

APA

Frame it Right!
Back to Basics for Big Buildings



Presented by Warren Hamrick



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


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Webinar Attendee Survey



Warren Hamrick



[https://www.apawood.org/
Frame-it-right-survey](https://www.apawood.org/Frame-it-right-survey)



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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.




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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.



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Agenda

- Why is training needed?
- Building from the ground up
 - Wood Strength
 - Walls
 - Floors
 - Roofs
 - Special Topics
- Q&A

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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



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Wood has a stronger direction

Load parallel to grain




Stronger

Load perpendicular to grain



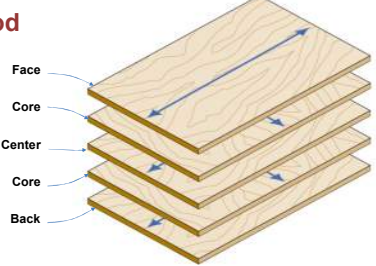

Weaker



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Wood's Strength Direction

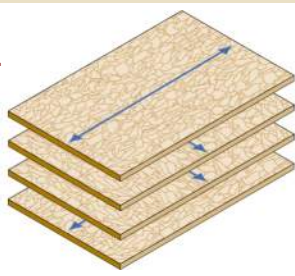
Plywood

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Structural Panels

OSB layers are engineered for strength.



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Manufacturing Standards




PS 1: Voluntary Product Standard
PRESCRIPTIVE Standard (revised 2020)

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

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APA Stamp in the Field



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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

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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

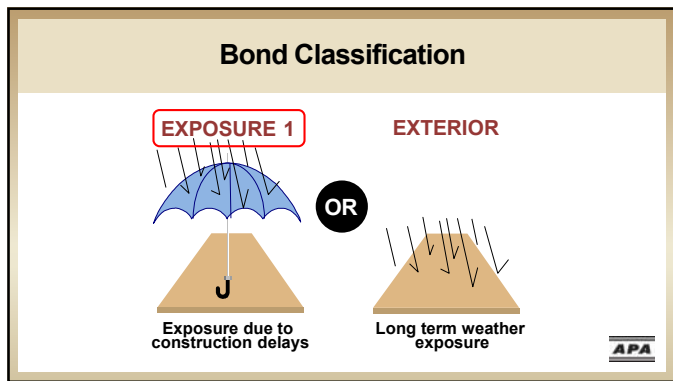
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Building From the Ground Up: Special Topics

