Frame It Right!
Engineered Wood use in Big Buildings

Presented by Larry Oenning, PE
November 15, 2023

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Introduction

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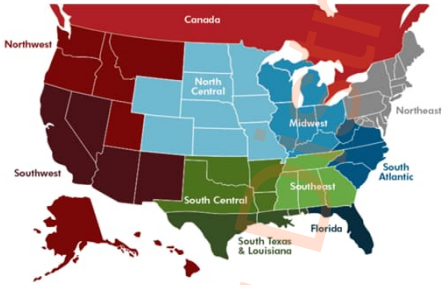

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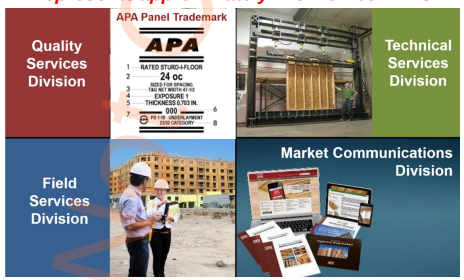
Who is APA – The Engineered Wood Association?

APA represents approximately 175 member mills in 23 states and seven provinces.



- Voice of industry
- Mark of quality
- Technical support
- Free education
- Research
- Non-profit trade association
- HQ in Tacoma, WA
- www.apawood.org

The leading resource for information about engineered wood products.

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Agenda

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

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Engineered Wood Products (EWP)

WARNING ACRONYMS AHEAD

- ✓ Plywood
- ✓ OSB – Oriented Strand Board
- ✓ I-joists
- ✓ Glulams – Glued Laminated Lumber
- ✓ LVL – Laminated Veneer Lumber
- ✓ LSL – Laminated Strand Lumber
- ✓ OSL – Oriented Strand Lumber
- ✓ CLT – Cross Laminated Timber

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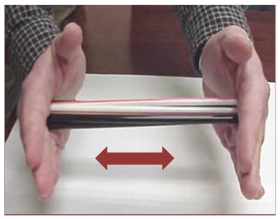
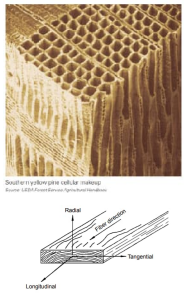
Wood as a Building Material

Wood has a strong and weak direction

Load parallel to grain



Stronger



Load perpendicular to grain

Weaker

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Mechanical Properties of Wood

Compression

- **Parallel—studs, columns, posts**
  Perpendicular—sill plate

Tension

- **Parallel—beams, panels**
- **Perpendicular—connections**

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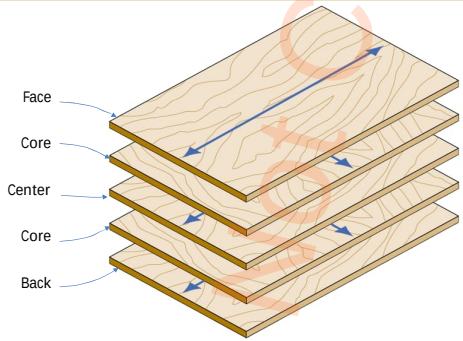
Wood's Strength Direction



Plywood

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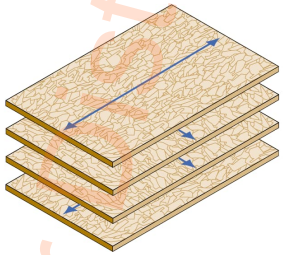
Wood's Strength Direction

OSB flakes are engineered for strength.



