Frame it Right: Optimizing Size & Framing Efficiency in Mid-Rise Buildings

September 25, 2025

Presented by

Laura Cullen, PE
WoodWorks

Patrick Schleisman
APA – The Engineered Wood Association

Image: Crescent Terminus, Lord Aeck Sargent, SCA Consulting Engineers, photo Richard Lubrant

Frame It Right!
Back to Basics for Big Buildings

Patrick Schleisman

Engineered Wood Specialist

Field Services Division Territories

Frame it Right!
Back to Basics for Big Buildings

Course Description:

The demand for commercial and multifamily construction is soaring, and the framing industry is expanding to meet this demand.

APA – The Engineered Wood Association has walked hundreds of job sites and identified the most common wood construction framing errors found in today's nonresidential buildings.

This session examines the consequences of these framing mistakes from the ground up providing practical solutions for avoiding typical issues using APA resources as a guide.

Frame it Right!
Back to Basics for Big Buildings

Learning Objectives:

- **Identify common pitfalls in the construction of low-rise wood buildings.**
- **Understand how the loads on a nonresidential wood building influence framing and mitigate negative effects of loading.**
- **Understand how engineered wood products (EWP) may be used and how to choose EWP products that meet those needs.**
- **Learn how to navigate technical resources to address the challenges with nonresidential wood buildings framers.**

APA

Agenda

Why is training needed?

- **Building from the ground up**
- **Wood Strength**
- **Walls**
- **Floors**
- **Roofs**
- **Special Topics**
- **Q&A**

Engineered Wood Products (EWP)

- ✓ **Plywood**
- ✓ **OSB – Oriented Strand Board**
- ✓ **I-joist and Rim Board**
- ✓ **Glulam – Glued Laminated Timber**
- ✓ **LVL – Laminated Veneer Lumber**
- ✓ **LSL – Laminated Strand Lumber**
- ✓ **OSL – Oriented Strand Lumber**
- ✓ **CLT – Cross Laminated Timber**
- ✓ **MPP – Mass Plywood Panels**

APA

Engineered Wood Products (EWP)

APA Stamp in the Field

APA Panel Certification Marks

APA panel grade

Span rating

Bond classification

SIZED FOR SPACING

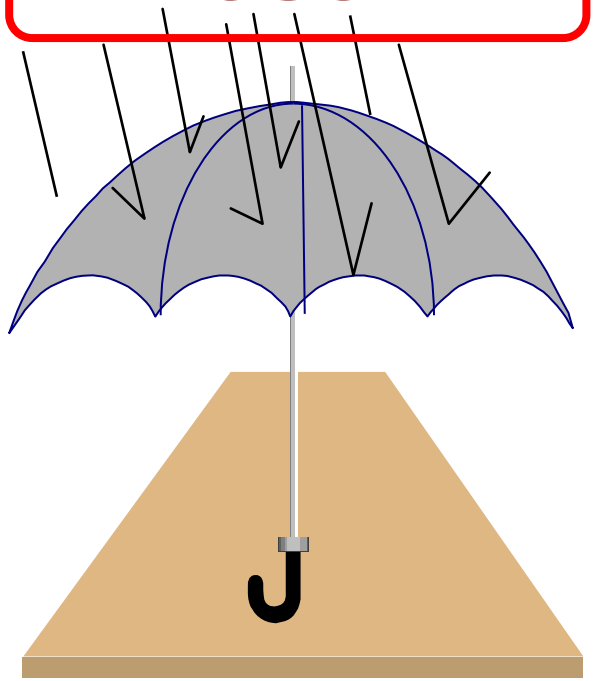
Mill number

Performance-rated panel standard

Performance category

Bond Classification

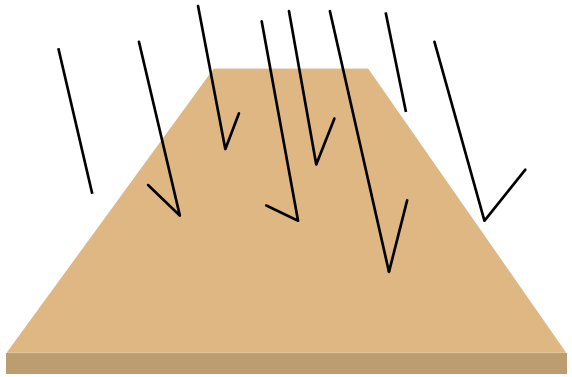
EXPOSURE 1



Exposure due to construction delays

OR

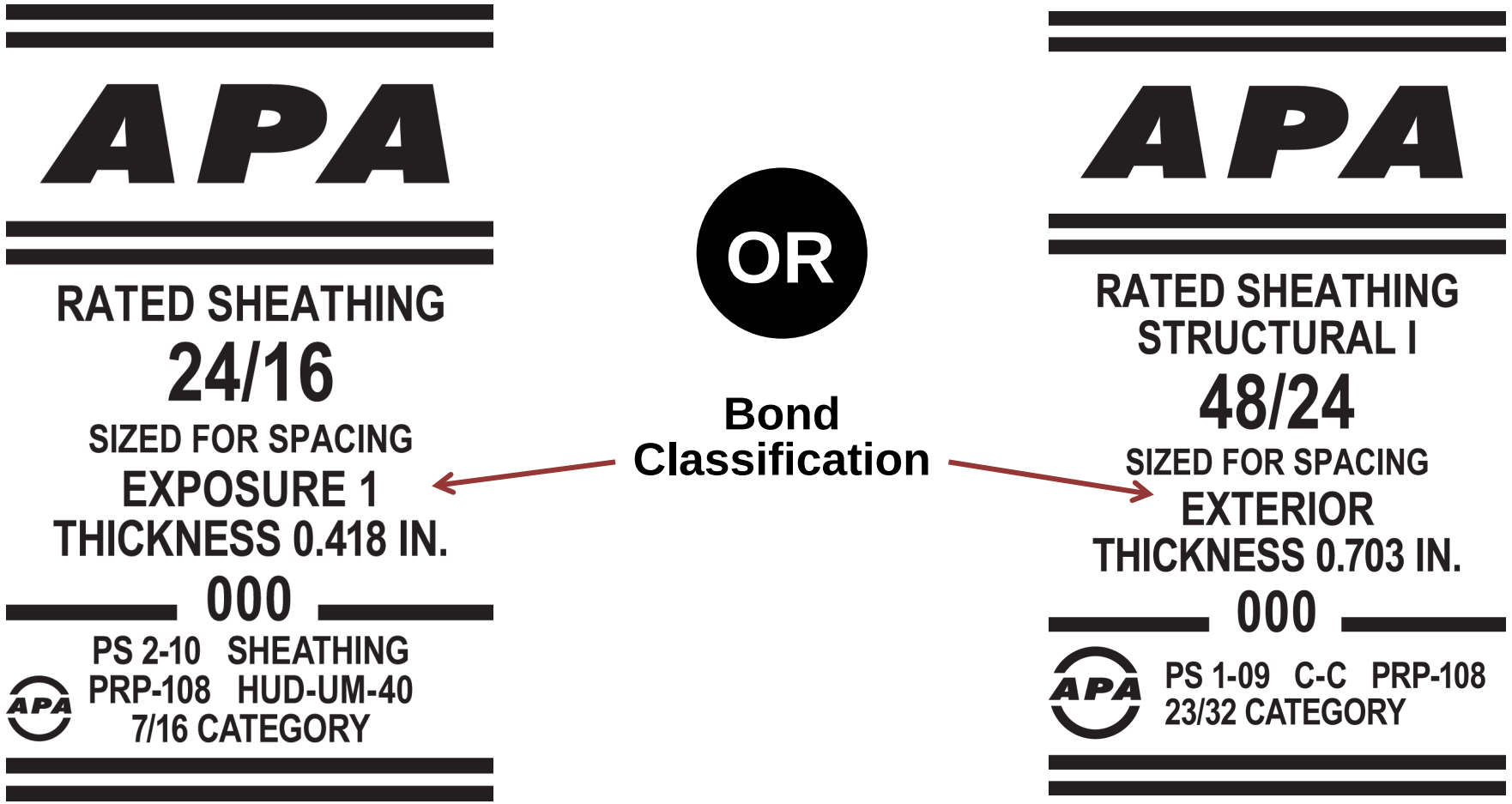
EXTERIOR



Long term weather exposure

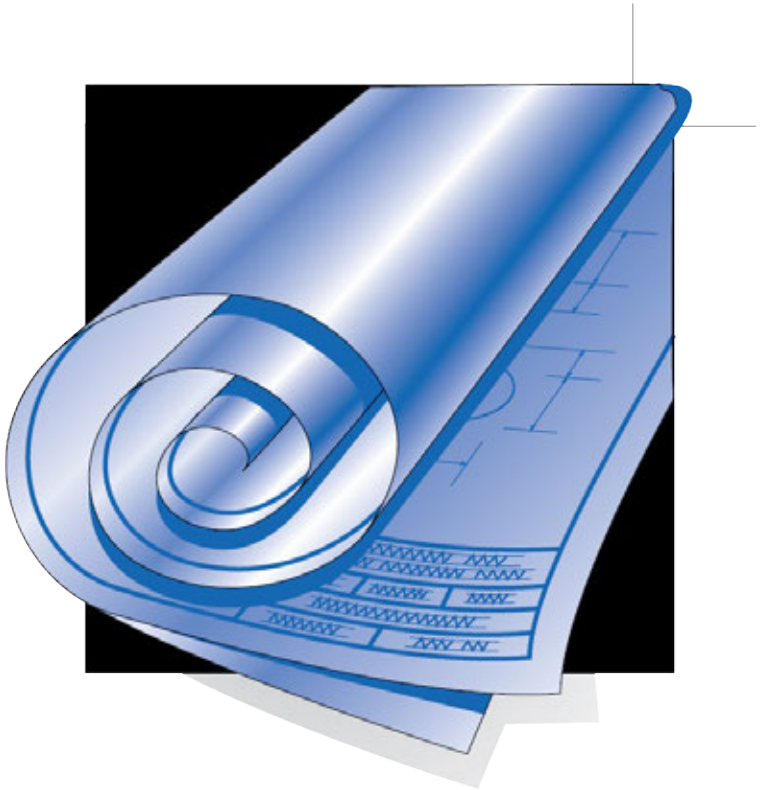
APA

Building From the Ground Up: Special Topics

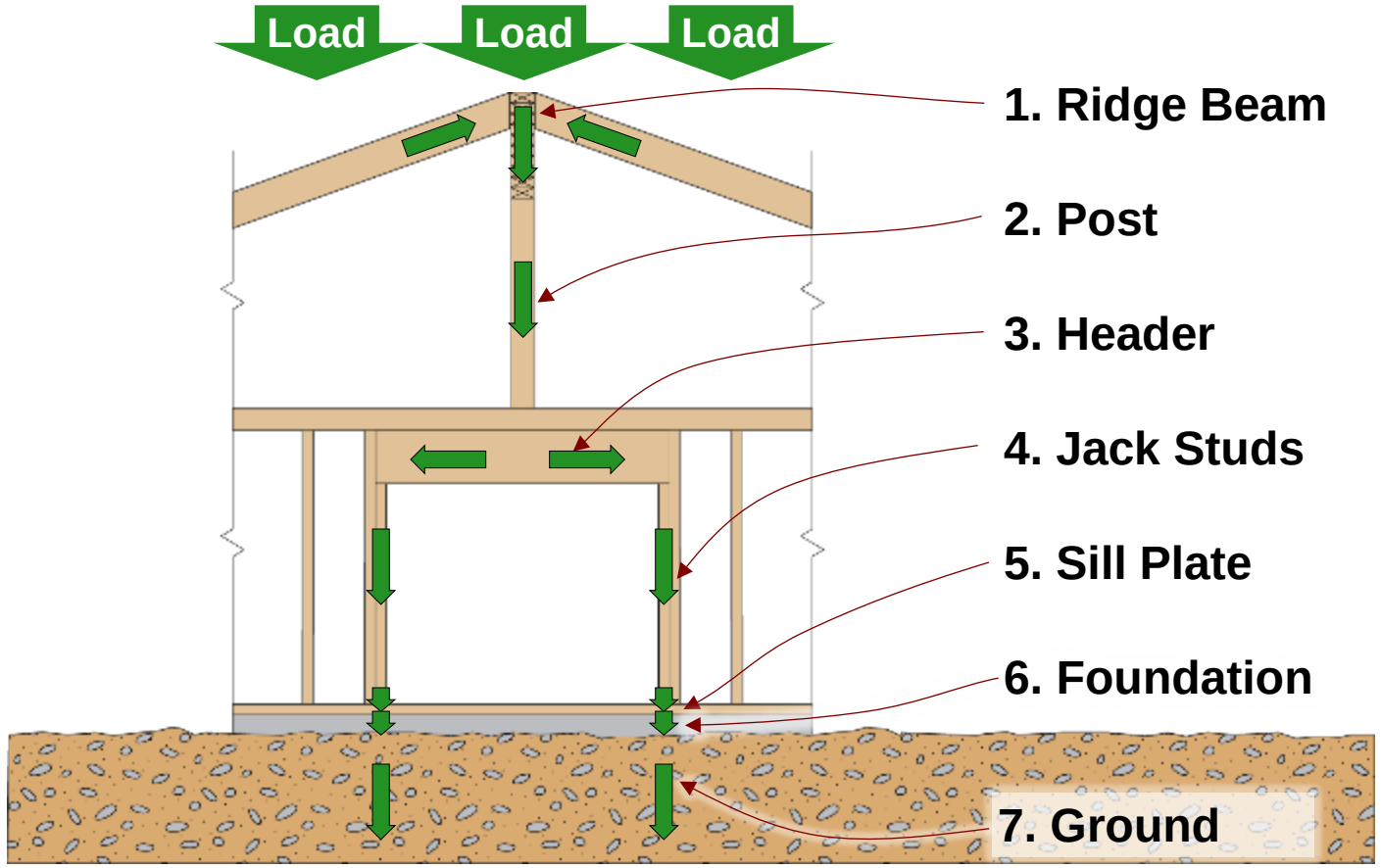


Frame it Right!

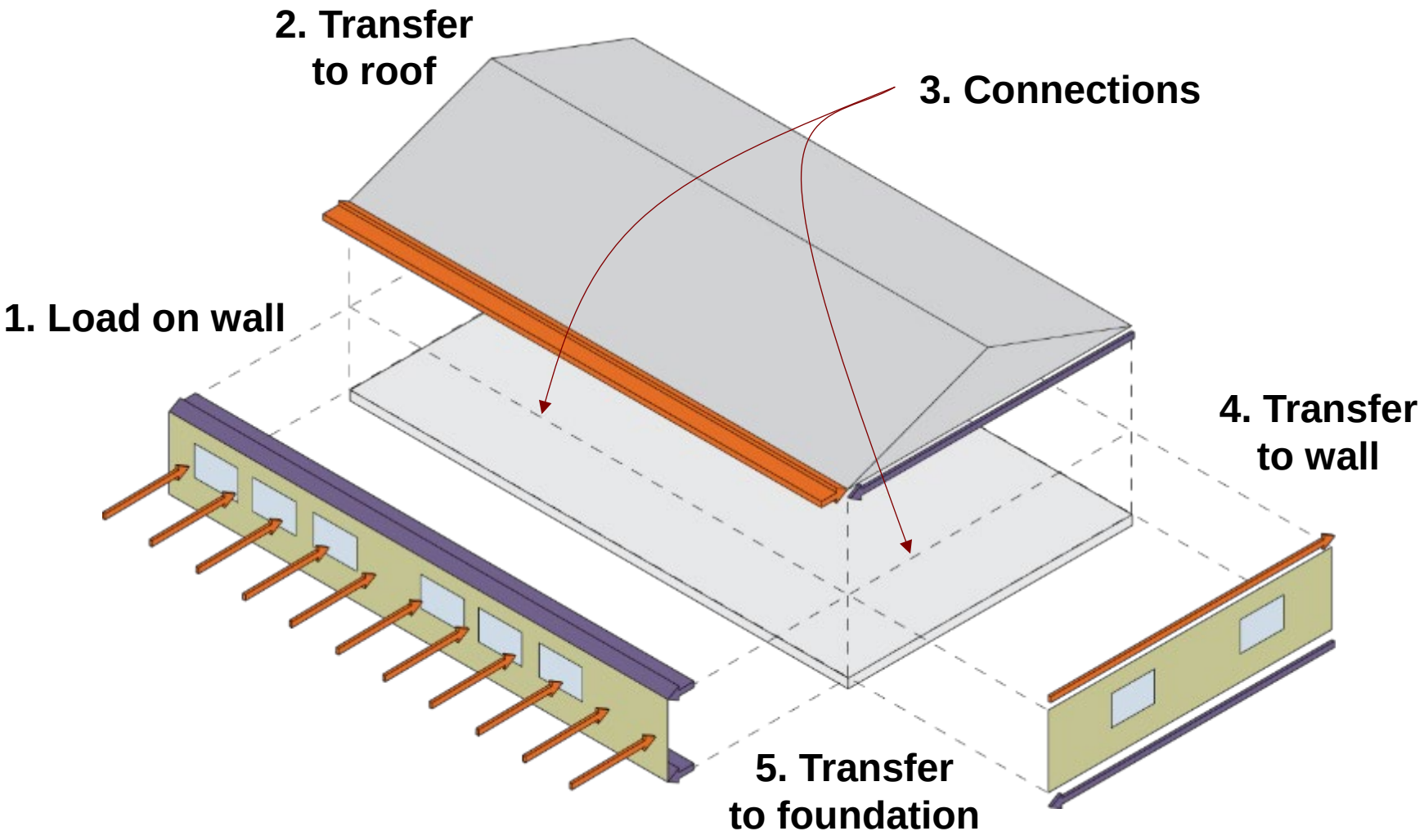
Does this match?



Vertical (Gravity) Load Path

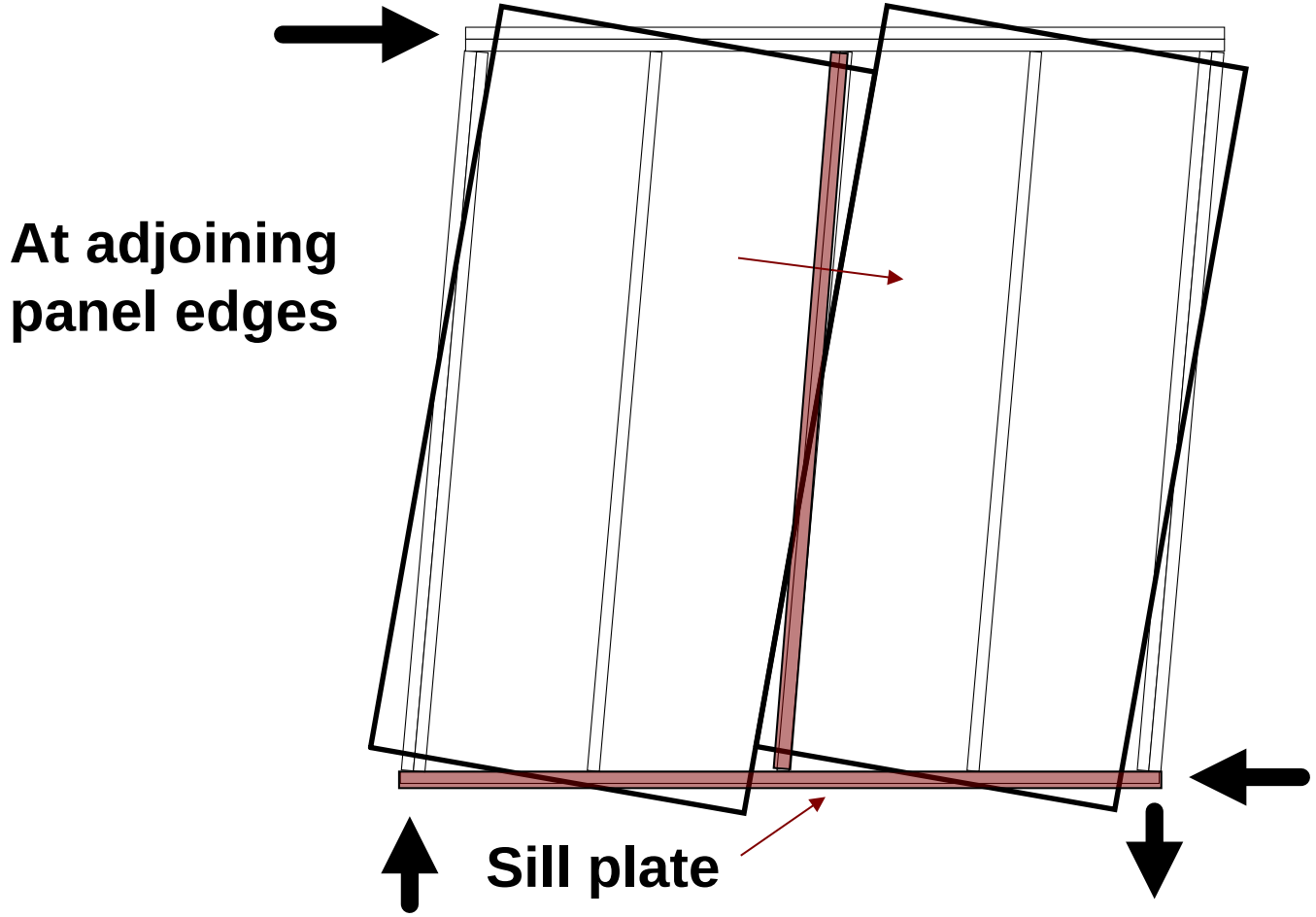


Lateral Load Path



Building From the Ground Up: Walls

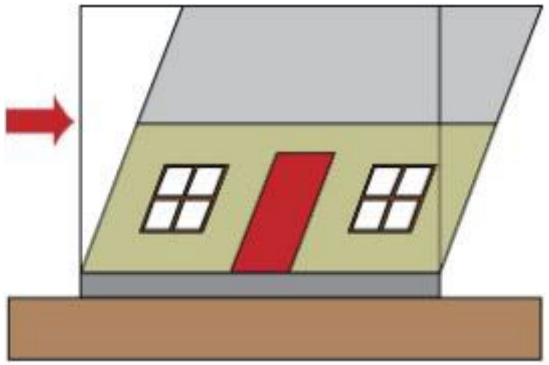
Building From the Ground Up: Walls



Lateral Forces

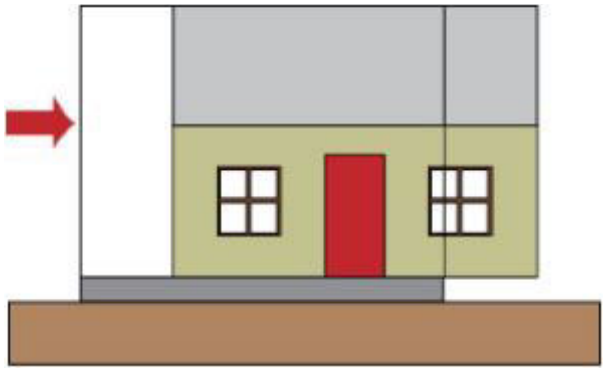
Modes of Failure

Racking



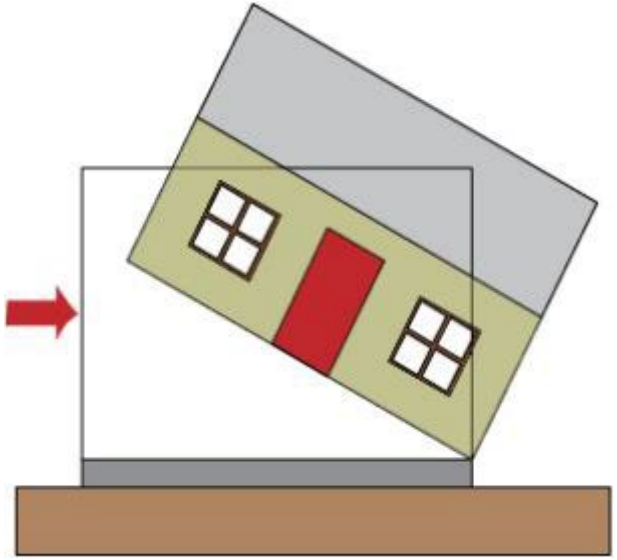
Resisted by Bracing

Base Shear



Resisted by Anchors

Overturning



Resisted by Hold-Downs & Dead Load

Building From the Ground Up: Walls

Anchor Bolts are not Hold-Downs

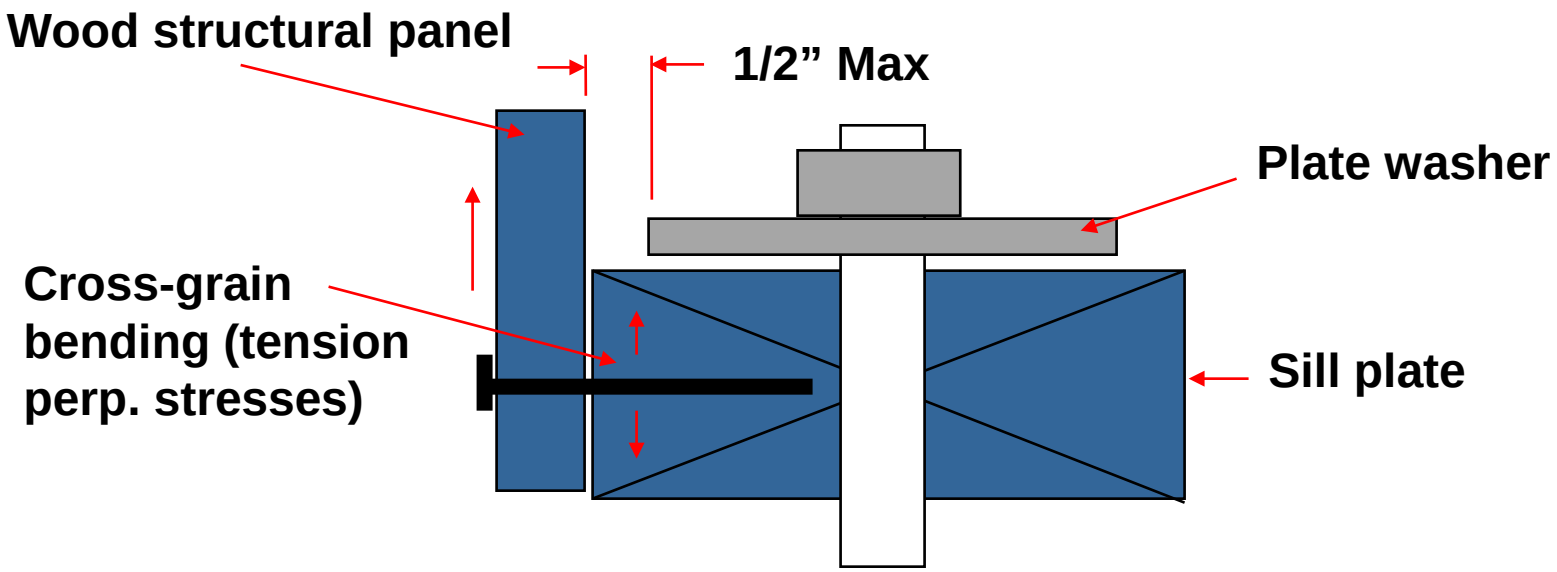
≠

Building From the Ground Up: Walls

Missing washer

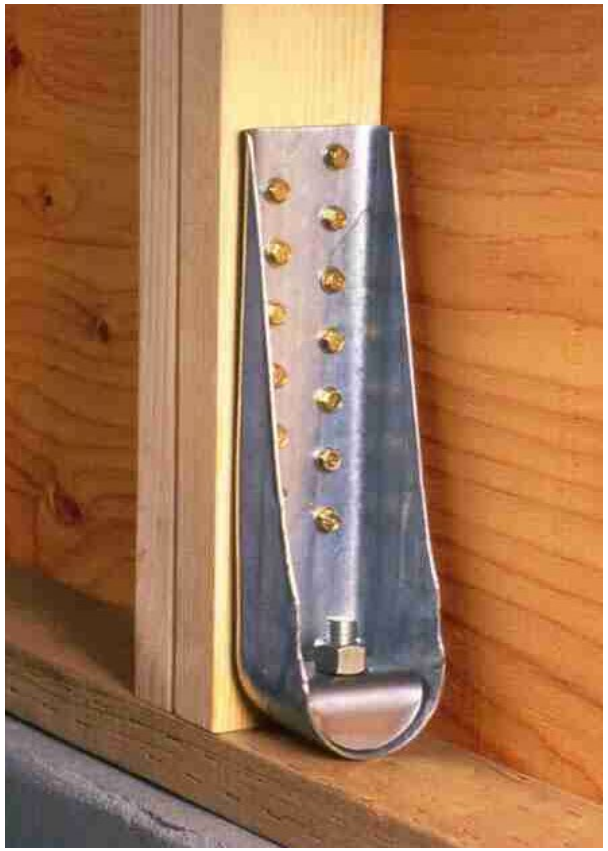
Anchor Bolts

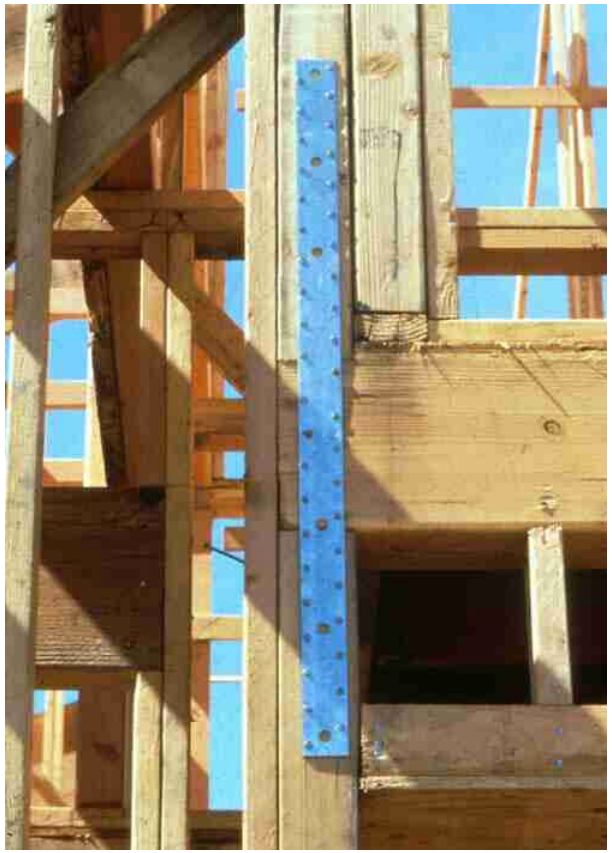
- **Size and spacing per engineer.**
- **Large plate washers (3" x 3" x 0.229") prevent cross- grain bending/splitting of sill plate (required in Seismic Zones D and E, IBC 2308.3.1). APA recommends these for high wind applications.**