OR

Bond Classification

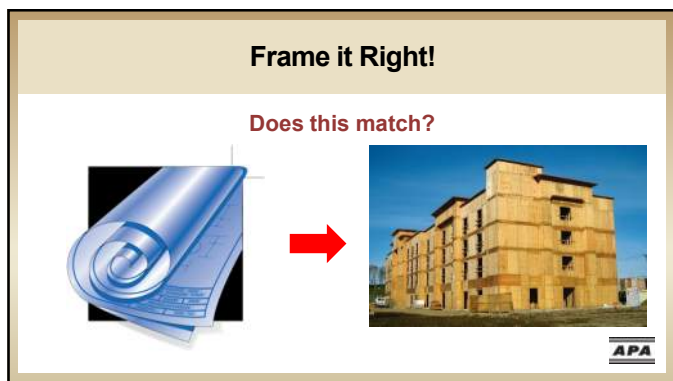
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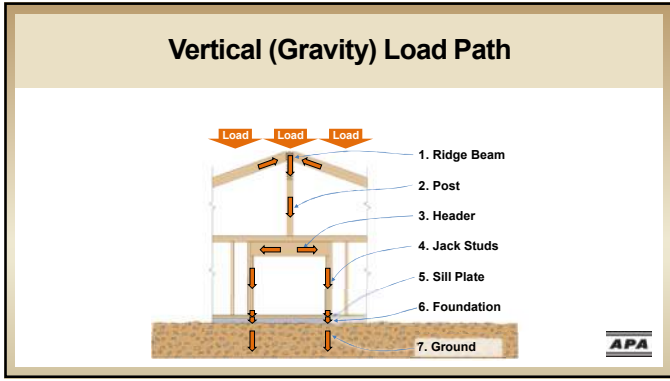
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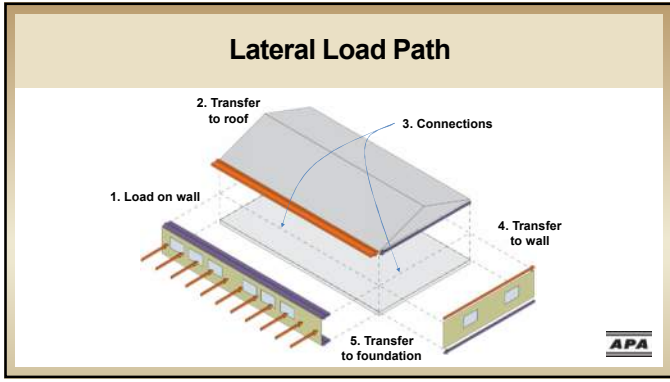
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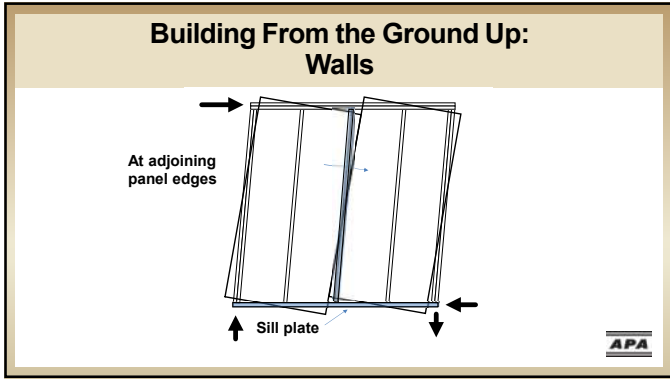
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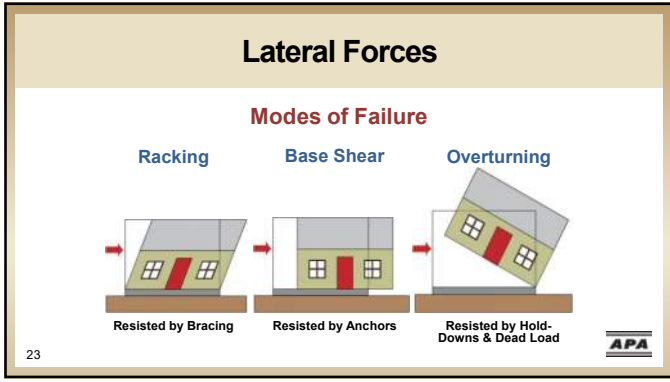
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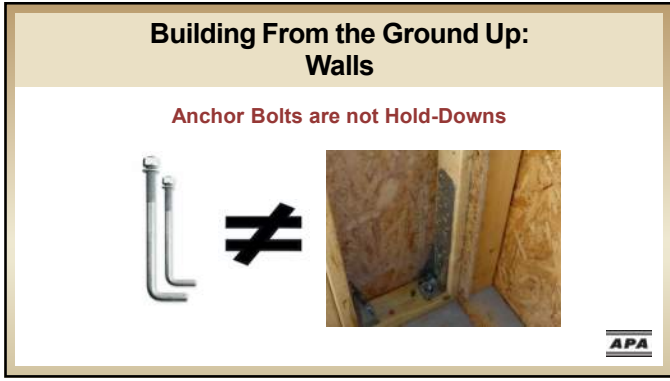
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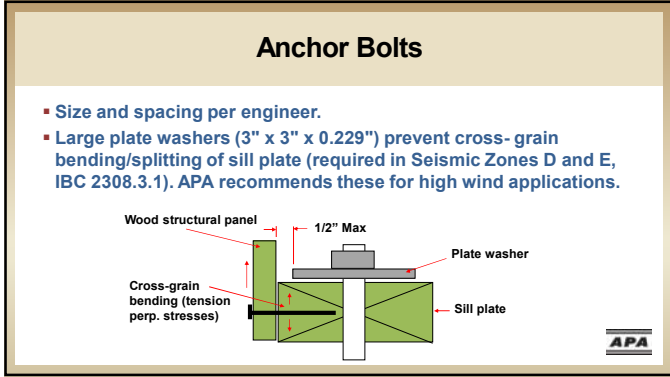
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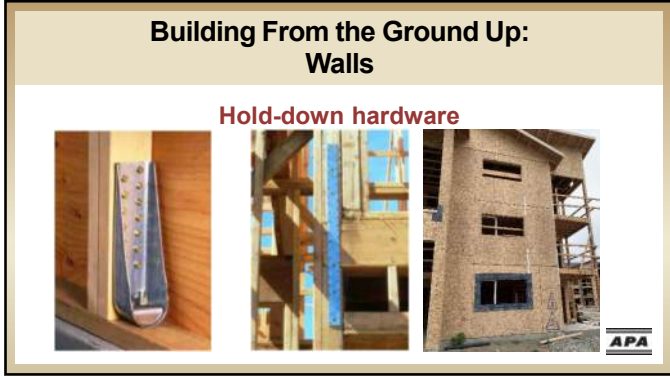
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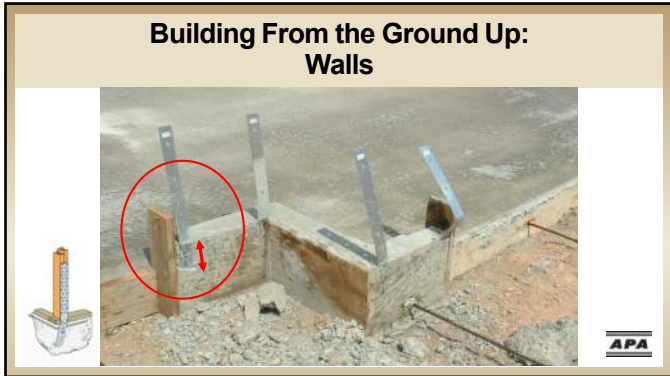
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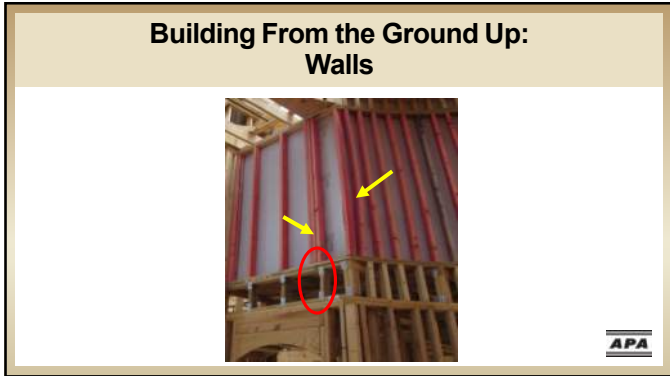
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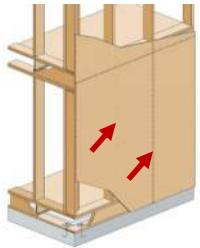



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Building From the Ground Up: Walls

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.