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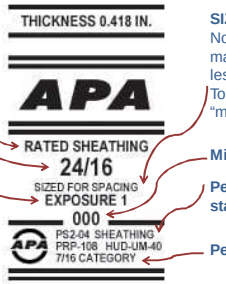
APA Panel Certification Marks



APA panel grade

Span Rating

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

SIZED FOR SPACING
Notation indicating panels may manuf. to length & width less than standard size. Tolerance is +/- 1/16" of "manufactured size"

Mill number

Performance-rated panel standard

Performance Category

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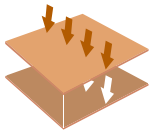
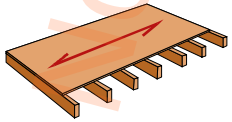
Panel Strength



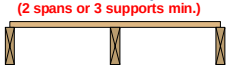
Roof Span L/240
30 PSF live
10 PSF dead

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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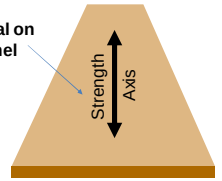
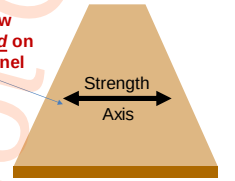
Panel Strength

Strength Axis

Arrow optional on the panel



Arrow *required* on the panel



48" 48"

Common Not Common

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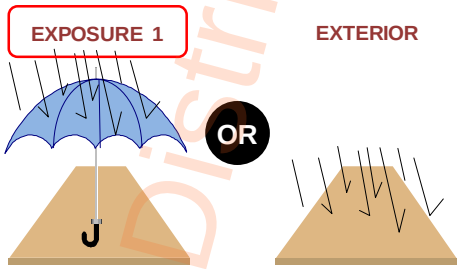
Bond Classification



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APA Stamp in the Field

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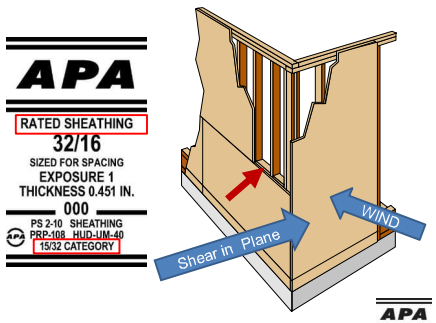
Walls

Wall sheathing

- "Wood Structural Panels"
- Plywood or OSB
- Racking/shear resistance
- Wind pressure resistance
- Square
- Nonstructural benefits
- Orientation



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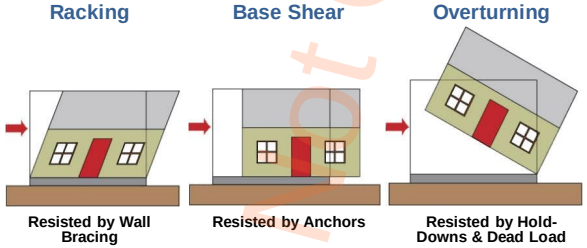
Lateral Forces

Modes of Failure



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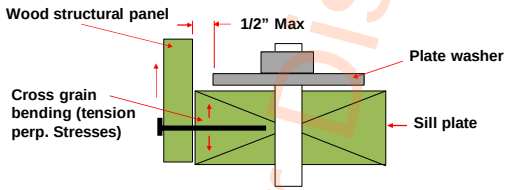
Anchor Bolts

- Size and spacing per engineer
- Large plate washers (3”x3”x0.229”) prevent cross grain bending-splitting of sill plate (Required in Seismic Zones D and E, IBC 2308.3.1)
- APA recommends for High Wind Applications



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Walls and Load Path

Hold-down hardware

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Shear Wall Design

Special Design Provisions for Wind & Seismic (SDPWS), provides designers three acceptable methods for designing wood shear walls to resist lateral forces.

