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

Simpson Strong-Tie Warehouse and Training Center
Kent, WA

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July 23, 2025

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AIA Approved Continuing Education

Course Description

Increasingly, building designers and developers are looking to mid-rise wood construction as a cost-effective and sustainable solution for commercial and multi-family buildings. This presentation will review the allowable construction types, with an emphasis on the opportunities and advantages of using light-frame wood in Types III and V. Presenters will cover design considerations associated with these projects, including how to maximize height and area through the use of sprinklers, open frontage, sloping sites, podiums, and mezzanines. Common framing methods will also be discussed in the context of ensuring that projects are designed to be structurally sound, constructable, and code compliant.

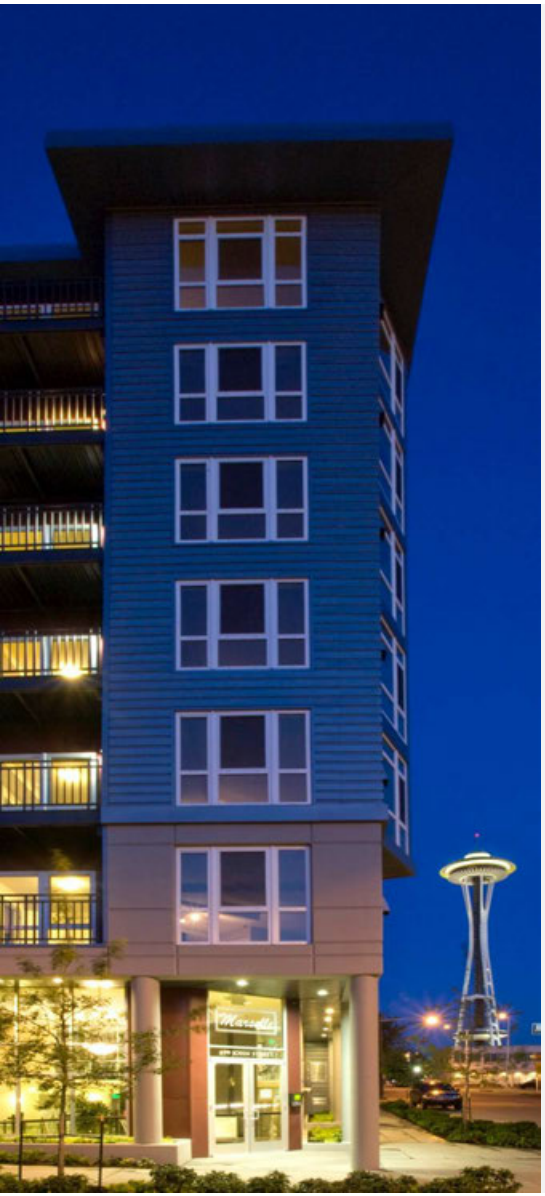
Learning Objectives

1. Discuss how mid-rise, light-frame wood construction meets the need for additional commercial space and multi-family housing while contributing to vibrant and sustainable communities.

2. Review allowable construction types, occupancies, and building heights and areas for wood-frame mid-rise construction per the International Building Code (IBC).

3. Explore potential modifications to the IBC's base tabular heights and areas based on building frontage, sprinklers, sloping sites, podiums, and mezzanines.

4. Understand how to design for standard framing practices to avoid costly construction errors and ensure the resulting building is structurally sound and code compliant.



Frame it Right:

Optimizing Size and Framing Efficiency in Mid-Rise Wood Buildings

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

MICHAEL J. MULLER, PE, SE

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

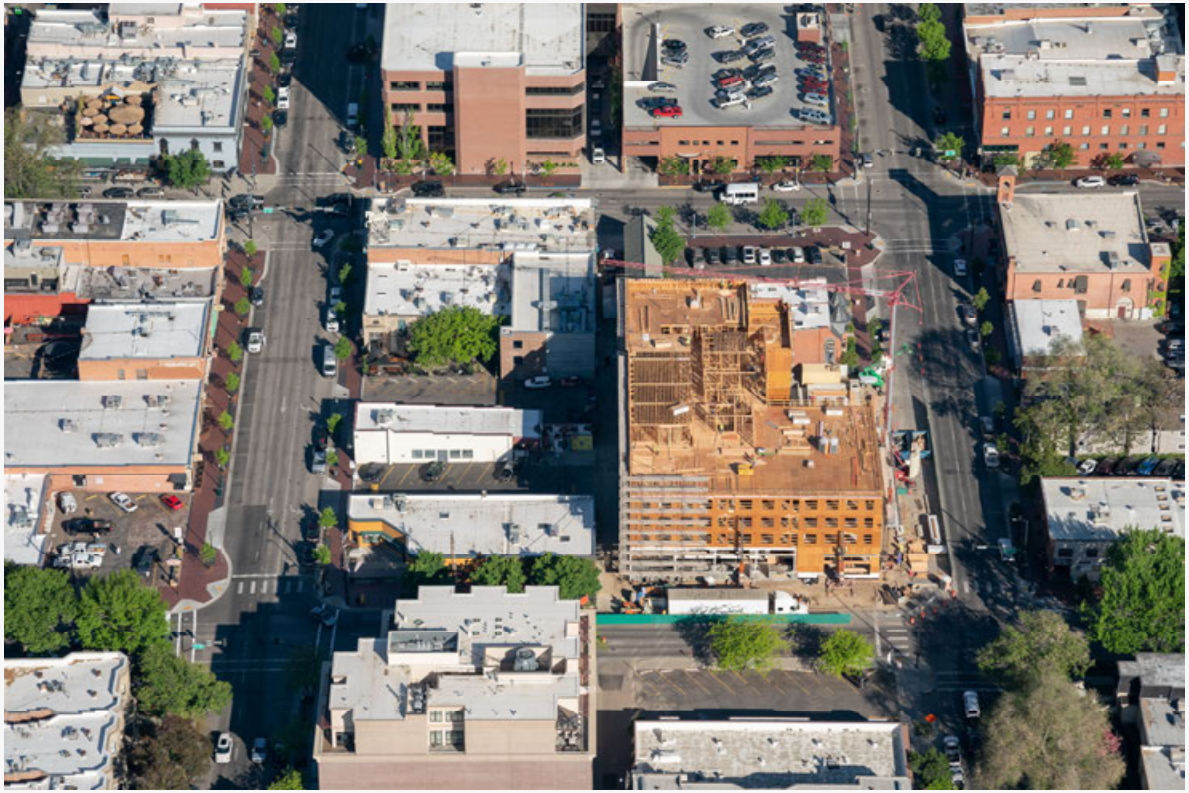
Mid-rise wood-frame construction provides a common ground for both

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

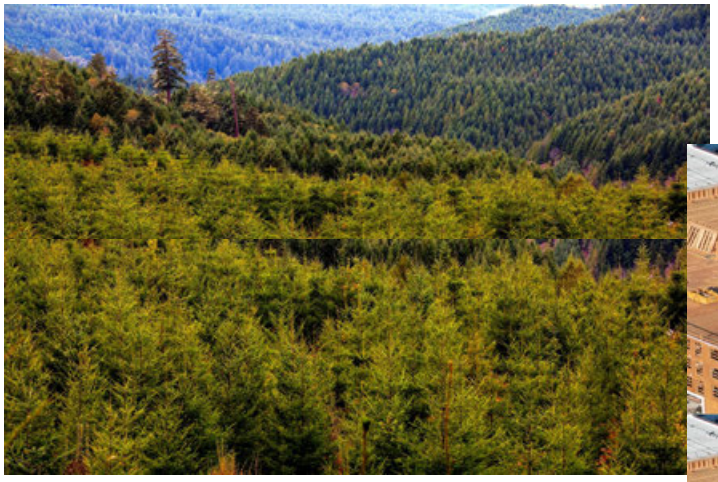


Photo courtesy OFRI

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

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
CAMDEN
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?

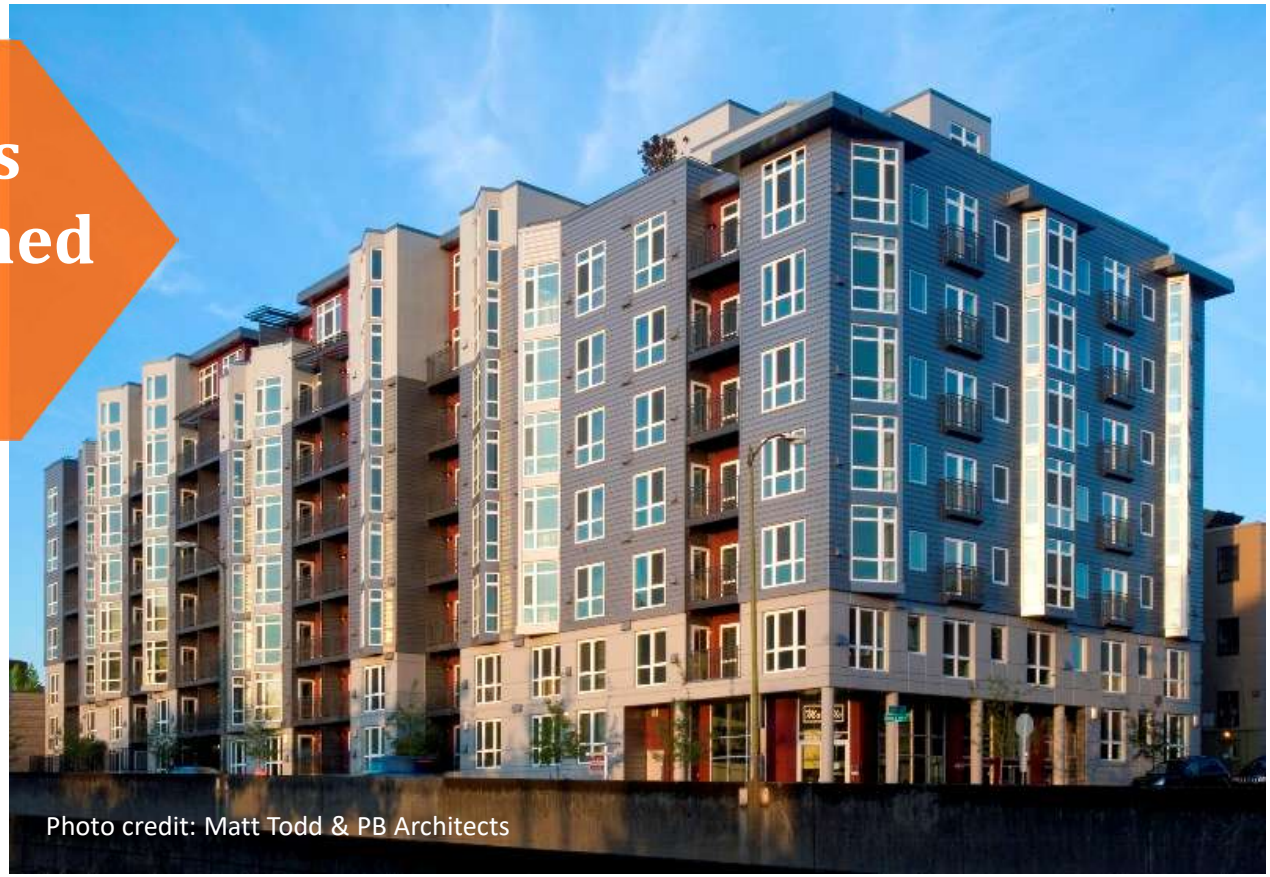


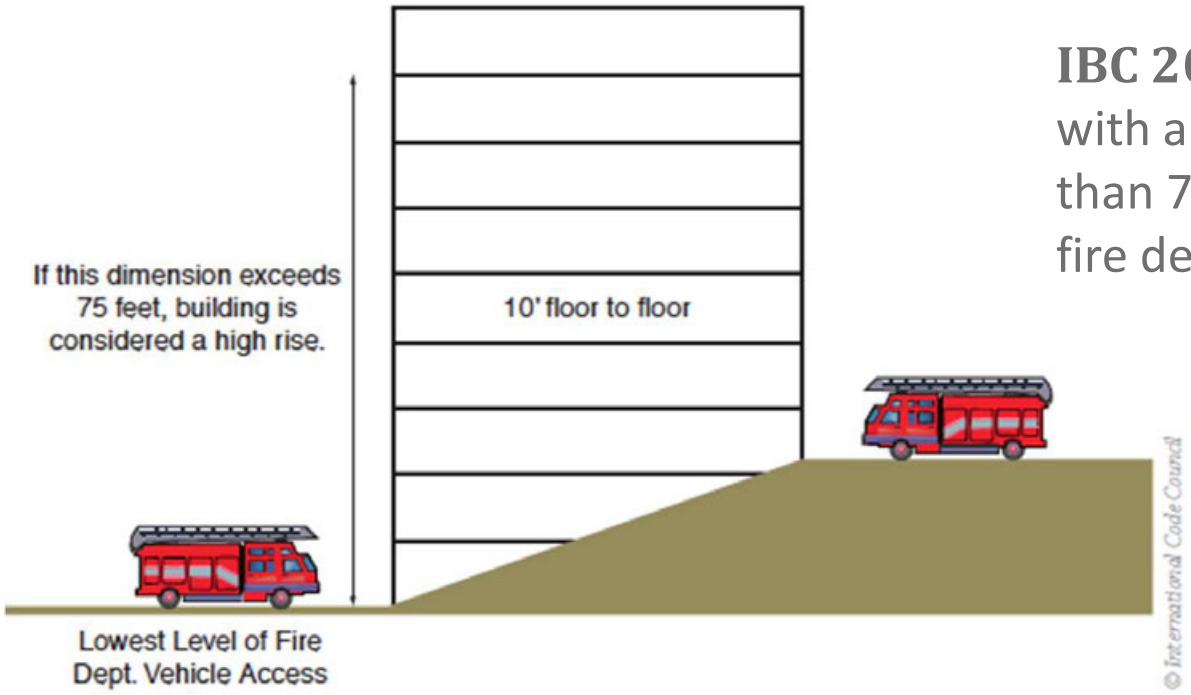
Photo credit: Matt Todd & PB Architects

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

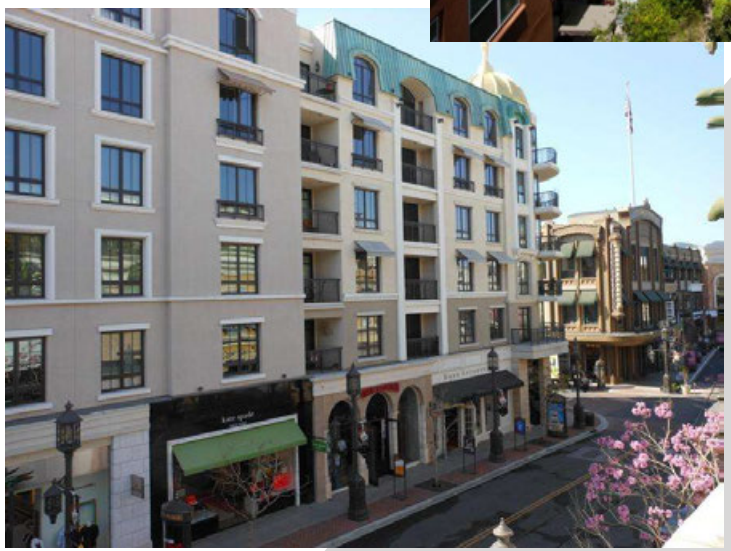
Inman Park Condos, Atlanta, GA
Davis & Church

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)

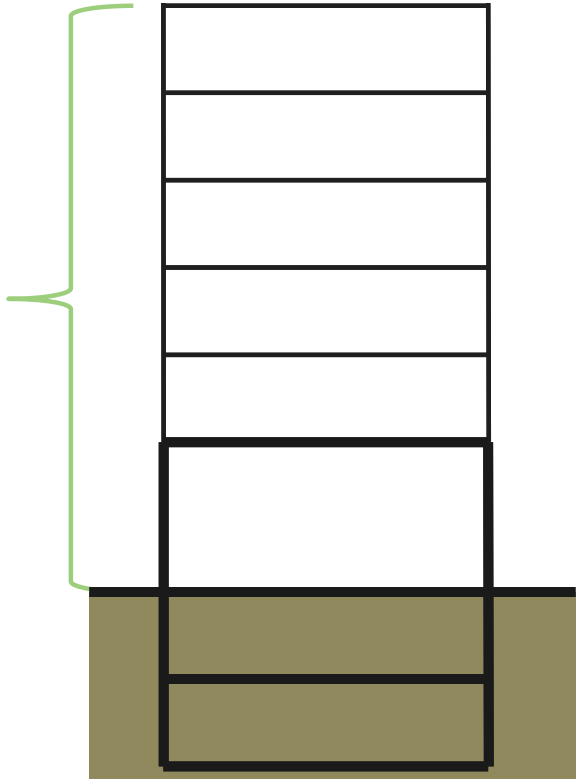
Apartments (R-2)

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:

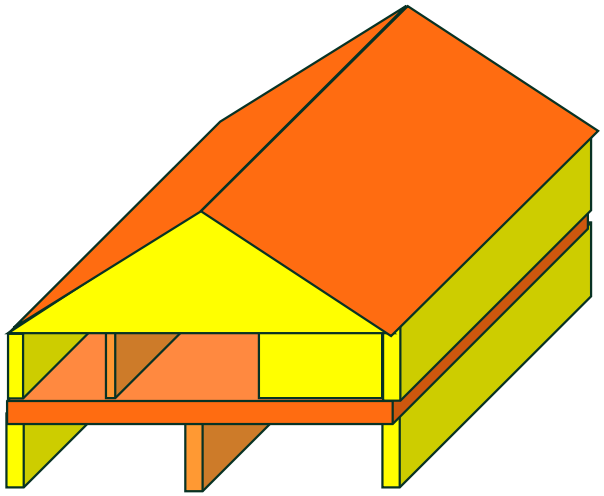
- A (protected)
- B (unprotected)

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

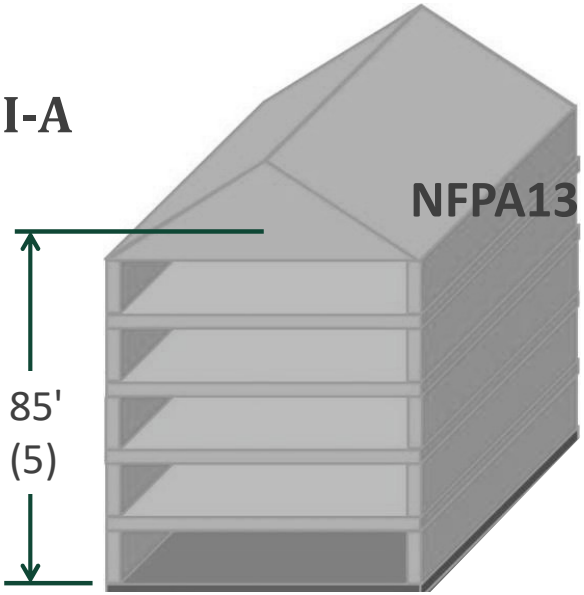
Fire Retardant Treated allowed
- Exterior walls if fire rating ≤ 2-hr

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

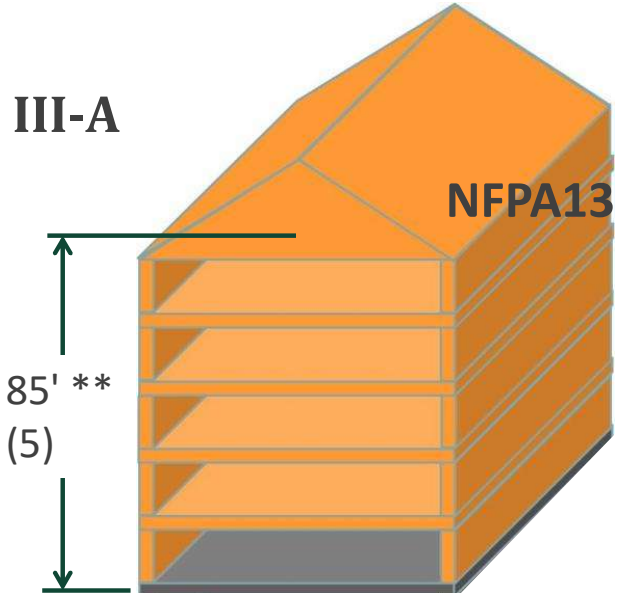
Untreated Lumber
- All interior elements

Increased Height & Story Area: Residential Occupancy

Type II-A



Type III-A

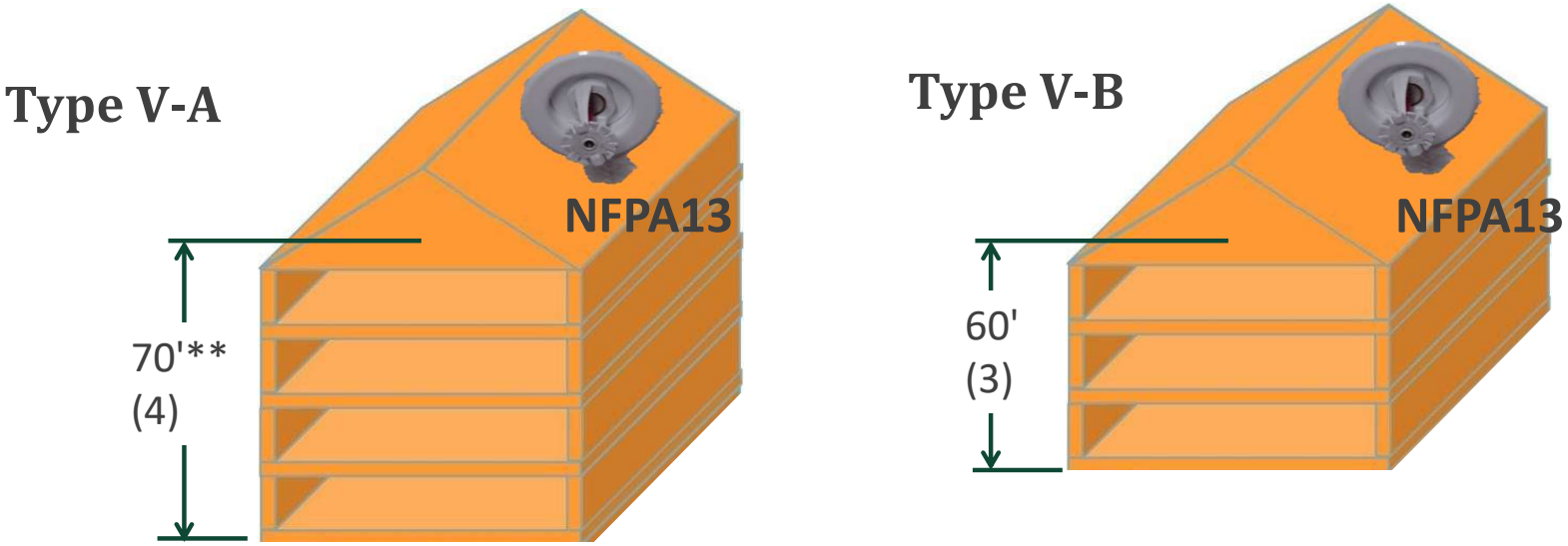


Occupancy	II-A (ft^2)*	III-A (ft^2)*
R-1	72,000 +18,000 (max frontage)	72,000 +18,000 (max frontage)
R-2	72,000 +18,000 (max frontage)	72,000 +18,000 (max frontage)