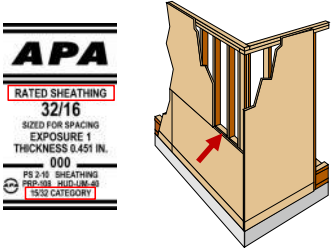



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Building From the Ground Up: Walls

Wall sheathing

- Plywood or OSB
- Orientation




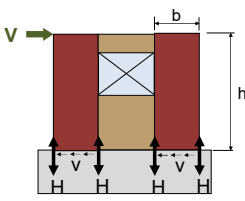



Resource: APA Technical Topics: Plywood or OSB? Used as Intended, the Two Products are Interchangeable, Form TT-047

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Segmented Shear Walls




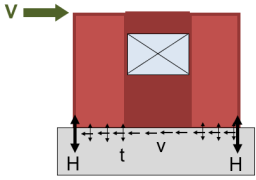




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Perforated Shear Walls




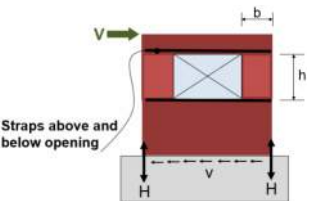


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Force Transfer Around Openings (FTAO) Shear Walls





Straps above and below opening

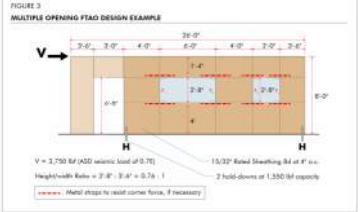
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FTAO Technical Note, Form T555

- Provides a design example for FTAO wall with two window openings
- FTAO Calculator: Companion to Technical Note www.apawood.org/ftao

FIGURE 2
MULTIPLE OPENING FTAO DESIGN EXAMPLE




$V = 3,750 \text{ lb}$ (ADD seismic load of 0.75)
 Height/width Ratio = $2.8' : 3.4' = 0.76 < 1$
 1-1/2" x 1/2" Bolts Spacing 8d at 4" o.c.
 2 hold-downs at 1,500 lb capacity
 Metal straps to resist corner forces, if necessary

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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**




APA Force Transfer Around Openings Calculator

This calculator is an Excel-based tool for professional designers. It uses FTAO methodology to calculate maximum hold-down force for girth members, the required horizontal strap force for the window above door and below openings, the maximum shear force for sheathing attachment, and the maximum deflection of the wall system. The calculator includes worksheets for shear walls with one, two, and three openings and a design example.


Download

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High Load Shear Walls



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Rated Sheathing versus **Structural I**



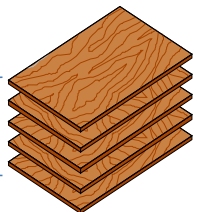
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Structural I Panels

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



Group 1 Species





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Building From the Ground Up: Walls

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

Framing
Wood Structural Panel
Nail
1/8" Gap Between Panels

Nailing not staggered Nailing staggered

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Staggered Fastening

Splitting occurs parallel to grain

Staggering

Splitting will not occur perpendicular to grain, no matter how close nails are

Staggering a line of nails parallel to wood grain minimizes splitting

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Floor to floor load transfer options

Using Wood Structural Panels for Combined Uplift and Shear Resistance

APA System Report
Design for Combined Shear and Uplift from Wind

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**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



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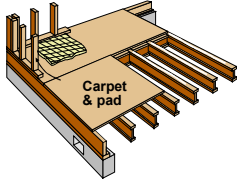

**Building From the Ground Up:
Floors**




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**Building From the Ground Up:
Floors**

- **Sturd-I-Floor**
 - Combined subfloor & underlayment
 - Resistant to concentrated & impact loads
 - Plywood or OSB

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RATED STURD-I-FLOOR
20 oc
 SIZED FOR SPACING
 1 & 6" NET WIDTH 41-5/2"
 EXPOSURE 1
 THICKNESS 0.578 IN.
 000
 PS 2-99 SINGLE FLOOR
 PRO-SM MEDIUM-LE
 TRUSS CATEGORY 1

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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

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Building From the Ground Up: Floors

Strength Axis

Arrow optional on the panel

48"

Common

Arrow required on the panel

48"

Not Common

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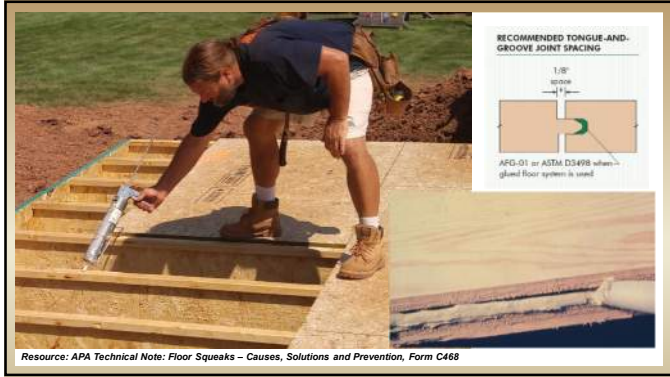
Building From the Ground Up: Floors

- **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**

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

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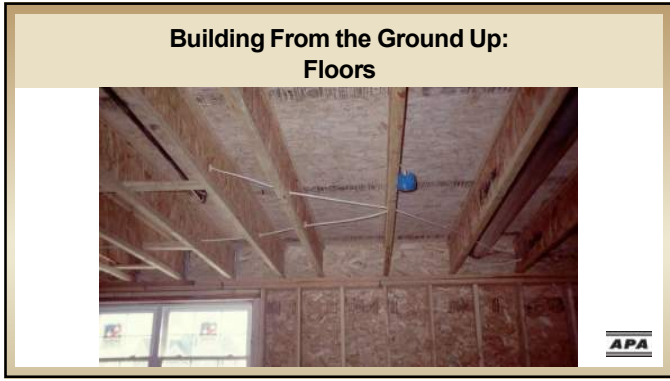
Overdriven Nails