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Engineered Shear Wall Design

- Engineered Design
  - Segmented
  - Perforated
  - Force Transfer Around Openings (FTAO)

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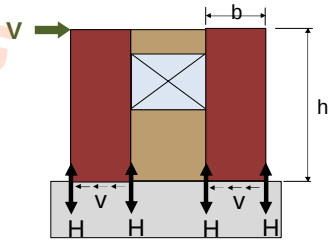
Segmented Shear Walls



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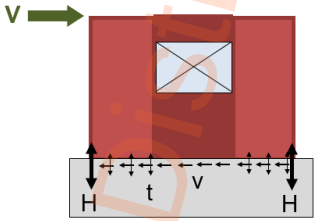
Perforated Shear Walls

Continuously sheathed walls



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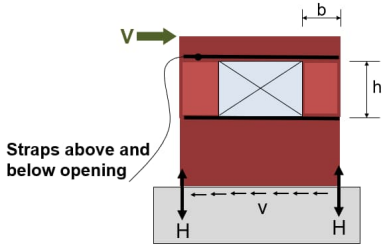
Force Transfer Around Openings (FTAO) Shear Walls

Continuously sheathed walls



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FTAO

Continuously sheathed walls

Force Transfer Around Openings

- Window Flange
- Length of strap
- Blocking in interior - flatwise
- Strap interior/exterior
- APA FTAO Calculator
- APA T555 - FTAO Publication

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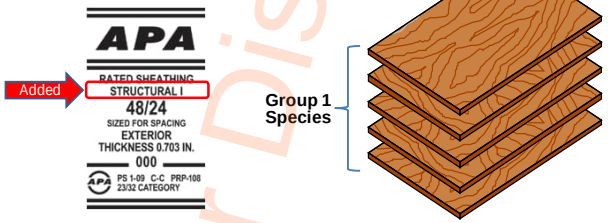
Structural I Panels

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



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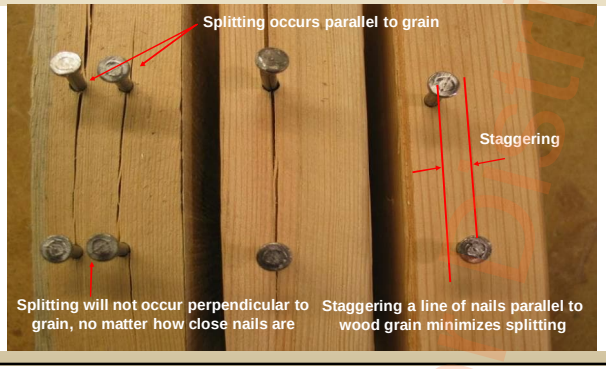
Staggered Fastening



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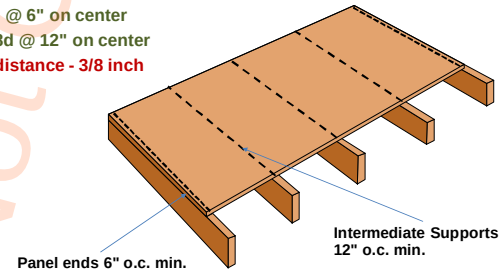
Floors

- IBC Minimum Nailing
  - Panel ends - 8d @ 6" on center
  - Intermediate – 8d @ 12" on center
  - Fastener edge distance - 3/8 inch



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Q300 - Builder Tips:
Construct a Solid, Squeak-Free Floor System

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Fully Fasten with Clamping Force

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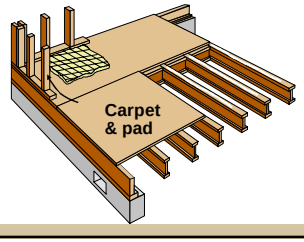
Floors

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



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Overdriven Fasteners

Nail installation

- Overdriving reduces performance
- APA recommends – add one for every two overdriven

APA TT-012 - Effect of Overdriven Fasteners on Shear Capacity publication

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Overdriven Nails

Refer to APA publication TT-012
to maintain shear capacity:

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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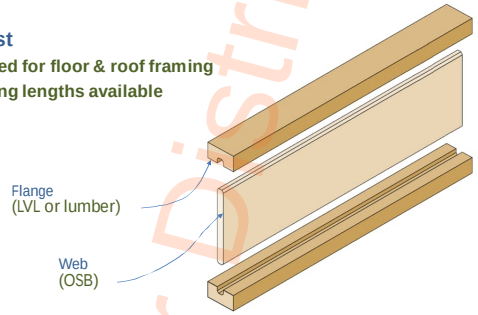
Use Wood's Strength Direction

