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

September 24, 2025

Presented by

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Image: Stella, DesignARC, Taylor and Syfan, Photo Lawrence Anderson/Esto

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

AIA Approved Continuing Education

Course Description

Increasingly, building designers and developers are looking to mid-rise light-frame 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. Today's speakers will cover design considerations associated with these types of 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 mid-rise light-frame wood construction under the 2022 California Building Code (CBC).

3. Explore potential modifications to the CBC'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.

Mid-Rise Design: Optimizing Size, Maximizing Value

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

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Senior Regional Director | CA-South, AZ,NM

Outline

- Context for Mid-Rise Construction (Urban Densification)
- Mid-Rise Building Configurations
- Maximizing Height & Area
- Case Studies

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

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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

40% increase

Source: United Nations Department of Economic and Social Affairs

Need for Sustainable Multi-Family & Mixed-Use Structures

Economically Meet our Urban Housing Needs

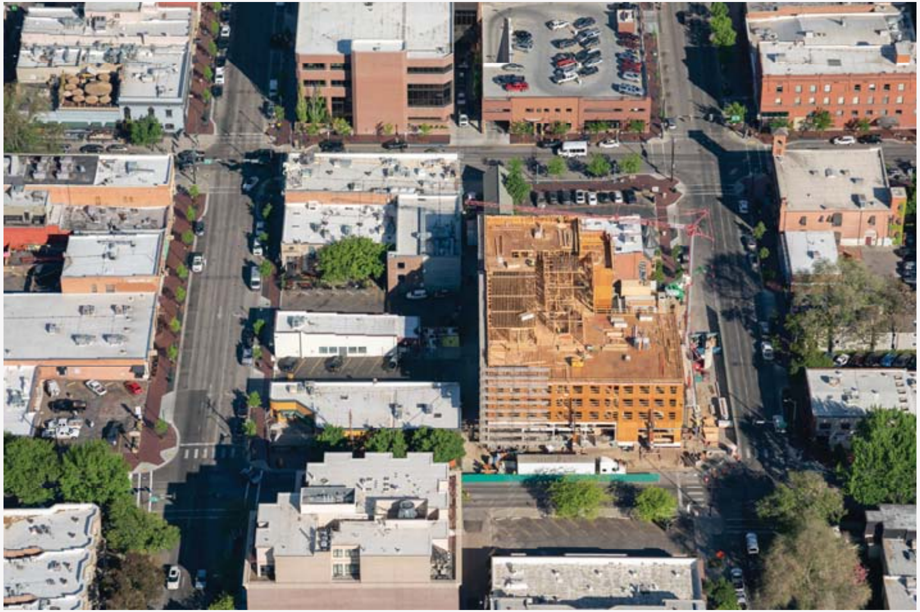
Increased Environmental Responsibility

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

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 a significant role in the 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

Carbon Footprint | High Density Housing


AvalonBay Stadium- Anaheim, CA

Sustainability 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.

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- » Context for Mid-Rise Construction (Urban Densification)
- Mid-Rise Building Configurations
- » Maximizing Height & Area
- » Case Studies

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

Mid-Rise Wood Construction

How many stories can be wood framed in the CBC?

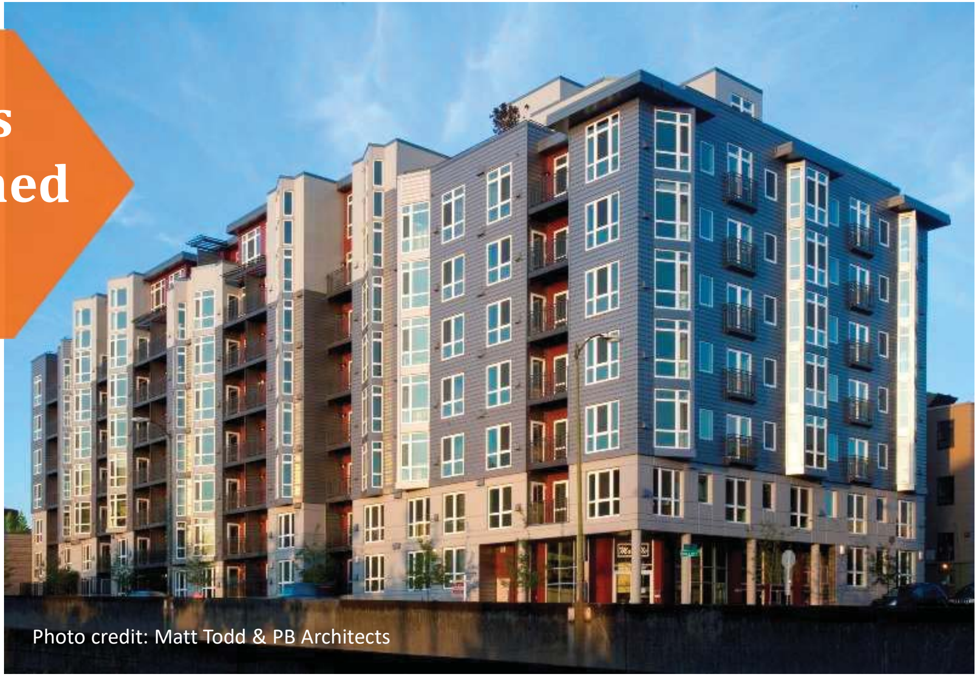


Photo credit: Matt Todd & PB Architects

Mid-Rise Wood Construction

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

Photo credit: Matt Todd & PB Architects

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 (aka the Texas Donut)

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-stories yields 60-80 units/acre

Podium (not a code-defined term)

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

4 Over 1 Podium

4 wood stories of residential over 1-story (parking or retail) podium

- » 80–100 units/acre

Inman Park Condos, Atlanta, GA
Davis & Church

5 Over 1 Podium

5 wood stories of residential over 1-story (parking or retail) podium

» 100–120 units/acre

AvalonBay Stadium, Anaheim, CA
VanDorpe Chou Associates

Inman Park Condos, Atlanta, GA
Davis & Church

5 Over 1 Podium

5 wood stories of residential over 1-story (residential) podium

» 120–140 units/acre

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

Outline

» Context for Mid-Rise Construction (Urban Densification)

» Mid-Rise Building Configurations

Maximizing Height & Area

1. Construction Types
2. Tabulated Heights & Areas
3. Measuring Height
4. Sprinkler Systems
5. Frontage
6. Calculating Allowable Building Area
7. Basements, Mezzanines & Special Design Provisions

» Case Studies

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

Construction Types – Section 602

Type V

- All building elements can be any material allowed by code
- Subdivided into **V-A** (protected) and **V-B** (unprotected)

Type IV (Heavy/Mass Timber)

- Minimum prescriptive sizes per CBC Section 2304.11
- Exterior walls must be noncombustible or MT (may be FRTW in **IV-HT**)
- Interior building elements must be noncombustible or MT (may be light-frame wood in **IV-HT** if fire rated)
- Subdivided into **IV-A**, **IV-B**, **IV-C** and **IV-HT**, each with different levels of protection

Type III

- Exterior walls must be noncombustible (may be FRTW in most cases)
- Interior building elements can be any material allowed by code
- Subdivided into **III-A** (protected) and **III-B** (unprotected)

Tabulated Heights & Areas

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

OCCUPANCY CLASSIFICATION	See Footnotes	Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV A	Type IV B	Type IV C	Type IV HT	Type V A	Type V B
B, 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-2[h]	*NS[d]*	UL	160	65	55	65	55	*65*	*65*	*65*	65	50	40
	S13R	60	60	60	*55*	60	*55*	*60*	*60*	*60*	60	*50*	*40*
	S (without area increase)	UL	180	85	75	85	75	*270*	*180*	*85*	85	70	60
	S (with area increase)	*UL*	*160*	*65*	*55*	*65*	*55*	*250*	*160*	*65*	*65*	*60[j]*	*40*