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

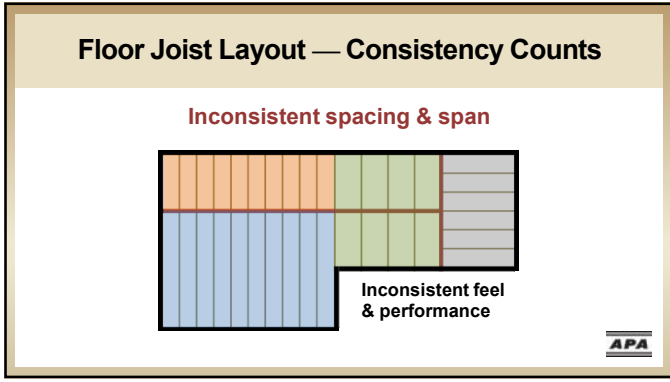
Overdriven Fasteners	Overdriven Distance	Action
≤ 20% Perimeter	< 1/8"	None
> 20% Perimeter	> 1/16"	Add 1 nail for every 2 overdriven
Any	> 1/8"	



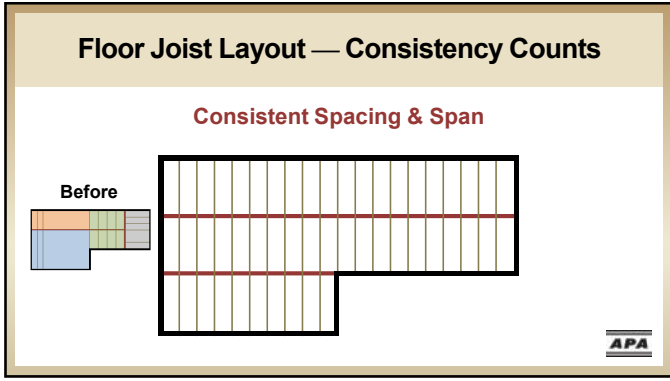
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Use Wood's Strength Direction

- **I-joist**
 - Used for floor & roof framing
 - Long lengths available

Flange (LVL or lumber)

Web (OSB)

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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

I-joist

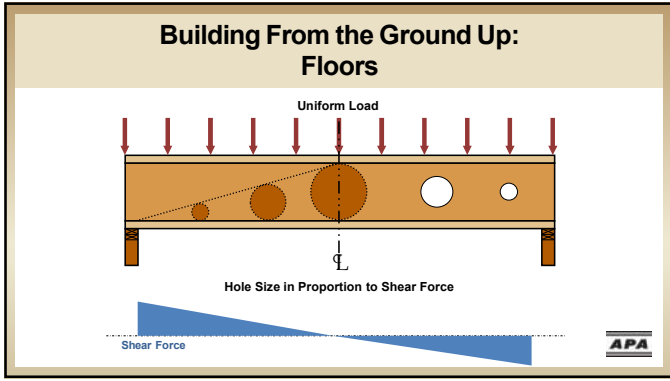
Lumber

VS.

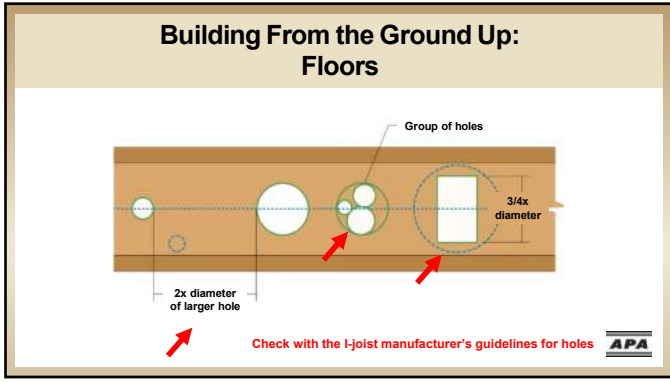
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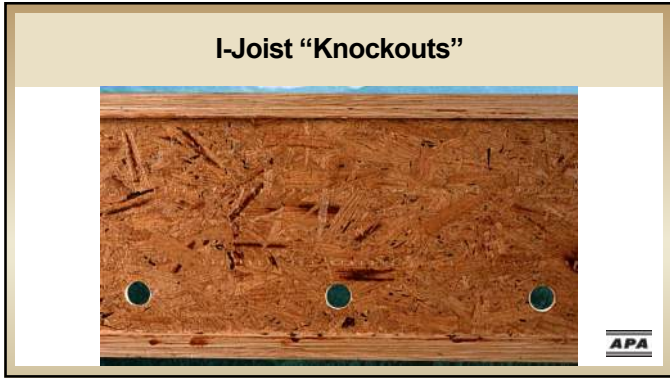
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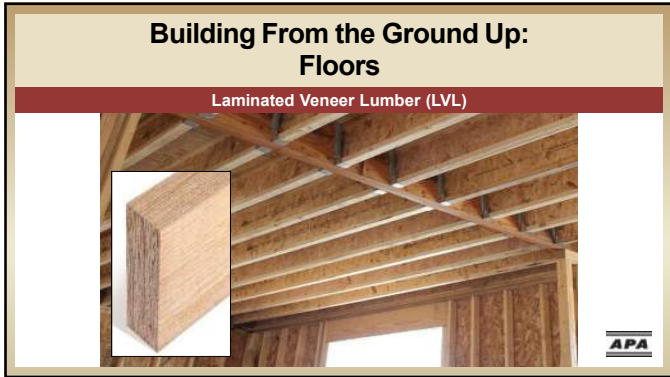
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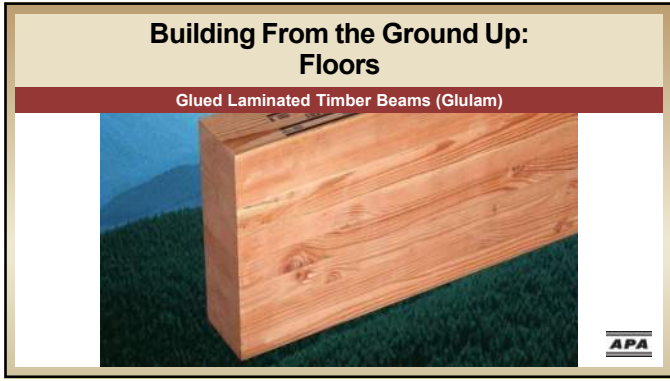
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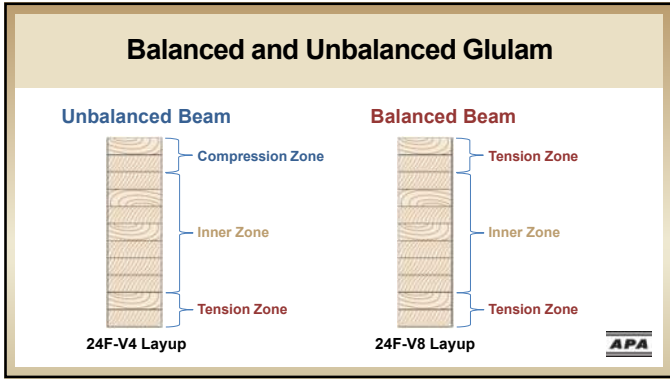
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**Building From the Ground Up:
Floors**

