Description

This course is an introduction to the ever-growing family of traditional and engineered wood products (EWP). Products covered are lumber, glued-laminated timber (glulam), cross-laminated timber, structural composite lumber, wood I-joists, and wood structural panels. The standards that form the basis for the manufacture and development of design stresses for each product are discussed as well as design provisions included in AWC’s *National Design Specification (NDS) for Wood Construction*. Unique characteristics for each product are highlighted and extensive examples of the use of these products in a wide range of building applications are presented.

Learning Objectives

- Be familiar with the ever-growing family of engineered wood products (EWP’s) and their unique characteristics, including: lumber, glued-laminated timber (glulam), cross laminated timber (CLT), structural composite lumber, wood I-joists, plywood, oriented strand board.
- Be familiar with the standards that form the basis for the manufacture, development of design stresses, and design procedures for each product.
- Be knowledgeable about the use of these products through examples of a wide range of building applications.
- Be familiar with the resources that are available to obtain more information.
Palette of Wood Framing Members Available

Wood Framing Members

| Structural Panels | Repetitive Framing | Beams/Girders | Wall Studs | Mass Timber |

Copyright © 2015 American Wood Council. All rights reserved.
NDS 2012 Chapters

1. General Requirements for Building Design
2. Design Values for Structural Members
3. Design Provisions and Equations
4. Sawn Lumber
5. Structural Glued Laminated Timber
6. Round Timber Poles and Piles
7. Prefabricated Wood I-Joists
8. Structural Composite Lumber
9. Wood Structural Panels
10. Mechanical Connections
11. Dowel-Type Fasteners
12. Split Ring and Shear Plate Connectors
13. Timber Rivets
14. Shear Walls and Diaphragms
15. Special Loading Conditions
16. Fire Design of Wood Members

SDPWS 2008 Chapters

- General Design Requirements
- Members and Connections
- Lateral Force-Resisting Systems
  - Diaphragms
  - Shear Walls
## Wood Framing Members

<table>
<thead>
<tr>
<th>Structural Panels</th>
<th>Repetitive Framing</th>
<th>Beams/Girders</th>
<th>Wall Studs</th>
<th>Mass Timber</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Structural Panels" /></td>
<td><img src="image2" alt="Repetitive Framing" /></td>
<td><img src="image3" alt="Beams/Girders" /></td>
<td><img src="image4" alt="Wall Studs" /></td>
<td><img src="image5" alt="Mass Timber" /></td>
</tr>
</tbody>
</table>

CHECK LOCAL AVAILABILITY

- [www.sfpa.org](http://www.sfpa.org) #200
- [www.wwpa.org](http://www.wwpa.org) Model #A
- [www.apawood.org](http://www.apawood.org) APA Form E30U
Wood Structural Panels

Wood Parallel to Grain

Parallel

Stronger

Perpendicular

Less strong
Plywood Layup

FACE
CORE
CENTER
CORE
BACK

Structural Panels Manufacturing
Oriented Strand Board (OSB)
OSB layers are engineered for strength.
Manufacturing Standards

H860  J350  S350
Grade Stamping

APA RATED SHEATHING
A-P Structual | RATED SHEATHING
Typical Trademark

APA RATED
STURD-I-FLOOR
Typical Trademark

APA Trademark
Panel Grade
Span Rating
Manf. Standard
Bond Classification
Dimensional Thickness
Performance Category
Span Rating Design Criteria

Roof Span: L/240
- 30 PSF live
- 10 PSF dead

Floor Span: L/360
- 100 PSF live
- 10 PSF dead

Span Rating Conditions

Strength axis perpendicular to supports

Continuous across 2 or more spans
Correct Panel Spacing

- Panel clip or tongue-and-groove edges if required
- SHEATHING
  - 1/8" spacing
- Asphalt or wood shingles or shakes. (refer to manufacturer's recommendations)
- Protect edges of Exposure 1 panels, or use Exterior panel starter strip
- Stagger ends (optional)

Veneer Grade of Sheathing

A Smooth, paintable. Not more than 18 neatly made repairs.

B Solid surface. Repairs, and tight knots to 1 inch.

C-Plugged
- Improved C veneer. Knotholes or other open defects limited to 1/4 x 1/2 inch.

