townhouse)

Getting Started: Loads & Limits

R301.2.2.2.1 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

Force = Mass x Acceleration

Getting Started: Loads & Limits

Irregular building definitions

1

2

3

4

5

6

7

R301.2.2.2.5 Irregular buildings

- "Prescriptive construction ... 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

Irregular building provisions do not apply

Seismic Requirements

Irregular building provisions apply

Getting Started: Loads & Limits

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

R301.2.3

Getting Started: Loads & Limits

**TABLE R301.2(1)
CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA**

Ground Snow Load	Wind Speed (mph)	Seismic Design Category	Subject to Damage From			Winter Design Temp	Ice Barrier Underlayment Required	Flood Hazards	Air Freezing Index	Mean Annual Temp
			Weathering	Frost Line Depth	Termite					
≤70	<110 ⁽¹⁾	A-D ₂								

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

Bracing Topics

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	Terminology Loads & Limits <u>Irregular Buildings</u> Wind Exposure Connecting the Systems			

Getting Started: Irregular Buildings

Irregular building definitions

1

2

3

4

5

6

7

R301.2.2.2.5 Irregular buildings

“Prescriptive construction ... 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

Irregular building provisions do not apply

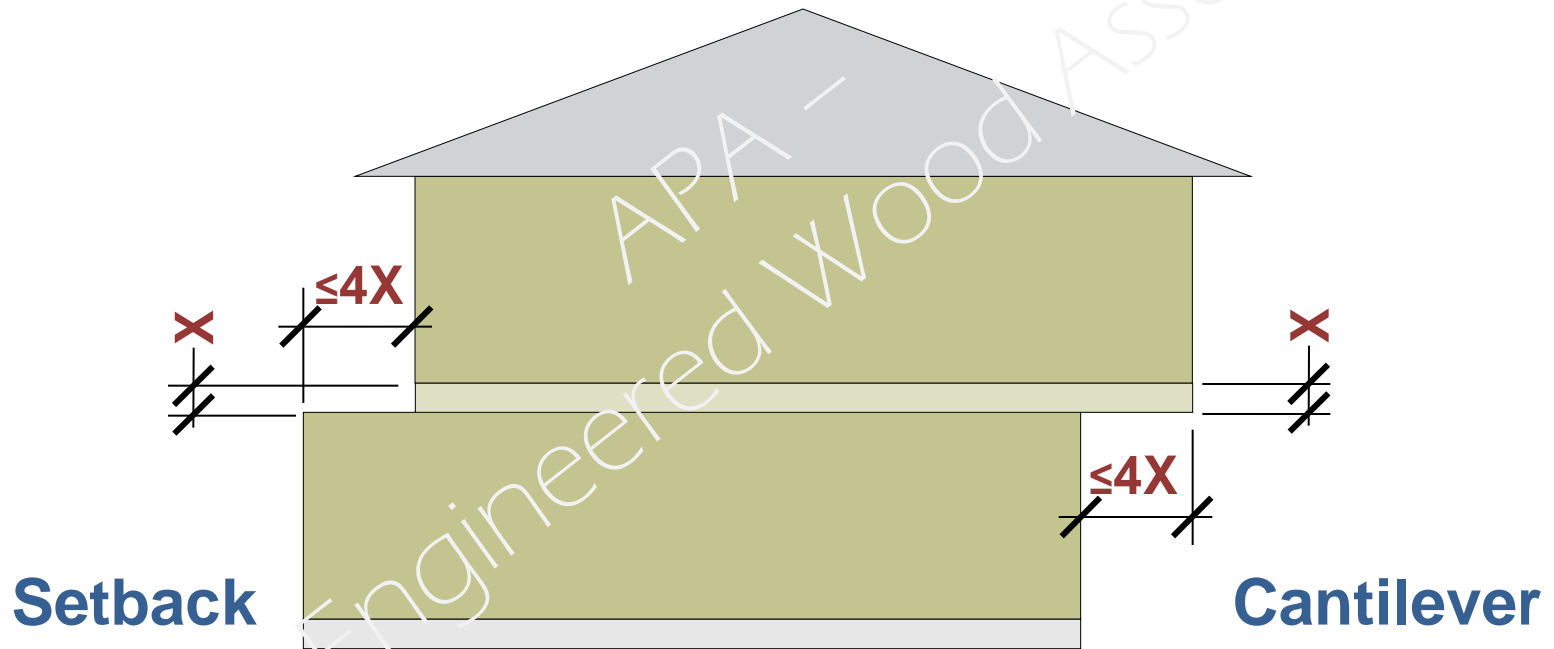
Seismic Requirements

Irregular building provisions apply

Additional building shape and structural requirements apply

Getting Started: Irregular Buildings

1



Getting Started: Irregular Buildings

1 Summary

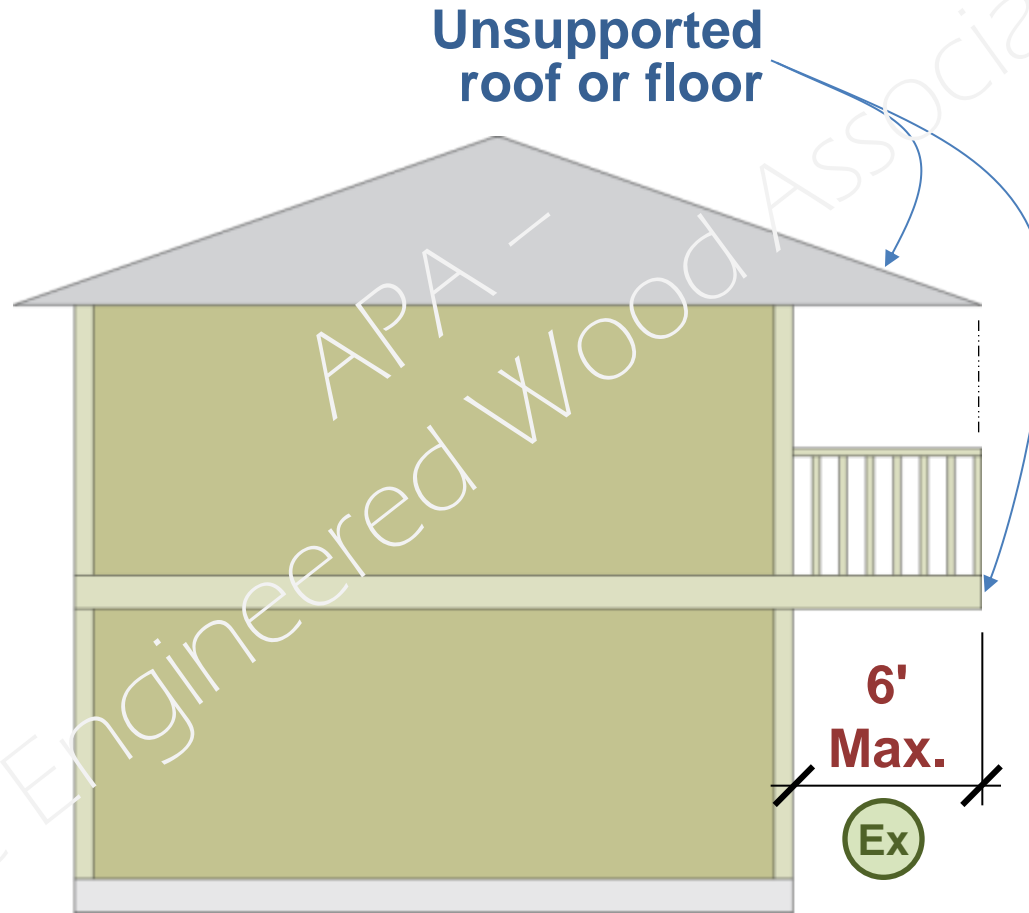
Setback or Cantilever

1. 2" x 10" Joists @ 16" Max.
2. Back span to cantilever = 2:1
3. Doubled joists at BWP ends
4. Continuous rim or approved splice
5. Uniform load & 8' max header



Getting Started: Irregular Buildings

2



R301.2.2.2.5

Getting Started: Irregular Buildings

2

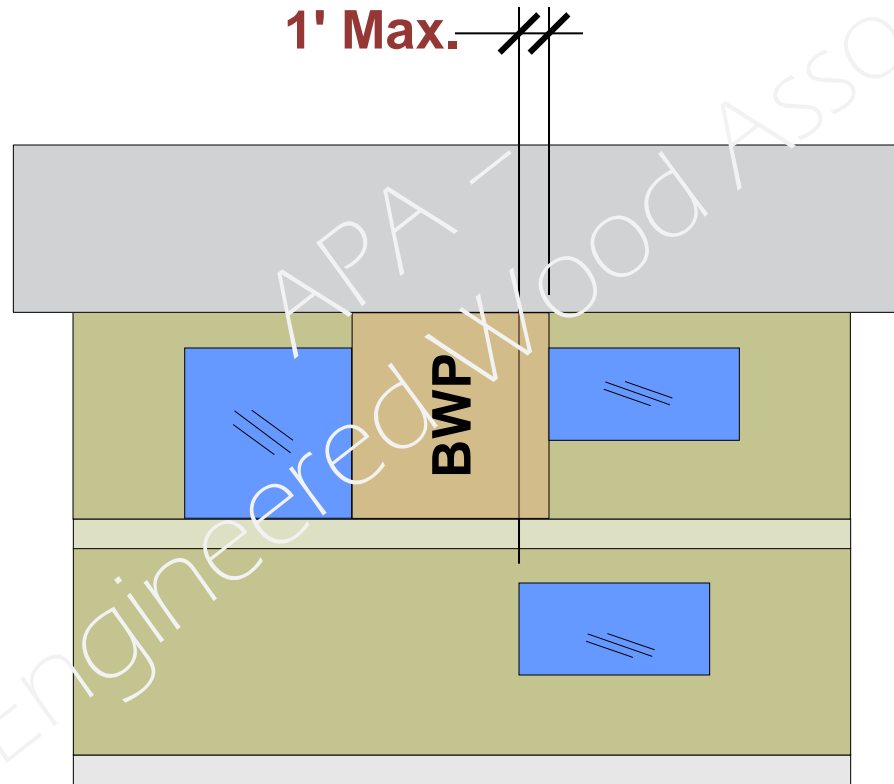
Lateral Support:

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



Getting Started: Irregular Buildings

3



R301.2.2.2.5



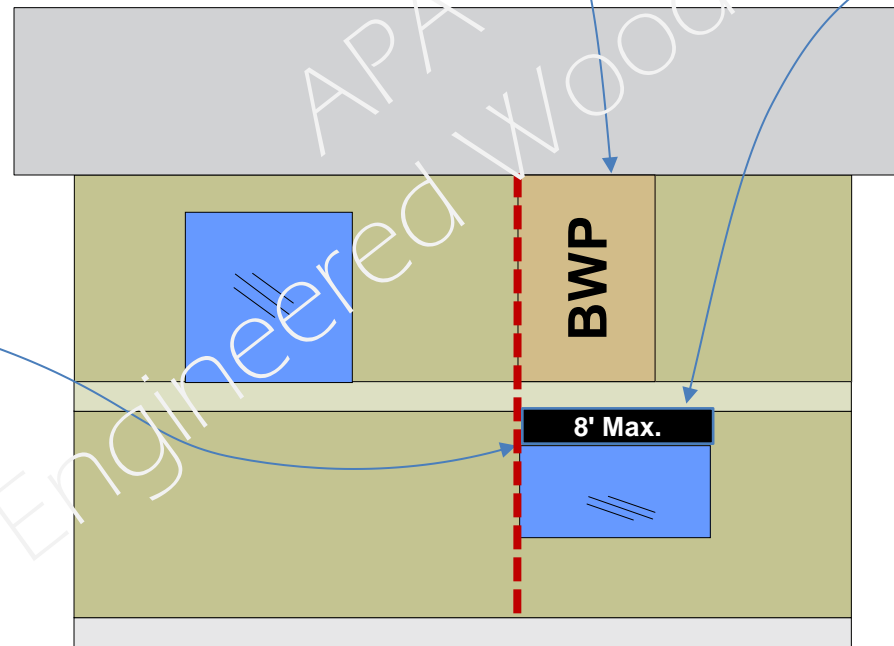
Getting Started: Irregular Buildings

3

Entire BWP length shall not occur over opening below

Header requirement

Okay; BWP & window in line



R301.2.2.2.5



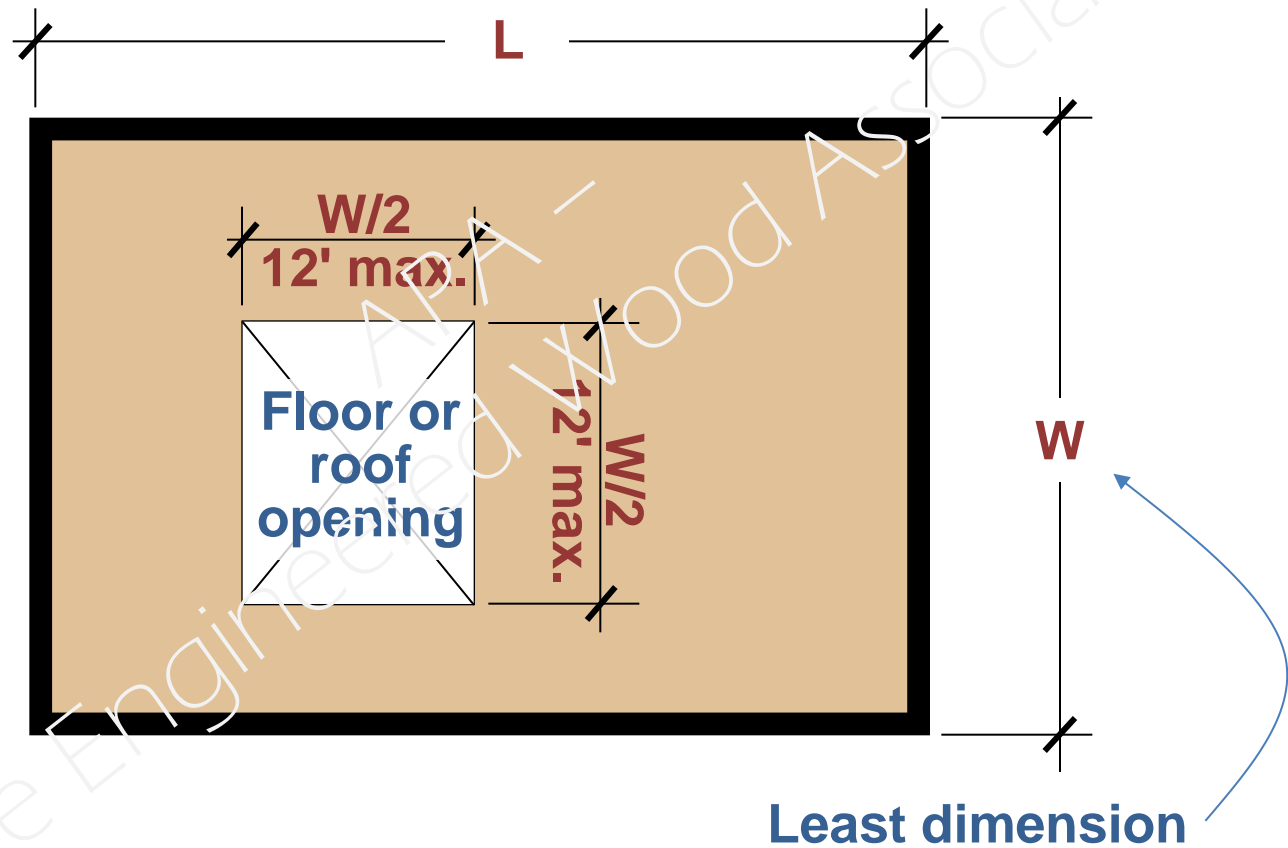
Getting Started: Irregular Buildings

3

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

Getting Started: Irregular Buildings

4

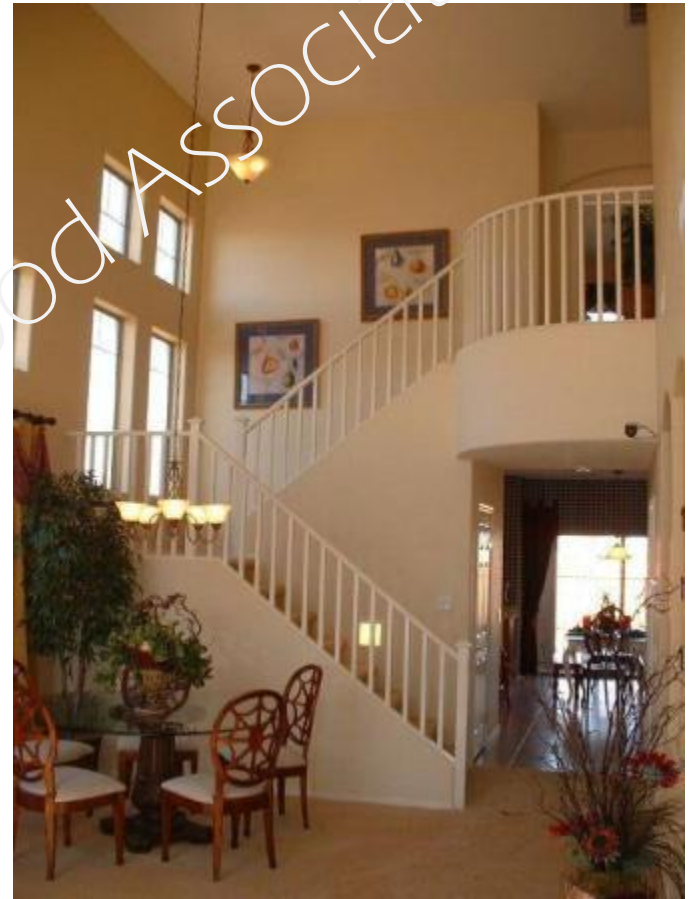


Getting Started: Irregular Buildings

4

Floor or Roof Opening:

When an opening in a floor or roof exceeds the lesser of 12 feet or 50% of the least floor dimension it must be engineered in high seismic regions.



R301.2.2.2.5

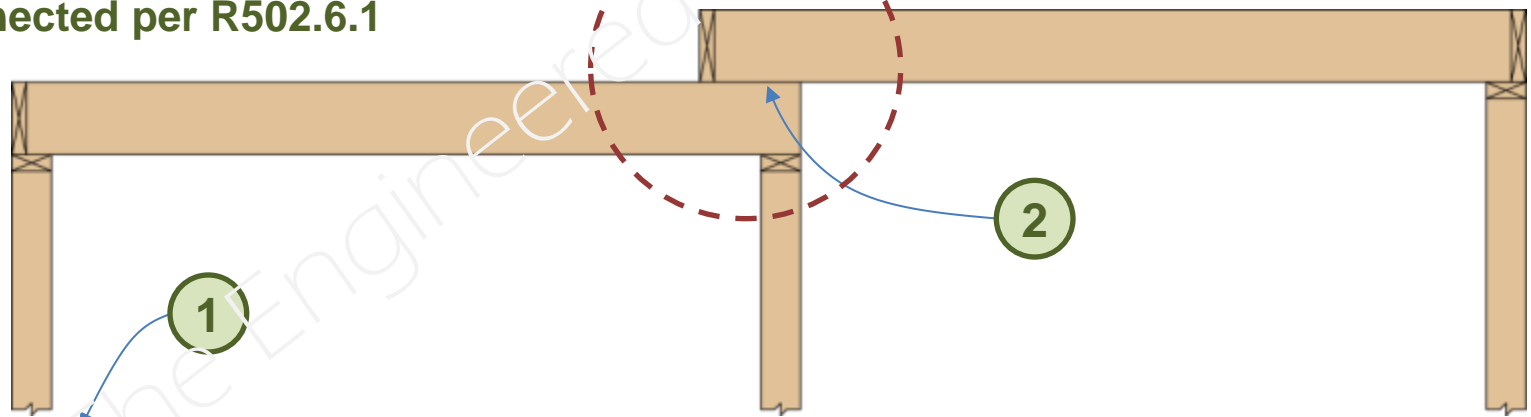


Getting Started: Irregular Buildings

5

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

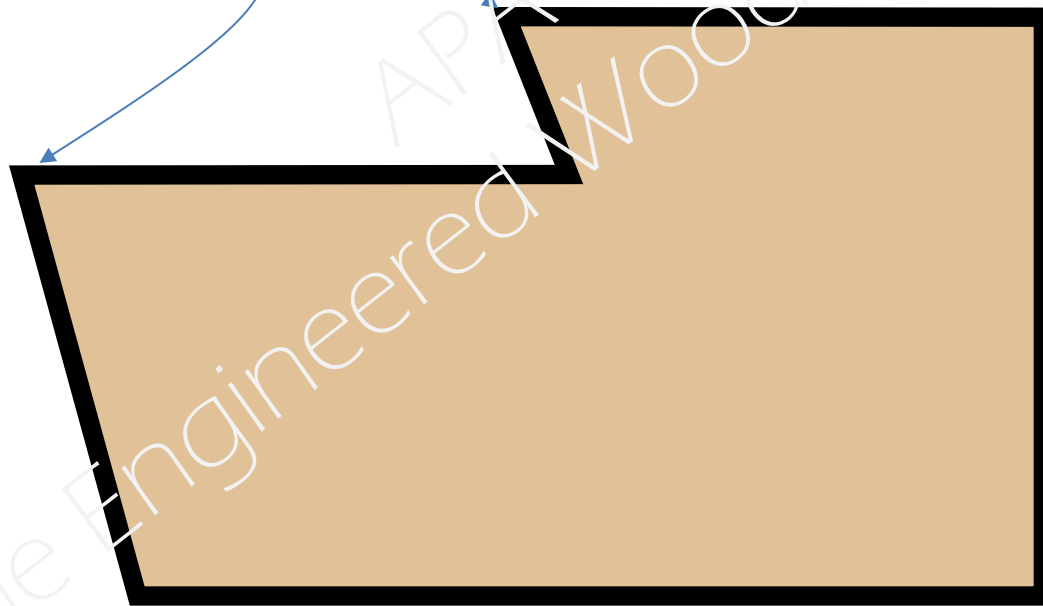


R301.2.2.2.5

Getting Started: Irregular Buildings

6

Not perpendicular



Getting Started: Irregular Buildings

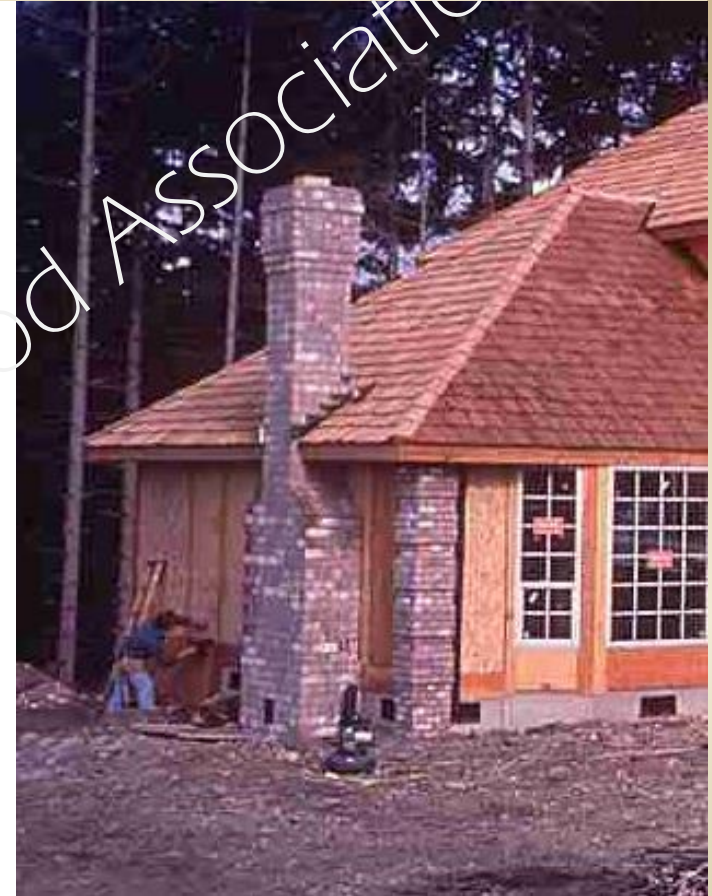
7

Masonry or Concrete:

When stories above-grade...include masonry or concrete construction.

Exception:

Fireplaces, chimneys, and masonry veneer are permitted by this code. Bracing requirements are defined in section R602.12.



Bracing Topics

Introduction	Getting Started	Bracing Basics	Connections	Other Topics
	Terminology Loads & Limits Irregular Buildings <u>Wind Exposure</u> Connecting the Systems			

Getting Started: Wind Exposure

R301.2.1.1 Design Criteria

Wind speeds greater than:

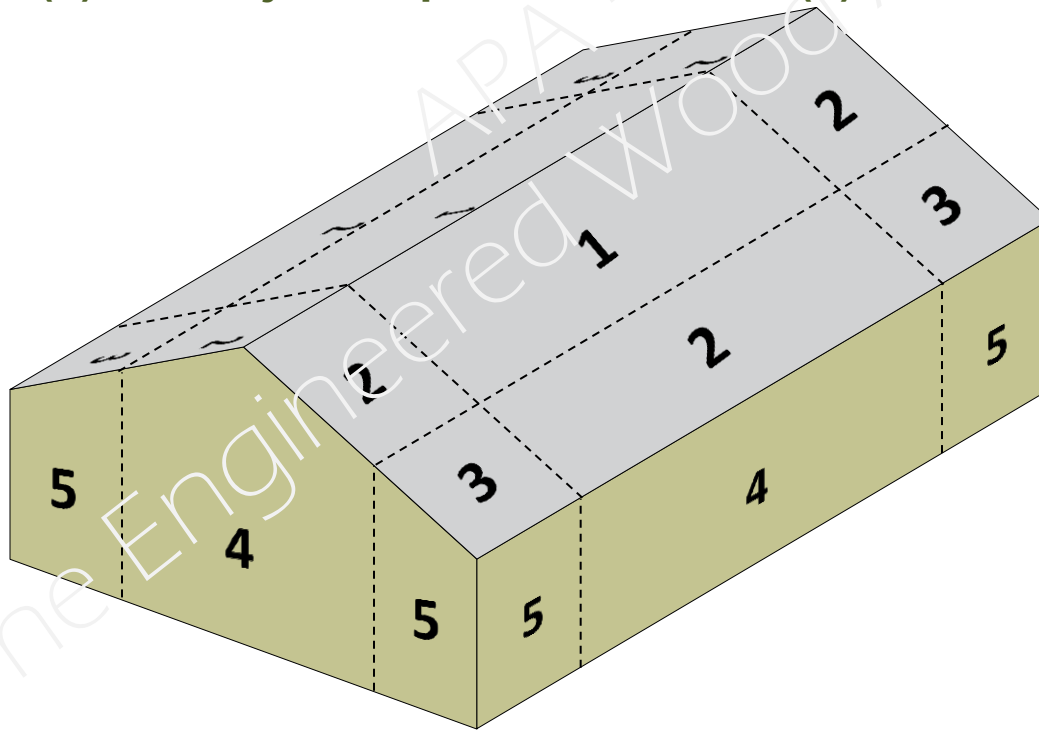
- 100 mph in hurricane-prone regions⁽¹⁾, or
- 110 mph elsewhere to be designed using one of the following:
 - WFCM
 - ICC 600
 - ASCE-7
 - AISI S230 (steel)

(1) R202 – Areas vulnerable to hurricanes, defined as the U.S. Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed is greater than 90 mph, and Hawaii, Puerto Rico, Guam, Virgin Islands, and America Samoa.

Getting Started: Wind Exposure

R301.2.1 Wind limitations

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



Getting Started: Wind Exposure

R301.2.1 Wind limitations



Cladding Failure

Getting Started: Loads & Limits

R301.2.4 Exposure Category.

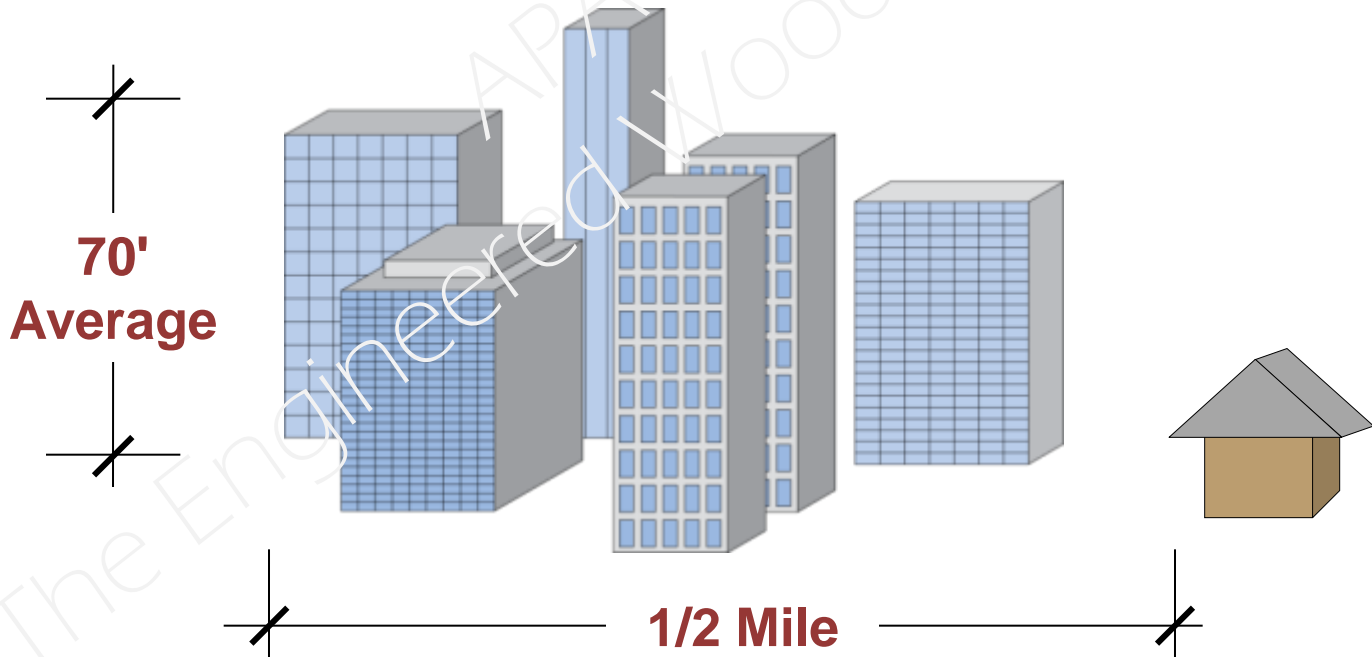
- 1. Exposure A. Large city centers**
- 2. Exposure B. Urban, suburban and wooded areas with numerous, closely spaced obstruction. Exposure B is assumed unless the site clearly meets other category types**
- 3. Exposure C. Open terrain with scattered obstructions**
- 4. Exposure D. Flat areas exposed to wind flowing over large bodies of water**

Table R301.2.3 Height and Exposure Adjustments for Table R301.2(2).

Getting Started: Wind Exposure

Exposure A:

Large city centers with at least 50 percent of the buildings having a height in excess of 70 feet for a distance of 0.5 mile upwind from the structure being designed.

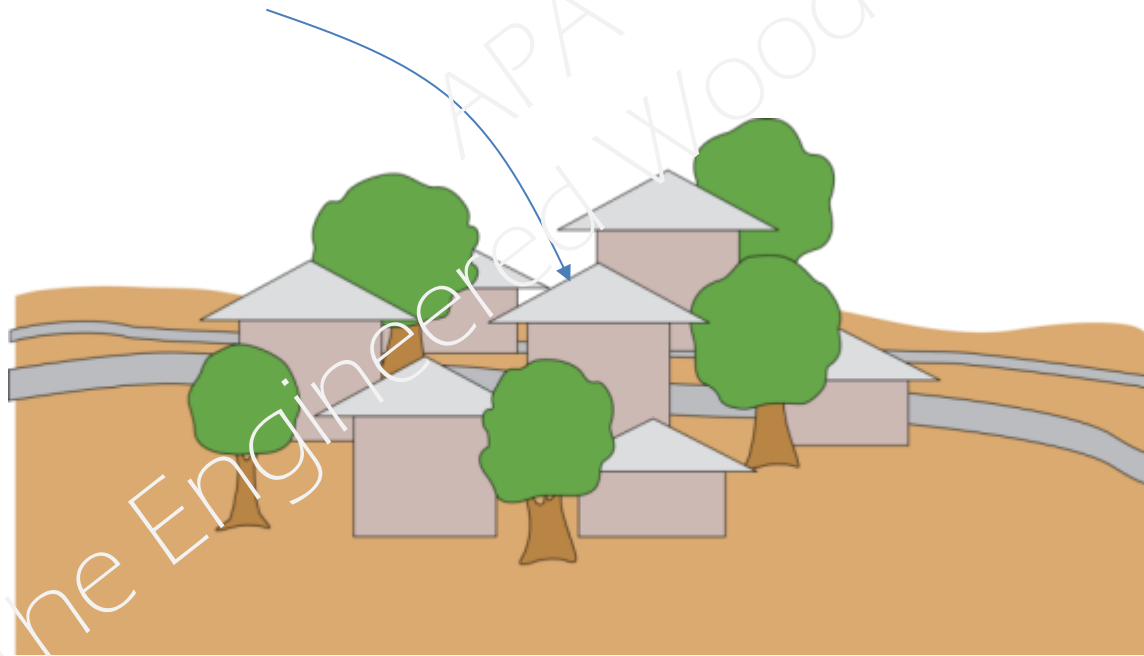


R301.2.1.4.1

Getting Started: 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.



Getting Started: Wind Exposure

Exposure C (1 of 2):

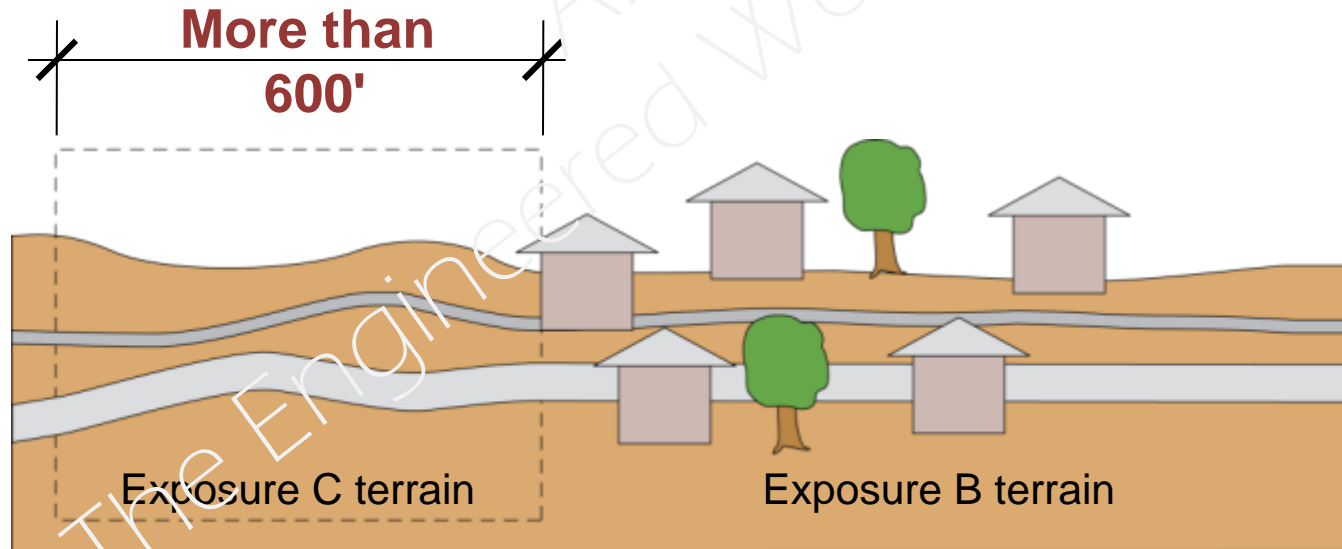
Open with scattered obstructions or undulations generally less than 30 feet in height extending for 1,500 feet in any direction.