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

OCCUPANCY CLASSIFICATION	See Footnotes	Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV A	Type IV B	Type IV C	Type IV HT	Type V A	Type V B
B	NS	UL	11	5	3	5	3	5	5	5	5	3	2
	S	UL	12	6	4	6	4	18	12	9	6	4	3
R-2[h]	NS[d]	UL	11	4	4	4	4	4	4	4	4	3	2
	S13R	4	4	4								4	3
	S *(without area increase)*	UL	12	5	5	5	5	18	12	8	5	4	3
	S (with area increase)	*UL*	*11*	*4*	*4*	*4*	*4*	*17*	*11*	*7*	*4*	*4[e]*	*2*

Tabulated Heights & Areas

TABLE 506.2
ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET[a, b, j]

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
B	NS	UL	UL	37,500	23,000	28,500	19,000	108,000	72,000	45,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	432,000	288,000	180,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	324,000	216,000	135,000	108,000	54,000	27,000
R-2[h]	NS[d] S13R	UL	UL	24,000	16,000	24,000	16,000	61,500	41,000	25,625	20,500	12,000	7,000
	S1	UL	UL	96,000	64,000	96,000	64,000	246,000	164,000	102,500	82,000	48,000	28,000
	SM (*without height increase*)	UL	UL	72,000	48,000	72,000	48,000	184,500	123,000	76,875	61,500	36,000	21,000
	SM (with height increase)	*UL*	*UL*	*24,000*	*16,000*	*24,000*	*16,000*	*61,500*	*41,000*	*25,625*	*20,500*	*12,000*	*7,000*
R-2 Type VA construction[k]	*NS*[d]	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*12,000*	*NP*
	S13R	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*12,000*	*NP*
	S1	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*48,000*	*NP*
	SM (without height increase)	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*36,000*	*NP*
	SM (with height increase)	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*NP*	*36,000*[j]	*NP*

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)

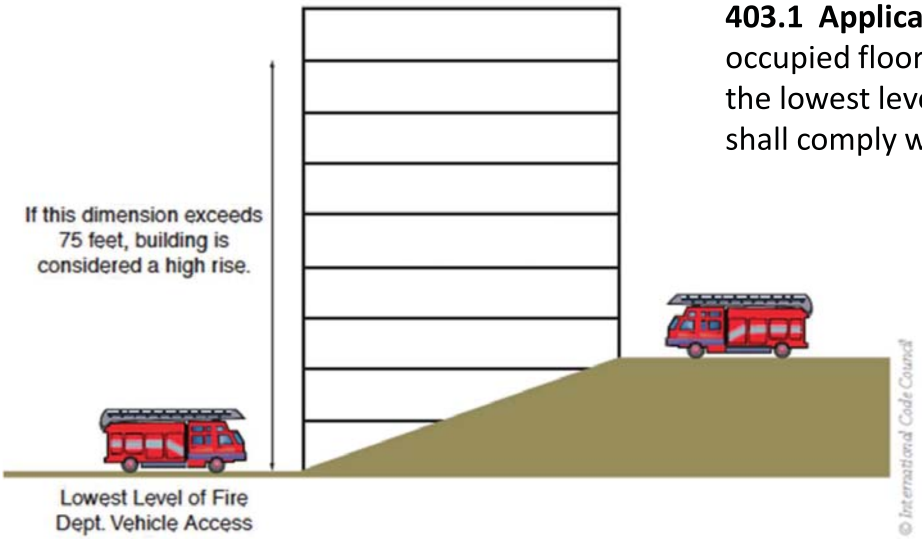
Measuring Height – Chapter 2 Definitions

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 from the building, between the building and a point 6 feet from the building.

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

Measuring Height – Section 403



Determination of high-rise building

403.1 Applicability. New high-rise buildings having occupied floors located more than 75 feet above the lowest level of fire department vehicle access shall comply with Sections 403.2 through 403.7.

Sprinkler Systems

In many cases, sprinklers are required by code depending on occupancy per Section 903.2

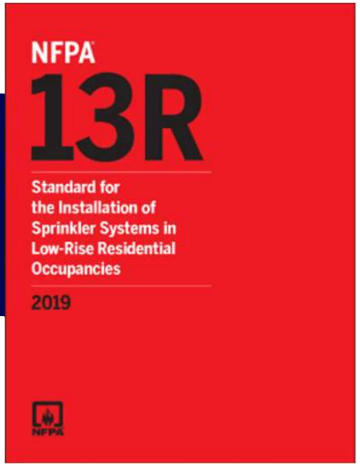
» Most new Group R fire areas

» Group A, E, M or S fire areas exceeding 1k-48k sf

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

Sprinkler Systems

- NFPA 13
  Standard for Commercial Occupancies per CBC Section 903.3.1.1
- NFPA 13R
  Standard for Low-Rise Residential Occupancies per CBC Section 903.3.1.2
- NFPA 13D
  Standard for One and Two-Family Residences per CBC Section 903.3.1.3

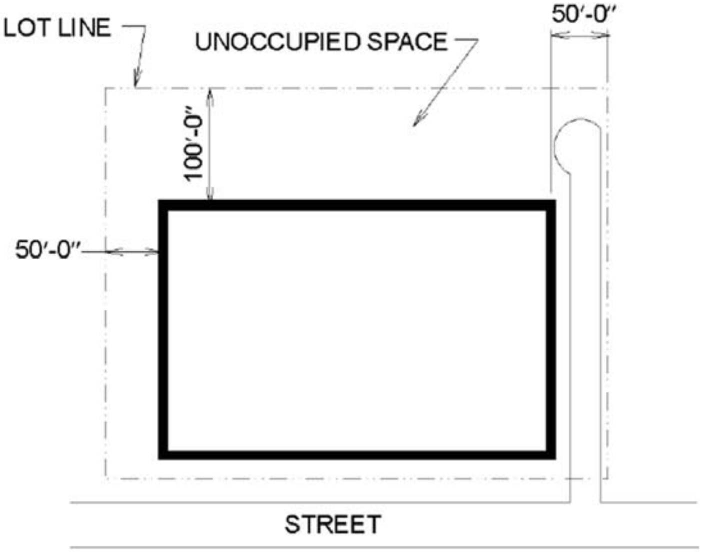


Sprinkler Systems – NFPA 13 vs. NFPA 13R

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

Frontage – Section 506.3

The allowable area of a building is permitted to be increased when it has a certain amount of frontage on streets (public ways) or open spaces, since this provides access to the structure by fire service personnel, a temporary refuge area for occupants as they leave the building in a fire emergency and a reduced fire exposure to and from adjacent structures.



Frontage – Sections 506.3.1 & 506.3.2

MINIMUM QUALIFICATIONS

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

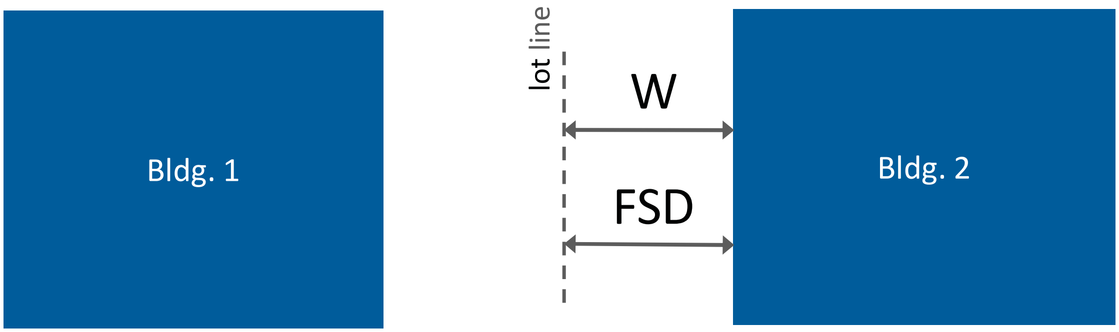
- The closest interior lot line
- The entire width of a street, alley or public way
- The exterior face of an adjacent building on the same property

Frontage

The width “W” of public way or open space is NOT always the same as fire separation distance (FSD) used for purposes of determining fire resistance ratings of exterior walls and openings