C Tight knots to 1-1/2 inch. Knotholes to 1 inch across grain. Occasional 1-1/2-inch knothole.

D Knots and knotholes to 2-1/2 inch. Occasional 3-inch knothole.
Bond Classifications

RATED SHEATHING
32/16
SIZED FOR SPACING
EXTERIOR
THICKNESS 0.451 IN.
000
PS 1-09  C-C  PRP-108
15/32 CATEGORY

RATED SHEATHING
32/16
SIZED FOR SPACING
EXPOSURE 1
THICKNESS 0.451 IN.
000
PS 1-09  C-D  PRP-108
15/32 CATEGORY

Bond Classifications

EXTERIOR

EXPOSURE 1
Exposure Durability Levels

Exposure 1
- Waterproof glue
- Permit D-grade veneer (plywood)

Exterior
- Waterproof glue
- Minimum C-grade veneer (plywood)

CDX does NOT mean Exterior grade!!!
Roof Sheathing Application – HUGE Warehouses

- 40% of US Imports flow through California ports
- Ports are Bottlenecks
- Consolidated warehousing gaining favor
- 1 Million square foot warehouses are becoming common place

Slide provided by John Lawson, S.E., Kramer and Lawson
Panelized Roof

- Pre-assemble large sections on the ground

2-3 people
4-5 minutes to assembly
Lift into position with high lift capacity forklifts
Fasten into place

Wall Sheathing

1/8" spacing
Filler strip if required
SHEATHING
8" minimum clearance
**Typical Sizes**

- **Floor sheathing** - 19/32, 5/8, 23/32, 3/4, 1, and 1-1/8 inch thick.
- **Plywood** –
  - 4 x 8 foot panels
  - 4 x 10, 5 x 10, 4 x 12 and 5 x 12 feet western mills
  - 10 and 12 foot panels few
  - Larger panels can be produced by joining two panels together with structural scarf or finger joints.
- **OSB** –
  - 4 x 8 foot panels
  - Most manufacturers make oversized panels up to 8 x 24 feet, which are typically used for panelized roof systems or modular floors.

---

**Wood Framing Members**

- **Structural Panels**
- **Repetitive Framing**
- **Beams/Girders**
- **Wall Studs**
- **Mass Timber**

- **Rafters, Joist, I-Joist**
Solid Sawn Lumber

Rafters and Joists
• Readily available
• 2x4 to 2x12 (sometimes 2x14
• 8’ to 20’ lengths (2’ increments)
• < 16’ spans are the most cost effective solution

NOTE: check local availability

Products Association

• Rules writing/ Quality Services
• Economic Services
• Lumber Grading
• Technical Support
• Information Services
• Product Support Services
Visual Stress-Graded Lumber

• Dimension Lumber evaluated by certified lumber graders
  • Visually examine each piece
  • Assigned grade based on visual characteristics
  • Each grade denotes design strength and stiffness value
  • Based on ASTM D1990
  • +90% of lumber is visually graded.

Grade Stamps

GRADE MARKS:
  a) Certification mark
  b) Mill Identification
  c) Grade designation
  d) Species identification
  e) Condition of seasoning

BASIC INFORMATION FROM STAMP:
  1. Who made it
  2. How strong is it

  SPF®
  WEST WOODS
  WEST CDR

MC-15 - 15% max. MC
KD-15
S-DRY - 19% max. MC
KD
S-GRN - over 19% MC (unseasoned)
Machine Graded Lumber

Machine Stress-Rated Lumber (MSR)
- Machine Non-destructively evaluates stiffness

Machine Evaluated Lumber (MEL)
- Machine Non-destructively evaluates density
- Both MSR & MEL
  - Strength - Bending Stiffness
  - Stiffness - Sorts by Modulus of Elasticity

Machine Grade Lumber - MSR and MEL

- Machine Stress Lumber
- Grading machinery induces slight stresses to measure stiffness.
Machine Stress-Rated Lumber (MSR)

GRADE STAMP
• Product Designation – MSR, MACHINED RATED
• Registered Trademark of Grading Agency
• Mill Number or Name
• Moisture Content
• Species Fb and E rating
• When additional control process are implemented Ft, SG, Fc_{perp} and Fv