Getting Started: Wind Exposure

Exposure C (2 of 2):

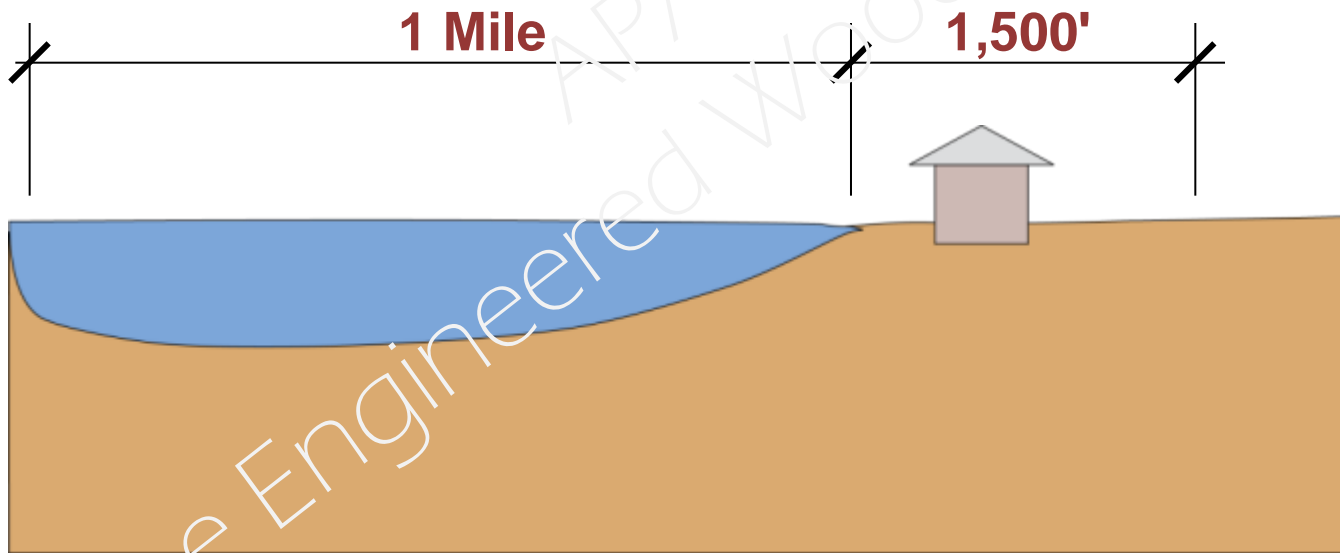
Within Exposure B terrain, but located directly adjacent to open areas of Exposure C for a distance of more than 600 ft.



Getting Started: Wind Exposure

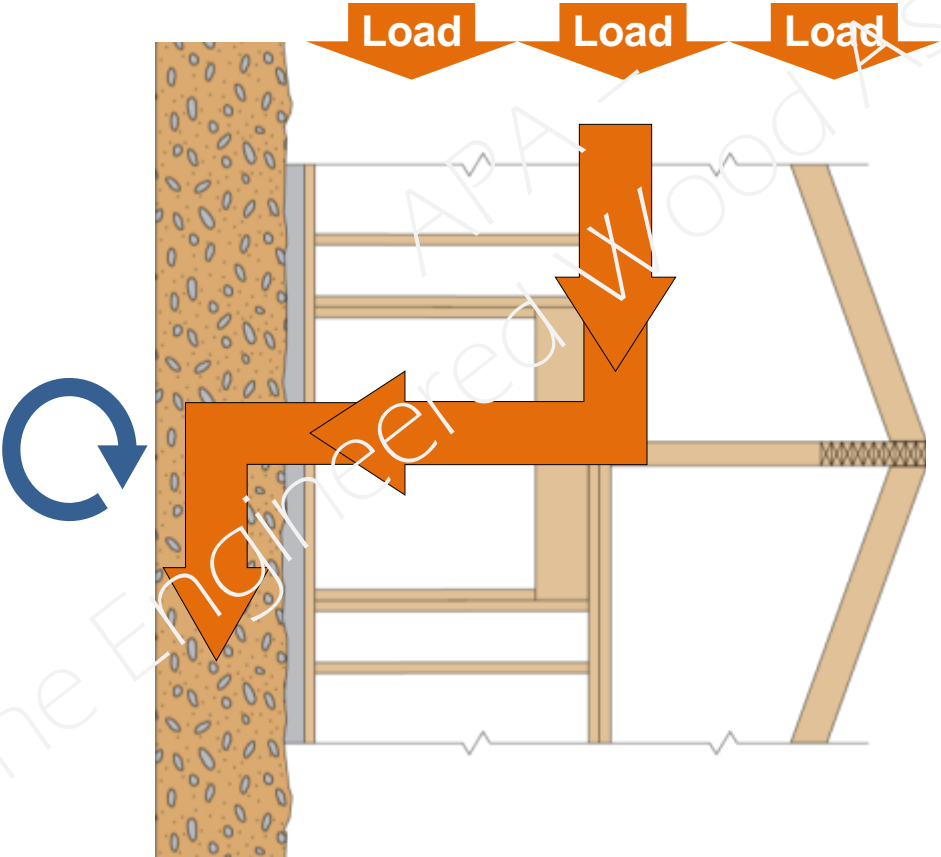
Exposure D:

Flat, unobstructed areas exposed to wind flowing over open water for at least 1 mile. Extends inland 1,500 feet.



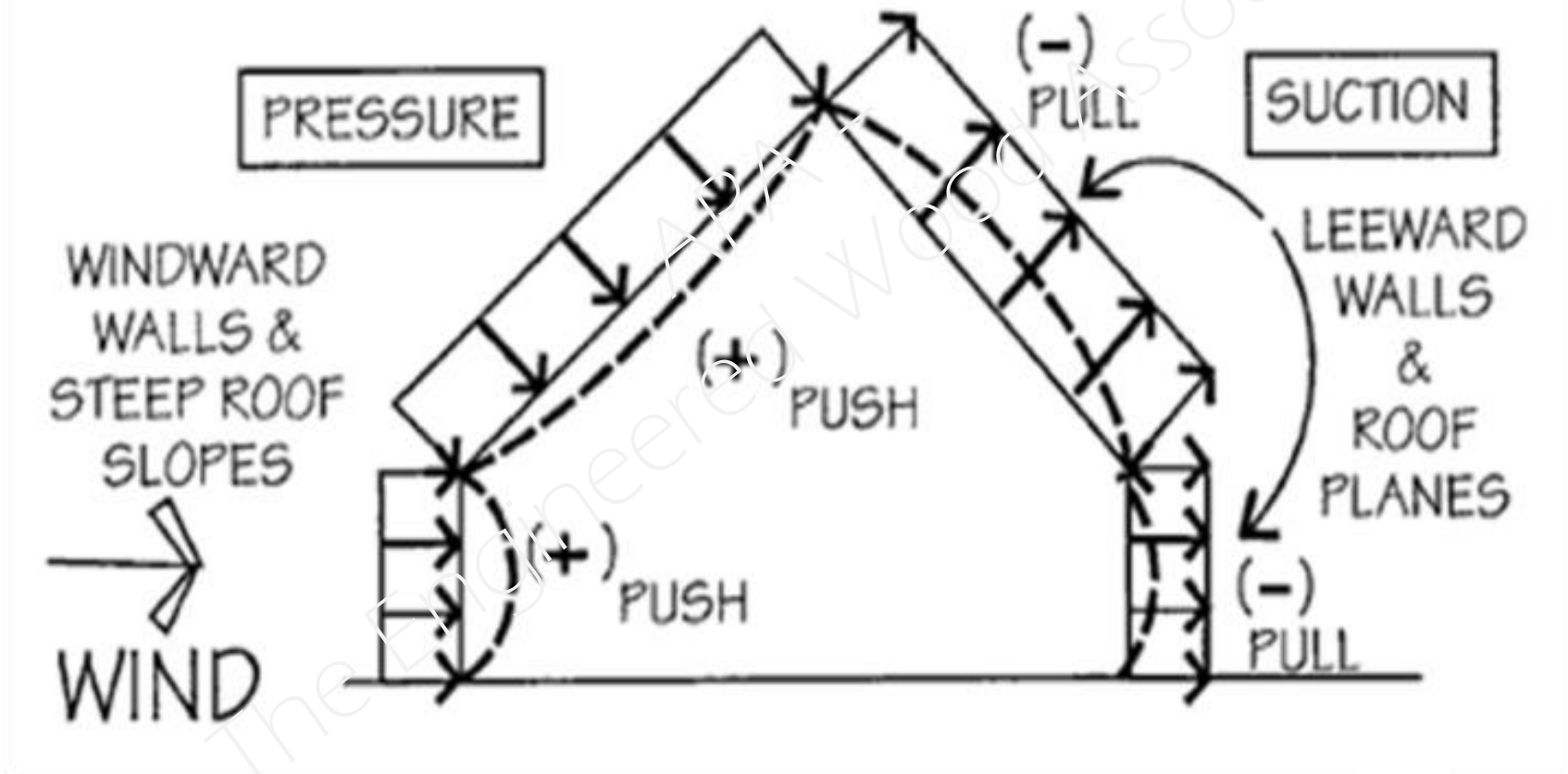
Getting Started: Wind Exposure

Lateral (Sideways) Load Path



Getting Started: Wind Exposure

Outward and Inward Wind Pressure Loads



Getting Started: Wind Exposure

R301.2.1 Wind limitations.



Cladding failures have been more common than bracing failures in recent events

Getting Started: Wind Exposure

Table R301.2.(2) Component and Cladding Loads.

- Provides values for both positive and negative pressures
- Negative values for leeward side always higher than windward side, nature of wind
- Code does not provide information on capability of products to resist wind pressures – especially suction loads.

The Engineered Wood Association

Getting Started: Wind Exposure

R301.2.1 Wind limitations.



The Engineered Wood Association

Bracing Topics

Introduction	Getting Started	Bracing Basics	Connections	Other Topics
	Terminology Loads & Limits Irregular Buildings Wind Exposure <u>Connecting the Systems</u>			

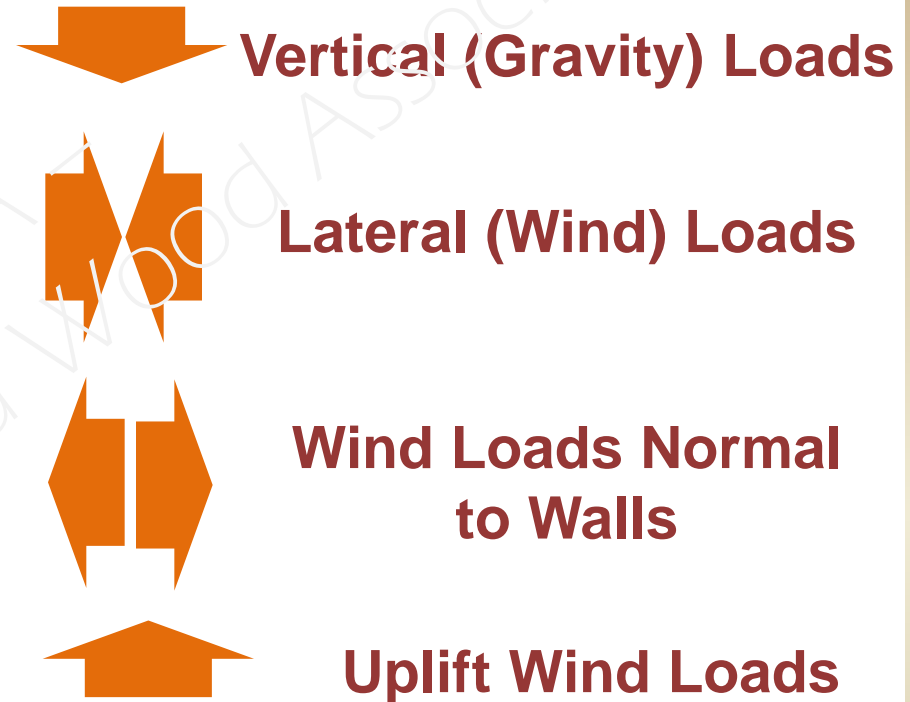
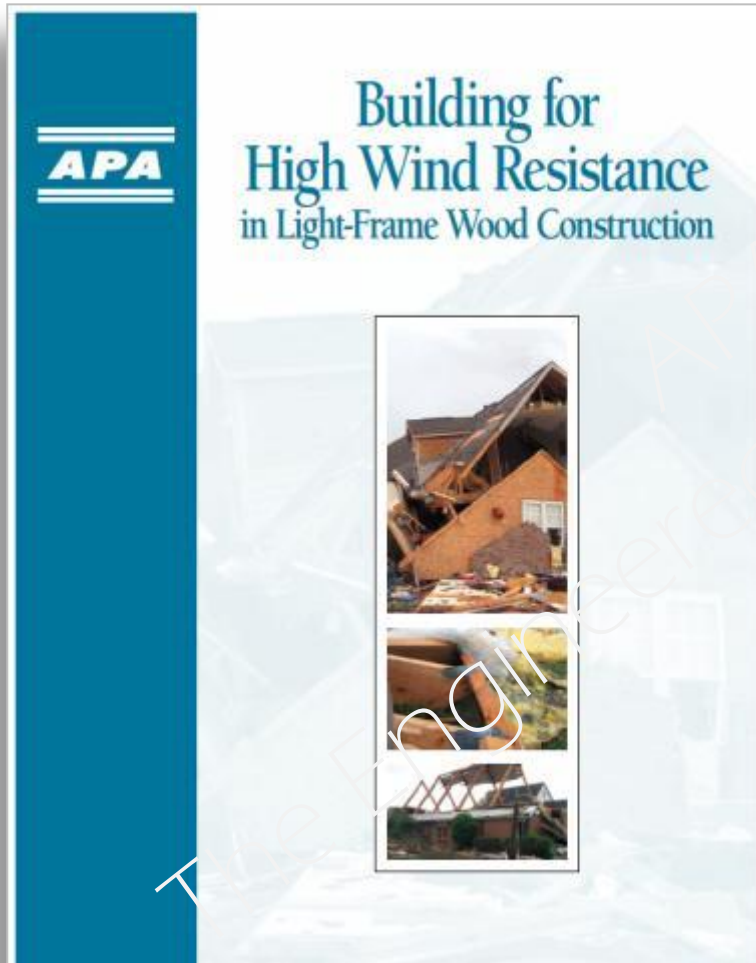
Connecting the Systems



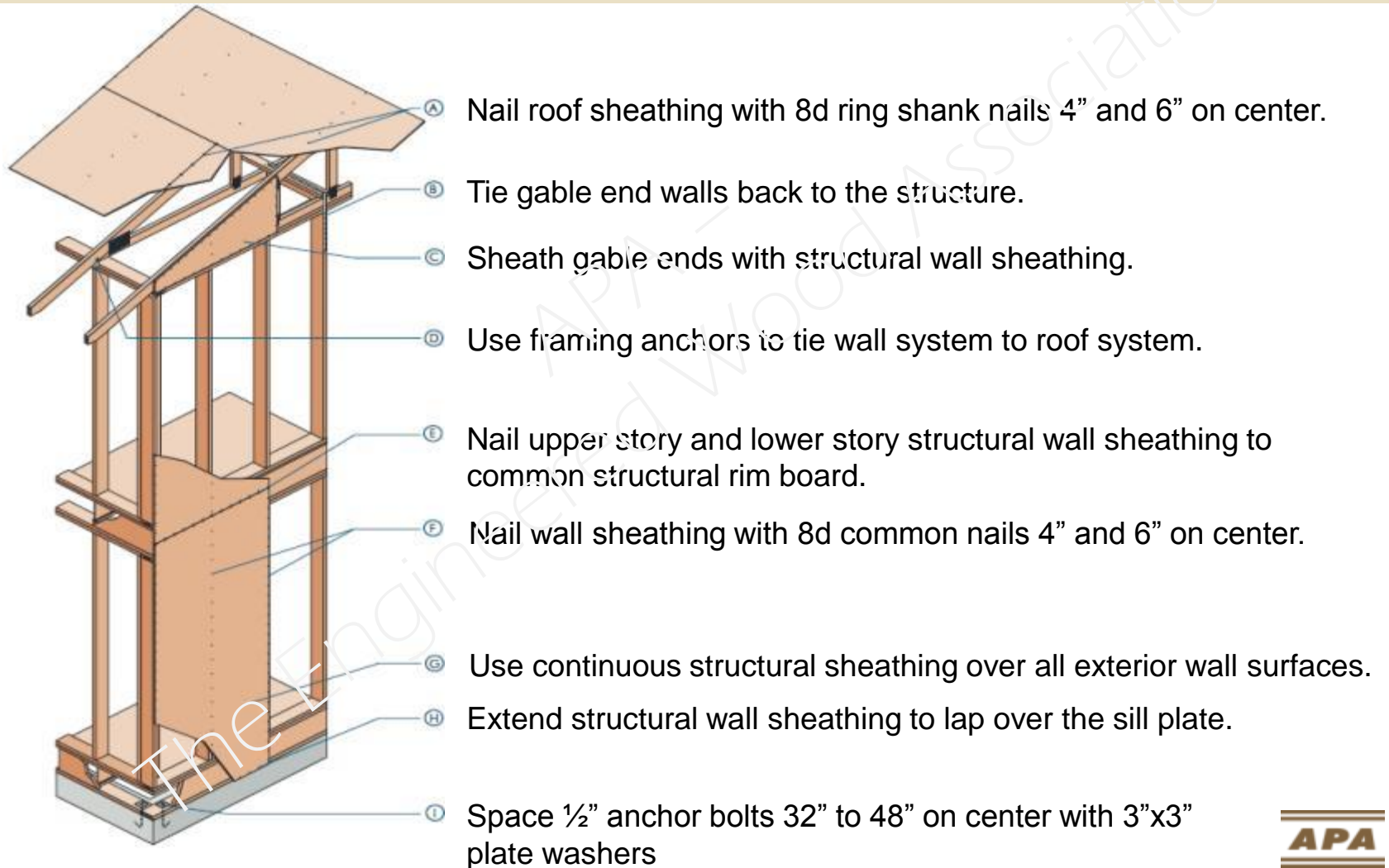
Connecting the Systems



Connecting the Systems



Connecting the Systems



Connecting the Systems



Connecting the Systems



Connecting the Systems



Bracing Topics

Introduction

Getting Started

Bracing Basics

Connections

Other Topics

Braced Panel Construction

Intermittent Bracing Methods

Continuous Bracing Methods

Mixing Bracing Methods

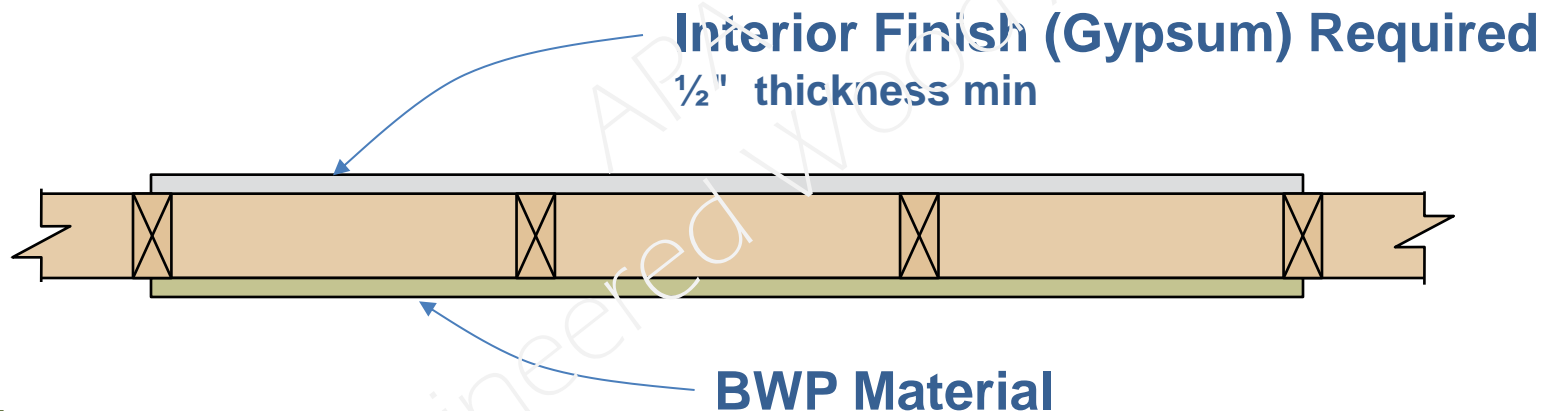
BWP Placement

BWL Spacing

Required Bracing Length

Bracing Basics: Braced Panel Construction

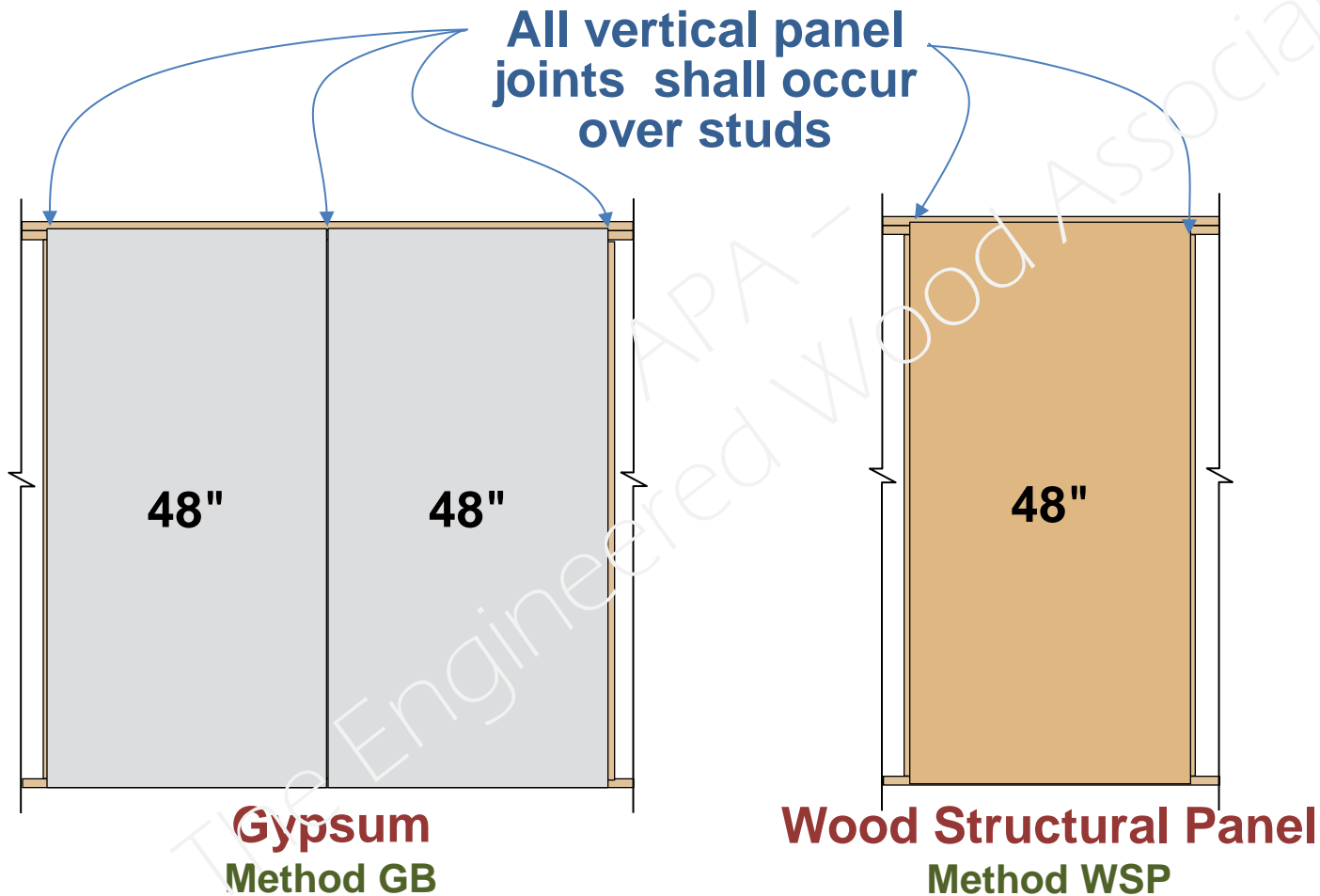
R602.10.2.1 Braced Wall Panel Interior Finish Material



Exceptions:

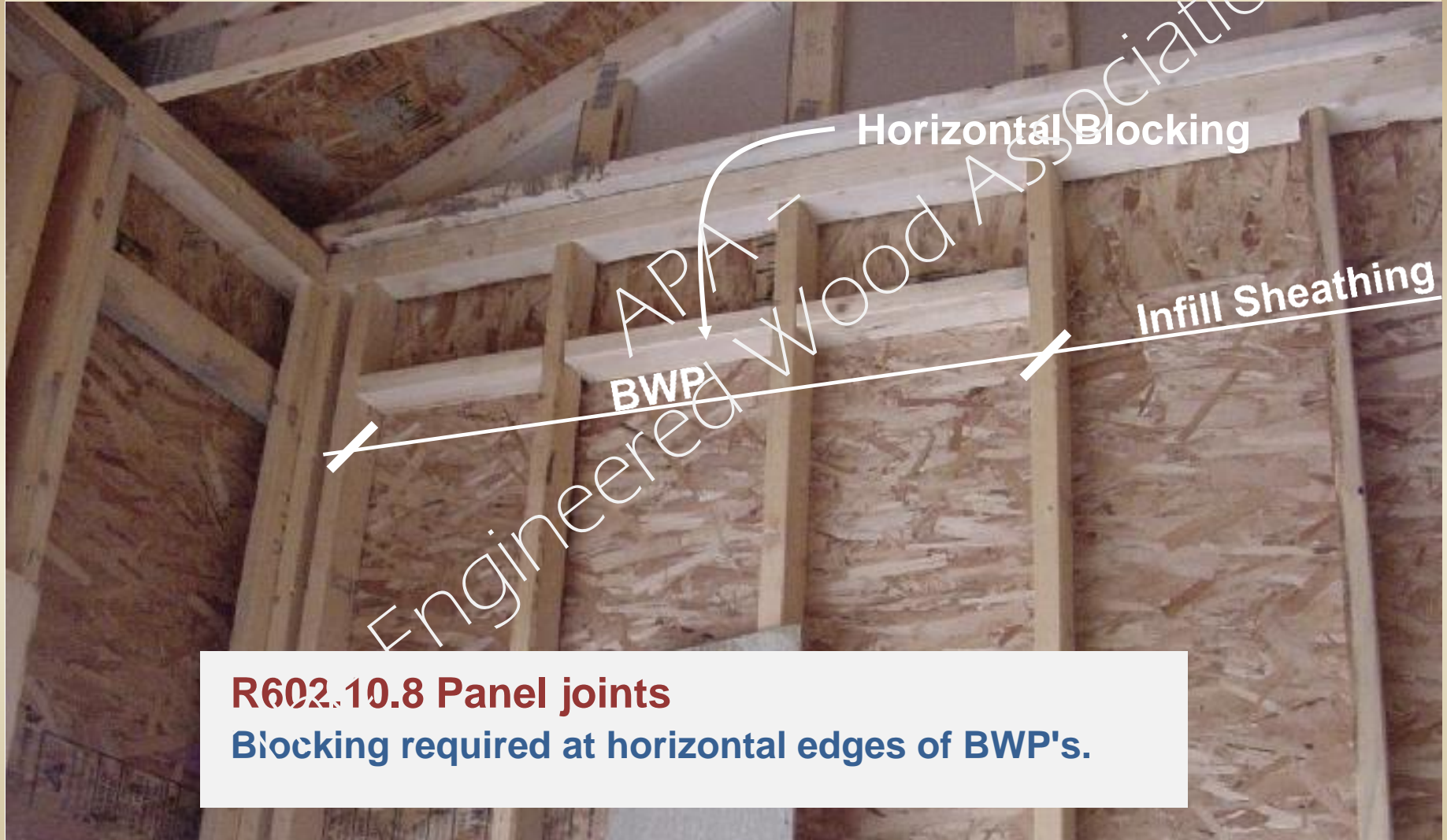
1. Wall panels braced with Methods GB, ABW, PFG and PFH.
2. When an *approved interior finish material* with an in-plane shear resistance equivalent to gypsum board is installed.
3. For Methods DWB, WSP, SFB, PBS, PCP and HPS, omitting gypsum wall board is permitted when the length of bracing in Tables R602.10.1.2(1) and R602.10.1.2(2) is multiplied by a factor of 1.5.

Bracing Basics: Braced Panel Construction



R602.10.8

Bracing Basics: Braced Panel Construction



R602.10.8 Panel joints

Blocking required at horizontal edges of BWP's.

Bracing Basics: Braced Panel Construction

Blocking is required at horizontal edges of BWP's

Exceptions:

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

Bracing Topics

Introduction	Getting Started	Bracing Basics	Connections	Other Topics
		<p>Braced Panel Construction</p> <p><u>Intermittent Bracing Methods</u></p> <p>Continuous Bracing Methods</p> <p>Mixing Bracing Methods</p> <p>BWP Placement</p> <p>BWL Spacing</p> <p>Required Bracing Length</p>		

The Engineered Wood Association

Bracing Basics: Intermittent Bracing

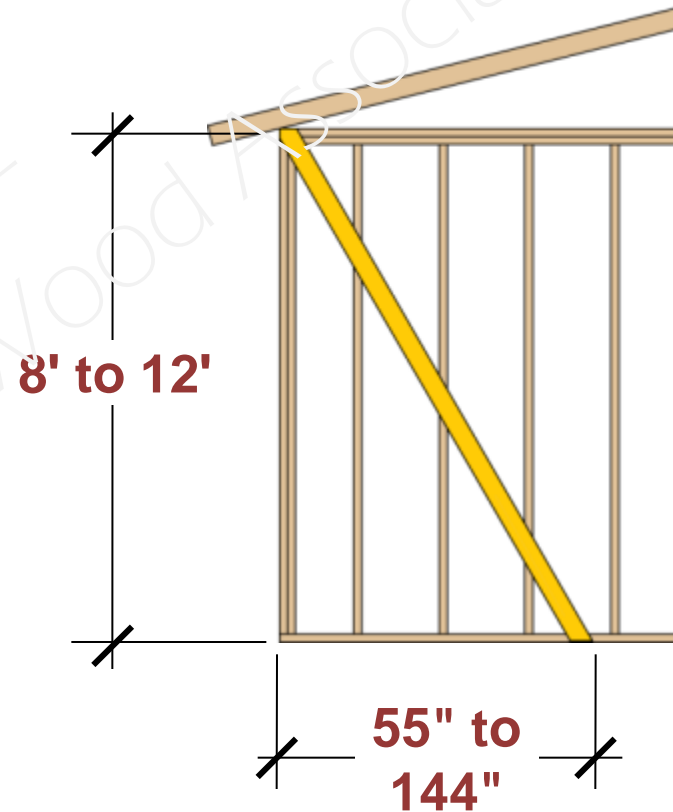
Intermittent Bracing Methods:

- LIB** - Let-in diagonal brace
- DWB** - 3/4" Diagonal wood boards
- WSP** - 3/8" Wood structural panel
- SFB** - 1/2" Structural fiberboard
- GB** - 1/2" Interior gypsum wallboard or gypsum sheathing particleboard
- PBS** - 3/8" Particleboard sheathing
- PCP** - Portland cement plaster on studs
- HPS** - 7/16" Hardboard panel siding
- ABW** - Alternate braced wall
- PFH** - Intermittent portal frame
- PFG** - Intermittent portal frame at garage door openings in SDC A-C

Bracing Basics: Intermittent Bracing

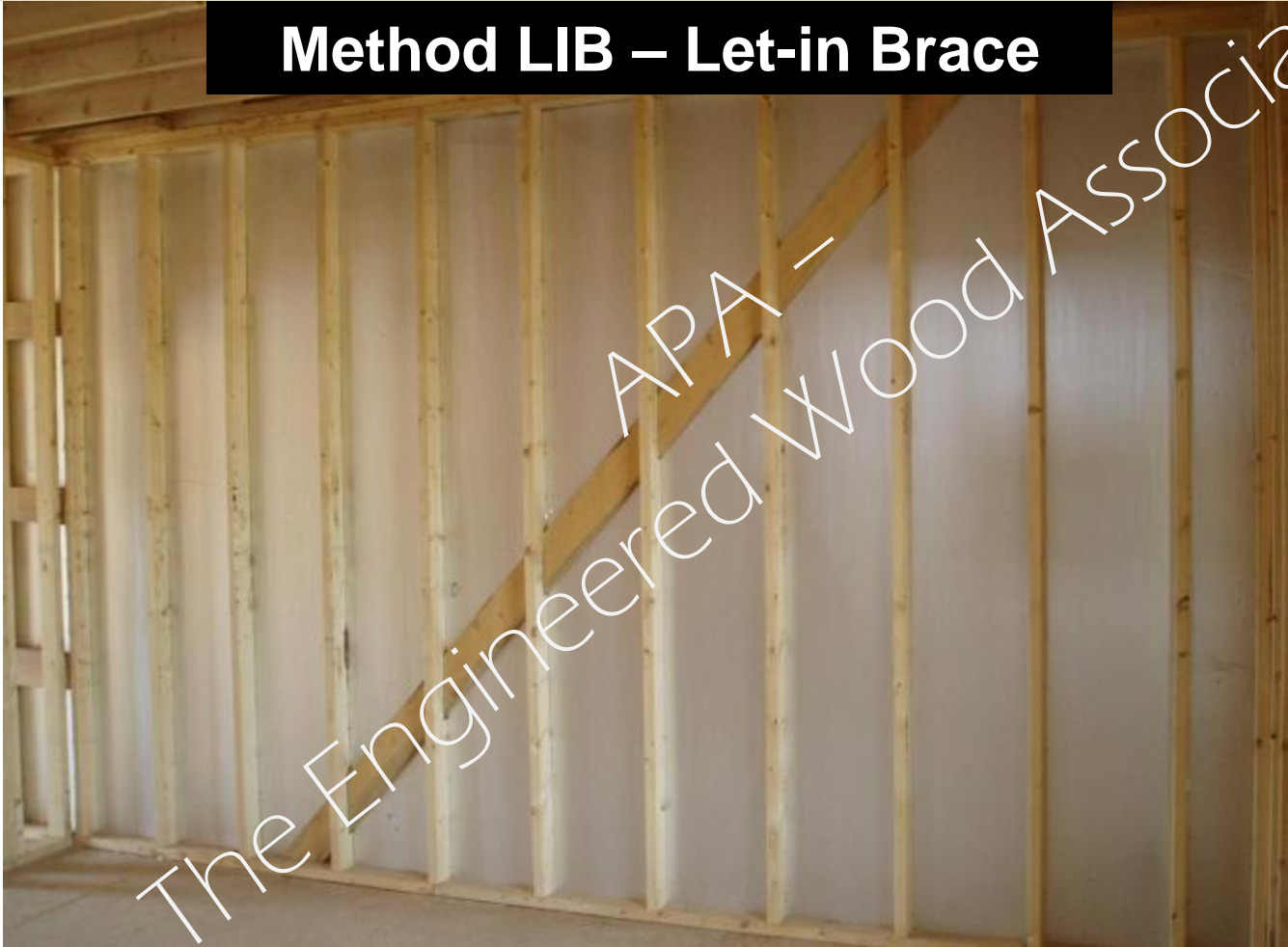
Method LIB – Let-in Brace

- Angled 45 to 60 degrees from horizontal
- Extends continuously from bottom plate to top plate
- 1x4 lumber or approved metal strap
- Application limited
 - 1st and 2nd story in SDC A & B
 - 1st story in SDC C
 - Not permitted in SDC D₀-D₂