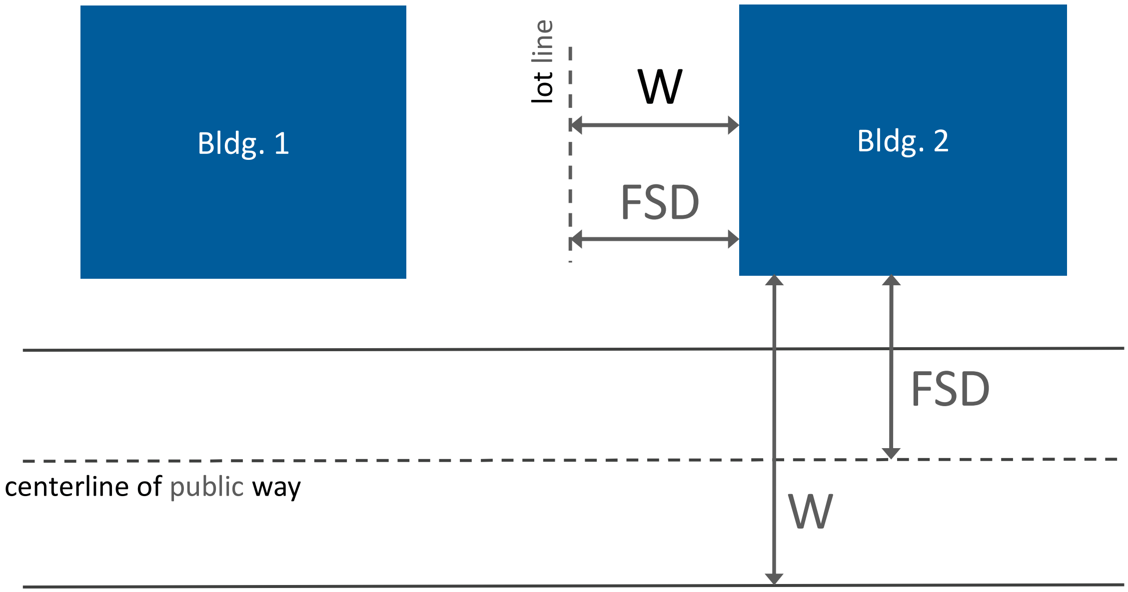
Frontage – Section 506.3.2

For two buildings on DIFFERENT lots



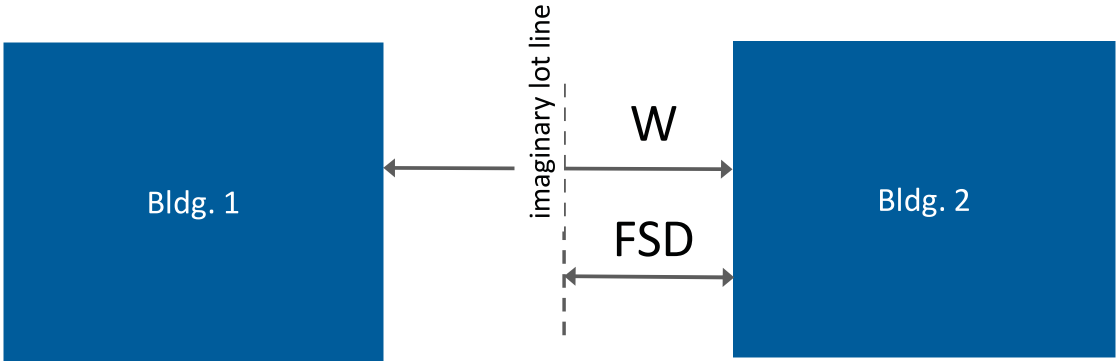
Frontage – Section 506.3.2

For buildings near public right of ways:



Frontage – Section 506.3.2

For two buildings on the SAME lot



Frontage – 2019 CBC Section 506.3.2

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

(Equation 5-4)

WHERE:

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

L_n = Length of a portion of the exterior perimeter wall

w_n = Width ($\geq$ 20 feet) 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 a width of 20 feet or more

Frontage – 2019 CBC Section 506.3.3

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

(Equation 5-5)

Where:

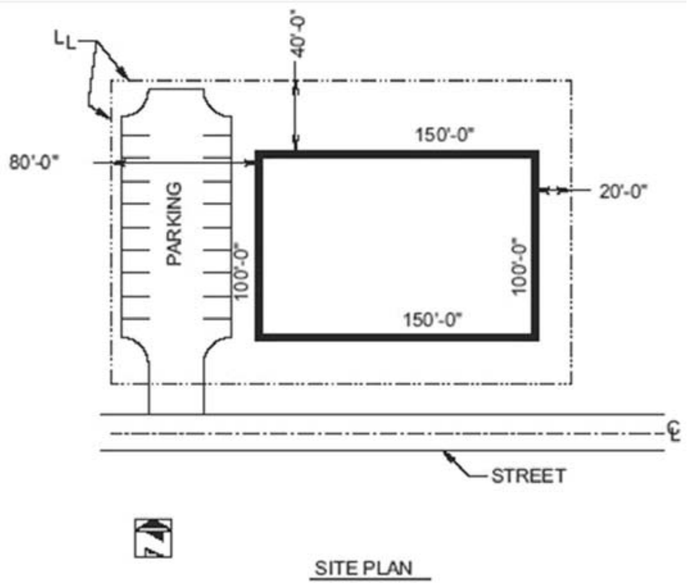
I_f = Area factor increase due to frontage ($I_{f\,max.}$ = 0.75)

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

P = Perimeter of entire building (feet)*

W = Width of public way or open space (feet) in accordance with Section 506.3.2 (30 feet max.)

* Fire walls must be treated like a perimeter wall with zero frontage



Frontage – 2022 CBC Section 506.3.3

506.3.3 Amount of increase. The area factor increase based on frontage shall be determined in accordance with Table 506.3.3.

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

Calculating Allowable Building Area (Single-Occupancy Building 3** Stories or Less) – Section 506.2.1

$$A_a = A_t + (NS \times I_f)$$

(Equation 5-1)

A_a = Allowable area of each story (sq. ft.)

A_t = Tabular allowable area factor (NS, S1 or S13R) per Table 506.2*

NS = Tabular allowable area factor per Table 506.2 for nonsprinklered building (sprinklered or not)

I_f = Area factor increase due to frontage (percent) per Section 506.3

* Code error; SM should have been included

** Code error; for A, E, H, I, L and R occupancies, Equation 5-1 should apply to buildings 2 stories or less

Calculating Allowable Building Area (Single-Occupancy Building More Than 3* Stories) – Section 506.2.1

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

(Equation 5-2)

A_a = Allowable area (sq. ft.)

A_t = Tabular allowable area factor (NS, S13R or SM) per Table 506.2

NS = Tabular allowable area factor per Table 506.2 for nonsprinklered building (sprinklered or not)

I_f = Area factor increase due to frontage (percent) per Section 506.3

S_a = Except for A, E, H, I, L and R occupancies, actual number of stories above grade plane, not to exceed 3. For A, E, H, I, L and R occupancies, actual number of stories above grade plane, not to exceed 2.

* Code error; for A, E, H, I, L and R occupancies, Equation 5-2 should apply to buildings more than 2 stories

Basements on Sloping Sites– Section 506.1.3

Basements need not be included in the total allowable floor area of a building provided the total area of such basements does not exceed the area permitted for a one-story above grade plane building.