Machine Evaluated Lumber (MEL)

GRADE STAMP
• Product Designation – MEL, MACHINE RATED
• Registered Trademark of Grading Agency
• Mill Number or Name
• Moisture Content
• Species Fb and E rating
• When additional control process are implemented Ft, SG, Fc_{perp} and Fv
Solid Sawn - Availability

- US and Canadian Wood Species
- In the Western U.S. Douglas Fir, Larch, Hem Fir, and Spruce Pine-Fir are commonly available.
- In the Eastern U.S. Southern Pine

Excerpt from American Wood Council’s NDS Supplement

American Wood Council

American Wood Council

American Wood Council

I-Joist

Floor Framing

Roof Framing
I-Joist:
- Commonly used for floor and roof framing
- Long lengths readily available

Flange Widths:
- 1-1/2" to 3-1/2"

Common Depths:
- 9-1/2"
- 11-7/8"
- 14"
- 16"
- 18"
- 20" - 32"

Sprinklers may be required
Concealed spaces > 160 ft³

Flange:
- Lumber
- LVL

Web:
- OSB
- Plywood

I-Joist:
- Long floor spans approx. 60'
- Design flexibility
I-Joist

Adaptability to skewed, curved, radiuses plans

Holes in Web

Uniform Load

Hole Size in Proportion to Shear Force

1/8" clear T & B

APA Form No. EWS D710
I-Joist Holes

Limit: 3 holes maximum per span

Group of holes

2x dia of larger hole

3/4x dia

APA Form
No. EWS
D710

Knockouts

Copyright © 2015 American Wood Council. All rights reserved.
I-Joist

APA Form D710

Performance Rated I-Joist
Roof Framing Details

APA Form Z725

Performance Rated I-Joists

Wood Framing Members

- Structural Panels
- Repetitive Framing
- Beams/Girders
- Wall Studs
- Mass Timber

Copyright © 2015 American Wood Council.
All rights reserved.
Solid Sawn Timber– Beams

• Readily available
• Western species 4x, 6x and 8x (possibly 20x)
• Southern Pine 2x (built-up)
• 8’ to 20’ lengths (2’ increments)

NOTE: check local availability

Solid Sawn Lumber

Beams and Timbers
• Readily available
• Western species 4x, 6x and 8x (possibly 20x)
• Southern Pine 2x (built-up)
• 8’ to 20’ lengths (2’ increments)

NOTE: check local availability
Structural Composite Lumber (SCL):
- The wood grain of veneers or strands is primarily oriented in the same direction.
- Strong when either face- or edge-loaded.
- Milled (sawn) to consistent sizes.

Strength Properties
- APA publishes strength properties for its members on a proprietary basis.
- See manufacturer
Laminated Veneer Lumber (LVL):  
- Produced by bonding thin veneers together  
- Used for beams, headers, rafters & scaffold planking

Common Thicknesses:  
- 1-3/4” to 7”

 Depths:  
- 5-1/2” – 24”  
- Up to 60’ lengths

The grain of all veneers is parallel to the long direction
SCL Product Basics

Parallel Strand Lumber (PSL):
• Manufactured from veneers clipped into long strands in a parallel formation and bonded together
• Strand length-to-thickness ratio is around 300
• Used for headers and beam as well as columns.

SCL Product Basics

Stock Widths
3-1/2”
5-1/4”
7”

Stock Depths:
9-1/2”
11-7/8”
14”
16”
18”

Standard Widths
3-1/2”
5-1/4”
7”

Standard Depths (in 2” increments)
3-1/2” width: 20” through 24”

• Lengths up to 60’ (for up to 66’ check w/local manufacturer.)
SCL Product Basics

Laminated Strand Lumber (LSL):
• Similar to PSL.
• Flaked strand length-to-thickness ratio is around 150
• Used for a variety of applications from studs to millwork components and Rim Board

SCL Product Basics

Oriented Strand Lumber (OSL):
• Similar to LSL.
• Flaked strand length-to-thickness ratio is around 75
• Used for a variety of applications from studs to millwork components
Glulam:
- Wood laminations bonded together
- Wood grain runs parallel to the length