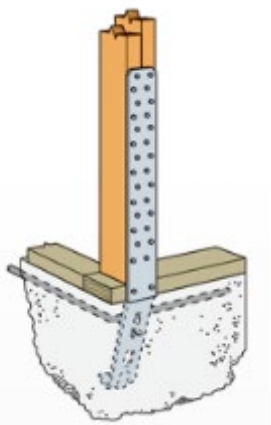
Building From the Ground Up: Walls

Hold-down hardware





Building From the Ground Up: Walls



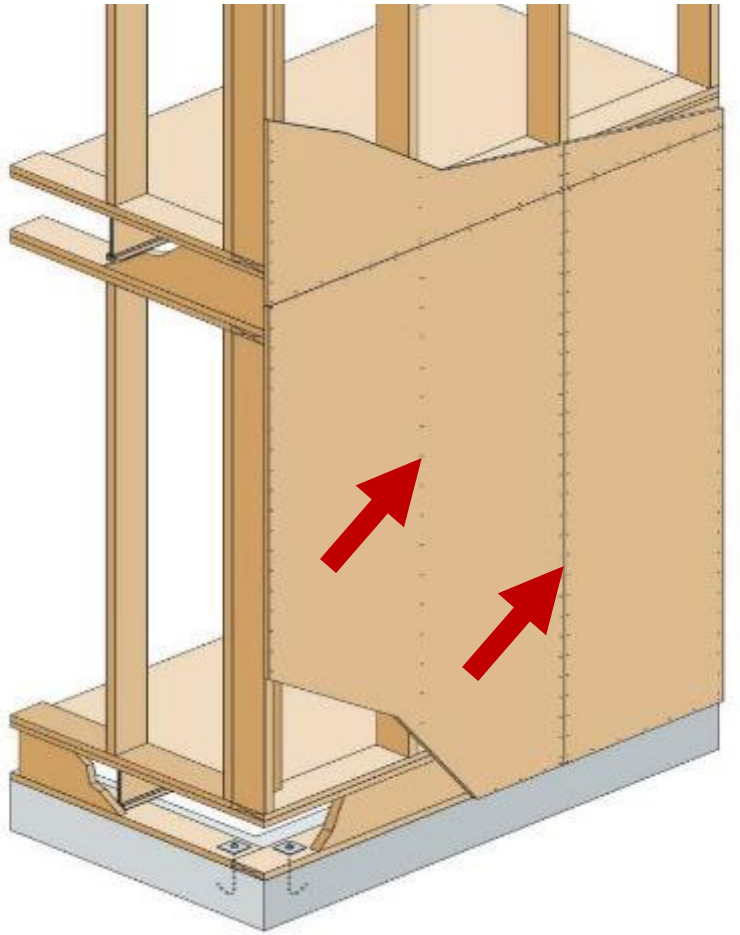
APA

Building From the Ground Up: Walls

Building From the Ground Up: Walls

Wall Sheathing

- **Racking/shear resistance**
- **Wind pressure resistance**
- **Nonstructural benefits**
- **Installation:**
  - Per engineer’s design
  - Min. fastening: 8d nails @ 6" o.c. perimeter
  - and 12" o.c. in the field min.

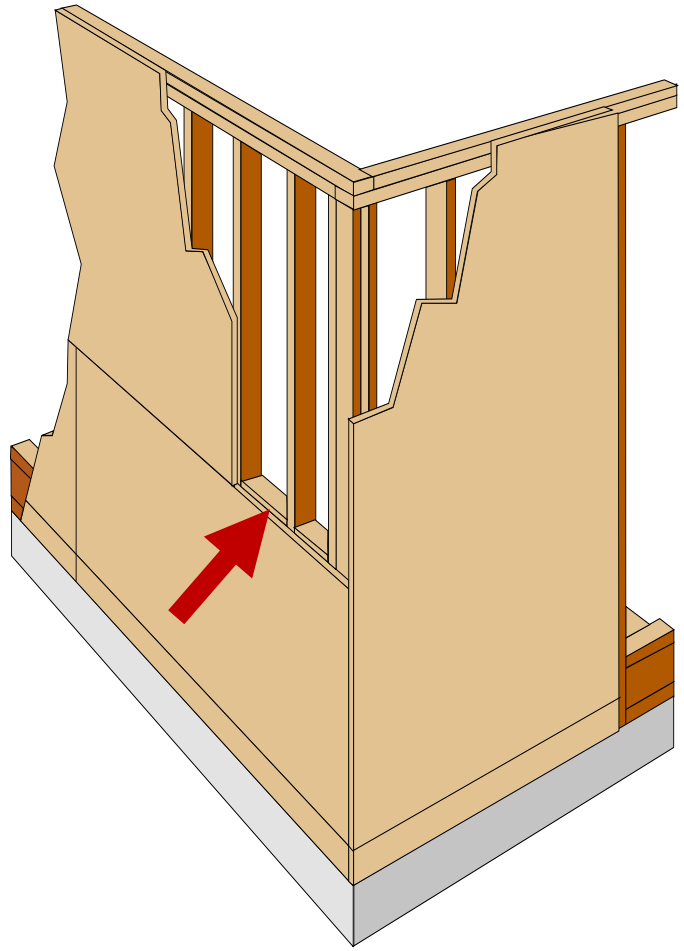


Building From the Ground Up: Walls

Wall sheathing

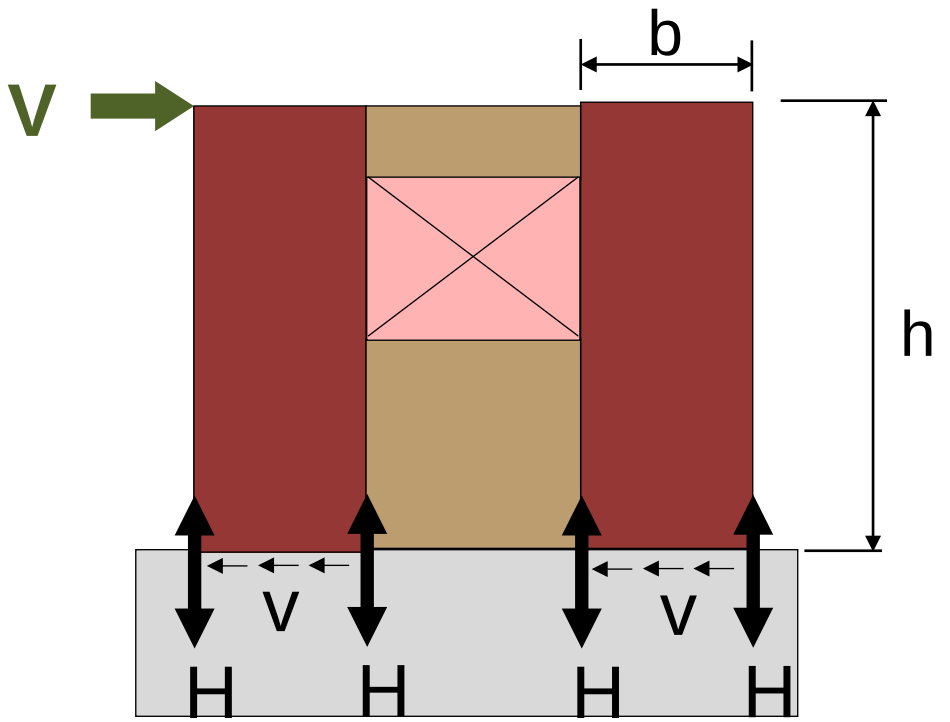
Can be Plywood or OSB

Orientation may require blocking

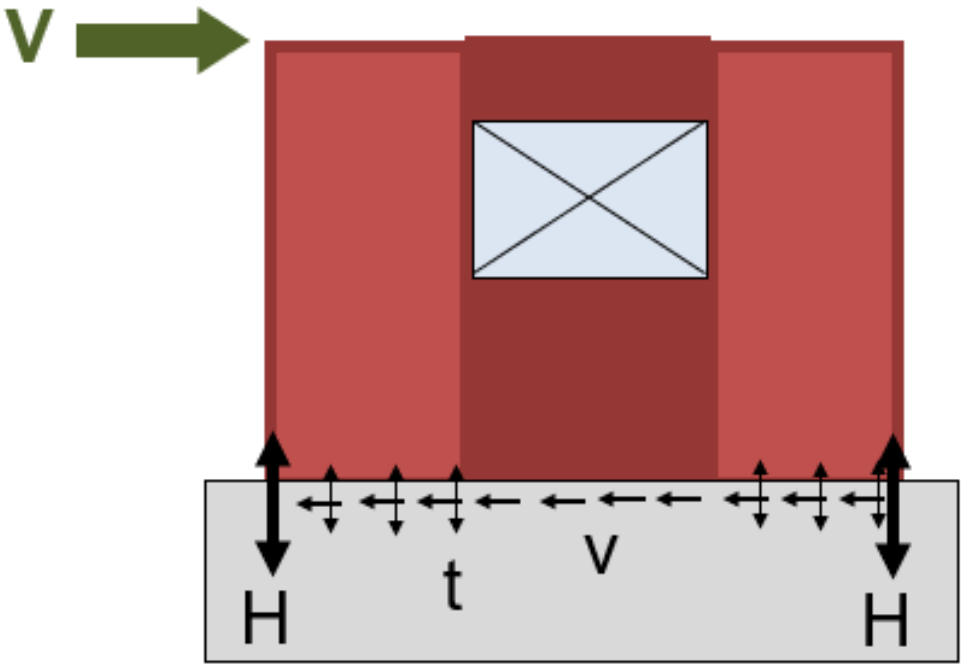


Resource: APA Technical Topics: Plywood or OSB? Used as Intended, the Two Products are Interchangeable, Form TT-047

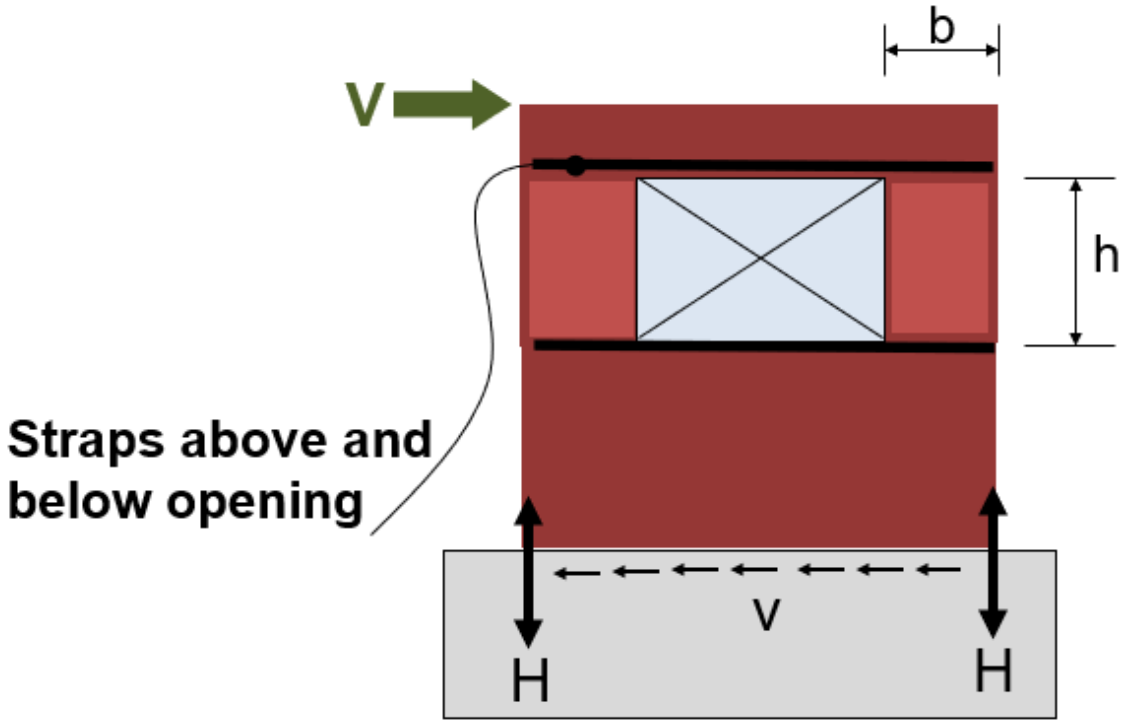
Segmented Shear Walls



Perforated Shear Walls

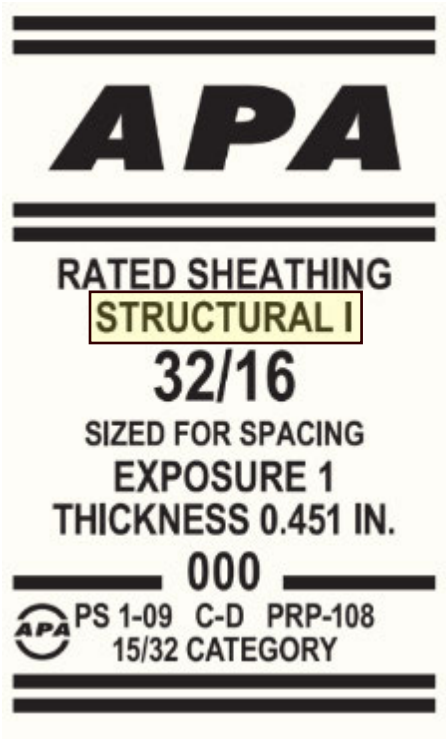


Force Transfer Around Openings (FTAO) Shear Walls



High Load Shear Walls

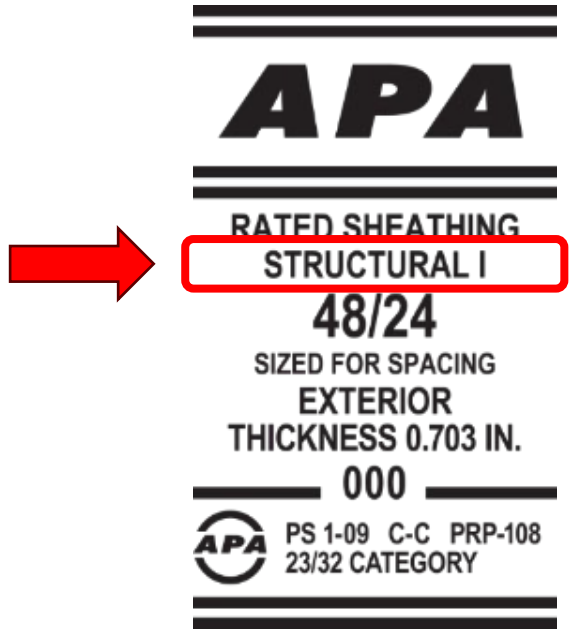
≠

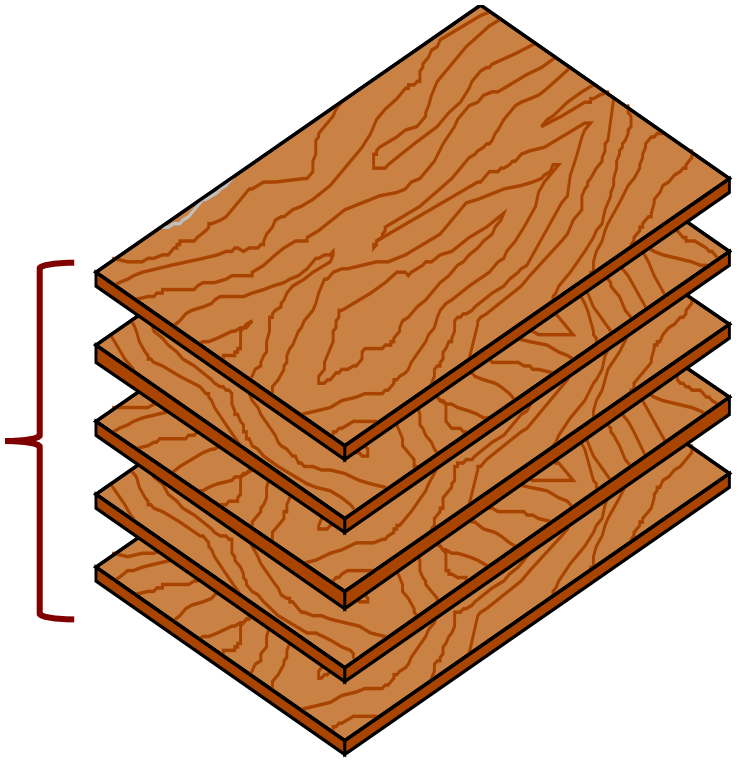


Rated Sheathing versus **Structural I**

Structural I Panels

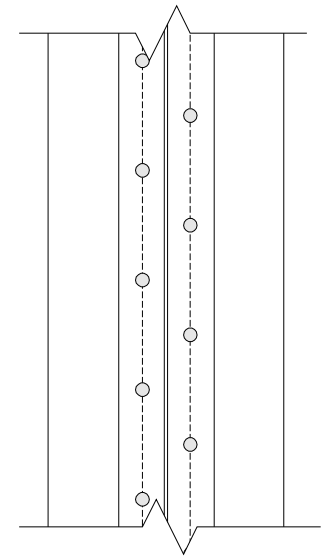
- Increased shear capacity
- Increased stiffness, especially across the panel
- Plywood & OSB (performance tested)
- Before specifying, check local availability



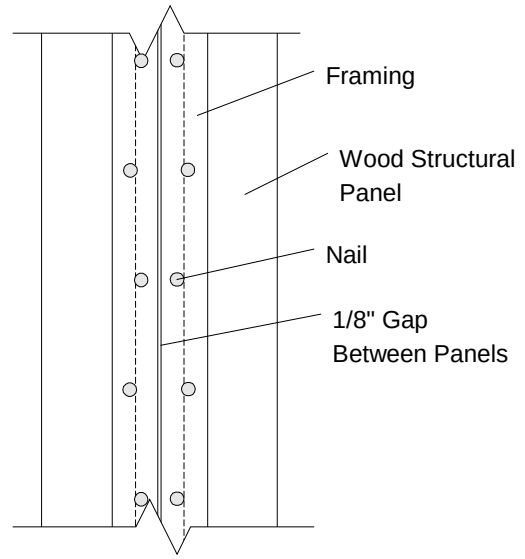


Building From the Ground Up: Walls

Staggered nailing in tightly nailed shear wall helps prevent splitting of framing



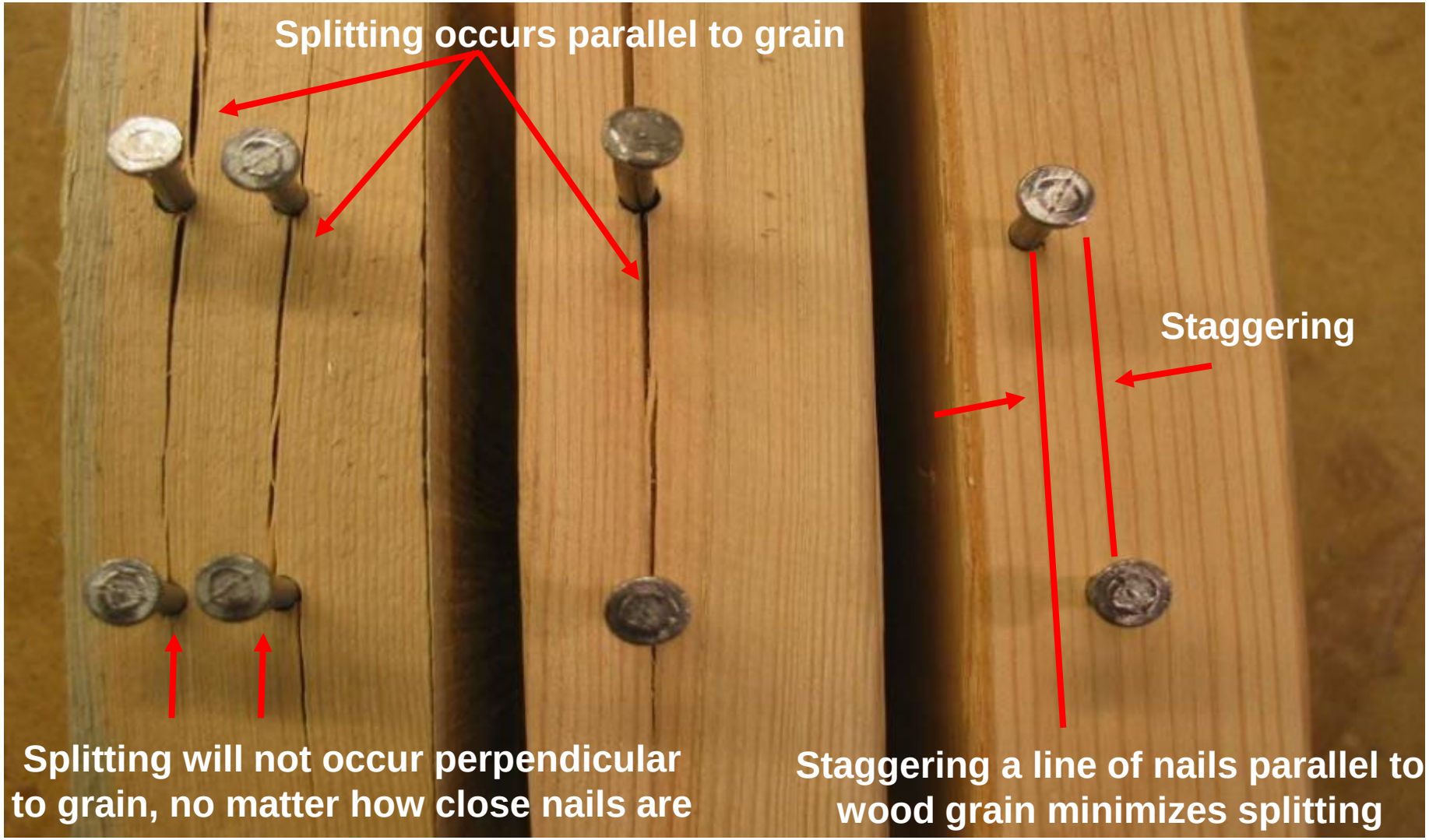
Nailing not staggered



Nailing staggered

APA

Staggered Fastening



Building From the Ground Up: Floors

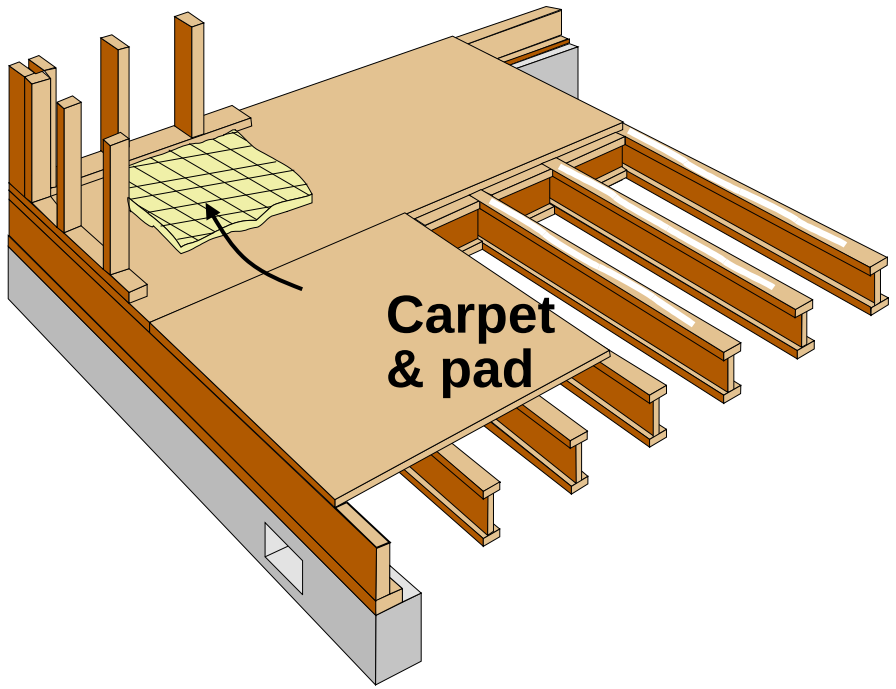
Building From the Ground Up: Floors

Sturd-I-Floor

Combined subfloor & underlayment

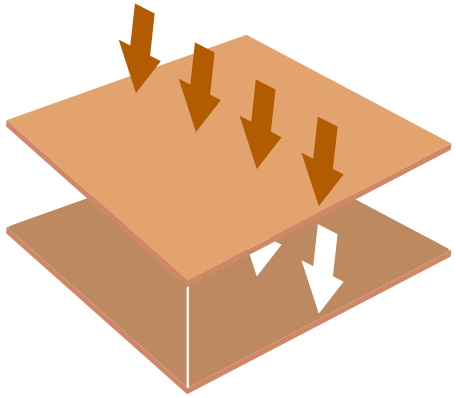
Resistant to concentrated & impact loads

Plywood or OSB



APA

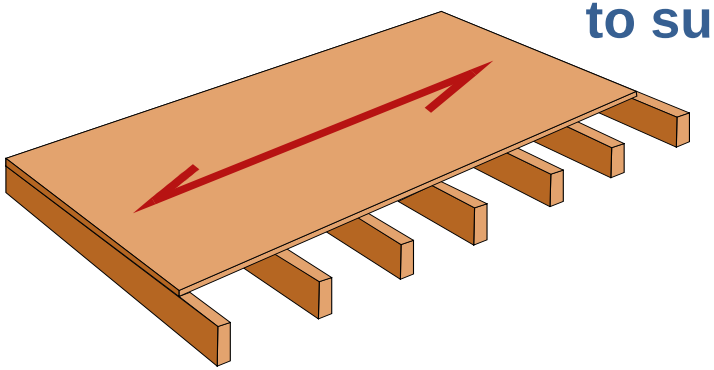
Building From the Ground Up: Floors



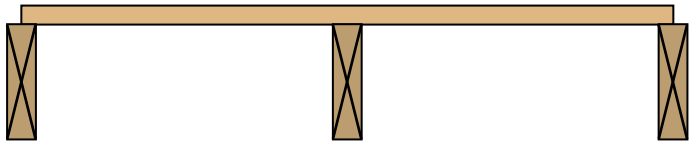
Roof Span L/240
30 PSF live
10 PSF dead

Floor Span L/360
100 PSF live
10 PSF dead

Strength axis perpendicular to supports



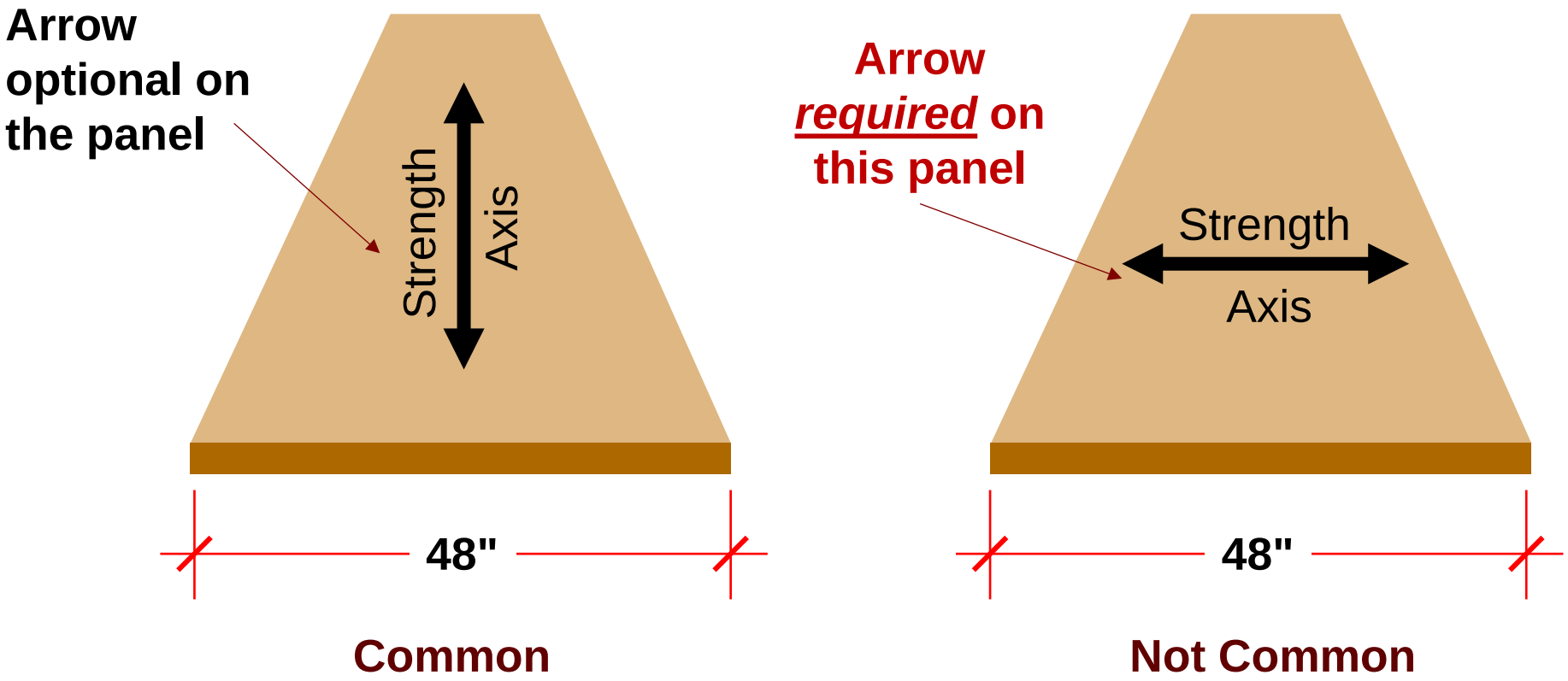
Continuous Span
(2 spans or 3 supports min.)