* 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

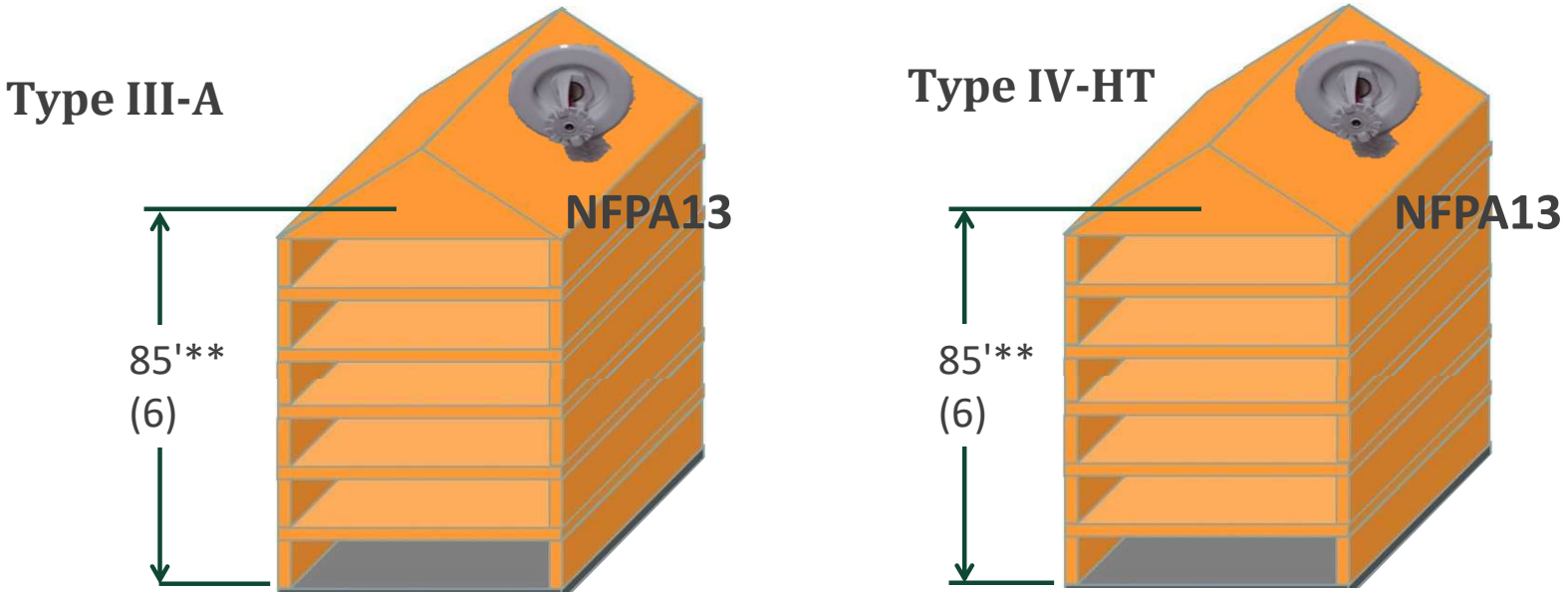


Occupancy	V-A (ft^2)*	V-B (ft^2)
R-1	36,000 +9,000 (max frontage)	21,000 +5,250 (max frontage)
R-2	36,000 +9,000 (max frontage)	21,000 +5,250 (max frontage)

* 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 – 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	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
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 – 2021/2024 IBC Table 504.4

TABLE 504.4
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE[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	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 – 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.)

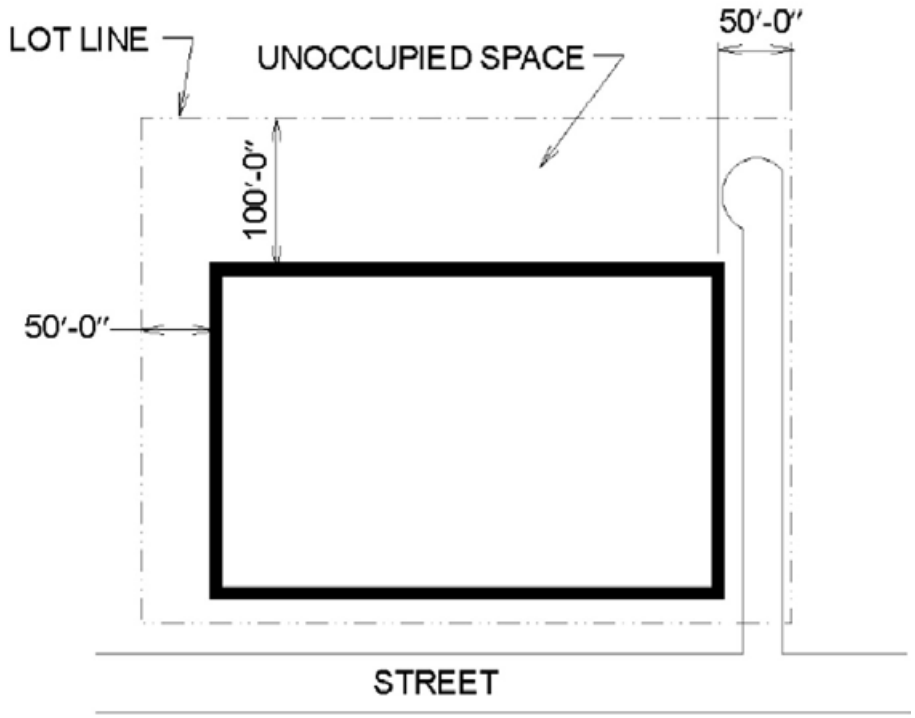
A_t = Tabular allowable area per story per Table 506.2 for NS, S1 or S13R (sq. ft.)

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 – 2021/2024 IBC 506.3.3

I_f = Area factor increase due to frontage

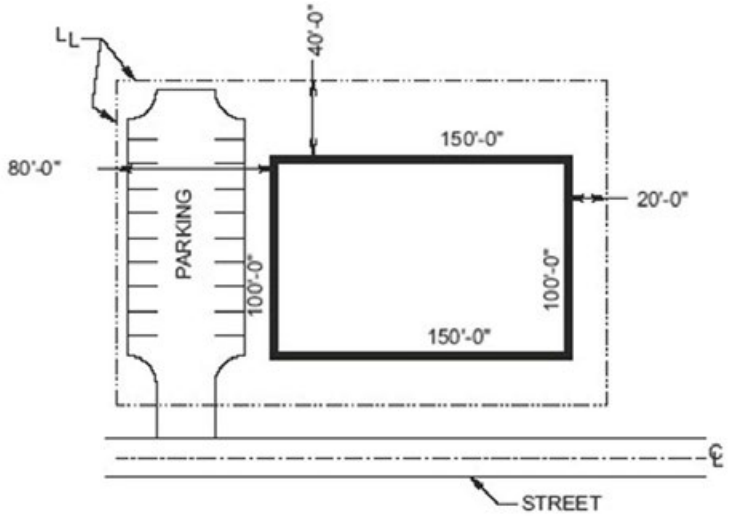


TABLE 506.3.3
FRONTAGE INCREASE FACTOR[a]

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'

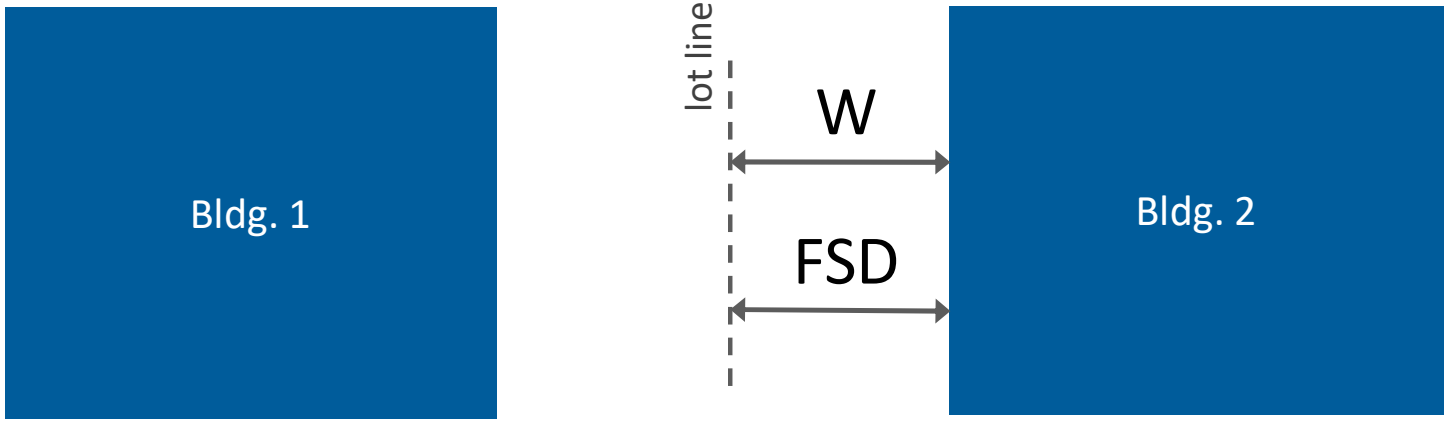
W_{max} = 60'

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

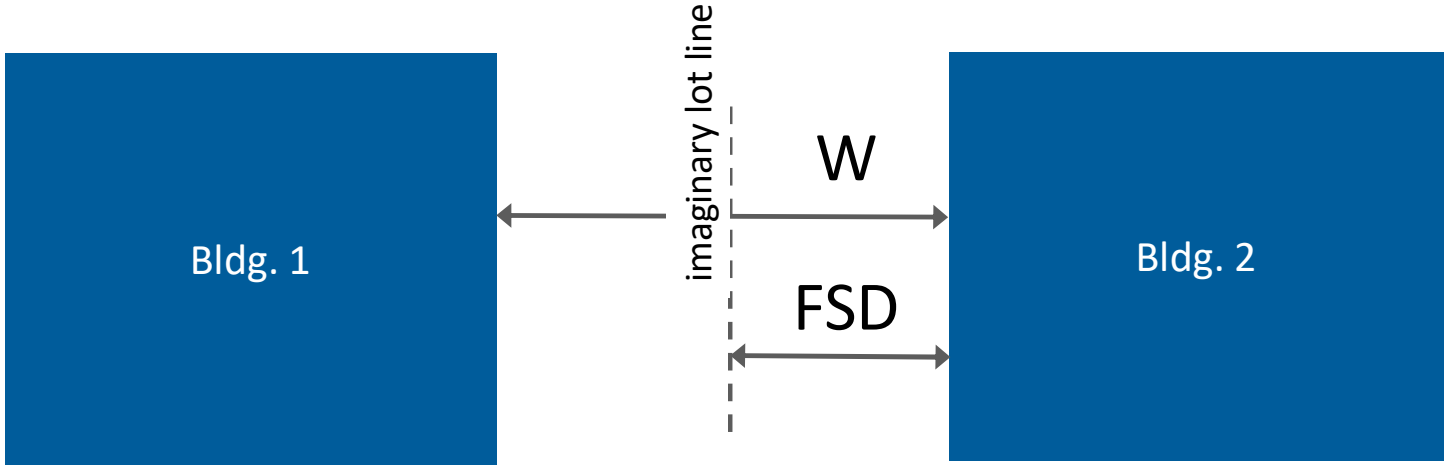
Frontage Increases – IBC 506.3

Two buildings on DIFFERENT lots



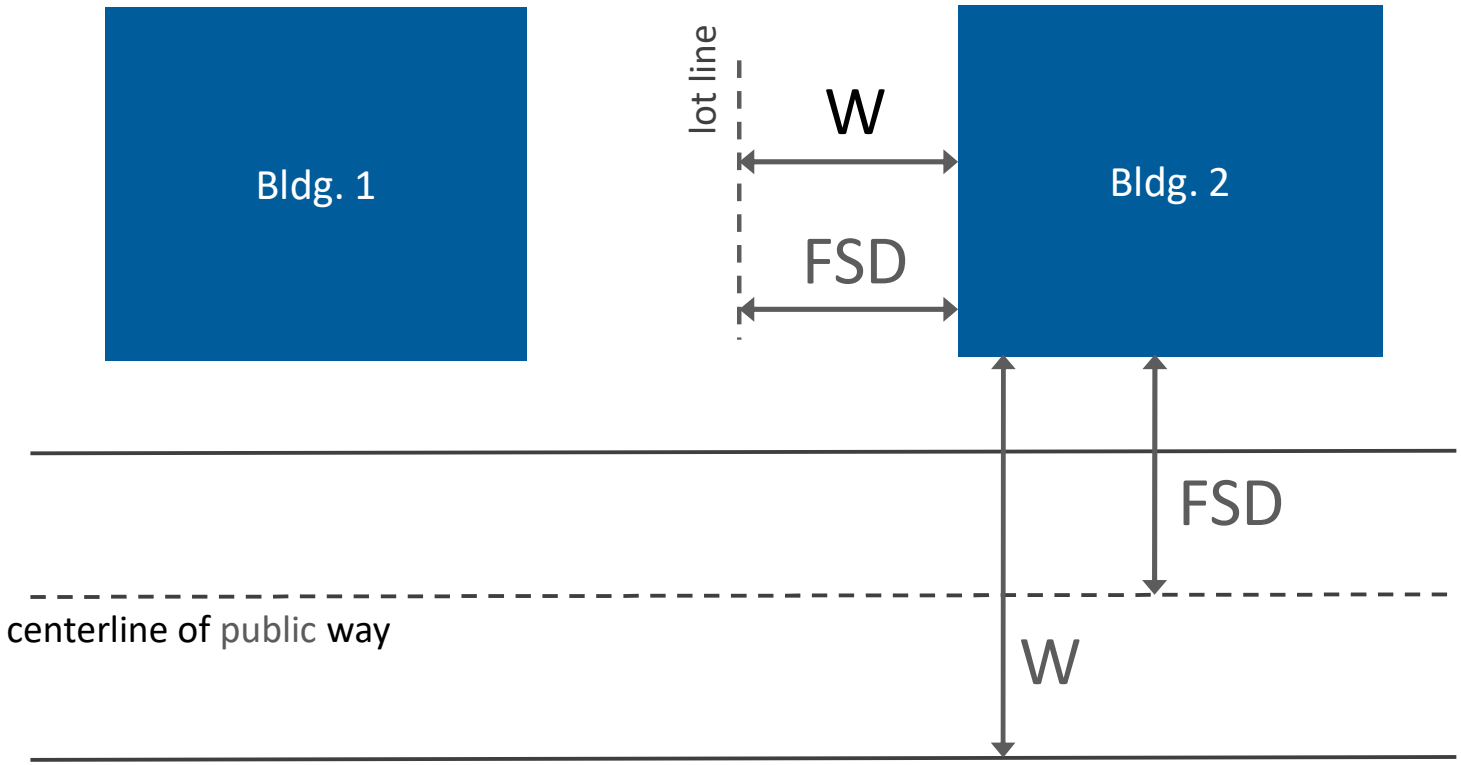
Frontage Increases – IBC 506.3

Two buildings on SAME lot



Frontage Increases – IBC 506.3

Buildings near public right of ways:



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

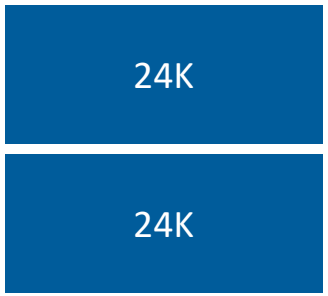
Max Area =
96,000 sf total

Total Building Area – IBC 506.2

2 story building (Type III-A)

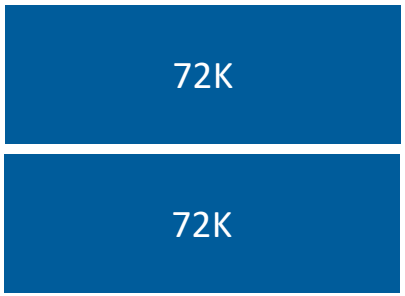
- Total Area is 2 x A_a
- No frontage increase shown

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)

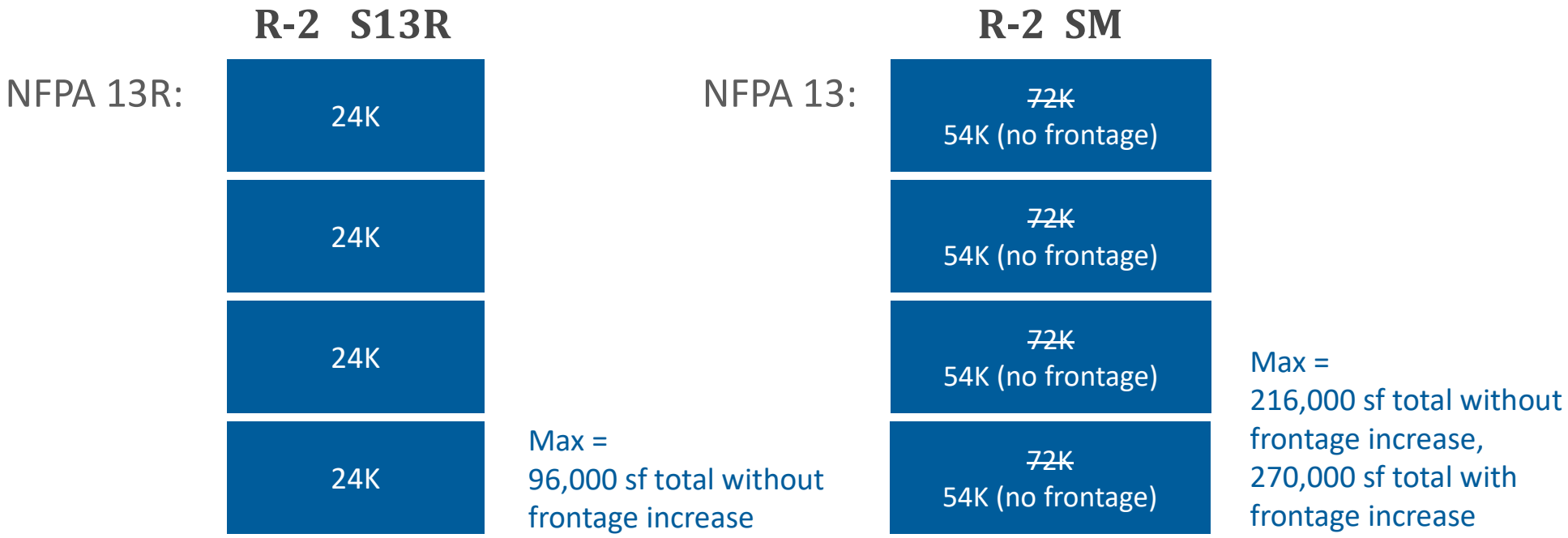
72K +	.75(24K)
72K +	.75(24K)
72K +	.75(24K)

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 Occupancy, Multi-story

Story Area: $\Sigma (A_i / A_{a,i}) \leq 1$

(Described in 2021/2024 IBC 508.4.2)

Total Building Area: $\Sigma (A_i / A_{a,i}) \leq S_a$

(Described in 2021/2024 IBC 506.2.2)

$\mathbf{A_i}$ = Actual area of occupancy *i* at a given story (sq. ft)

$\mathbf{A_{a,i}}$ = Allowable area per story for occupancy *i* (sq. ft) = $[A_{t,i} + (NS_i \times I_f)]$

$\mathbf{A_{t,i}}$ = Tabular allowable area per story for occupancy *i* per Table 506.2 (sq. ft.)