Typical Widths:
- 3-1/8", 3-1/2, 5-1/8" and 6-3/4" (possibly 10-3/4")

Laminations:
- 1-3/8" for Southern Pine
- 1-1/2" for Douglas Fir
Glulam Manufacturing-
Appearance Classifications

- **Appearance Classifications:**
  - Framing (-L) (3-1/2”, 5-1/2”)
  - Industrial (-L)
  - Architectural
  - Premium (verify local availability)

Note: Appearance classifications do not affect design values.
Glulam Manufacturing – Camber

Camber

3500 Ft. r Western

2000 Ft. r Southern

Zero Camber

Delta = Camber (in)

L = Span (ft)

3500 Ft. Radius = Western

2000 Ft. Radius = Southern

Copyright © 2015 American Wood Council.
All rights reserved.
Glulam Manufacturing – Engineered Layups

Simple Span – Unbalanced Layup

Cantilever or Continuous Span

Copyright © 2015 American Wood Council. All rights reserved.
Cantilever or Continuous Span

TOP Stamp
Glulam Manufacturing – Decay Resistance

Alternative to Preservative Treatment:
• Alaska Yellow Cedar
• Western Red Cedar
• Port Orford Cedar

Fire Resistant

Glulam

Steel
Performance of Wood vs. Steel

Chapter 16 – Fire (ASD)

- Fire resistance up to **two hours**
  - Columns
  - Beams
  - Tension Members
  - ASD only

- Products
  - Lumber
  - Glulam
  - SCL
  - Decking

SECTION 722
CALCULATED FIRE RESISTANCE

722.1 General. The provisions of this section contain procedures by which the fire resistance of specific materials or combinations of materials is established by calculation. These procedures apply only to the information contained in this section and shall not be otherwise used. The calculated fire resistance of concrete, concrete masonry and clay masonry assemblies shall be permitted in accordance with ACI 216.1/TMS 6216. The calculated fire resistance of steel assemblies shall be permitted in accordance with Chapter 5 of ASCE 19. The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/AF&PA National Design Specification for Wood Construction (NDS).
Chapter 16 – Fire (ASD)

Technical Report No. 10

• Simplified approach
• Beams/Columns

7.22.6.3 Design of fire-resistant exposed wood members. The fire-resistance rating, in minutes, of timber beams and columns with a minimum nominal dimension of 6 inches (152 mm) is equal to:

IBC 2012 use empirical design equations

DCA 2
Design of Fire-Resistive Exposed Wood Members

* Simplified approach
* Beams/Columns
Chapter 16 – Fire (ASD)

Code Updates - Design of Fire-Resistive Exposed Wood Members

http://www.awc.org/publications/download.php

Glulam Specification

- Specification Challenges
- 50+ Glulam Bending Stress combinations tabulated in the 2012 NDS
- 51+ Glulam Axial Load combinations in the 2012 NDS
- Specification Solution
- Simplified Table of 7 stress class combinations in the 2012 NDS
### Specification

- **NDS Stress Classes**

<table>
<thead>
<tr>
<th>Stress Class</th>
<th>Fb</th>
<th>MOE</th>
<th>Fv</th>
</tr>
</thead>
<tbody>
<tr>
<td>16F-1.3E</td>
<td>1600</td>
<td>1,300,000</td>
<td>195</td>
</tr>
<tr>
<td>20F-1.5E</td>
<td>2000</td>
<td>1,500,000</td>
<td>210</td>
</tr>
<tr>
<td>24F-1.7E</td>
<td>2400</td>
<td>1,700,000</td>
<td>210</td>
</tr>
<tr>
<td>24F-1.8E</td>
<td>2400</td>
<td>1,800,000</td>
<td>265</td>
</tr>
<tr>
<td>26F-1.9E</td>
<td>2600</td>
<td>1,900,000</td>
<td>265</td>
</tr>
<tr>
<td>28F-2.1E</td>
<td>2800</td>
<td>2,100,000</td>
<td>300</td>
</tr>
<tr>
<td>30F-2.1E</td>
<td>3000</td>
<td>2,100,000</td>
<td>300</td>
</tr>
</tbody>
</table>