Bracing Basics: Intermittent Bracing

Method LIB – Let-in Brace



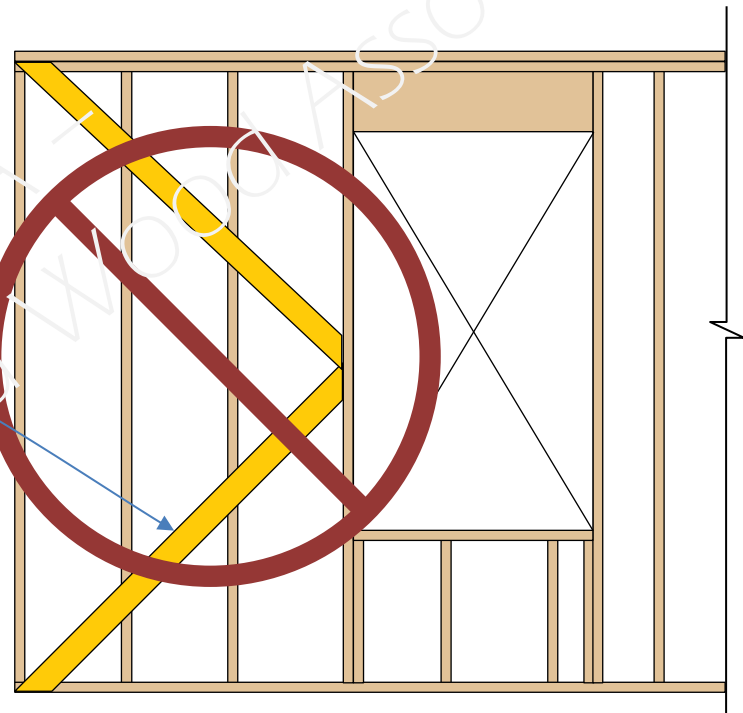
R602.10.2



Bracing Basics: Intermittent Bracing

Method LIB – Let-in Brace

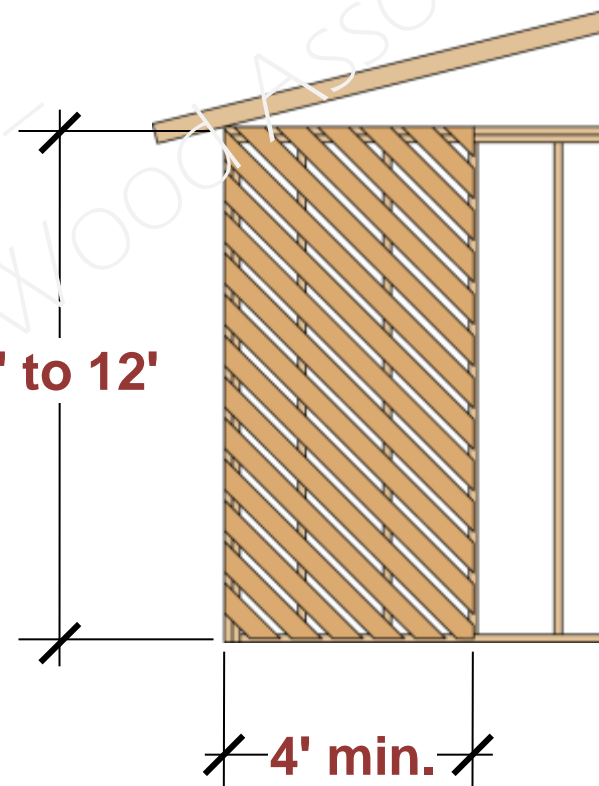
Must extend
continuously from
bottom plate to top plate



Bracing Basics: Intermittent Bracing

Method DWB – Diagonal Wood Boards

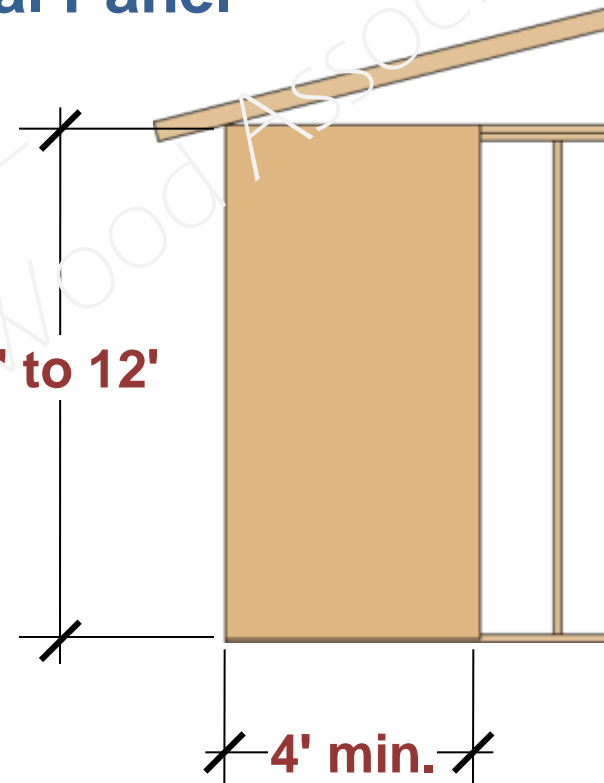
- Wood boards 3/4" (1" nominal) thick applied diagonally
- Studs spaced 24" max.



Bracing Basics: Intermittent Bracing

Method WSP – Wood Structural Panel

- 3/8" min. thickness
- Wood structural panel defined in R604



R602.10.2

Bracing Basics: Intermittent Bracing

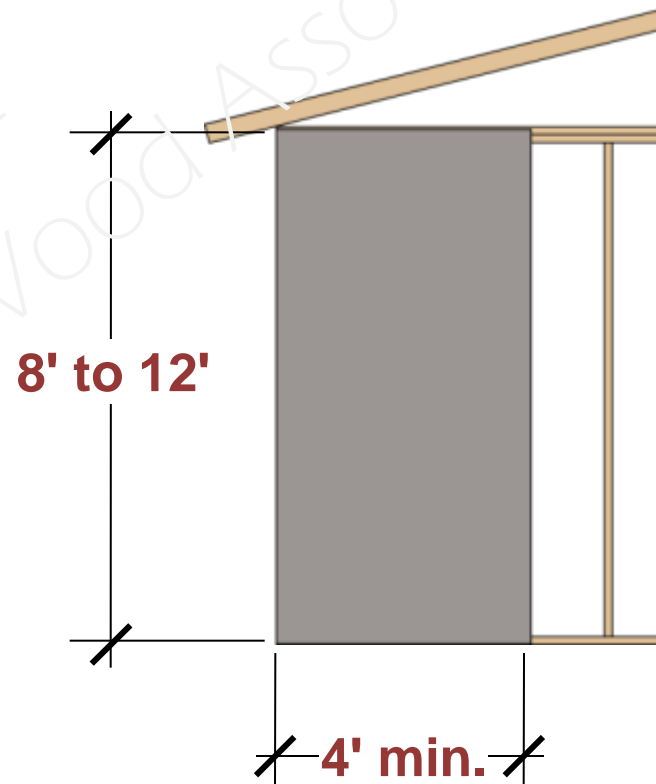
Method WSP – Wood Structural Panel



Bracing Basics: Intermittent Bracing

Method SFB – Structural Fiberboard Sheathing

- 1/2" or 25/32" thick
- Studs spaced 16" o.c. max.
- Must conform to ASTM C 208



Bracing Basics: Intermittent Bracing

Method GB – Gypsum Board

- 1/2" min. thick for studs spaced 24" o.c. max.
- 8' length for 1-sided
- 4' length for 2-sided



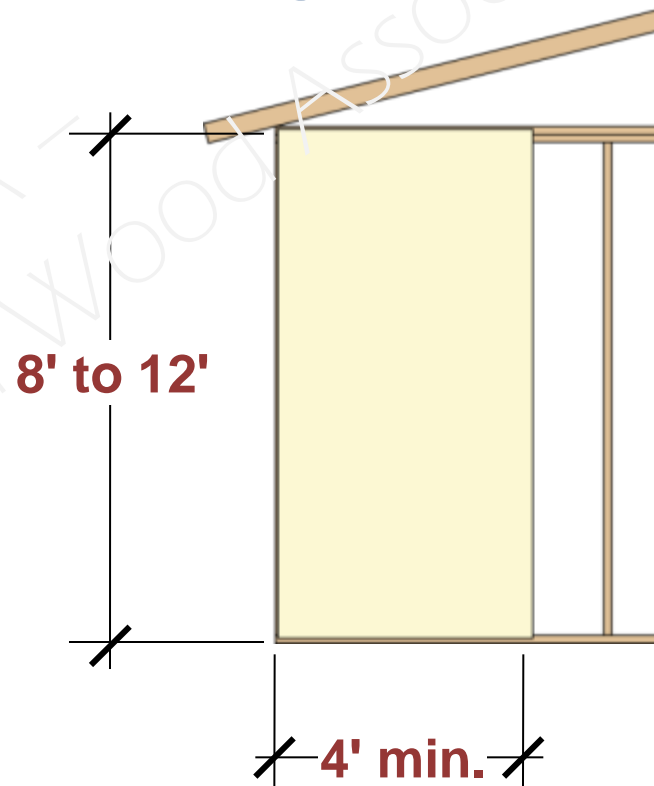
8' to 12'

8' min.

Bracing Basics: Intermittent Bracing

Method PBS – Particleboard Sheathing

Installed in accordance
with Tables R602.3(2) &
R602.3(4)



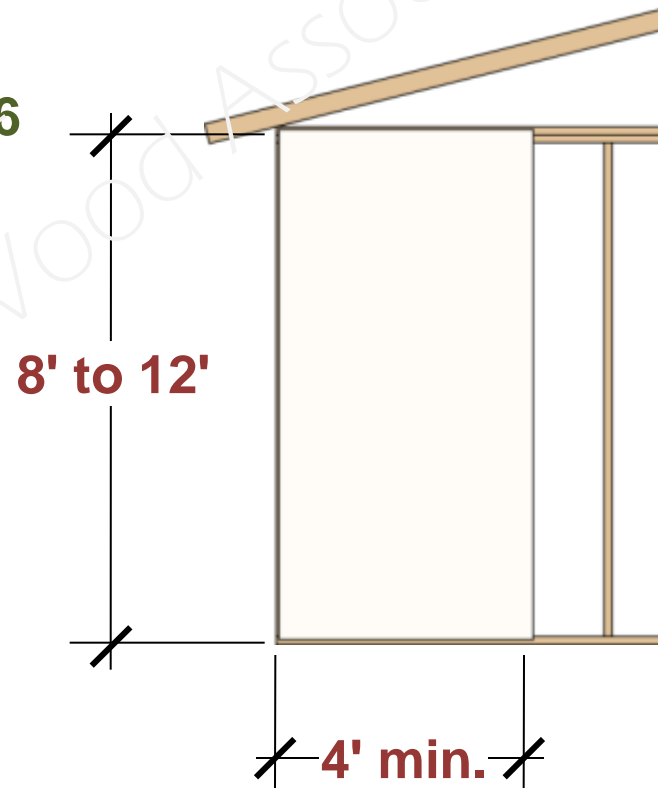
R602.10.2



Bracing Basics: Intermittent Bracing

Method PCP – Portland Cement Plaster

- On studs spaced 16" o.c. max.
- Installed in accordance with R703.6

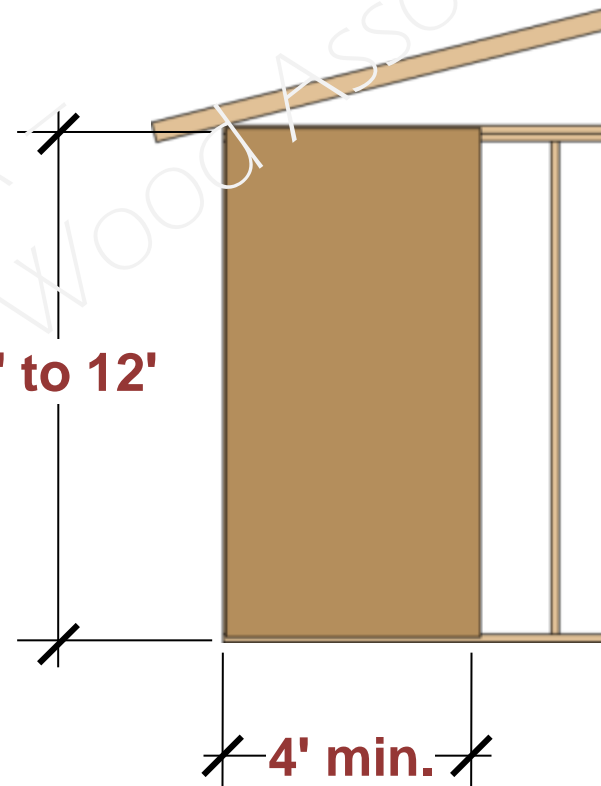


R602.10.2

Bracing Basics: Intermittent Bracing

Method HPS – Hardboard Panel Siding

Installed in accordance
with Table R703.4



R602.10.2

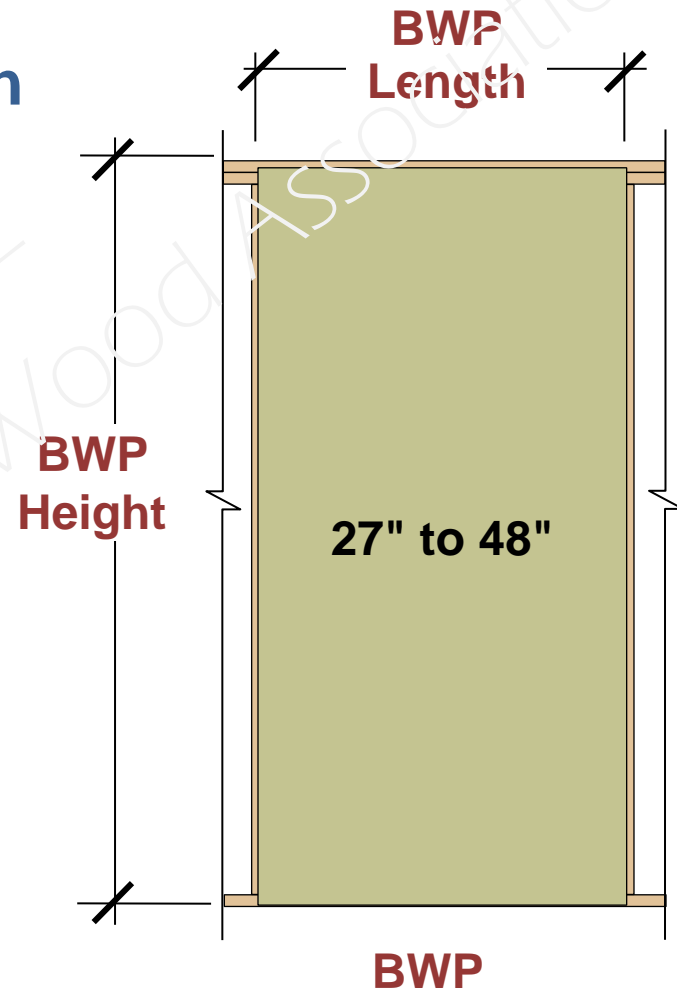


Bracing Basics: Intermittent Bracing

Minimum Braced Panel Length

Table R602.10.3 Effective length of braced panels less than 48"

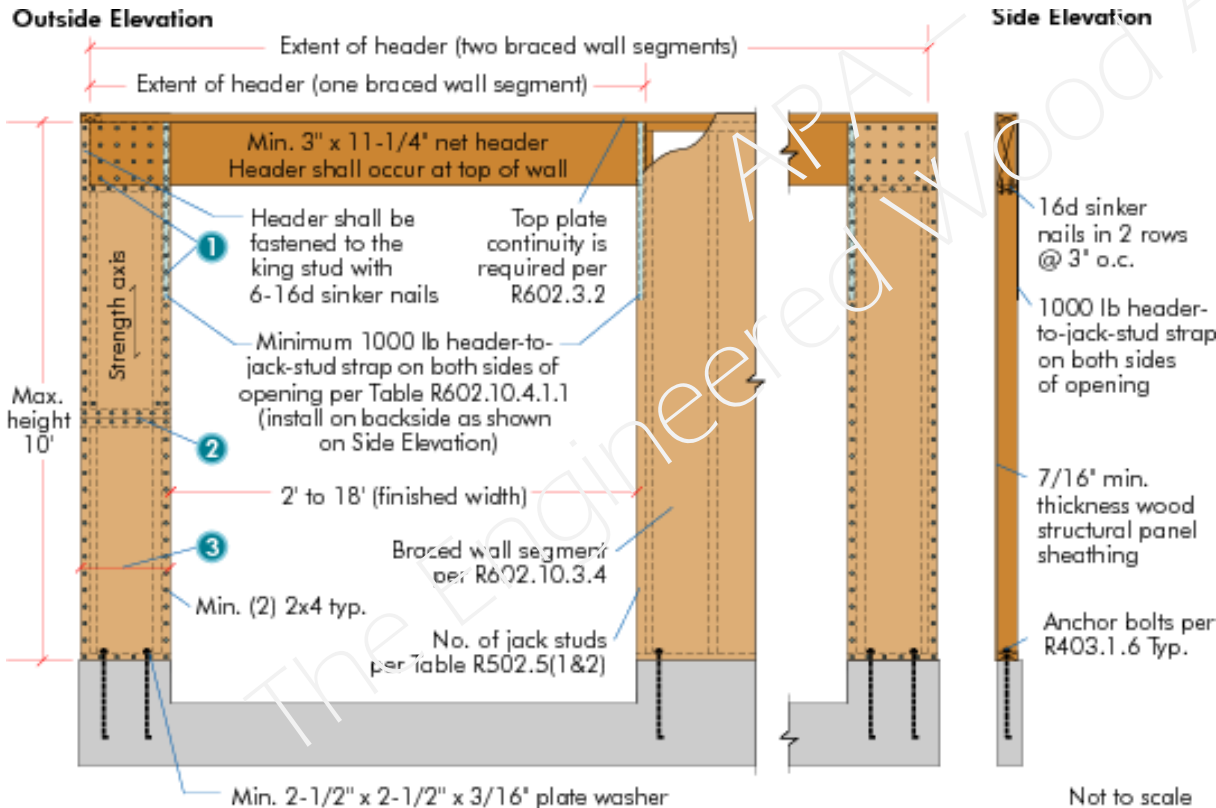
For Methods DWB, WSP, SFB, PBS, PCP, HPS			
Actual Length	Effective Length of BWP		
	8'	9'	10'
48"	48"	48"	48"
42"	36"	36"	N/A
36"	27"	N/A	N/A



Bracing Basics: Intermittent Bracing

Method PFG – Intermittent Portal Frame at Garage

- For use in SDC A-C only
- Length of the panel is multiplied by 1.5
- Minimum 24" length
- Header 6' min. to 18' max.



Bracing Basics: Intermittent Bracing

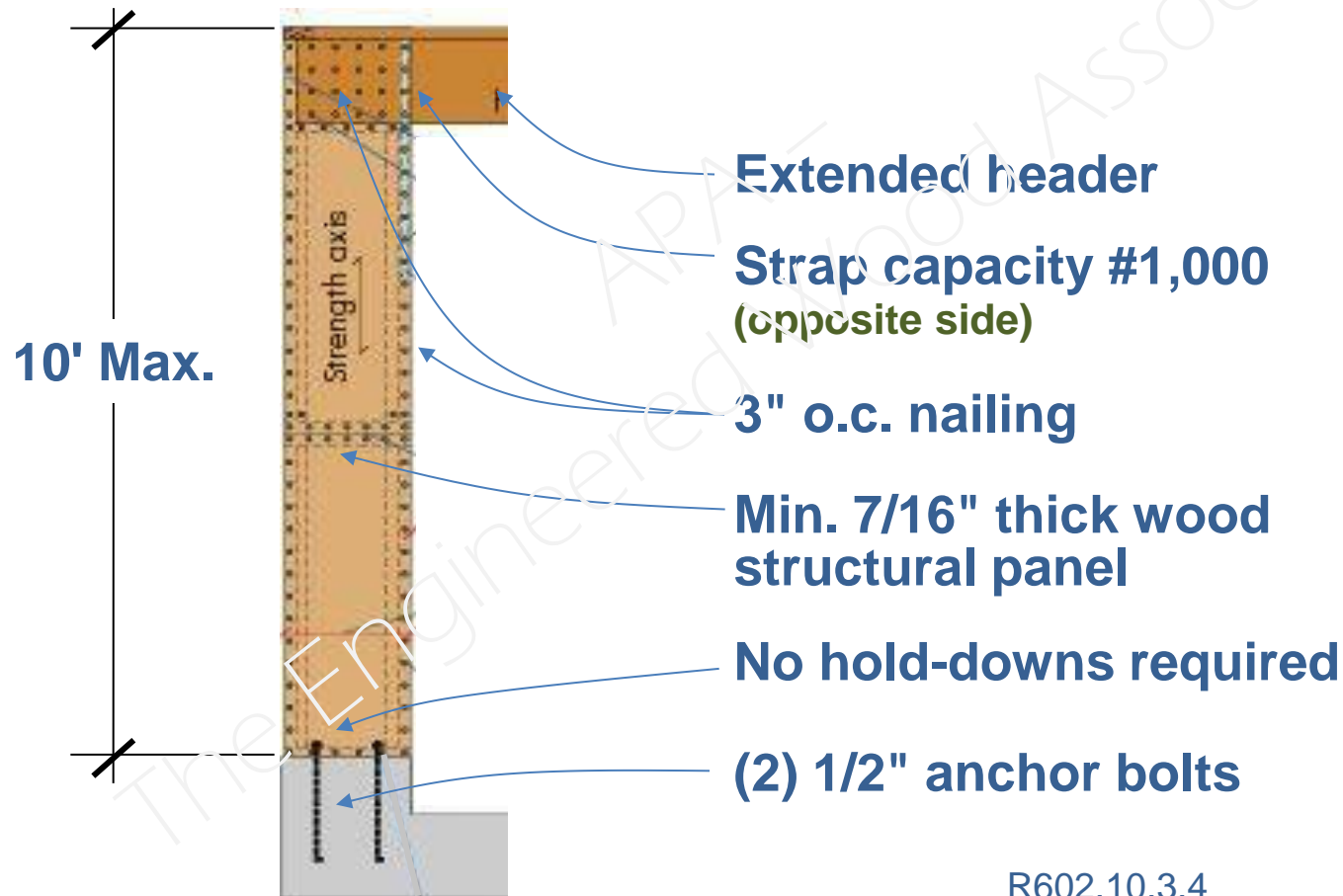
Method PFG – Intermittent Portal Frame at Garage

1 or 2-Story	
Height	Min. length
8'	24"
9'	27"
10'	30"

Limited to 10' height maximum
Including header height

Bracing Basics: Intermittent Bracing

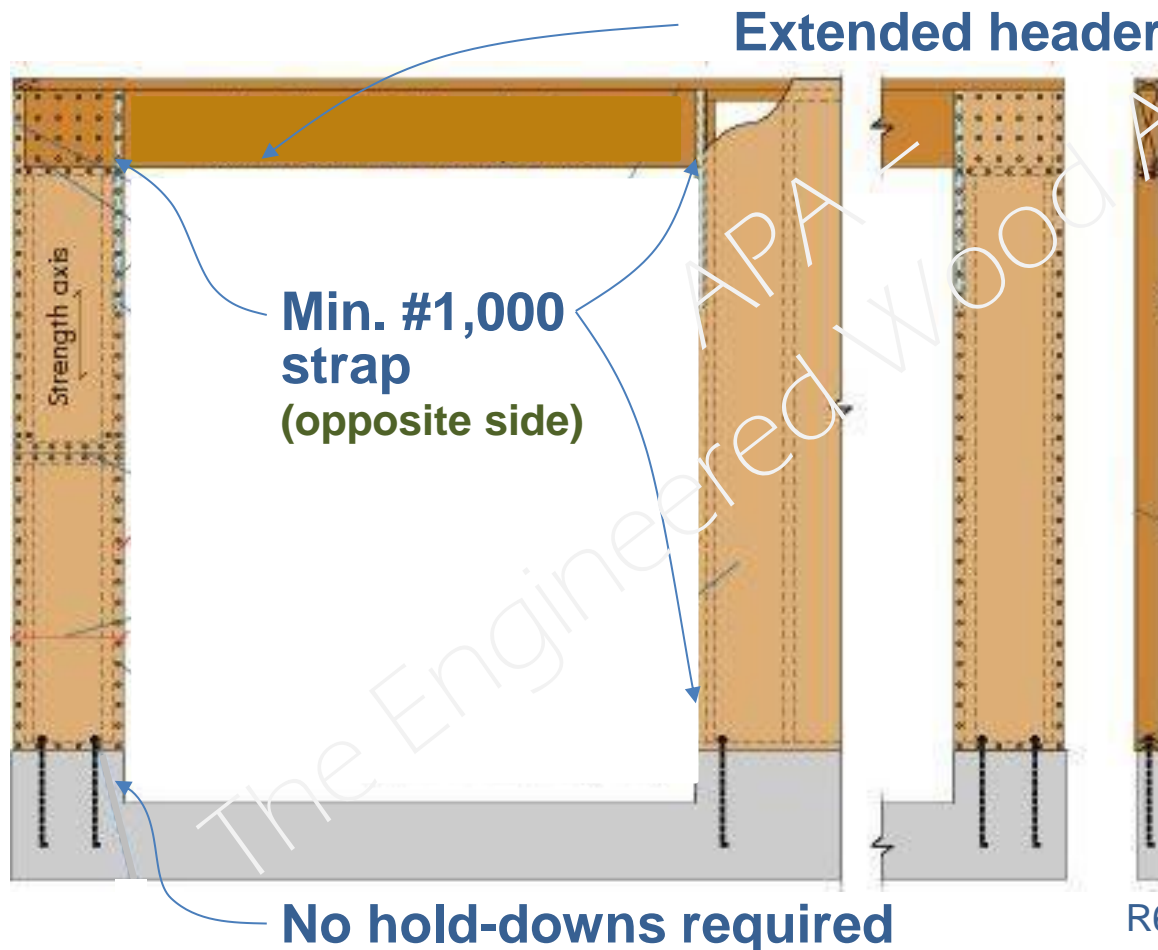
Method PFG – Intermittent Portal Frame at Garage



R602.10.3.4

Bracing Basics: Intermittent Bracing

Method PFG – Intermittent Portal Frame at Garage



R602.10.3.4

Bracing Basics: Intermittent Bracing

Other bracing methods per code report

- Prefabricated units
- Laminated Kraft-paper board
- Fiberboard in various thicknesses

Bracing Basics: Intermittent Bracing

Bracing Per Code Report



Bracing Topics

Introduction	Getting Started	Bracing Basics	Connections	Other Topics
		<p>Braced Panel Construction</p> <p>Intermittent Bracing Methods</p> <p><u>Continuous Bracing Methods</u></p> <p>Mixing Bracing Methods</p> <p>BWP Placement</p> <p>BWL Spacing</p> <p>Required Bracing Length</p>		

The Engineered Wood Association

Bracing Basics: Continuous Method

Main Concepts

- Allows for narrow BWP's without hold-downs
- BWL's must be fully sheathed with wood structural panel or structural fiberboard sheathing (continuously sheathed)
- Continuous sheathing with WSP is described in R602.10.4
- Continuous sheathing with SFB is described in R602.10.5



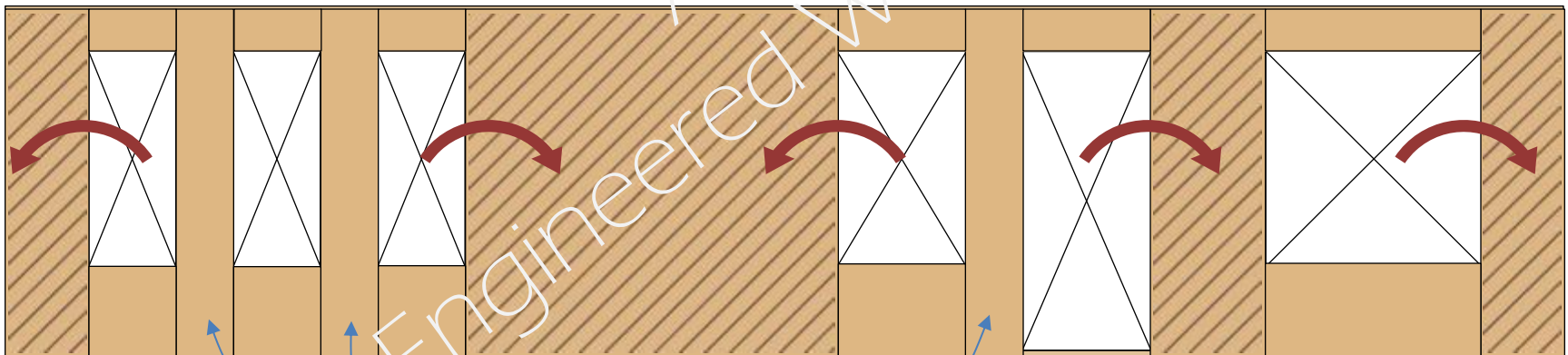
R602.10.4 & R602.10.5



Bracing Basics: Continuous Method

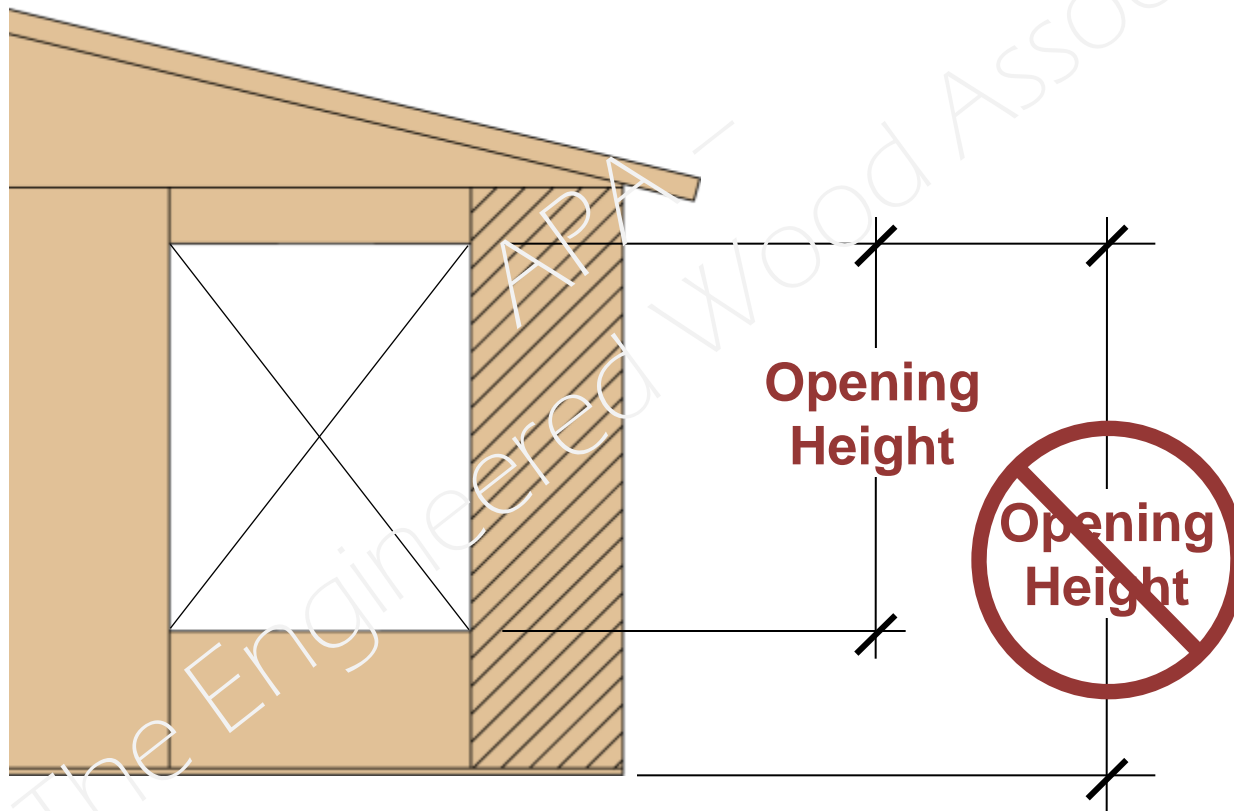
Sheathing Requirements:

1. Sheath full height areas
2. Sheath above and below openings
3. Adjacent openings determine minimum BWP length



Too Narrow

Bracing Basics: Continuous Method



R602.10.4 & R602.10.5

Bracing Basics: Continuous Method

Aspect Ratio:

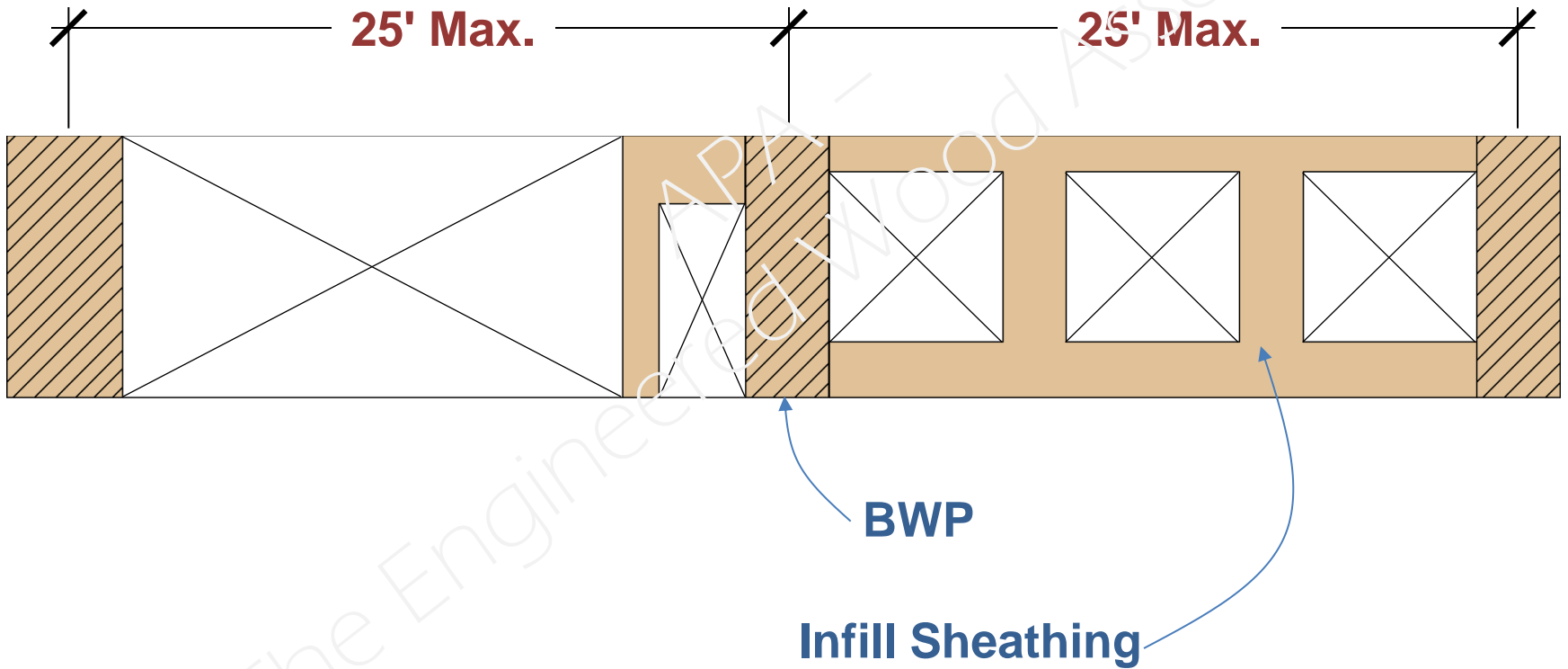
The ratio of the height of a bracing unit to its length.

$$\text{Aspect Ratio} = \frac{\text{Height}}{\text{Length}}$$

$$\text{Aspect Ratio} = \frac{8'}{4'} = 2$$



Bracing Basics: Continuous Method



R602.10.4 & R602.10.5

Bracing Basics: Continuous Method

Method CS-WSP

Continuous Sheathing with Wood Structural Panel

- Area above and below openings fully sheathed
- Min 3/8" wood structural panel sheathing

Method CS-SFB

Continuous Sheathing with Structural Fiberboard Sheathing

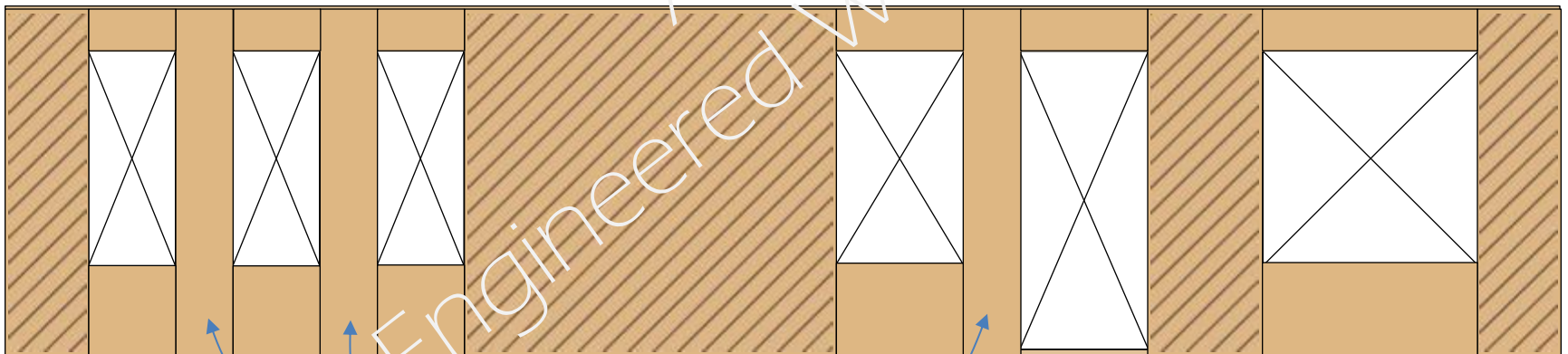
- Area above and below openings fully sheathed
- Min 1/2" structural fiberboard sheathing

Bracing Basics: Continuous Method

Method CS-WSP

Full-height sheathed wall segments having a width equal or greater than Table R602.10.4.2 are counted toward the total bracing length.