$\mathbf{NS_i}$ = Tabular allowable area per story for occupancy *i* per Table 506.2 for non-sprinklered building (sprinklered or not)

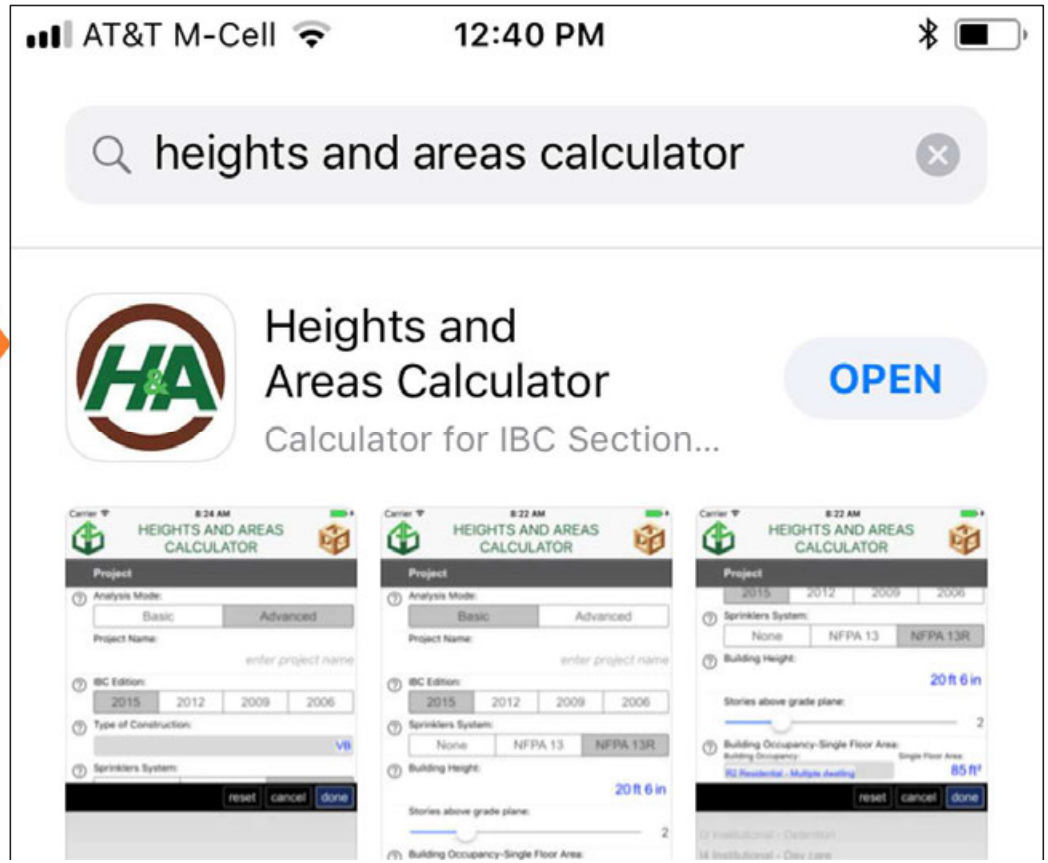
$\mathbf{I_f}$ = Area increase factor due to frontage per 506.3
I_f, max = 0.75

$\mathbf{S_a}$ = Actual number of building stories above grade not to exceed 3 for non-sprinklered buildings and those w/ NFPA13. **OR** 4 for buildings w/ NFPA 13R

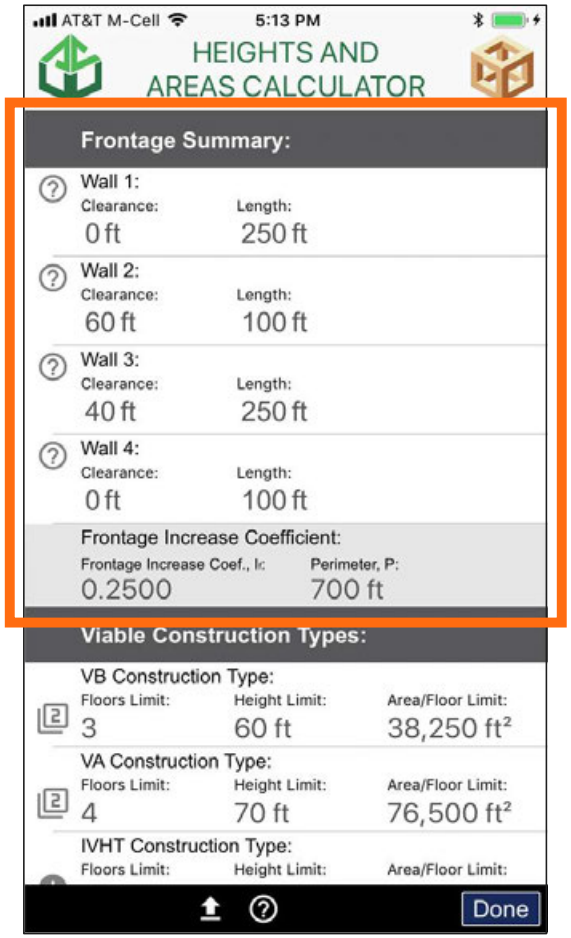
Mixed Use Occupancy – Design Aid

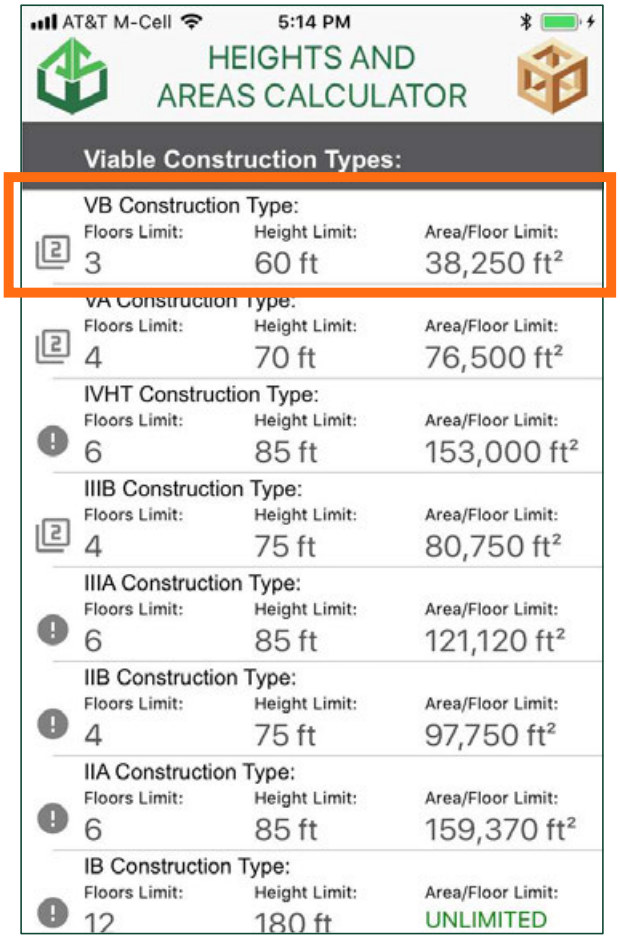
WoodWorks/AWC Heights & Areas Calculator App

Available for FREE at woodworks.org



Frontage Calculation – Design Aid





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

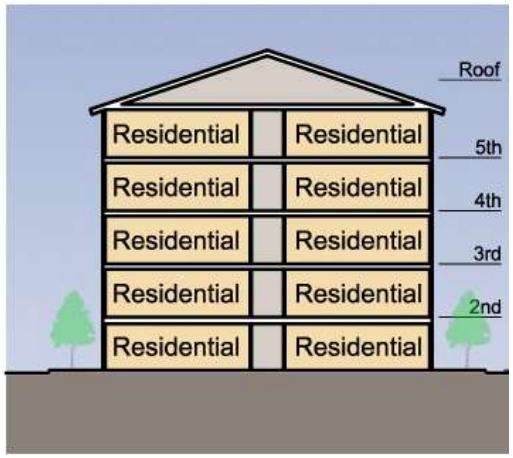
Engineer: Yu & Trochalakis

Contractor: Norcon, NW

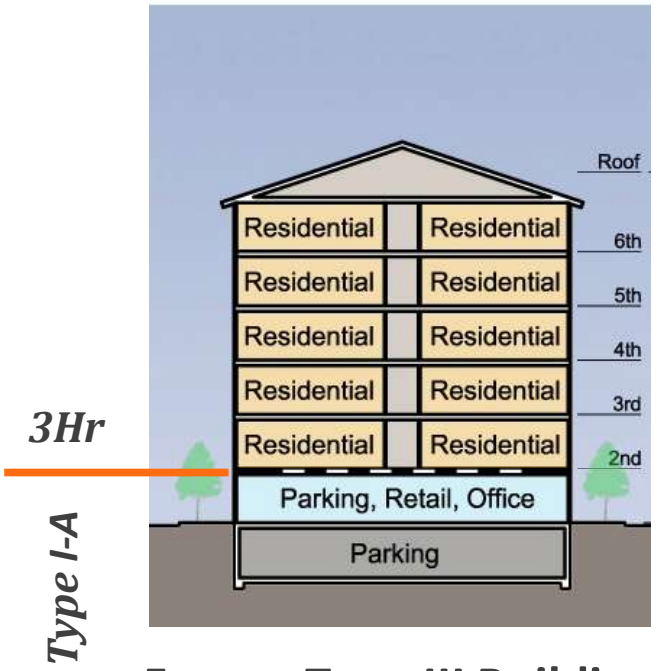
Completed: 2009

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

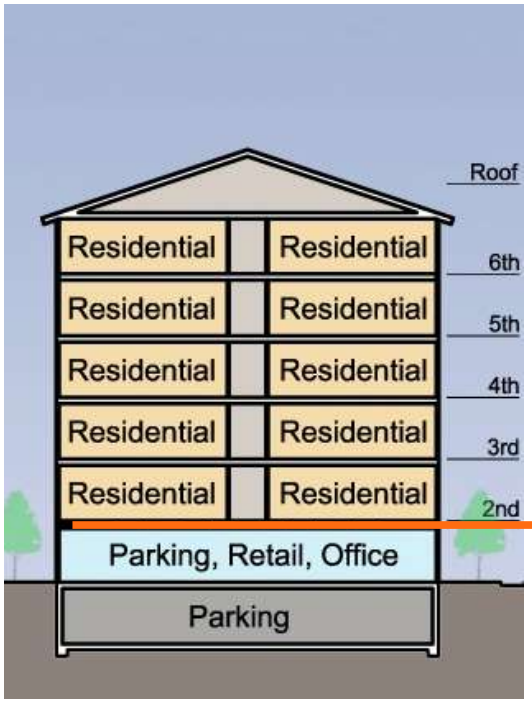
Horizontal Building Separation – 510.2

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



3Hr

Type IA

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						
Lower Occupancy	S-2 Parking	A, B, M, R or S-2 Parking		Any Except H			
Podium Height	1 Story			No Restriction			

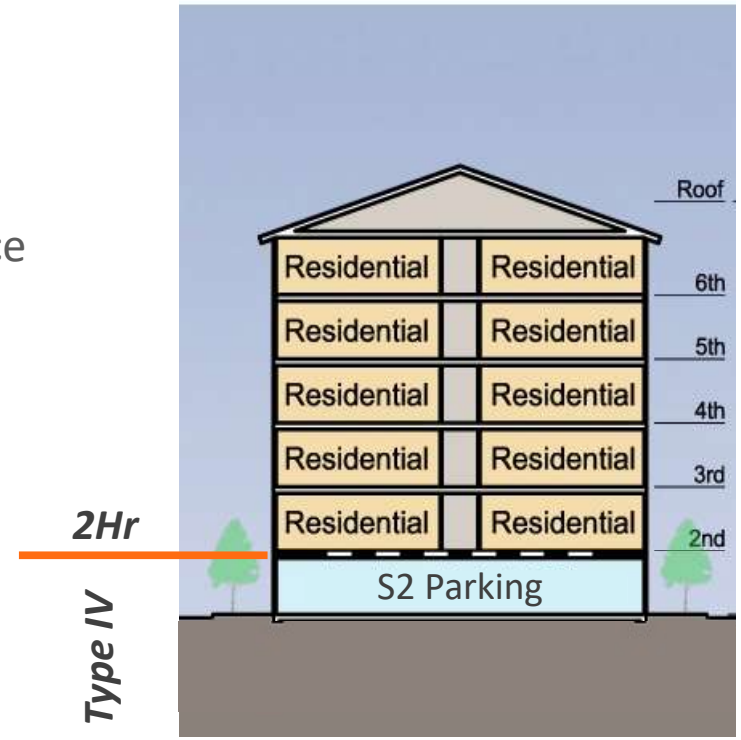
IBC Provisions for mixed-use podiums have been evolving.

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

Parking Beneath Group R – IBC 510.4

Possibility of a Type IV podium where number of stories starts above parking when:

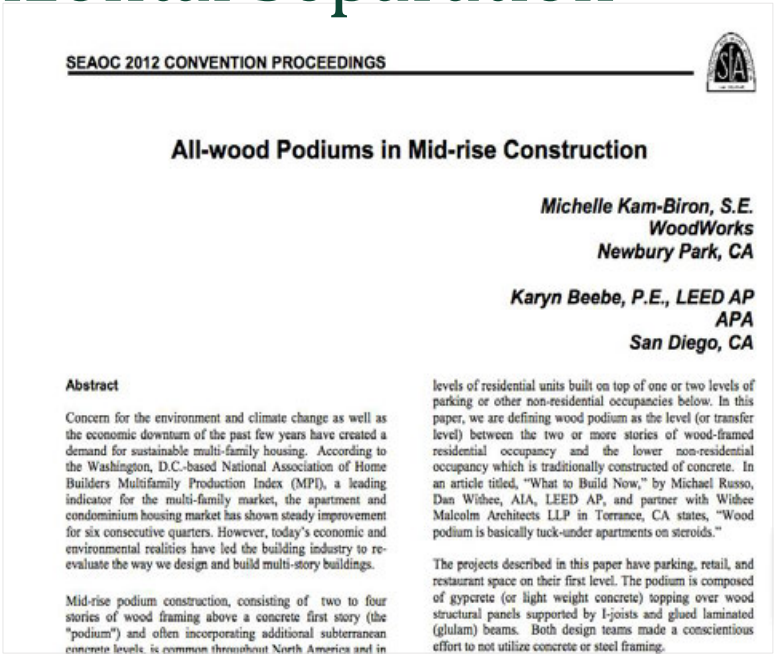
- Occupancy above is R and below is S-2
- Lower floor is Type IV (open) parking with grade entrance
- Horizontal assembly between 1st and 2nd floor shall be:
  - Same construction type as lower floor (Type IV)
  - 1-hr fire resistance rating when sprinklered
  - Overall height is still limited to occupancy



5 story Type III Building On Top of a Type IV

http://www.woodworks.org/experttip/can-parking-incorporated-mixed-use-wood-frame-buildings-construction-type-perspective/

Horizontal Separation



SEAOC 2012 CONVENTION PROCEEDINGS

All-wood Podiums in Mid-rise Construction

Michelle Kam-Biron, S.E.
WoodWorks
Newbury Park, CA

Karyn Beebe, P.E., LEED AP
APA
San Diego, CA

Abstract

Concern for the environment and climate change as well as the economic downturn of the past few years have created a demand for sustainable multi-family housing. According to the Washington, D.C.-based National Association of Home Builders Multifamily Production Index (MPI), a leading indicator for the multi-family market, the apartment and condominium housing market has shown steady improvement for six consecutive quarters. However, today's economic and environmental realities have led the building industry to re-evaluate the way we design and build multi-story buildings.

Mid-rise podium construction, consisting of two to four stories of wood framing above a concrete first story (the "podium") and often incorporating additional subterranean concrete levels, is common throughout North America and in levels of residential units built on top of one or two levels of parking or other non-residential occupancies below. In this paper, we are defining wood podium as the level (or transfer level) between the two or more stories of wood-framed residential occupancy and the lower non-residential occupancy which is traditionally constructed of concrete. In an article titled, "What to Build Now," by Michael Russo, Dan Withee, AIA, LEED AP, and partner with Withee Malcolm Architects LLP in Torrance, CA states, "Wood podium is basically tuck-under apartments on steroids."

The projects described in this paper have parking, retail, and restaurant space on their first level. The podium is composed of gypcrete (or light weight concrete) topping over wood structural panels supported by I-joists and glued laminated (glulam) beams. Both design teams made a conscientious effort to not utilize concrete or steel framing.

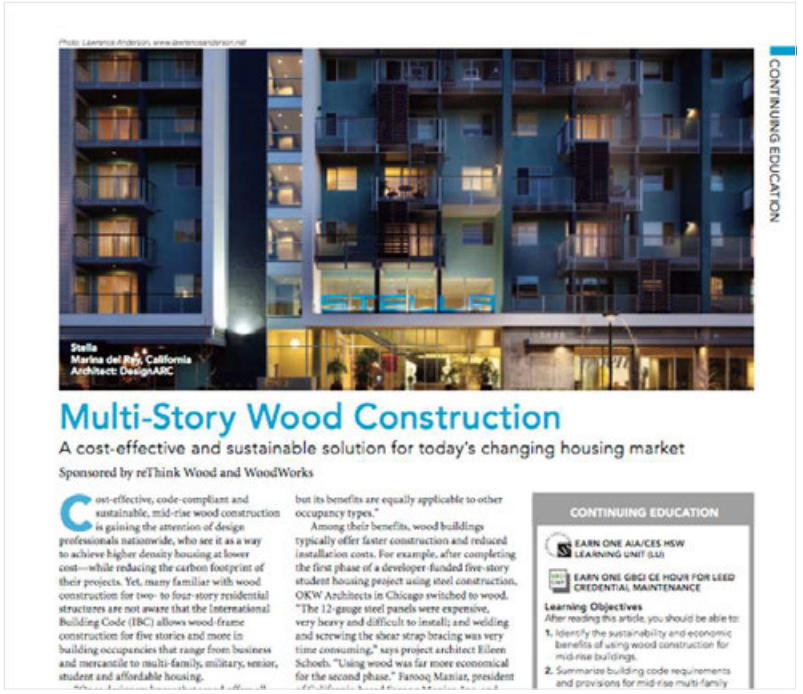
ALL-WOOD PODIUMS

Although a podium structure typically refers to wood-frame construction over concrete, a handful of designers have lowered their costs even further by designing the podium in wood.

"When determining the cost of a structure, there are a lot variables, including most notably time, materials and labor," said Karyn Beebe, P.E., of APA. "Using wood instead of concrete lowers the mass of the building, which results in more economical podium shear walls and foundations. Using the same material for the entire structure may also mean lower design costs, and the construction team experiences savings in the form of fewer trades on site, which means less mobilization time, greater efficiency because framing is repeated on all of the levels, easier field modifications, and a faster schedule."

Architect Dan Withee, AIA, LEED AP, of Withee Malcolm Architects designed an 85-unit wood podium project in San Diego. He estimated that a concrete podium can cost $15,000 per parking space compared to $9,500 for wood podium.[6]

Horizontal Wood Assemblies are effectively used to transition from Residential units above to Retail/Parking below



CONTINUING EDUCATION

Multi-Story Wood Construction

A cost-effective and sustainable solution for today's changing housing market

Sponsored by reThink Wood and WoodWorks

Cost-effective, code-compliant and sustainable, mid-rise wood construction is gaining the attention of design professionals nationwide, who see it as a way to achieve higher density housing at lower cost—while reducing the carbon footprint of their projects. Yet, many familiar with wood construction for two- to four-story residential structures are not aware that the International Building Code (IBC) allows wood-frame construction for five stories and more in building occupancies that range from business and mercantile to multi-family, military, senior, student and affordable housing.

but its benefits are equally applicable to other occupancy types."

Among their benefits, wood buildings typically offer faster construction and reduced installation costs. For example, after completing the first phase of a developer-funded five-story student housing project using steel construction, OKW Architects in Chicago switched to wood. "The 12-gauge steel panels were expensive, very heavy and difficult to install; and welding and screwing the shear strap bracing was very time consuming," says project architect Eileen Schoeb. "Using wood was far more economical for the second phase." Farooq Maniar, president

CONTINUING EDUCATION

EARN ONE AIA/CES HSW LEARNING UNIT (LU)

EARN ONE GBCI CE HOUR FOR LEED CREDENTIAL MAINTENANCE

Learning Objectives

After reading this article, you should be able to:

1. Identify the sustainability and economic benefits of using wood construction for mid-rise buildings.
2. Summarize building code requirements and provisions for mid-rise multi-family

2021 Code Conforming Wood

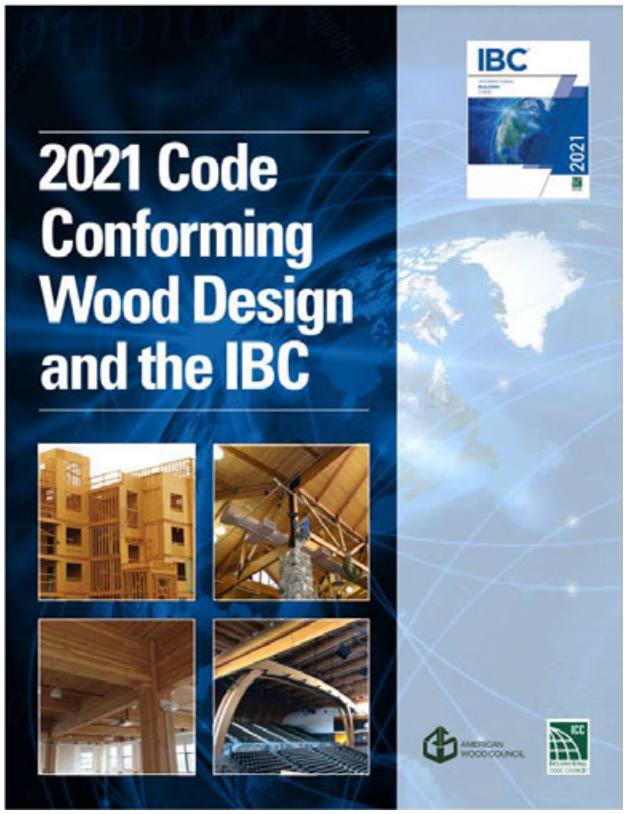


Table of Contents

Available for Free Download: www.awc.org


BREAK
TIME!

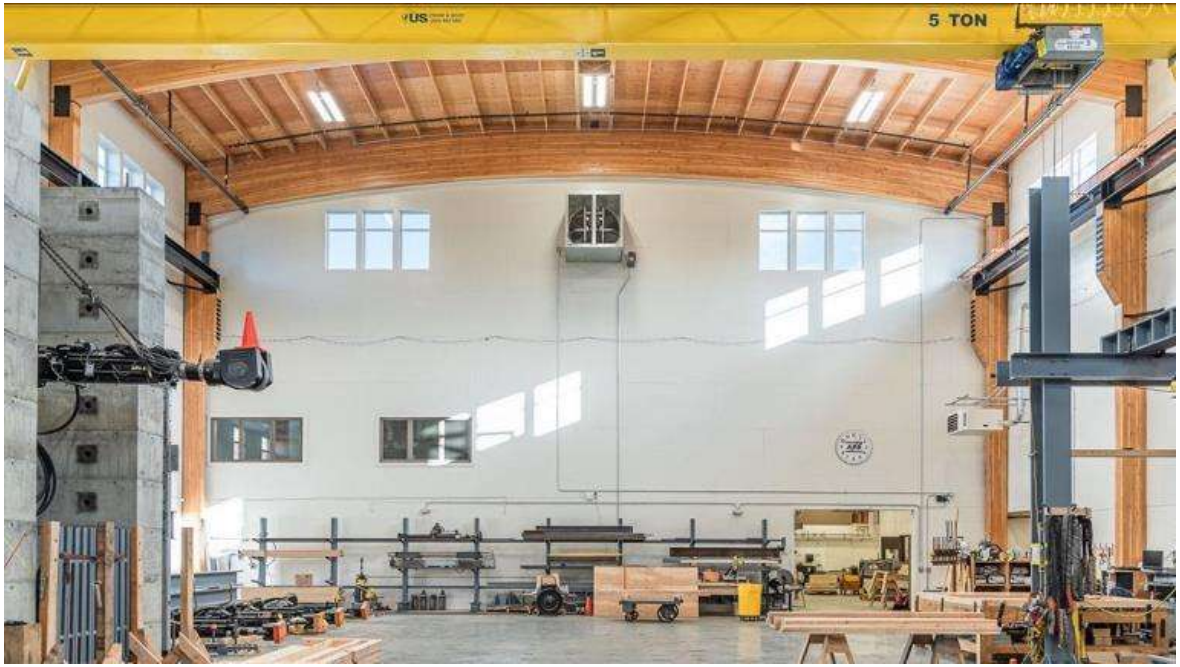
Frame it Right!
Back to Basics for Big Buildings

Van Wilfinger, CBO CFM

What is APA – The Engineered Wood Association?

1933: Douglas Fir Plywood Association
1994: APA–The Engineered Wood Association

APA




APA


APA

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.