- **Stress Class Western Species Southern Pine**

<table>
<thead>
<tr>
<th>Stress Class</th>
<th>Western Species</th>
<th>Southern Pine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unbalanced</td>
<td>Balanced</td>
</tr>
<tr>
<td>16F-1.3E</td>
<td>16F-V1 (DF/SW)</td>
<td>16F-V2 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>16F-V2 (HF/HF)</td>
<td>16F-V3 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>16F-V3 (DF/DF)</td>
<td>16F-V4 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>16F-V4 (DF/SW)</td>
<td>16F-V5 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>16F-V6 (DF/SW)</td>
<td>16F-V7 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>16F-V7 (HF/HF)</td>
<td>16F-V8 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>16F-V8 (DF/DF)</td>
<td>16F-V9 (SP/SP)</td>
</tr>
<tr>
<td>20F-1.5E</td>
<td>20F-V1 (DF/SW)</td>
<td>20F-V2 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>20F-V2 (HF/HF)</td>
<td>20F-V3 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>20F-V3 (DF/DF)</td>
<td>20F-V4 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>20F-V4 (DF/SW)</td>
<td>20F-V5 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>20F-V5 (DF/SW)</td>
<td>20F-V6 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>20F-V6 (HF/HF)</td>
<td>20F-V7 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>20F-V7 (DF/DF)</td>
<td>20F-V8 (SP/SP)</td>
</tr>
<tr>
<td>24F-1.7E</td>
<td>24F-V1 (DF/SW)</td>
<td>24F-V2 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>24F-V2 (HF/HF)</td>
<td>24F-V3 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>24F-V3 (DF/DF)</td>
<td>24F-V4 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>24F-V4 (DF/SW)</td>
<td>24F-V5 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>24F-V5 (DF/SW)</td>
<td>24F-V6 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>24F-V6 (HF/HF)</td>
<td>24F-V7 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>24F-V7 (DF/DF)</td>
<td>24F-V8 (SP/SP)</td>
</tr>
<tr>
<td>28F-2.1E</td>
<td>28F-V1 (DF/SW)</td>
<td>28F-V2 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>28F-V2 (HF/HF)</td>
<td>28F-V3 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>28F-V3 (DF/DF)</td>
<td>28F-V4 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>28F-V4 (DF/SW)</td>
<td>28F-V5 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>28F-V5 (DF/SW)</td>
<td>28F-V6 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>28F-V6 (HF/HF)</td>
<td>28F-V7 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>28F-V7 (DF/DF)</td>
<td>28F-V8 (SP/SP)</td>
</tr>
<tr>
<td>30F-2.1E</td>
<td>30F-V1 (DF/SW)</td>
<td>30F-V2 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>30F-V2 (HF/HF)</td>
<td>30F-V3 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>30F-V3 (DF/DF)</td>
<td>30F-V4 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>30F-V4 (DF/SW)</td>
<td>30F-V5 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>30F-V5 (DF/SW)</td>
<td>30F-V6 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>30F-V6 (HF/HF)</td>
<td>30F-V7 (SP/SP)</td>
</tr>
<tr>
<td></td>
<td>30F-V7 (DF/DF)</td>
<td>30F-V8 (SP/SP)</td>
</tr>
</tbody>
</table>
Wood Framing Members

- Structural Panels
- Repetitive Framing
- Beams/Girders
- Wall Studs
- Mass Timber

Stud Walls

- For walls over 10’ prescriptive tables not applicable. Engineering is required.
- 2x4, 3x4, 2x6 & 2x8
- When wall framing exceeds 20’ in height special orders may be required.
- NDS has slenderness requirement for studs (l/d<50).
- For a load bearing
  - 2x4 L < 14'-7” ALWAYS
Finger Jointed Sawn Lumber

- Also known as end-jointed & edge-glued
- 2303.1.1 Sawn lumber - Approved end-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade.
- Note HRA for fire-resistance rating

WWPA - http://www2.wwpa.org/Portals/9/docs/PDF/FF-HRA.pdf

AWC - FAQ http://www.awc.org/helpoutreach/faq/FAQFiles/Finger-joinedLumber.html
2304.9.5 Fasteners and connectors in contact with preservative-treated and fire-retardant-treated wood.

2304.9.5.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations.