A "basement" is defined as "A story that is not a story above grade plane" such that the finished surface of the floor next above is:

- No more than 6 feet above grade plane; <u>and</u>
- No more than 12 feet above the finished ground level at any point

Fashion Valley, CA
AvalonBay Communities

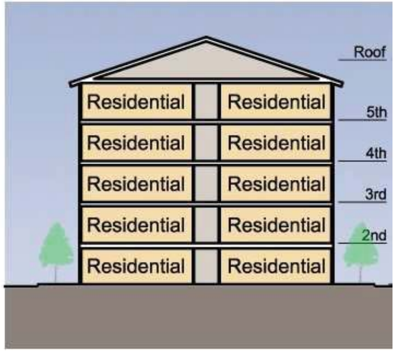
Mezzanines – Section 505.2

Mezzanines are considered a portion of the story below and are not counted toward building area* or number of stories if:

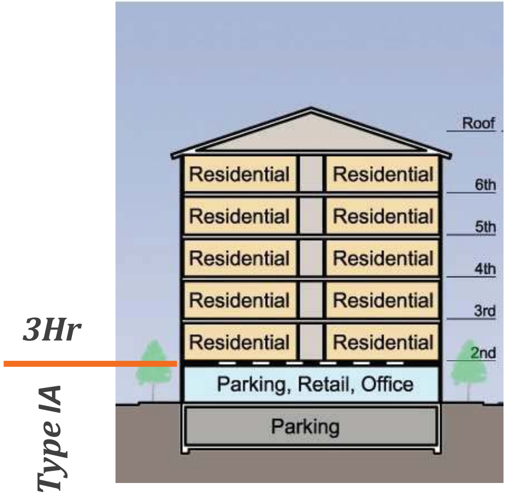
- Maximum 1/3 the floor area of a *room* or *space* where located (1/2 the floor area within dwelling units located in buildings equipped throughout with NFPA 13 or NFPA 13R sprinkler systems)
- Special egress provisions apply
- Must be open and unobstructed to room in which it's located (walls ≤ 42" allowed)
  - Several exceptions
- Slightly different for equipment platforms

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

Special Design Provisions (Podiums) – Section 510.2



5-story Type III building



5-story Type III building
on top of a Type I-A podium

Increases total allowable stories…not allowable building height

Special Design Provisions (Podiums) – Section 510.2

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

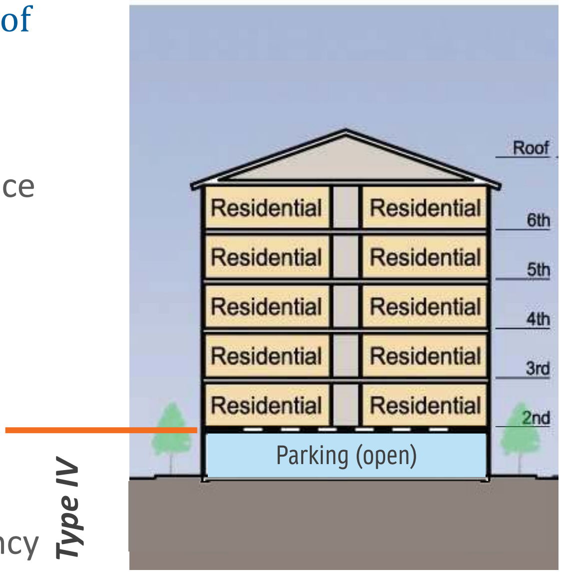
- Overall height is still limited to min. of either building
- 3-hr rated horizontal assembly
- Building below is Type I-A with sprinklers
- Enclosures penetrating horizontal assembly are 2-hr rated
- Occupancy above is A (occupant load <300), B, M, R or S
- Occupancy below is anything except H
- Fire walls (if req.'d), can terminate at podium level

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

Special Design Provisions (Wood Podiums) - Section 510.4

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

- Occupancy above is R and below is S-2
- Parking garage is open Type IV parking with grade entrance
- Horizontal assembly between 1st and 2nd floor shall be:
  - Type IV
  - Have 1-hr fire rating when sprinklered
  - Have 2-hr fire rating when not sprinklered
- Overall height from grade is still limited by the R occupancy



Parking beneath Group R

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

Wood Podiums

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.*

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 ...

Outline

- » Context for Mid-Rise Construction (Urban Densification)
- » Mid-Rise Building Configurations
- » Maximizing Height & Area
- » **Case Studies**

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

Case Study – Wood Buildings Aim High

Inman Park Condominiums

Atlanta, GA

Architect: Brown Doane Architects

Engineer: Davis & Church

4 stories of wood over 1 story of concrete parking

Floor joists selected to maximize headroom and not exceed building height (10' ceilings)

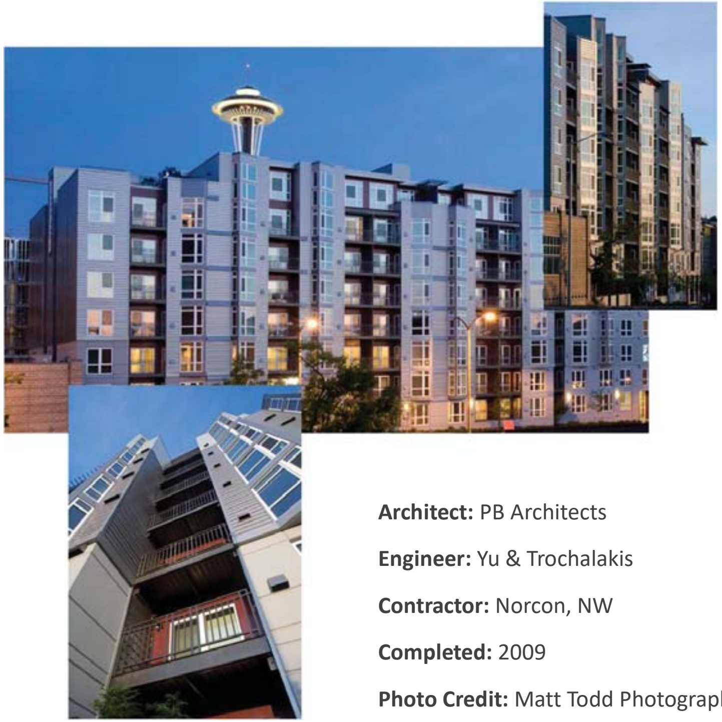
Drop ceilings for MEP at perimeter of some rooms

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
- Mezzanines added $250 in 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

Case Study – Innovations in Wood

Emory Point Atlanta, GA

- 3 mixed-use buildings completed – Luxury apt.'s, retail and restaurants
- (1) 5-story building of Type III-A wood over slab on grade
- (2) 4-story buildings of Type V-A wood over 1-story concrete podium

35% Structure Savings

- $14/sf (wood floor structure)
- $22/sf (concrete floor structure)

Architect: Cooper Carry, The Preston Partnership

Engineer: Ellinwood + Machado, Pruitt Eberly Stone

Contractor: Fortune-John

Photo credit: Gables Residential

Frame it Right!
Back to Basics for Big Buildings

Lindsey Kuster, PE
Engineered Wood Specialist

APA

APA – The Engineered Wood Associate

APA's 42,000 square-foot research center

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.

Agenda

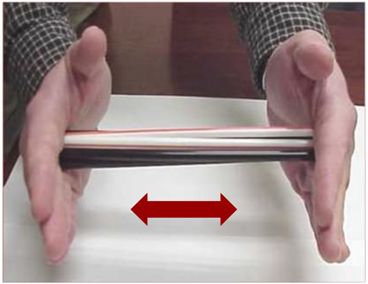
Why is Training Needed?

Building from the ground up

- Wood Strength
- Walls
- Floors
- Roofs
- Special Topics
- Q&A

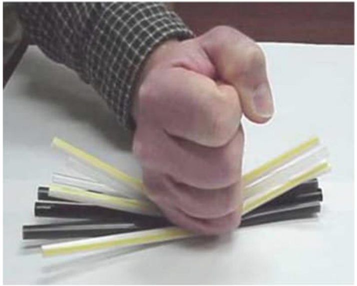
Wood has a Stronger Direction

Load parallel to grain



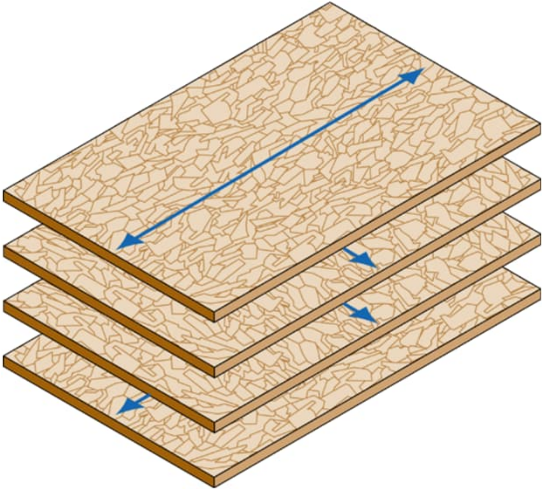
Stronger

Load perpendicular to grain



Weaker

Oriented Strand Board (OSB) Layup



Frame it Right!