**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

■ Zones where horizontal holes are permitted for passage of wires, conduits, etc.

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**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

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**Building From the Ground Up:
Floors**

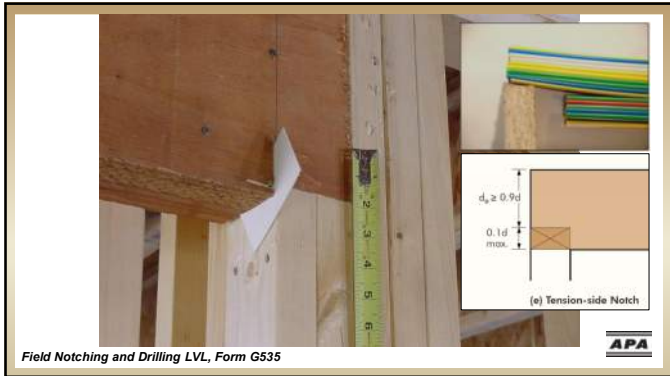
**APA Tech Notes: Effect of Large Diameter Horizontal Holes on
Properties of LVL and Glulam Beams, Forms V900 and V700**

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

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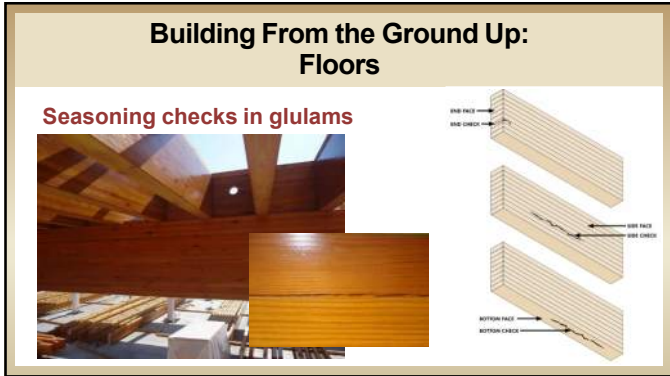
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Wood Properties

EVALUATION OF CHECK SIZE IN GLUED LAMINATED TIMBER BEAMS

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

IS MY CHECK OK?

Is the span of the glulam beam greater than 10 times the depth?
Example: Depth is 12" span is greater than 120

Where do the checks appear?

TOP FACE
Is the check parallel to the grain of wood?

SIDE FACE
Is the depth of the check less than one-third the width of the beam, and is the length less than one-third the length of the beam?

END FACE
Is the length of the check in split less than one-half the depth of the member?


YES
NO

If all checks are on one side of the glulam beam, no additional engineering analysis is required. These recommendations apply to both vertical split beams and vertical split beams under-end-grain beams.
If checks in glulam extend from one end of the beam, a full analysis of the effect of the checks is required. CONSULT DESIGN PROFESSIONAL.

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Building From the Ground Up: Roof

- Rated Sheathing**
 - Floor, wall or roof
 - Plywood or OSB



Roof Covering

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RATED SHEATHING

32/16

SIZED FOR SPACING
EXPOSURE 1
THICKNESS 0.451 IN.