2304.9.5.4 Fasteners for fire-retardant-treated wood used in interior applications.

- Reduced design values for lumber.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SERVICE TEMPERATURE&lt;sup&gt;1&lt;/sup&gt;</th>
<th>PYRO-GUARD&lt;sup&gt;2&lt;/sup&gt;</th>
<th>ROOF FRAME CLIMATE ZONE&lt;sup&gt;3,4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SP</td>
<td>DP</td>
</tr>
<tr>
<td>Tension in bending</td>
<td>0.11</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Tension parallel to grain</td>
<td>0.65</td>
<td>0.56</td>
<td>0.63</td>
</tr>
<tr>
<td>Compression parallel to grain</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Horizontal shear</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Modulus of elasticity</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Compression perpendicular to grain</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Shear stress</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<sup>1</sup>Climate Zone definition:
<sup>2</sup>Minimum design roof live load or maximum ground snow load up to 20 psf.
<sup>3</sup>- Southwest Arizona, Southwest Nevada (Las Vegas-Yuma-Phoenix-Tucson triangle).
<sup>4</sup>- All other qualifying areas of the Continental United States.
Fire Retardant Plywood/Lumber

- Design values and span ratings are often adjusted for FRT treatment
- Information available from manufacturer’s or www.icc-es.org.

<table>
<thead>
<tr>
<th>PLYWOOD THICKNESS (inches)</th>
<th>UNTREATED ROOF/SUBFLOOR SPAN RATING</th>
<th>ROOF SHEATHING MAX LIVE LOAD (psf)</th>
<th>ROOF SHEATHING MAX LIVE LOAD (psf)</th>
<th>Span (inches)</th>
<th>Climate Zone</th>
<th>Span (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>⅛, ⅛</td>
<td>32/16</td>
<td>25</td>
<td>16</td>
<td>30</td>
<td>IB</td>
<td>43</td>
</tr>
<tr>
<td>⅛, ⅛</td>
<td>40/20</td>
<td>32</td>
<td>20</td>
<td>45</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>⅛, ⅛</td>
<td>48/24</td>
<td>48</td>
<td>34</td>
<td>50</td>
<td>2</td>
<td>71</td>
</tr>
<tr>
<td>⅛, ⅛</td>
<td>48/24</td>
<td>48</td>
<td>34</td>
<td>50</td>
<td>2</td>
<td>71</td>
</tr>
<tr>
<td>⅛, ⅛</td>
<td>48/24</td>
<td>48</td>
<td>34</td>
<td>50</td>
<td>2</td>
<td>71</td>
</tr>
</tbody>
</table>

Wood Framing Members

- Structural Panels
- Repetitive Framing
- Beams/Girders
- Wall Studs
- Mass Timber

Copyright © 2015 American Wood Council. All rights reserved.
Cross-laminated Timber

Some Advantages of CLT Panels

- Cross lamination minimizes swelling and shrinkage in the board plane
- Good load-bearing capacity - in-plane & out-of-plane
- Two way action capability as concrete slab

Source: FPInnovations
Shake Table Tests on 7-Story Building

- Conducted at E-Defense
- Building weight 270t
  - Self weight 120t
  - Added weight 150t
- Panel thickness
  - 140 mm (5.5”) floors 1 and 2
  - 125 mm (4.9”) floors 3 and 4
  - 85 mm (3.3”) top 3 floors
- Wall panels length 2.3 m (7.5’)

Copyright © 2015 American Wood Council.
All rights reserved.
Stradthaus-Murray Grove Tower, London

- Completed 2009
- 8 over 1 - 29 apartments
- Stores 186 tonnes of carbon
- 5 people on site, worked only 3 days/week
- Completed 49 weeks.