APA

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**

APA

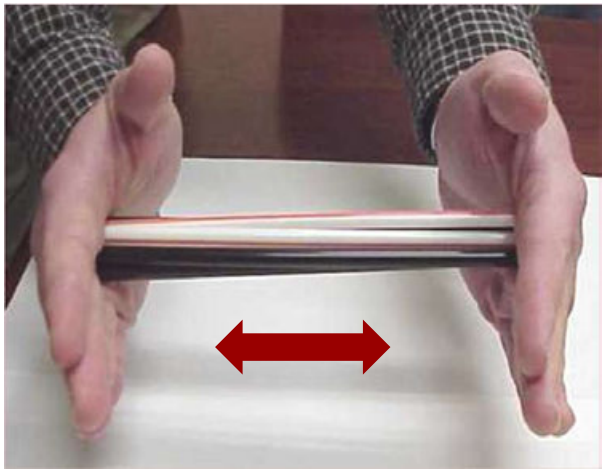
Engineered Wood Products (EWP)

- ✓ **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

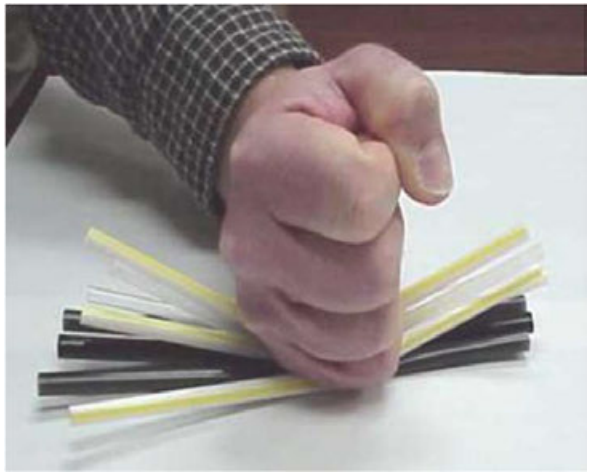
Wood has a stronger direction

Load parallel to grain



Stronger

Load perpendicular to grain

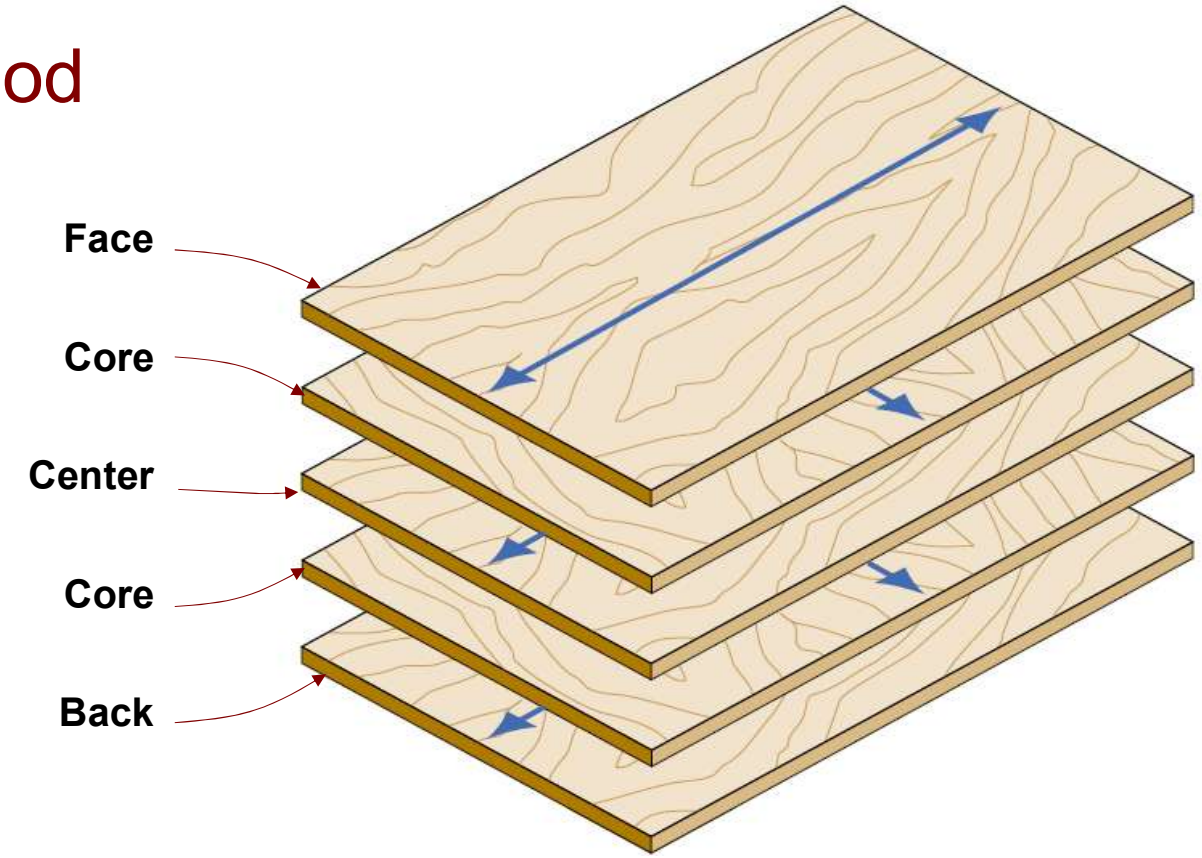


Weaker

APA

Wood's Strength Direction

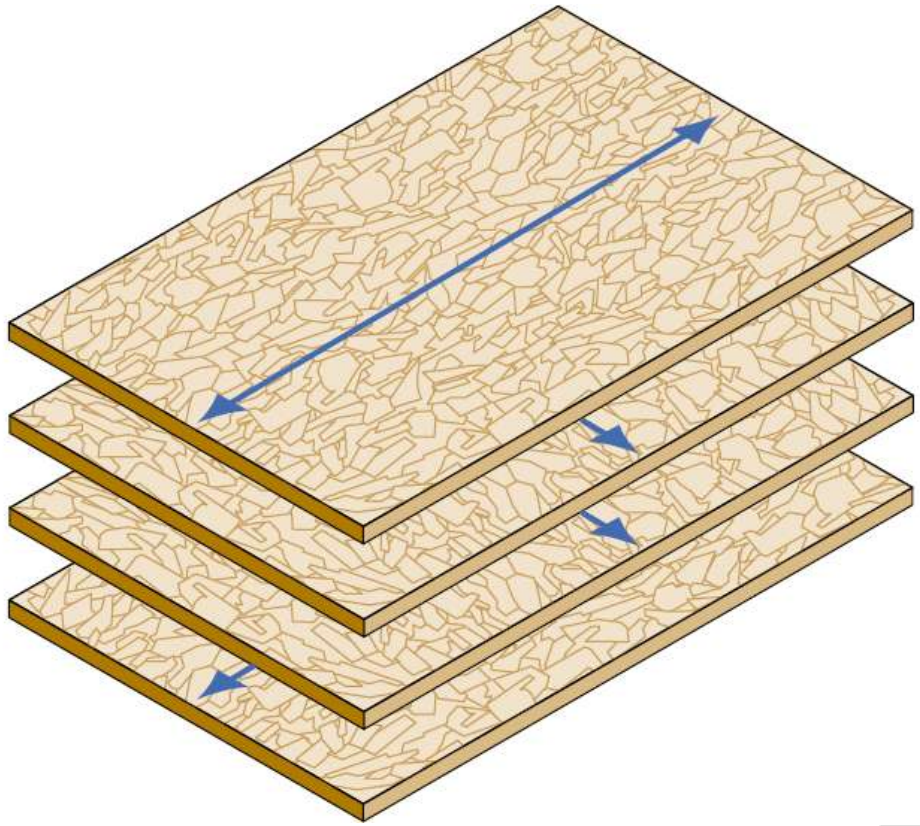
Plywood



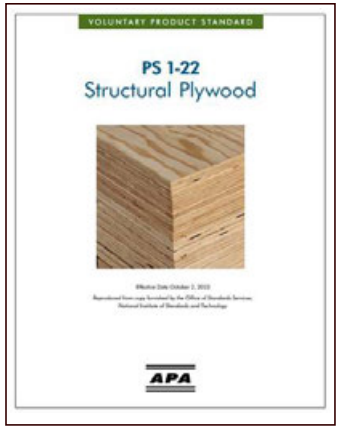
APA

Structural Panels

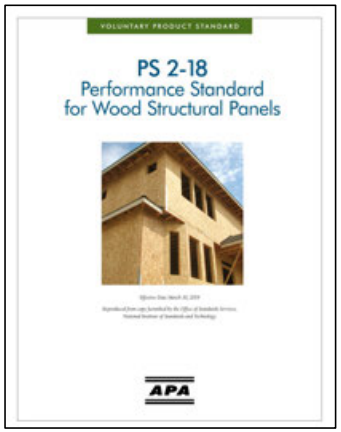
OSB layers are engineered for strength.



Manufacturing Standards



PS 1: Voluntary Product Standard
PRESCRIPTIVE Standard *(revised 2022)*



PS 2: Voluntary Product Standard
PERFORMANCE Standard *(revised 2019)*

APA

APA Stamp in the Field

APA Panel Certification Marks

APA panel grade

Span rating

(Bond classification)
Exposure 1
Applications where construction delays are expected prior to providing protection, not intended for permanent exposure to the weather

SIZED FOR SPACING

Mill number

Performance-rated panel standard

Performance category

APA

APA Panel Certification Marks - Plywood

Visually-Graded Panels

Dual letters, separated by hyphen, mean the grade of veneer on the panel face is A and the grade of veneer on panel back is C

Bond Classification

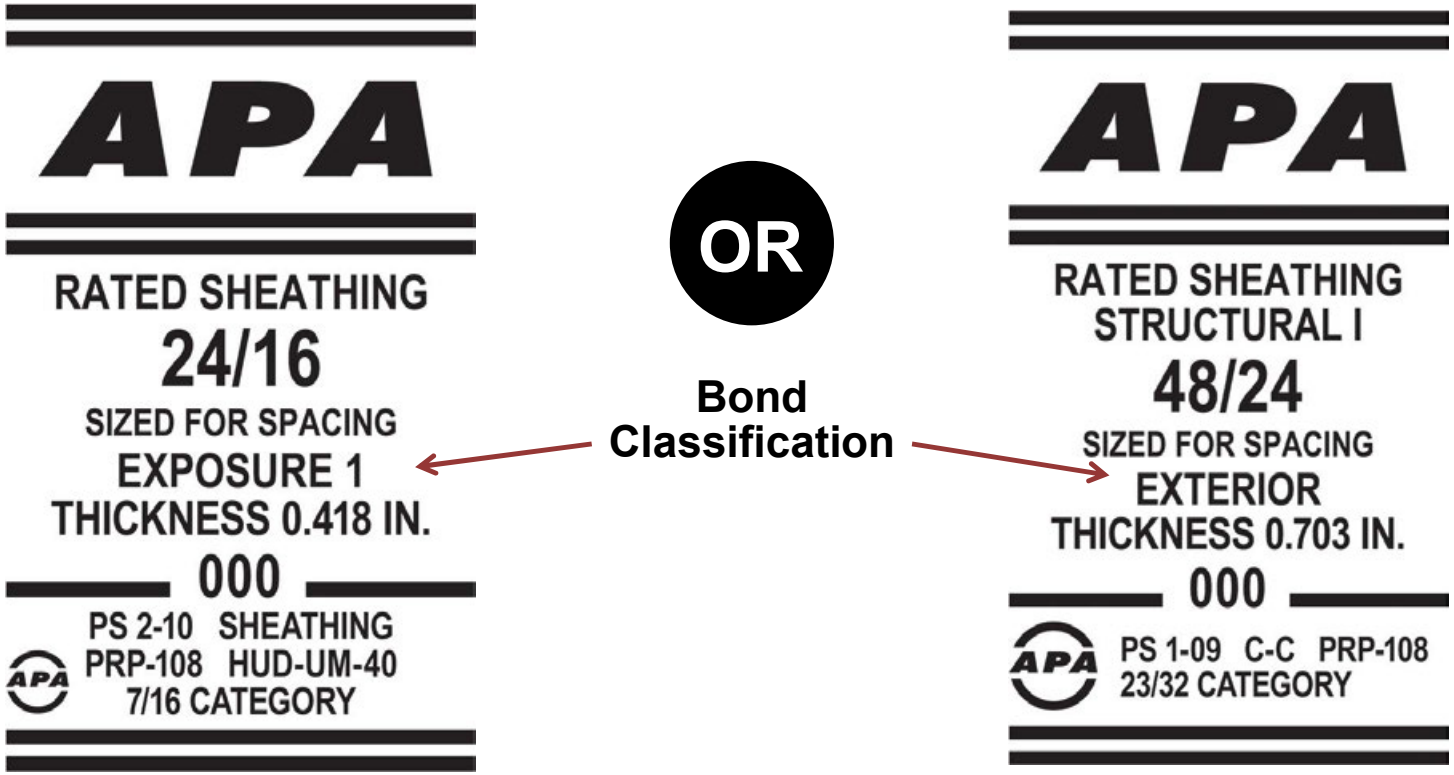
“Exterior” is intended for applications where panels are permanently exposed to weathering

GROUP 1

“Groups” refers to strength grouping of wood species used to make face veneer. There are 5 Groups. Group 1 is the strongest

Supplemental Thickness Label

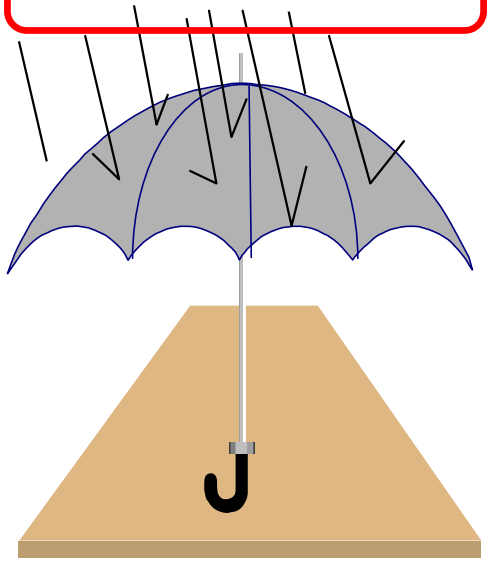
Building From the Ground Up: Special Topics



APA

Bond Classification

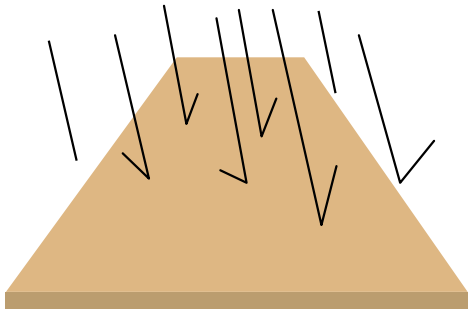
EXPOSURE 1



Exposure due to construction delays

OR

EXTERIOR



Long term weather exposure

APA Panel Certification Marks

Out-of-Date Specifications

- **1/2" CDX – C & D veneers, with exterior glue (when panels were made with interior & exterior glue)**

Previous Specifications

- **15/32" APA Rated Sheathing, 32/16, Exposure 1**

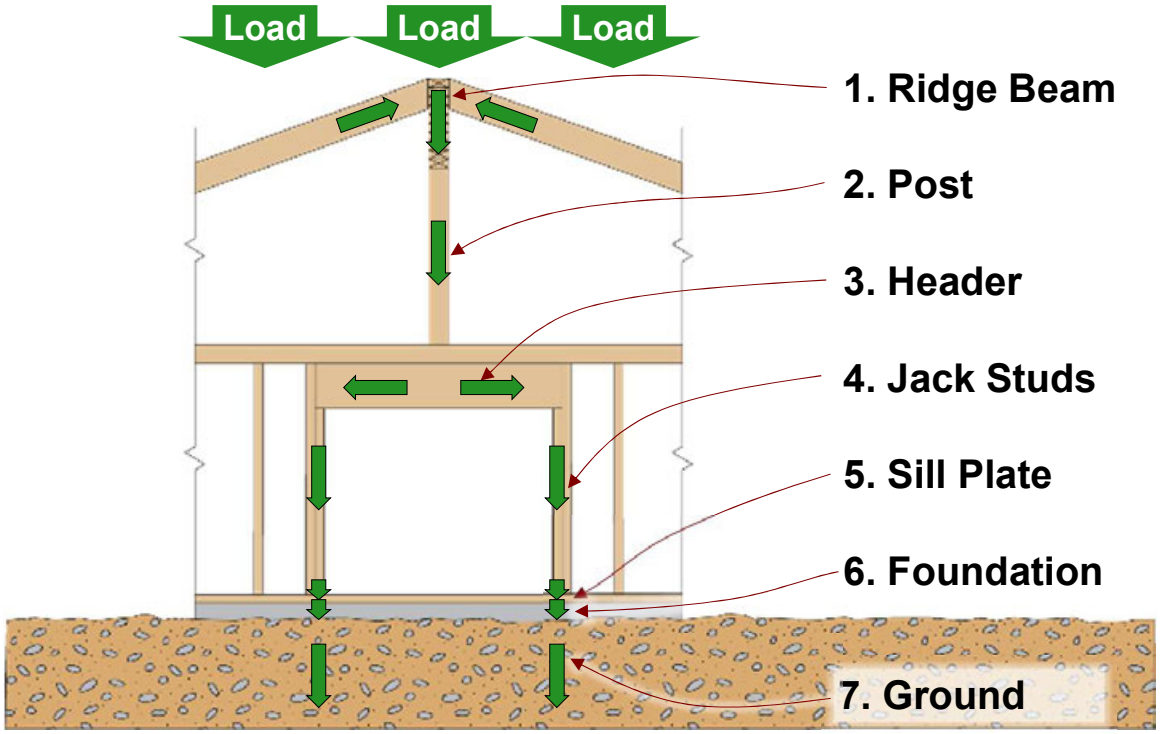
New Terminology

- **15/32 Performance Category, APA Rated Sheathing, 32/16, Exposure 1, Square edge (or T&G)**