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



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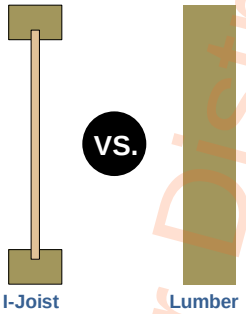
Sustainability

- 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



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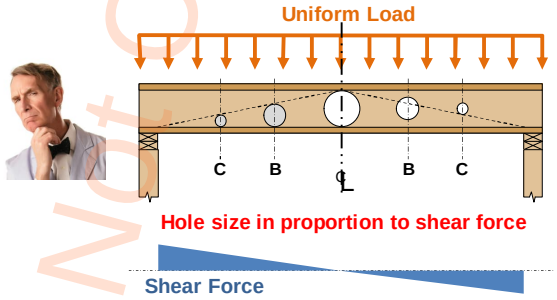
Cutting Holes in I-Joists

Before cutting any holes, refer to the I-joist manufacturer's guidelines.



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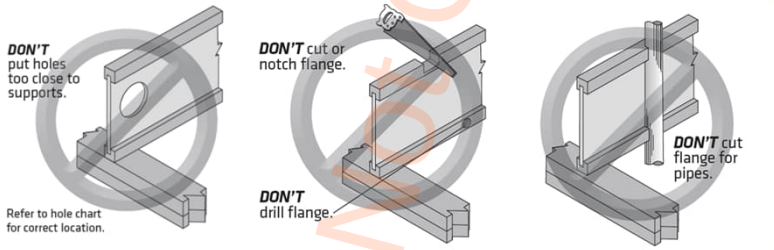
NO!



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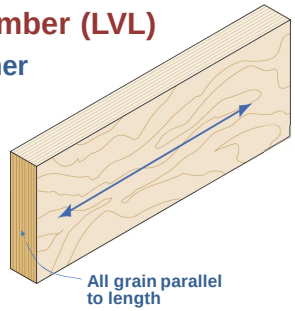
Structural Composite Lumber

Laminated Veneer Lumber (LVL)

- Veneers bonded together
- Common uses
  - Beams
  - Headers
  - Rafters
  - Tall Wall studs
  - Stringer



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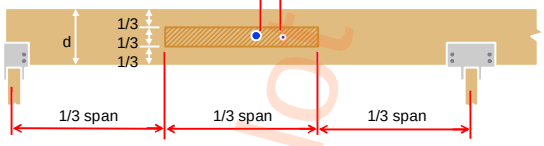
Floors

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 the I-joist Manufacturer's guidelines for holes

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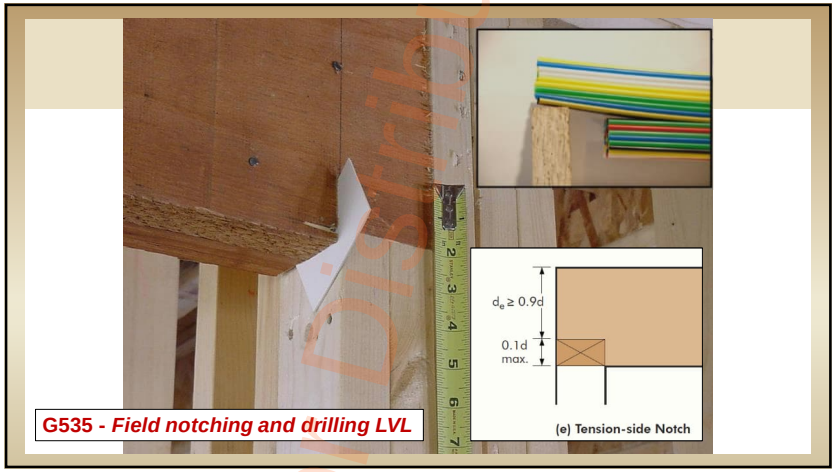