No simple spans

Building From the Ground Up: Floors

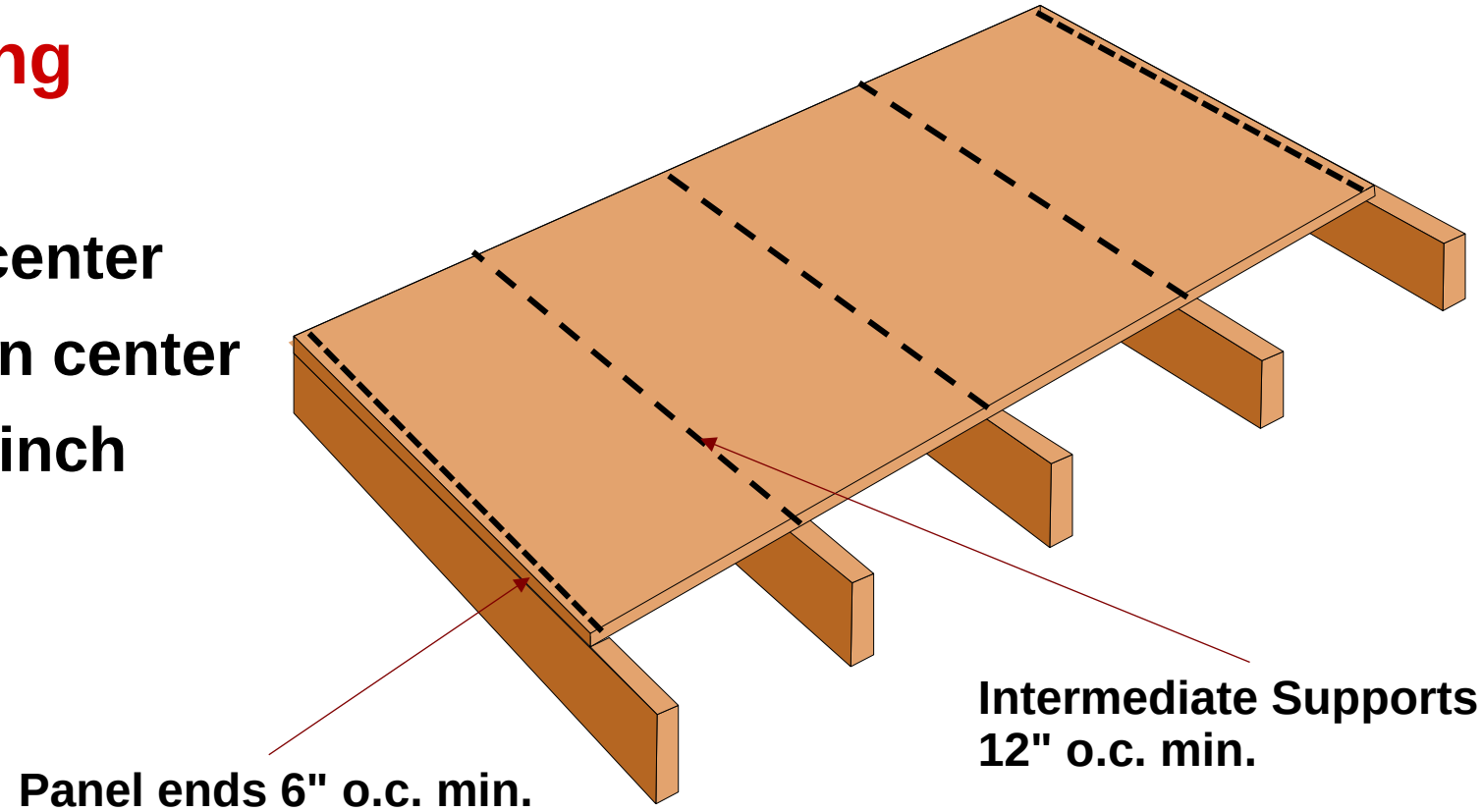
Strength Axis



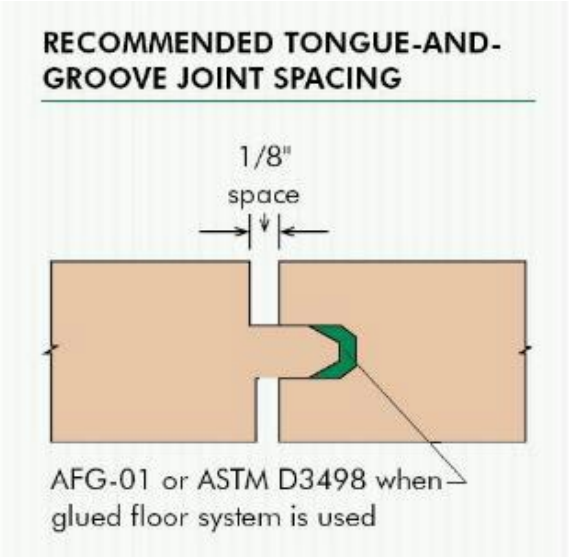
Building From the Ground Up: Floors

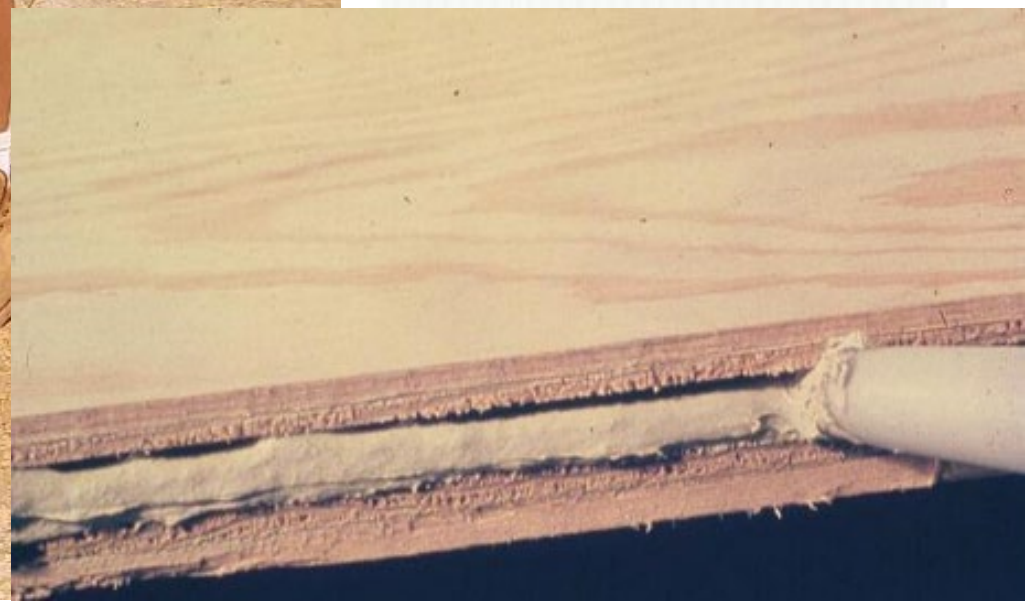
IBC Minimum Nailing

- 8d Common Nails
- Panel ends - 6" on center
- Intermediate - 12" on center
- Edge distance - 3/8 inch



APA





Resource: APA Technical Note: Floor Squeaks – Causes, Solutions and Prevention, Form C468

Fully Fasten with Clamping Force

APA

Building From the Ground Up: Floors

Nail installation

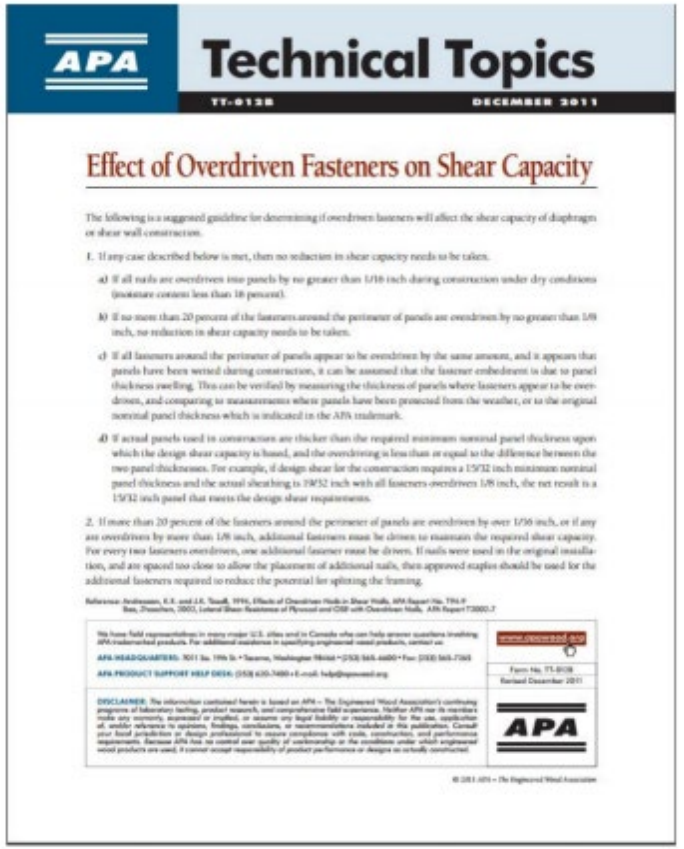
Overdriving reduces performance APA recommends adding one for every two overdriven

Resource: APA Technical Topics: Effect of Overdriven Fasteners on Shear Capacity, Form TT-012

Overdriven Nails

To Maintain Shear Capacity
(APA Technical Topic TT-012)

Overdriven Fasteners	Overdriven Distance	Action
≤ 20% Perimeter	< 1/8"	None
> 20% Perimeter	> 1/16"	Add 1 nail for every 2 overdriven
Any	> 1/8"	



APA Technical Topics

TT-012B DECEMBER 2011

Effect of Overdriven Fasteners on Shear Capacity

The following is a suggested guideline for determining if overdriven fasteners will affect the shear capacity of diaphragm or shear wall construction.

1. If any case described below is met, then no reduction in shear capacity needs to be taken.

a) If all nails are overdriven into panels by no greater than 1/16 inch during construction under dry conditions (moisture content less than 16 percent).

b) If no more than 20 percent of the fasteners around the perimeter of panels are overdriven by no greater than 1/8 inch, no reduction in shear capacity needs to be taken.

c) If all fasteners around the perimeter of panels appear to be overdriven by the same amount, and it appears that panels have been wetted during construction, it can be assumed that the fastener embedment is due to panel thickness swelling. This can be verified by measuring the thickness of panels where fasteners appear to be over-driven, and comparing to measurements where panels have been protected from the weather, or to the original nominal panel thickness which is indicated in the APA trademark.

d) If actual panels used in construction are thicker than the required minimum nominal panel thickness upon which the design shear capacity is based, and the overdriving is less than or equal to the difference between the two panel thicknesses. For example, if design shear for the construction requires a 15/32 inch minimum nominal panel thickness and the actual sheathing is 19/32 inch with all fasteners overdriven 1/8 inch, the net result is a 15/32 inch panel that meets the design shear requirements.

2. If more than 20 percent of the fasteners around the perimeter of panels are overdriven by over 1/16 inch, or if any are overdriven by more than 1/8 inch, additional fasteners must be driven to maintain the required shear capacity. For every two fasteners overdriven, one additional fastener must be driven. If nails were used in the original installation, and are spaced too close to allow the placement of additional nails, then approved staples should be used for the additional fasteners required to reduce the potential for splitting the framing.

Reference: Anderson, E.S. and J.R. Tissell, 1991, Effects of Overdriven Nails in Shear Walls, APA Report No. TT-91-9
Bott, Chunchen, 1993, Lateral Shear Resistance of Plywood and OSB with Overdriven Nails, APA Report T2003-7

We have field representatives in many major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying engineered wood products, contact us:

APA HEADQUARTERS: 7011 So. 19th St. • Tacoma, Washington 98466 • (253) 565-6600 • Fax: (253) 565-7265

APA PRODUCT SUPPORT HELP DESK: (253) 620-7400 • E-mail: help@apawood.org

www.apawood.org

Form No. TT-012B
Revised December 2011

DISCLAIMER: The information contained herein is based on APA – The Engineered Wood Association's continuing programs of laboratory testing, product research, and comprehensive field experience. Neither APA nor its members make any warranty, guarantee or implied, or assume any legal liability or responsibility for the use, application of, and/or reference to opinions, findings, conclusions, or recommendations included in this publication. Consult your local jurisdiction or design professional to ensure compliance with code, construction, and performance requirements. Because APA has no control over quality of workmanship or the conditions under which engineered wood products are used, it cannot accept responsibility of product performance or designs as actually constructed.

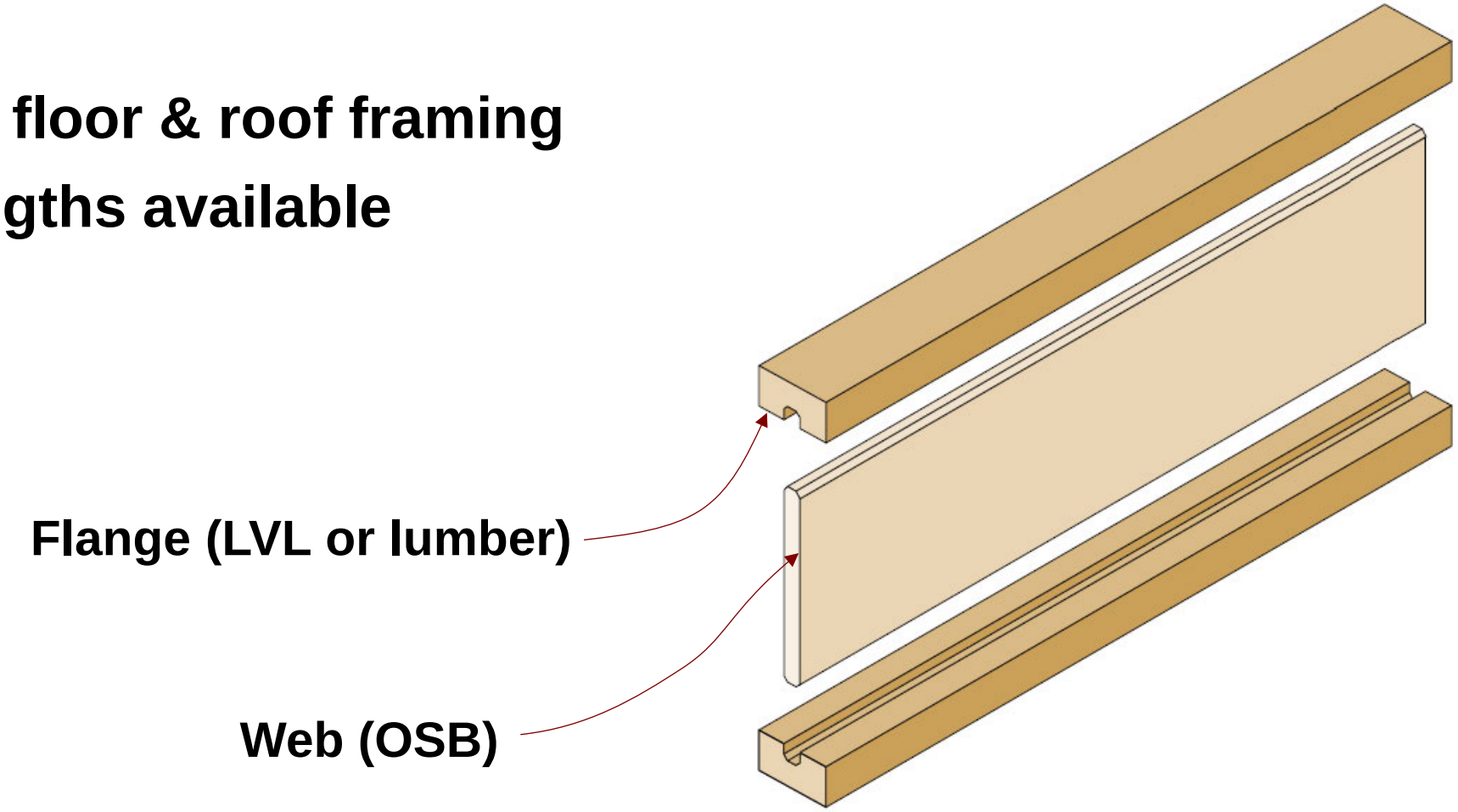
© 2011 APA – The Engineered Wood Association

APA

Use Wood's Strength Direction

I-joist

- Used for floor & roof framing
- Long lengths available



Sustainability

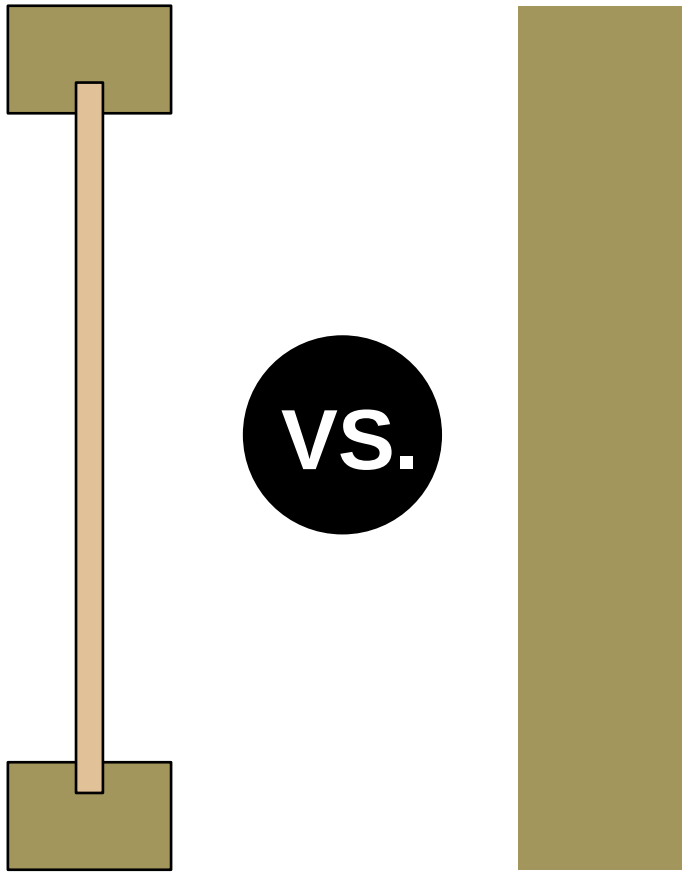
I-joist vs. Lumber

Both at 16" o.c.

- 36% less wood fiber

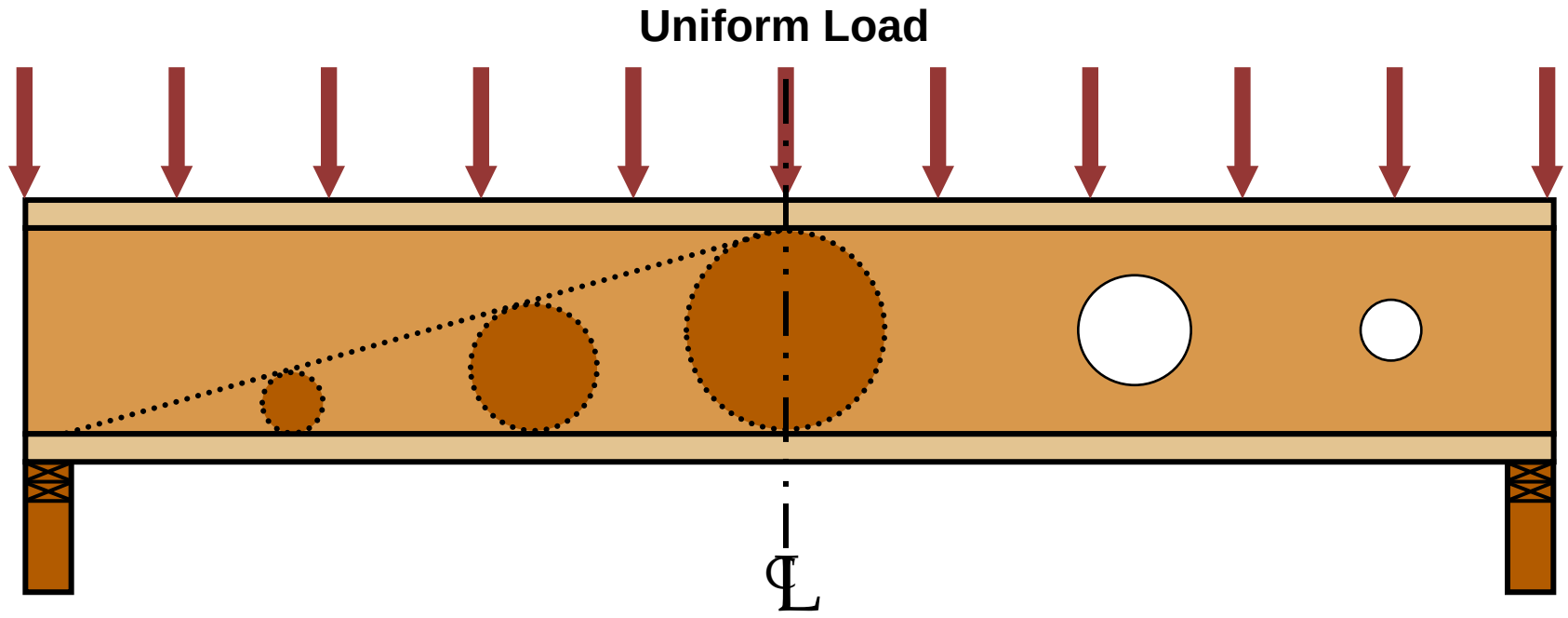
I-joist at 19.2" o.c & Lumber at 16" o.c.

- 46% less wood fiber

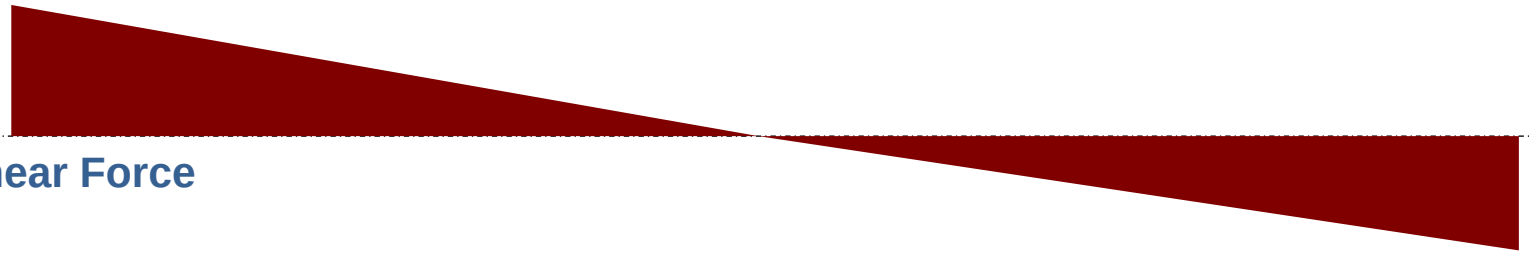



12" OC
24" OC
20'-9"
19'-3"

Building From the Ground Up: Floors

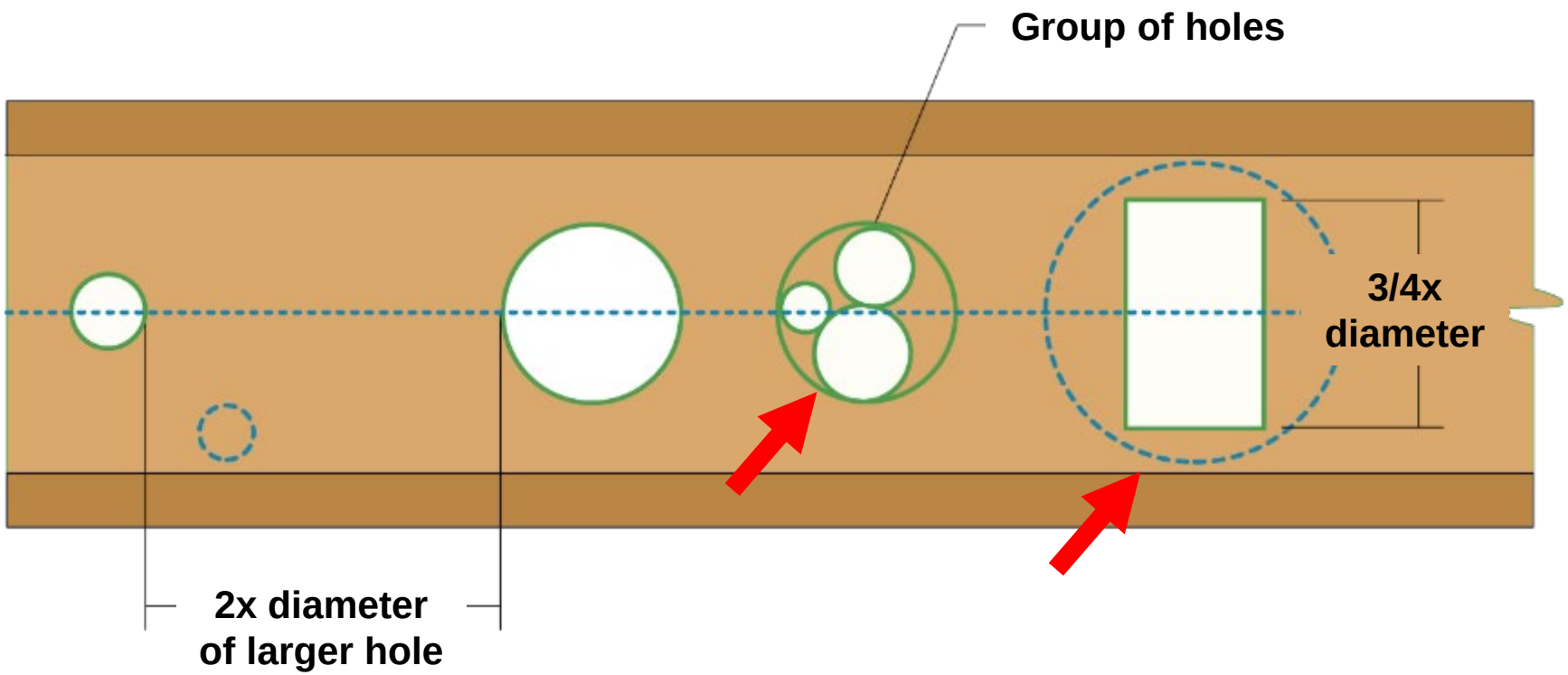


Hole Size in Proportion to Shear Force



Shear Force

Building From the Ground Up: Floors



Check with the I-joist manufacturer's guidelines for holes

I-Joist “Knockouts”


SPACING
SIMPLE SPAN
MULTIPLE SPAN

Building From the Ground Up: Floors

Laminated Veneer Lumber (LVL)

Building From the Ground Up: Floors

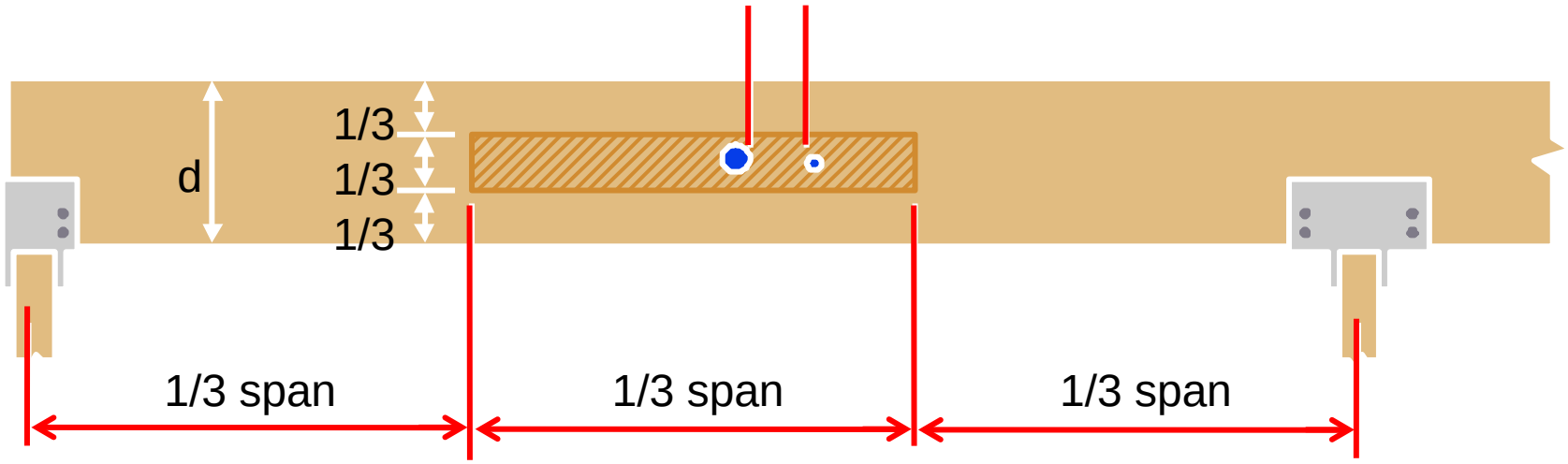
Laminated Strand Lumber (LSL)

Caution when using Unbalanced Glulams

Building From the Ground Up: Floors

APA Tech Note: Field Notching and Drilling LVL, Form G535

Minimum amount of spacing = 2 x diameter of the largest hole



Zone where holes are permitted for passage of wires, conduits, etc.