https://www.apawood.org/apa-trademark

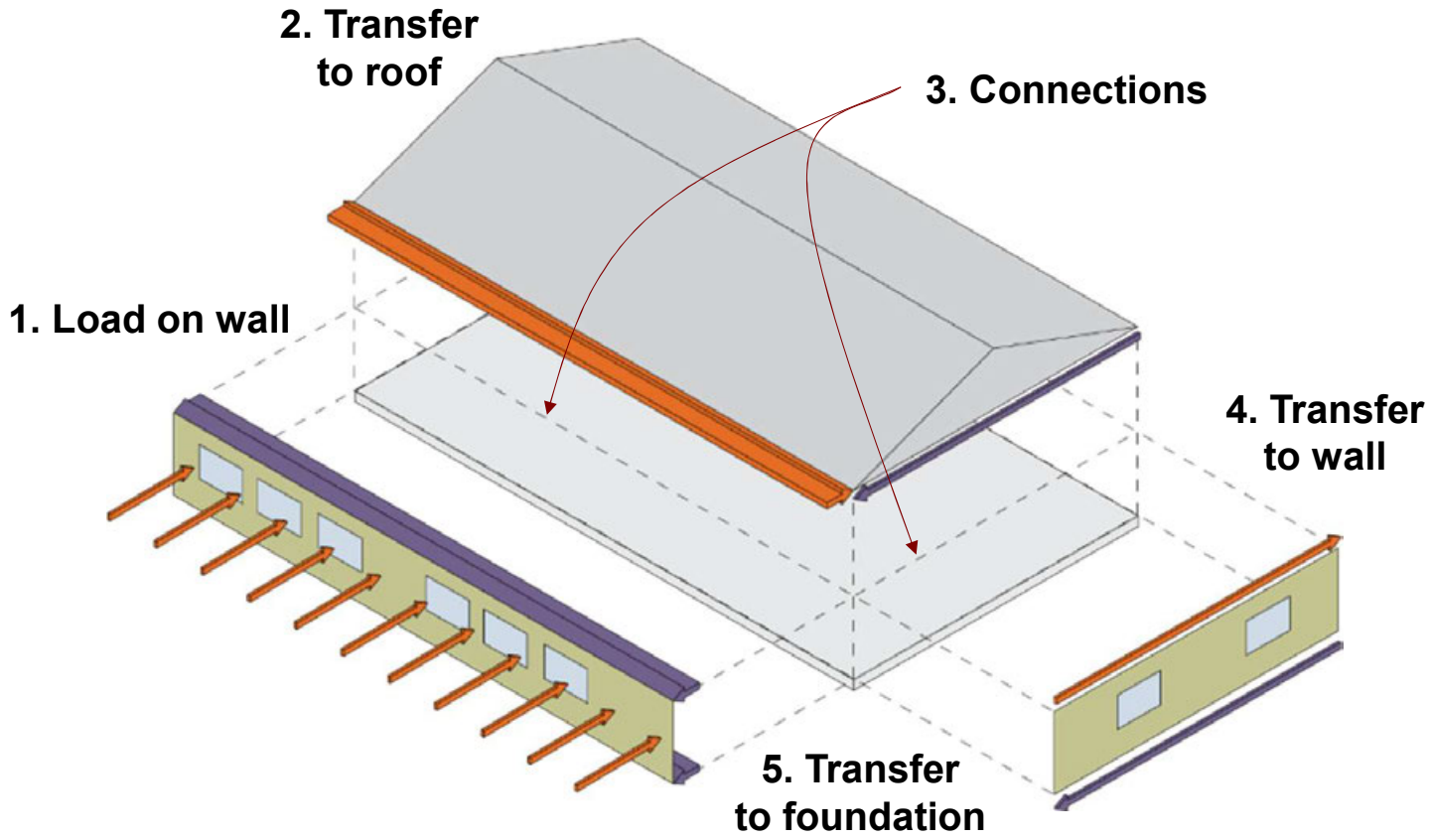
APA

Vertical (Gravity) Load Path



APA

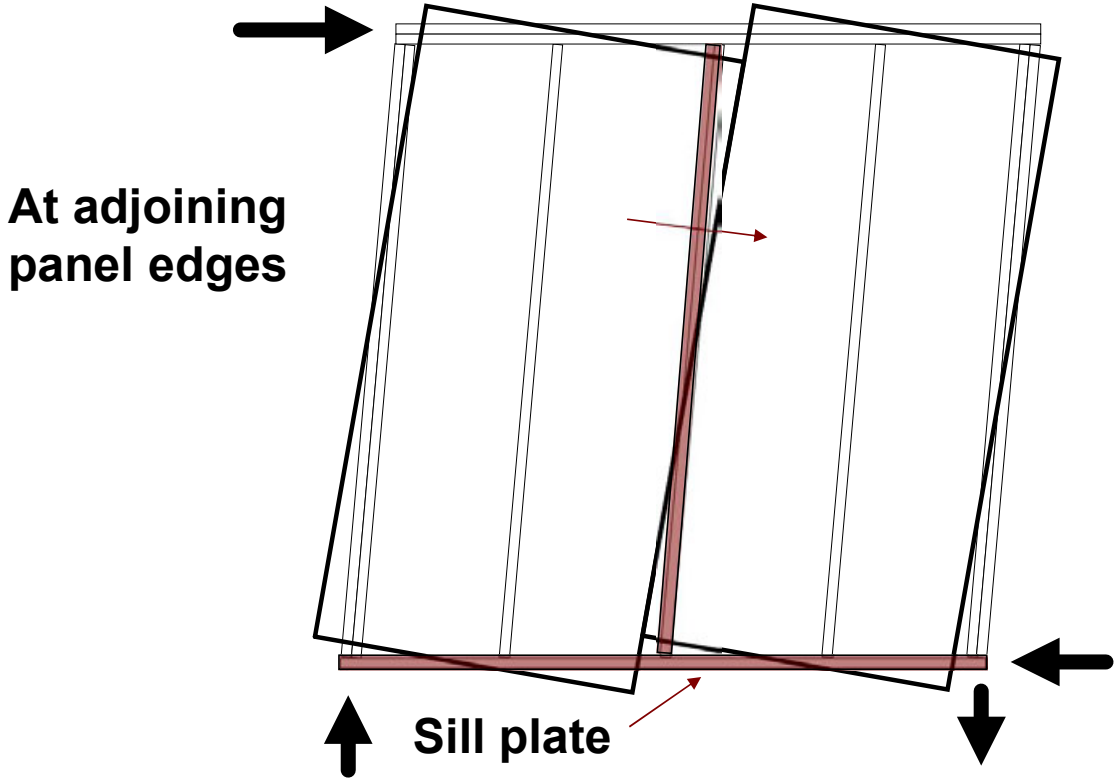
Lateral Load Path



Building From the Ground Up: Walls

APA

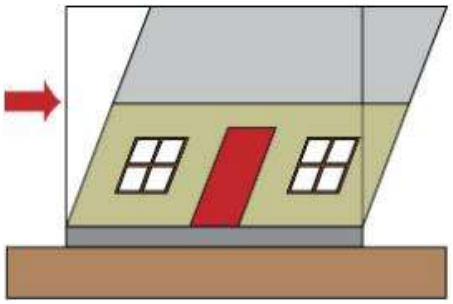
Building From the Ground Up: Walls



Lateral Forces

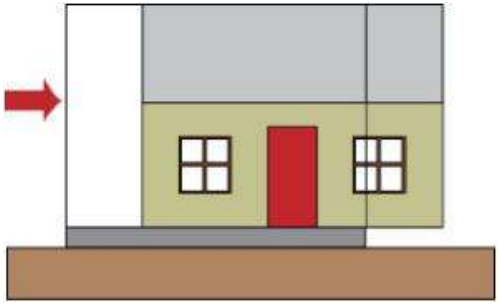
Modes of Failure

Racking



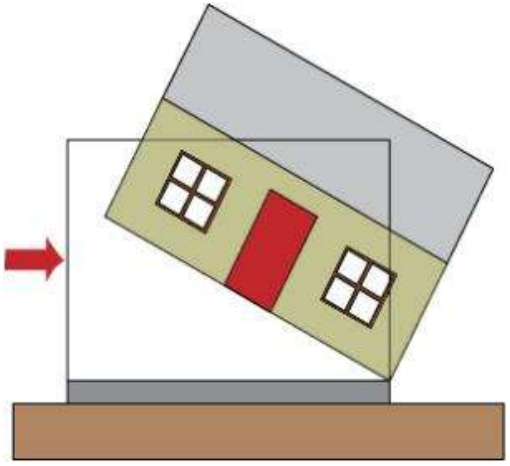
Resisted by Bracing

Base Shear



Resisted by Anchors

Overturning

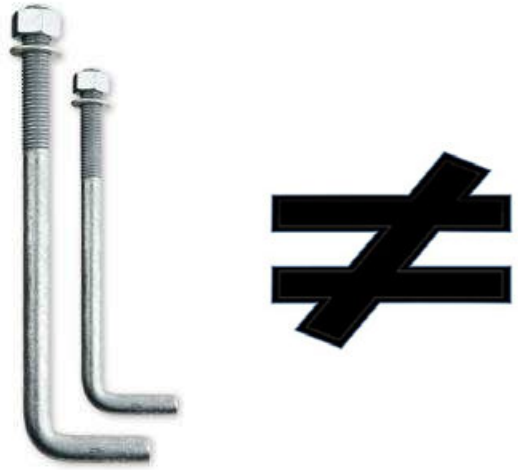


Resisted by Hold-Downs & Dead Load

APA

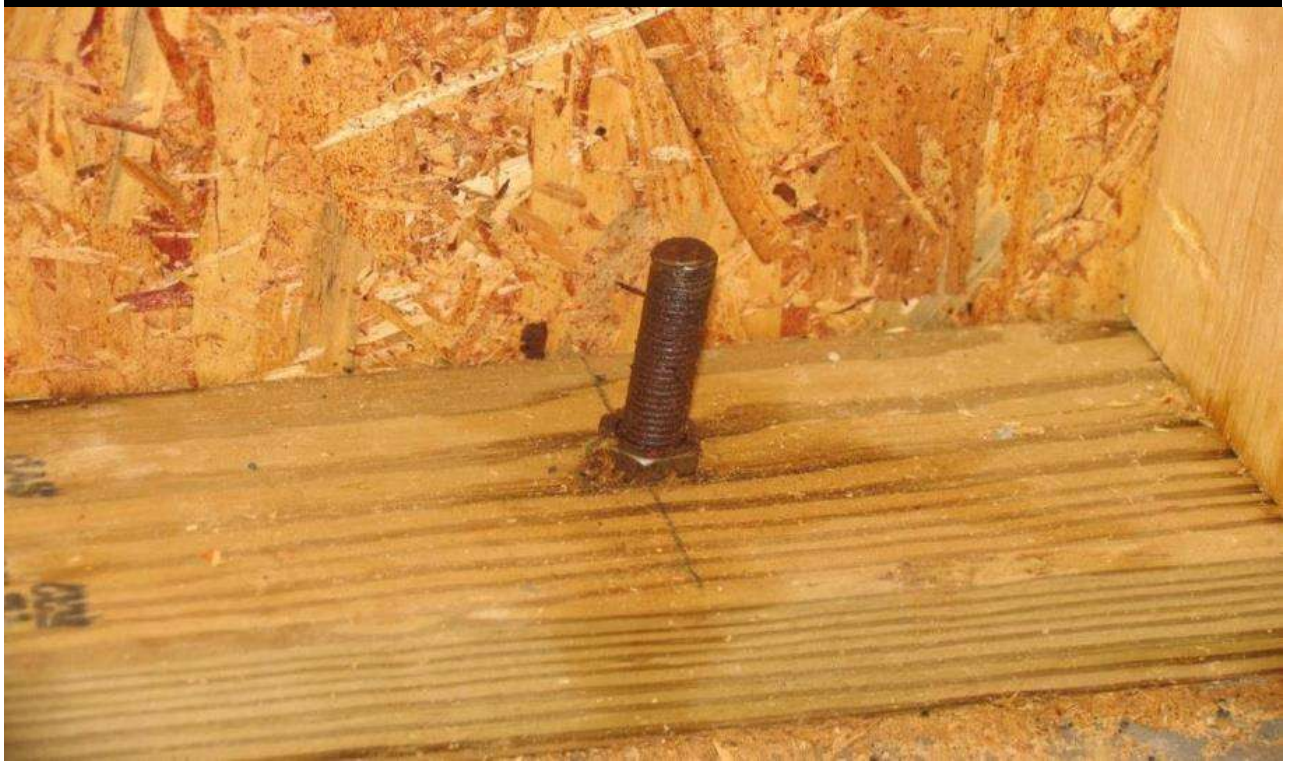
Building From the Ground Up: Walls

Anchor Bolts are not Hold-Downs



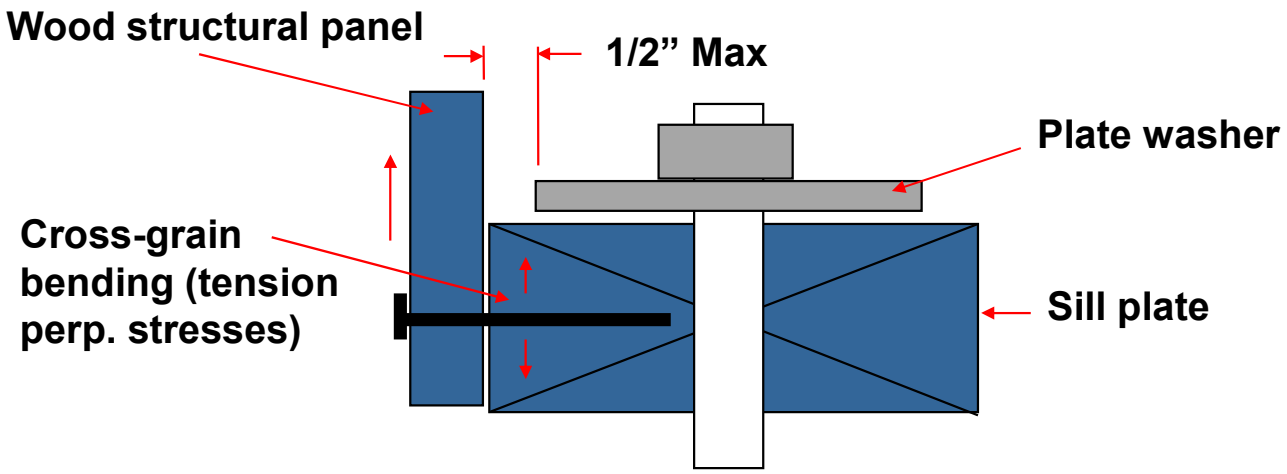
Building From the Ground Up: Walls

Missing washer



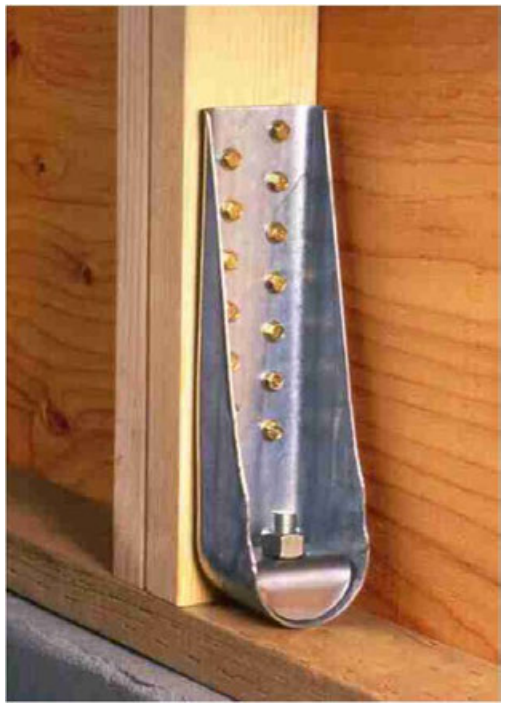
Anchor Bolts

- **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.**

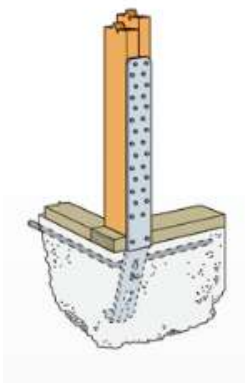


Building From the Ground Up: Walls

Hold-down hardware



Building From the Ground Up: Walls



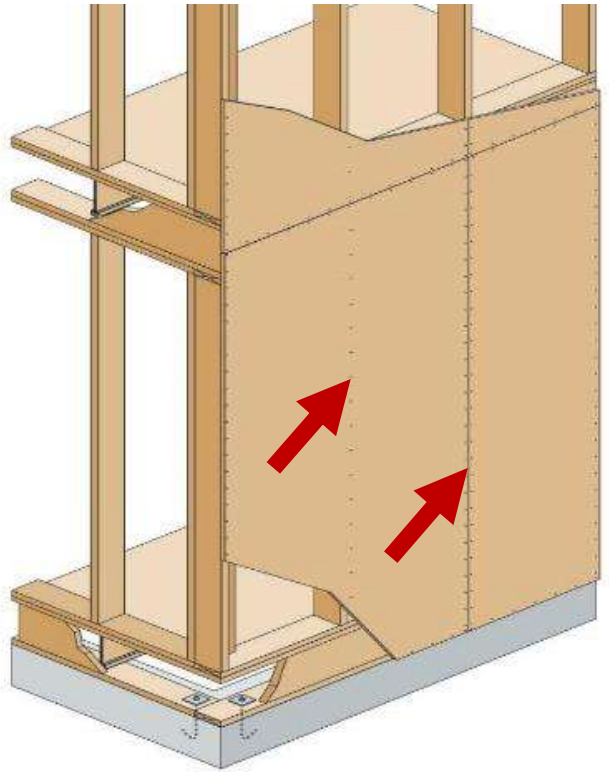
APA

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.



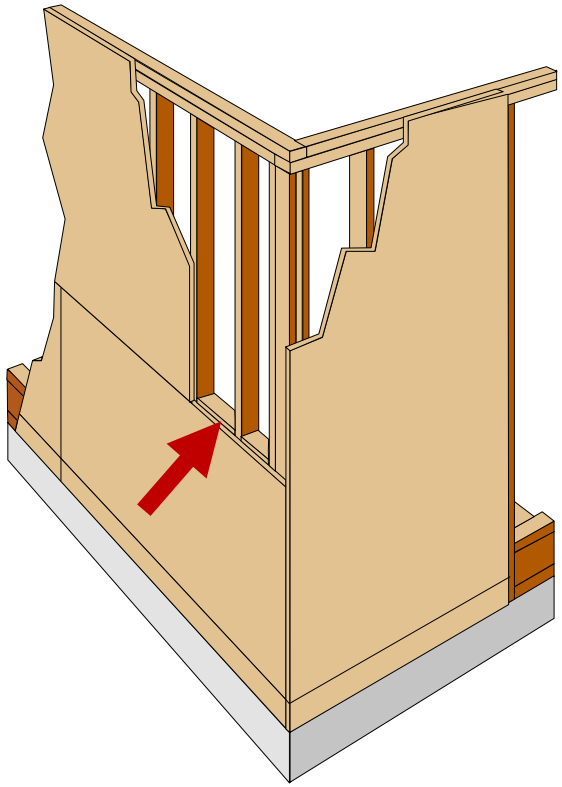
APA

Building From the Ground Up: Walls

Wall sheathing

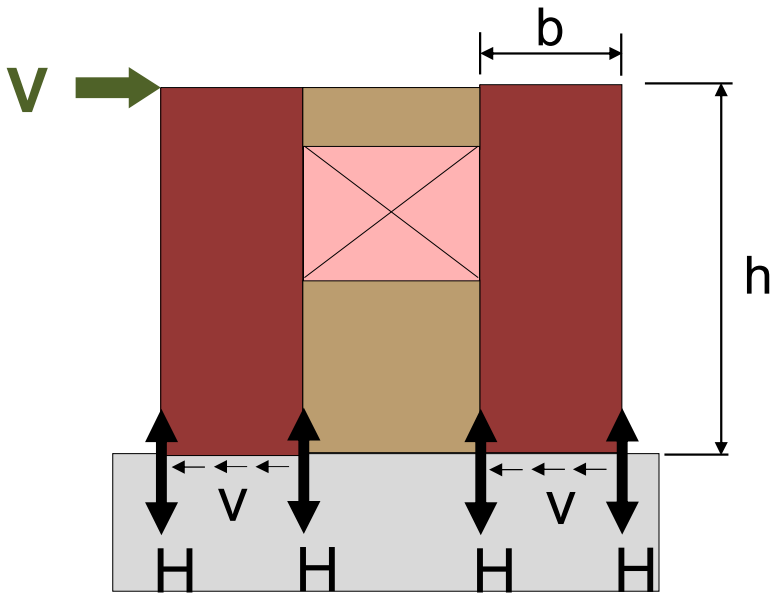
Can be Plywood or OSB

Orientation may require blocking



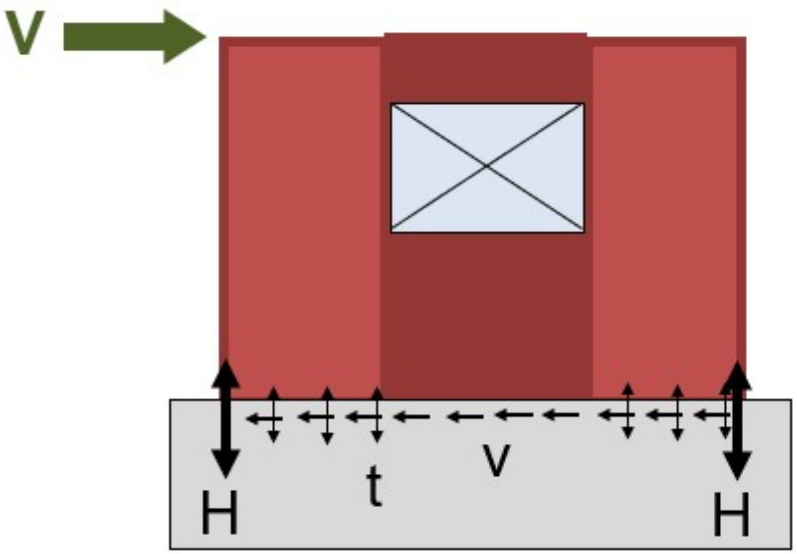
Resource: APA Technical Topics: Plywood or OSB? Used as Intended, the Two Products are Interchangeable, Form TT-047

Segmented Shear Walls

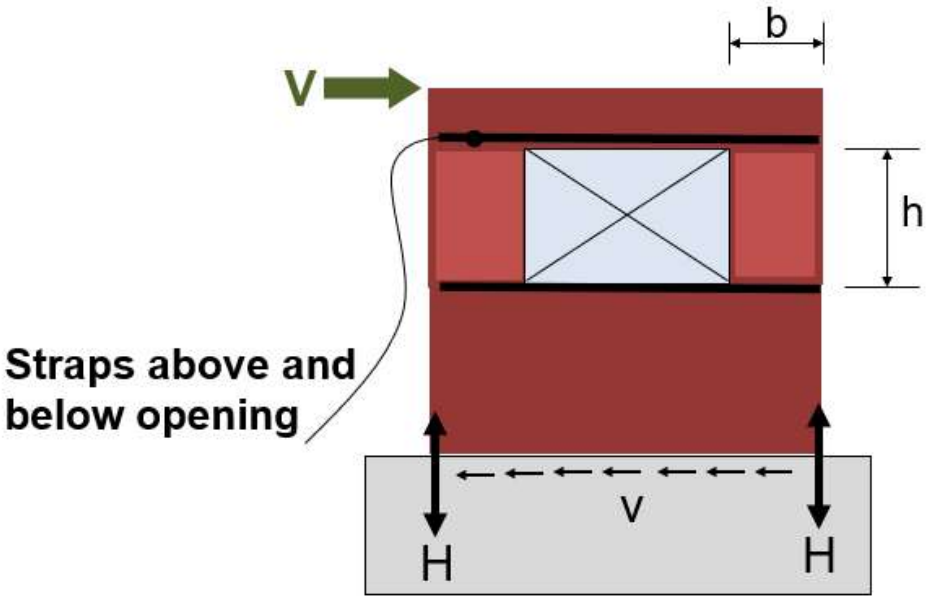


APA

Perforated Shear Walls



Force Transfer Around Openings (FTAO) Shear Walls



APA

High Load Shear Walls

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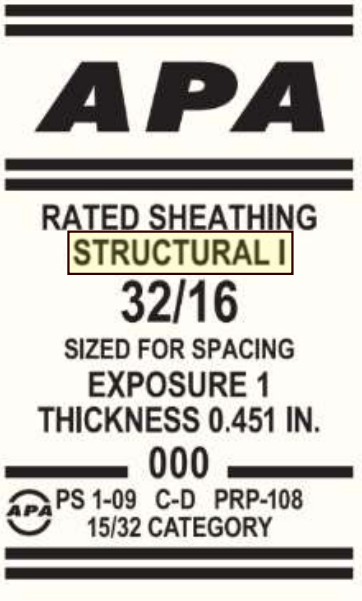
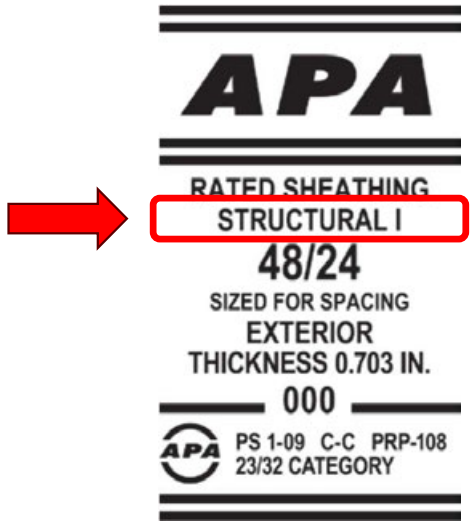
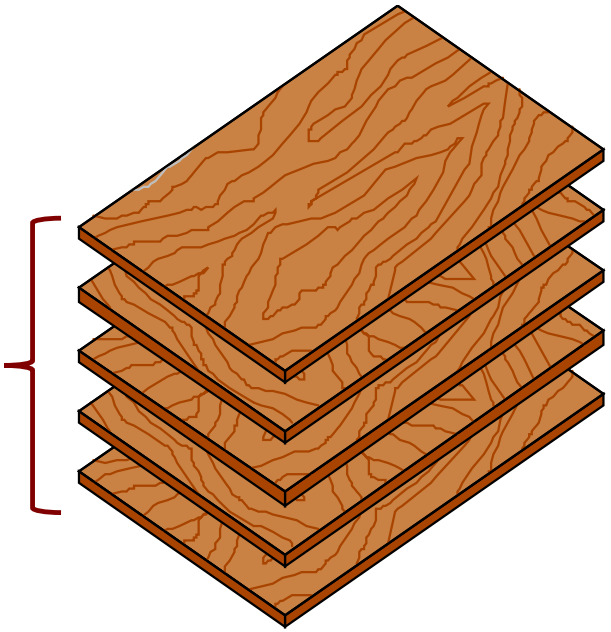


Rated Sheathing versus **Structural I**

Structural I Panels

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





APA

Building From the Ground Up: Floors

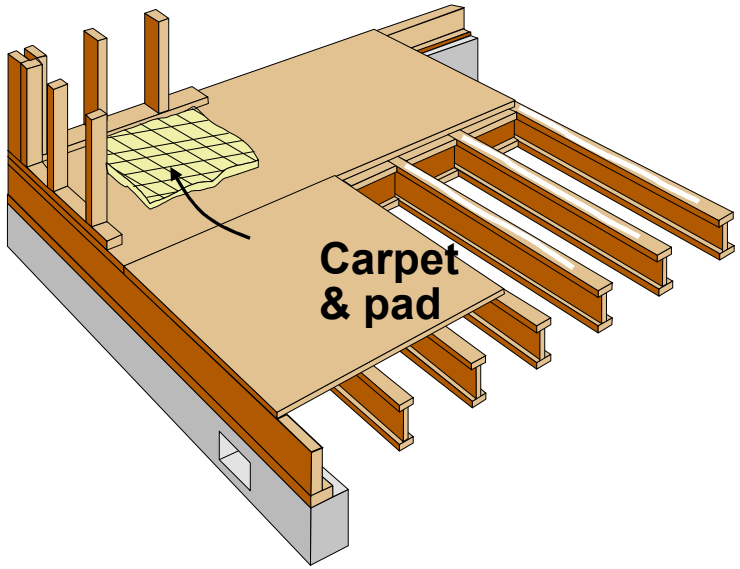
Building From the Ground Up: Floors

Sturd-I-Floor

Combined subfloor & underlayment

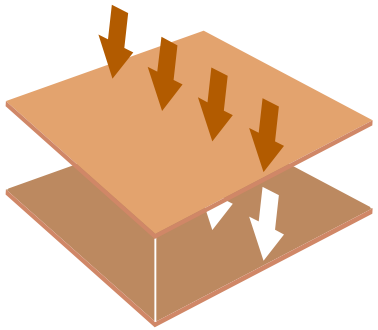
Resistant to concentrated & impact loads