000

PS 2-15 SHEATHING
PROD. 1001 16(1) (1) (1)
S33 CATEGORY

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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 SHEATHINGS* AND APA RATED STUDED-I-FLOOR WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS*		[Minimum] [Maximum Span (in.)]		[Nominal Live Load (psf)]							
Panel Span Rating	Panel Performance Category	With Support	Without Edge Support	Spacing of Supports Center-to-Center (in.)							
				12	14	20	24	32	40	48	60
APA RATED SHEATHING*											
12/0	3/8	12	12	30							
14/0	3/8	16	14	70	30						
20/0	3/8	19.2	19.2	120	50	30					
24/0	3/8	24	19.2*	190	100	60	30				
24/16	3/16	24	24	190	100	60	30				
32/16	1/2	32	28	300	150	110	60	30			
40/20	19/32	40	32	—	275	195	120	60	30		
48/24	25/32	48	34	—	270	175	95	45	30		
60/27	7/8	60	40	—	—	300	145	100	70	35	
60/48	1-1/8	60	48	—	—	—	305	145	100	70	35

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Building From the Ground Up: Roof

APA Engineered Wood Construction Guide, Form E30, Table 37


Panel Grade	Panel Performance Category	Span Spacing	Maximum Span ^b		Level of Maximum Span ^c	
			Span	Span ^d	Level	Span
APA STRUCTURAL RATED SHEATHING	7/16	24/16	24	13	25	
	15/32, 1/2	32/16	24	30 ^e	40 ^f	
	19/32, 5/8	40/20	24	30 ^e	40 ^f	
APA RATED SHEATHING	15/32, 1/4	48/24	24	10 ^g	11 ^h	
	19/32, 1/4	24/16	16	10 ^g	45	
	19/32, 5/16	32/16	24 ^e	40 ^f	50 ⁱ	
	22/32, 1/4	48/24	24	7 ^g	8 ^h	

a. For gable-end or overhanging roofs, contact manufacturer instructions for acceptable loads.
b. Recessed edge supports.
c. Solid blocking recommended at panel ends for 24-inch spans.
d. For 4-ply plywood, reduce load by 10 psf.
e. For 4-ply plywood, reduce load by 10 psf.
f. For 4-ply plywood, reduce load by 45 psf.
g. For 4-ply plywood, reduce load by 5 psf.
h. For 4-ply plywood, reduce load by 15 psf.




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Building From the Ground Up: Roof





Top plates



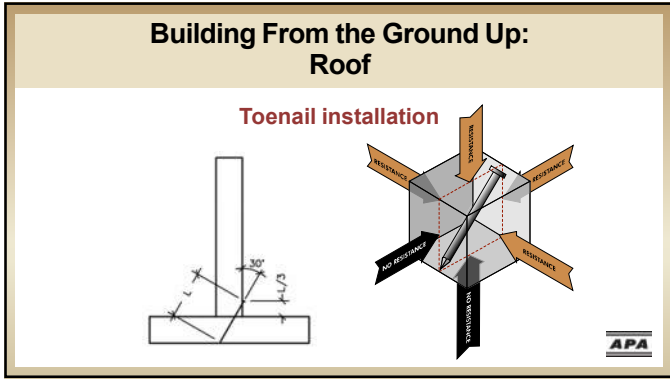
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Building From the Ground Up: Roof