Client Telford Homes PLC and Metropolitan Housing Trust
Architect: Waugh Thistleton Architects
Structural Engineer: Techniker
Main Contractor: Telford Homes
Timber supplier and erector: KLH UK
Bridport House, London Borough

Client  London Borough of Hackney
Architect  Karakusevic Carson Architects
Main contractor  Willmott Dixon
Engin. and timber contractor  Eurban
Structural engineer  Peter Brett Assoc.
CLT supplier  Stora Enso Wood Products
Completed:  September 2011

• 41 Units
• 8 stories
Canadian Projects - 1st NA Multi-Family, Quebec

- Forte will have positively affected the environment by:
  - Storing (sequestering) 785 tonnes CO₂ eq an advantage of 1,461 tonnes CO₂ eq over concrete and steel construction
  - Equivalent to taking 345 cars off the road for a year
  - Saving 7.7 ML of water
  - Lowering eutrophication the supply of excess nutrients to the water systems by 75%
  - In addition, the smart design and efficient systems of the building could save an average over $1000 per year on energy and water bills.
Condominiums – Chibougamau, QC

Actual - 22 construction days (10 hours a day) - 5 men

Changes to the 2015 IBC

**ICC Final Action Hearing Results**

The International Code Council (ICC) held its final action hearings October 21-28, 2012 in Portland, Oregon to allow ICC members to make final decisions on proposals received on two 2015 ICC codes – the International Building Code (IBC) and International Existing Building Code. AWC was very successful in its advocacy on behalf of the wood products industry and some of the approved changes will provide additional opportunities for wood use. Over 300 of the original 1,068 IBC proposals were challenged (appealed), and therefore reconsidered by the full ICC voting membership. Results of several critically important issues to the industry include:

- Introducing cross-laminated timber (CLT) in Heavy Timber (Type IV) construction (G142): after conducting a successful ASTM E119 fire resistance test on a CLT wall (see story below), AWC overcame the original recommendation of denial, and gained approval to include CLT in Heavy Timber construction. This change opens new markets for CLT in non-residential structures.
Fire Test

ASTM E119 Fire Endurance Test
- 5-Ply CLT (approx. 7" thick)
- 5/8” Type X GWB each side
- Sought 2 hour rating
- RESULTS: 3 hours 6 minutes

American Wood Council

ASTM E119 Fire Endurance Test
- 5-Ply CLT (approx. 7” thick)
- 5/8” Type X GWB each side
- Sought 2 hour rating
- RESULTS: 3 hours 6 minutes

Where is CLT Allowed in IBC 2015?

**Type IV Construction**

**602.4 Type IV.** Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces. The details of Type IV construction shall comply with the provisions of this section. Fire retardant treated wood framing complying with Section 2303.2 shall be permitted within exterior wall assemblies with a 2-hour rating or less. Exterior walls complying with Section 602.4.1 or 602.4.2 shall also be permitted. Minimum solid sawn nominal dimensions are required for structures built using Type IV construction (HT). For glued-laminated members the equivalent net finished width and depths corresponding to the minimum nominal width and depths of solid sawn lumber are required as specified in Table 602.4. Cross lamintated timber (CLT) dimensions used in this section are actual dimensions.
Where is CLT Allowed in IBC 2015?

Code modifications to Ch. 23 Wood

2303.1.4 Structural glued cross laminated timber. Cross-laminated timbers shall be manufactured and identified as required in ANSI/APA PRG 320-2011.

CROSS-LAMINATED TIMBER. A prefabricated engineered wood product consisting of at least three layers of solid-sawn lumber or structural composite lumber where the adjacent layers are cross-oriented and bonded with structural adhesive to form a solid wood element.

Code modifications to Ch. 35 Wood

ANSI or APA
Franklin Elementary School

Franklin, West Virginia
Architect: MSES Architects, Fairmont, WV
Source: LignaTerra

Franklin, West Virginia
46,200 sq. ft.
8 week assembly

Source: LignaTerra
Franklin Elementary School

Source: LignaTerra

Scheduled completion date: Winter 2015
U.S. CLT Handbook

CONTENTS

CHAPTER 1
Introduction to Cross Laminated Timber

CHAPTER 2
Unbraced laminated timber manufacturing

CHAPTER 3
Detailed design of cross-laminated timber elements

CHAPTER 4
Installation of cross-laminated timber elements

CHAPTER 5
Connection to cross-laminated timber elements

CHAPTER 6
Insulation of cross-laminated timber elements

CHAPTER 7
Vibration performance of cross-laminated timber elements

CHAPTER 8
Thermal performance of cross-laminated timber elements

CHAPTER 9
Structural performance of cross-laminated timber elements

CHAPTER 10
Fire-resistant performance of cross-laminated timber elements

CHAPTER 11
Elevating and handling of cross-laminated timber elements

http://www.awc.org/standards/manuals.html

CLT Resources

http://www.awc.org/publications/download.php

Copyright © 2015 American Wood Council.
All rights reserved.
Recap

• Featured:
  • Solid Sawn
  • Wood Structural Panels
  • I-Joists
  • Engineered Beams
  • Studs
  • CLT