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Floors

Laminated Strand Lumber (LSL)

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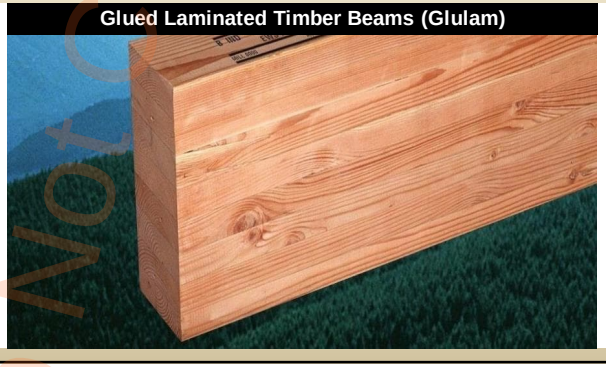
Floors

Glued Laminated Timber Beams (Glulam)



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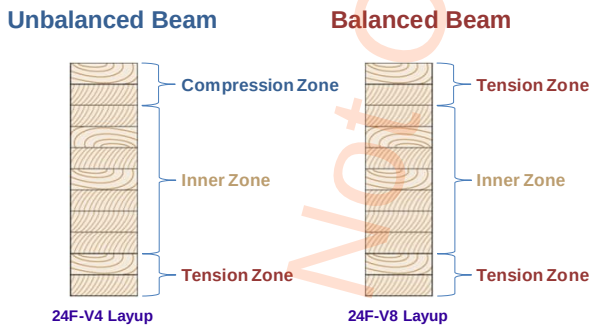
Balanced and Unbalanced Glulam



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Caution when using Unbalanced Glulams

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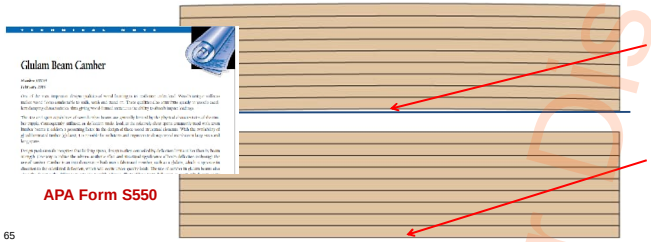
Glulam Product Basics

Stock Beams – Camber is not an issue

Camber in stock beams is usually zero or based on a 3500' or 5000' radius where a 20' beam has a curvature of 1/8" or less



APA Form S550

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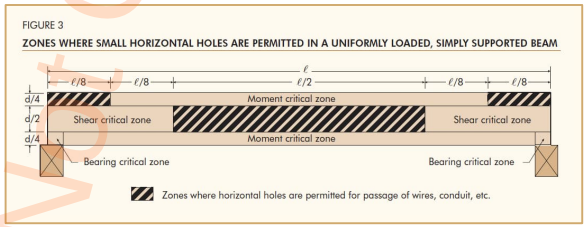
Floors

Field notching and drilling glulam (APA Form S560)



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Large Holes

Large Diameter Holes in LVL and Glulam Beams (APA Forms V900, V700)

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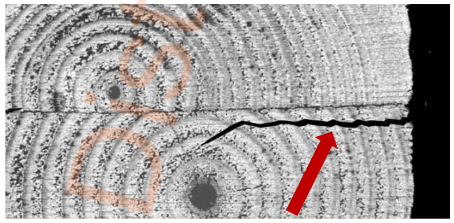
Season Checks in Glulams

Seasoning Checks

Uneven surfaces with torn wood fiber



APA Owners Guide to Understanding Checks in Glued Laminated Timber – Form F450

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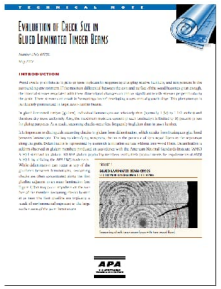
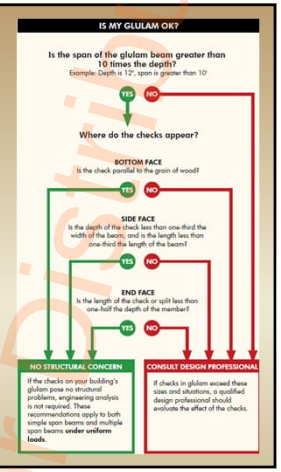
Wood Properties