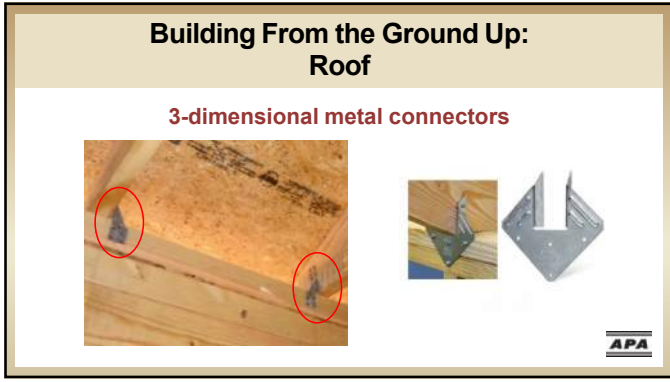
Top Plate Connection

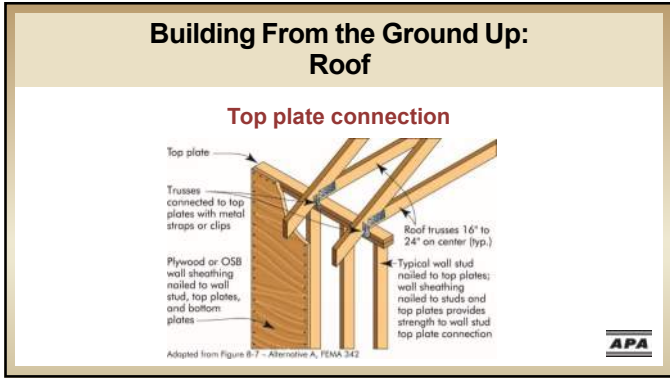
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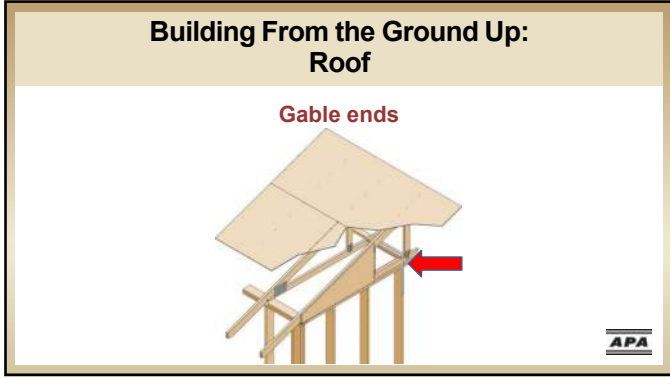
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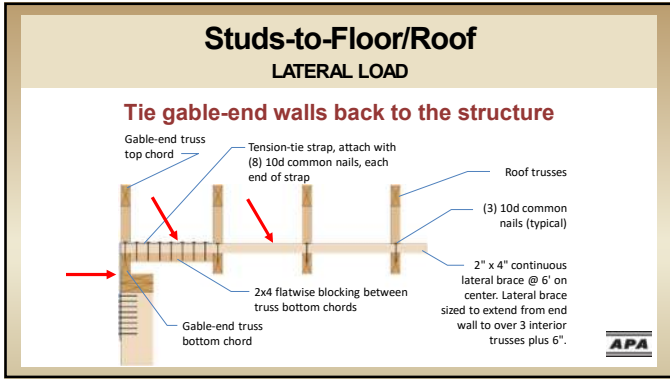
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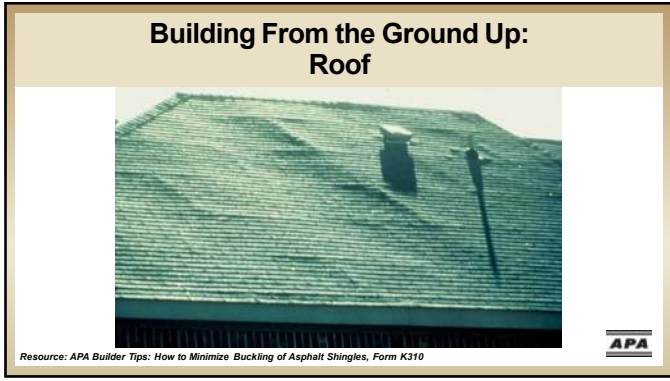
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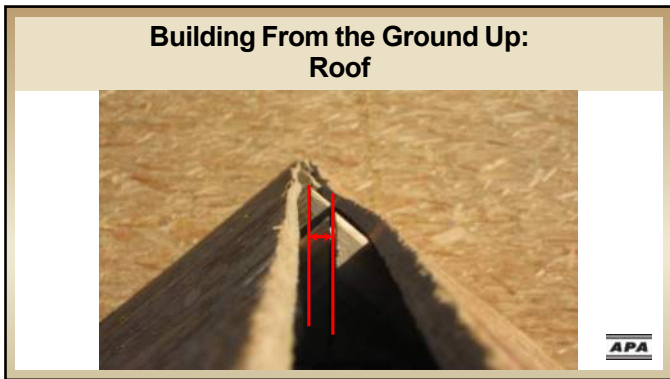
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APA Technical Note: Panel Edge Support for Narrow Width Roof Sheathing, Form R275

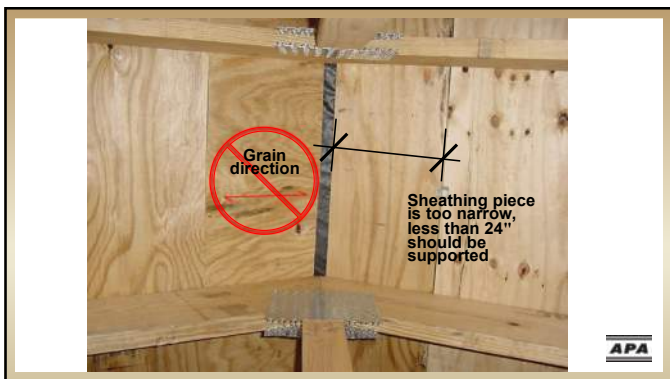
Narrow Roof Sheathing

- 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)

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

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**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**

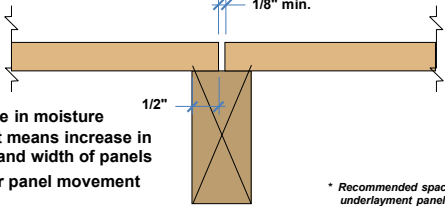



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**Building From the Ground Up:
Special Topics**

Installation Recommendations*

Space all panels 1/8"




1. Increase in moisture content means increase in length and width of panels

2. Plan for panel movement

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

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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 performance, grade, growth or natural characteristics are often misperceived as performance issues when they are merely variance and have no impact on panel performance. A guide of terms associated with panel performance follows.

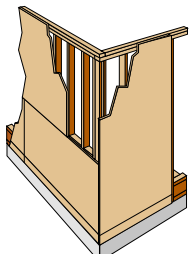



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Building From the Ground Up: Special Topics

Grade and clearance

- Did we make the grade?
 - How's the slope? 6" in first 10'
 - Do we have ground to frame minimums?
 - Is there a capillary break?
 - What's the finish detail?

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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?




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Building From the Ground Up: Special Topics

Use Flashing

Flashing keeps the panel from contacting the concrete.

SHEAR WALL HOLD-DOWN ANCHOR

Shear wall overturning moments may be transferred by a fabricated steel bracket such as this. Regular foundation bolts may be all that is required in some cases depending on engineering analysis.

Labels in diagram:
 APA RATED SHEATHING or APA RATED SIDING 303
 Studs
 Fasteners to framing, size as required
 Hold-down anchor
 Bolt to foundation
 Concrete foundation
 Flashing to separate siding from concrete

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Building From the Ground Up: Special Topics

Allow for panel expansion

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

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Building From the Ground Up: Special Topics

Allow for panel expansion

L (after expansion) = 96.125"

L = 96" h = 2.12"

L (after expansion) = 48.125"

L = 48" h = 1.5"

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**Building From the Ground Up:
Special Topics**

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

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**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...