No holes greater than 2" in diameter. No more than 3 holes per span.

Check with LVL manufacturer's guidelines for holes

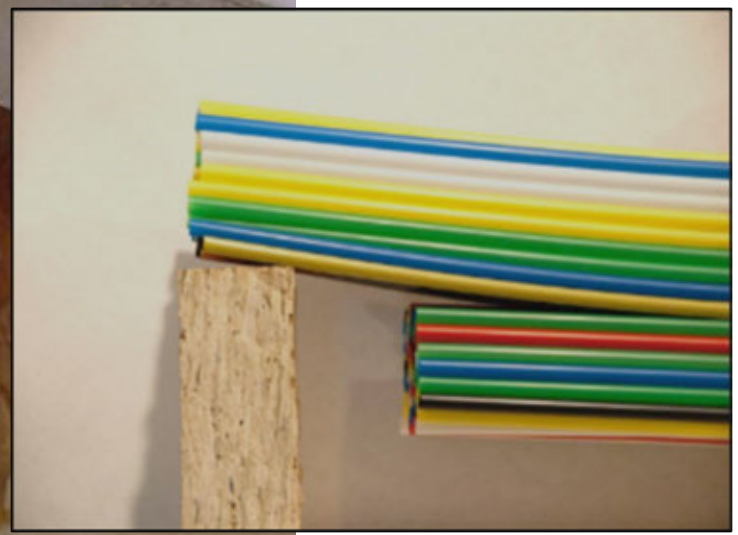
APA Tech Notes: Effect of Large Diameter Horizontal Holes on Properties of LVL and Glulam Beams, Forms V900 and V700

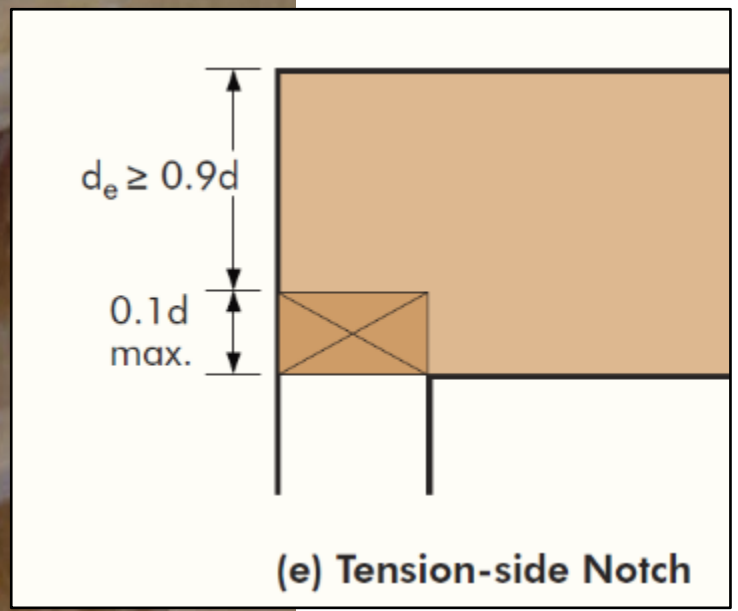
TECHNICAL NOTE

Effect of Large Diameter Horizontal Holes on the Bending and Shear Properties of Laminated Veneer Lumber

TECHNICAL NOTE

Effect of Large Diameter Horizontal Holes on the Bending and Shear Properties of Structural Glued Laminated Timber





Field Notching and Drilling LVL, Form G535

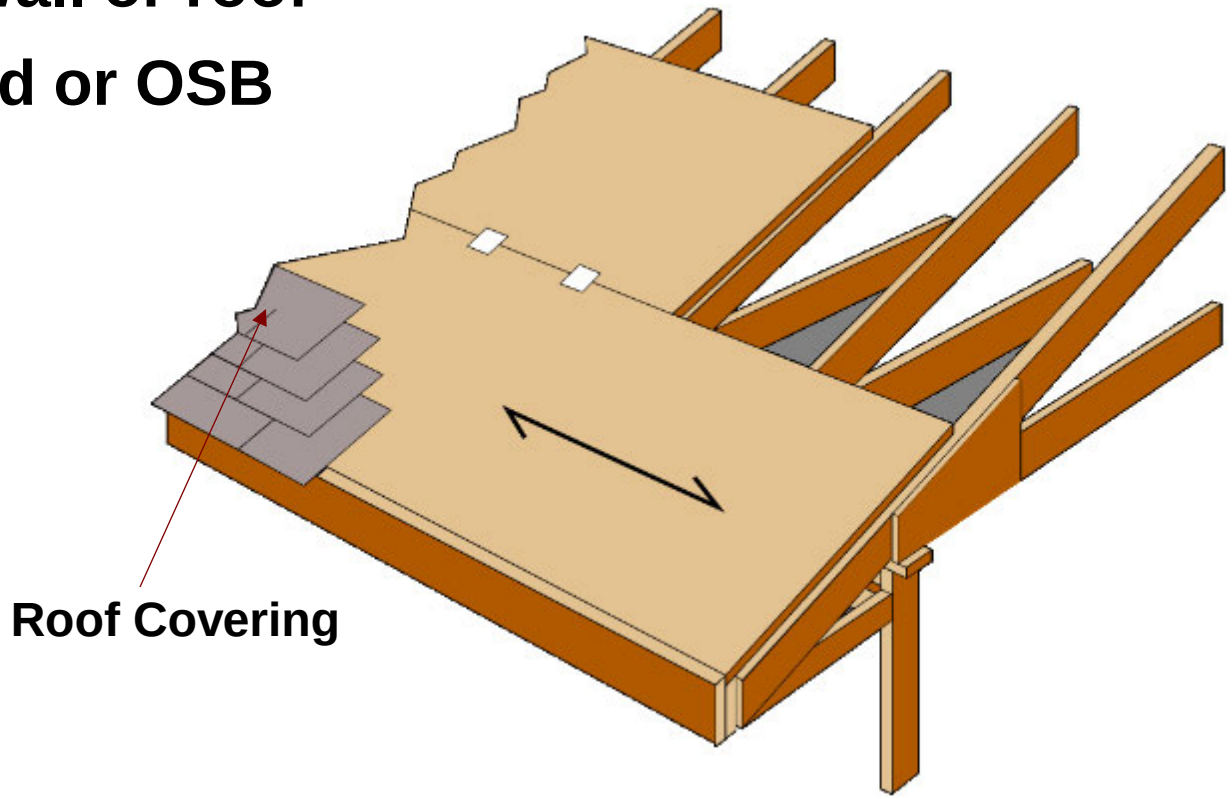
Building From the Ground Up: Floors

Building From the Ground Up: Roof

Rated Sheathing

Floor, wall or roof

Plywood or OSB



Building From the Ground Up: Roof

APA Engineered Wood Construction Guide, Form E30, Table 33

TABLE 33

RECOMMENDED UNIFORM ROOF LIVE LOADS FOR APA RATED SHEATHING[a] AND APA RATED STURD-I-FLOOR WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS[b]

Panel Span Rating	Minimum Panel Performance Category	Maximum Span (in.)		Allowable Live Loads (psf)[d]							
		With Edge Support[c]	Without Edge Support	Spacing of Supports Center-to-Center (in.)							
				12	16	20	24	32	40	48	60
APA RATED SHEATHING[a]											
24/0	3/8	24	19.2[e]	190	100	60	30				
24/16	7/16	24	24	190	100	65	40				
32/16	15/32	32	28	300	165	110	65	30			
40/20	19/32	40	32	—	275	195	120	60	30		
48/24	23/32	48	36	—	—	270	175	95	45	30	
APA RATED STURD-I-FLOOR[f]											
20 oc	19/32	32	32	270	150	100	60	30			
24 oc	23/32	48	36	—	240	160	100	50	30	20	
32 oc	7/8	48	40	—	—	295	185	100	55	35	
48 oc	1-3/32	60	48	—	—	—	290	160	100	65	40

Building From the Ground Up: Roof

APA Engineered Wood Construction Guide, Form E30, Table 36

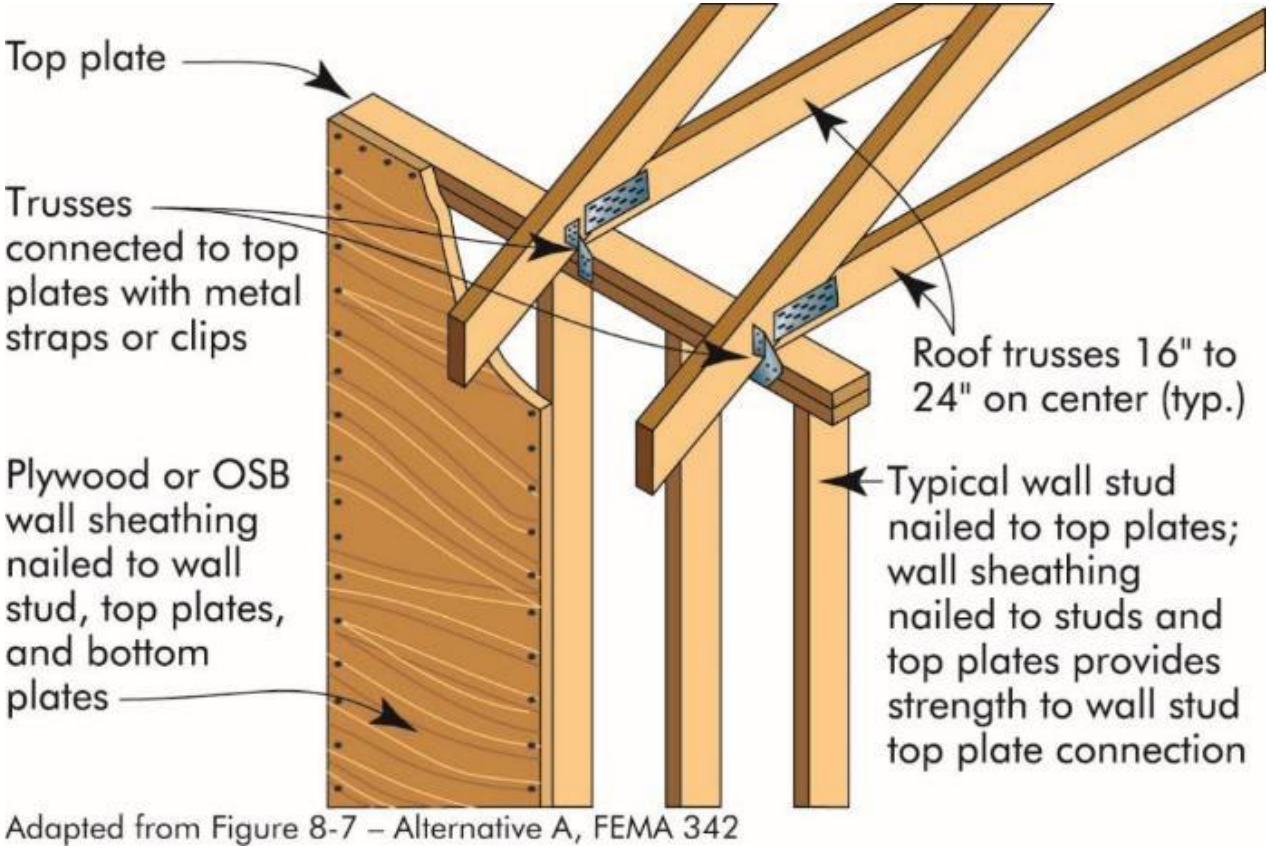
TABLE 36

RECOMMENDED ROOF LOADS (PSF) FOR APA RATED SHEATHING WITH STRENGTH AXIS PARALLEL TO SUPPORTS[a,b] (OSB and 5-ply/5-layer plywood panels unless otherwise noted)

Panel Grade	Panel Performance Category	Span Rating	Maximum Span (in.)	Load at Maximum Span	
				Live	Total
APA STRUCTURAL I RATED SHEATHING	7/16	24/16	24[c]	15	25
	15/32, 1/2	32/16	24	30[d]	40[d]
	19/32, 5/8	40/20	24	70[e]	80[e]
	23/32, 3/4	48/24	24	105[f]	115[f]
APA RATED SHEATHING	7/16	24/16	16	35	45
	15/32, 1/2	32/16	24[c]	15[g]	25[g]
	19/32, 5/8	40/20	24	40[h]	50[h]
	23/32, 3/4	48/24	24	70[e]	80[e]

Building From the Ground Up: Roof

Top plate connection



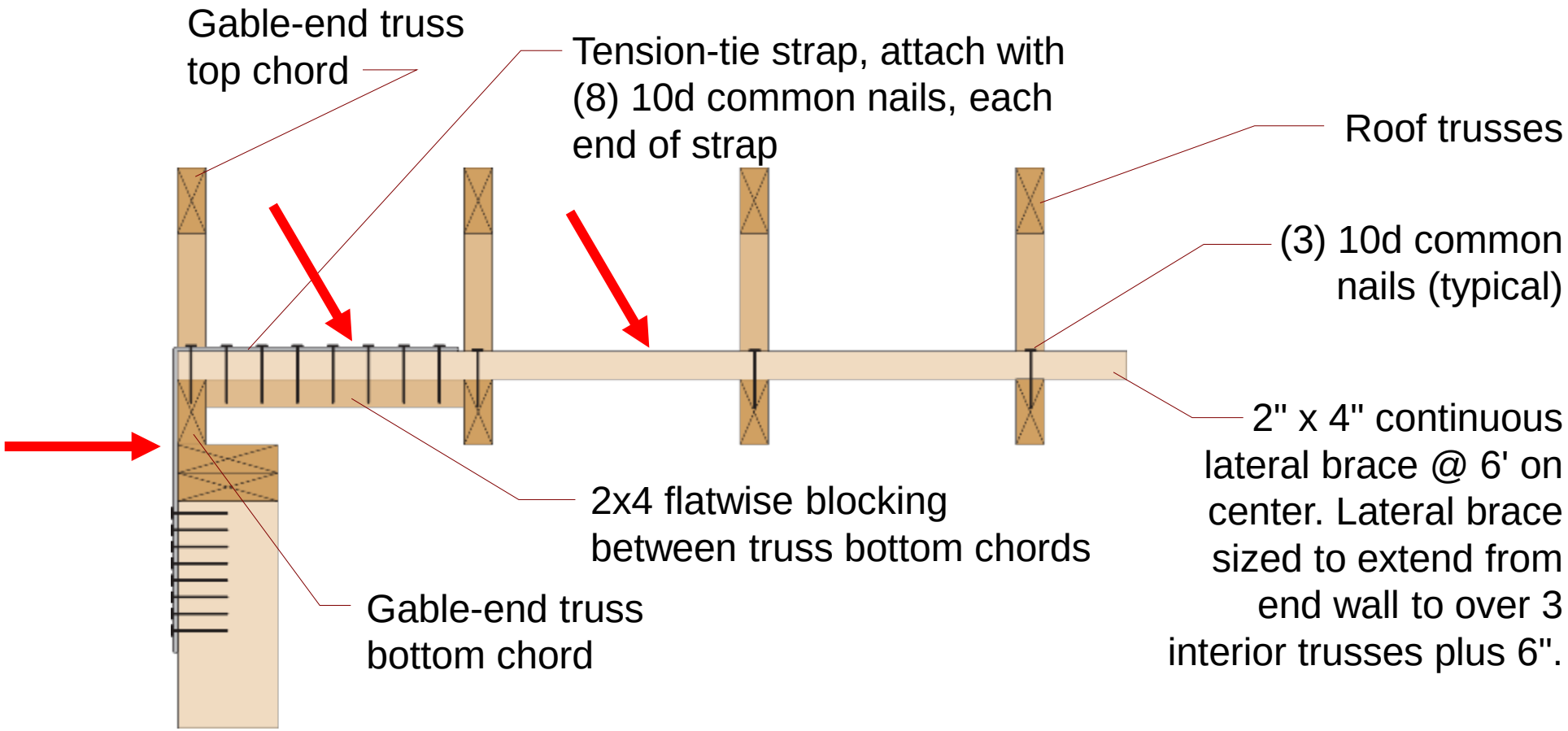
Adapted from Figure 8-7 – Alternative A, FEMA 342

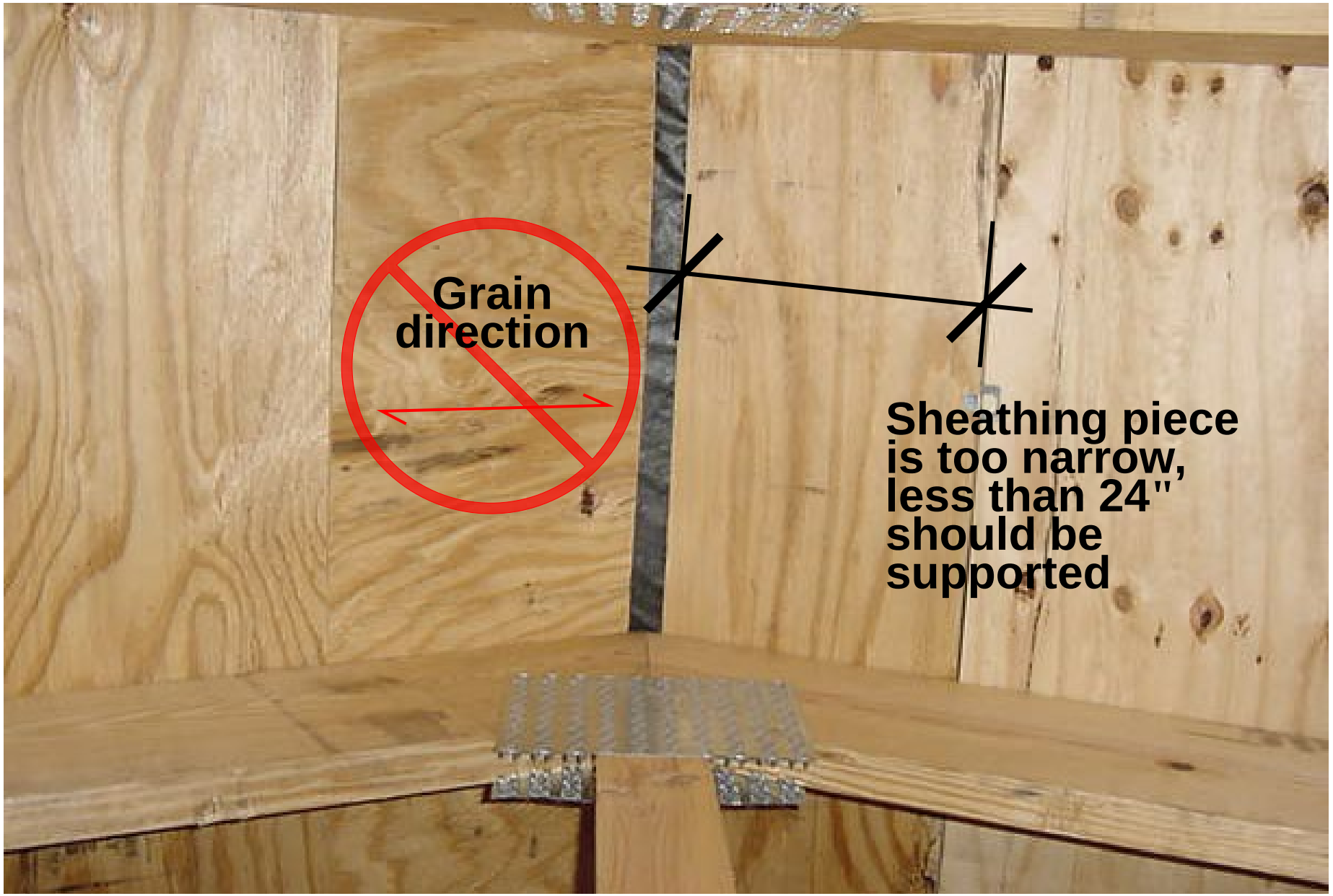
APA

Studs-to-Floor/Roof

LATERAL LOAD

Tie gable-end walls back to the structure




Grain direction
Sheathing piece is too narrow, less than 24" should be supported

APA Technical Note: Panel Edge Support for Narrow Width Roof Sheathing, Form R275

Narrow Roof Sheathing

- **If WSP* is 16" to 24"**

  2 clips at lower edge acceptable

  Lumber block lower edge

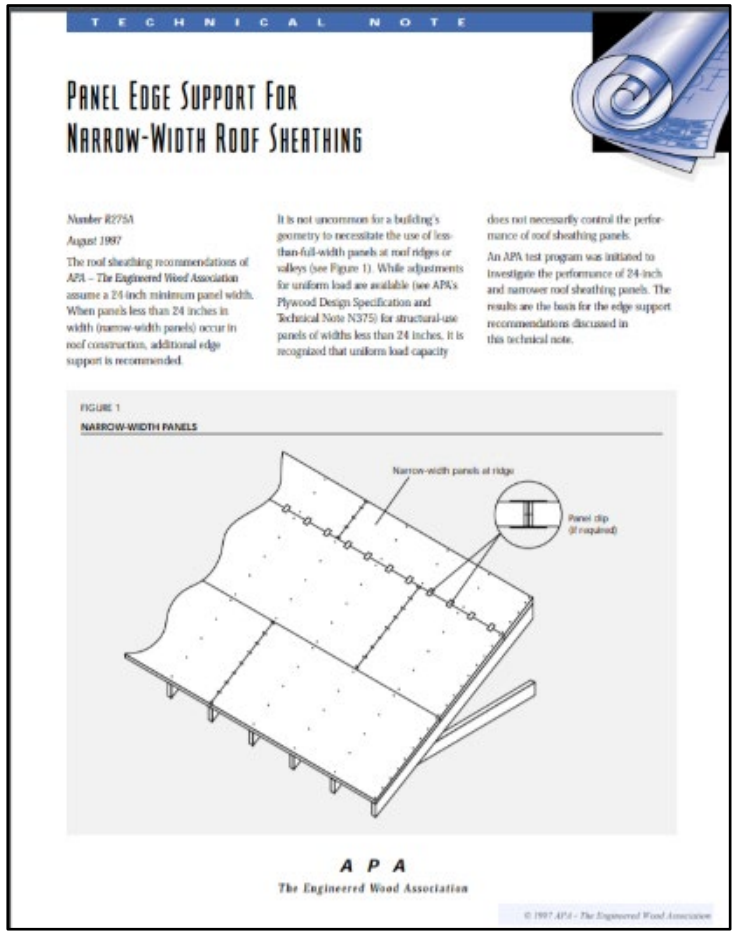
- **If WSP is 12" to 16"**

  Lumber block lower edge

- **If WSP is less than 12"**

  Lumber block upper and lower edges

  (Regardless of adjacent ridge or valley)



TECHNICAL NOTE

PANEL EDGE SUPPORT FOR NARROW-WIDTH ROOF SHEATHING

Number R275A

August 1997

The roof sheathing recommendations of APA – The Engineered Wood Association assume a 24-inch minimum panel width. When panels less than 24 inches in width (narrow-width panels) occur in roof construction, additional edge support is recommended.

It is not uncommon for a building's geometry to necessitate the use of less-than-full-width panels at roof ridges or valleys (see Figure 1). While adjustments for uniform load are available (see APA's Plywood Design Specification and Technical Note N375) for structural-use panels of widths less than 24 inches, it is recognized that uniform load capacity does not necessarily control the performance of roof sheathing panels.

An APA test program was initiated to investigate the performance of 24-inch and narrower roof sheathing panels. The results are the basis for the edge support recommendations discussed in this technical note.