Wall minimum length is based on wall height and height of the adjacent clear opening.



Too Narrow

R602.10.4.2



Bracing Basics: Continuous Method

Method CS-WSP Braced Panel Minimum Length

Minimum Length of BWP (inches)			Maximum Opening Next to the BWP (% of wall height)
8-ft wall	9-ft wall	10-ft wall	
48	54	60	100%
32	36	40	85%
24	27	30	67%

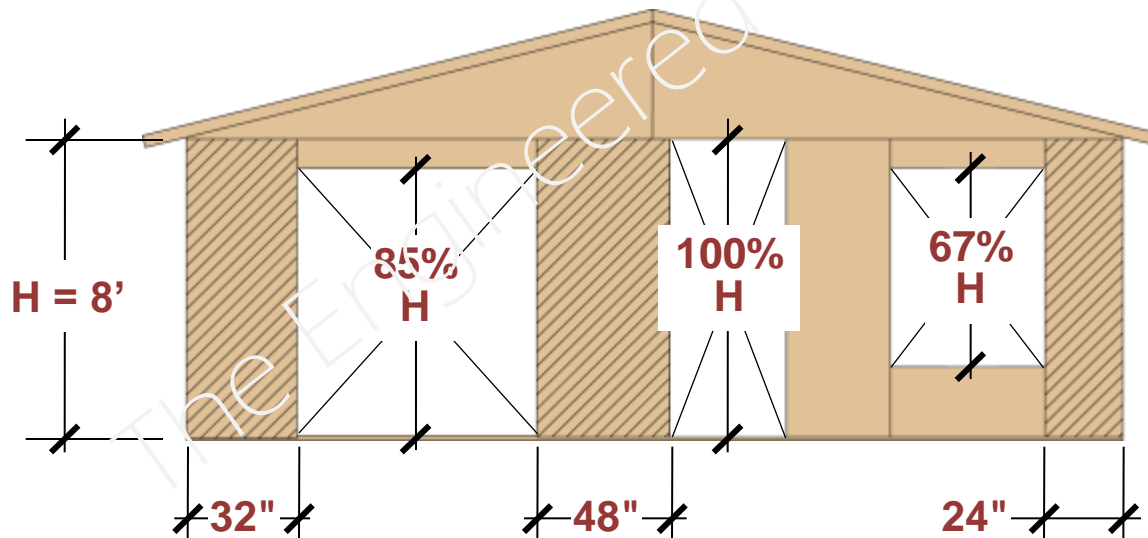


Table R602.10.5.2

Bracing Basics: Continuous Method

Method CS-WSP

Braced Panel Length Requirements for Continuously Sheathed Wall Lines (in)

Method	Adjacent Clear Opening Height (ft)	Wall Height (ft)				
		8	9	10	11	12
CS-WSP	64	24	27	30	33	36
	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	

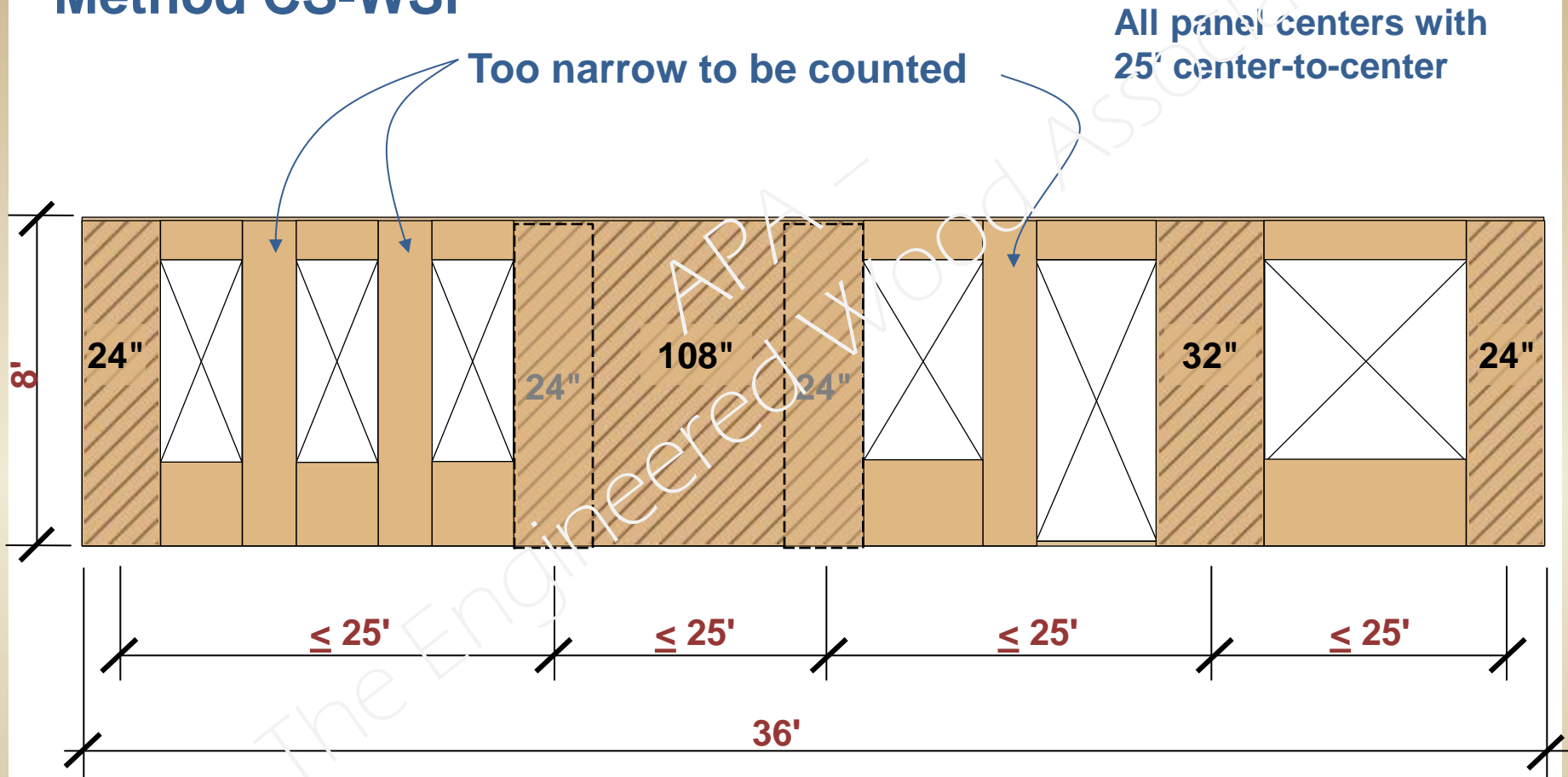
Method	Adjacent Clear Opening Height (ft)	Wall Height (ft)				
		8	9	10	11	12
CS-WSP	124				56	51
	128				61	54
	132				66	58
	136					62
	140					66
	144					72
CS-G	a	24	27	30	33	36
CS-PF	≤120	16	18	20	22	24

- a. Garage opening adjacent to method CS-G panel shall have header. Max opening height includes header height.

Table R602.10.4.2

Bracing Basics: Continuous Method

Method CS-WSP



R602.10.4.2 & Table R602.10.4.2



Bracing Basics: Continuous Method

Method CS-G Wood structural panel adjacent to garage opening

- Full-height sheathed wall segments to either side of garage openings
- Roof covering dead loads of 3 psf or less
- Applied to one wall only
- 4:1 aspect ratio

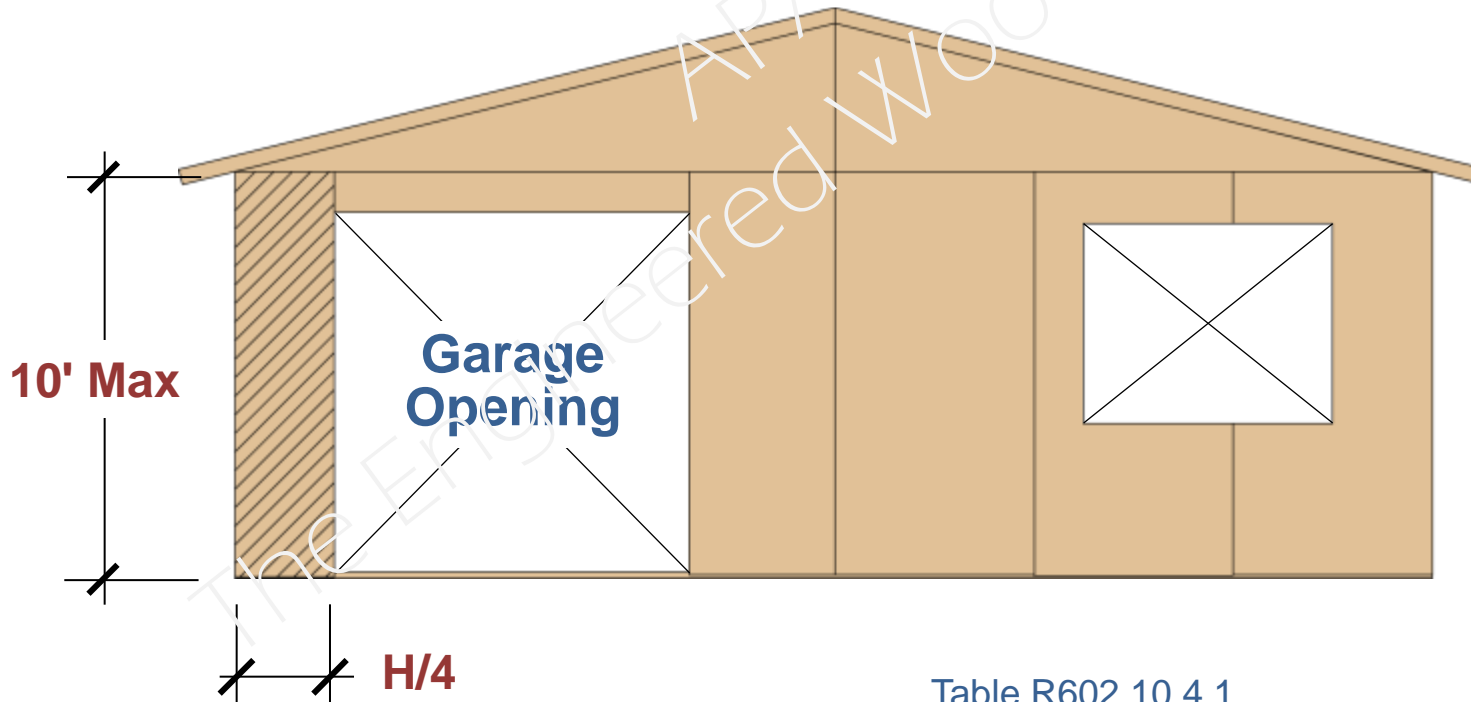


Table R602.10.4.1

Bracing Basics: Continuous Method

Method CS-G



Garage only, supporting roof with 3 psf covering.

Standard Header

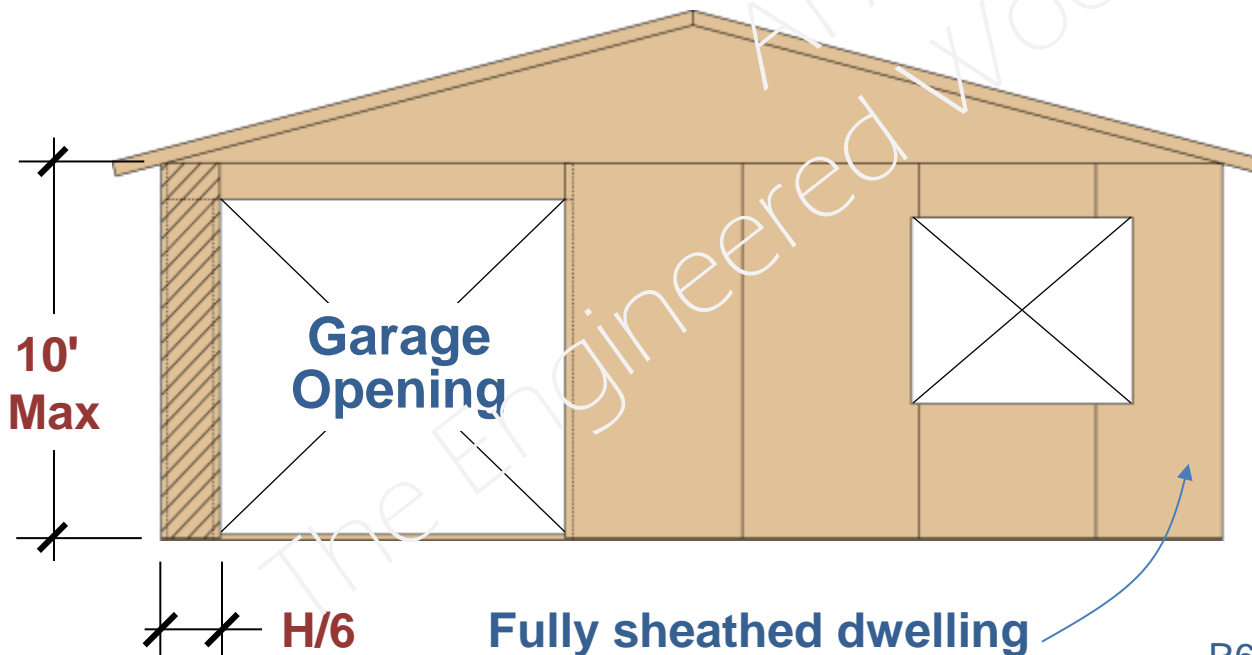
4:1 Aspect Ratio (24" min.)

Table R602.10.4.1

Bracing Basics: Continuous Method

Method CS-PF Continuous portal frame

Walls on either or both sides of openings in garage may have wall segment with a maximum 6:1 height-to-length ratio.



R602.10.4.1.1

Bracing Basics: Continuous Method

Method CS-PF



FULLY SHEATHED
Garage only, story
above permitted.

6:1 Aspect Ratio (16" min.)

R602.10.4.1.1



Bracing Basics: Continuous Method

Method CS-PF

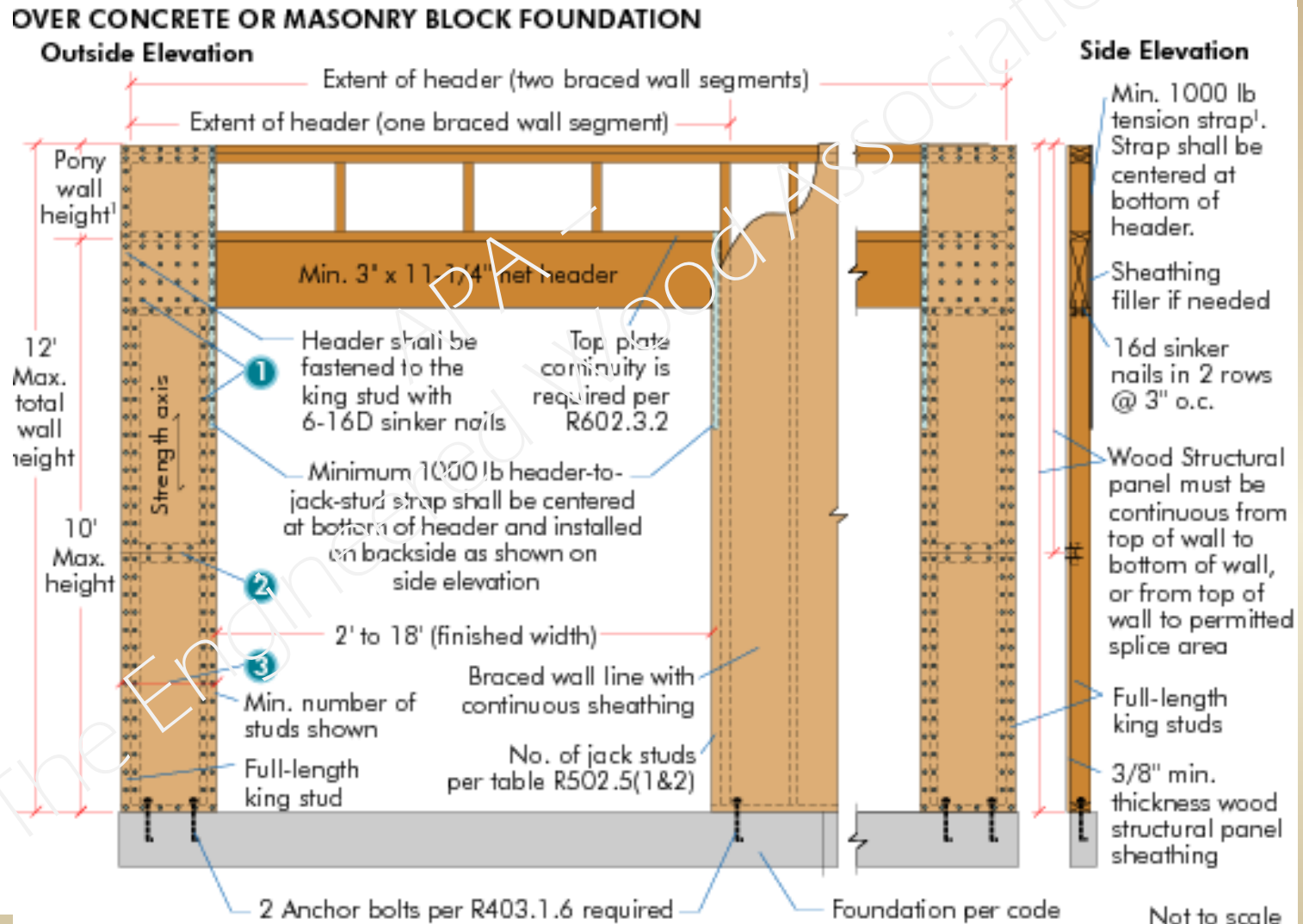


Figure R602.10.4.1.1

APA Portal Frame Test



Bracing Basics: Continuous Method

Method CS-PF

Table R602.10.4.1.1: Tension Strap Capacity Required for Resisting Wind Pressures Perpendicular to 6:1 Aspect Ratio Walls

MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (feet)	BASIC WIND SPEED (mph)						
				85	90	100	85	90	100	
				Exposure B			Exposure C			
				Tension strap capacity required (lbf)						
2 × 4 No. 2 Grade	0	10	18	1000	1000	1000	1000	1000	1000	
			1	9	1000	1000	1000	1000	1000	1275
				16	1000	1000	1750	1800	2325	3500
	2	10	18	1000	1200	2100	2175	2725	DR	
			9	16	1525	2025	3125	3200	3900	DR
				18	1875	2400	3575	3700	DR	DR
	2	12	9	1000	1200	2075	2125	2750	4000	
			16	2600	3200	DR	DR	DR	DR	
			18	3175	3850	DR	DR	DR	DR	

Bracing Basics: Continuous Method

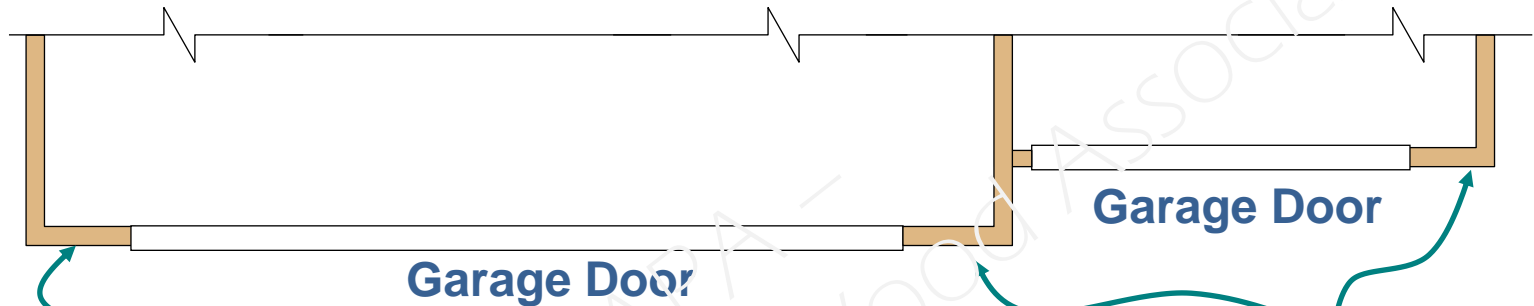
Method CS-PF

Table R602.10.4.1.1 cont.: Tension Strap Capacity Required for Resisting Wind Pressures Perpendicular to 6:1 Aspect Ratio Walls

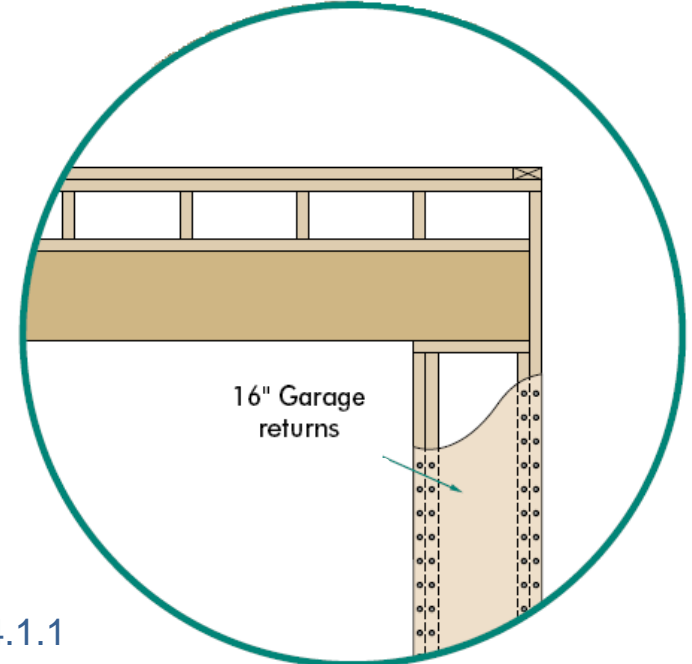
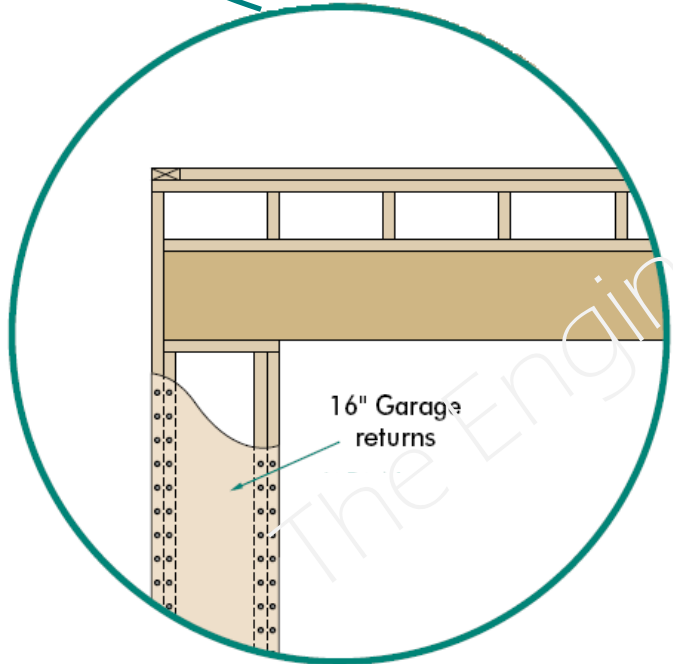
MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (feet)	BASIC WIND SPEED (mph)					
				85	90	100	85	90	100
				Exposure B			Exposure C		
				Tension strap capacity required (lbf)					
2 × 4 No. 2 Grade	4	12	9	1775	2350	3500	3550	DR	DR
			16	4175	DR	DR	DR	DR	DR
2 × 6 Stud Grade	2	12	9	1000	1000	1325	1375	1750	2550
			16	1650	2050	2925	3000	3550	DR
			18	2025	2450	3425	3500	4100	DR
	4	12	9	1125	1500	2225	2275	2775	3800
			16	2650	3150	DR	DR	DR	DR
			18	3125	3675	DR	DR	DR	DR

Bracing Basics: Continuous Method

Method CS-PF



Plan View



R602.10.4.1.1

Bracing Basics: Continuous Method



CS-G

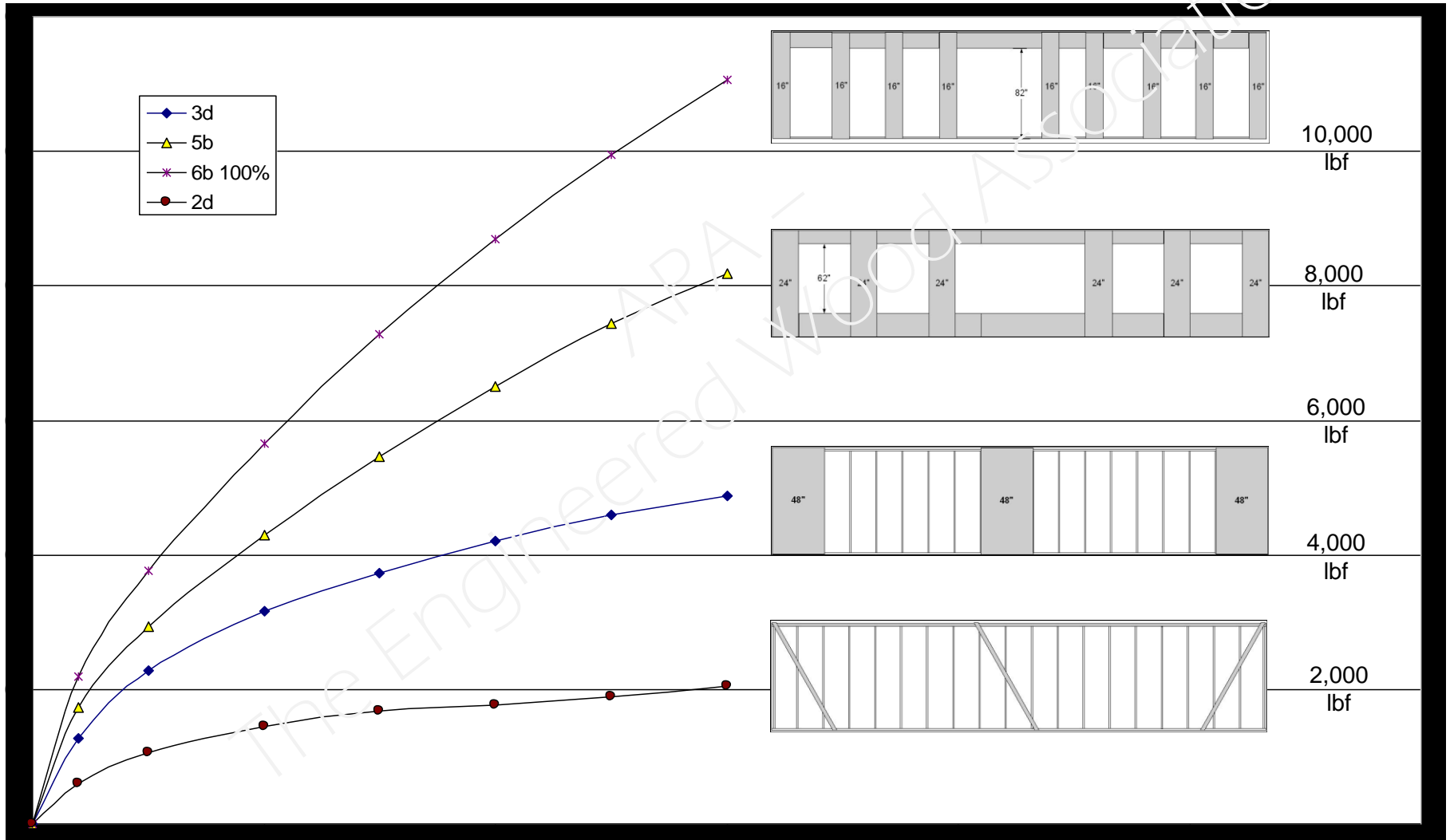
CS-PF

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APA Whole House Bracing Test



Bracing Basics: Continuous Method



Bracing Basics: Continuous Method

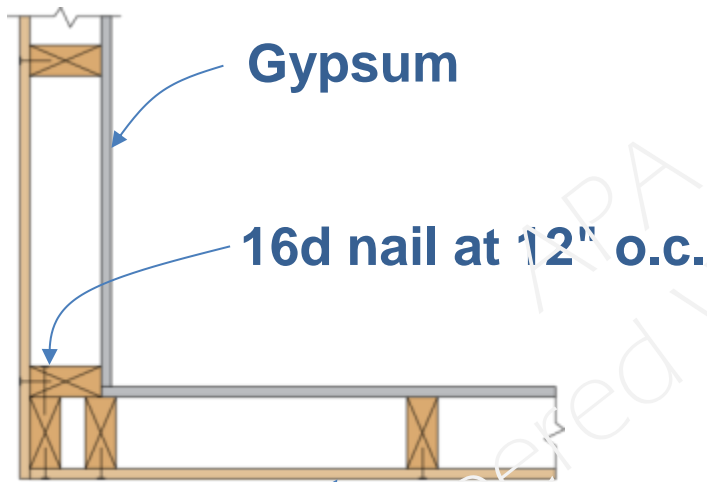
Method CS-SFB

Continuous Sheathing with Structural Fiberboard

- Wall minimum length based on wall height and height of adjacent clear opening
- Maximum wall height = 10'
- Length requirements for braced wall panels in Table R602.10.5.2