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*, APA Form F450



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

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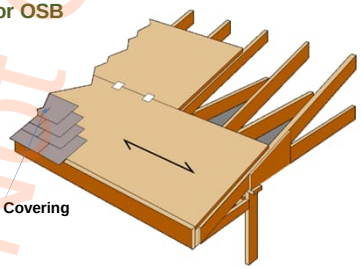
Roof

- **Rated Sheathing**
  - Plywood or OSB



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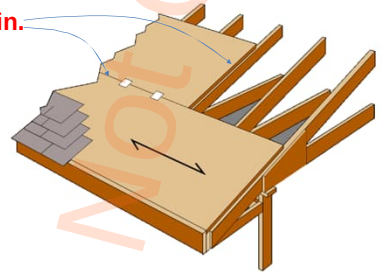
Special Topics

Allow for panel expansion

Space panels 1/8" min.

(ends & edges)



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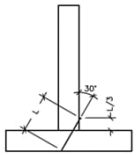
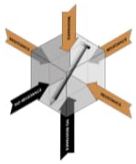
Roof

Top Plate Connection





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Roof

3-dimensional metal connectors

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Roof

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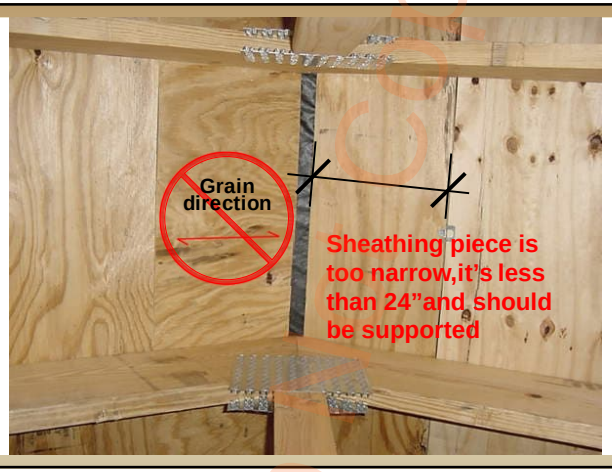

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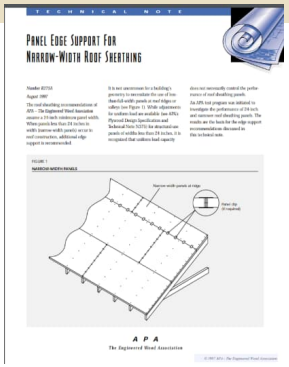
Narrow Width Roof Sheathing
Form R275

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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Special Topics

Special topics

- On-site moisture management
- Wood shrinkage

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Prevent Moisture Intrusion
Drying of Subfloor

Fans

Dehumidification

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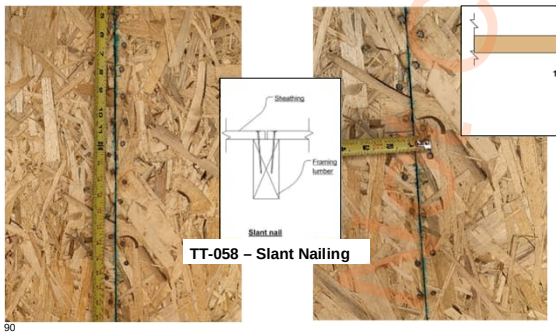
Proper spacing



TT-058 – Slant Nailing

1/8”
10d box nail
3/8”