FIGURE 1
NARROW-WIDTH PANELS

APA
The Engineered Wood Association

*"WSP" = wood structural panel (plywood or OSB)

Building From the Ground Up: Special Topics

FAQs: Questions about Plywood and OSB

Questions include:

- **Delamination**
- **Buckling**
- **Checking**
- **Warping**
- **Grade**
- **Swelling**
- **Flaking**
- **Applications**
- **Siding substrate**

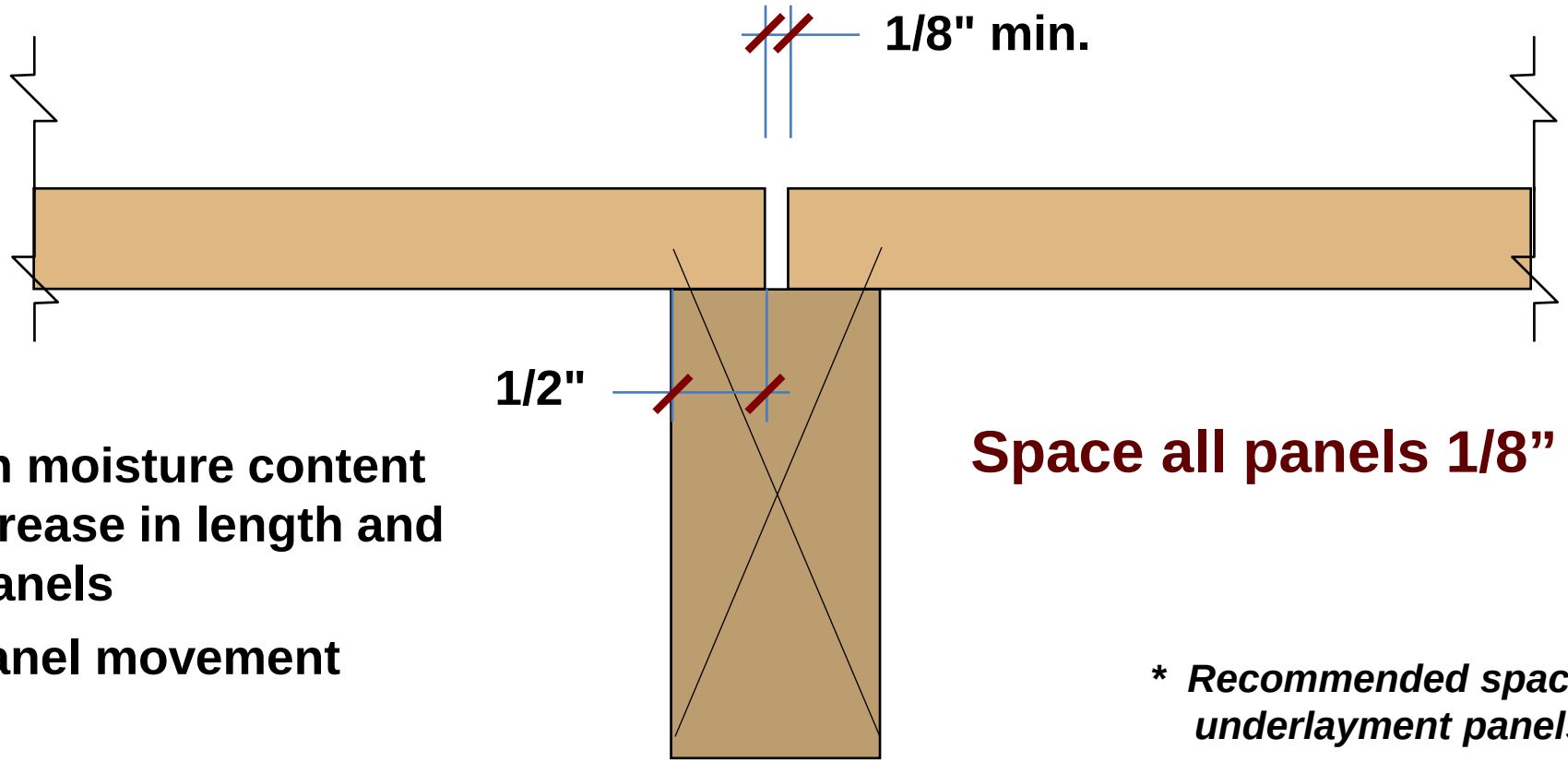
FAQs

Questions About Structural Plywood and OSB Performance

APA-trademarked panel performance concerns are infrequent, but they arise on occasion. Some permissible performance, grade, growth or natural characteristics are often interpreted as performance issues when they are merely cosmetic and have no impact on panel performance. A guide of terms associated with panel performance follows.

APA

Building From the Ground Up: Special Topics



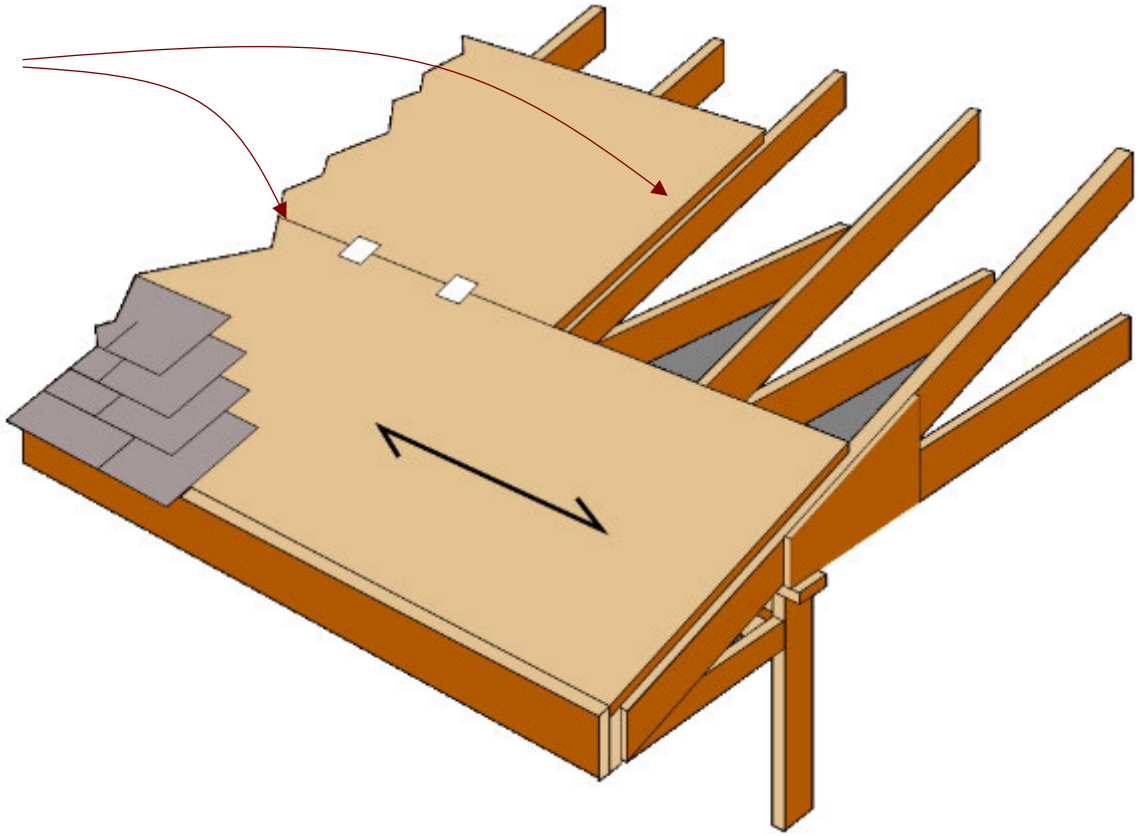
1. Increase in moisture content means increase in length and width of panels
2. Plan for panel movement

Space all panels 1/8” *

** Recommended spacing of floor underlayment panels = 1/32"*

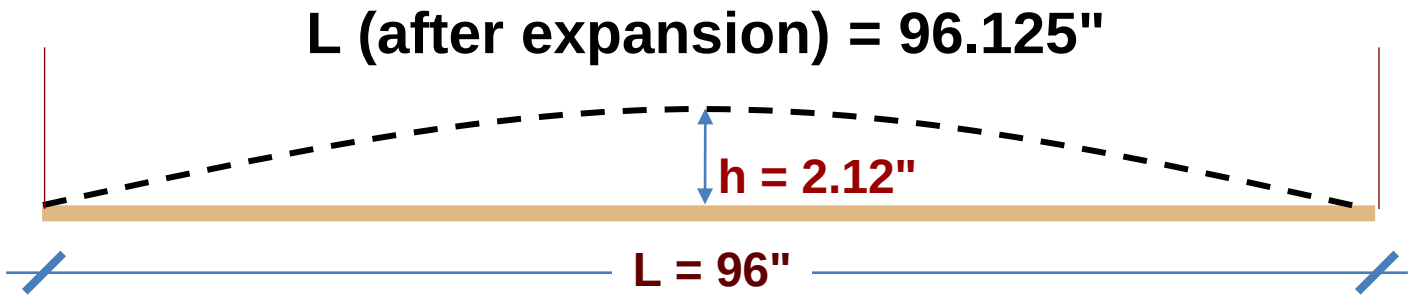
Building From the Ground Up: Special Topics

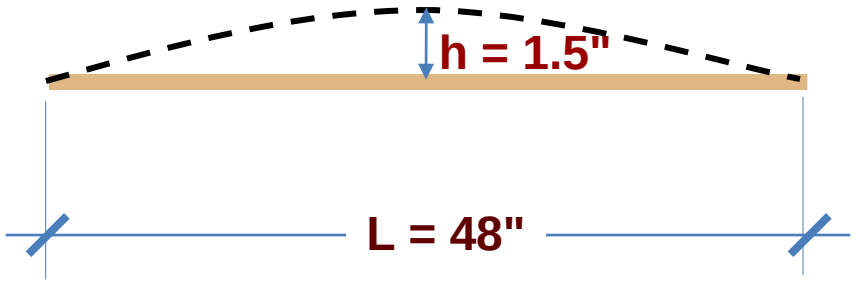
Space panels 1/8" min.
(ends & edges)



Allow for panel expansion

Building From the Ground Up: Special Topics





Allow for panel expansion

Building From the Ground Up: Special Topics

What can happen if panels aren't allowed to acclimate?

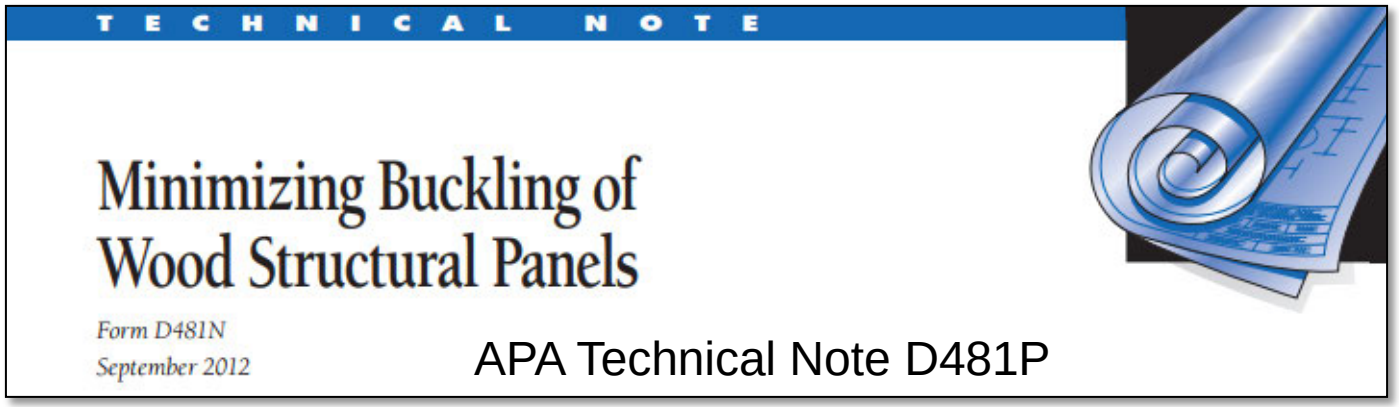
Building From the Ground Up: Special Topics

Nailing approx. 3" o.c.

Building From the Ground Up: Special Topics

Buckling — High Risk Applications

- **Panels installed parallel to supports (e.g., walls)**
- **Edge nailing 4" o.c. or closer**
- **Long lasting rainy weather or high humidity**
- **Panels installed within a few days of their manufacture**
- **Others…**



High risk because the conditions may reduce edge gap's effectiveness in absorbing panel expansion.

Building From the Ground Up: Special Topics

Allow panels to acclimate to ambient temperature and humidity

- **Low panel moisture content at the time of manufacture**
  - Generally, panels at the mill are 2% to 8% moisture content
- **Jobsite relative humidity might vary from 40% to 80%**
  - Result: panel equilibrium moisture content ranging between 6% and 14%
- **Panel movement occurs as panels reach equilibrium moisture content.**

Resource: APA Builder Tips: Storage and Handling of APA Trademarked Panels, Form U450

APA

Building From the Ground Up: Special Topics

Sequence wall panel installation to allow panels to acclimate to jobsite conditions:

- **Tack panels in place prior to installing edge fasteners**
  - Nail spacing of 12 or 24 inches on center at ends, edges and intermediate supports
- **After panels become acclimated to jobsite moisture conditions, complete final nailing**
- **Install fasteners 3/8 inch from panel edges and ends**
- **Ensure proper nail size and spacing**

Building From the Ground Up: Special Topics

Panel Expansion of large structures

- **Panel expansion may accumulate through the framing of large, continuous floor or roof decks**
- **Provide temporary expansion joints to minimize displacement when building plan dimension exceeds 80'**


STANLEY

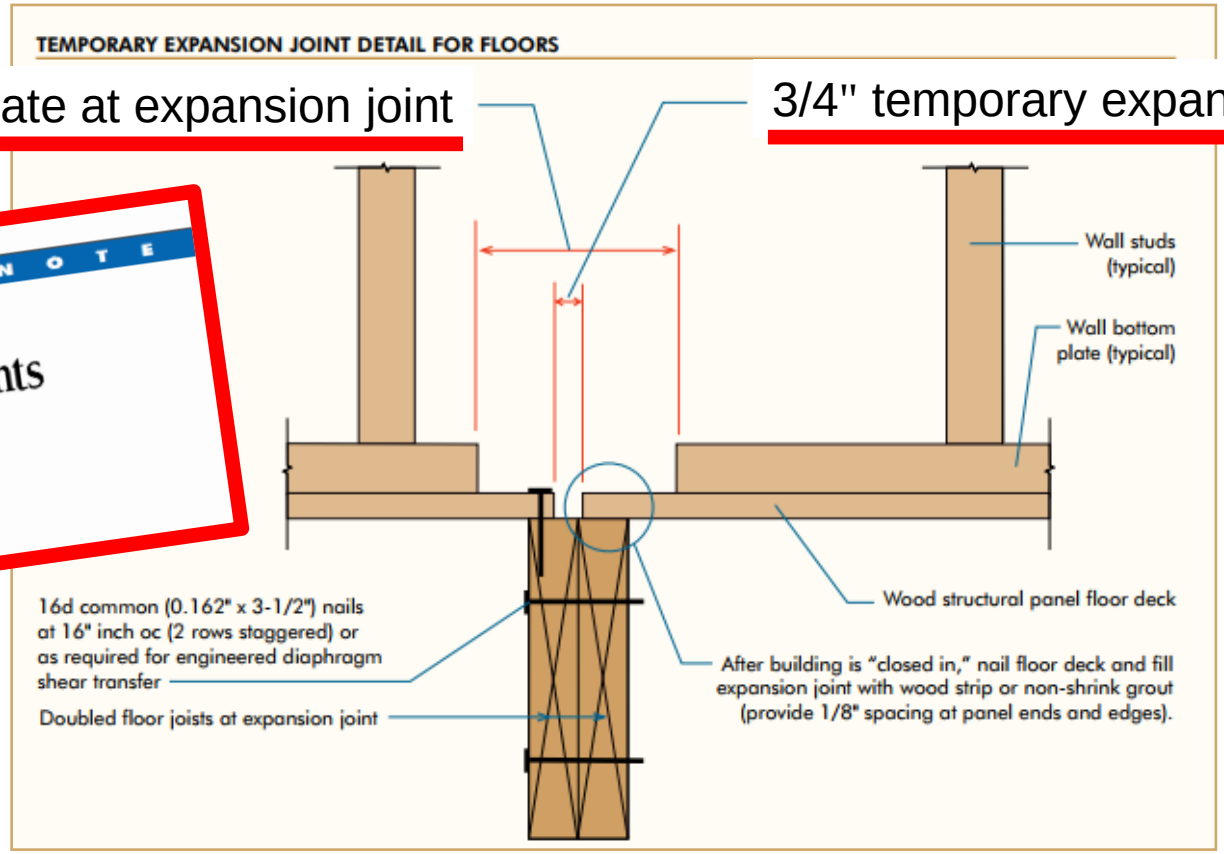

ADEBP.COM
STANLEY


STANLEY

Building From the Ground Up: Special Topics

12" gap in wall bottom plate at expansion joint

3/4" temporary expansion joint at 80' intervals

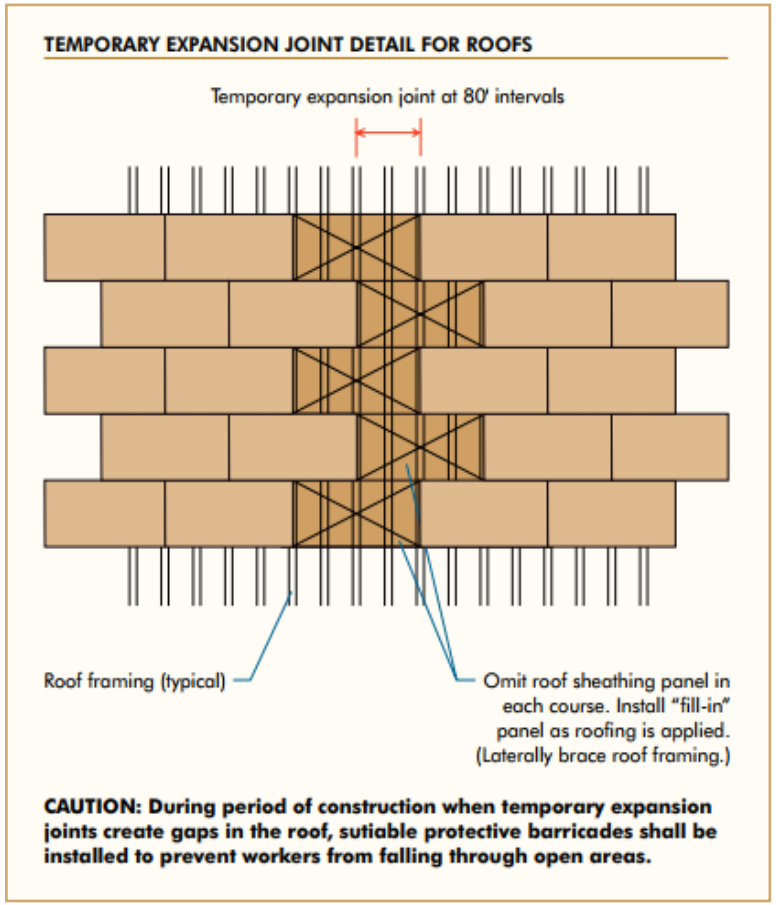


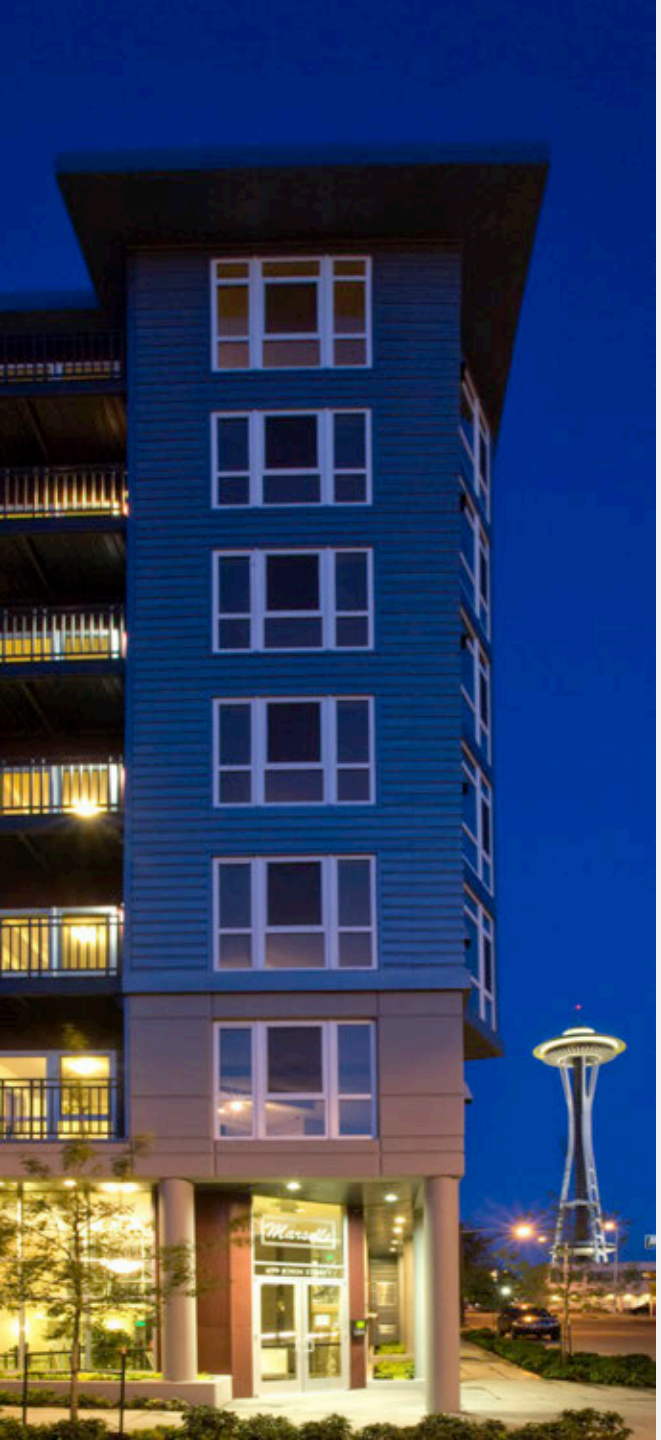
APA Technical Note U425

Building From the Ground Up: Special Topics

Provisions for large structures

- **Sheath 80-foot sections, omitting a roof sheathing panel between sections**
- **Complete installation with fill-in panels immediately before sheathing is covered with roof underlayment**





Mid-Rise and Multi-Family Design

Optimizing Size, Maximizing Value

INTRODUCTION TO HEIGHTS AND AREAS FOR MID-RISE WOOD FRAME BUILDINGS

Laura Cullen, PE

September 25, 2025

Outline

- Context for Mid-Rise Construction
- Mid-rise Building Types/Configurations
- Maximizing Height & Area

Landing Apartments, Russell Scott Steedle & Capione Architects, photo Gregory Folkins

Outline

- Context for Mid-Rise Construction
  - Mid-rise Building Types/Configurations
  - Maximizing Height & Area

1430 Q, The HR Group Architects, Buehler Engineering, Greg Folkins Photography

Global Population Boom

Global Population

7.9 billion in 2022

9.7 billion by 2050

23% increase

Urban Population

6.4 billion by 2050

62% increase

Source: United Nations Department of Economic and Social Affairs

Sustainable Multi-Family & Mixed-Use Structures

Economically Meet
Urban Housing Needs

Increase Environmental
Responsibility

These 2 items don't need to be in opposition—
Wood-framing helps them work together!

Sustainable Multi-Family & Mixed-Use Structures

Mid-rise wood-frame construction provides a common ground for both

How?

Mid-Rise Construction

Where **wood** is a viable option,
it's likely the most appropriate choice.

- Senior Living
- Apartments/Condos
- Mixed Use
- Student Housing
- Affordable Housing
- Hotels

The Gibson, Hummel Architects, KPFF Consulting Engineers, photo Leo A. Geis

Why Wood?

Using wood helps reduce environmental impact
Wood products play significant role in modern economy

- Wood Costs Less
- Wood is Versatile
- Wood Meets Code
- Wood is Durable
- Wood is Renewable

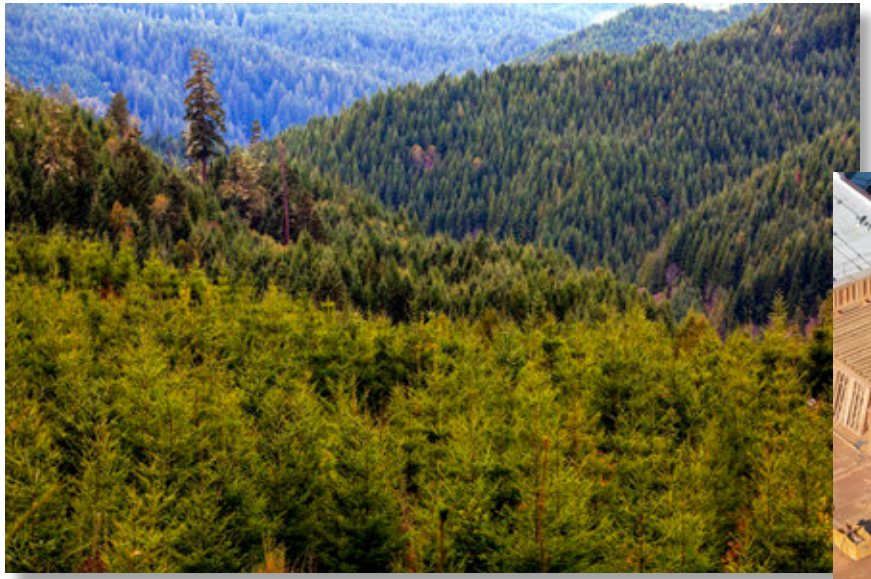
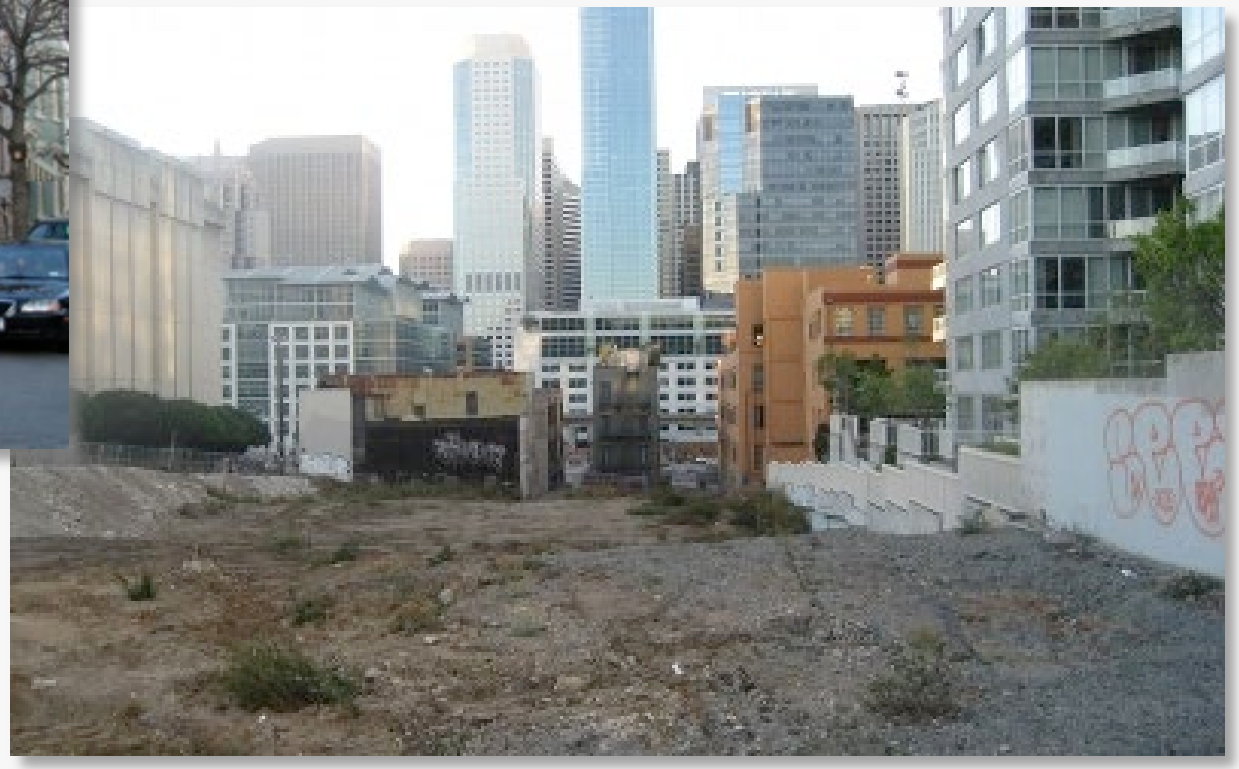


Photo courtesy OFRI

The Gibson, Hummel Architects, KPFF Consulting Engineers, photo Leo A. Geis

Urban Infill Development



Case Study | Wood Buildings Aim High

AvalonBay Stadium

Location: Anaheim, CA
251 Apts., 13K sf retail/restaurant
Type III modified
50% of their projects are podium
Semi-balloon framed with 16" Open web trusses at exterior walls

Architect: Withee Malcolm Architects
Engineer: VanDorpe Chou Associates
Developer/Contractor: AvalonBay Communities
Photo credit: Arden Photography

Carbon Case Study | High Density

AvalonBay Stadium- Anaheim, CA

Climate Change Advantage:

Volume of wood used:
5,200 cubic meters / 183,600 cubic feet of lumber and sheathing

U.S. and Canadian forests grow this much wood in:
15 minutes

Carbon stored in the wood:
3,970 metric tons of CO_2

Avoided greenhouse gas emissions:
8,440 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
12,410 metric tons of CO_2

EQUIVALENT TO:

2,370 cars off the road for a year

Energy to operate a home for 1,050 years

Source: US EPA

For information on the calculations in this chart, visit woodworks.org
Note: CO_2 on this chart refers to CO_2 equivalent.

Outline

- Context for Mid-Rise Construction
- **Mid-rise Building Types/Configurations**
- Maximizing Height & Area

1430 Q, The HR Group Architects, Buehler Engineering, Greg Folkins Photography

Seattle, WA

Photo: Matt Todd/PB Architects

College Park , MD

Photo: Matt Church

Normal, IL

Image: OKW Architects

Los Angeles, CA

Photo: Lawrence Anderson/Esto

Atlanta, GA

Image: Lord Aeck Sargent

Wood Mid-Rise Construction

How many stories can be wood framed in the IBC?