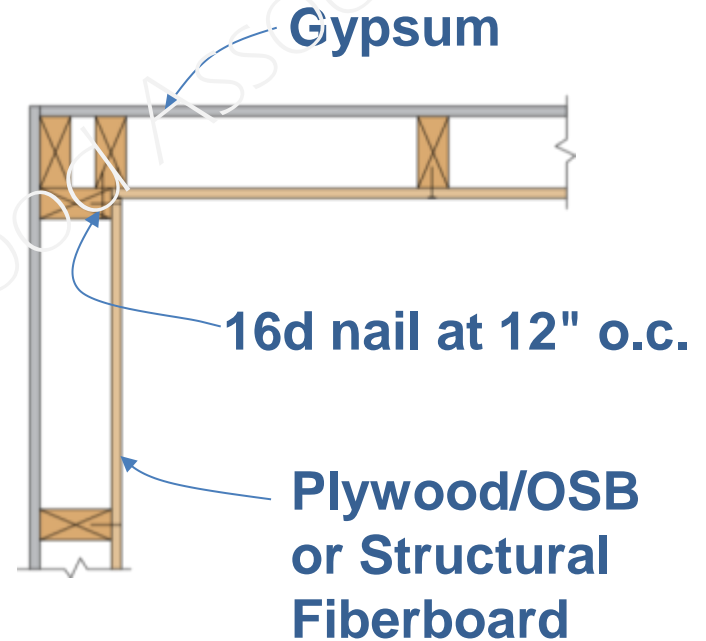
Bracing Basics: Continuous Method

Continuous Sheathing Corner Requirements



Plywood/OSB or Structural
Fiberboard

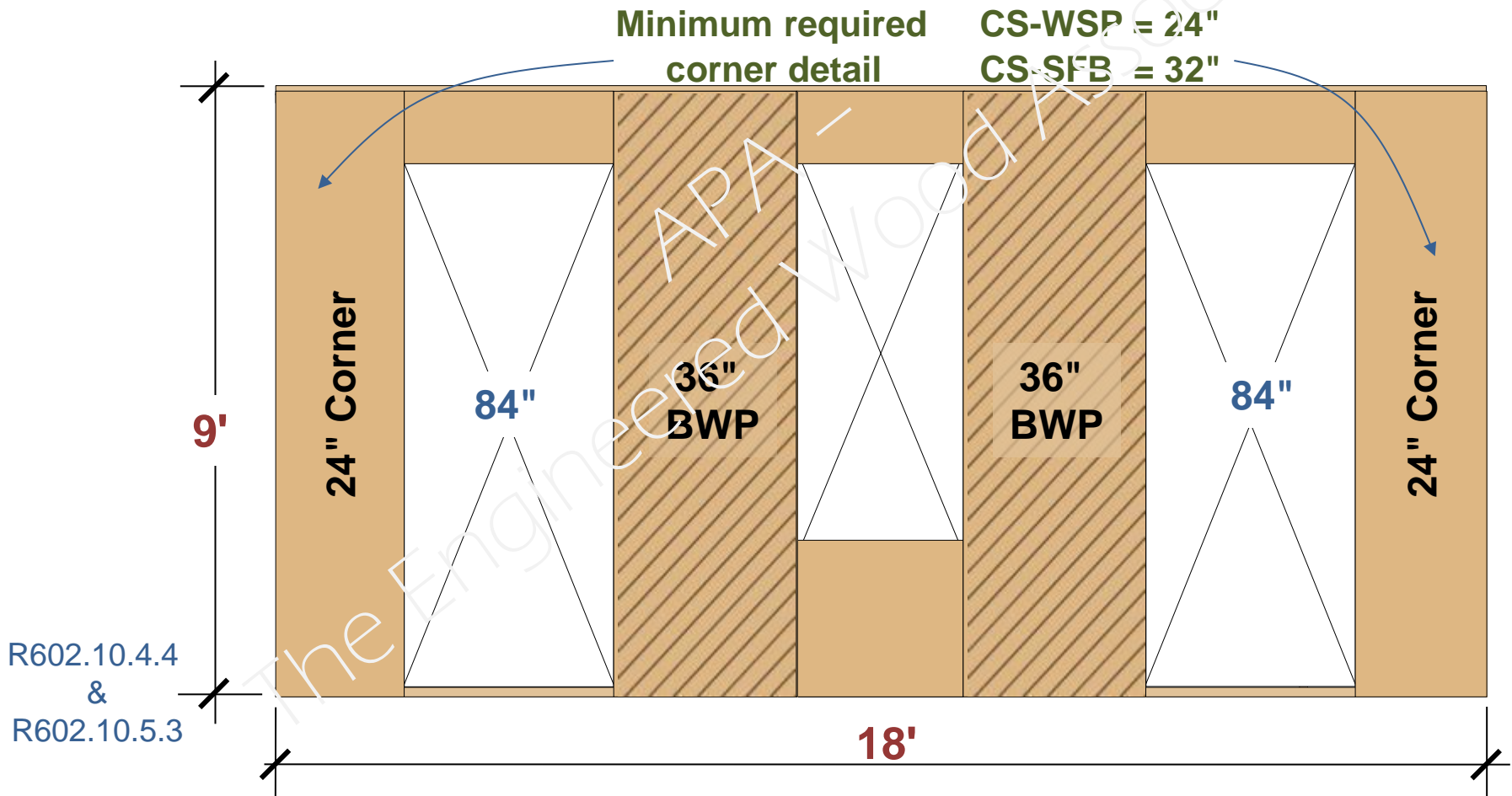
Outside Corner Detail



Inside Corner Detail

Bracing Basics: Continuous Method

Continuous Sheathing Corner Requirements



Bracing Topics

Introduction	Getting Started	Bracing Basics	Connections	Other Topics
		<p>Braced Panel Construction</p> <p>Intermittent Bracing Methods</p> <p>Continuous Bracing Methods</p> <p><u>Mixing Bracing Methods</u></p> <p>BWP Placement</p> <p>BWL Spacing</p> <p>Required Bracing Length</p>		

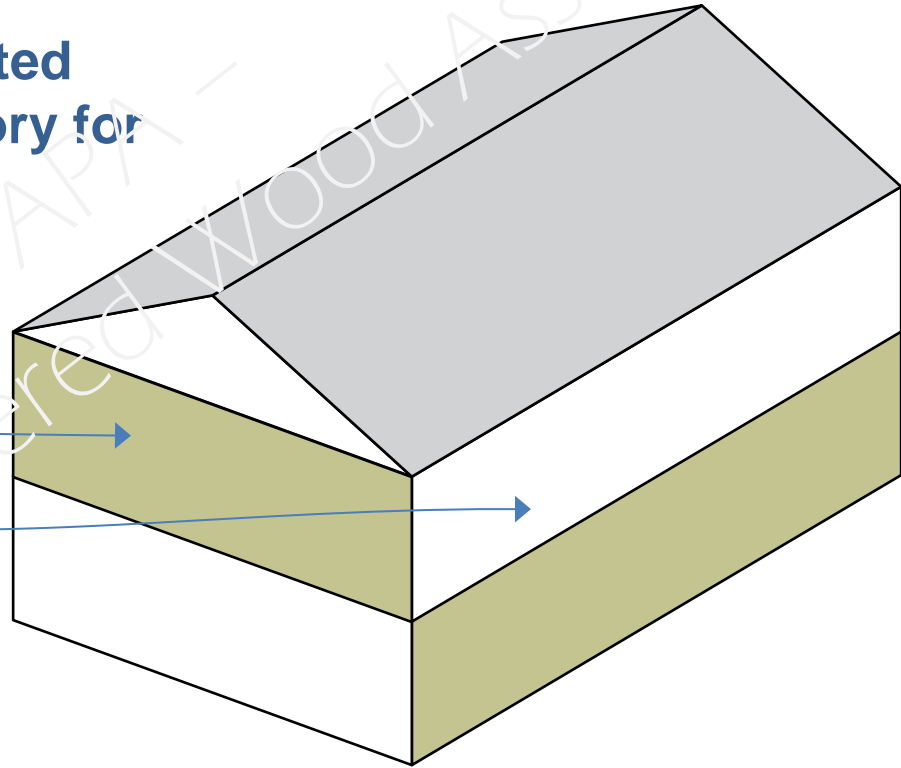
The Engineered Wood Association

Bracing Basics: Mixing Bracing Methods

R602.10.1.1.2 Braced Wall Panels

BWP method variation permitted from BWL to BWL within a story for intermittent and continuous sheathing

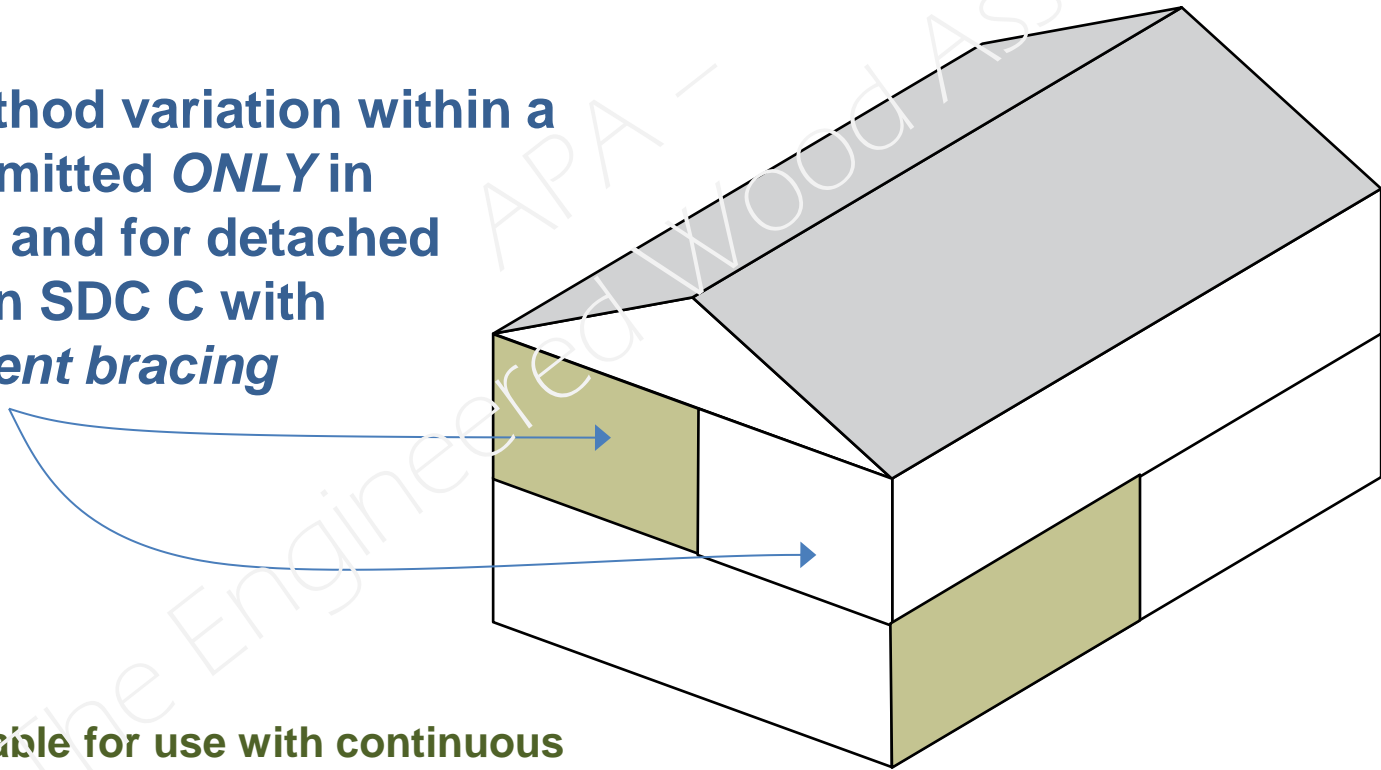
For continuous sheathing, this variation may only be used in SDC A-C with winds ≤ 100 mph



Bracing Basics: Mixing Bracing Methods

R602.10.1.1.3 Braced Wall Panels

**BWP method variation within a
BWL permitted *ONLY* in
SDC A-B and for detached
houses in SDC C with
*intermittent bracing***



**Not applicable for use with continuous
sheathing or dwellings in SDC D₀-D₂**

Bracing Topics

Introduction	Getting Started	Bracing Basics	Connections	Other Topics
		<p>Braced Panel Construction</p> <p>Intermittent Bracing Methods</p> <p>Continuous Bracing Methods</p> <p>Mixing Bracing Methods</p> <p><u>BWP Placement</u></p> <p>BWL Spacing</p> <p>Required Bracing Length</p>		

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Bracing Basics: BWP Placement

Overview

Wall Bracing Parameter	Intermittent		CS-WSP		CS-SFB	
	Wind & SDC A-C	SDC D ₀ -D ₂	Wind & SDC A-C	SDC D ₀ -D ₂	Wind & SDC A-C	SDC D ₀ -D ₂
Panel end distance	12.5' Combined	0' or 8' (a)	12.5'	8'	12.5'	Not Permitted
Corner return length	Not required		24" Min. (b)		32" Min. (b)	

(a) 8' with 24" panel at corner or 1,800 lb hold down per R602.10.1.4.1, exception items 1 & 2.

(b) In lieu of a corner return, an 800 lb hold-down may be fastened to the side of the BWP closest to the corner per R602.10.5.3, exception item 2.

Bracing Basics: BWP Placement

R602.10.1.4 Braced Wall Panel Location (Intermittent Bracing Methods)

Placement Requirements

- BWP to begin no more than "X" feet from the end of a BWL.
- Total combined distance of the end panels to each wall end shall not be more than "X" feet.
- BWP located not more than 25' o.c.
- BWP minimum length in accordance with its method.

Wind

"X" = 12.5'

Combined distance for
both ends of wall line

Seismic

"X" = 0'

Method WSP only:

1. 8' w/1,800# hold-down
2. 24" panel at corner

Permitted at both ends

Bracing Basics: BWP Placement

R602.10.4.4 Braced Wall Panel Location

Continuous Sheathing with Wood Structural Panel

Methods CS-WSP, CS-G, CS-PF

Placement Requirements

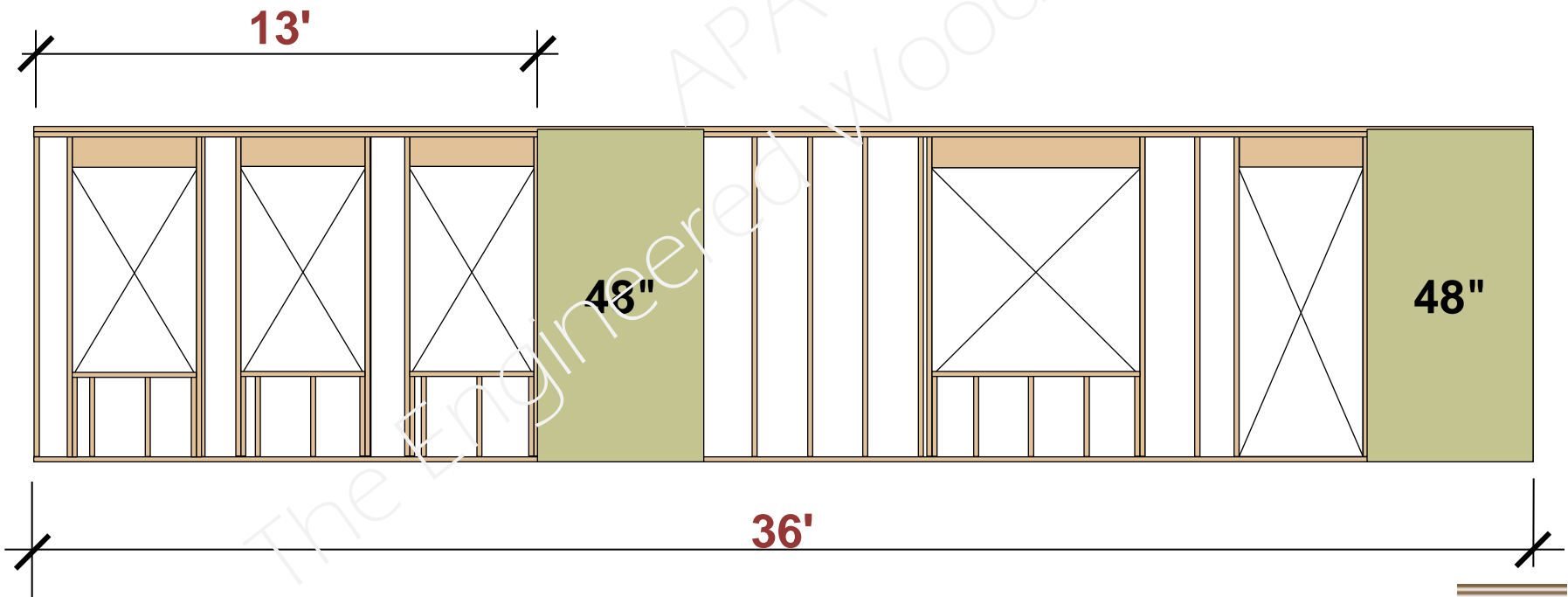
- BWPs to begin at each end of a BWL.
- BWP located not more than 25' o.c.
- A minimum 24" corner return at each end of the braced wall line.
 - In lieu of a corner return, an 800 lb hold-down may be fastened to the corner stud.

Bracing Basics: BWP Placement

Does this meet code?

- No, BWP required to begin no more than 12'-6" from the end of the wall.

Wind	
<input checked="" type="checkbox"/>	25' Centers
<input type="checkbox"/>	"X" End
<input checked="" type="checkbox"/>	BWP Width

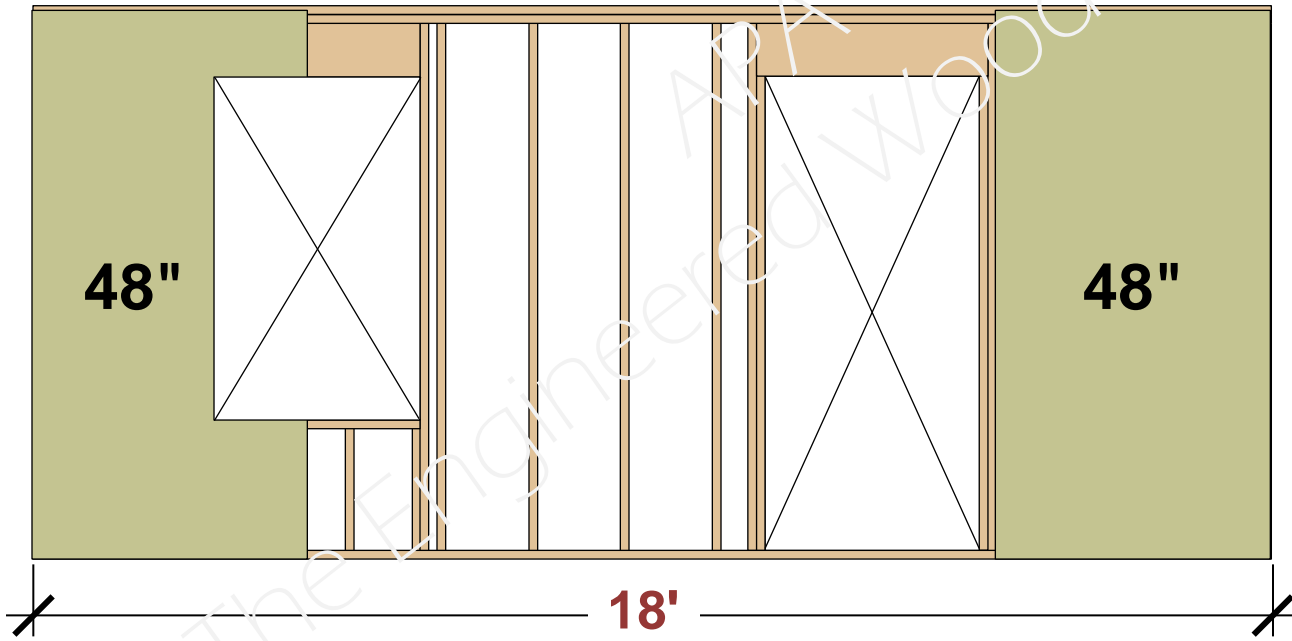


Bracing Basics: BWP Placement

Does this meet code?

- No, width requirement not met.

Wind & Seismic	
<input checked="" type="checkbox"/>	25' Centers
<input checked="" type="checkbox"/>	"X" End
<input checked="" type="checkbox"/>	BWP Width



Bracing Basics: BWP Placement

Does this meet code?

Wind

- ✓ 25' Centers
- ✓ "X" End
- ✓ BWP Width

11'

4'

4'

R602.10.1.4

Bracing Basics: BWP Placement

How many BWL's?

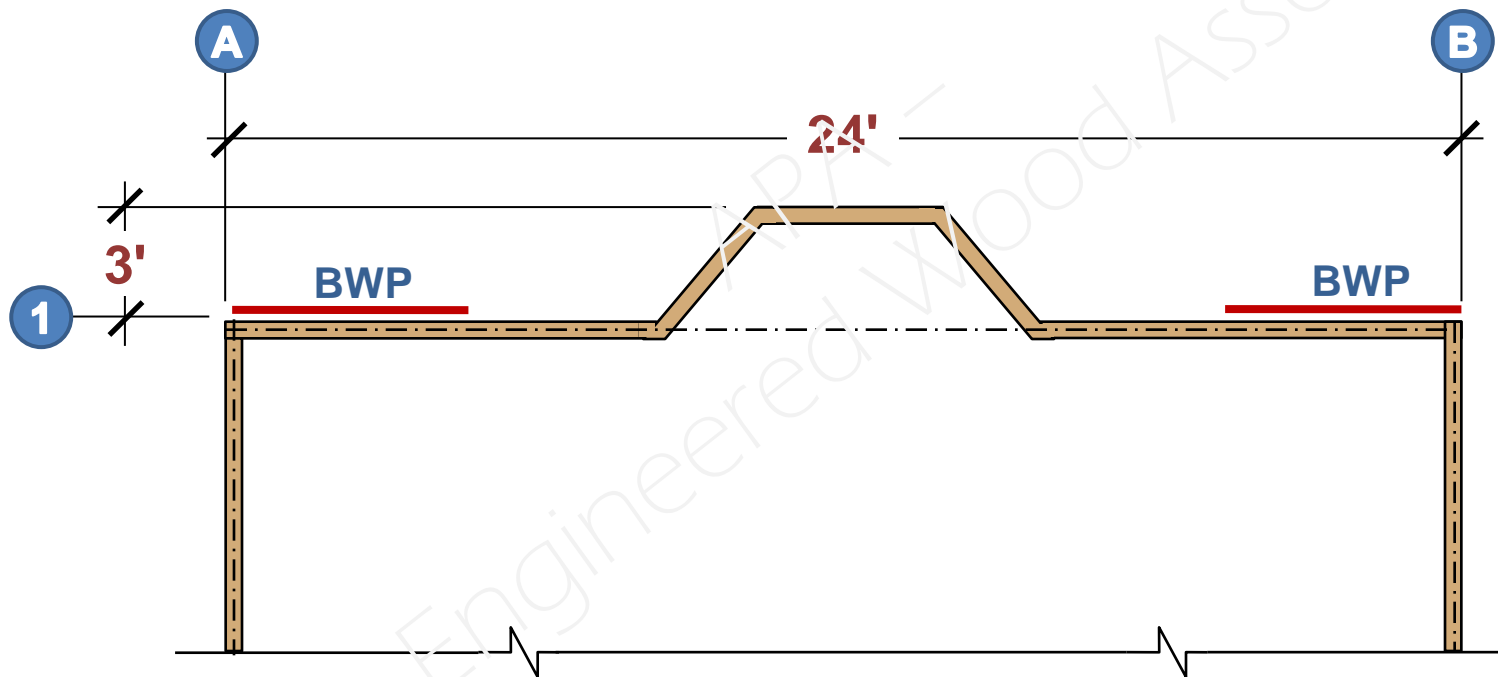


Bracing Basics: BWP Placement

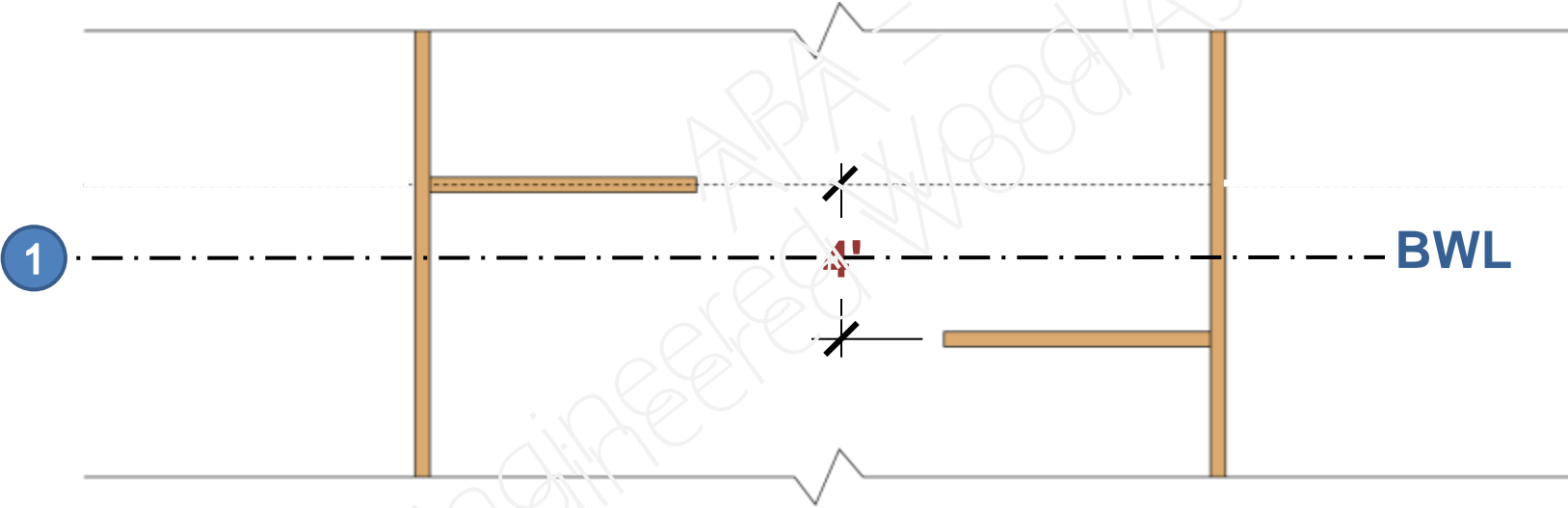
Offset Limitations

- BWP that are counted as part of a BWL must be in line.
- Offsets out-of-plane up to 4' shall be permitted such that the total out-to-out offset is not more than 8 feet.

Bracing Basics: BWP Placement



Bracing Basics: BWP Placement

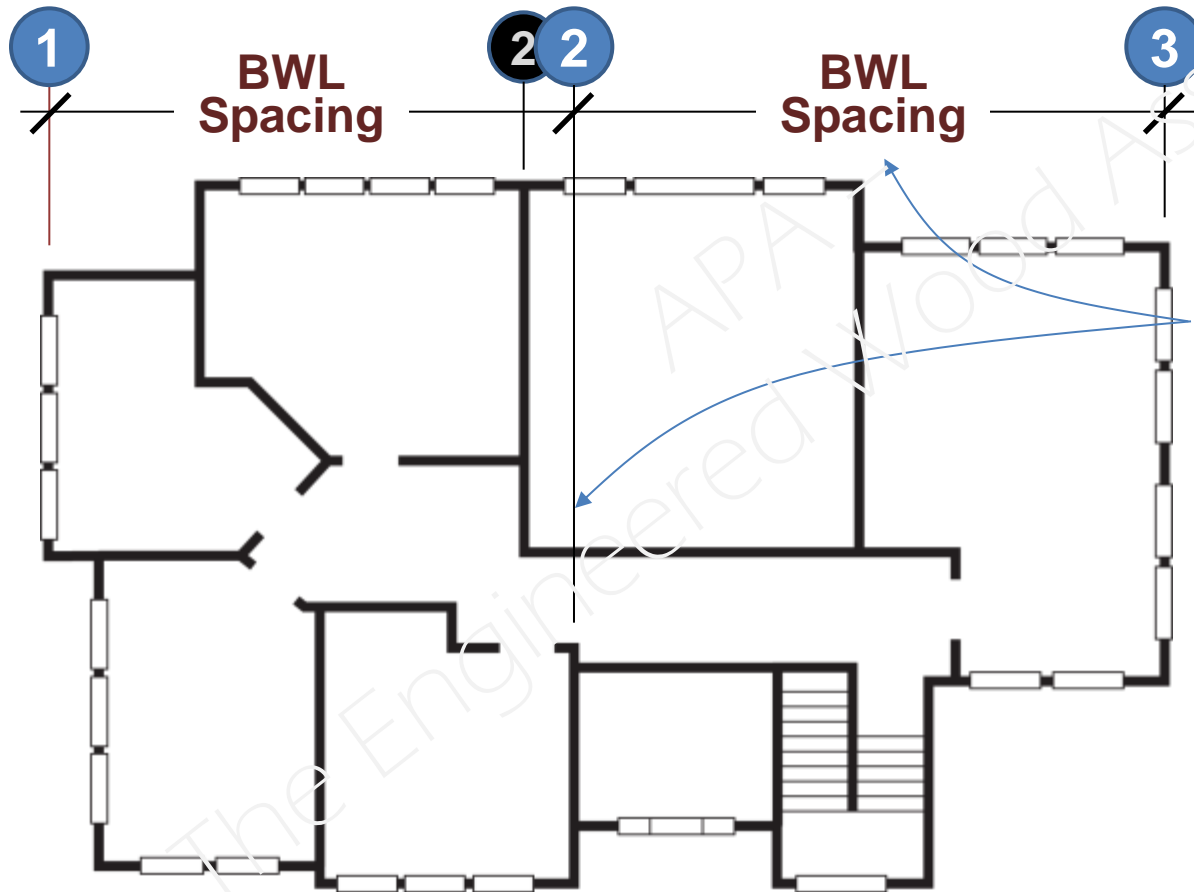


Bracing Basics: BWP Placement

How many BWL's?



Bracing Basics: BWP Placement



Locating BWL 2 here makes distance between BWL's less.

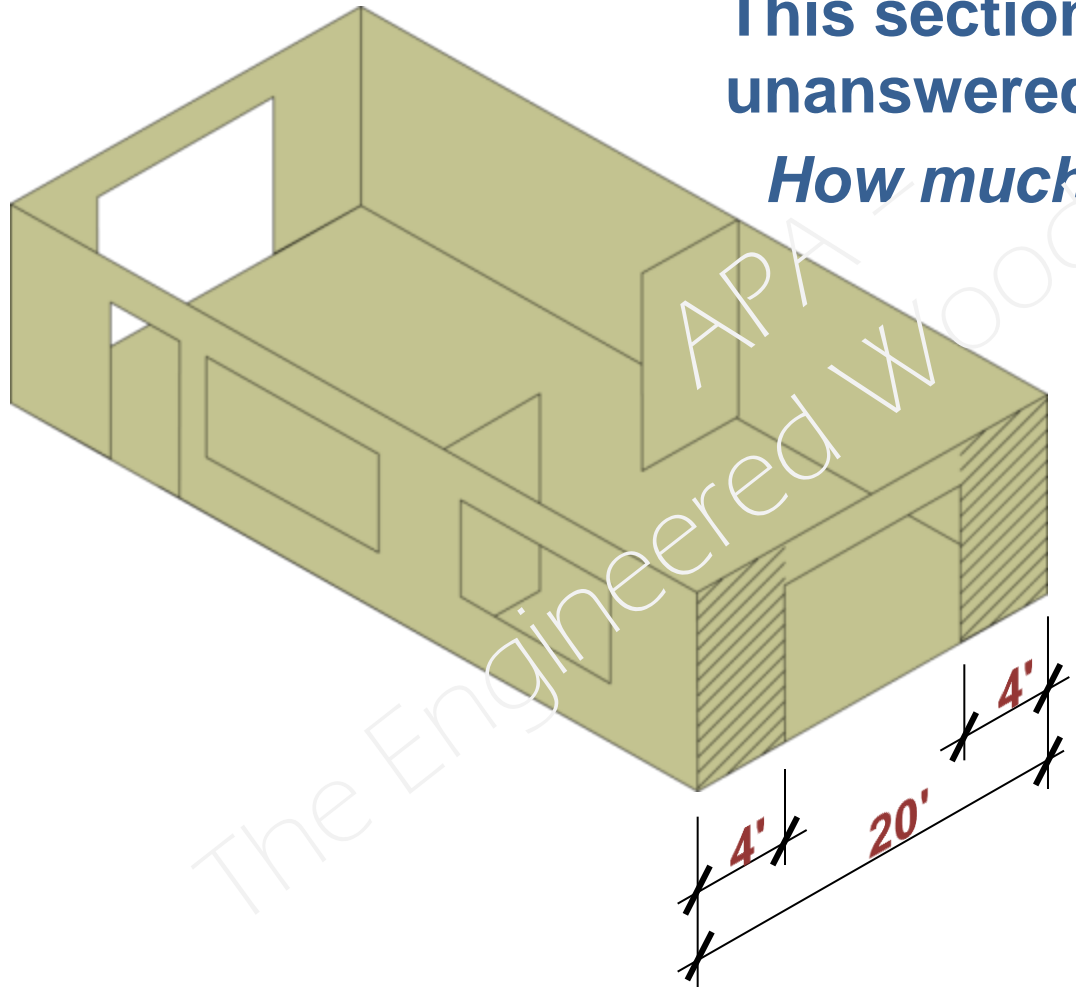
Bracing Topics

Introduction	Getting Started	Bracing Basics	Connections	Other Topics
		<p>Braced Panel Construction</p> <p>Intermittent Bracing Methods</p> <p>Continuous Bracing Methods</p> <p>Mixing Bracing Methods</p> <p>BWP Placement</p> <p>BWL Spacing</p> <p><u>Required Bracing Length</u></p>		

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Bracing Basics: Required Bracing Length

This section will answer the yet unanswered question:
How much bracing is needed?