Plywood or OSB



APA

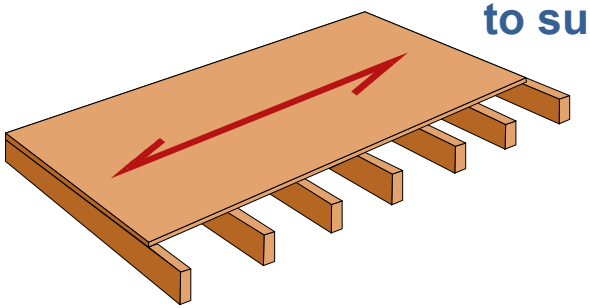
Building From the Ground Up: Floors



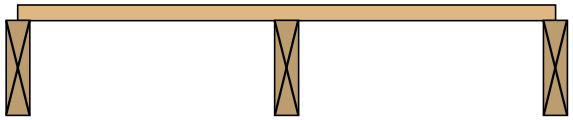
Roof Span L/240
30 PSF live
10 PSF dead

Floor Span L/360
100 PSF live
10 PSF dead

Strength axis perpendicular to supports



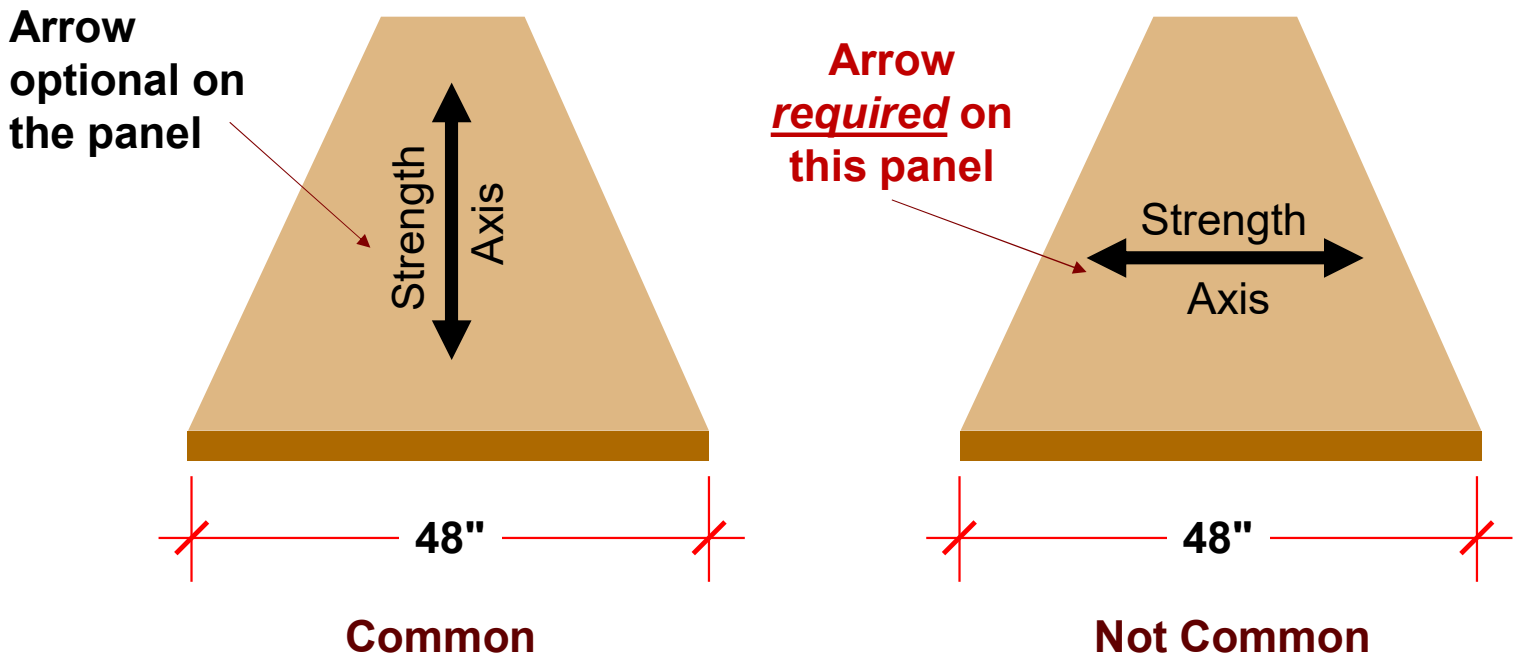
Continuous Span
(2 spans or 3 supports min.)



No simple spans

Building From the Ground Up: Floors

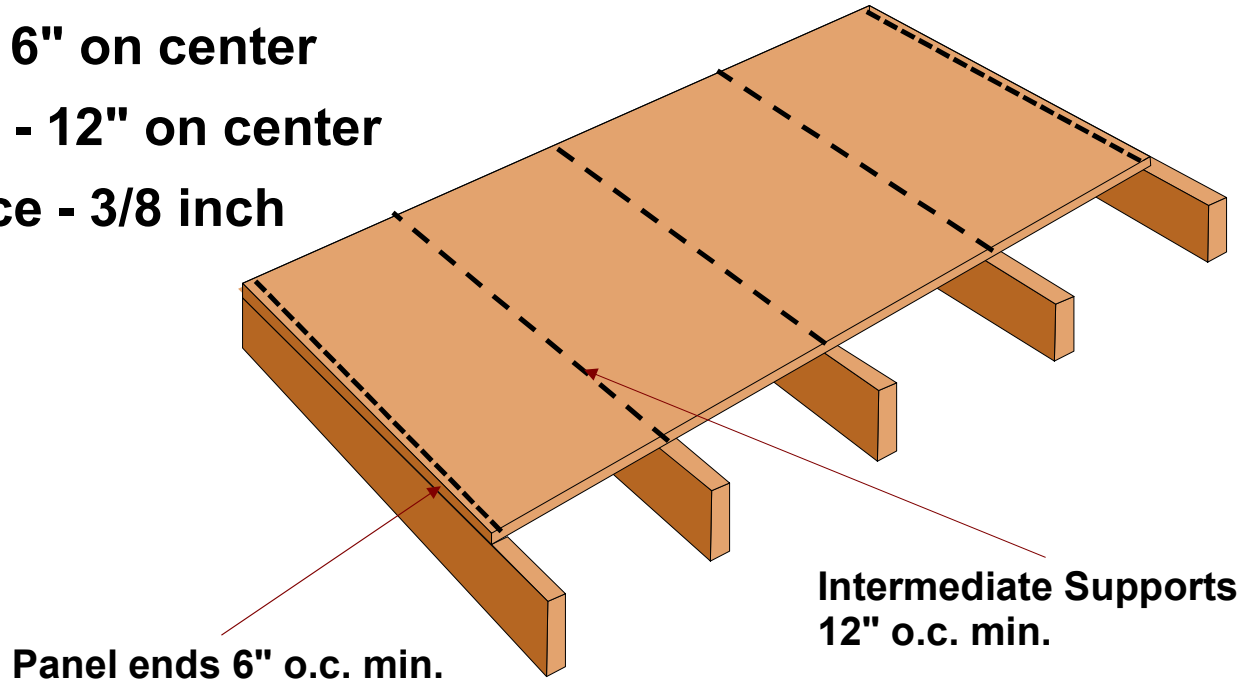
Strength Axis



Building From the Ground Up: Floors

IBC Minimum Nailing

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



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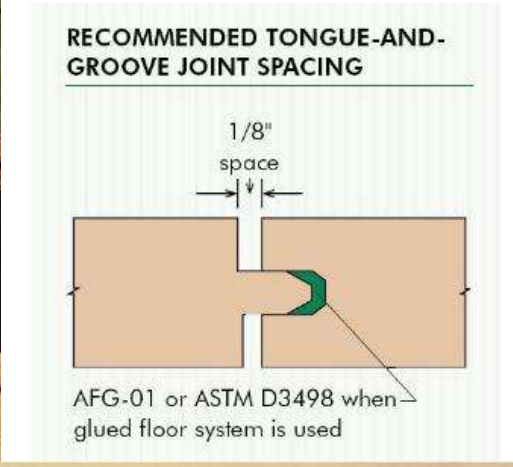
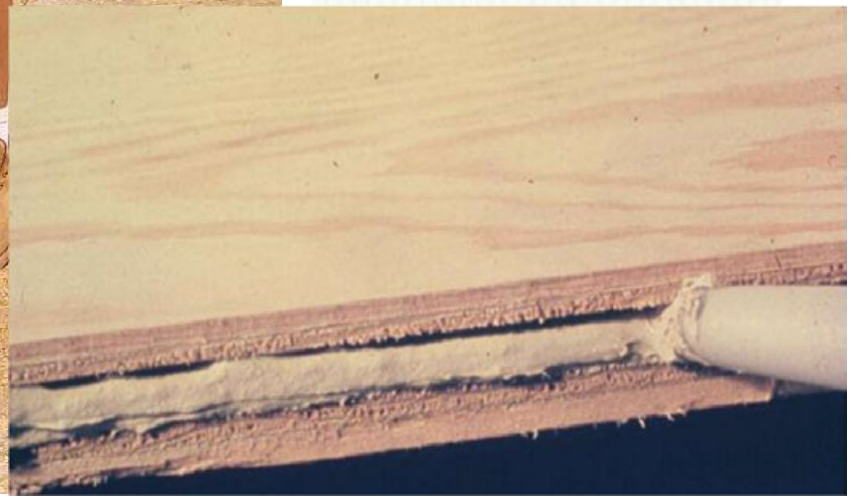
Building From the Ground Up: Floors

Resource: Subfloor Preparation to Receive Finished Flooring, Form V440





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

Fully Fasten with Clamping Force

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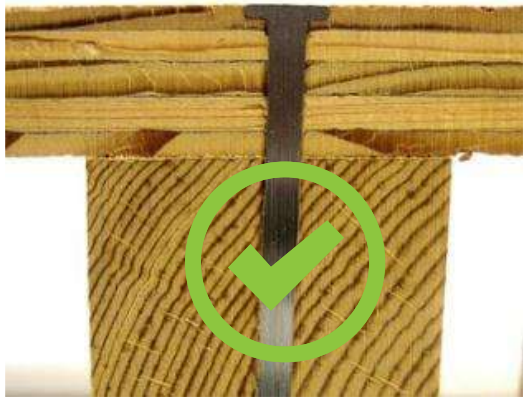
Building From the Ground Up: Floors