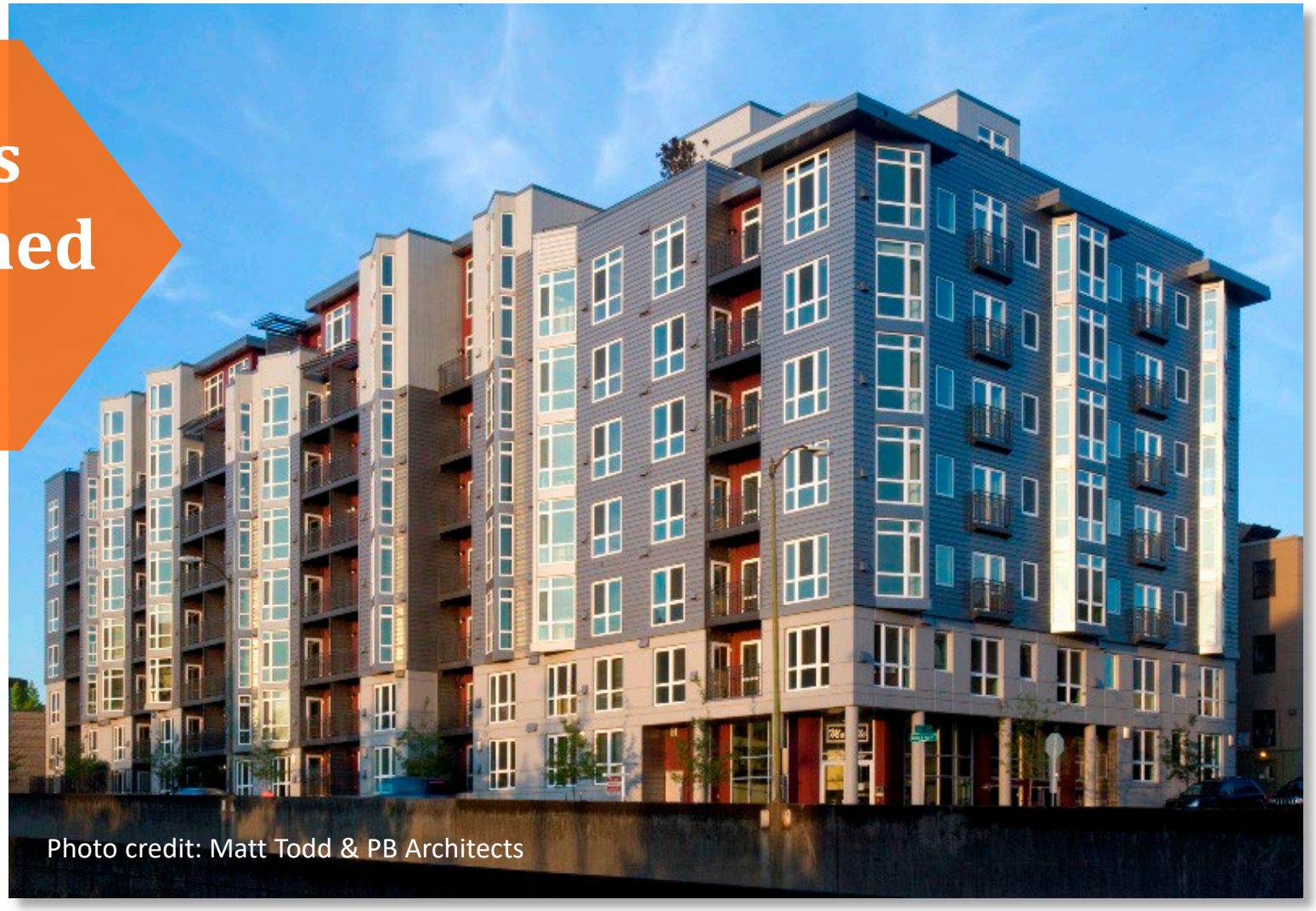


Photo credit: Matt Todd & PB Architects

Wood Mid-Rise Construction

6 stories for Offices,
5 stories for Residential
+ Mezzanine
+ Multi-Story Podium

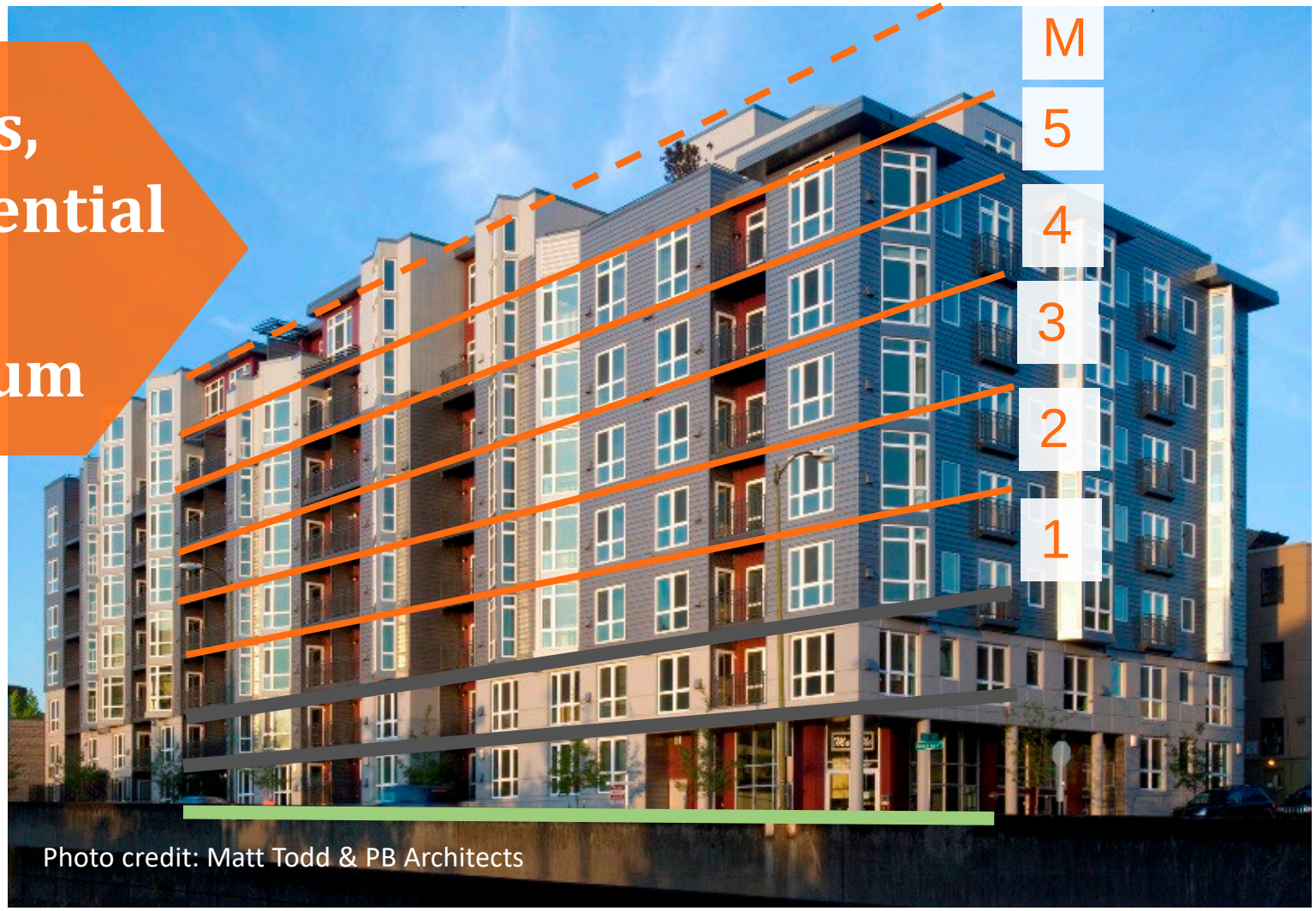
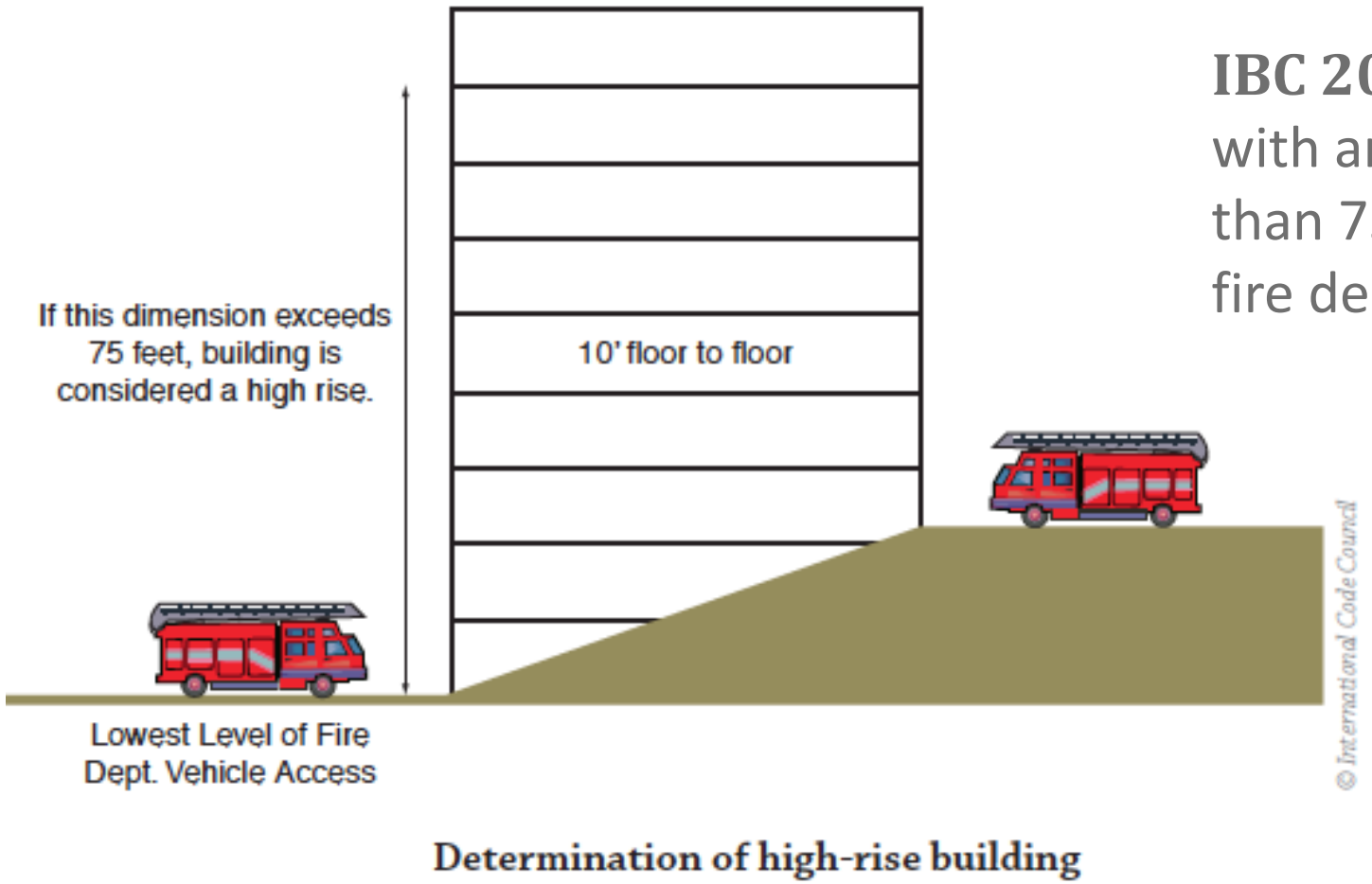


Photo credit: Matt Todd & PB Architects

Mid-Rise vs. High-Rise Definition – 2021 IBC 202



Determination of high-rise building

IBC 202: High-Rise Building: A building with an occupied floor located more than 75 feet above the lowest level of fire department vehicle access.

Walk-up / Tuck Under

First floor walk up units with private garage

Benefits:

- Eliminates need for S-2 parking garage
- Can be all wood
- Least expensive overall but lowest densification rates (20-35 units/acre)

Wrap-Around

Walk up units surround parking structure

Benefits:

- Enhanced security
- Centralized access to parking
- Visual appeal from street
- More expensive than walk/up tuck-under
- 5 story yields 60-80 units/acre

Podium

Multiple stories of wood over an elevated concrete deck

Benefits:

- Increased number of stories
- Accommodates Mixed-use occupancies
- Most expensive but can allow increased density

Podium

4 stories of residential over podium (parking or retail)

- 60–80 units/acre

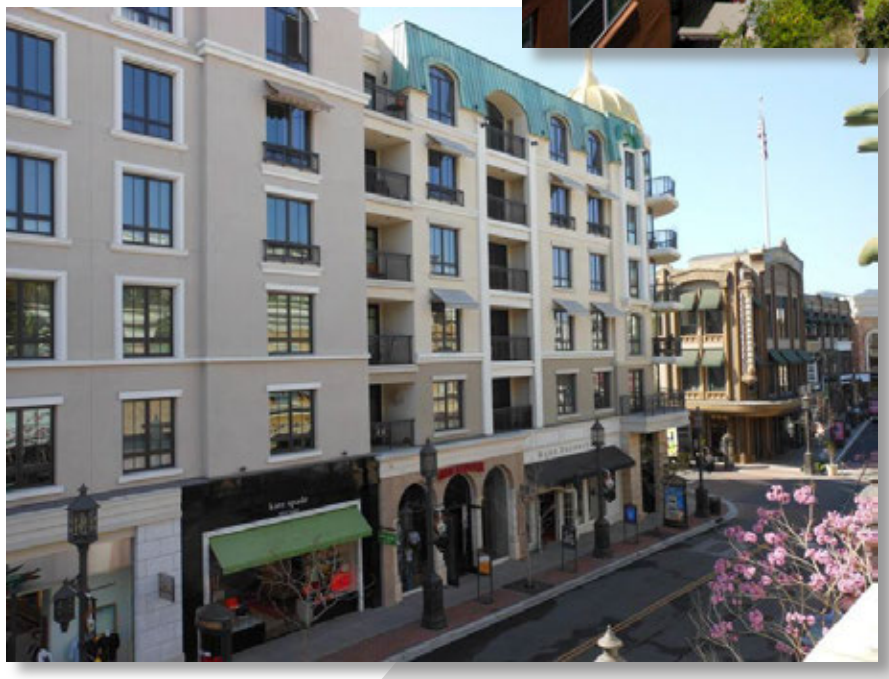
Inman Park Condos, Atlanta, GA
Davis & Church

Podium

5 stories over retail

» 100–120 units/acre

AvalonBay Stadium, Anaheim, CA
VanDorpe Chou Associates



Inman Park Condos, Atlanta, GA
Davis & Church

Podium

5 stories over residential podium

» 120–140 units/acre

16 Powerhouse, Sacramento, CA
D&S Development
LPA Sacramento

Mezzanine & Podium

5 stories with mezzanine + residential podium

- 125–145 units/acre

120 Union, San Diego, CA
Togawa Smith Martin

Outline

- » Context for Mid-Rise Construction
- » Mid-rise Building Types/Configurations
- Maximizing Height & Area
  1. Construction Types
  2. Tabulate Areas & Stories
  3. Allowable increases
  4. Mezzanine & Special Design Provisions

1430 Q, The HR Group Architects, Buehler Engineering, Greg Folkins Photography

Typical Mid-rise Occupancy

Hotels (R-1)

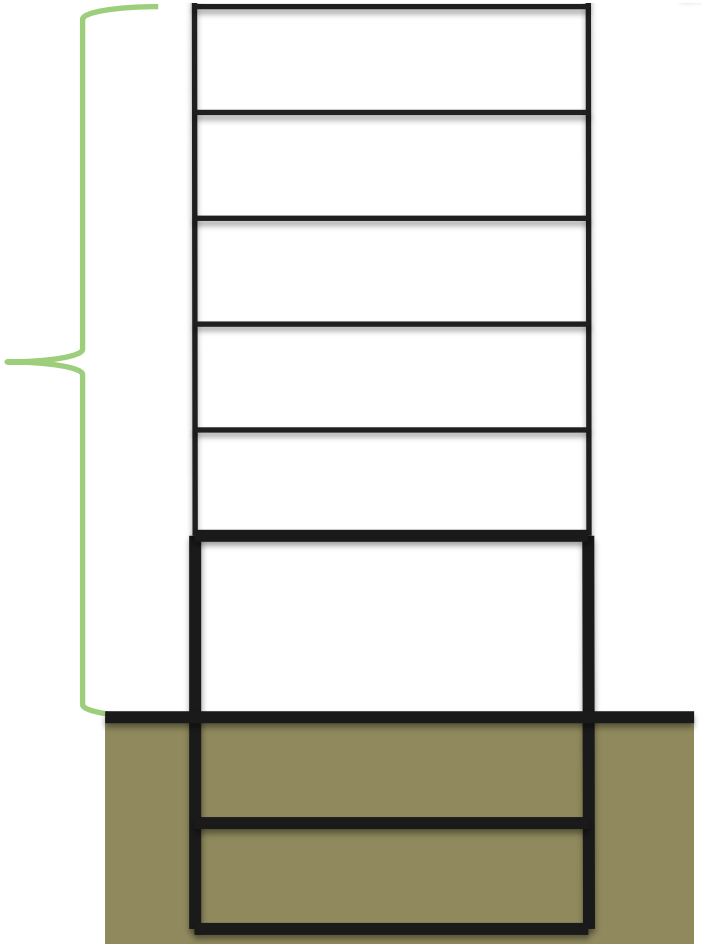
Apartments (R-2)

Condominiums (R-2)

Student housing (R-2)

Live/work units (R-2)

Assisted living (R-4)



(A-2) Restaurants/cafeterias

(A-3) Workout facilities

(A-3) Meeting rooms

(B) Offices

Nursing homes (I-2)

(M) Shops

(S-2/U) Parking

(S-1) Storage

Mid-Rise Construction Types

Type III

- Exterior walls non-combustible (may be light frame FRTW)
- Interior elements any allowed by code

Type V

- All building elements any allowed by code

Types III and V can be subdivided:

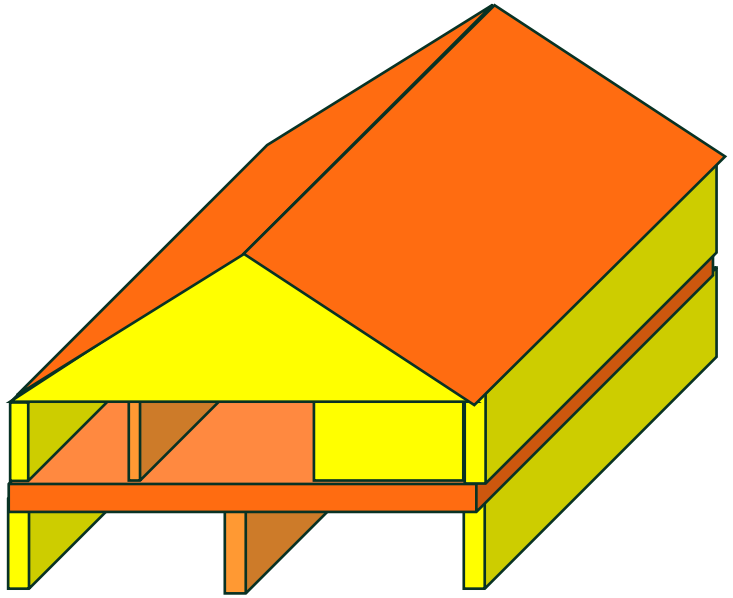
- A (protected)
- B (unprotected)

Type IV (C & HT)

- All building elements mass timber (covered CLT) or non-combustible
  - For IV-HT, interior elements may also be 1-hour FRR light frame
  - For IV-HT, exterior walls may also be FRTW, including light frame walls)

Type III Construction

- Exterior walls: noncombustible materials
  - FRTW permitted for FRR ≤ 2-hr
- Interior building elements: any material



Non-combustible
- Exterior walls

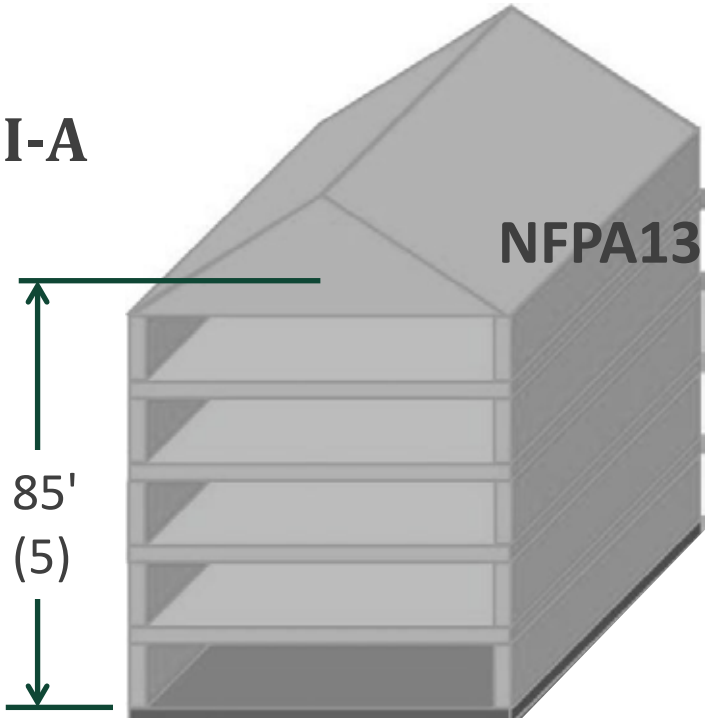
Fire Retardant Treated allowed
- Exterior walls if fire rating ≤ 2-hr

Heavy Timber
- HT used in place of 1-hr rating or less

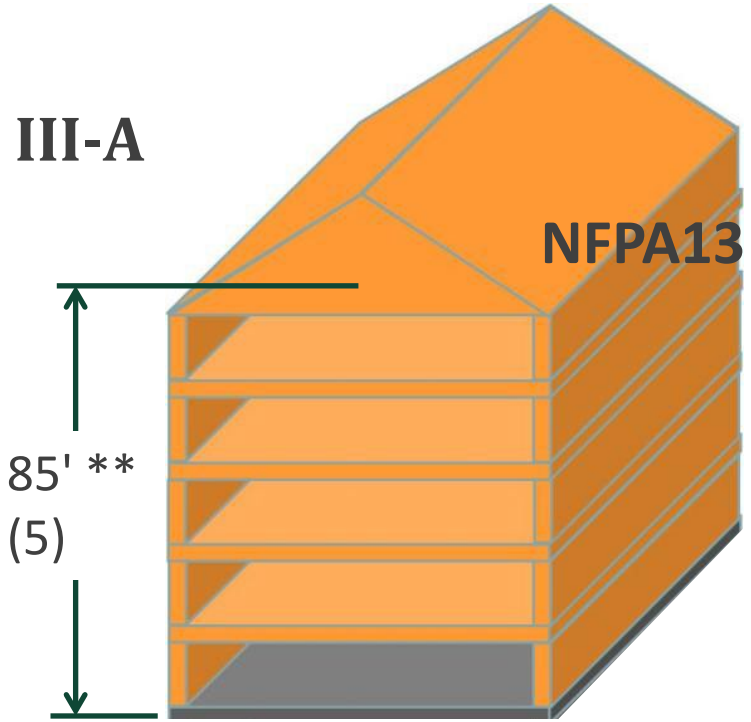
Untreated Lumber
- All interior elements

Increased Height & Story Area: Residential Occupancy

Type II-A



Type III-A



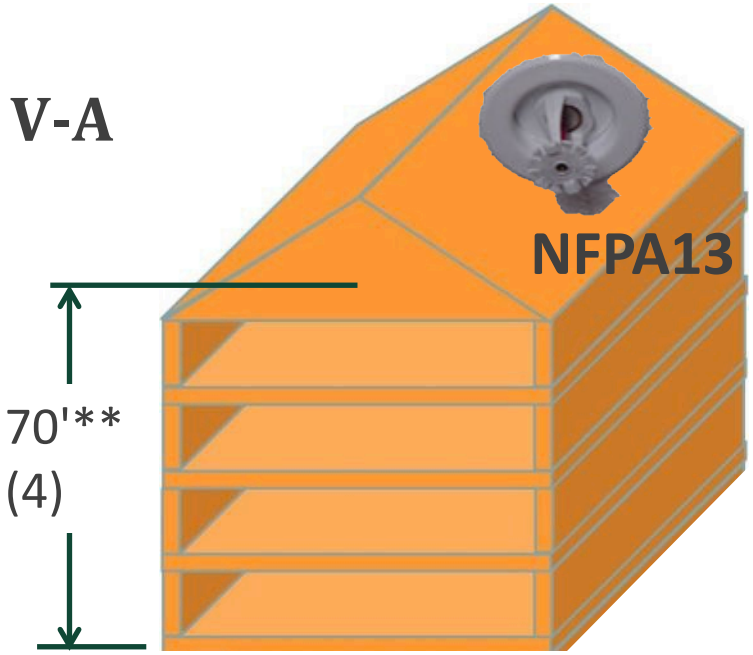
Occupancy	II-A (ft^2)*	III-A (ft^2)*
R-1	72,000 +18,000 (max frontage)	72,000 +18,000 (max frontage)
R-2	72,000 +18,000 (max frontage)	72,000 +18,000 (max frontage)

* Areas reflect PER STORY max. Total building max may limit area further.

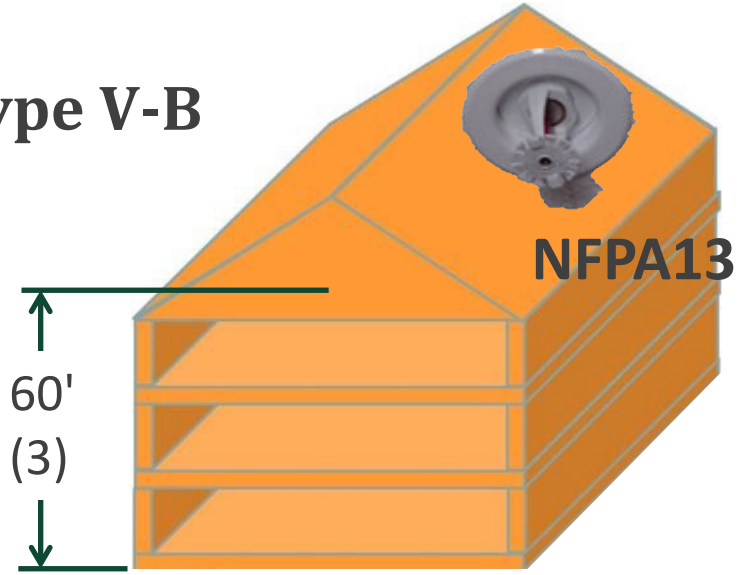
** ASCE7-16 Table 12.2-1 limits wood shear wall seismic systems to 65' in height in SDC D,E,F

Increased Height & Story Area: Residential Occupancy

Type V-A



Type V-B

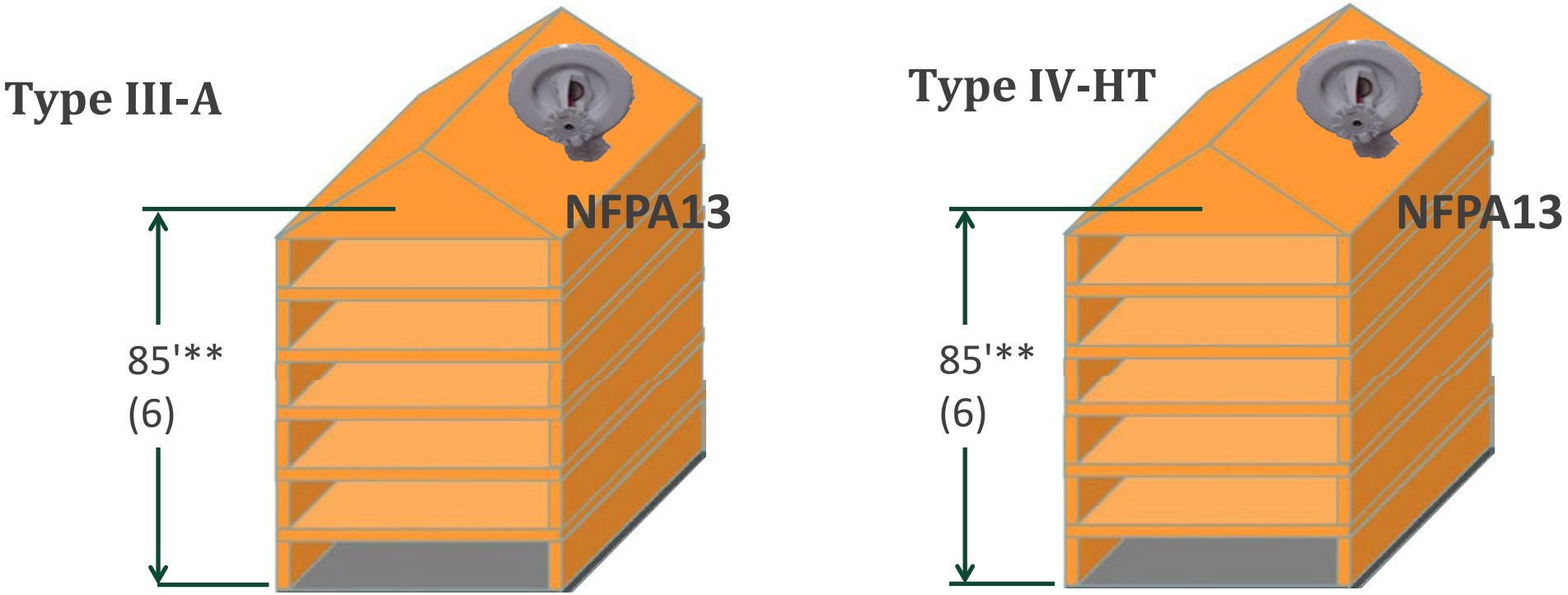


Occupancy	V-A (ft^2)*	V-B (ft^2)
R-1	36,000 +9,000 (max frontage)	21,000 +5,250 (max frontage)
R-2	36,000 +9,000 (max frontage)	21,000 +5,250 (max frontage)

* Areas reflect PER STORY max. Total building max may limit area further.