Bracing Basics: Required Bracing Length

Bracing Length Tables

2009 – Two bracing length tables

- Wind Table R602.10.1.2(1)
- Seismic Table R602.10.1.2(2)

Required bracing length is the maximum of the two tables' bracing length x all adjustment factors

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



Bracing Basics: Required Bracing Length

Bracing Requirements Based on Wind Speed

Wind Bracing Table based on these assumptions:

- Wind exposure category B
- Mean roof height of 30 ft
- Eave to ridge height of 10 ft
- Wall height of 10 ft
- Two braced wall lines

Required bracing length is determined by:

- Wind speed
- Story location
- Wall line spacing
- Bracing method

Bracing Basics: Required Bracing Length

Bracing Requirements Based on Wind Speed – Adjustment Factors

Wind bracing adjustment factors found in the footnotes of Table R602.10.1.2(1)

Footnote:

- a) Wind exposure category
- b) Mean roof height
- c) Eave-to-ridge height
- d) Wall height
- e) Number of braced wall lines
- f) Application of gypsum board finish
- g) Single sided Method GB factor
- h) Method LIB gypsum finish board requirement
- i) Reduction factor for tie downs added to each braced wall panel

Table R602.10.1.2(1)



Bracing Basics: Required Bracing Length

Adjustment Factor – Wind Exposure Category, Mean Roof Height

Table R602.10.1.2(1), footnote a, b

Number of Stories	Exposure/Height Factor		
	Exposure B	Exposure C	Exposure D
1	1.0	1.2	1.5
2	1.0	1.3	1.6
3	1.0	1.4	1.7

Bracing Basics: Required Bracing Length

Adjustment Factor – Roof Eave-to-Ridge Height

Support Condition	Roof Eave-to-Ridge Height			
	≤ 5'	10'	15'	20'
Roof only	0.7	1.0	1.3	1.6
Roof + floor	0.85	1.0	1.15	1.3
Roof + 2 floors	0.9	1.0	1.1	NP

NP – Not Permitted

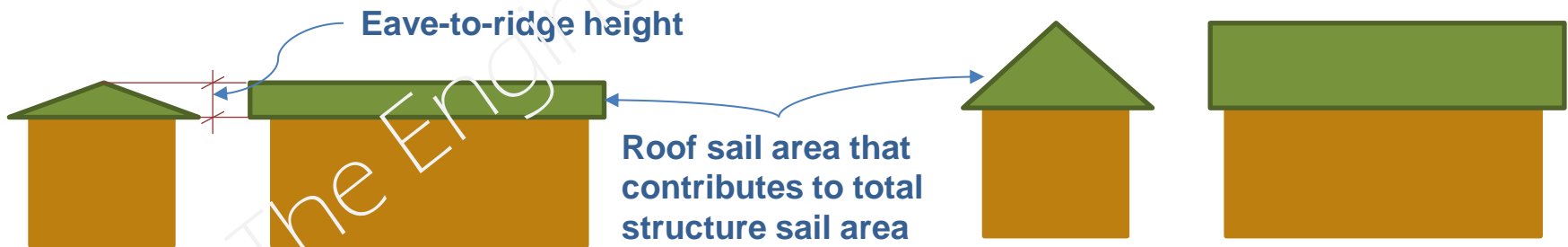


Table R602.10.1.2(1), footnote c

Bracing Basics: Required Bracing Length

Adjustment Factor – Wall Height

Table R602.10.1.2(1), footnote d


Wall Height (ft)	Adjustment Factor
10'	1.0
9'	0.95
8'	0.9
12'	1.1

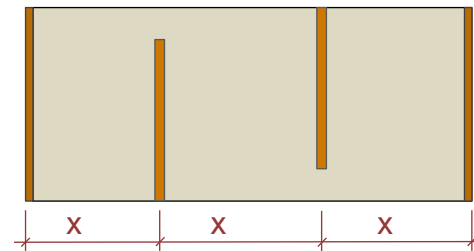
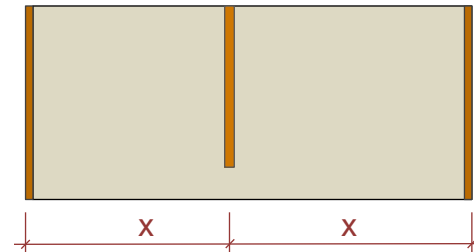
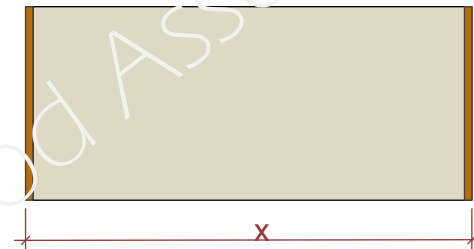
Bracing Basics: Required Bracing Length

Adjustment Factor – Number of Braced Wall Lines

Table R602.10.1.2(1), footnote e

Number of Braced Wall Lines	Adjustment Factor
3	1.30
4	1.45
≥ 5	1.60

-  – Braced wall line
- x – Braced wall line spacing



Bracing Basics: Required Bracing Length

Adjustment Factor – No gypsum finish board applied to interior of wall line

Table R602.10.1.2(1), footnote f

Bracing Method	Adjustment Factor
Method LIB	1.8
Methods DWB, WSP, SFB, PBS, PCP, and HPS	1.4

Bracing Basics: Required Bracing Length

Adjustment Factors – Footnotes g, h, and i

Table R602.10.1.2(1) Footnote	Methods	Requirements	Adjustment Factor
g	GB	Single sided gypsum	2.0
g	GB	Double sided gypsum when fastened 4" o.c. at panel edges and blocked at horizontal joints	0.7
h	LIB	Gypsum board must be attached to at least one side using Section R602.10.2 Method GB fastening requirements	1.0
i	DWB, WSP, SFB, PBS, PCP, and HPS	In one story buildings and top of two or three story buildings, when 800 lb minimum uplift hold-downs are fastened to end studs of each braced wall panel in the braced wall line and to the framing or foundation below.	0.8

Bracing Basics: Required Bracing Length

Building Type: All Dwellings

Wind Requirements: All

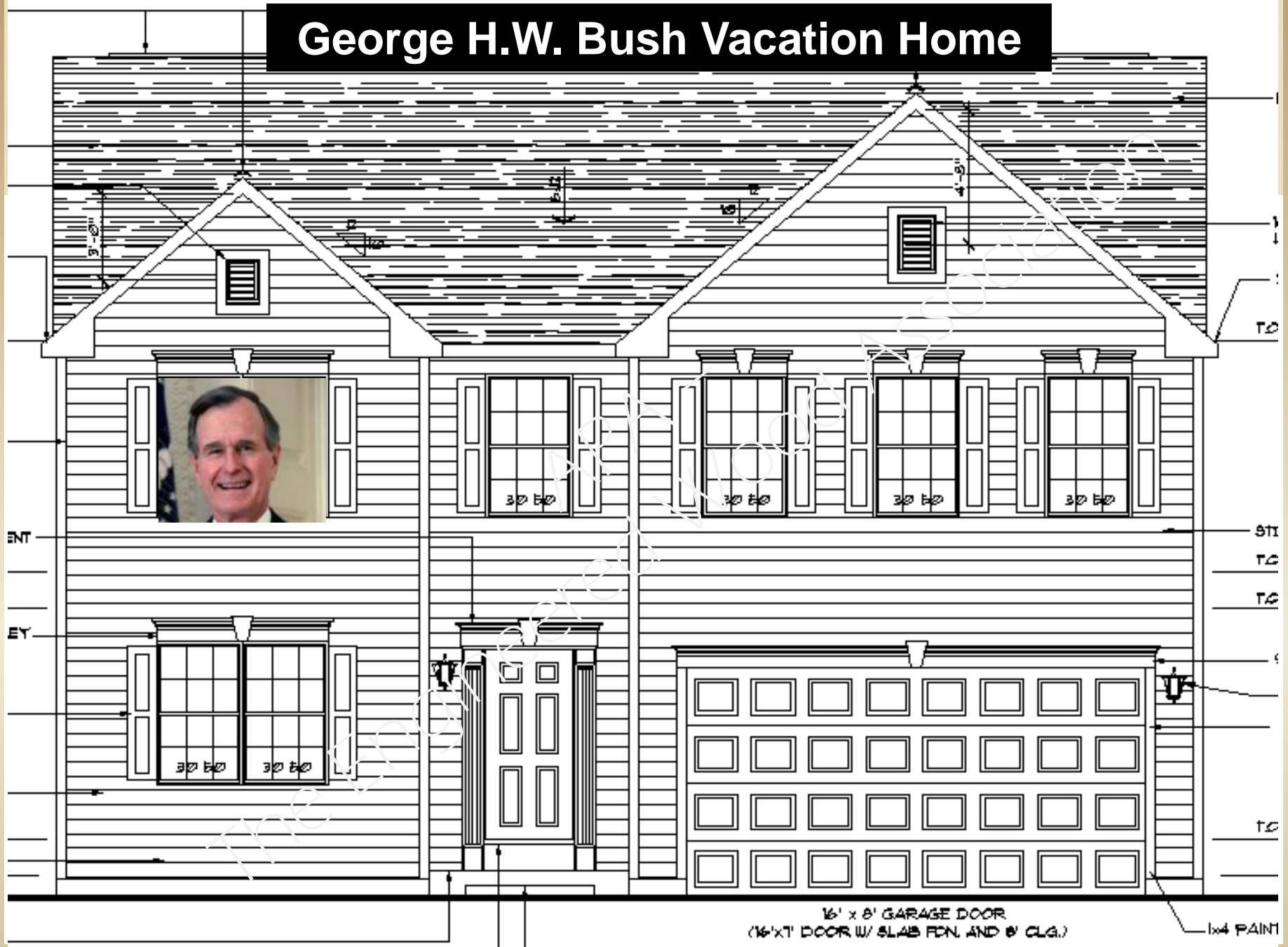
SDC Zone: A & B

Seismic Requirements: None

Description	Table R602.10.1.2(1) Footnote	Adjustment Factor
Minimum Total Length of B.W.P.s	Table R602.10.1.2(1)	NA
Wind Exposure	a	1.0 - 1.7
Roof Eave to Ridge Height	b, c	0.7 - 1.6
Wall Height	d	0.9 - 1.1
Number of Braced Wall Lines	e	1.3 - 1.6
No gypsum finish	f	1.4 - 1.8
Approved hold-down added	i	0.8

Table R602.10.1.2(1)

George H.W. Bush Vacation Home



Description	Adjustment Factors	
Wind Exposure	1.0 - 1.7	1.0 (B)
Roof Eave to Ridge Height	0.7 - 1.6	1.3 (<15')
Wall Height	0.9 - 1.1	.9 (8')
Number of Braced Wall Lines	1.3 - 1.6	1.3 (3)
No gypsum finish	1.4 - 1.8	1.0 (No)
Approved hold-down added	0.8	1.0 (No)

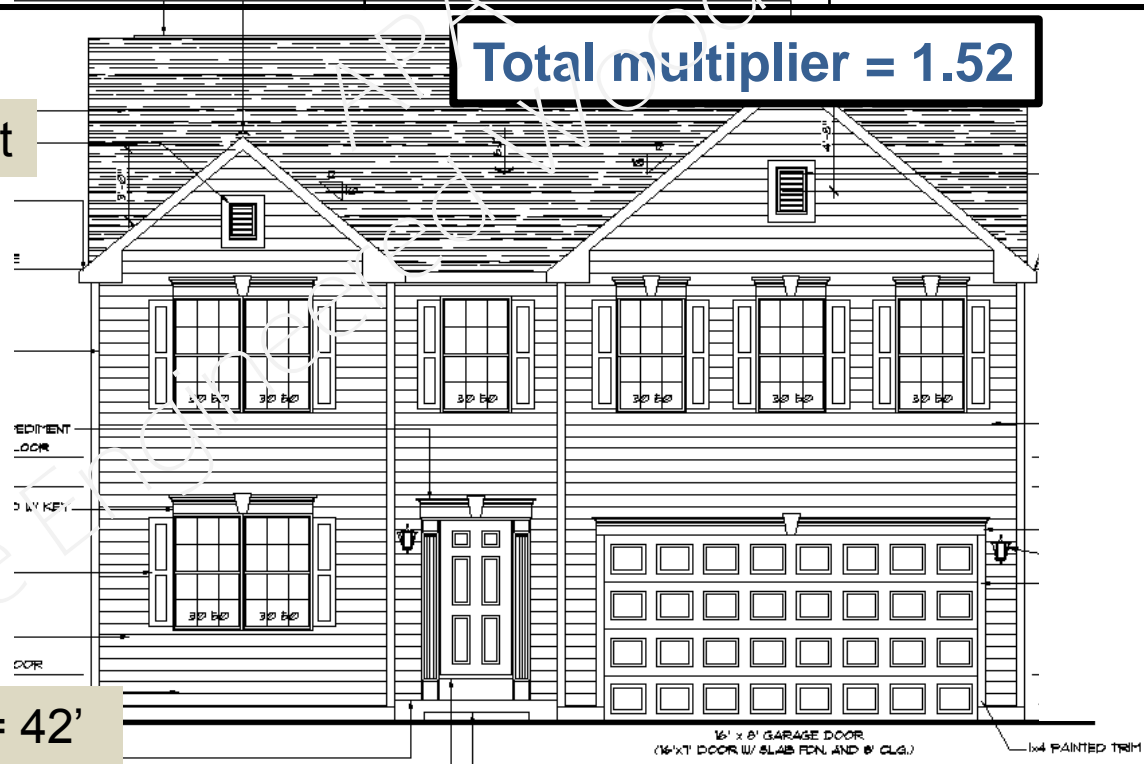
Total multiplier = 1.52

< 15' ridge height

8' wall

8' wall

Perpendicular wall = 42'



Bracing Basics: Required Bracing Length

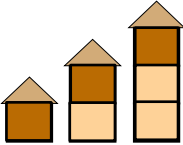

Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (ft)	Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line			
			Method LB	Method GB (double sided)	Methods DWB, WSP, SFB, PBS, PCP, HPS	Continuous Sheathing
≤ 90 (mph)		10	3.5	3.5	2	2
		20	7	7	4	3.5
		30	9.5	9.5	5.5	5
		40	12.5	12.5	7.5	6
		50	15.5	15.5	9	7.5
		60	18.5	18.5	10.5	9
		10	7	7	4	3.5
		20	13	13	7.5	6.5
		30	18.5	18.5	10.5	9
		40	24	24	14	12
		50	29.5	29.5	17	14.5
		60	35	35	20	17

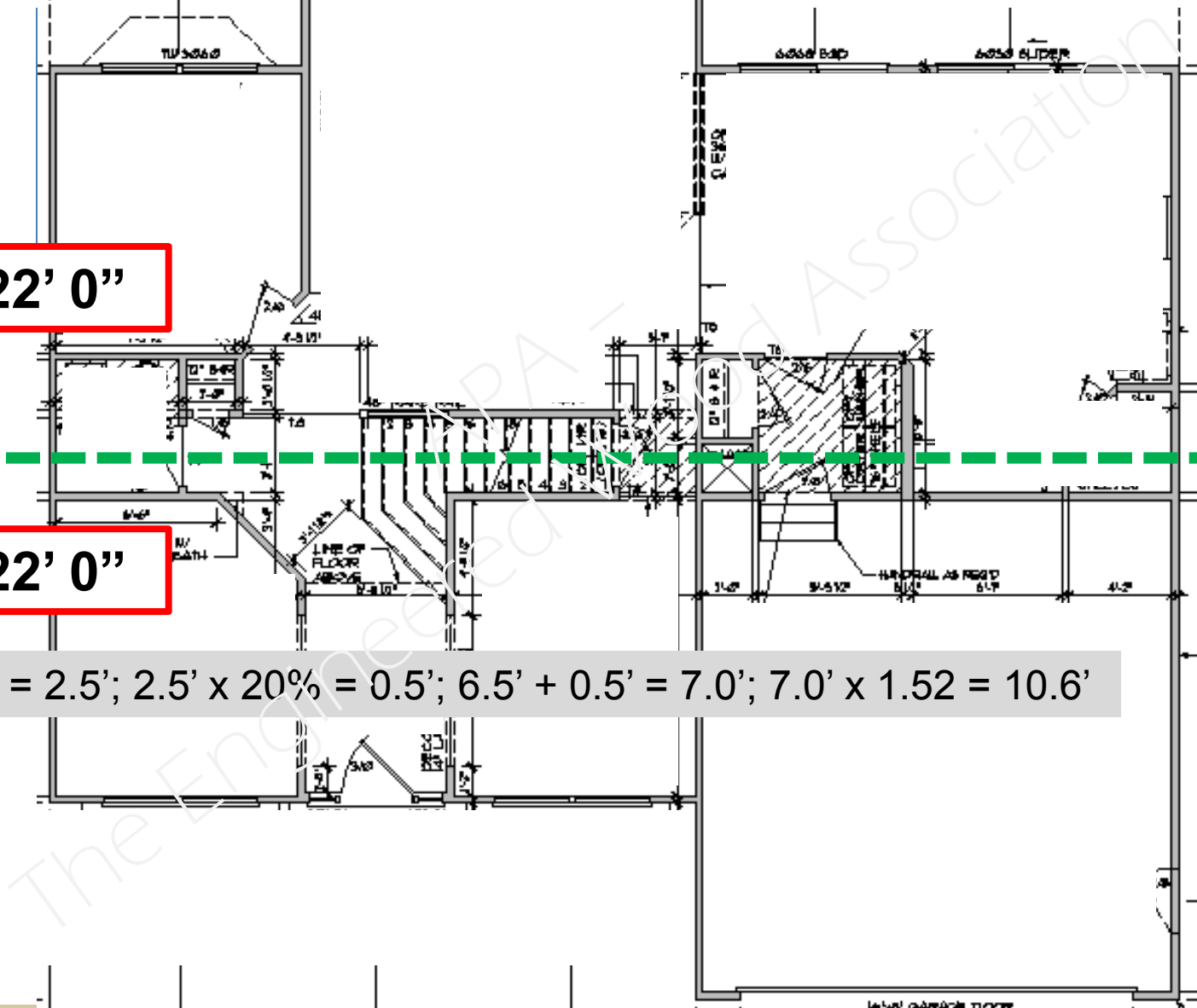
Table R602.10.1.2(1)

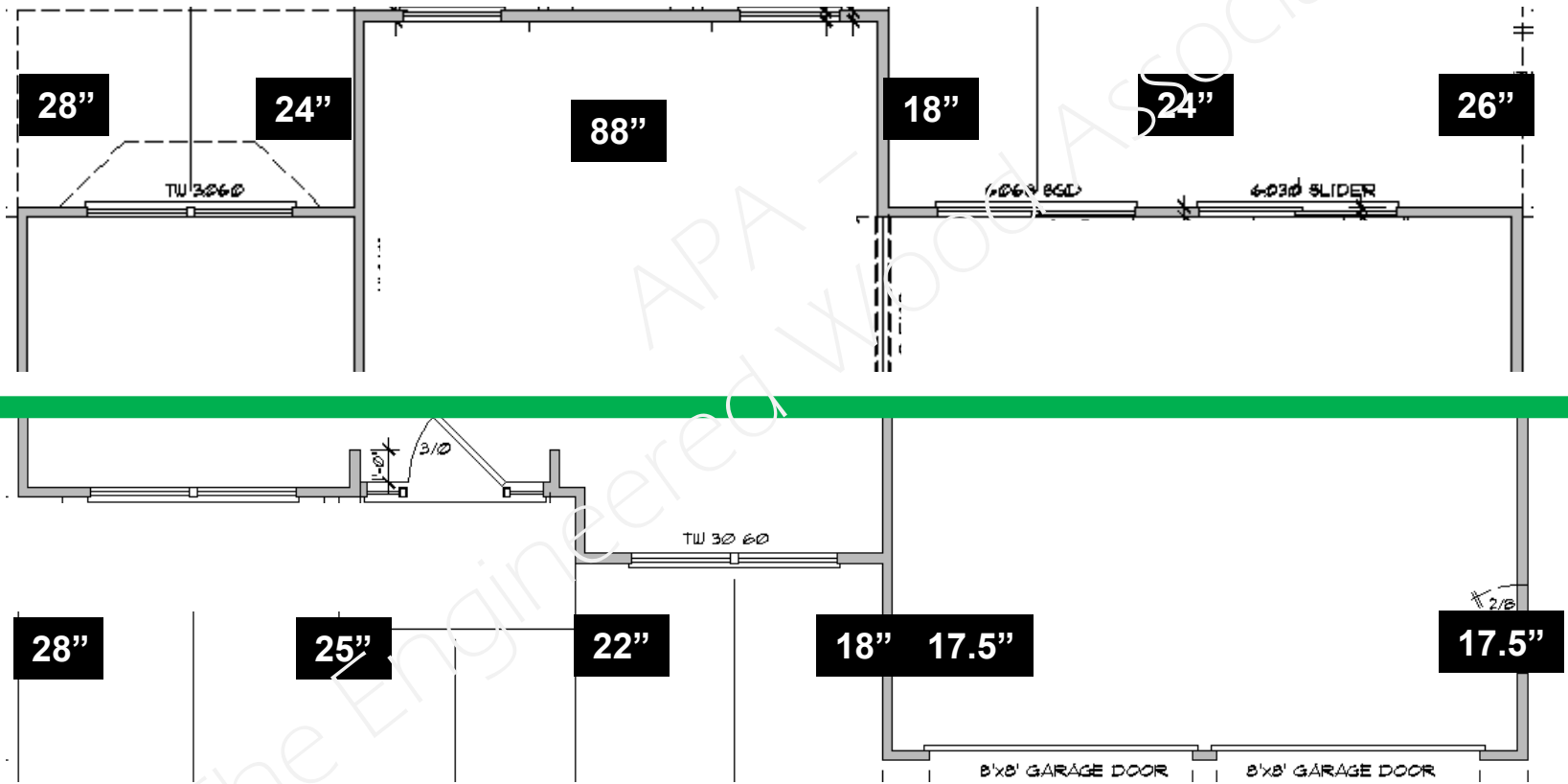
46' 0"

22' 0"

22' 0"

$9.0' - 6.5' = 2.5'$; $2.5' \times 20\% = 0.5'$; $6.5' + 0.5' = 7.0'$; $7.0' \times 1.52 = 10.6'$





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Bracing Basics: Required Bracing Length

Method CS- WSP

CS-WSP	90 mph	SDC A
Bottom Story	?	NA

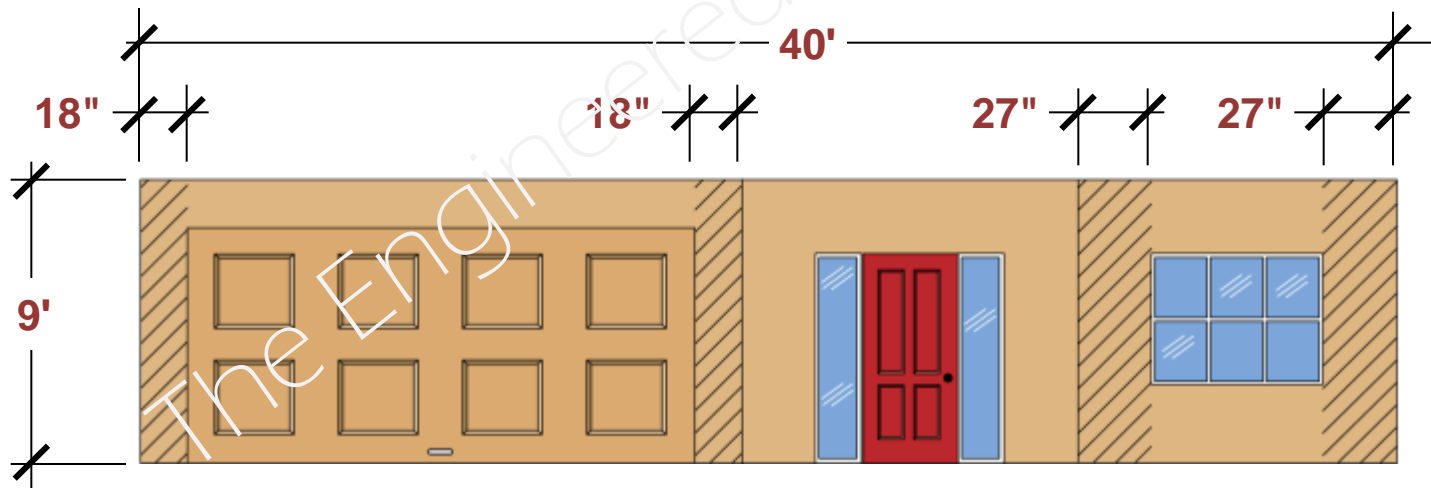


Table R602.10.1.2(1)

Bracing Basics: Required Bracing Length


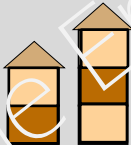
Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (ft)	Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line			
			Method LB	Method GB (double sided)	Methods DWB, WSP, SFB, PBS, PCP, HPS	Continuous Sheathing
≤ 90 (mph)		10	3.5	3.5	2	2
		20	7	7	4	3.5
		30	9.5	9.5	5.5	5
		40	12.5	12.5	7.5	6
		50	15.5	15.5	9	7.5
		60	18.5	18.5	10.5	9
		10	7	7	4	3.5
		20	13	13	7.5	6.5
		30	18.5	18.5	10.5	9
		40	24	24	14	12
		50	29.5	29.5	17	14.5
		60	35	35	20	17

Table R602.10.1.2(1)

Bracing Basics: Required Bracing Length

Method CS- WSP

CS-WSP	90 mph	SDC A
Bottom Story	12'	NA

Total Bracing Length = 11.5' vs. 12' Required
Bracing is insufficient
(From Table – 40' BWL)

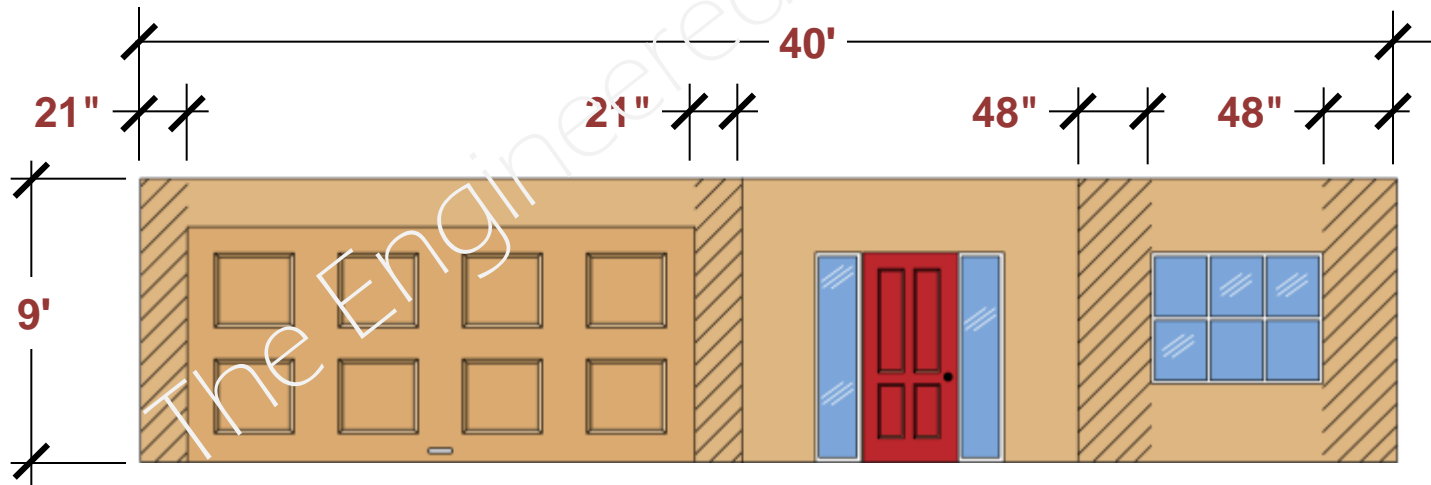


Table R602.10.1.2(1)

Bracing Basics: Required Bracing Length

Method CS- WSP

CS-WSP	90 mph	SDC A
Bottom Story	11.4'	NA

Total Bracing Length = 11.5' vs. 11.4' Required
Bracing is OK
 $0.95 \times 12' = 11.4'$

Footnote d. = 9' walls – 95% multiplier; $12.0' \times 95\% = 11.4'$

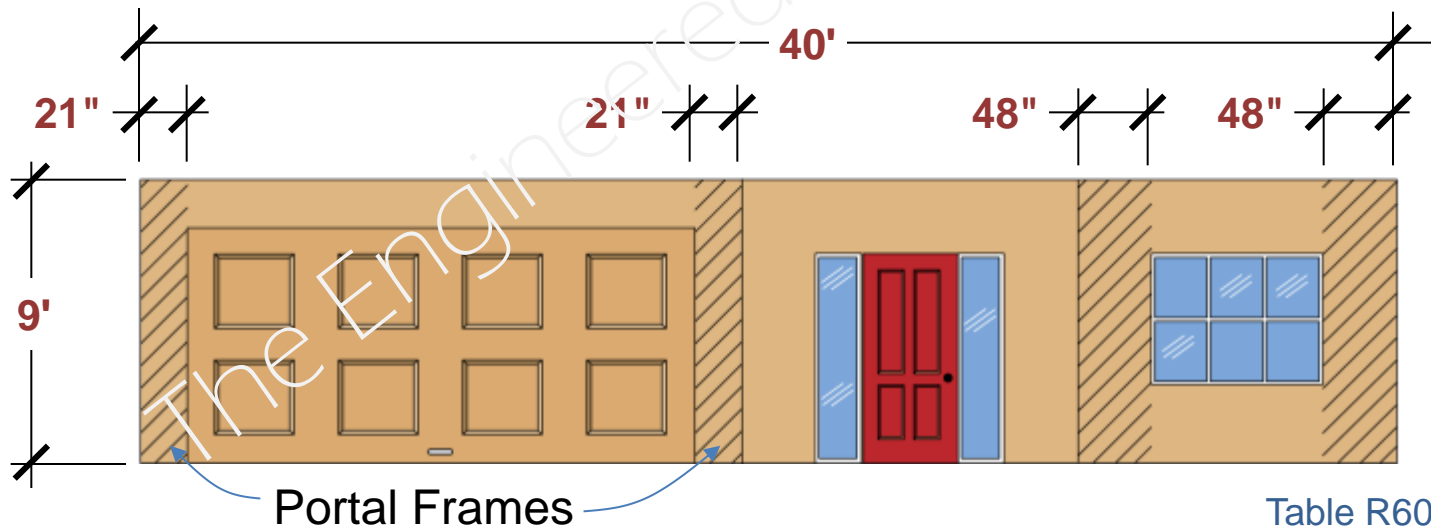


Table R602.10.1.2(1)

Bracing Basics: Required Bracing Length

Method CS-WSP

CS-G	90 mph	SDC C
One Story	?	NA

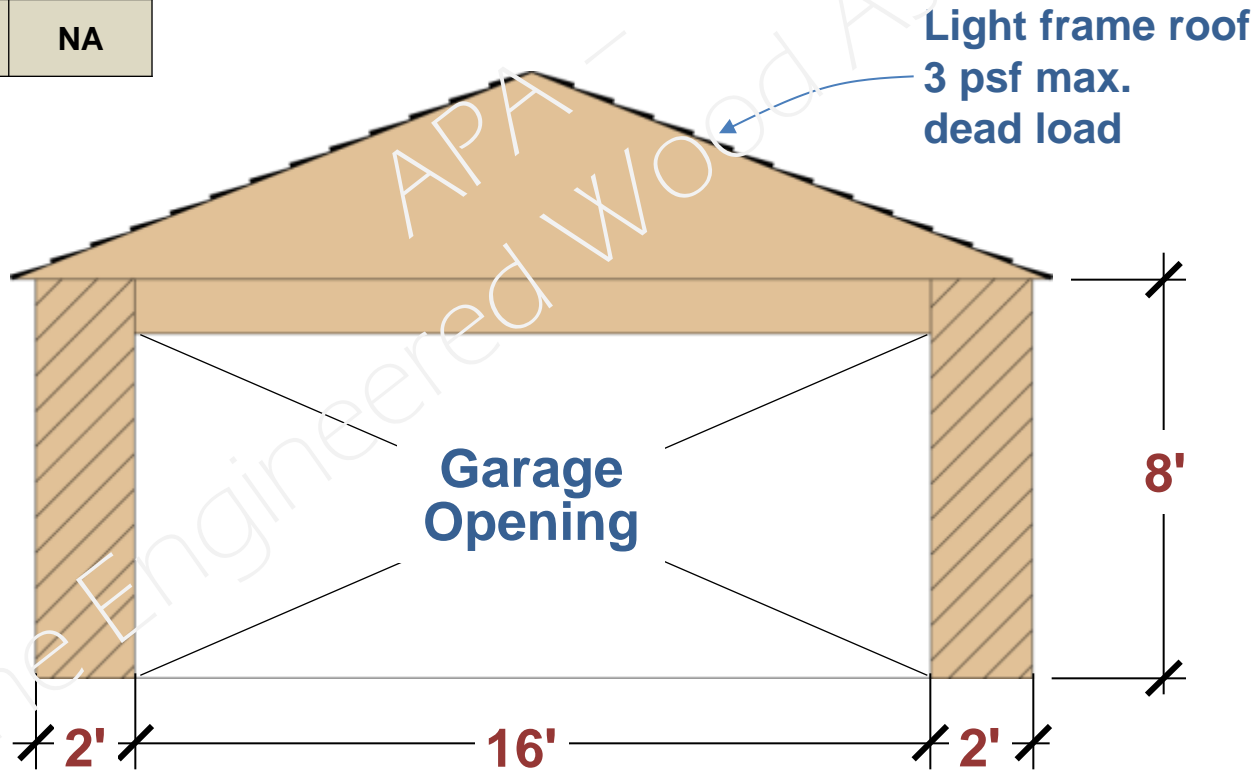


Table R602.10.1.2(1)



Bracing Basics: Required Bracing Length

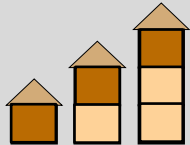
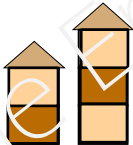
Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (ft)	Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line			
			Method LB	Method GB (double sided)	Methods DWB, WSP, SFB, PBS, PCP, HPS	Continuous Sheathing
≤ 90 (mph)		10	3.5	3.5	2	2
		20	7	7	4	3.5
		30	9.5	9.5	5.5	5
		40	12.5	12.5	7.5	6
		50	15.5	15.5	9	7.5
		60	18.5	18.5	10.5	9
		10	7	7	4	3.5
		20	13	13	7.5	6.5
		30	18.5	18.5	10.5	9
		40	24	24	14	12
		50	29.5	29.5	17	14.5
		60	35	35	20	17

Table R602.10.1.2(1)

Bracing Basics: Required Bracing Length

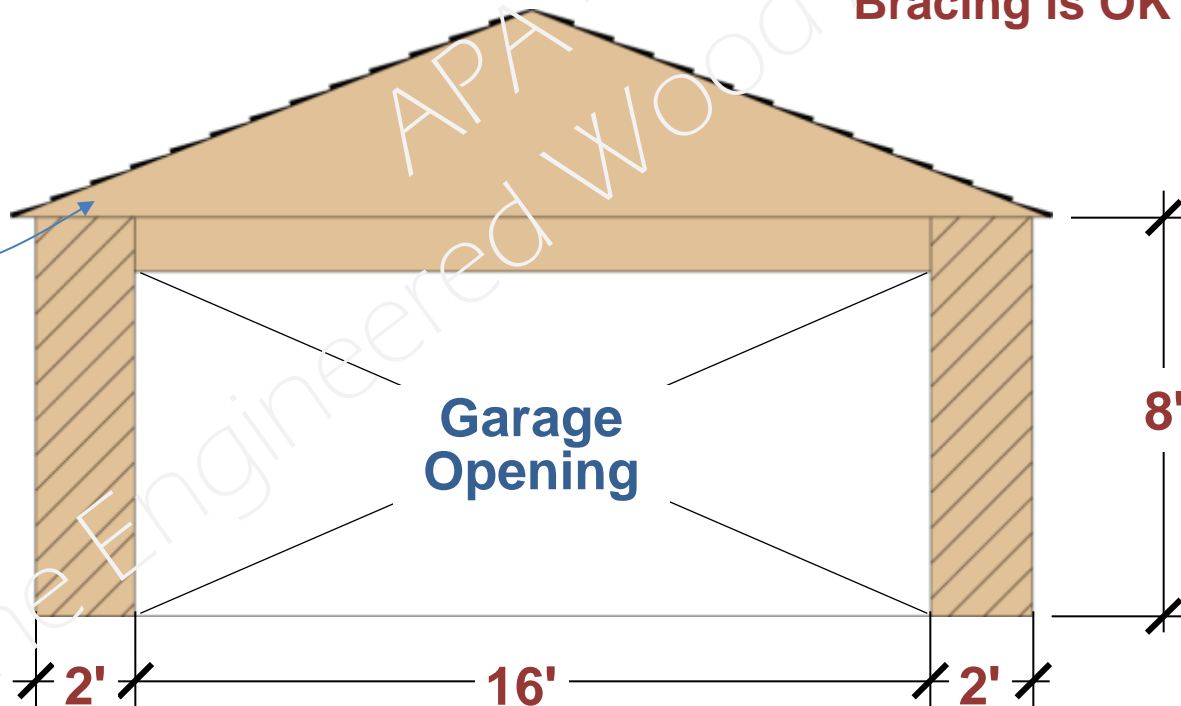
Method CS-G

CS-G	105 mph	SDC C
One Story	3.5'	NA

Total Bracing Length = 4' vs. 3.5' Required

Bracing is OK

Light frame roof
3 psf max.
dead load

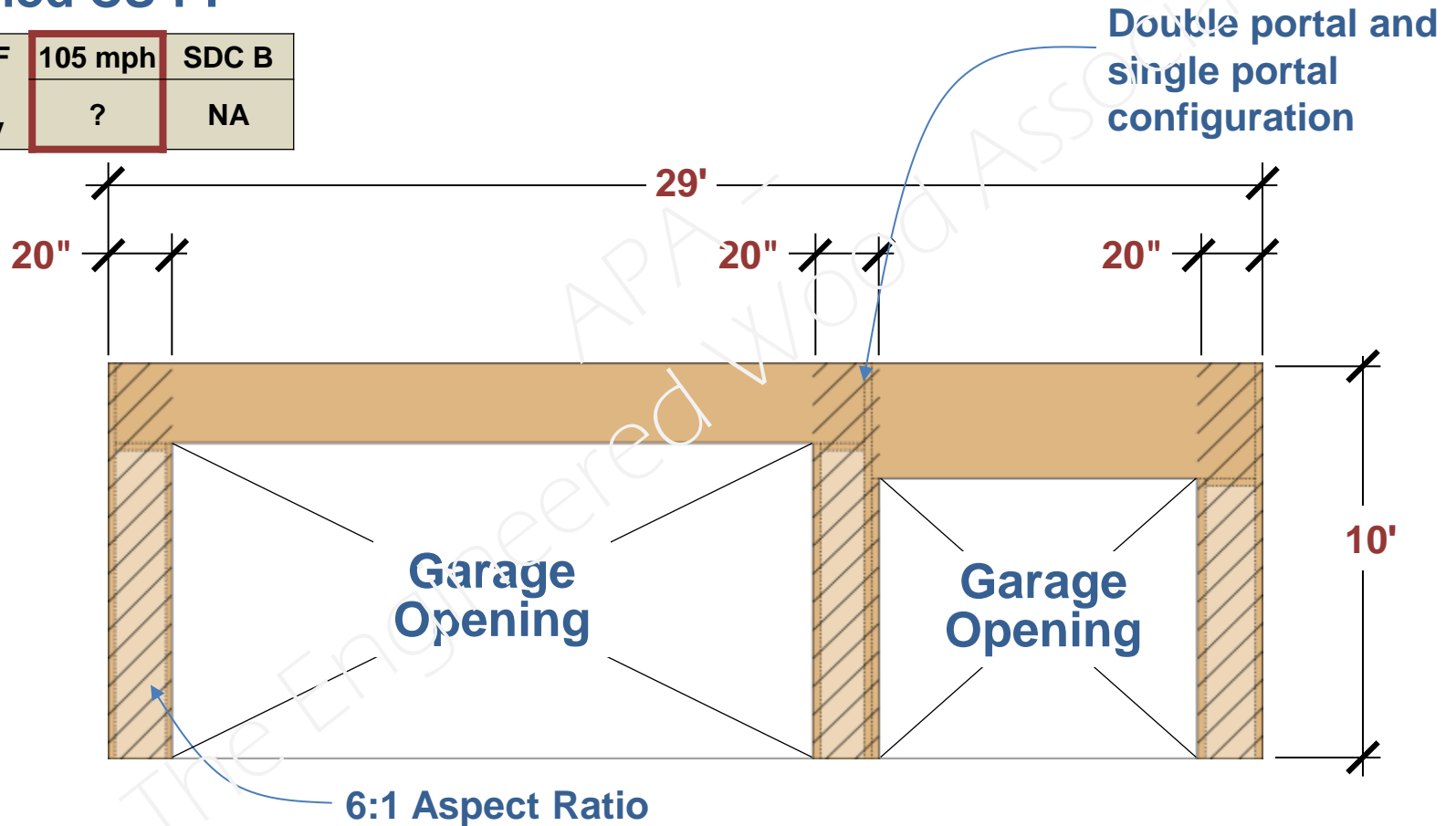


R602.10.1.2 & Table R602.10.1.2(1)