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

APA

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-012R DECEMBER 2011

Effect of Overdriven Fasteners on Shear Capacity

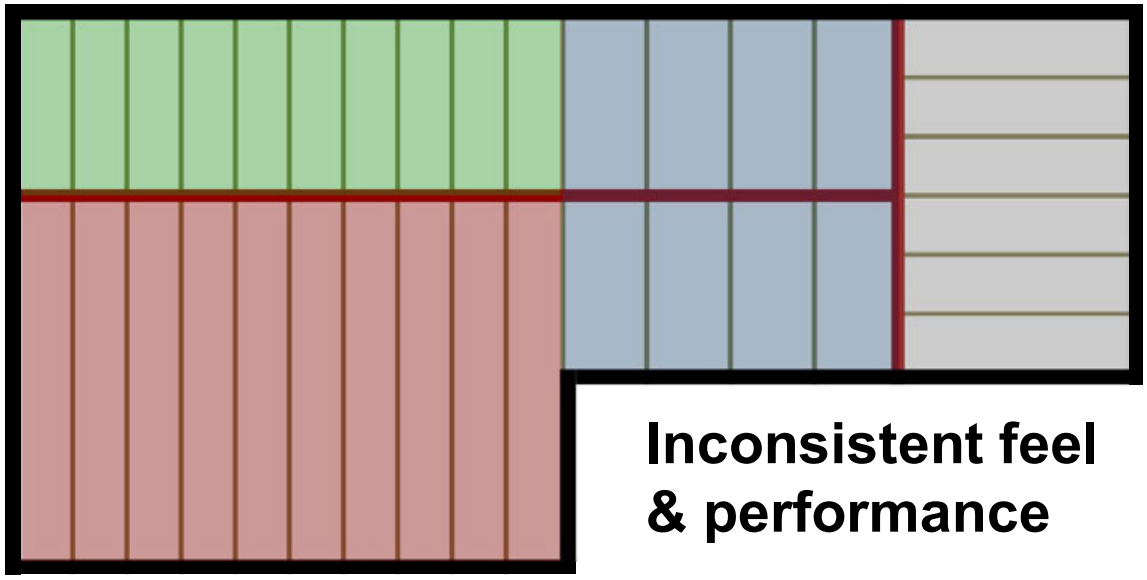
APA

Building From the Ground Up: Floors

APA

Floor Joist Layout — Consistency Counts

Inconsistent spacing & span



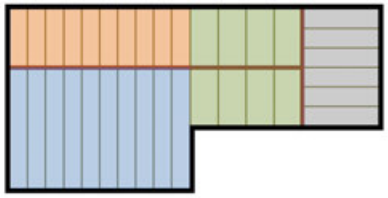
Inconsistent feel & performance

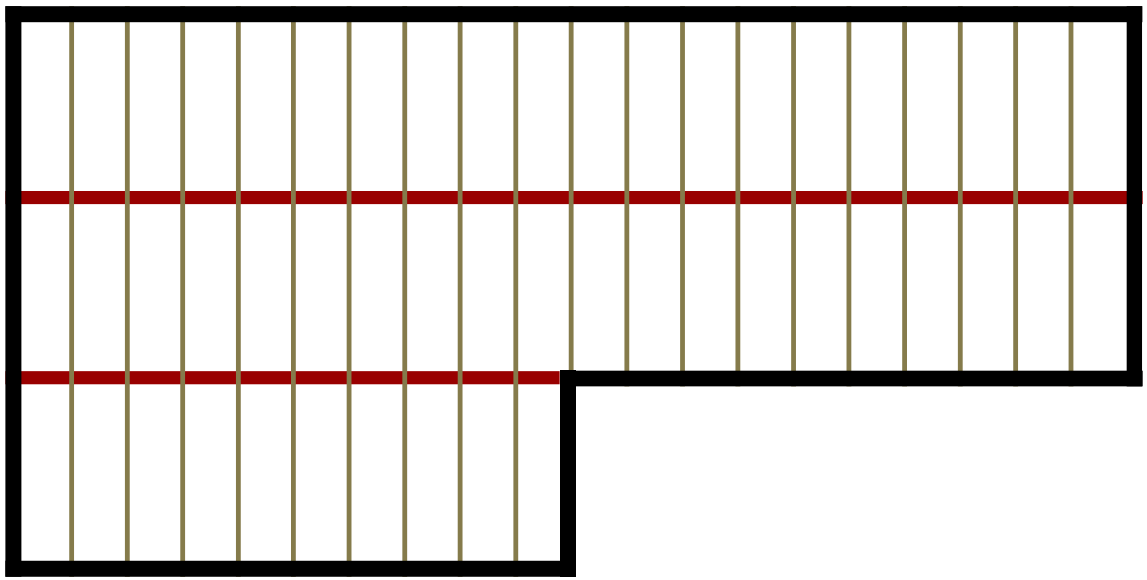
APA

Floor Joist Layout — Consistency Counts

Consistent Spacing & Span

Before

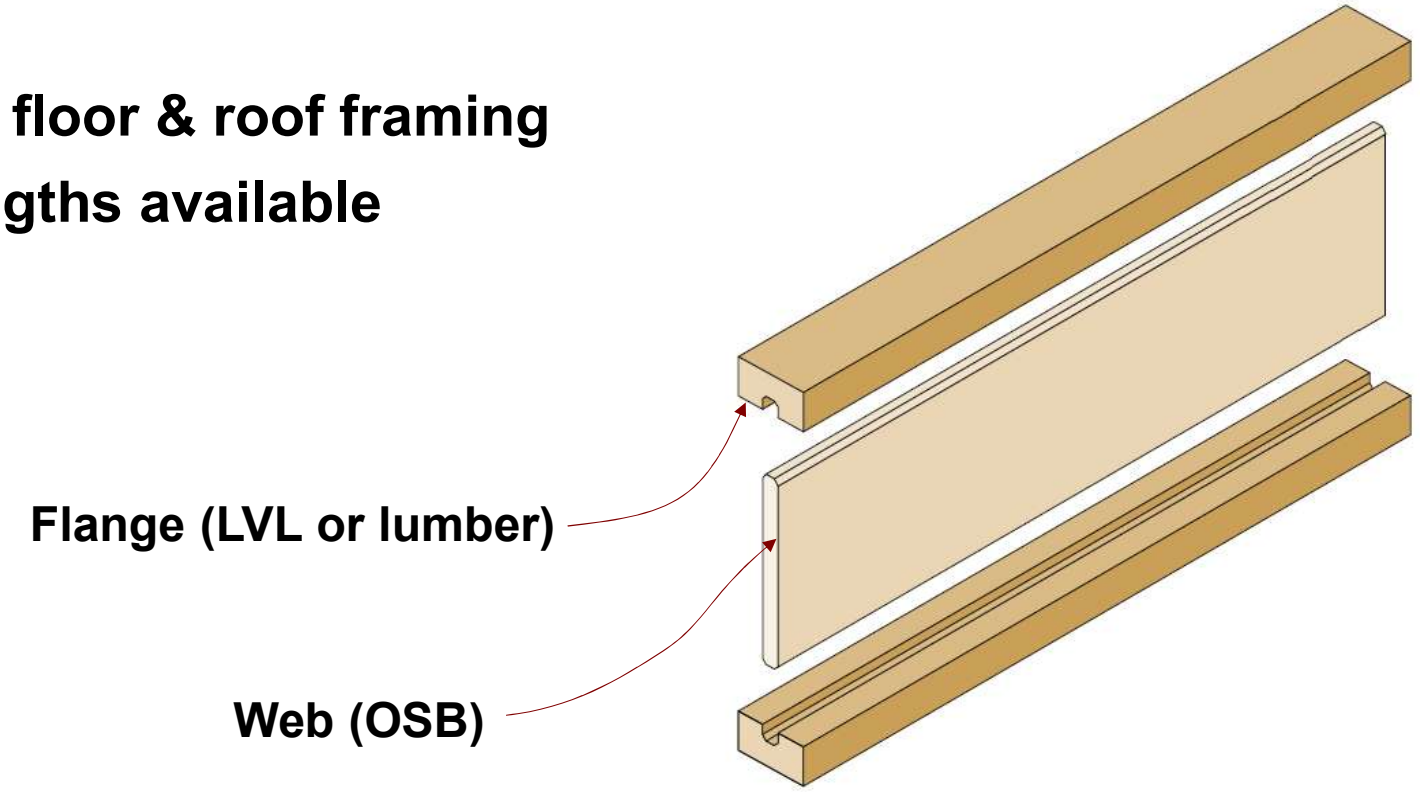




Use Wood's Strength Direction

I-joist

- Used for floor & roof framing
- Long lengths available



Sustainability

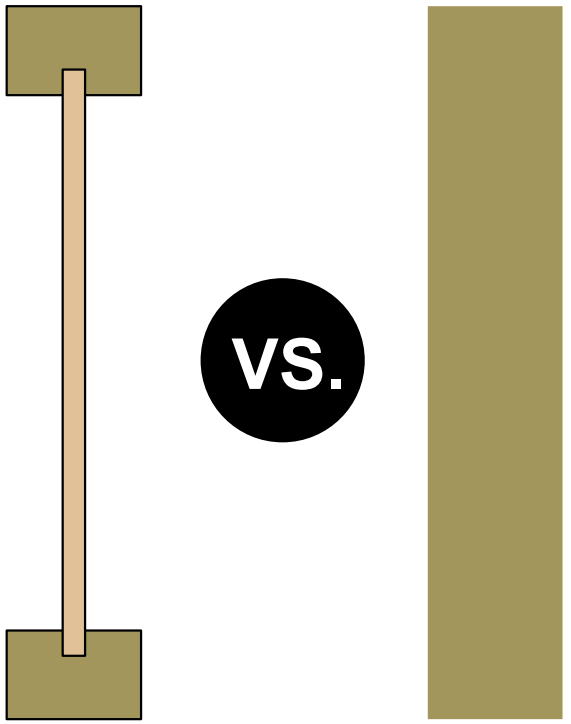
I-joist vs. Lumber

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



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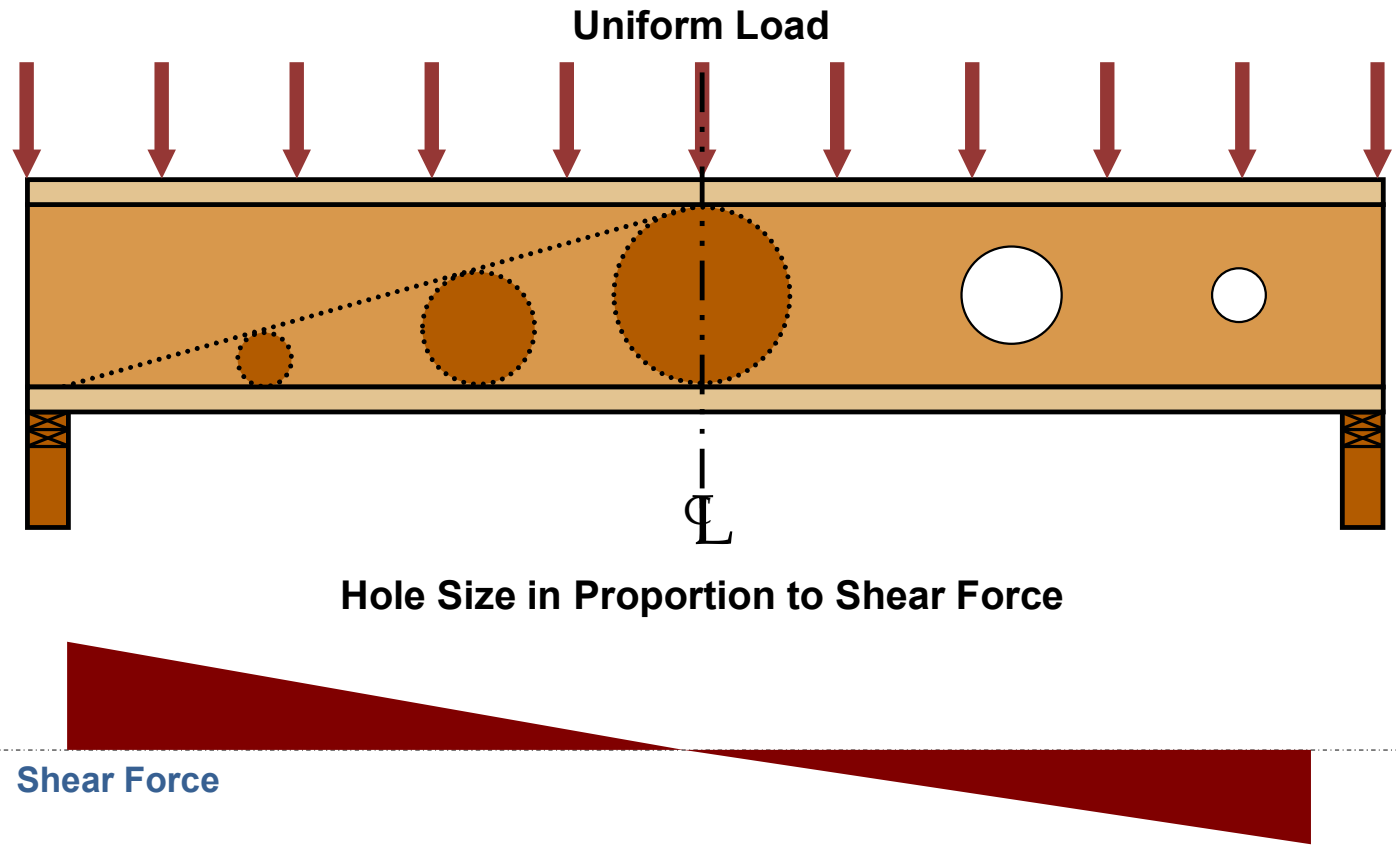
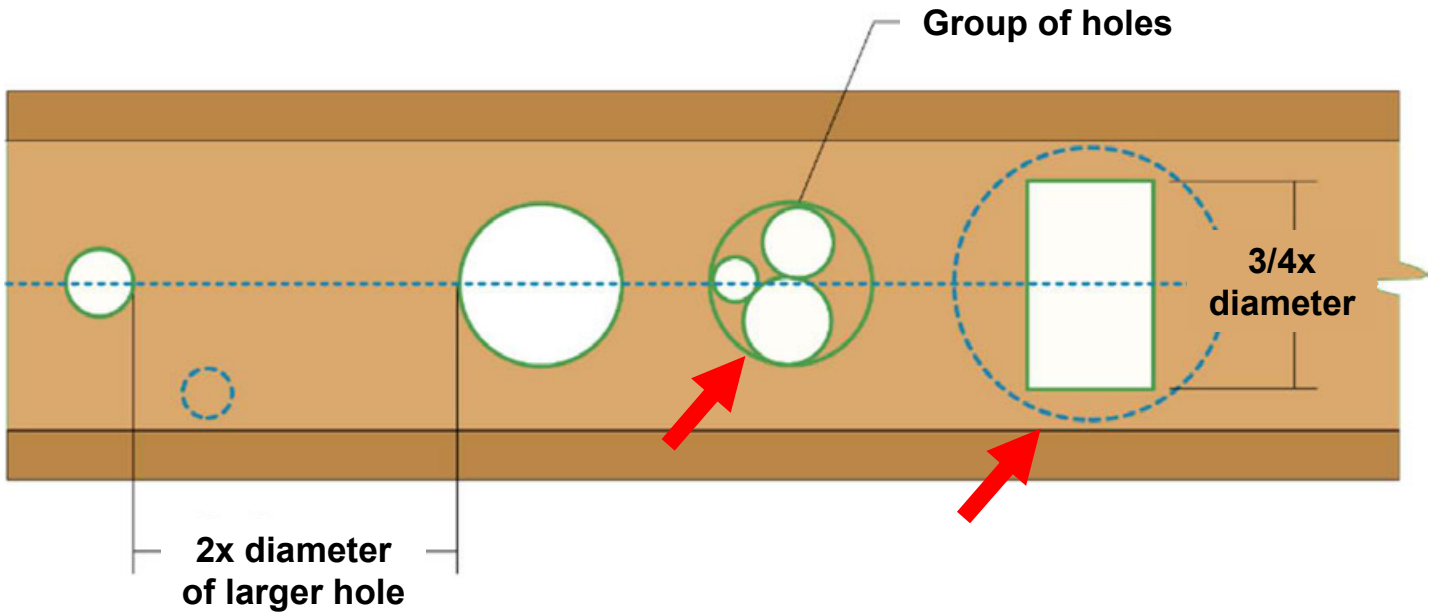
Building From the Ground Up: Floors



Building From the Ground Up: Floors



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

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I-Joist “Knockouts”

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SPACING
SIMPLE SPAN
MULTIPLE SPAN


24"oc
APA

Building From the Ground Up: Floors

Laminated Veneer Lumber (LVL)

Building From the Ground Up: Floors

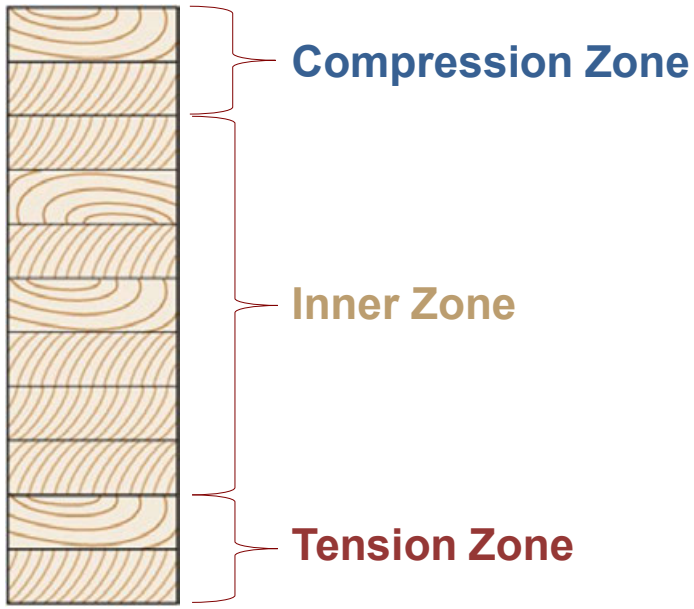
Laminated Strand Lumber (LSL)

Building From the Ground Up: Floors

Glued Laminated Timber Beams (Glulam)

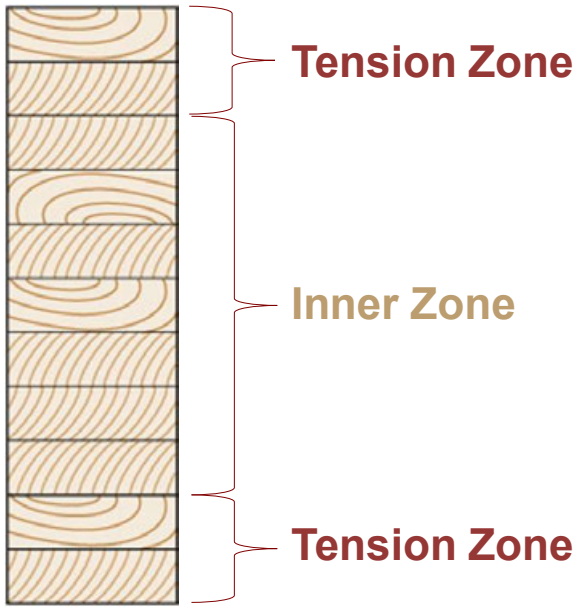
Balanced and Unbalanced Glulam

Unbalanced Beam



24F-V4 Layup

Balanced Beam



24F-V8 Layup

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Constructability

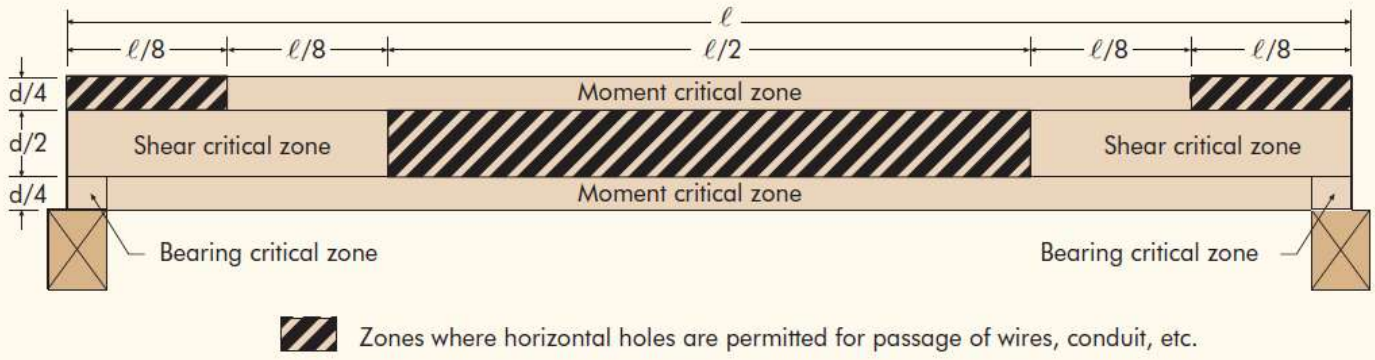
Caution when using Unbalanced Glulams

Building From the Ground Up: Floors

APA Tech Note: Field Notching and Drilling Glulam, Form S560

FIGURE 3

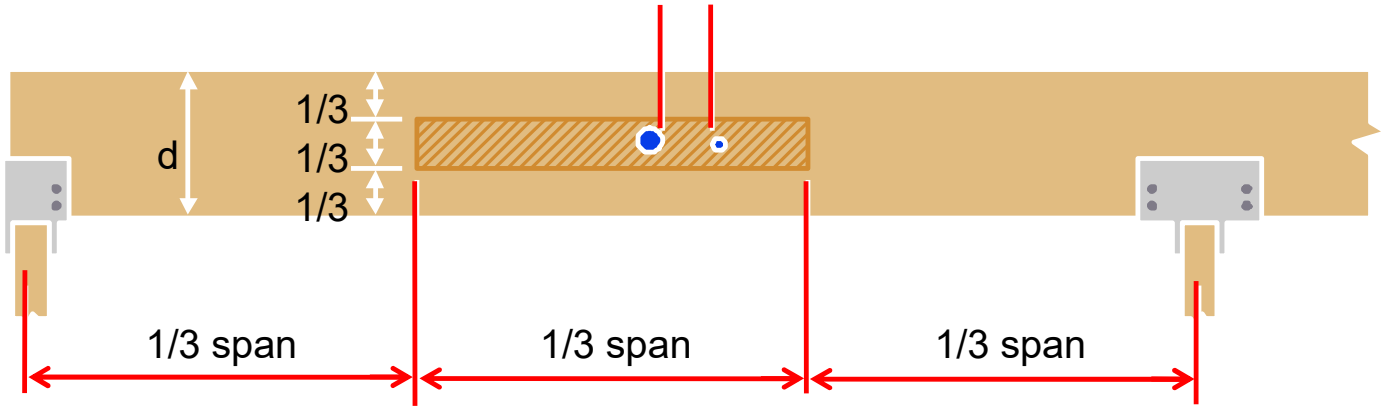
ZONES WHERE SMALL HORIZONTAL HOLES ARE PERMITTED IN A UNIFORMLY LOADED, SIMPLY SUPPORTED BEAM



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

Building From the Ground Up: Floors

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

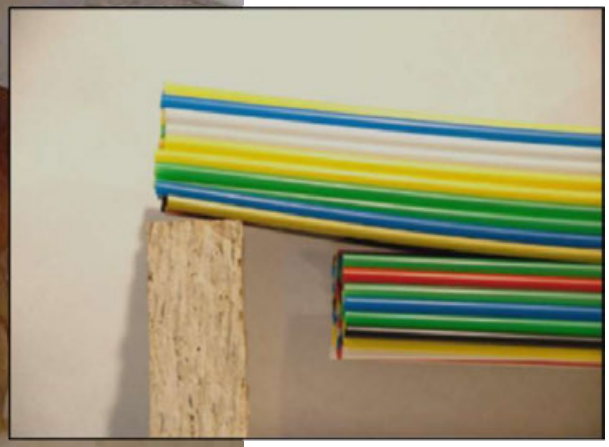
TECHNICAL NOTE

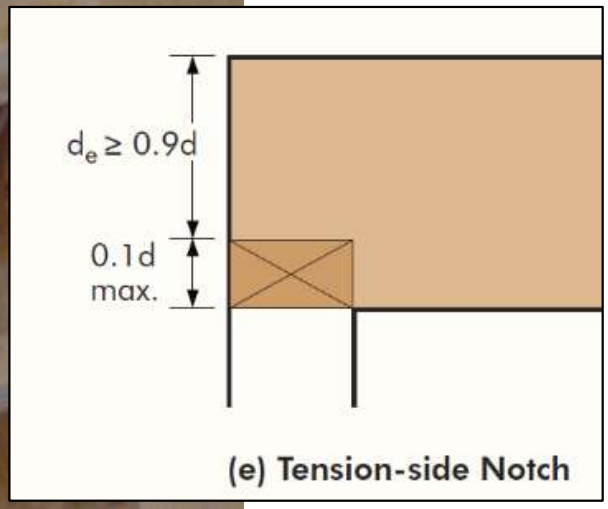
Effect of Large Diameter Horizontal Holes on the Bending and Shear Properties of Laminated Veneer Lumber

TECHNICAL NOTE

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

APA





Field Notching and Drilling LVL, Form G535

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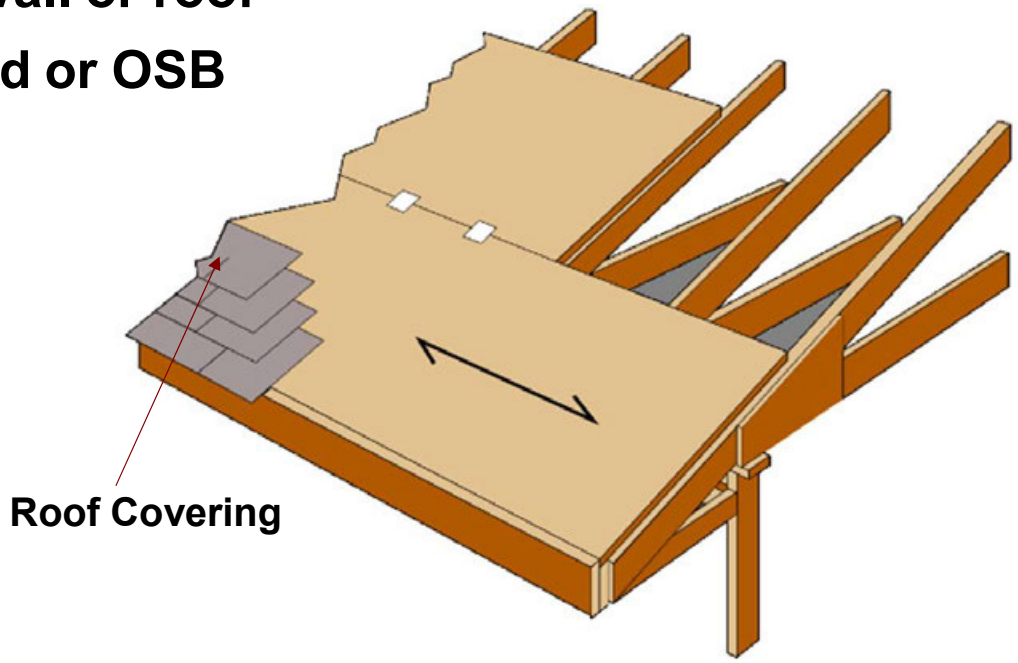
Building From the Ground Up: Floors

Building From the Ground Up: Roof

Rated Sheathing

Floor, wall or roof

Plywood or OSB



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Building From the Ground Up: Roof

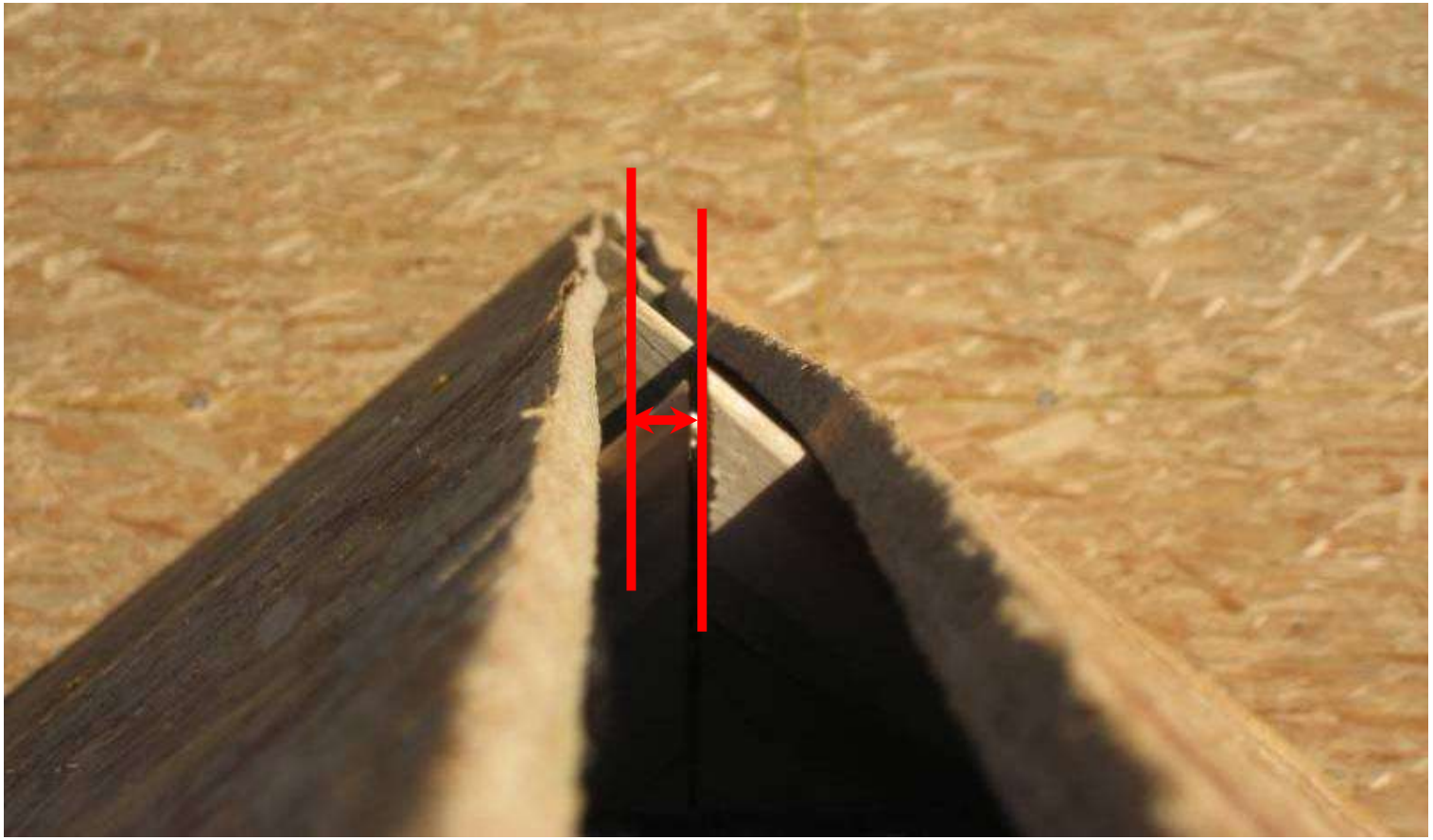
Building From the Ground Up: Roof

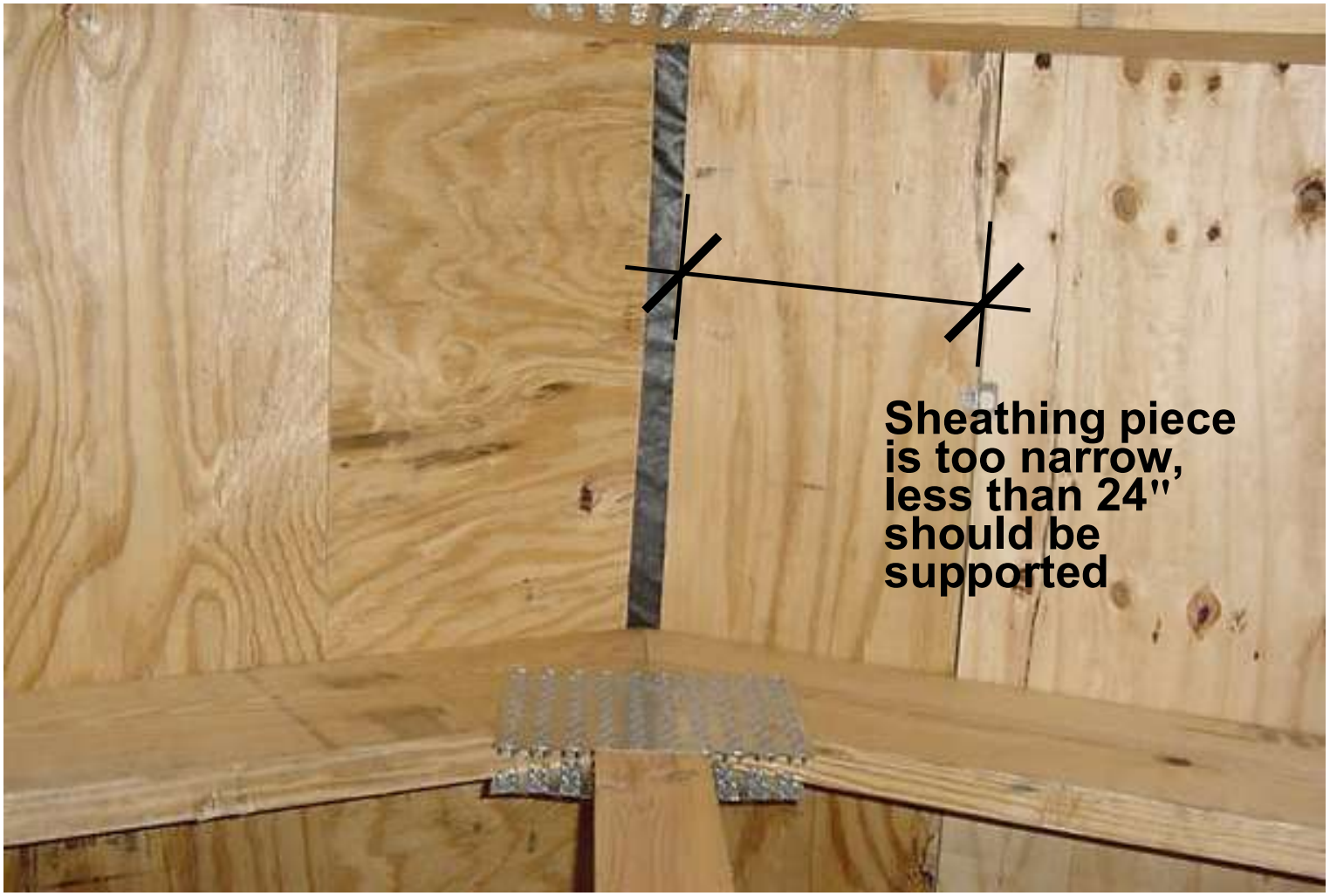
3-dimensional metal connectors

Building From the Ground Up: Roof

Resource: APA Builder Tips: How to Minimize Buckling of Asphalt Shingles, Form K310