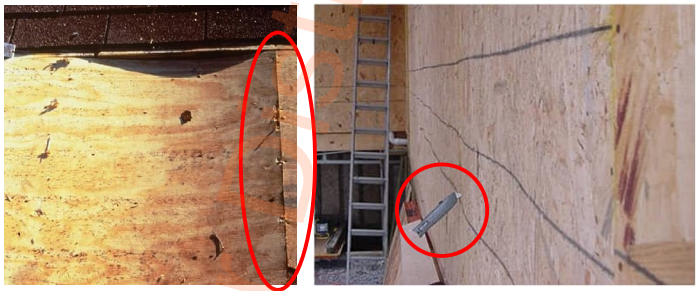
M300 – Builder Tip

90

90

Special Topics

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



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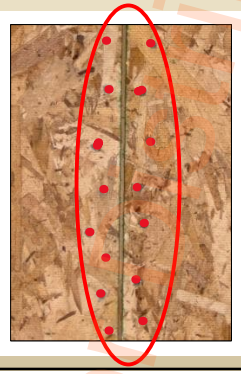
Special Topics



Nailing approx. 3" oc

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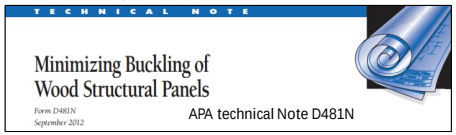
Special Topics

Buckling - High Risk Applications:

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



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

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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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APA Form F505 – Q & A

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.

Questions include:

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

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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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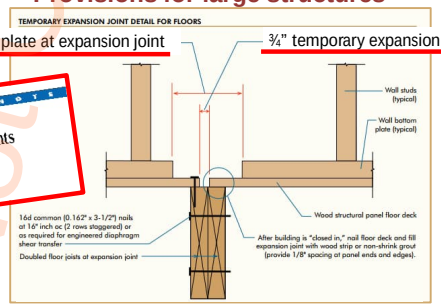
Special Topics

Provisions for large structures

12" gap in wall bottom plate at expansion joint

¾" temporary expansion joint at 80' intervals



APA Technical note U425

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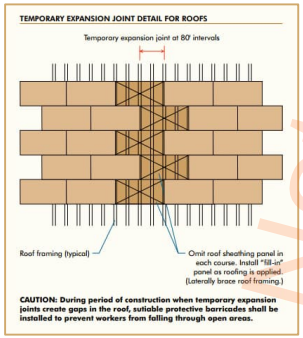
Special Topics



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

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Special Topics

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

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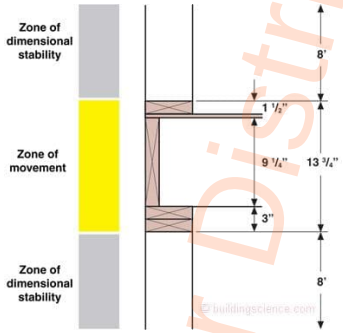
Special Topics

Zone of movement

- Shrinkage occurs primarily in horizontal members such as wall plates and floor joists.
- WoodWorks paper, ***Accommodating Shrinkage in Multi-Story Wood-Frame Structures***



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Quick Summary

- **Simple steps make a big difference:**
  - Follow plans and specifications
  - Space panels
  - Follow fastening guidelines
  - Check load paths/stacking
  - Control moisture

Assistance is available from APA

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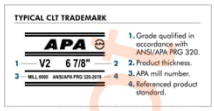
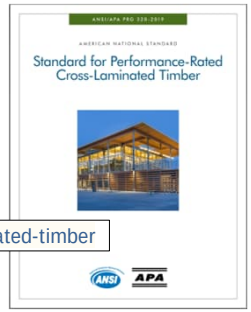
APA CLT Resources

APA Form S500



www.apawood.org/cross-laminated-timber



APA Form PRG 320

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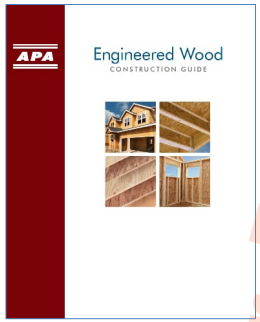
APA Resources



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Thank You!

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