** ASCE7-16 Table 12.2-1 limits wood shear wall seismic systems to 65' in height in SDC D,E,F

Increased Height & Story Area: Office Occupancy



Occupancy	III-A (ft^2)*	IV-HT (ft^2)*
B	85,500 +21,375 (max frontage)	108,000 +27,000 (max frontage)

* Areas reflect PER STORY max. Total building max may limit area further.

** ASCE7-16 Table 12.2-1 limits wood shear wall seismic systems to 65' in height in SDC D,E,F

Height – 2018 IBC Table 504.3

- IBC 2018: Table 504.3 provides base & increased heights

TABLE 504.3[a]
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
R	NS[d, h]	UL	160	65	55	65	55	65	50	40
	S13R	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	85	70	60

NS = Buildings not equipped throughout with an automatic sprinkler system

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R)

S13D (not shown) = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3 (NFPA 13D)

Height – 2021/2024 IBC Table 504.3

- IBC 2021: Table 504.3 provides base & increased heights

TABLE 504.3
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE[a]

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	270	180	85	85	70	60
R[h]	NS[d]	UL	160	65	55	65	55	65	65	65	65	50	40
	S13D	60	60	60	60	60	60	60	60	60	60	50	40
	S13R	60	60	60	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	270	180	85	85	70	60

NS = Buildings not equipped throughout with an automatic sprinkler system

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R)

S13D (not shown) = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3 (NFPA 13D)

Stories – 2018 IBC Table 504.4

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-3	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
R-1	NS[d, h]	UL	11	4	4	4	4	4	3	2
	S13R	4	4						4	3
	S	UL	12	5	5	5	5	5	4	3
R-2	NS[d, h]	UL	11	4	4	4	4	4	3	2
	S13R	4	4	4					4	3
	S	UL	12	5	5	5	5	5	4	3
S-1	NS	UL	11	4	2	3	2	4	3	1
	S	UL	12	5	3	4	3	5	4	2

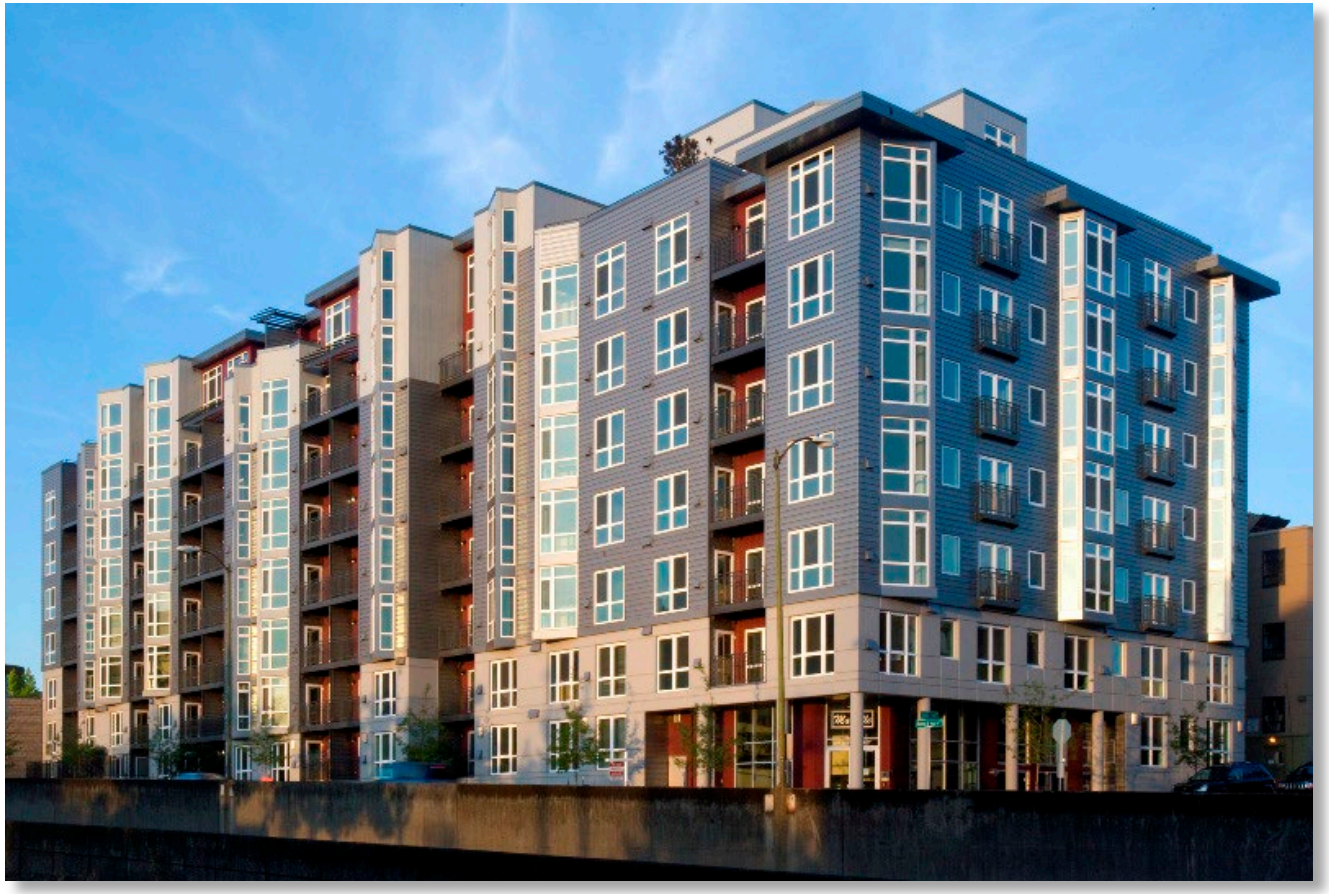
Stories – 2021/2024 IBC Table 504.4

TABLE 504.4
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE[a, b]

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-3	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
R-1[h]	NS[d]	UL	11	4	4	4	4	4	3	2
	S13R	4	4						4	3
	S	UL	12	5	5	5	5	5	4	3
R-2[h]	NS[d]	UL	11	4	4	4	4	4	3	2
	S13R	4	4	4					4	3
	S	UL	12	5	5	5	5	5	4	3
S-1	NS	UL	11	4	2	3	2	4	3	1
	S	UL	12	5	3	4	3	5	4	2

Sloped Sites

Fashion Valley, CA
AvalonBay Communities



Seattle, WA
PB Architects

Sloped Sites – Chapter 2 Definitions

HEIGHT, BUILDING. The vertical distance from *grade plane* to the average height of the highest roof surface.

GRADE PLANE. A reference plane representing the average of finished ground level adjoining the building at *exterior walls*. Where the finished ground level slopes away from the *exterior walls*, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 6 feet (1829 mm) from the building, between the building and a point 6 feet (1829 mm) from the building.

626 DeKalb Avenue, Atlanta, GA
Matt Church - Davis Church Structural Engineers

Basements –IBC 506.1.3

A basement is not included in the total allowable building area if it doesn't exceed the area permitted for a building with no more than one story above grade plane.

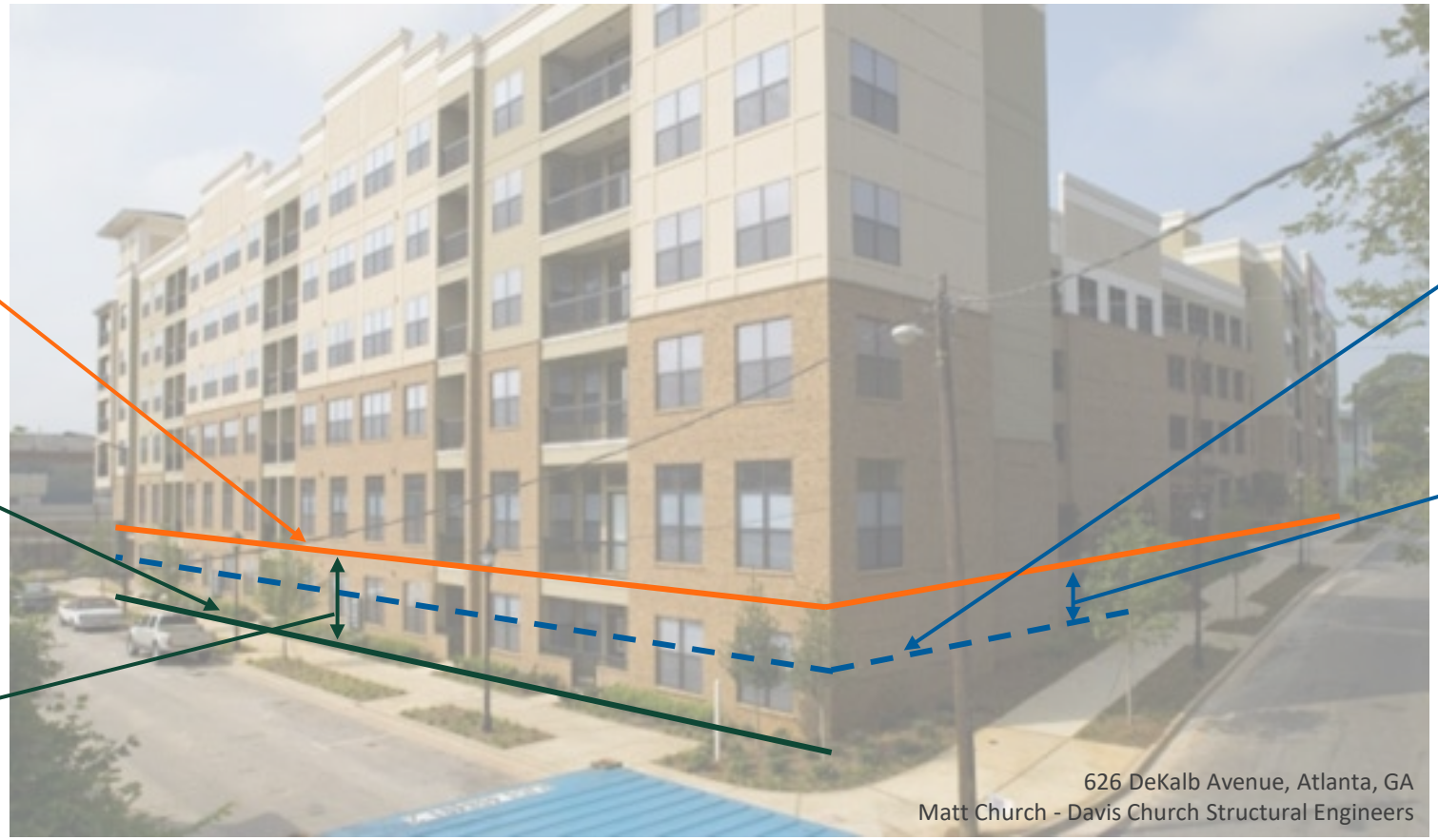
"Basement" is defined as "not a story above grade plane" and has a finished floor surface of the next floor above:

- Less than 6 feet above grade plane; or
- Less than 12 feet above the finished ground level at any point

Fashion Valley, CA
AvalonBay Communities

Basements –IBC 506.1.3

To qualify as a basement (and therefore not be included in building area):



Summary of Building Heights

Building Heights and Stories by Building Type With NFPA 13 Sprinklers				
Occupancy	III-A	III-B	V-A	V-B
	85 ft	75 ft	70 ft	60 ft
R-1/R-2/R-4	5	5	4	3
A-2/A-3	4	3	3	2
B	6	4	4	3
M	5	3	4	2
S-2	5	4	5	3
S-1	4	4	4	2

**ASCE7 12.2-1 limits wood shear wall seismic systems to 65’ in height in SDC D,E,F

Area Increases – IBC 2018 Table 506.2

TABLE 506.2[a, b]
ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, or SM, as applicable) IN SQUARE FEET

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
R-1	NS[d, h]	UL	UL	24,000	16,000	24,000	16,000	20,500	12,000	7,000
	S13R									
	S1	UL	UL	96,000	64,000	96,000	64,000	82,000	48,000	28,000
	SM	UL	UL	72,000	48,000	72,000	48,000	61,500	36,000	21,000

**Can still increase these areas by the Frontage Factor of Section 506.3

NS = Buildings not equipped throughout with an automatic sprinkler system

S1 = Buildings a maximum of one story above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

SM = Buildings two or more stories above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R)

Area Increases – 2021/2024 IBC Table 506.2

TABLE 506.2

ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET[a, b]

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
R-1[h]	NS[d]	UL	UL	24,000	16,000	24,000	16,000	61,500	41,000	25,625	20,500	12,000	7,000
	S13R												
	S1	UL	UL	96,000	64,000	96,000	64,000	246,000	164,000	102,500	82,000	48,000	28,000
	SM	UL	UL	72,000	48,000	72,000	48,000	184,500	123,000	76,875	61,500	36,000	21,000

**Can still increase these areas by the Frontage Factor of Section 506.3

NS = Buildings not equipped throughout with an automatic sprinkler system

S1 = Buildings a maximum of one story above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

SM = Buildings two or more stories above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 (NFPA 13)

S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R)

Sprinkler Systems: IBC 903.2

In some cases, sprinklers are required by code depending on occupancy

- Most new Group R fire areas
- Group A, E, M, S-1, I fire areas exceeding 1-12k sf

Stella Apartments, DesignARC, Taylor and Syfan, photo Lawrence Anderson

Commercial Sprinkler Systems – IBC 903.3.1

- NFPA 13
  Standard for Commercial Construction 903.3.1.1
- NFPA 13R
  Residential Occupancies (One- and Two-Family or Low-Rise Multi-Family and Commercial) 903.3.1.2
- NFPA 13D
  Standard for One- and Two-Family Residences (but allowed in a few commercial occupancies) 903.3.1.3

NFPA 13 vs. NFPA 13R

NFPA 13	NFPA 13R
Goal: Provide life safety and property protection	Goal: Provide life safety only
Fully sprinklered system throughout entire building even in unoccupied spaces (closets, attics)	Partially sprinklered system; unoccupied spaces often don't require sprinklers
Can cost more	Lower levels of water discharge, shorter water supply time can result in smaller pipe sizes, reduce need for storage & pumps
Permitted for many occupancies, buildings of many sizes, allows greater building size increases	Limited applications, mainly for multi-family up to 4 stories, 60 feet

Single Occupancy – IBC 506.2.1

$$A_a = A_t + [NS \times I_f]$$

(Equation 5-1)

A_a = Allowable area per story (sq. ft.)

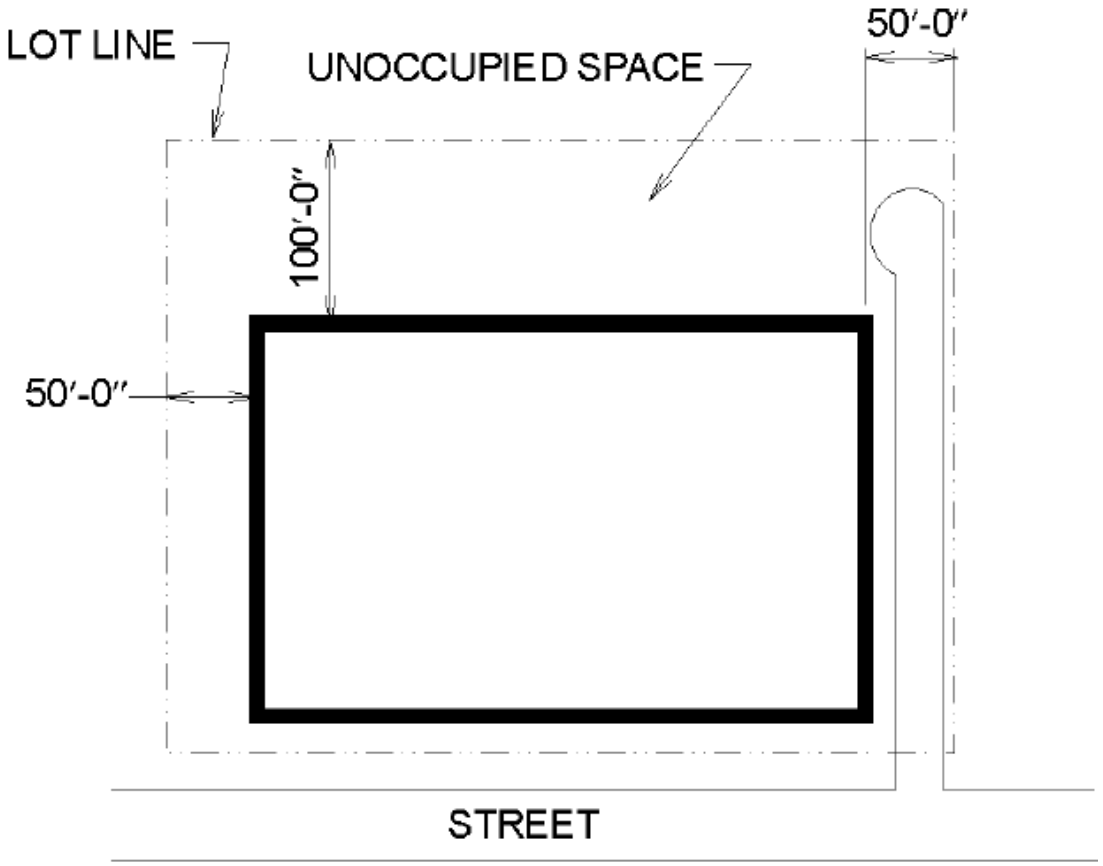
A_t = Tabular allowable area per story per Table 506.2 for NS, S1 or S13R (sq. ft.)

NS = Tabular allowable area per story per Table 506.2 for non-sprinklered building (sprinklered or not)

I_f = Area increase factor due to frontage per 506.3
$I_{f,\ max} = 0.75$

Area Modification – Frontage IBC 506.3

- Allowable area increase for frontage
  - Streets (public ways)
  - Open Spaces
- Frontage provides:
  - Access by fire service personnel
  - Temporary refuge for occupants
  - Reduced exposure to/from adjacent structures



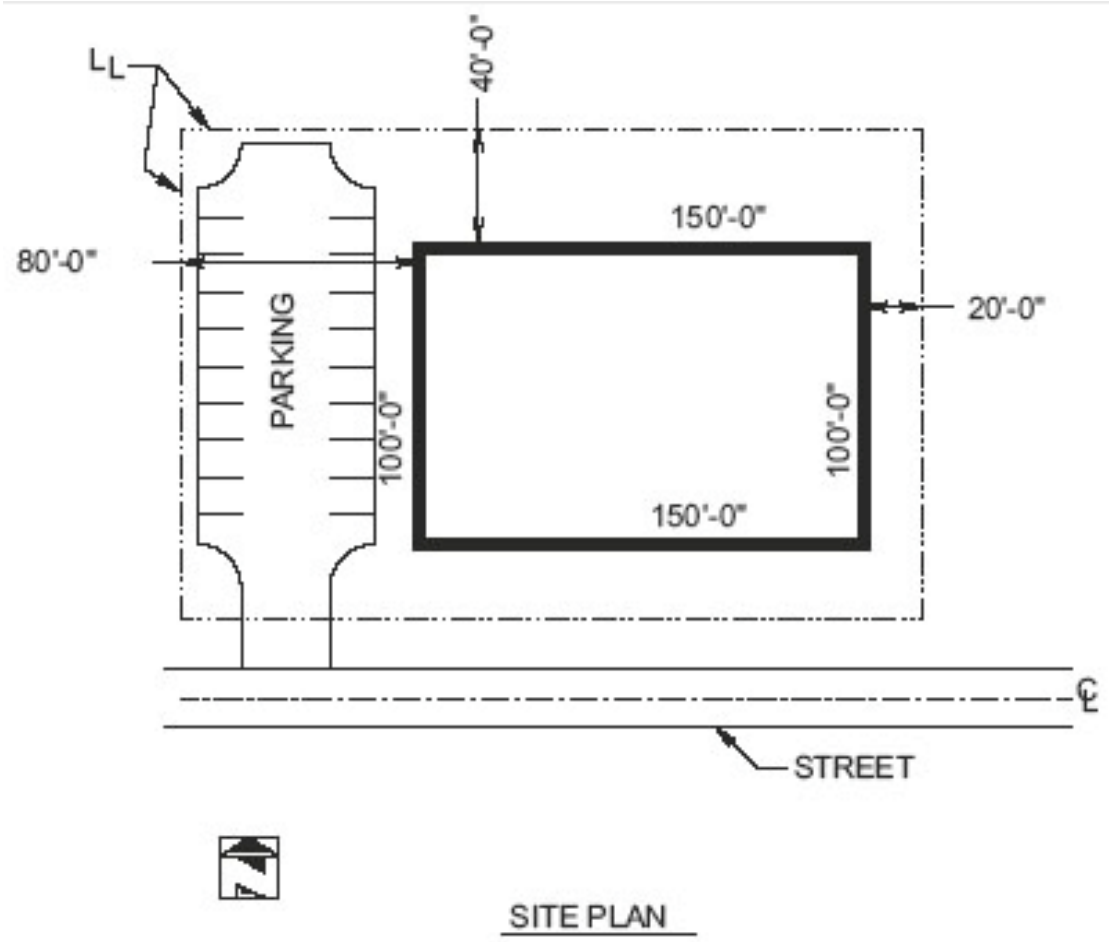
Frontage Increases – 2018 IBC 506.3.3

$$I_f = [F/P - 0.25]W/30$$

(IBC Equation 5-5)

WHERE:

- I_f = Area increase due to frontage
- F = Building perimeter that fronts on a public way or open space having 20 feet open minimum width
- P = Perimeter of entire building
- W = Width of public way or open space (feet) in accordance with section 506.3.2



Frontage Increases – 2021/2024 IBC 506.3.3

I_f = Area factor increase due to frontage

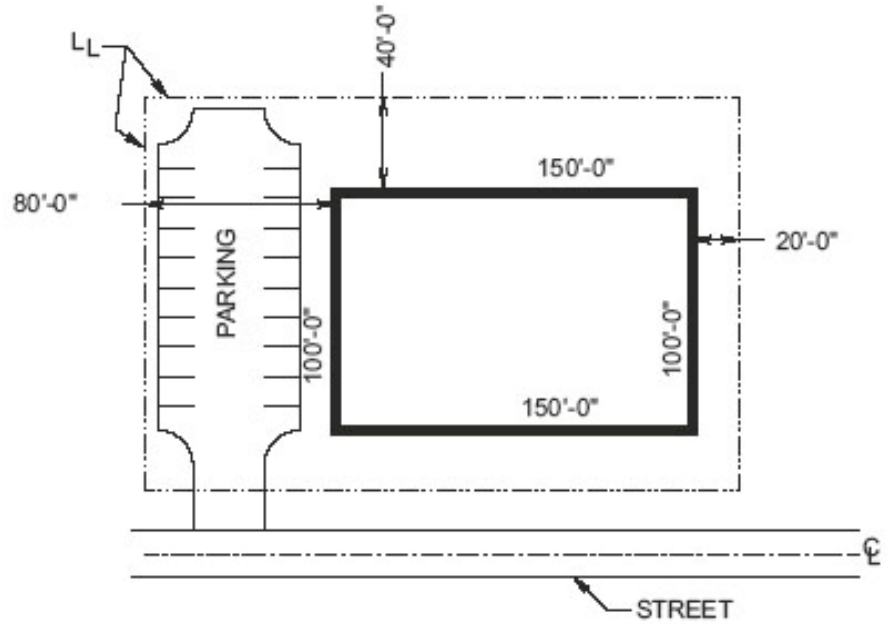


TABLE 506.3.3
FRONTAGE INCREASE FACTOR[a]

PERCENTAGE OF BUILDING PERIMETER	OPEN SPACE (feet)			
	0 to less than 20	20 to less than 25	25 to less than 30	30 or greater
0 to less than 25	0	0	0	0
25 to less than 50	0	0.17	0.21	0.25
50 to less than 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

Area Modification – Frontage IBC 506.3

MINIMUM QUALIFICATIONS

25% min of building perimeter is on a public way or open space 20' min distance from building face to:

- Closest interior lot line
- Entire width of street, alley, or public way
- Exterior face of adjacent building

EXCEPTIONS

Where building meets Unlimited requirements of IBC 507

And W > 30'

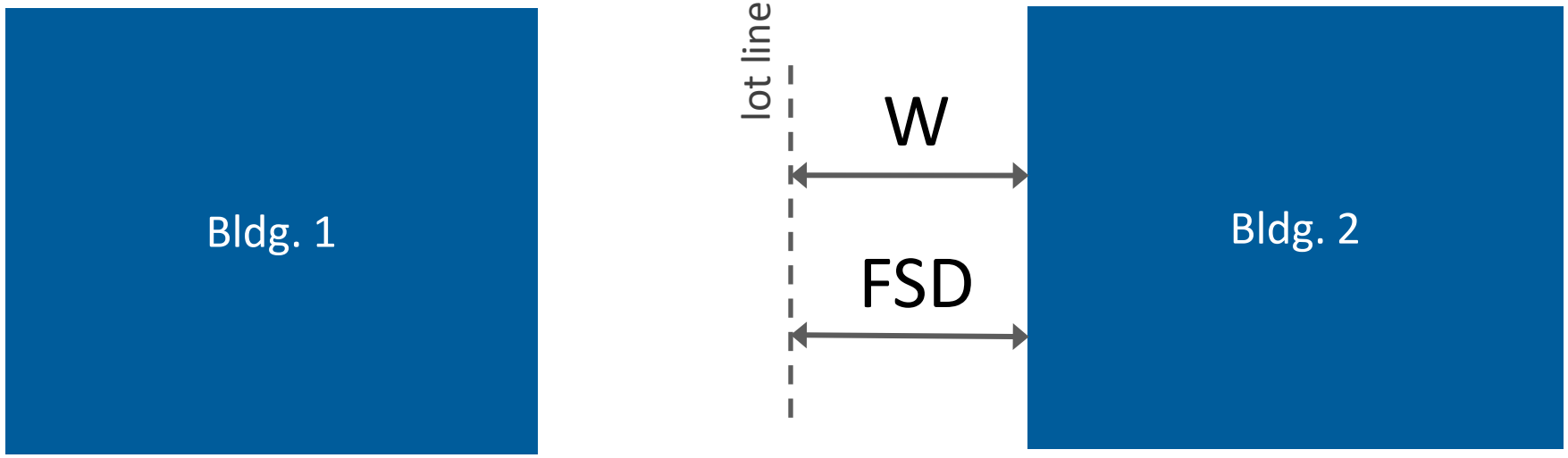
W_{max} = 60'

Frontage Increases – IBC 506.3

"W" for area increases NOT always the same as Fire Separation Distance (FSD) for purposes of fire resistance ratings of walls and openings