APA Stamp in the Field

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

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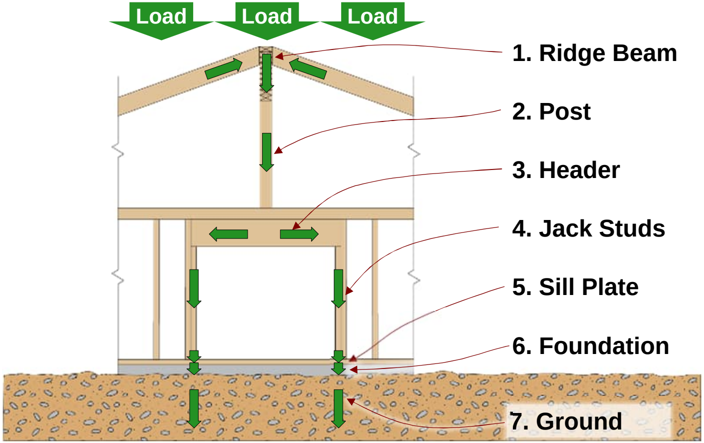
Vertical (Gravity) Load Path



Building From the Ground Up: Walls

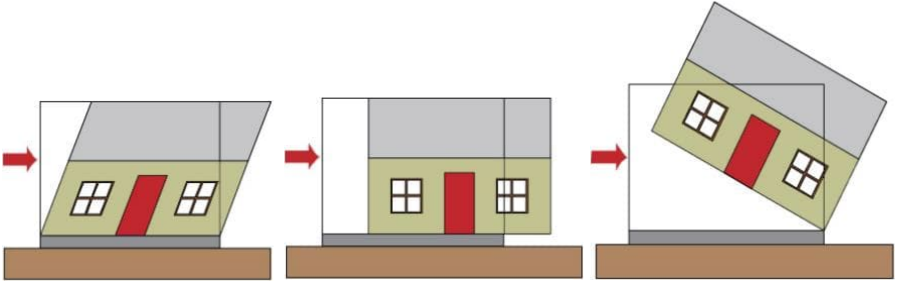
Lateral Forces

Modes of Failure

Racking

Sliding

Overturning



Resisted by Bracing

Resisted by Anchors

Resisted by Hold-Downs & Dead Load

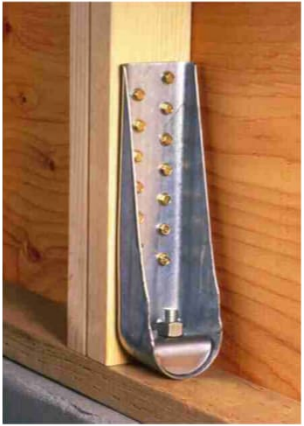
APA

Building From the Ground Up: Walls

Missing washer

Building From the Ground Up: Walls

Hold-down hardware



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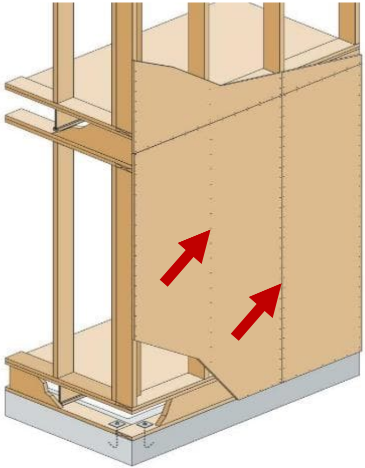
Building From the Ground Up: Walls

Building From the Ground Up: Walls

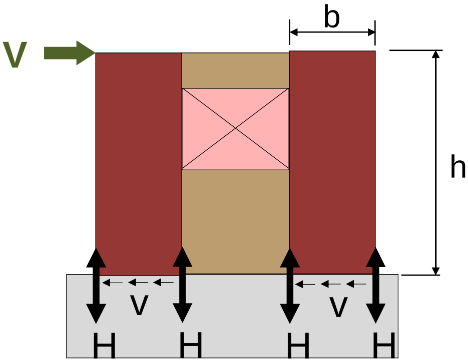
Wall Sheathing

- **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.

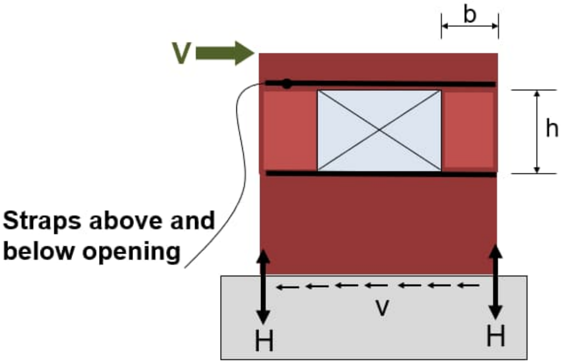


APA

Segmented Shear Walls



Force Transfer Around Openings (FTAO) Shear Walls



APA FTAO Calculator

Excel-based tool released January 2018

Based on design methodology developed by Diekmann

Calculates:

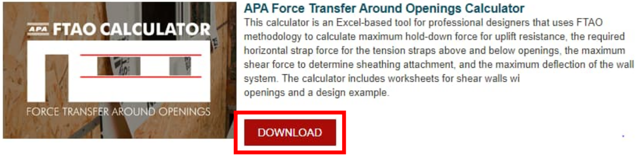
Max hold-down force for uplift resistance

Required horizontal strap force above and below openings

Max shear force for sheathing attachments

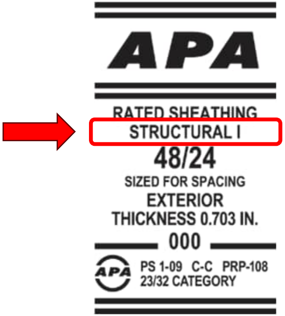
Max deflection

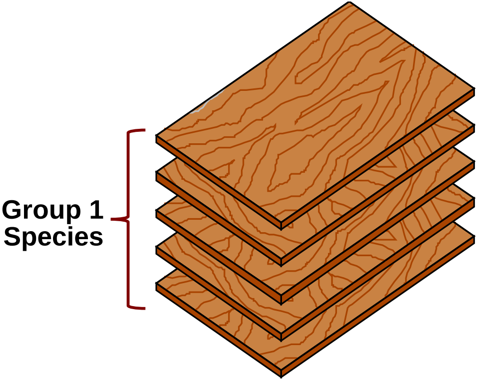
Design example corresponds with FTAO Technical Note, Form T555



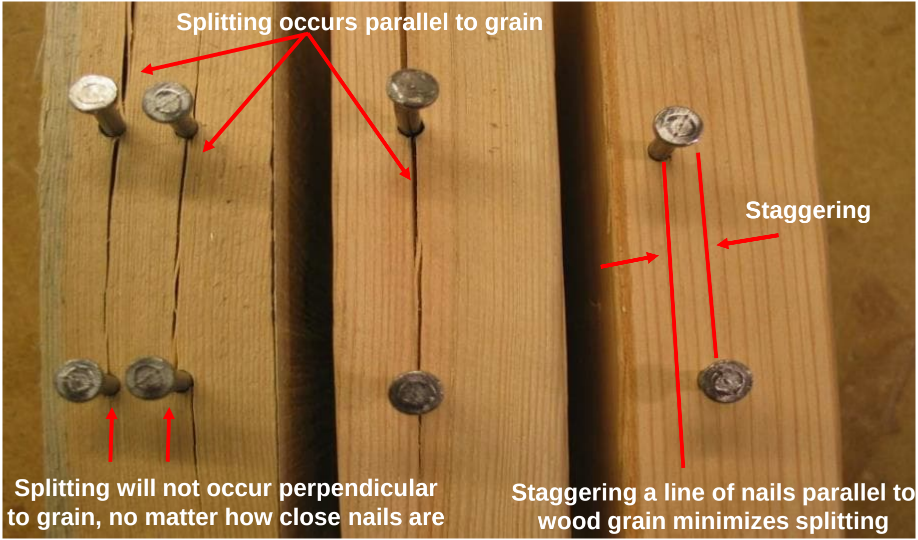
Structural I Panels

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





Staggered Fastening



Building From the Ground Up: Walls

Wall Sheathing

Nail-base sheathing

Resource: APA Construction Guide: Nail-Base Sheathing for Siding and Trim Attachment, Form Q250