Bracing Basics: Required Bracing Length

Method CS-PF

CS-PF	105 mph	SDC B
One Story	?	NA



Bracing Basics: Required Bracing Length

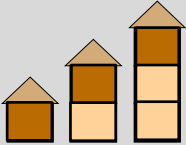
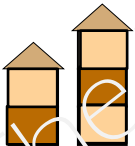
Basic Wind Speed (mph)	Story Location	Braced Wall Line Spacing (ft)	Minimum Total Length of Braced Wall Panels Required Along Each Braced Wall Line			
			Method LIB	Method GB (double sided)	Methods DWB, WSP, SFB, PBS, PCP, HPS	Continuous Sheathing
≤ 110 (mph)		10	5.5	5.5	3	3
		20	10	10	6	5
		30	14.5	14.5	8.5	7
		40	18.5	18.5	11	9
		50	23	23	13	11.5
		60	27.5	27.5	15.5	13.5
		10	10.5	10.5	6	5
		20	19	19	11	9.5
		30	27.5	27.5	16	13.5
		40	36	36	20.5	17.5
		50	44	44	25.5	21.5
		60	52.5	52.5	30	25.5

Table R602.10.1.2(1)

Bracing Basics: Required Bracing Length

Method CS-PF

CS-PF	105 mph	SDC B
One Story	7'	NA

Total Bracing Length = 5' vs. 7' Required
Bracing is insufficient

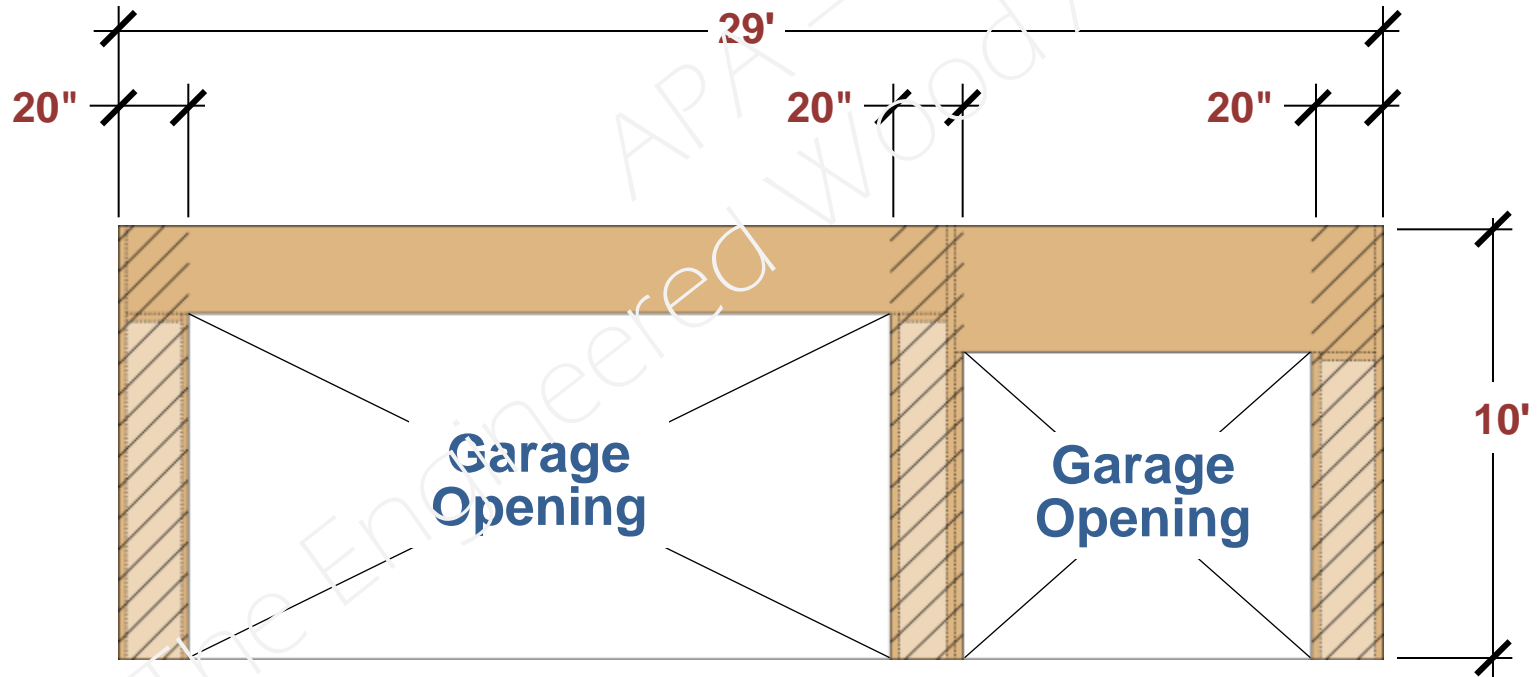


Table R602.10.1.2(1)



Bracing Topics

Introduction

Getting
Started

Bracing
Basics

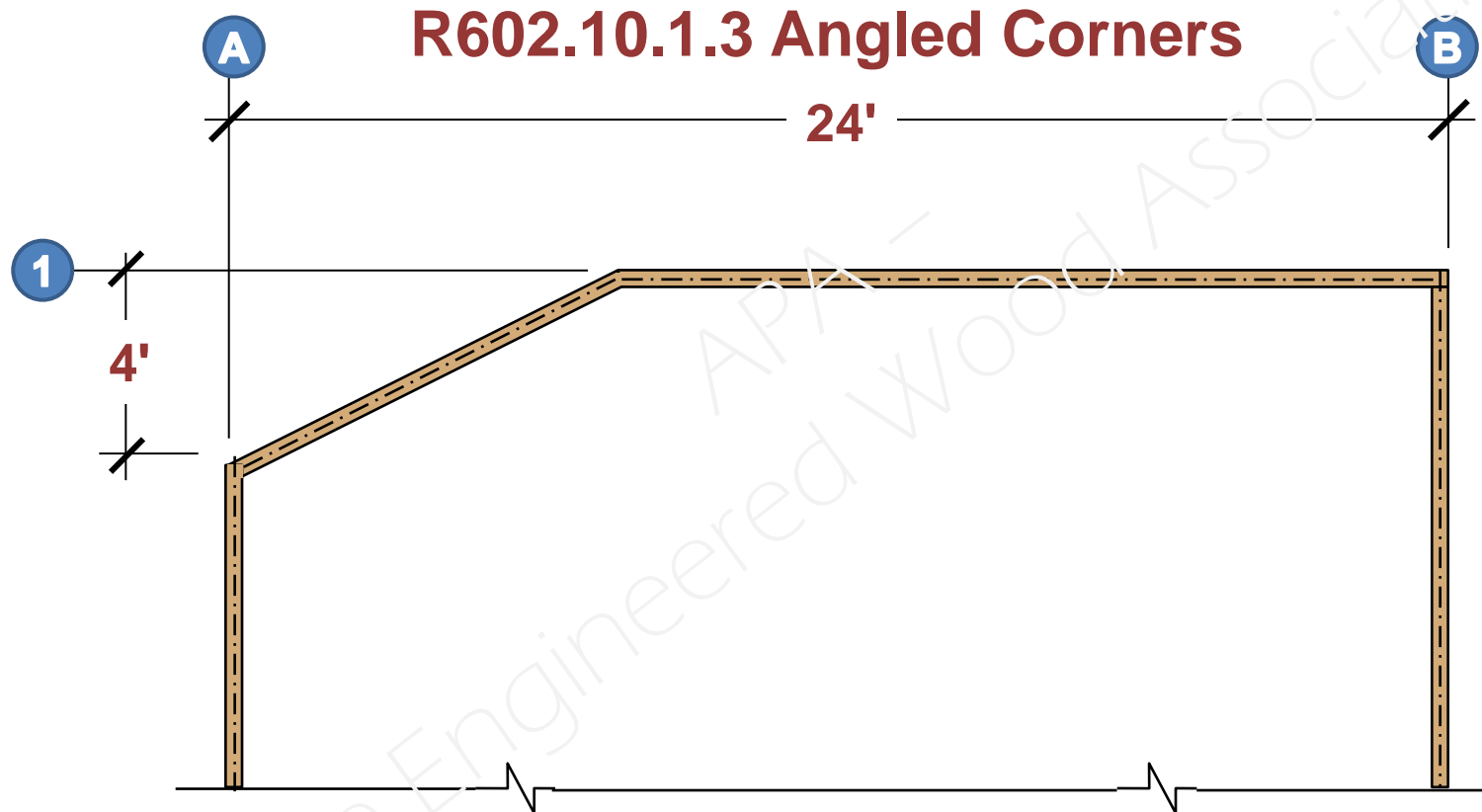
Connections

Other
Topics

Corners &
Collectors

Above &
Below

Connections: Corners & Collectors

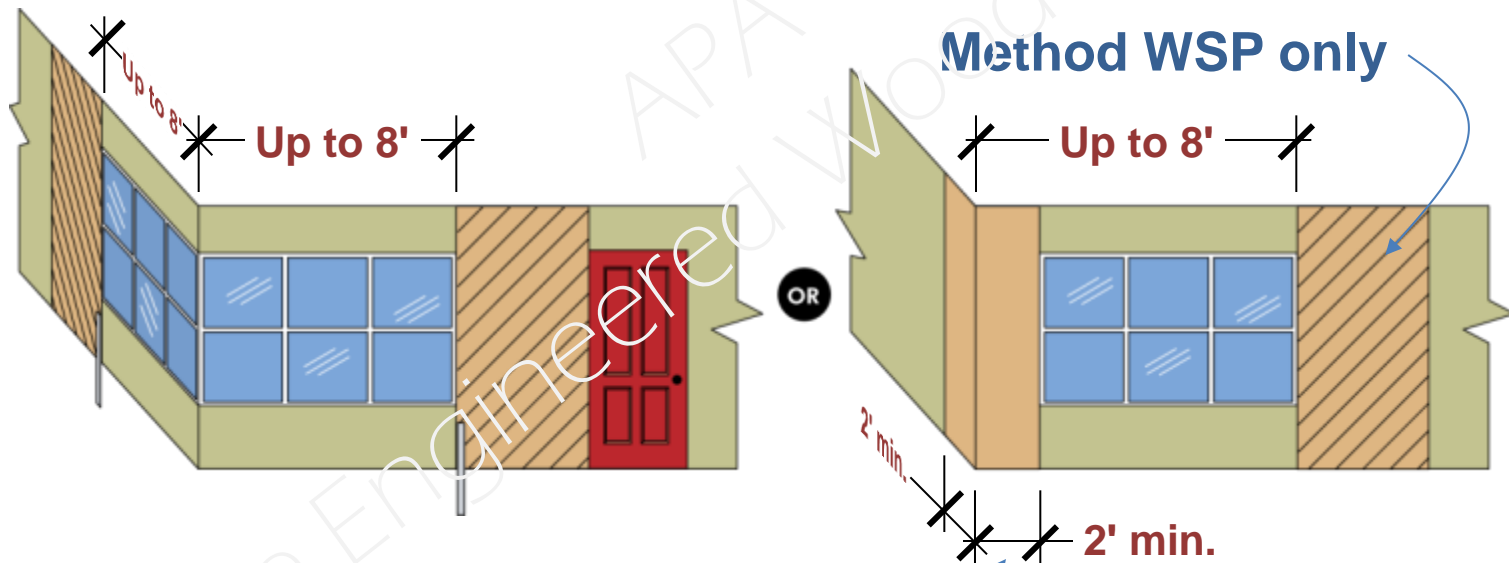


Wall sheathing in a diagonal wall section may be counted for a wall line's bracing length if the diagonal wall line is 8' or less in length.

Connections: Corners & Collectors

Braced Panel Starting Location

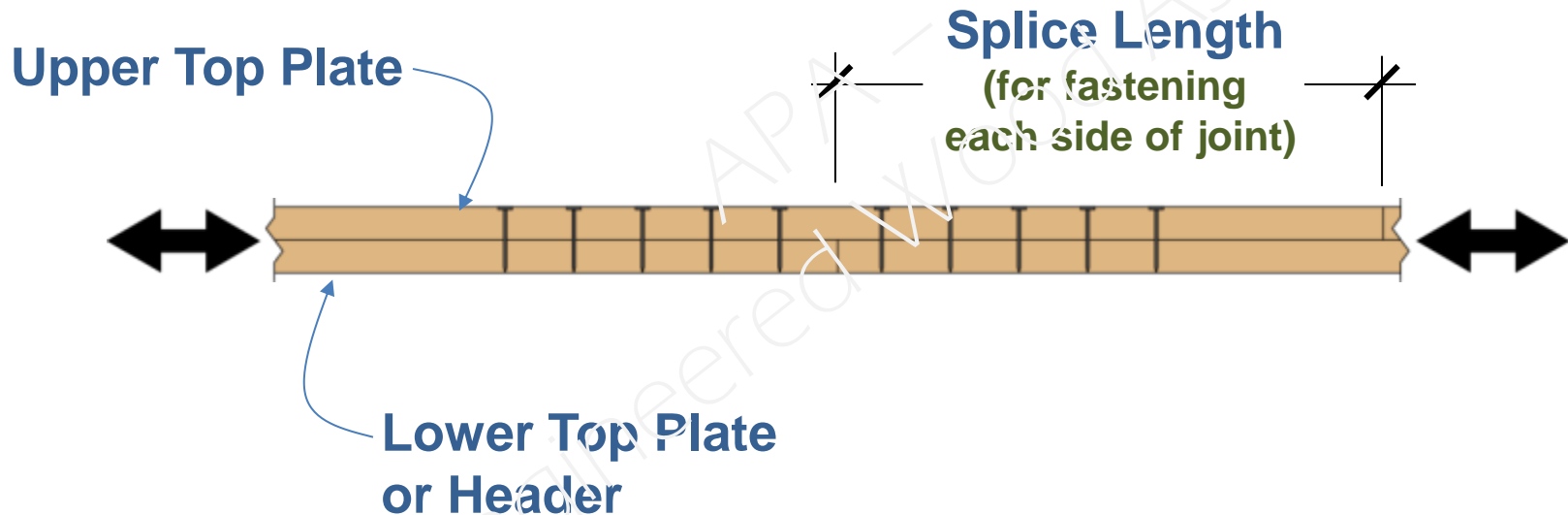
Seismic
Up to 8' for Method WSP
per illustration below



Segment does not count as bracing
(Unless dwelling is continuously sheathed per R602.10.4)

Connections: Corners & Collectors

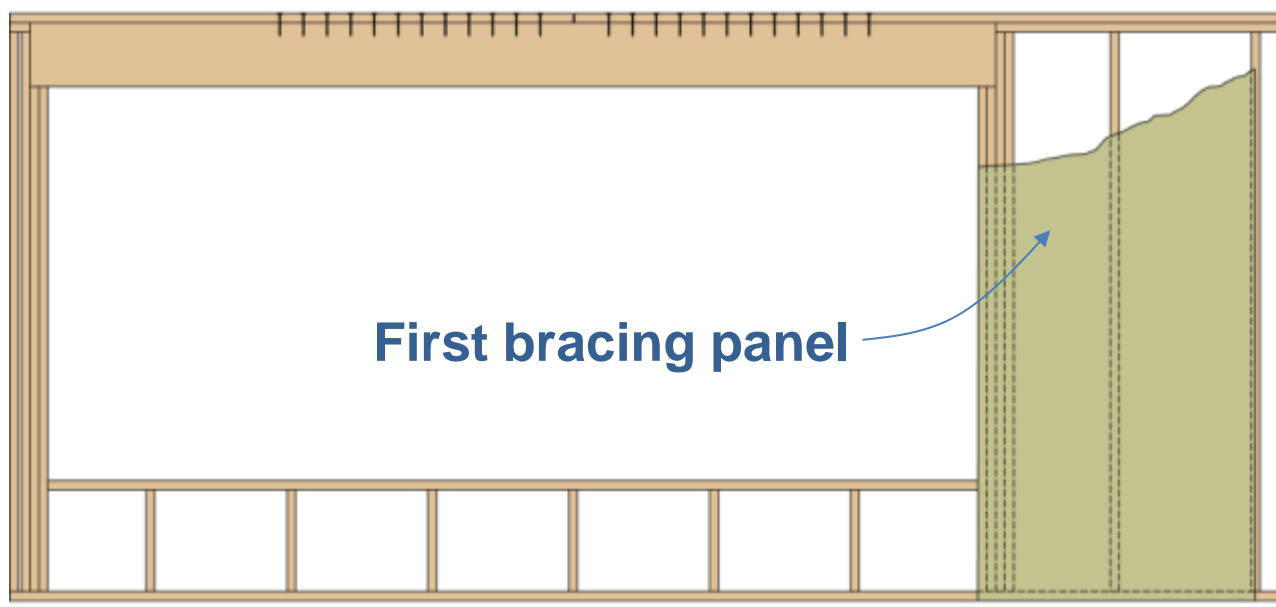
Engineered Collector



Reference:
APA publication TT-102
Collector Design for Bracing in Conventional Construction

Connections: Corners & Collectors

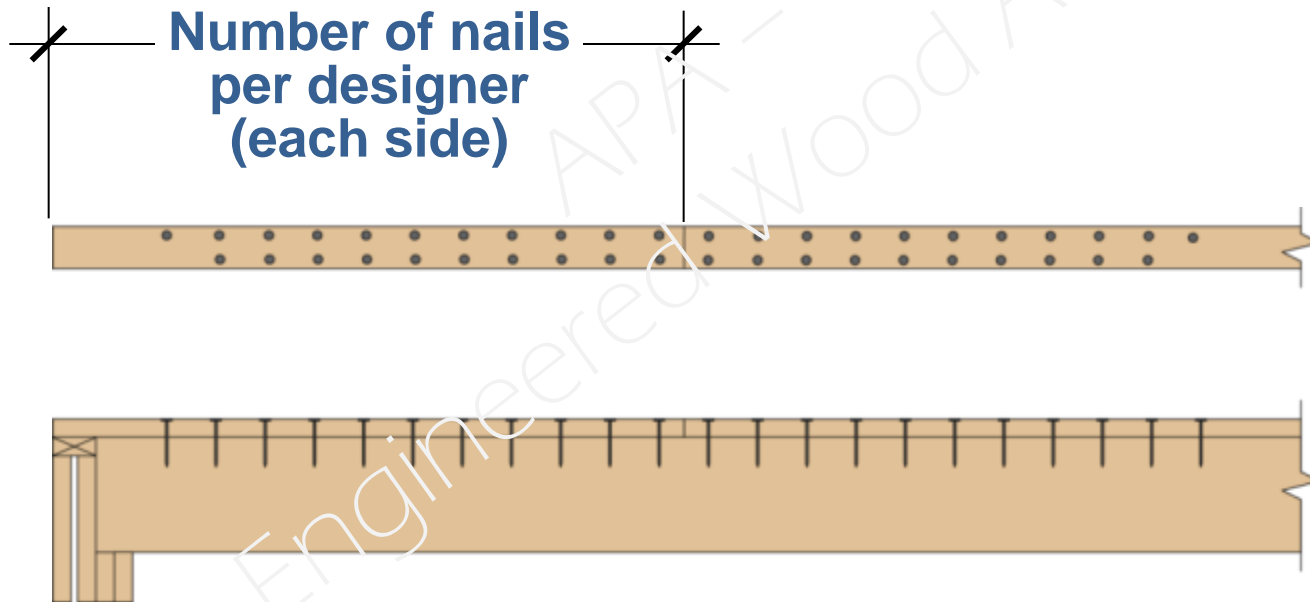
Engineered Collector



First bracing panel

Connections: Corners & Collectors

Engineered Collector



Reference:
APA publication TT-102
Collector Design for Bracing in Conventional Construction

Bracing Topics

Introduction

Getting
Started

Bracing
Basics

Connections

Other
Topics

Corners &
Collectors

Above &
Below

Foundation

Connection: Above & Below

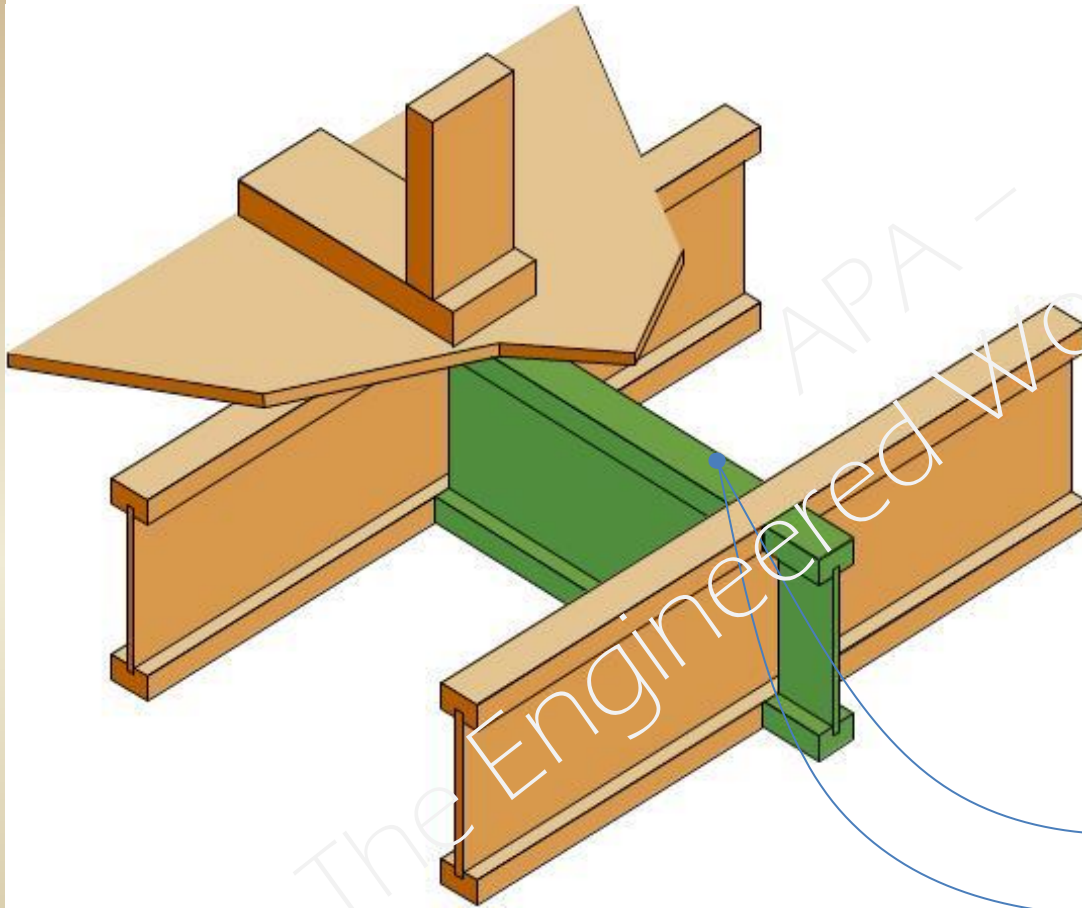


BWP sole plates and top plates connections per Table R602.3(1)

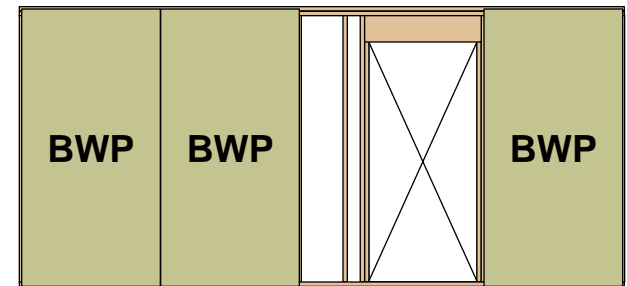
R602.10.6



Connection: Above & Below



When braced walls are perpendicular to joists above or below, blocking shall be provided above or below and in line with the BWP's...



R602.10.6

Connection: Above & Below

BWP Perpendicular to Framing

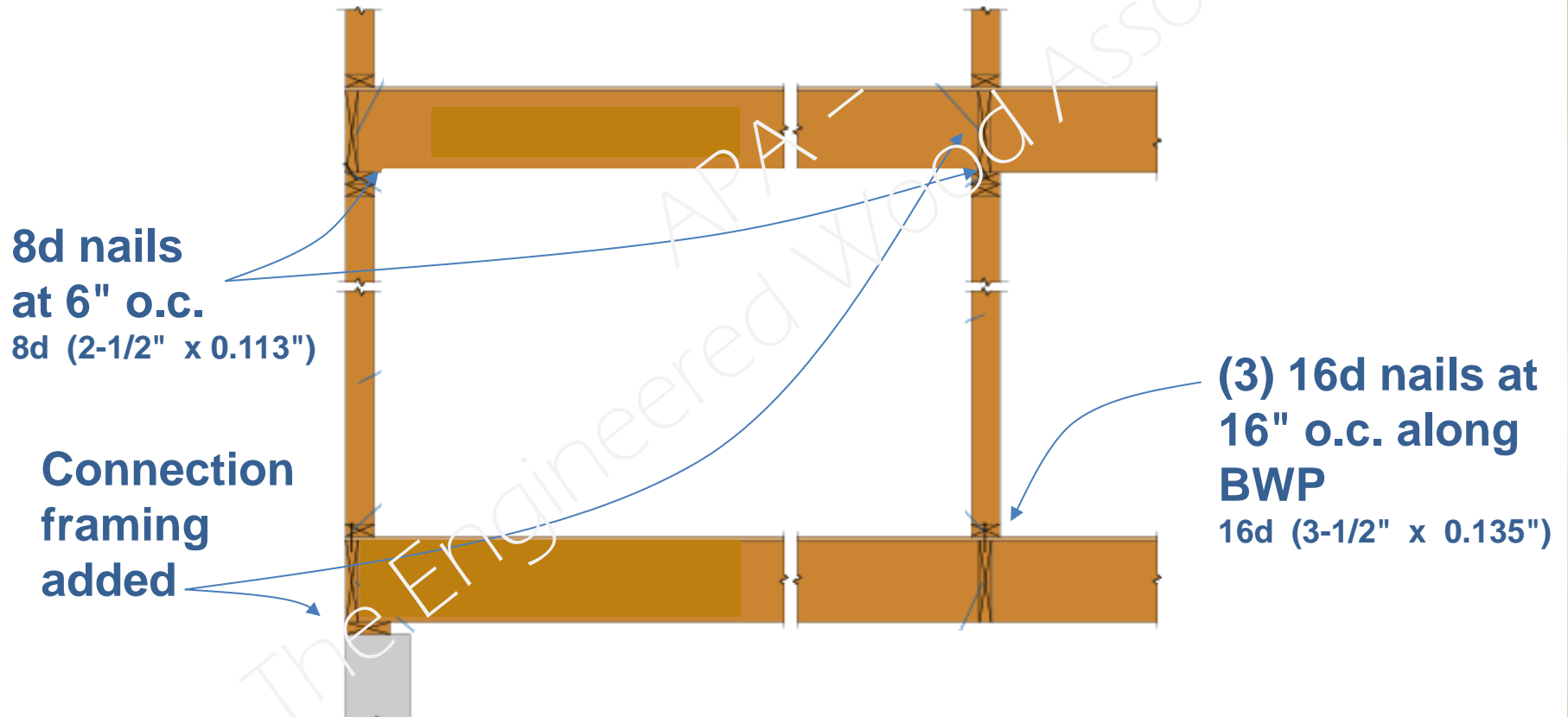
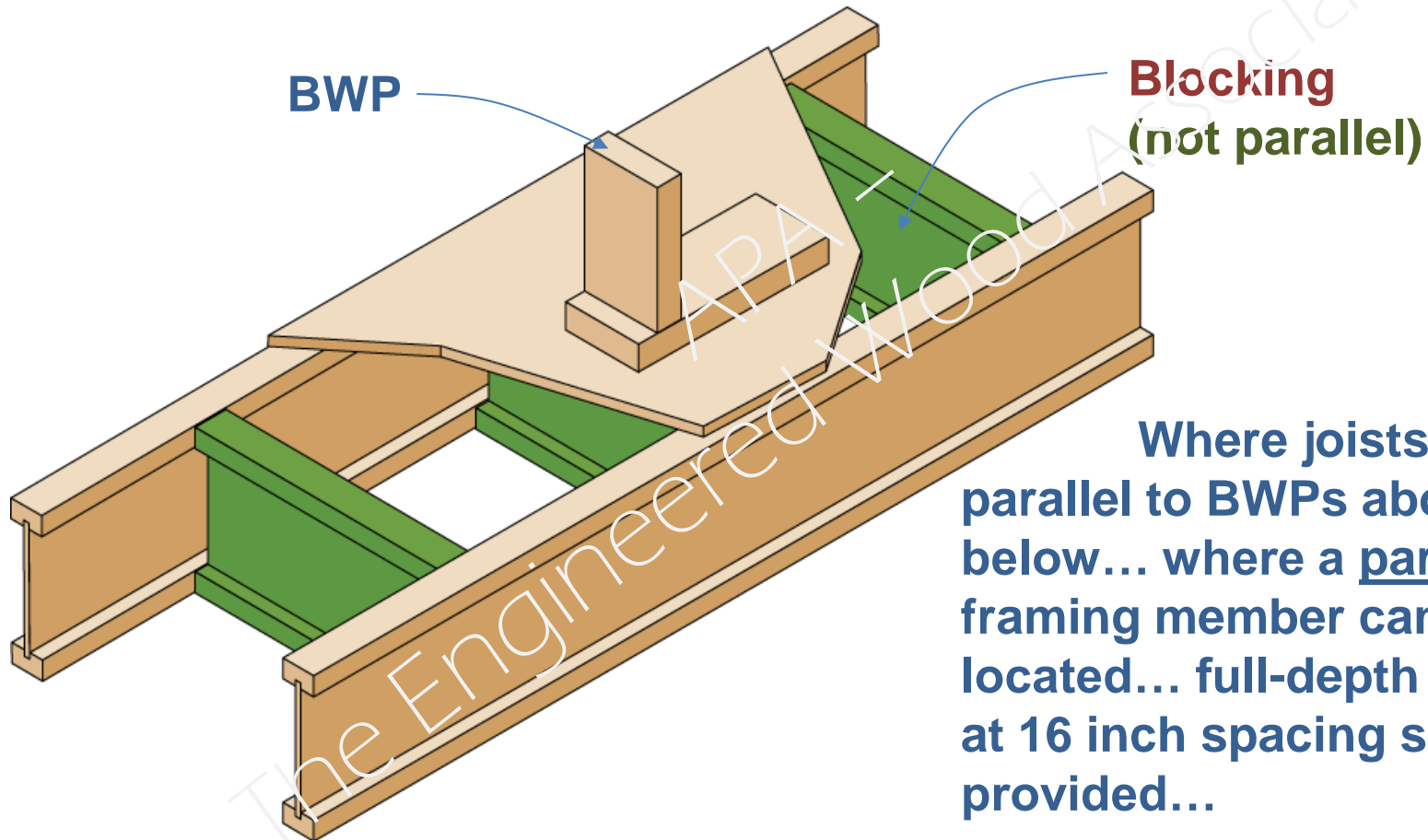


Figure R602.10.6(1) & Table R602.3(1)

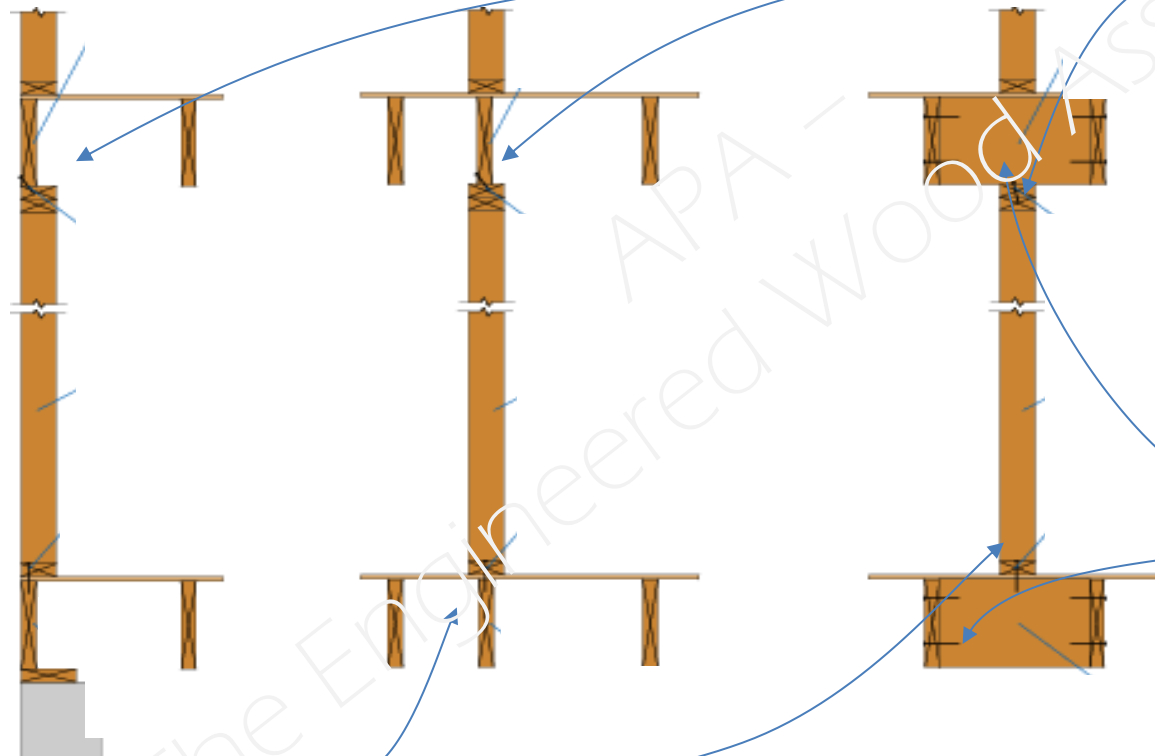
Connection: Above & Below



Where joists are parallel to BWPs above or below... where a parallel framing member cannot be located... full-depth blocking at 16 inch spacing shall be provided...