Building From the Ground Up: Roof




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

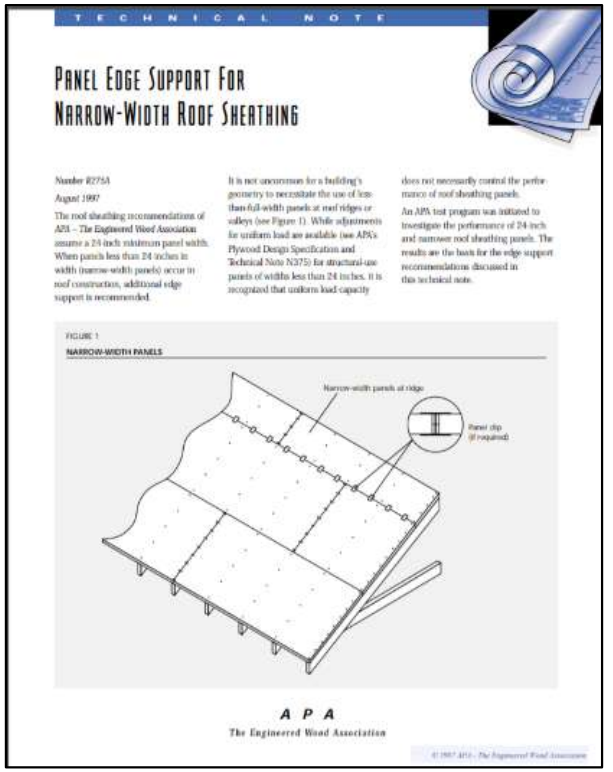
- **If WSP is 12" to 16"**

  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

Narrow-width panels at ridge

Panel clip (if required)

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The Engineered Wood Association

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

Building From the Ground Up: Special Topics

Special topics

- **On-site moisture management**
- **Shrinkage**

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Building From the Ground Up: Special Topics

APA

Prevent Moisture Intrusion- Drying of Subfloor

Fans

Dehumidification

Prevent Moisture Intrusion

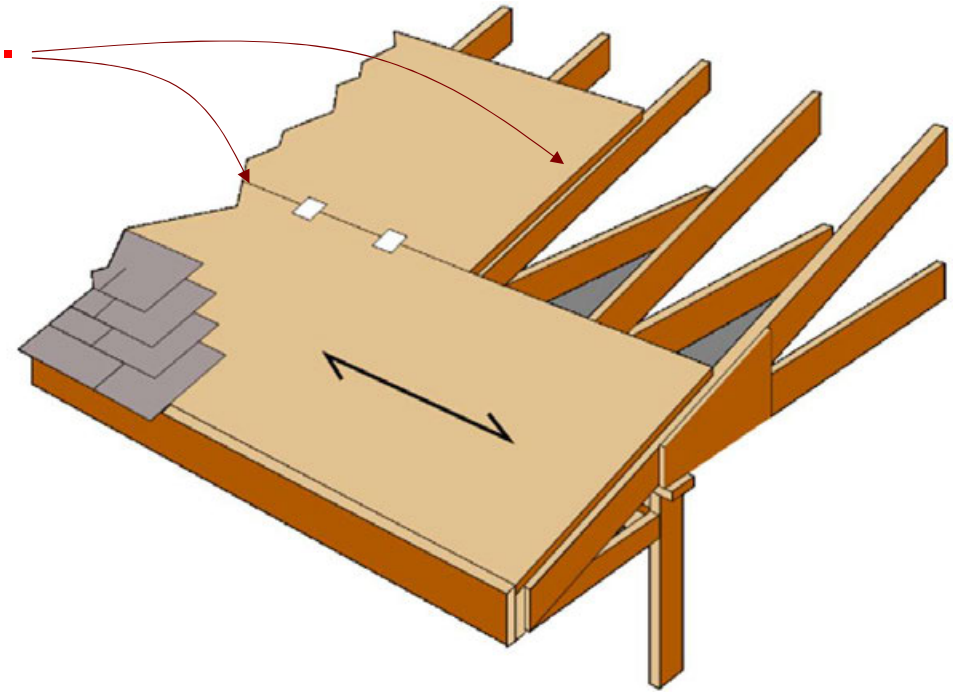
Improper Storage

Prevent Moisture Intrusion

Proper Storage

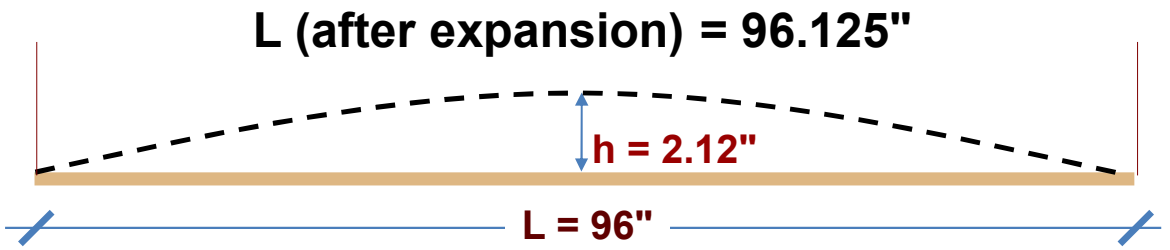
Building From the Ground Up: Special Topics

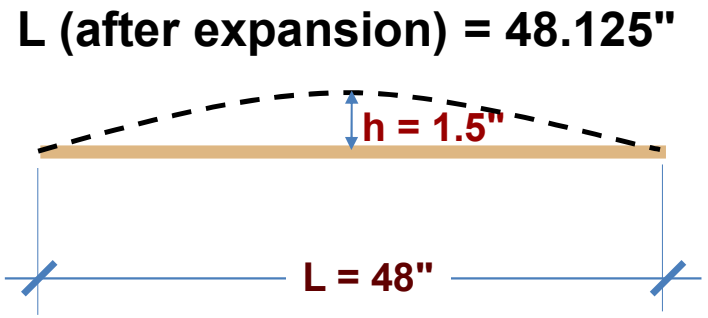
Space panels 1/8" min.
(ends & edges)



Allow for panel expansion

Building From the Ground Up: Special Topics



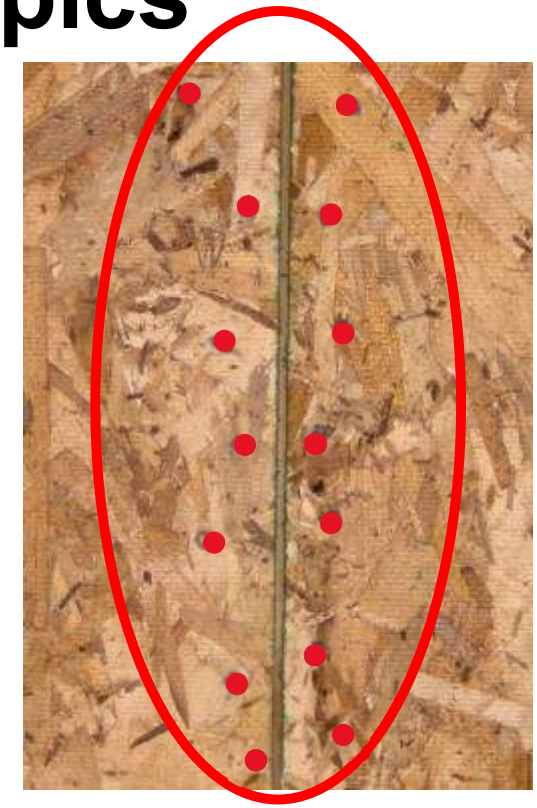


Allow for panel expansion

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.

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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…**

APA Technical Note D481

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

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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**

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FAQs: Questions about Plywood and OSB Form F505

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.

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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'**

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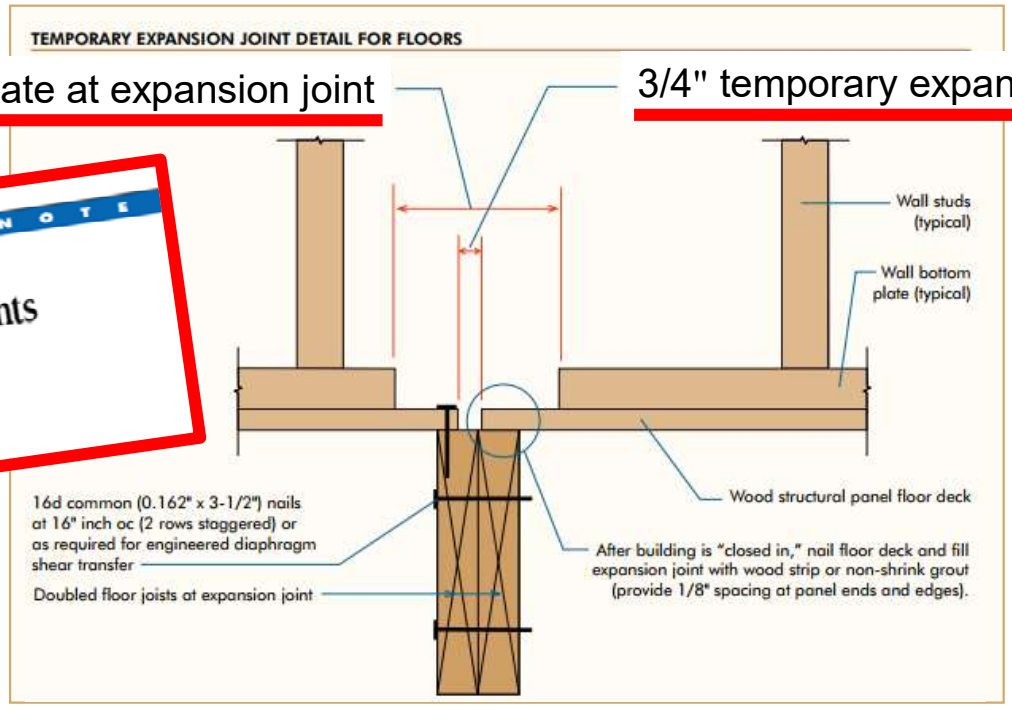
Building From the Ground Up: Special Topics

12" gap in wall bottom plate at expansion joint

3/4" temporary expansion joint at 80' intervals

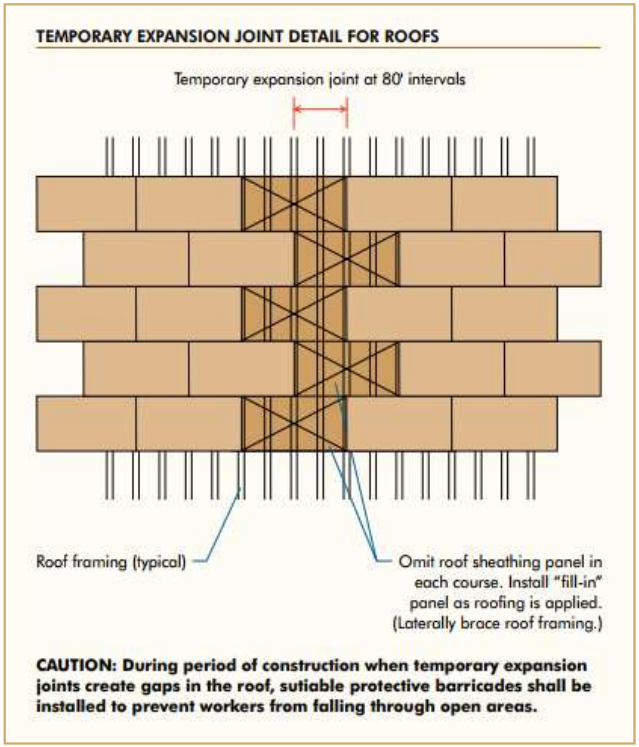


APA Technical Note U425

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**



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Building From the Ground Up: Special Topics

Tips:

- Keep materials dry, and dry in as soon as possible
- Load floors ASAP
- Accommodate movement in plumbing and electrical (vertical slip joints, vertical slot holes at horizontal runs, etc.)
- Limit or avoid dissimilar materials.
- Additional information on Accommodating Shrinkage in Wood-Frame Structures can be found on WoodWorks web page, www.woodworks.org

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Quick Summary

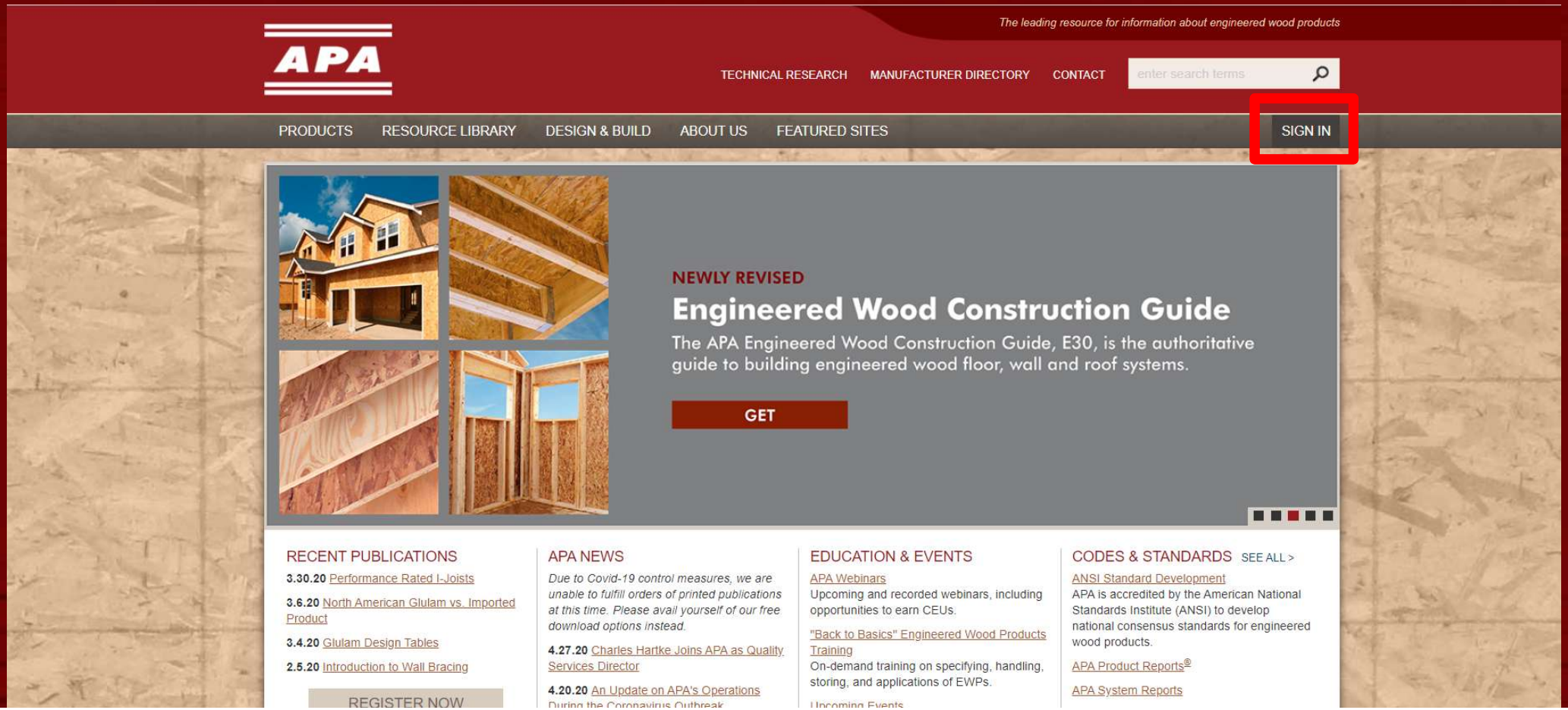
Simple basics make a big difference:

- **Follow the prints and specifications**
- **Space panels**
- **Follow fastening guidelines**
- **Check load paths/stacking**
- **Control moisture**

Assistance is available from APA

APA

APA Update Newsletter
(www.apawood.org)



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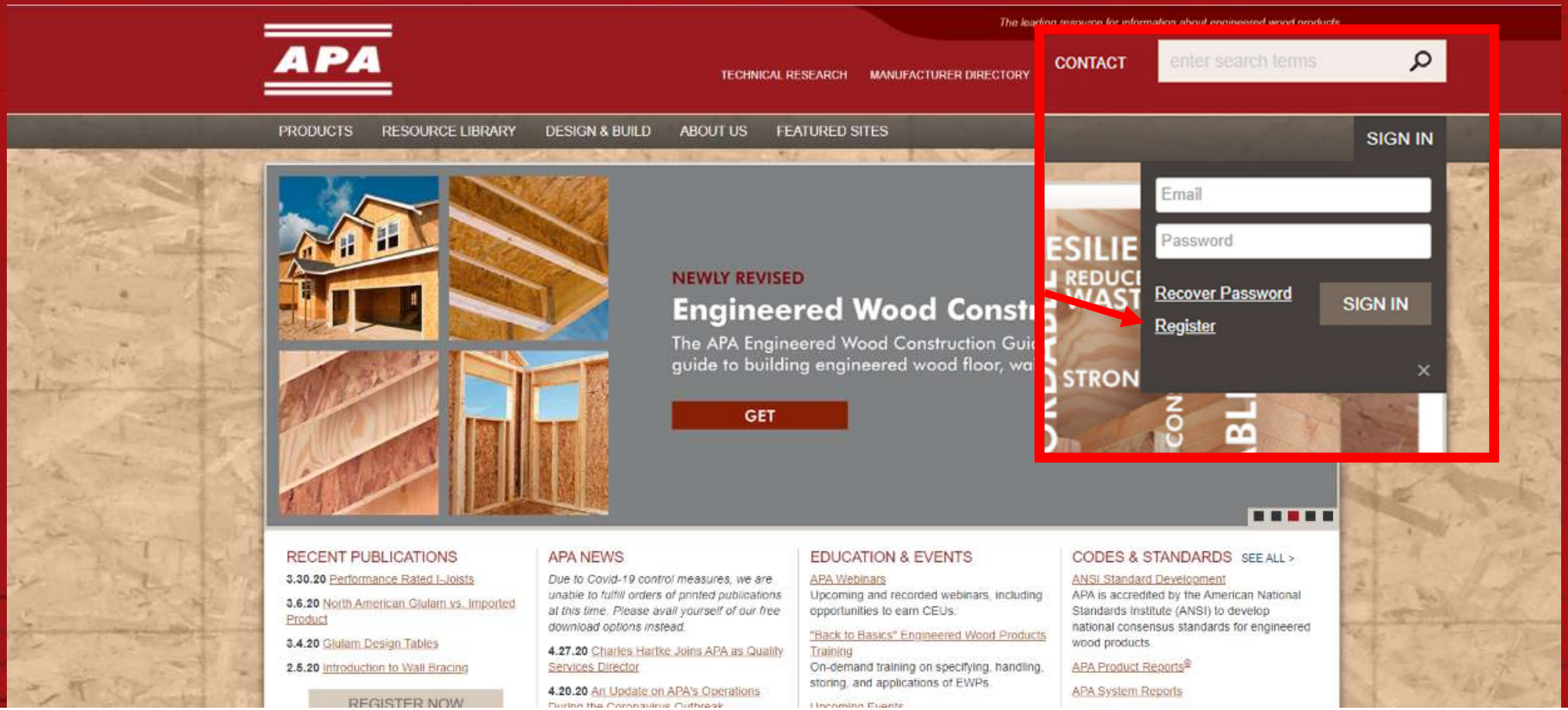
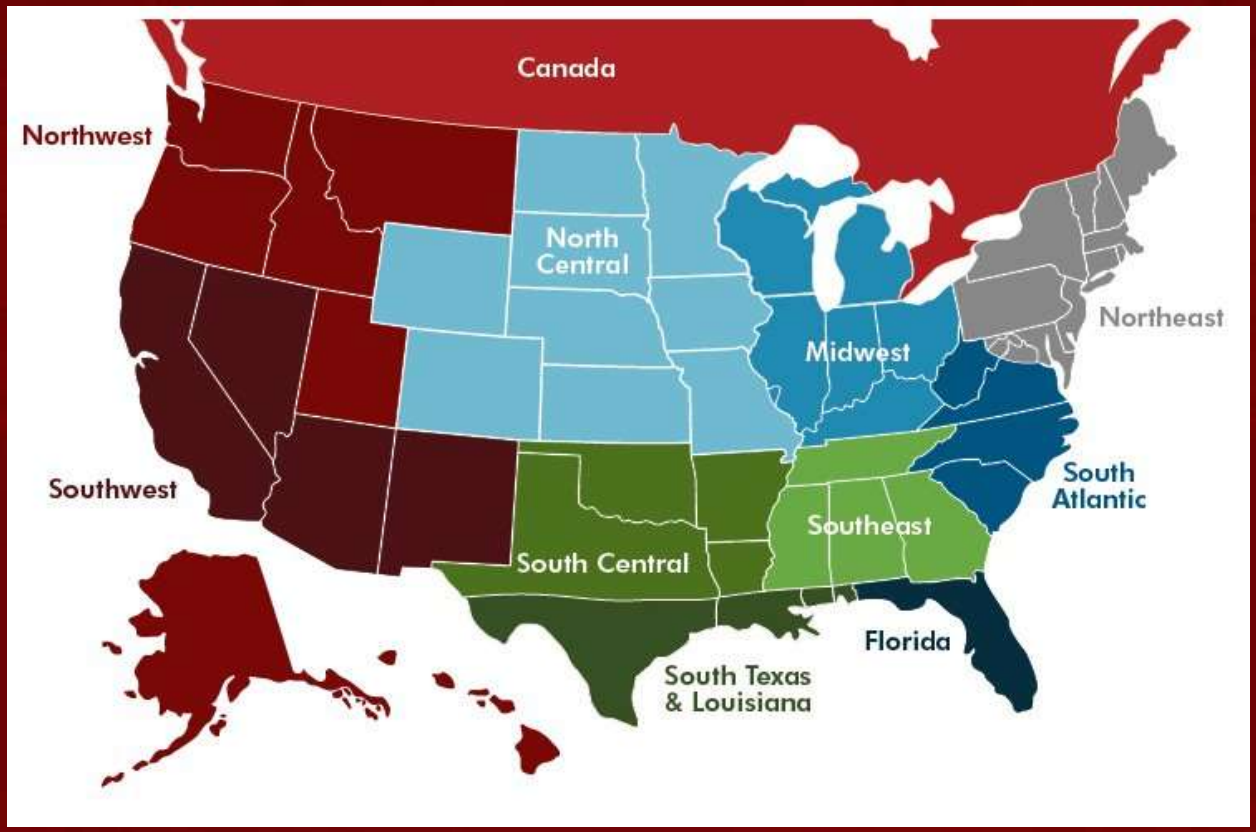


Field Services Division Territories



APA

Questions? Ask us anything.

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901 East Sixth, Thoughtbarn-Delineate Studio, Leap!Structures, photo Casey Dunn