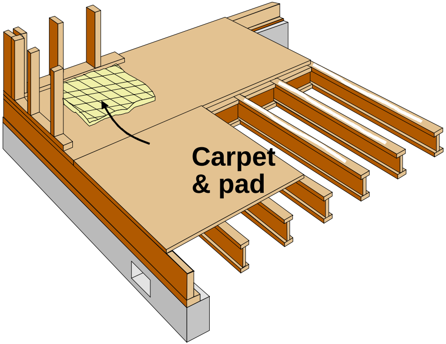
Building From the Ground Up: Floors

Sturd-I-Floor

Combined subfloor & underlayment

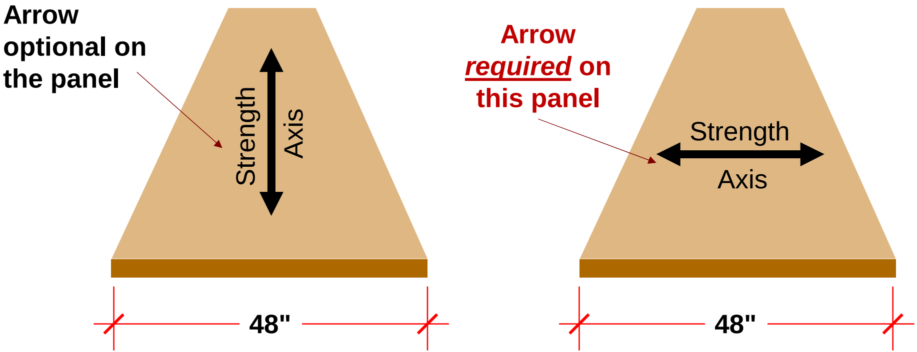
Resistant to concentrated & impact loads

Plywood or OSB



Building From the Ground Up: Floors

Strength Axis



Common

Not Common

Building From the Ground Up: Floors

Resource: Subfloor Preparation to Receive Finished Flooring, Form V440

Fully Fasten with Clamping Force

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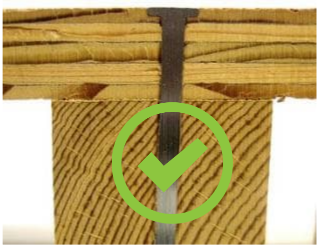
Building From the Ground Up: Floors

Nail installation

Overdriving reduces performance APA recommends adding one for every two overdriven



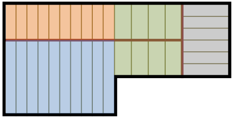
Resource: APA Technical Topics: Effect of Overdriven Fasteners on Shear Capacity, Form TT-012

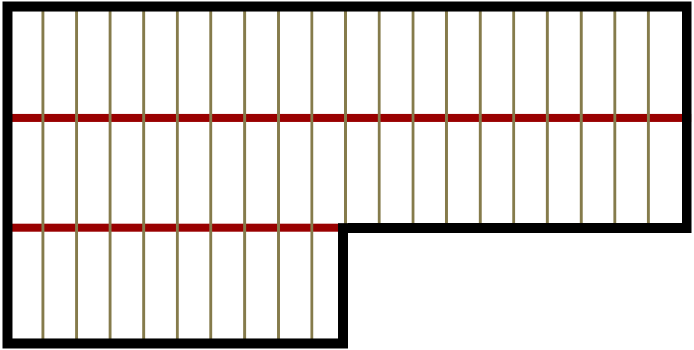
Building From the Ground Up: Floors

Floor Joist Layout — Consistency Counts

Consistent Spacing & Span

Before





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Sustainability

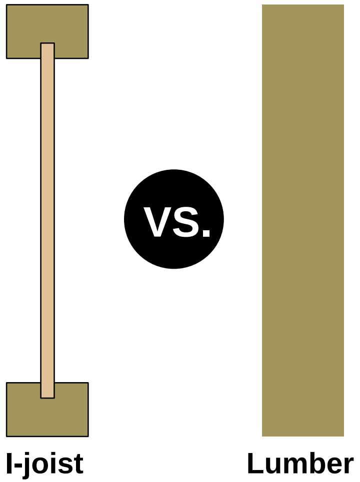
I-joist vs. Lumber

Both at 16" o.c.

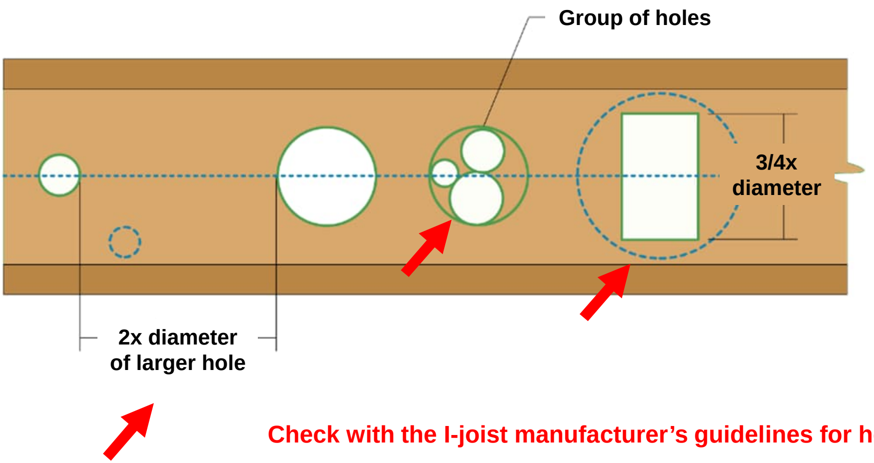
- 36% less wood fiber

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

- 46% less wood fiber



Building From the Ground Up: Floors



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

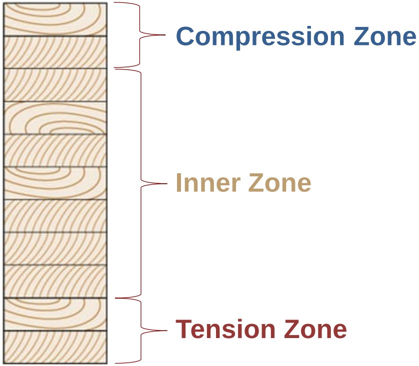

SIMPLE SPAN

Building From the Ground Up: Floors

Laminated Strand Lumber (LSL)

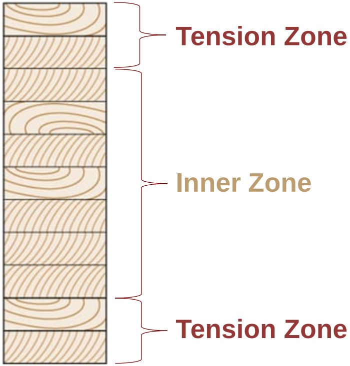
Balanced and Unbalanced Glulam

Unbalanced Beam



24F-V4 Layup

Balanced Beam



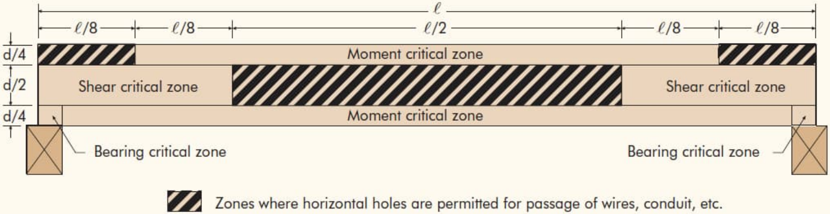
24F-V8 Layup

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 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

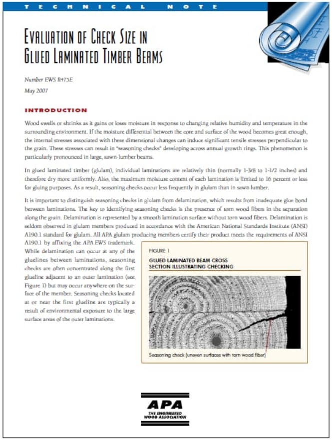
TECHNICAL NOTE

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

APA

Building From the Ground Up: Floors

Wood Properties


TECHNICAL NOTE

EVALUATION OF CHECK SIZE IN GLUED LAMINATED TIMBER BEAMS

Number EWS R475E

May 2007

INTRODUCTION

Wood swells or shrinks as it gains or loses moisture in response to changing relative humidity and temperature in the surrounding environment. If the moisture differential between the core and surface of the wood becomes great enough, the internal stresses associated with these dimensional changes can induce significant tensile stresses perpendicular to the grain. These stresses can result in "seasoning checks" developing across annual growth rings. This phenomenon is particularly pronounced in large, sawn-lumber beams.