**Minimizing Buckling of
Wood Structural Panels**
Date: 04/01/14
September 2012
APA Technical Note D481

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

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**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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**Building From the Ground Up:
Special Topics**

Attic spaces require adequate ventilation

- **Provide adequate moisture control both during and after construction**
- **Ventilate attics and roof structural spaces per requirements of International Building Code (IBC) Section 1203.2**



Mold from Improper Ventilation



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Building From the Ground Up: Special Topics

Panel Expansion of large structures

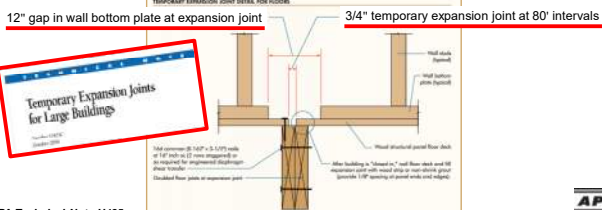
- Panel expansion may accumulate through the framing of large, continuous floor or roof decks
- Provide temporary expansion joints to minimize displacement when building plan dimension exceeds 80'



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Building From the Ground Up: Special Topics

Provisions for large structures



APA Technical Note U425

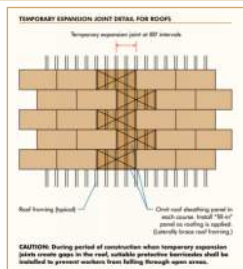


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Building From the Ground Up: Special Topics

Provisions for large structures

- Roofs
- 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



CAUTION: During period of construction when temporary expansion joints create gaps in the roof, suitable protective barricades shall be installed to prevent workers from falling through open areas.



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**Building From the Ground Up:
Special Topics**



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




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**Building From the Ground Up:
Special Topics**

Moisture Changes In Wood
Causes greatest dimensional changes perpendicular to grain





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**Building From the Ground Up:
Special Topics**

Wood shrinkage

- Wood mostly shrinks *perpendicular* to grain.
(Shrinkage parallel to grain is approximately 1/40 of the shrinkage perpendicular to grain and can be neglected.)
- The amount of shrinkage (or expansion) in wood is directly proportional to the *change* in moisture content.
- The higher the moisture content at time of construction, the more shrinkage that can occur in the structure as the structure dries out/acclimates.
- Wood shrinkage must be accounted for in structures > than 2 stories.



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**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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**Building From the Ground Up:
Special Topics**

Tips:

- ✓ Keep materials dry, 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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Construction Fire Prevention

**CONSTRUCTION FIRE
SAFETY COALITION**

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Mission



CONSTRUCTION FIRE SAFETY COALITION

The Construction Fire Safety Coalition mission:
To educate public and private sector organizations on how to reduce the frequency and severity of fires during construction.

constructionfiresafety.org 

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Stakeholders

- **Charter members:**
 - American Wood Council
 - International Code Council
 - National Fire Sprinkler Association
 - National Association of Home Builders
- **Partners:**
 - APA – The Engineered Wood Association
 - Over 75 Fire departments, 50+ building departments




constructionfiresafety.org

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Construction Fire Safety Best Practices

- **5 Steps to Follow**
 - Step 1: Identify the Risks and Hazards
 - Step 2: Determine Who is at Risk
 - Step 3: Evaluate and Protect
 - Step 4: Record, Plan and Train
 - Step 5: Review, Review, Review
- **Complete 90-min training at constructionfiresafety.org**




constructionfiresafety.org 

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Step 1: Identify the risk and hazards

- **What are your fire starters:**
 - **Heat**
 - Naked flames
 - Sparks and arcs
 - Smoking habits
 - Malfunctioning electrical equipment
 - Friction generated from equipment
 - **Fuel**
 - Flammable liquids
 - Paper, cardboard, trash and debris
 - Finely divided fuels such as shavings, sawdust, kindling
 - **Oxygen**
 - Natural airflow
 - High wind weather conditions



constructionfiresafety.org


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Step 2: Determine Who is at Risk

- **Make a checklist**
 - Where are the tradesmen and steel workers located in the building?
 - Can they evacuate safely?
 - What factors place them in danger?
 - Flame
 - Smoke
 - Potential for structural collapse?
- **Example checklists at constructionfiresafety.org**





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Step 3: Evaluate and Protect

- **Implement fire safe strategies:**
 - Reduce the risk of fire occurring
 - **Remove/reduce:**
 - Sources of ignition
 - Availability of fine fuel (sawdust, paper, cardboard)
 - Excess oxygen
 - Address risks to people working above you
 - Be prepared to implement general fire precautions



constructionfiresafety.org


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Step 4: Record, Plan and Train

- **Record**
 - Findings and actions
- **Plan**
 - Is the risk reduced/removed?
 - Are my records accurate for the situation?
 - *Example plans available at constructionfiresafety.org*
- **Train**
 - Workers on the emergency plan
 - Workers in overall strategies



constructionfiresafety.org



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Step 5: Review, Review, Review

- **During a project the fire safety plan will change, review:**
 - Progression of building construction
 - Change in labor force
 - Introduction of new hazardous substances
 - Change in the quantities and types of materials
 - *Construction site conditions change hourly and daily.*



constructionfiresafety.org



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5 STEPS TO FOLLOW

Step 1: Identify the Risks and Hazards

Step 2: Determine Who is at Risk

Step 3: Evaluate and Protect

Step 4: Record, Plan and Train

Step 5: Review, Review, Review

constructionfiresafety.org




Preventing construction fires is everyone's business.

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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



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Questions?






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APA Update Newsletter
(www.apawood.org)

November 2020

APAUPDATE
PUBLICATIONS, VIDEOS, CAD DETAILS AND MORE

Note: Due to Covid-19 control measures, we are unable to fulfil orders of printed publications at this time. These publications are available as downloadable PDFs.

EDUCATION

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On-Demand Webinars

20 recorded webinars offer credits. Topics include framing for residential and commercial construction, applications of engineered wood products, wall bracing, disaster-resistant design, sustainability of wood and more.

BROWSE

Wood University
Two courses, Engineered Wood Basics and Design of Wood Connections, offer up to 10 units through AIA or ASCE.





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