RESOURCES
Free Downloadable Resources

http://www.awc.org/helpoutreach/ecourses/index.html

- American Wood Council
  - www.awc.org

- APA – The Engineered Wood
  - www.apawood.org

- Western Wood Products Association
  - www2.wwpa.org

- Wood Truss Council of America
  - www.sbcindustry.com
Free Downloadable Resources

http://www.structuremag.org
October Issue
Traditional and Engineered Wood Products and EPD

Free Downloadable Resources

<table>
<thead>
<tr>
<th>Framing Member</th>
<th>Design Reference</th>
<th>Product Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawn lumber</td>
<td>NDS</td>
<td>USDOC PS20</td>
</tr>
<tr>
<td>Structural Glued Laminated Timber</td>
<td>NDS</td>
<td>ANSI A190.1 &amp; ASTM D3737</td>
</tr>
<tr>
<td>Prefabricated Wood I-Joists</td>
<td>NDS and ER</td>
<td>ASTM D5055</td>
</tr>
<tr>
<td>Structural Composite Lumber</td>
<td>NDS and ER</td>
<td>ASTM D5456</td>
</tr>
<tr>
<td>Wood Structural Panels</td>
<td>NDS and ER</td>
<td>USDOC PS1 &amp; PS2</td>
</tr>
<tr>
<td>Cross Laminated Timber</td>
<td>ER</td>
<td>ANSI/APA PRG 320</td>
</tr>
</tbody>
</table>

ER= Proprietary product see manufacturer’s Evaluation Report for design values.
Resources

• 2012 IBC Changes for Wood Design

Summary of Changes to 2012 IBC

<table>
<thead>
<tr>
<th>IBC Section</th>
<th>Standard or topic</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1609.1.1</td>
<td>Determination of wind loads</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1621.2.0</td>
<td>AG2 - 2012 Wood Frames</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1621.3.5.3</td>
<td>Structural design of wind bracing systems</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.2</td>
<td>Gb Design requirements</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.2.1</td>
<td>End-bearing load</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.6.7</td>
<td>Wood structural panels</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.6.7</td>
<td>Interior panels</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.7</td>
<td>Nordel Roof Raising System</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.8</td>
<td>Allowable stress design</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.8.1</td>
<td>Allowable stress design reference standards</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.8.1</td>
<td>Allowable stress design reference standards</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.8.1</td>
<td>Allowable stress design reference standards</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.8.1</td>
<td>Allowable stress design reference standards</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.8.1</td>
<td>Allowable stress design reference standards</td>
<td>Updated standard</td>
</tr>
<tr>
<td>1628.8.1</td>
<td>Allowable stress design reference standards</td>
<td>Updated standard</td>
</tr>
</tbody>
</table>
Resources

• 2012 NDS Changes

http://www.awc.org/helpoutreach/ecourses/index.html

2008 SDPWS - Diaphragm Deflection Design - Webinar
Resources

• Wind & Seismic Standards
• More details on changes
• Wood Design Focus papers
  • 2005 Special Design Provisions for Wind and Seismic (SDPWS)
  • 2008 Special Design Provisions for Wind and Seismic
  • Use of Wood Structural Panels to Resist Combined Shear and Uplift from Wind

Download free at www.awc.org

Resources

• ALLOWABLE USE OF WOOD IBC 2009 & 2012

http://www.awc.org/codes/ccwdindex.html
The American Wood Council (AWC) provides wood design and construction information to assist building industry professionals, develops structural and fire performance data on a wide range of traditional and engineered wood products, and engages in long-term research.
AWC provides technical expertise, education, and support on building codes, standards, and wood engineering design issues. [www.awc.org](http://www.awc.org)

[info@awc.org](mailto:info@awc.org)