In glued laminated timber (glulam), individual laminations are relatively thin (normally 1-3/8 to 1-1/2 inches) and therefore dry more uniformly. Also, the maximum moisture content of each lamination is limited to 16 percent or less for gluing purposes. As a result, seasoning checks occur less frequently in glulam than in sawn lumber.

It is important to distinguish seasoning checks in glulam from delamination, which results from inadequate glue bond between laminations. The key to identifying seasoning checks is the presence of torn wood fibers in the separation along the grain. Delamination is represented by a smooth lamination surface without torn wood fibers. Delamination is seldom observed in glulam members produced in accordance with the American National Standards Institute (ANSI) A190.1 standard for glulam. All APA glulam producing members certify their product meets the requirements of ANSI A190.1 by affixing the *APA EWS* trademark. While delamination can occur at any of the gluelines between laminations, seasoning checks are often concentrated along the first glueline adjacent to an outer lamination (see Figure 1) but may occur anywhere on the surface of the member. Seasoning checks located at or near the first glueline are typically a result of environmental exposure to the large surface areas of the outer laminations.

FIGURE 1

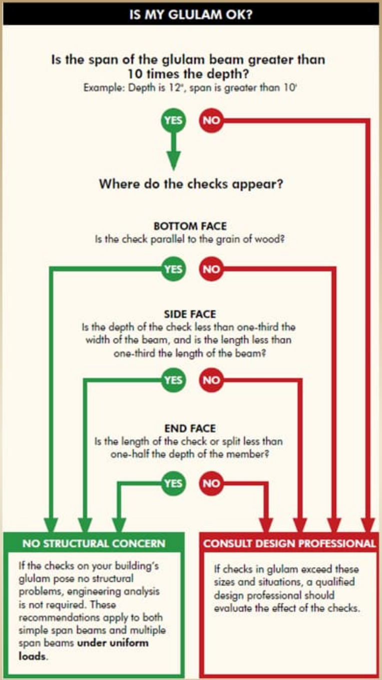
GLUED LAMINATED BEAM CROSS SECTION ILLUSTRATING CHECKING

Seasoning check (uneven surfaces with torn wood fiber)

APA THE ENGINEERED WOOD ASSOCIATION

Checking Evaluation

- Guidelines established for what size checks are okay without an engineering analysis
- Published in Owner's Guide to Understanding Checks in Glued Laminated Timber, Form F450



Also see *APA Technical Note: Evaluation of Check Size in Glued Laminated Timber Beams,* Form R475

Building From the Ground Up: Roof

APA Engineered Wood Construction Guide, Form E30, Table 34

TABLE 34

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

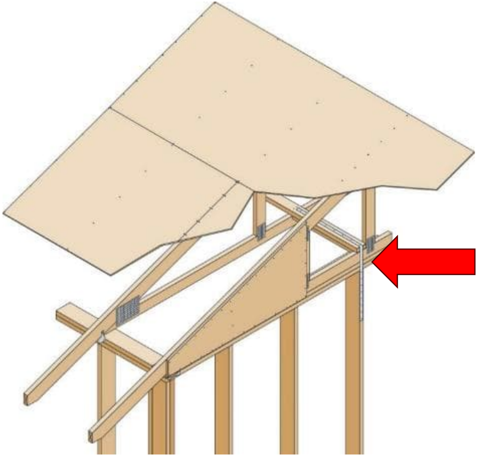
Panel Span Rating	Minimum Panel Performance Category	Maximum Span (in.) With Edge Support[c]	Maximum Span (in.) Without Edge Support	Allowable Live Loads (psf)[d] Spacing of Supports Center-to-Center (in.) 12	16	20	24	32	40	48	60
APA RATED SHEATHING[a]											
12/0	3/8	12	12	30							
16/0	3/8	16	16	70	30						
20/0	3/8	19.2	19.2	120	50	30					
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	
60/32[f]	7/8	60	40	—	—	—	305	165	100	70	35
60/48[f]	1-1/8	60	48	—	—	—	305	165	100	70	35

Building From the Ground Up: Roof

3-dimensional metal connectors

Building From the Ground Up: Roof

Gable ends



Narrow Width Roof Sheathing

Narrow Roof Sheathing

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

  2 clips at lower edge acceptable

  Lumber block lower edge

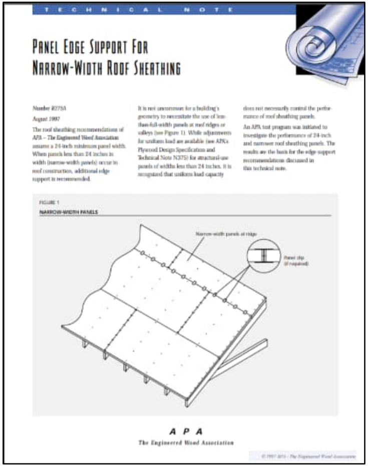
- **If WSP is 12" to 16"**

  Lumber block lower edge

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

  Lumber block upper and lower edges

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



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

A P A

The Engineered Wood Association

APA Technical Note Form R275

Building From the Ground Up: Special Topics

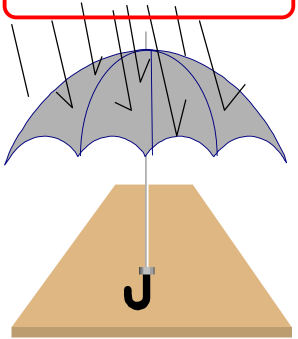
Special topics

- **On-site moisture management**

- **Shrinkage**

Bond Classification

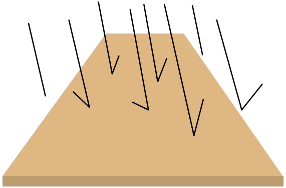
EXPOSURE 1



Exposure due to construction delays

OR

EXTERIOR



Long term weather exposure

Prevent Moisture Intrusion in Subfloors

Drying of Subfloor

Fans

Dehumidification

APA

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

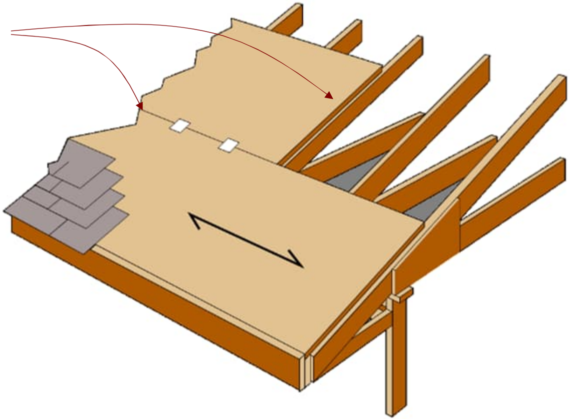
APA-trademarked panel performance concerns are infrequent, but they arise on occasion. Some permissible performance, grade, growth or natural characteristics are often interpreted as performance issues when they are merely cosmetic and have no impact on panel performance. A guide of terms associated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

Building From the Ground Up: Special Topics

Capillary Action

- Is the product touching the foundation rated for concrete contact?
- What are the long-term consequences?