Connection: Above & Below

BWP Parallel to Framing



8d nails toe-nailed at 6" o.c.

Connection framing added

(3) 16d nails at 16" o.c. along BWP

Figure R602.10.6(2) & Table R602.3(1)

Connection: Above & Below

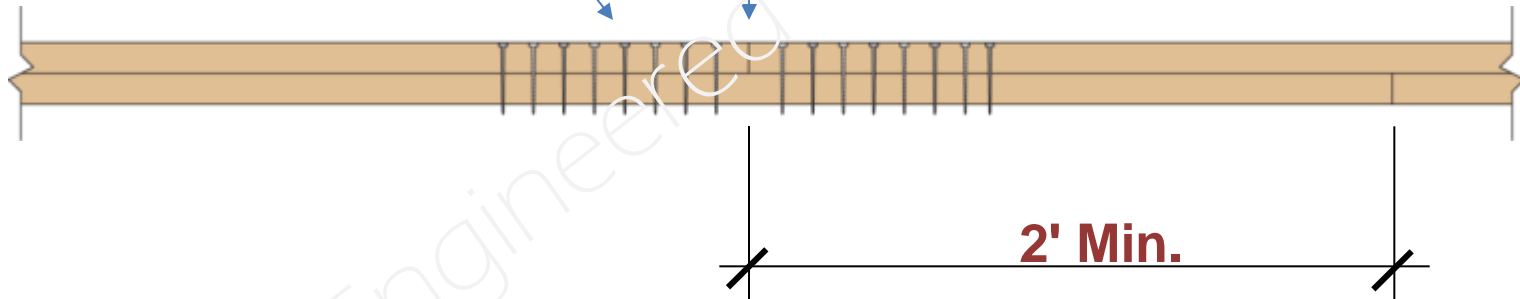
Top Plate Splice

(8) 16d nails each side of splice

Splice

Seismic

Intermediate Connections



Notes:

1) 16d (3-1/2" x 0.135")

Bracing Topics

Introduction

Getting
Started

Bracing
Basics









Connections







Other
Topics

Examples

APA -
The Engineered Wood Association

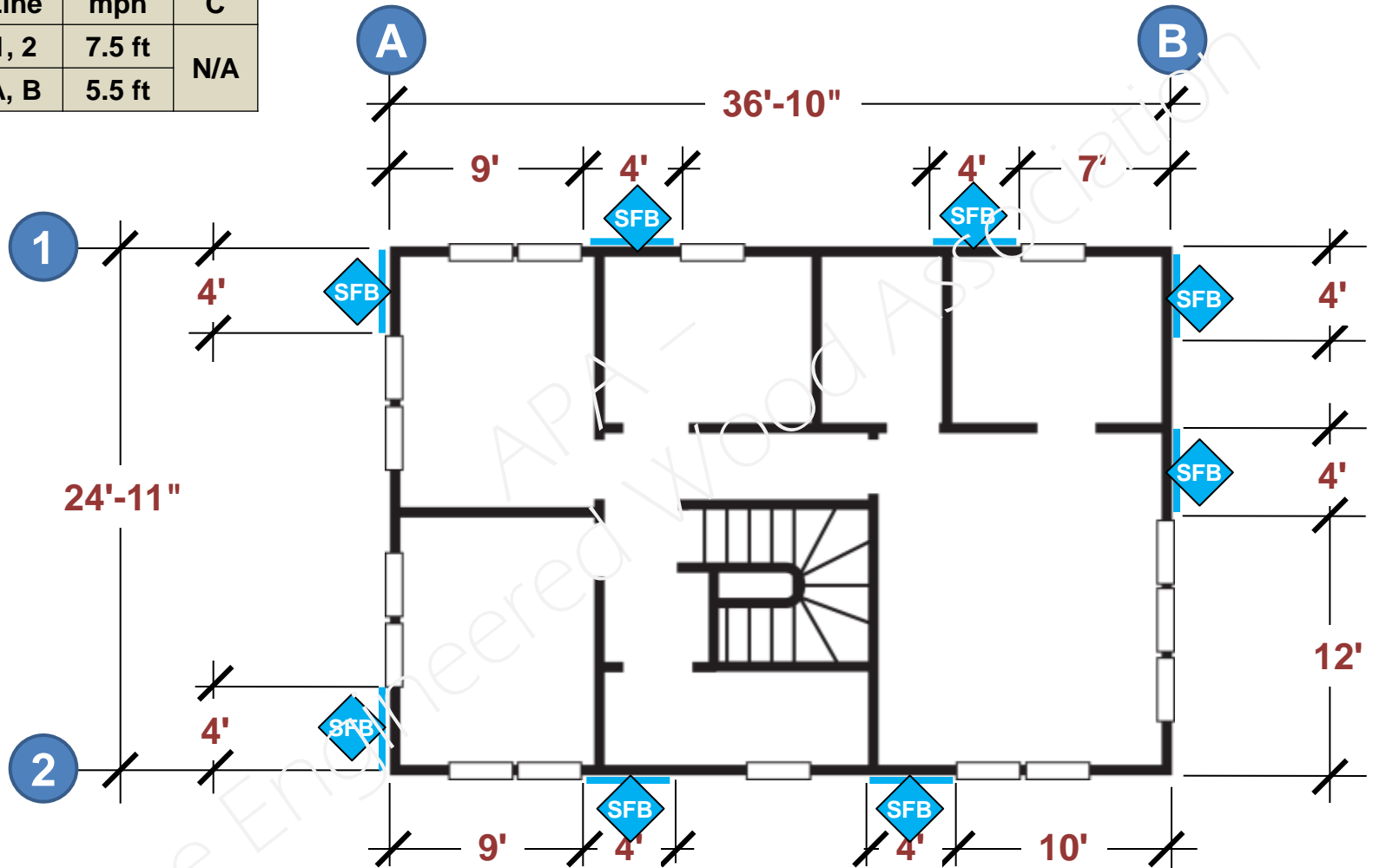
Examples

Symbol	Description
	Diagonal let-in
	Diagonal wood boards
	Wood structural panel
	Structural fiberboard
	Gypsum wallboard
	Particleboard
	Portland cement
	Hardboard

Symbol	Description
	Alternate BWP
	Alt. BWP adj. opening
	Continuous sheathing
	Continuous 4:1
	Continuous 6:1
	Continuous sheathing

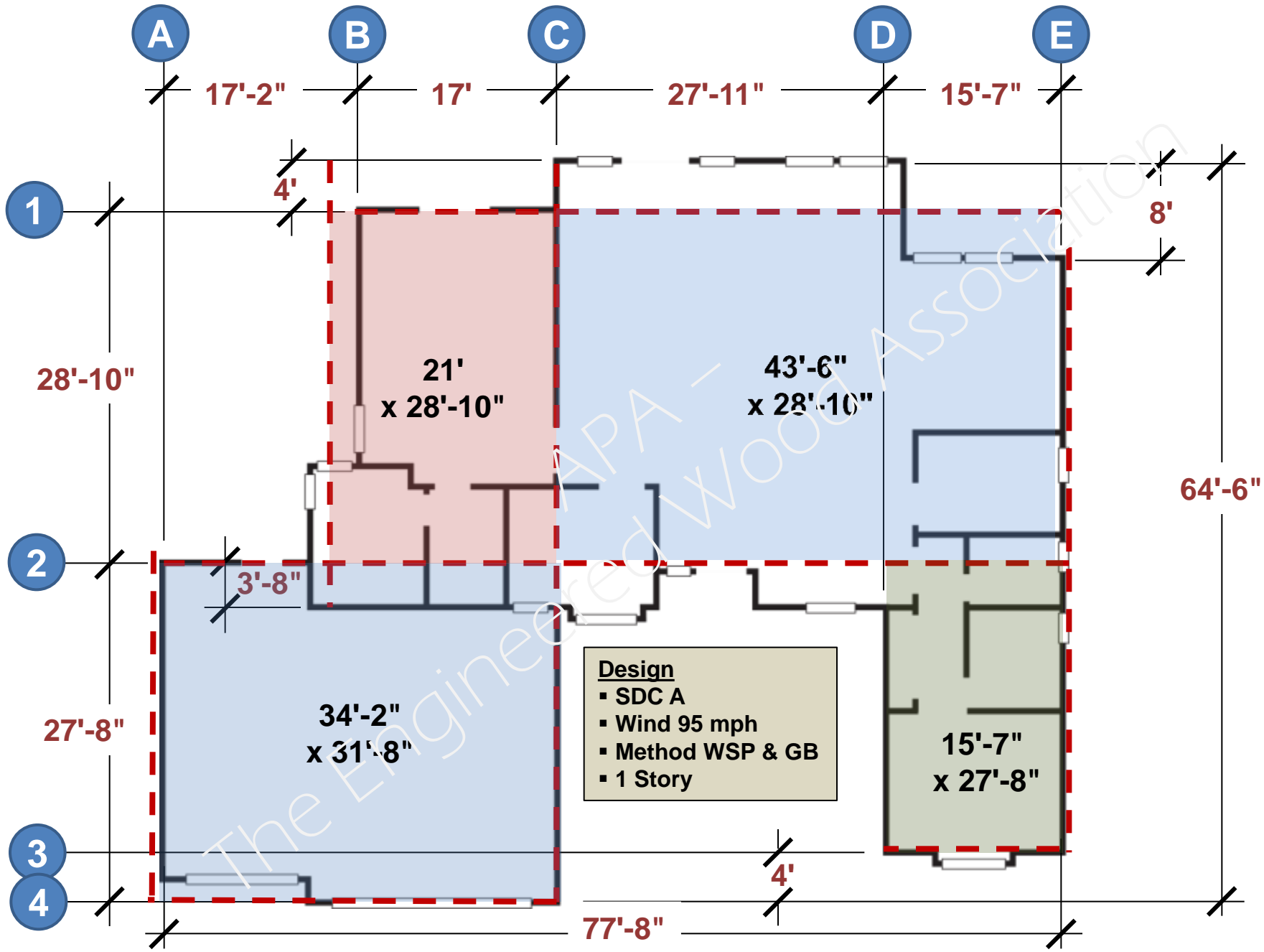
SFB Top Story	Wall Line	90 mph	SDC C
	1, 2	7.5 ft	N/A
	A, B	5.5 ft	N/A

Upper Story



$$1,2: 7.5' - 5.5' = 2.0'; 2.0' \times 68\% = 1.4'; 5.5' + 1.4' = 6.9'$$

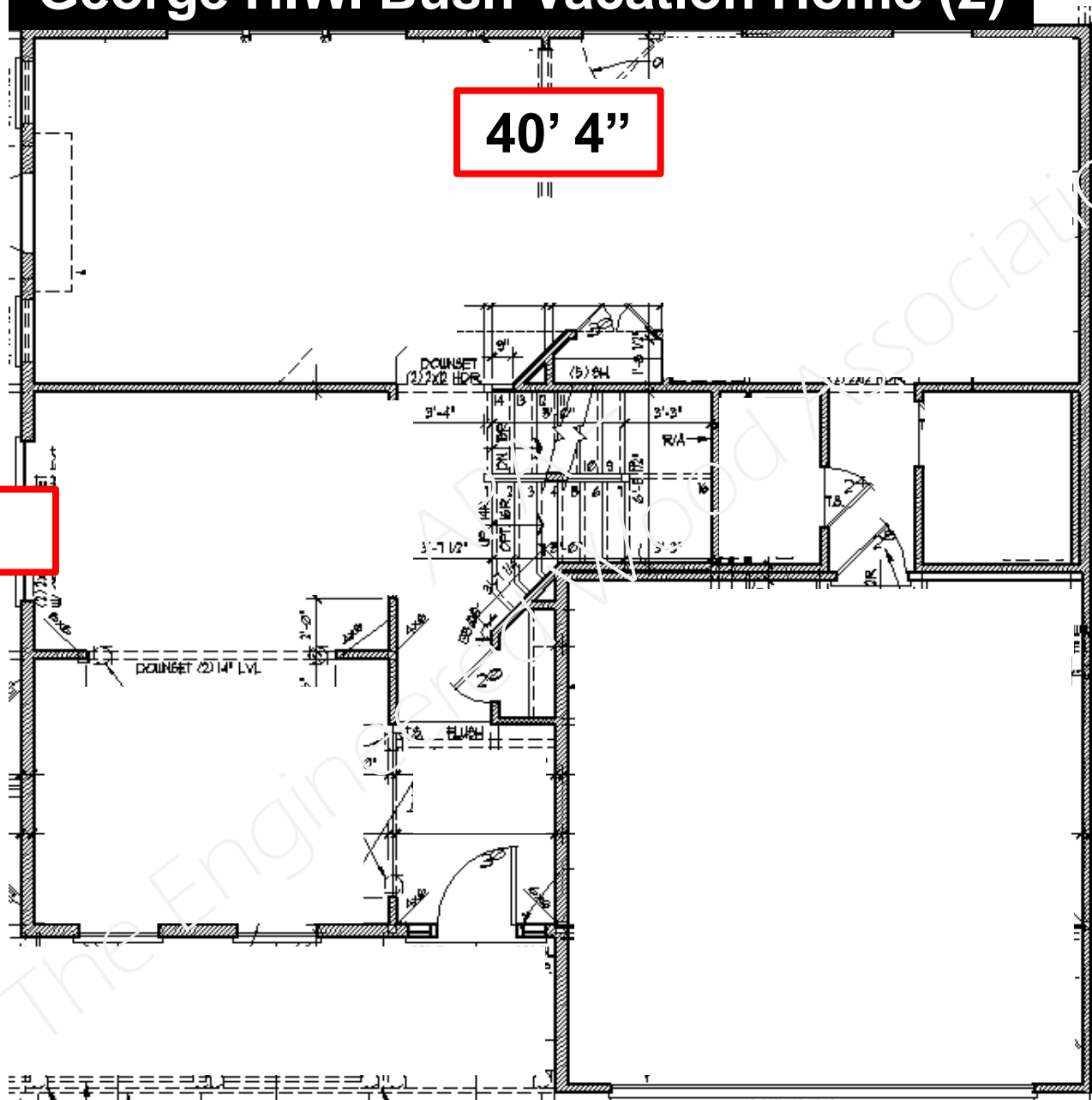
$$A,B: 5.5' - 4.0' = 1.5'; 1.5' \times 50\% = .8'; 4.0' + 0.8' = 4.8'$$



George H.W. Bush Vacation Home (2)

40' 4"

40' 2"



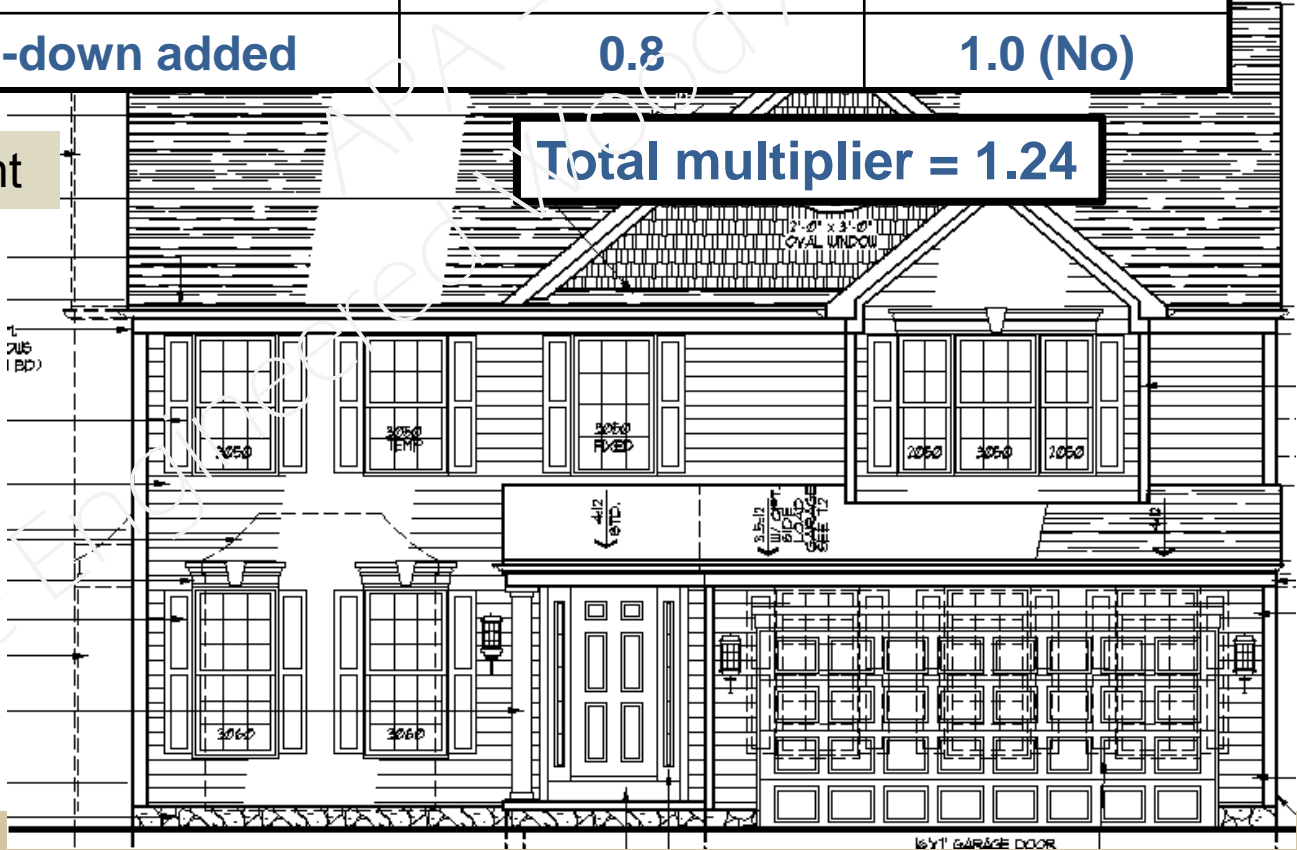
Description	Adjustment Factors	
Wind Exposure	1.0 - 1.7	1.0 (B)
Roof Eave to Ridge Height	0.7 - 1.6	1.3 (<15')
Wall Height	0.9 - 1.1	.95 (9')
Number of Braced Wall Lines	1.3 - 1.6	1.0 (2)
No gypsum finish	1.4 - 1.8	1.0 (No)
Approved hold-down added	0.8	1.0 (No)

< 15' Ridge height

Total multiplier = 1.24

8' wall

9' wall



Perpendicular Wall = 41'; First story of 2; 90 mph; CS-WSP

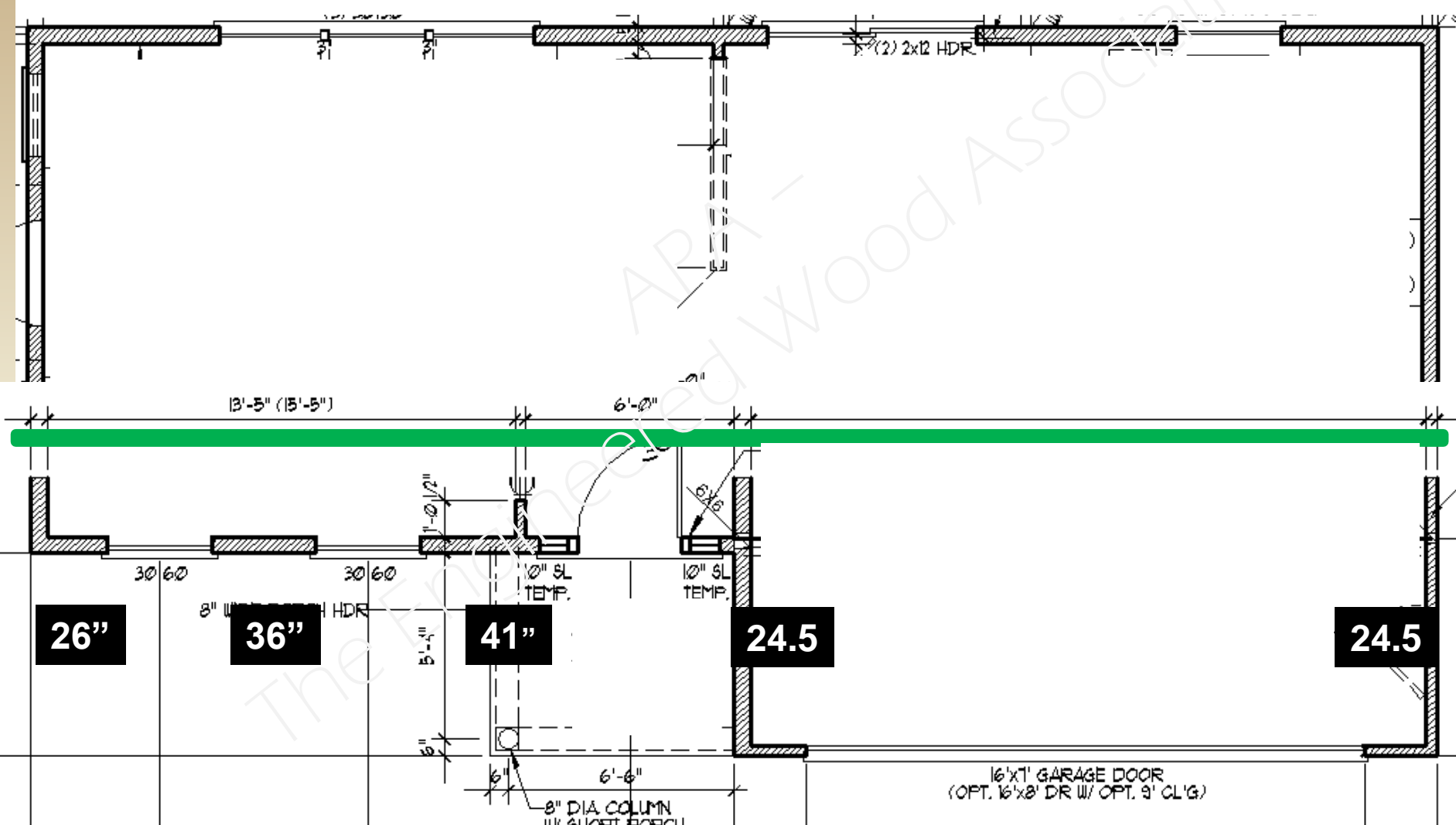
$14.5' - 12.0' = 2.5'$; $2.5' \times 10\% = .25'$; $12.0' + 0.25' = 12.25' \times 1.24 = 15.9'$

66"

79.5

68"

54"

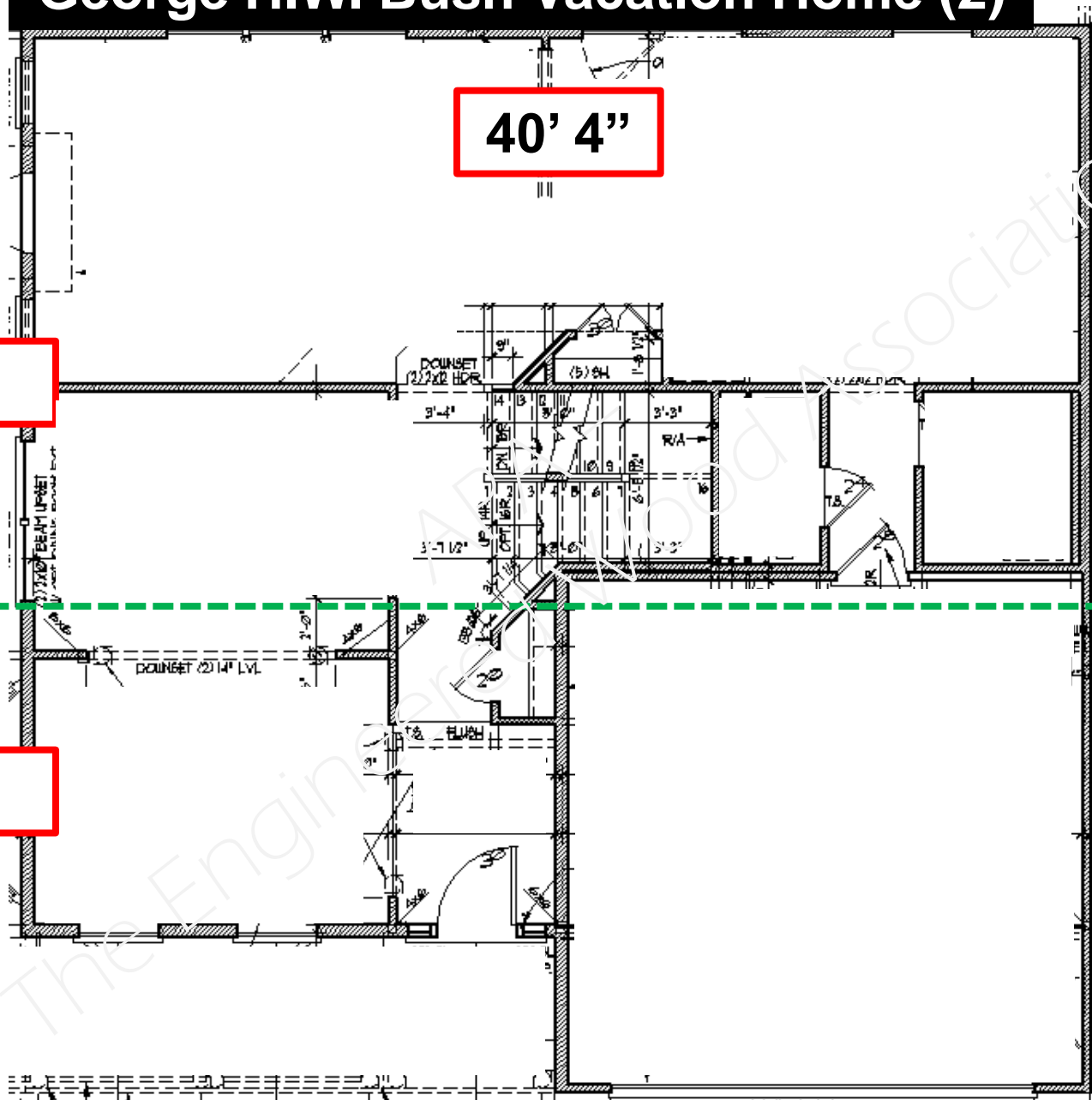


George H.W. Bush Vacation Home (2)

40' 4"

20' 0"

20' 2"

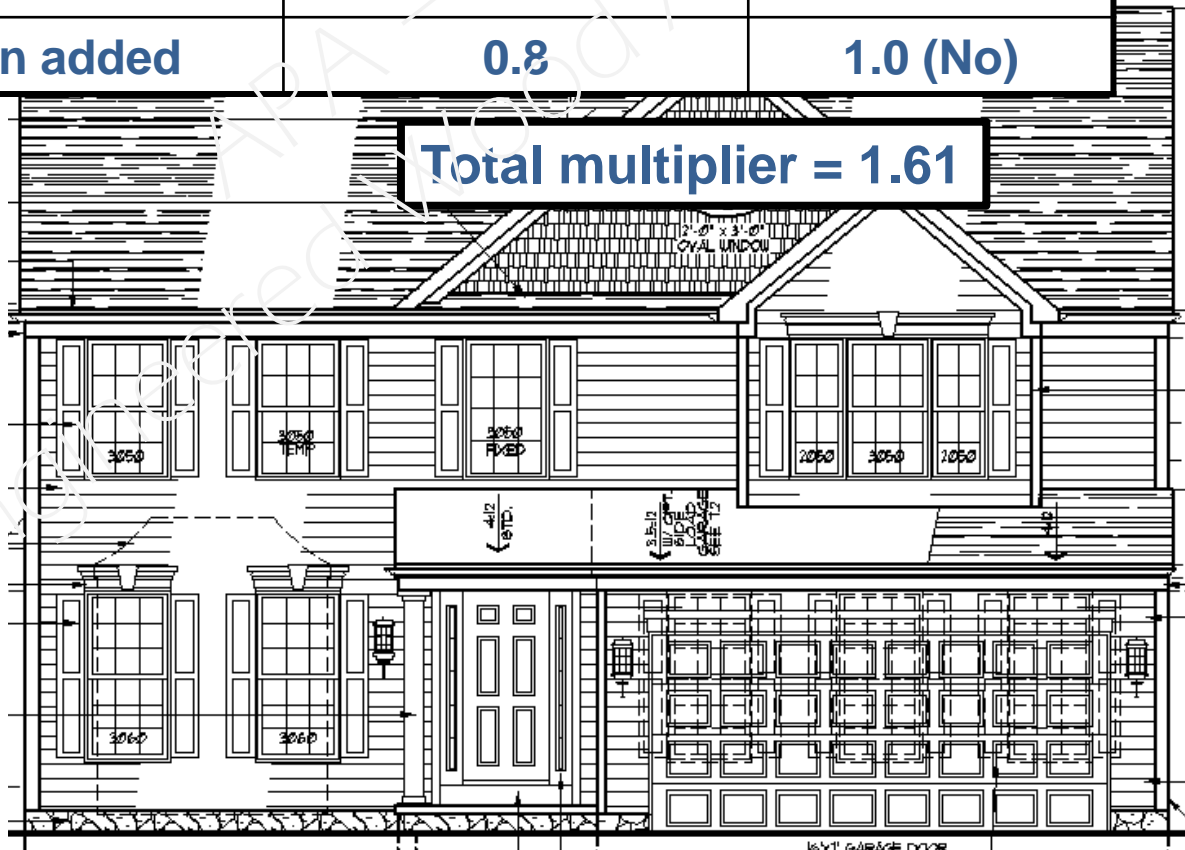


Description	Adjustment Factors	
Wind Exposure	1.0 - 1.7	1.0 (B)
Roof Eave to Ridge Height	0.7 - 1.6	1.3 (<15')
Wall Height	0.9 - 1.1	.95 (9')
Number of Braced Wall Lines	1.3 - 1.6	1.3 (3)
No gypsum finish	1.4 - 1.8	1.0 (No)
Approved hold-down added	0.8	1.0 (No)

< 15' Ridge height

8' wall

9' wall



Perpendicular Wall = 21'; First story of 2; 90 mph; CS-WSP

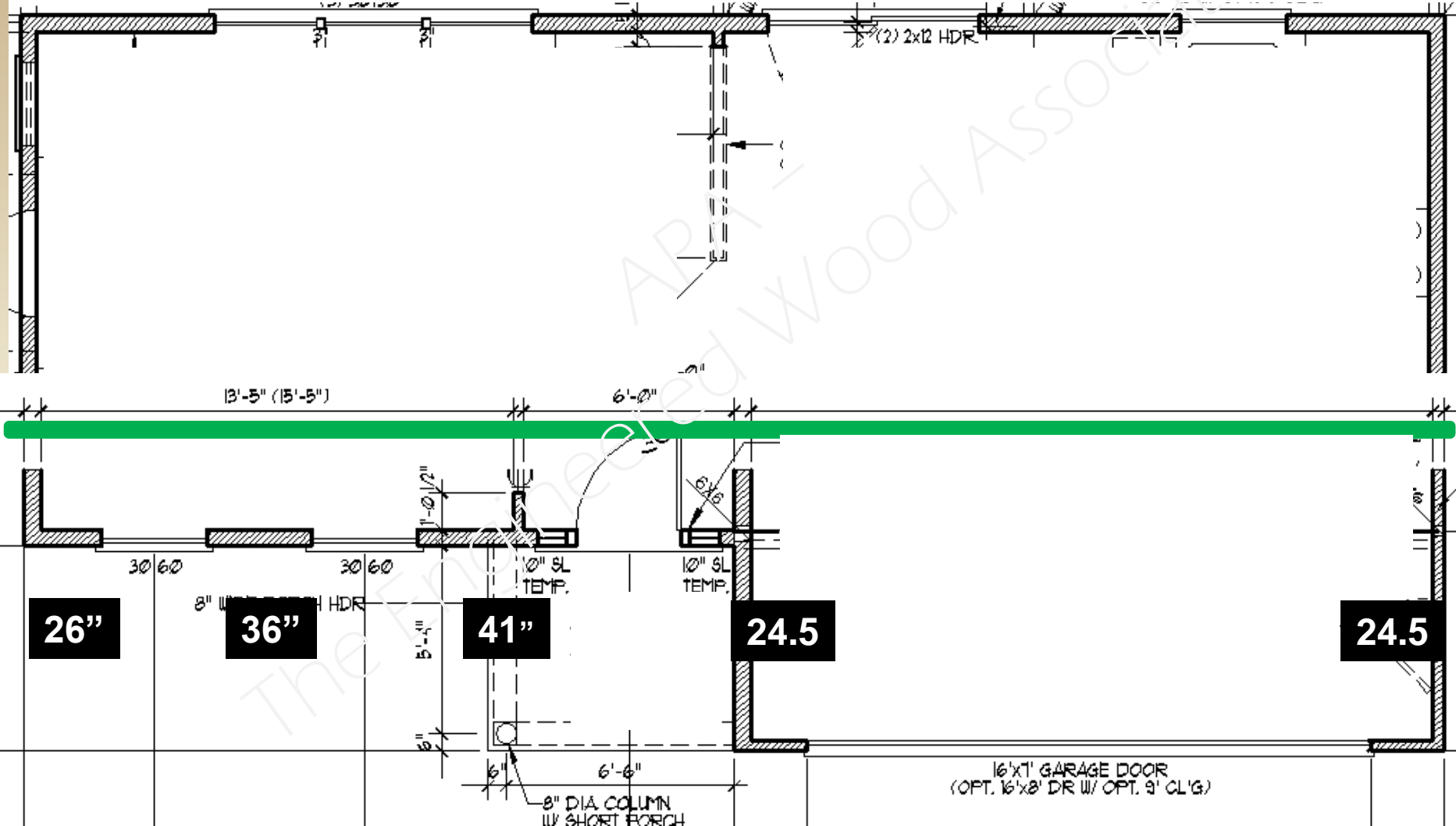
$9.0' - 6.5' = 2.5'$; $2.5' \times 11\% = .28'$; $6.5' + 0.28' = 6.8' \times 1.61 = 11.0'$

66"

79.5

68"

54"





Questions?

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