Frame It Right!
Engineered Wood use in Big Buildings

Presented by Larry Oenning, PE
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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.

Introduction

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Agenda

- Why is training needed?
- Building from the ground up
  - Woods Strength
  - Walls
  - Floors
  - Roofs
  - Special topics
- Q&A
Engineered Wood Products (EWP)

- 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

Wood as a Building Material

Wood has a strong and weak direction

Load parallel to grain

Load perpendicular to grain

Stronger

Weaker

Mechanical Properties of Wood

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

Tension
- Parallel—beams, panels
- Perpendicular—connections

Wood's Strength Direction

Plywood

Face

Core

Center

Core

Back
Wood’s Strength Direction

OSB flakes are engineered for strength.

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 be manufactured to length & width less than standard size.
Tolerance is ±1/16" of "manufactured size"

Mill number
Performance-rated panel standard
Performance Category

Panel Strength

Roof Span L/240
30 PSF live
10 PSF dead
Floor Span L/360
100 PSF live
10 PSF dead

Continuous Span (2 spans or 3 supports min.)
No simple spans
Strength axis perpendicular to supports

Arrow optional on the panel
48" Common

Strength Axis

Arrow required on the panel
48" Not Common

Strength Axis
**Bond Classification**

- **EXPOSURE 1**
  - Exposure due to construction delays
- **EXTERIOR**
  - Long term weather exposure

**APA Stamp in the Field**

- WALL
- ROOF
- FLOOR

**Walls**

- **Wall sheathing**
  - “Wood Structural Panels”
  - Plywood or OSB
  - Racking/shear resistance
  - Wind pressure resistance
  - Square
  - Nonstructural benefits
  - Orientation

**Lateral Forces**

- **Modes of Failure**
  - Racking
  - Base Shear
  - Overturning
  - Resisted by Wall Bracing
  - Resisted by Anchors
  - Resisted by Hold-Downs & Dead Load
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

Walls and Load Path

Hold-down hardware

Shear Wall Design

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

Engineered Shear Wall Design

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

Perforated Shear Walls

Force Transfer Around Openings (FTAO) Shear Walls

FTAO

- Window Flange
- Length of strap
- Blocking in interior - flatwise
- Strap interior/exterior
- APA FTAO Calculator
- APA T555 - FTAO Publication
### Structural I Panels
- Increased shear capacity
- Increased stiffness, especially across the panel
- Plywood & available in OSB (performance tested)
- Before specifying, check local availability

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

### Staggered Fastening
- Splitting will not occur perpendicular to grain, no matter how close nails are
- Staggering a line of nails parallel to wood grain minimizes splitting

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

- **Composite action**
- Panel ends 6" o.c. min.
- Intermediate Supports 12" o.c. min.
**Fully Fasten with Clamping Force**

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

**Carpet & pad**

**Overdriven Fasteners**

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

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

- **Overdriven Fasteners**
  - Overdriven Distance
  - Action

<table>
<thead>
<tr>
<th>Overdriven Fasteners</th>
<th>Overdriven Distance</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 20% Perimeter</td>
<td>&lt; 1/8”</td>
<td>None</td>
</tr>
<tr>
<td>&gt; 20% Perimeter</td>
<td>&gt; 1/16”</td>
<td>Add 1 nail for every 2 overdriven</td>
</tr>
<tr>
<td>Any</td>
<td>&gt; 1/8”</td>
<td></td>
</tr>
</tbody>
</table>
Use Wood's Strength Direction

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

Flange (LVL or lumber)

Web (OSB)

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

Cutting Holes in I-Joists

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

Uniform Load

Hole size in proportion to shear force

Shear Force

NO!

- DON'T put holes too close to supports.
- DON'T cut or notch flange.
- DON'T drill flange for pipes.
Laminated Veneer Lumber (LVL)
- Veneers bonded together
- Common uses
  - Beams
  - Headers
  - Rafters
  - Tall Wall studs
  - Stringer

Structural Composite Lumber

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
Grounds:

- **G535 - Field notching and drilling LVL**

Floors:

- **Laminated Strand Lumber (LSL)**
  - Tension Zone
  - Inner Zone
  - Tension Zone

Balanced and Unbalanced Glulam:

- **Glued Laminated Timber Beams (Glulam)**

Unbalanced Beam:

- Compression Zone
- Inner Zone
- Tension Zone

Balanced Beam:

- Compression Zone
- Inner Zone
- Tension Zone

Laminate 24F-V8 Layup

APA - WoodWorks Event

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Caution when using Unbalanced Glulams

- 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.

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.

Floors

- Field notching and drilling glulam (APA Form S560)

Large Holes

- Large Diameter Holes in LVL and Glulam Beams (APA Forms V900, V700)
Season Checks in Glulams

Seasoning Checks
Uneven surfaces with torn wood fiber

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

Roof

Rated Sheathing
• Plywood or OSB

Special Topics

Allow for panel expansion
Space panels 1/8" min. (ends & edges)
Top Plate Connection

3-dimensional metal connectors

Sheathing piece is too narrow, it’s less than 24” and should be supported
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)

Special Topics

- On-site moisture management
- Wood shrinkage

Prevent Moisture Intrusion
Drying of Subfloor

- Fans
- Dehumidification

Proper spacing

1/8"
10d box nail
3/8"

M300 – Builder Tip
What can happen if panels aren’t allowed to acclimate?

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...

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
Questions include:
- Delamination
- Buckling
- Checking
- Warping
- Grade
- Swelling
- Flaking
- Applications
- Siding substrate

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’

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

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

APA CLT Resources

www.apawood.org/cross-laminated-timber
APA Resources

APA Engineered Wood Construction Guide (E30)

- The “go to” APA publication
- Free download
- $12 to buy hard copy
- www.apawood.org/publication

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Thank You!