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

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…**


TECHNICAL NOTE

Minimizing Buckling of Wood Structural Panels

Form D481N

September 2012

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

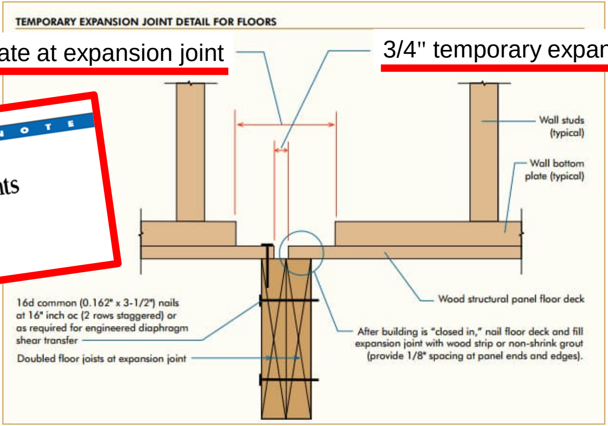
Sequence wall panel installation to allow panels to acclimate to jobsite conditions:

- **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

12" gap in wall bottom plate at expansion joint

3/4" temporary expansion joint at 80' intervals




TECHNICAL NOTE

Temporary Expansion Joints for Large Buildings

Number U425C
October 2016

APA Technical Note U425

APA

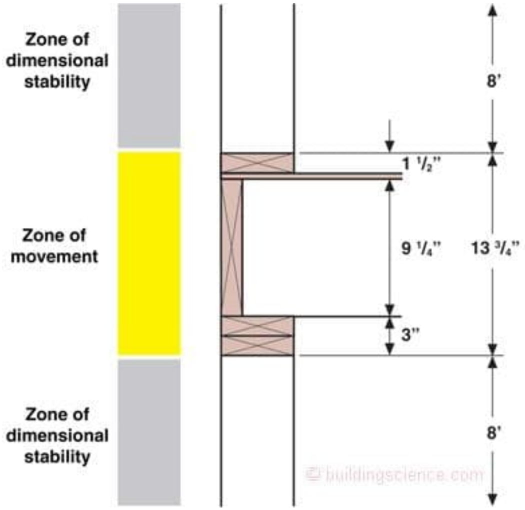
Building From the Ground Up: Special Topics

Shrinkage occurs primarily in horizontal wood dimensional lumber members such as wall plates and floor joists.

Building From the Ground Up: Special Topics

Zone of movement

Shrinkage occurs primarily in horizontal members such as wall plates and floor joists.



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Quick Summary

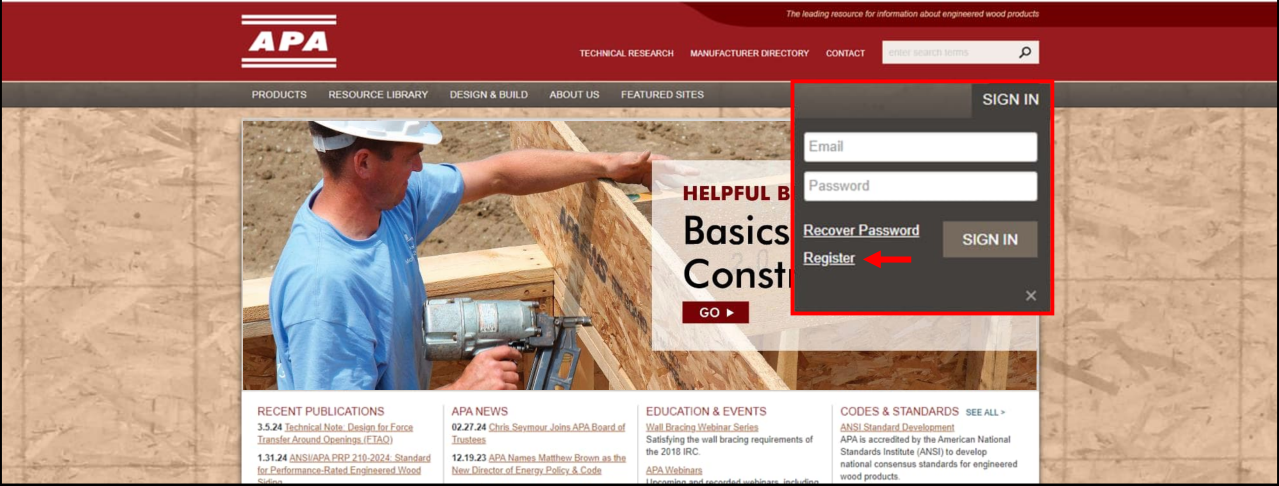
Simple basics make a big difference:

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

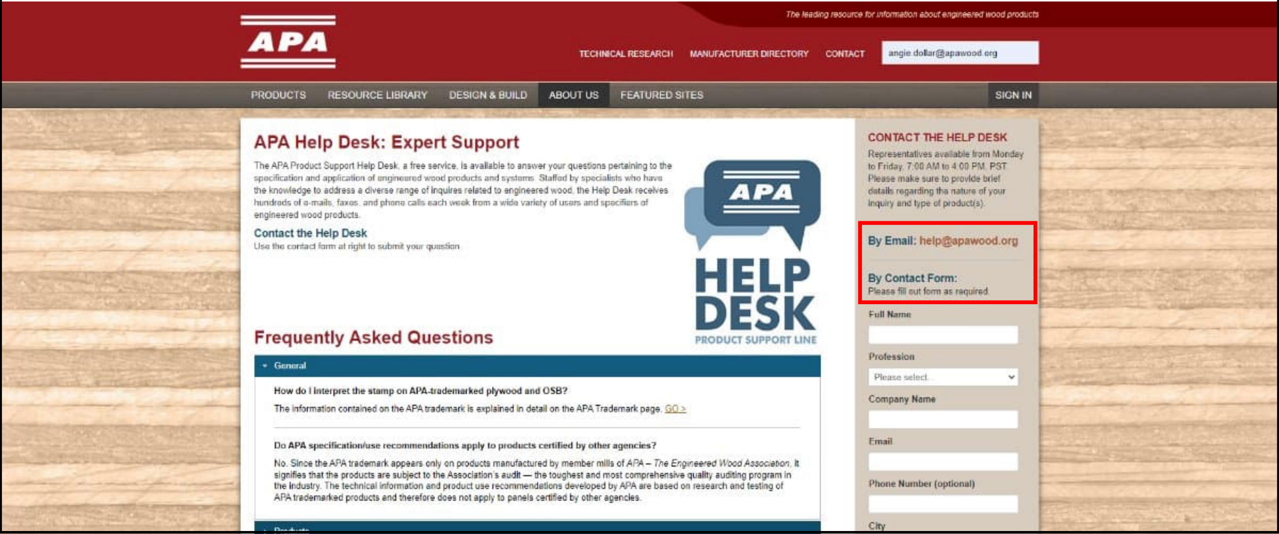
Assistance is available from APA

APA Update Newsletter

(www.apawood.org)



Help Desk



The leading resource for information about engineered wood products

APA

TECHNICAL RESEARCH MANUFACTURER DIRECTORY CONTACT angie.dollar@apawood.org

PRODUCTS RESOURCE LIBRARY DESIGN & BUILD ABOUT US FEATURED SITES SIGN IN

APA Help Desk: Expert Support

The APA Product Support Help Desk, a free service, is available to answer your questions pertaining to the specification and application of engineered wood products and systems. Staffed by specialists who have the knowledge to address a diverse range of inquires related to engineered wood, the Help Desk receives hundreds of e-mails, faxes, and phone calls each week from a wide variety of users and specifiers of engineered wood products.

Contact the Help Desk

Use the contact form at right to submit your question.

APA HELP DESK PRODUCT SUPPORT LINE

Frequently Asked Questions

General

How do I interpret the stamp on APA-trademarked plywood and OSB?

The information contained on the APA trademark is explained in detail on the APA Trademark page. GO >

Do APA specification/use recommendations apply to products certified by other agencies?

No. Since the APA trademark appears only on products manufactured by member mills of *APA – The Engineered Wood Association*, it signifies that the products are subject to the Association's audit — the toughest and most comprehensive quality auditing program in the industry. The technical information and product use recommendations developed by APA are based on research and testing of APA trademarked products and therefore does not apply to panels certified by other agencies.

Products

CONTACT THE HELP DESK

Representatives available from Monday to Friday, 7:00 AM to 4:00 PM, PST. Please make sure to provide brief details regarding the nature of your inquiry and type of product(s).

By Email: help@apawood.org

By Contact Form:
Please fill out form as required.

Full Name

Profession
Please select...

Company Name

Email

Phone Number (optional)

City

Questions? Ask us anything.

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Please take our survey!

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