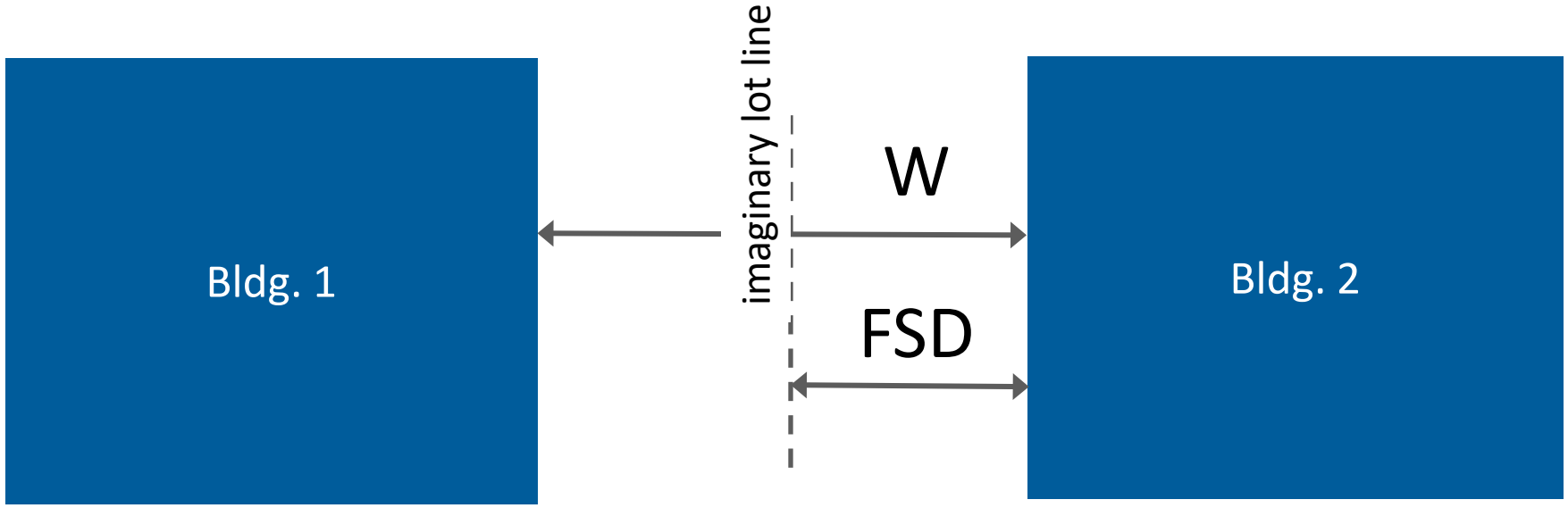
Frontage Increases – IBC 506.3

Two buildings on DIFFERENT lots



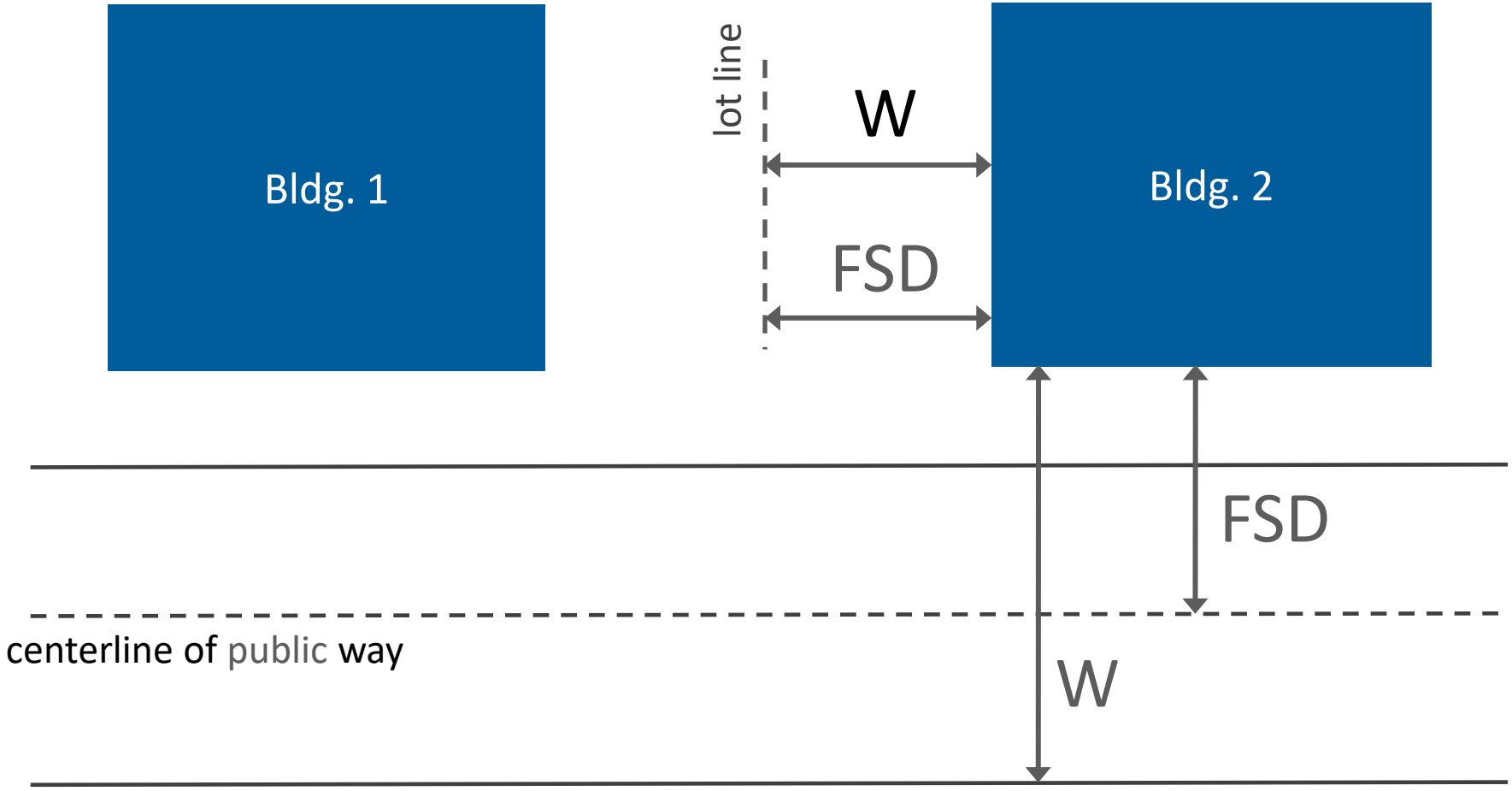
Frontage Increases – IBC 506.3

Two buildings on SAME lot



Frontage Increases – IBC 506.3

Buildings near public right of ways:



Frontage Increases – 2018 IBC 506.3

$$W = [(L_1 \times w_1) + (L_2 \times w_2) + (L_3 \times w_3)....]/F$$

(IBC Equation 5-4)

WHERE:

W = Calculated Width (weighted average) of public way or open space (feet)

$\mathbf{L_n}$ = Length of a portion of the exterior perimeter wall

$\mathbf{w_n}$ = Width (≥ 20 ft) of public way or open space associated with that portion of the exterior perimeter wall

F = Building perimeter that fronts on a public way or open space having 20 feet open minimum width

Total Building Area – IBC 506.2

$$A_a = [A_t + (NS \times I_f)] \times S_a$$

(Equation 5-2)

A_a = Allowable area, total (sq. ft.)

A_t = Tabular allowable area per story per Table 506.2 for NS, S1, SM, or S13R (sq. ft.)

NS = Tabular allowable area per story per Table 506.2 for non-sprinklered building (sprinklered or not)

I_f = Area increase factor due to frontage per 506.3
I_f, max = 0.75

S_a = Actual number of building stories above grade

$S_{a,\ max}$ = 3 for non-sprinklered buildings and those w/ NFPA13

$S_{a,\ max}$ = 4 for buildings w/ NFPA 13R

Total Building Area –IBC 506.2

1 story building (Type III-A)

» Total Area is 1 x A_a

R-2
S13R

Max Area =
24,000 sf total

R-2
S1

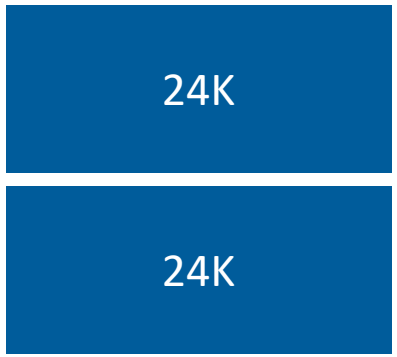
Max Area =
96,000 sf total

Total Building Area – IBC 506.2

2 story building (Type III-A)

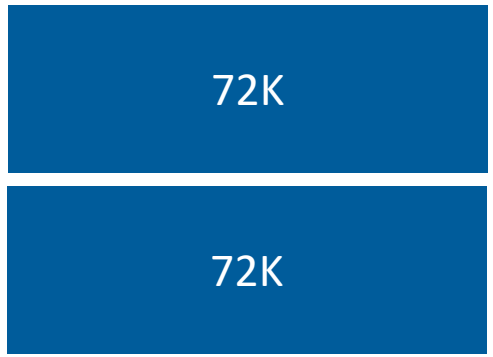
- Total Area is 2 x A_a
- No frontage increase shown

R-2
S13R



Max Area =
48,000 sf total

R-2
SM



Max Area =
144,000 sf total

Total Building Area – IBC 506.2

3 story building (Type III-A)

- Total Area is 3 x A_a
- Includes maximum frontage increase

R-2
S13R + I_f (NS)

24K +	.75(24K)
24K +	.75(24K)
24K +	.75(24K)

Max Area =
126,000 sf total

R-2
SM + I_f (NS)

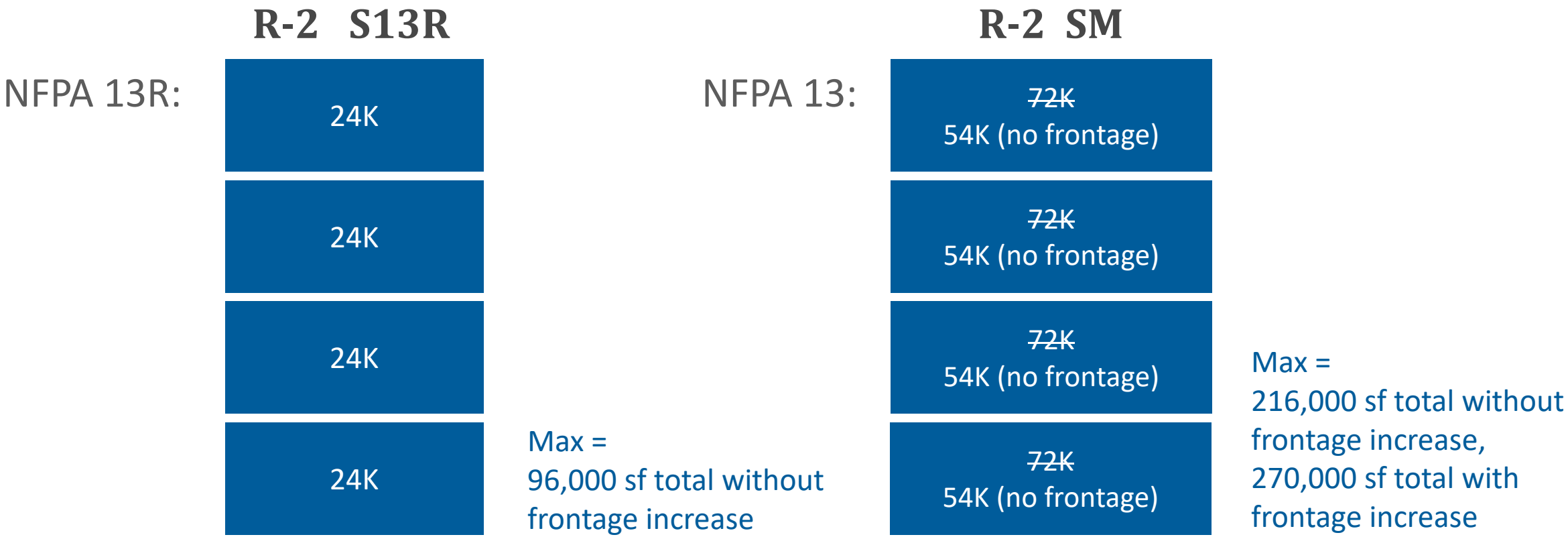
72K +	.75(24K)
72K +	.75(24K)
72K +	.75(24K)

Max Area =
270,000 sf total

Total Building Area – IBC 506.2

4 story building (Type III-A)

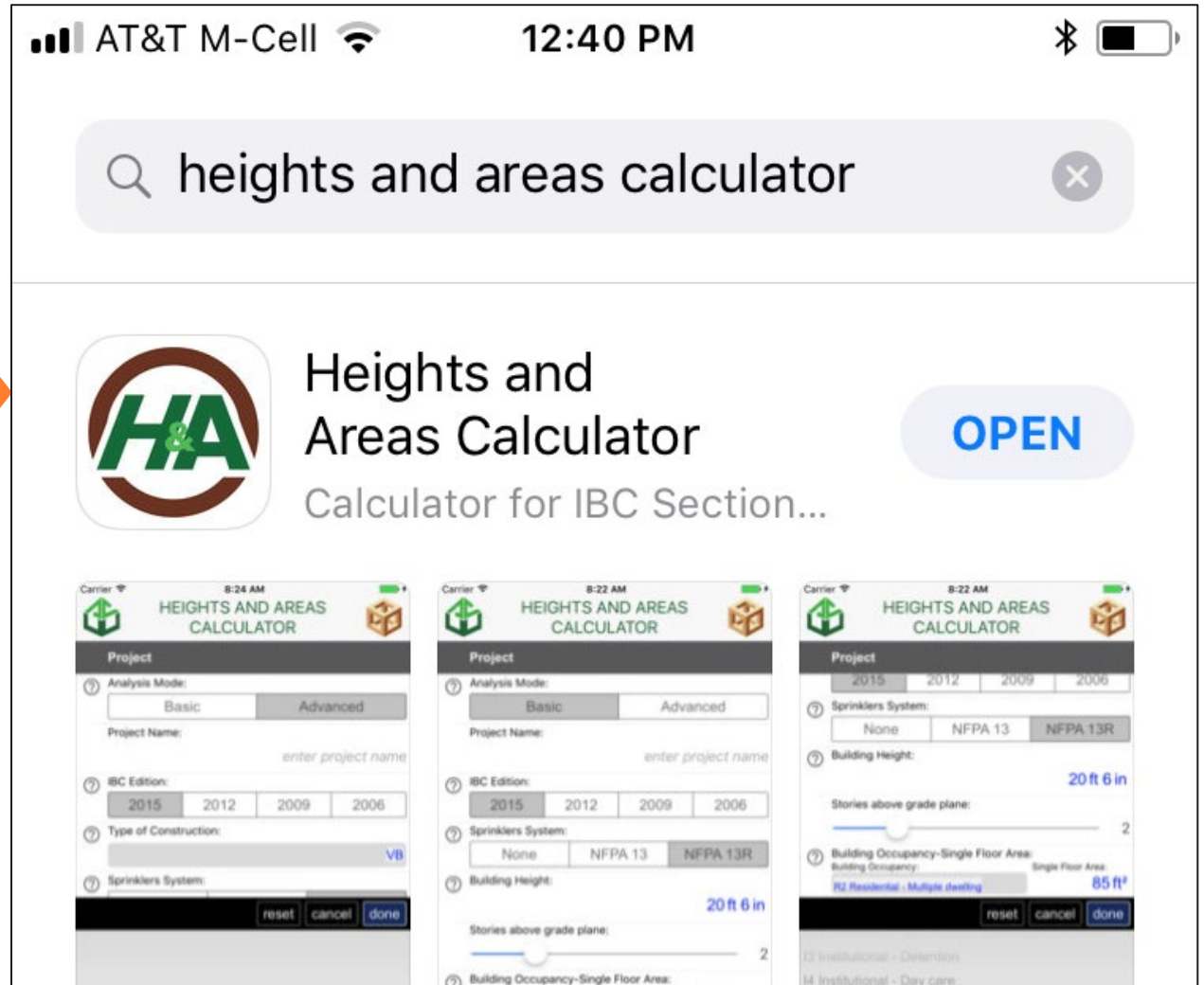
- Total Area is 3 x A_a for NFPA 13 sprinkler system (no frontage increase)
- Total area is 4 x A_a for NFPA 13R sprinkler system (no frontage increase)



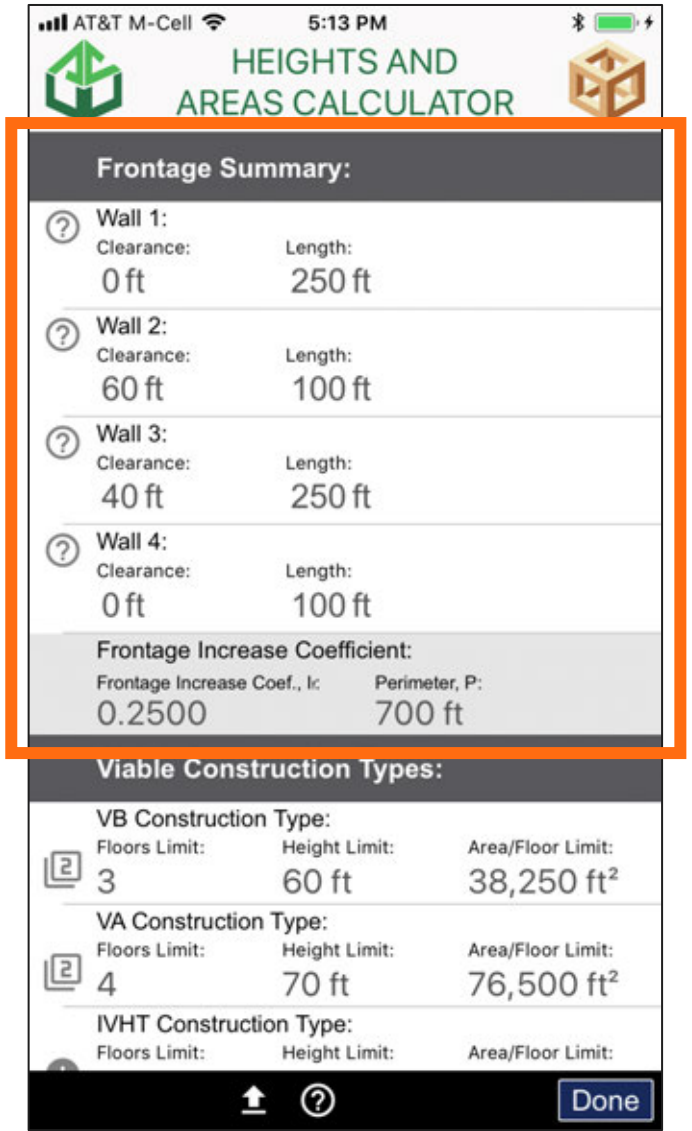
Mixed Use Occupancy – Design Aid

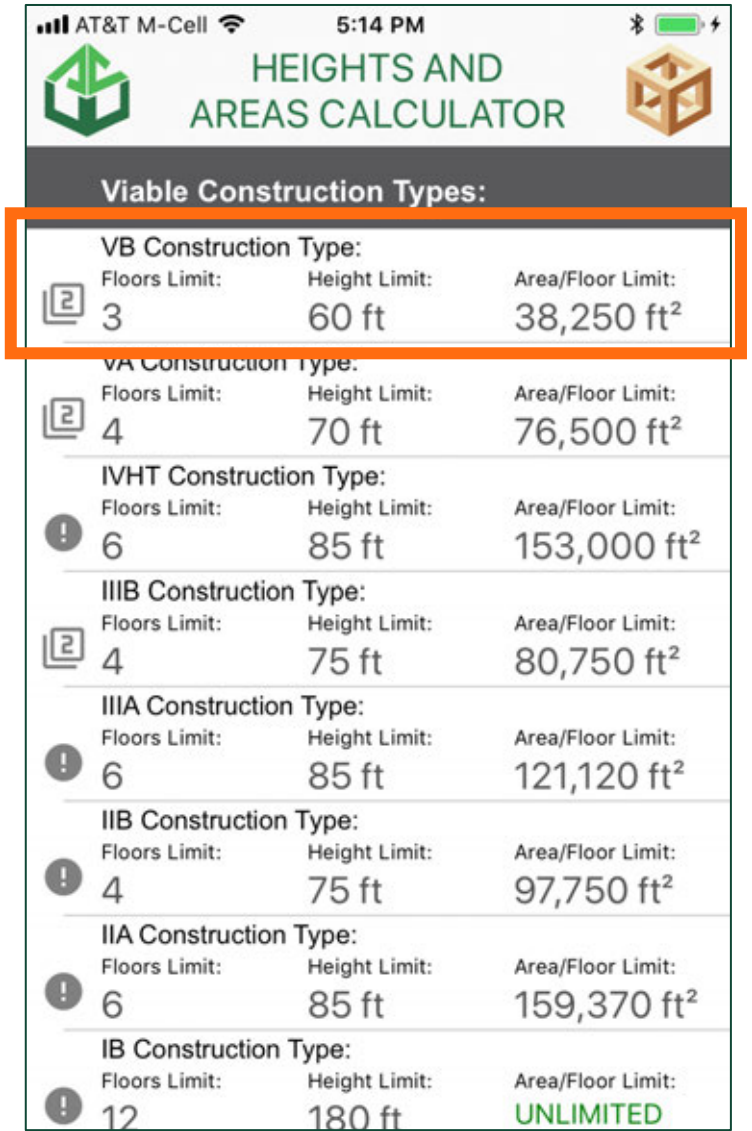
WoodWorks/AWC Heights & Areas Calculator App

Available for FREE at woodworks.org



Frontage Calculation – Design Aid





Case Study Innovations in Wood

Emory Point Atlanta, GA

- 3 buildings complete – Luxury Apt., retail, restaurants
- (1) 5 story Type III wood frame over slab on grade
- (2) 4 stories of wood over 1 story concrete podium

35% Structure Savings

- $14/sf (wood concept)
- $22/sf (PT conc. Slab and frame)

Architect: Cooper Carry, The Preston Partnership

Engineer: Ellinwood + Machado, Pruitt Eberly Stone

Contractor: Fortune-Johnson

Photo credit: Gables Residential

Mezzanines – IBC 505

Not counted toward building area* or number of stories if:

- Maximum 1/3 floor area of *room* or *space* where located
- Special egress provisions apply
- Must be open and unobstructed to room in which it's located (walls ≤ 42" allowed)
  - Several exceptions
- Slightly different for equipment platforms

*Does count toward fire area with regard to fire protection in Chapter 9

Case Study Maximizing View and Value With Wood

Marselle Condominiums

Seattle, WA

- Type III-A condo complex
- 5-1/2 stories of wood over 2 stories of concrete
- Mezzanine added $250K cost but $1M in value
- 30% cost saving over concrete
- Time savings over steel

Architect: PB Architects

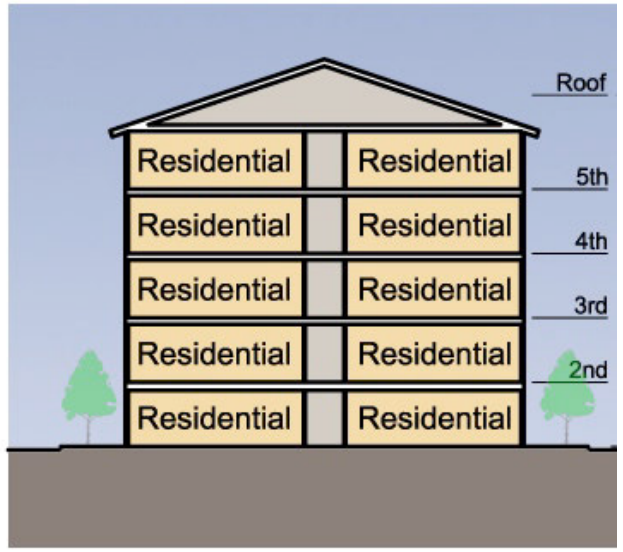
Engineer: Yu & Trochalakis

Contractor: Norcon, NW

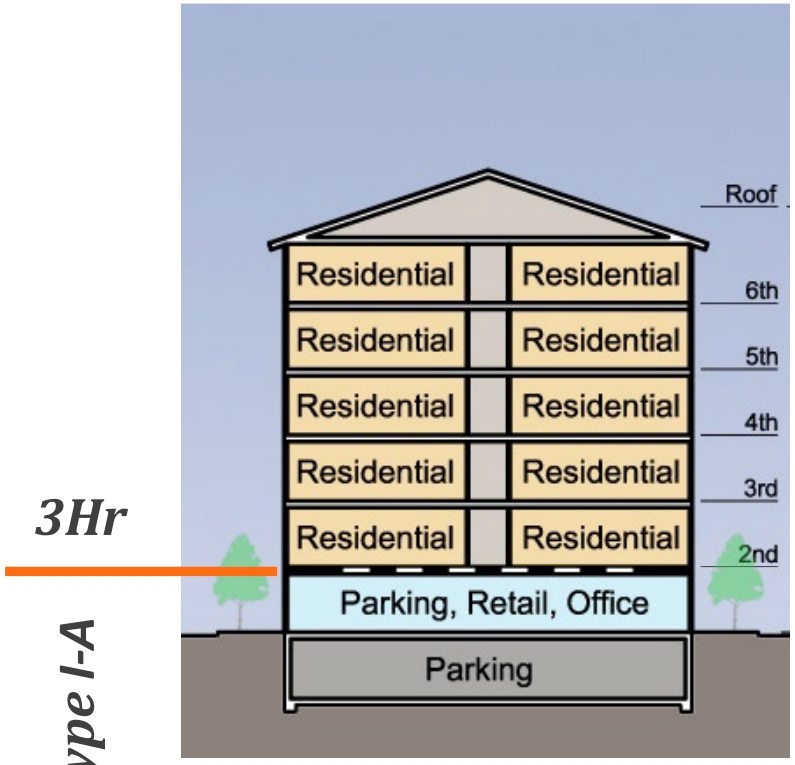
Completed: 2009

Photo Credit: Matt Todd Photography

IBC Podium Provisions



5 story Type III Building



5 story Type III Building
On Top of a Type I-A Podium

Special Provisions for Podiums in IBC 510.2
Increases allowable stories… not allowable building height

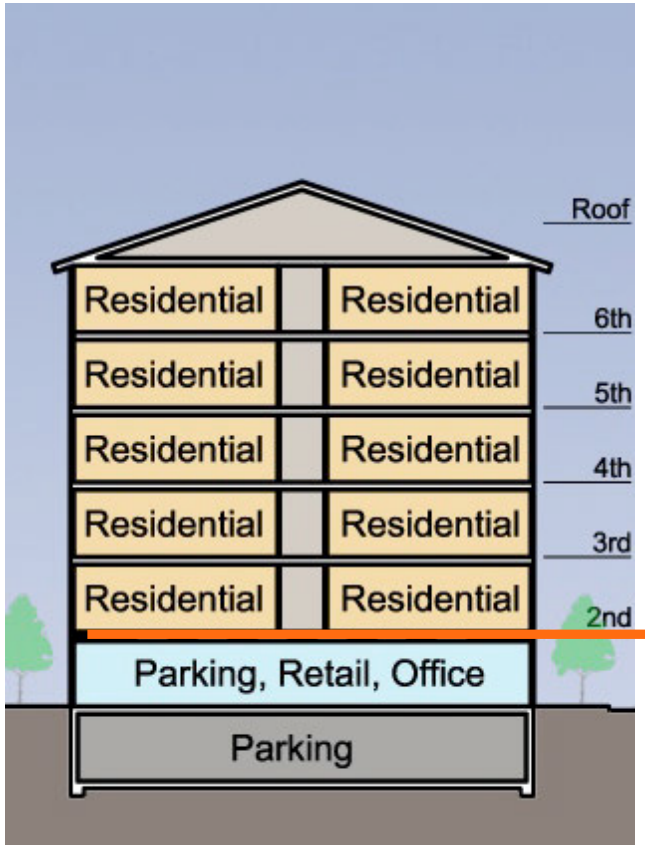
Horizontal Building Separation – 510.2

Considered separate buildings above and below for purposes of area calculations if:

- Overall height is still limited to min of either building
- 3-hr rated horizontal assembly
- Building below is Type I-A with sprinklers
- Enclosures penetrating horizontal assembly are 2-hr rated
- Occupancy above is A (occupant load <300), B, M, R or S
- Occupancy below is any except H

The Flats at ISU, Normal, IL
OKW Architects
Precision Builders & Associates

Evolution of IBC Mixed-Use Podium



IBC	2006	2009	2012	2015	2018	2021	2024
Section	509.2	509.2	510.2	510.2	510.2	510.2	510.2
Upper Occupancy	A, B, M, R or S						
3Hr							
Lower Occupancy	S-2 Parking	A, B, M, R or S-2 Parking		Any Except H			
Type IA							
Podium Height	1 Story			No Restriction			

IBC Provisions for mixed-use podiums have been evolving.

Starting in 2015, IBC allows multiple podium stories above grade.

Copyright Materials

Funding provided in part by the Softwood Lumber Board