Significant Changes to AWC's 2015 National Design Specification® for Wood Construction

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AWC’s 2015 National Design Specification® (NDS®) for Wood Construction is referenced in US building codes and used to design wood structures worldwide. The current edition, designated ANSI/AWC NDS-2015 was approved as ANSI American National Standards in 2014. This presentation will provide an overview of changes in the 2015 NDS relative to previous editions. Significant changes relate to the incorporation of cross laminated timber.
Objectives

Upon completion, participants will understand:
1. Discuss significant changes between the 2012 and 2015 NDS.
2. Discuss the load and material resistance design process and how it applies to wood structural design.
3. Be able to identify the similarities and differences with respect to design values, tabulated values, and behavioral equations.
4. Discuss the overall format and content within the 2015 NDS.

Outline

• Overview
• NDS
  • Chapter-by-chapter discussion
  • Changes from previous editions
• Summary
• More Info
NDS History

1944  1977  2001
1962  1982  2005
1968  1986  2012
1971  1991  2015
1973  1997

Governing Codes for Wood Design

2015 NDS referenced in 2015 IBC
ANSI Accreditation

- **AWC – ANSI-accredited standards developer**
- **Consensus Body**
  - Wood Design Standards Committee

Outline

- **Overview**
- **NDS**
  - Chapter-by-chapter discussion
  - Changes from previous editions
2015 NDS – Primary Change

New Provisions to Address CLT

- Charging Language
- Design Values
- Design Equations
- Product Chapter
- Connection Design
- Fire Design

2015 NDS Chapter Reorganization

2012 NDS
- 1-3 General
- 4-9 Products
- 10-13 Connections
- 14 Shear Walls & Diaphragms
- 15 Special Loading
- 16 Fire

2015 NDS
- 1-3 General
- 4-10 Products +CLT
- 11-14 Connections
- Shear Walls & Diaphragms
- 15 Special Loading
- 16 Fire
NDS 2015 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. Cross-Laminated Timber
11. Mechanical Connections
12. Dowel-Type Fasteners
13. Split Ring and Shear Plate Connectors
14. Timber Rivets
15. Special Loading Conditions
16. Fire Design of Wood Members

NDS 2015 Supplement

1. Sawn Lumber Grading Agencies
2. Species Combinations
3. Section Properties
4. Reference Design Values
   - Sawn Lumber and Timber
   - MSR and MEL
   - Decking
   - Non-North American Sawn Lumber
   - Structural Glued Laminated Timber
   - Timber Poles and Piles
NDS 2015 Appendices

A. Construction and Design Practices
B. Load Duration (ASD Only)
C. Temperature Effects
D. Lateral Stability of Beams
E. Local Stresses in Fastener Groups
F. Design for Creep and Critical Deflection Applications
G. Effective Column Length
H. Lateral Stability of Columns
I. Yield Limit Equations for Connections
J. Solution of Hankinson Equation
K. Typical Dimensions for Split Ring and Shear Plate Connectors
L. Typical Dimensions for Standard Hex Bolts, Hex Lag Screws, Wood Screws, Common, Box, and Sinker Nails
M. Manufacturing Tolerances for Rivets and Steel Side Plates for Timber Rivet Connections
N. Appendix for Load and Resistance Factor Design (LRFD) – Mandatory

NDS – Chapter 1

GENERAL REQUIREMENTS FOR STRUCTURAL DESIGN

1. Scope
2. General Requirements
3. Standard for Whole
4. Design Procedures
5. Properties and Plate
6. Bending

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Chapter 1 - Terminology

\[ f_b \leq F'_b \]

**Reference** design values \((F_{br}, F_v, F_{vr}, F_{clr}, E, E_{min})\)

**Adjusted** design values \((F'_b, F'_t, F'_v, F'_c, F'_cl, E', E_{min}')\)

Chapter 1 – Design Loads

- Reference loads
- Minimum load standards
- ASCE 7 – 10
Chapter 1 – CLT Charging Language

1.1 Scope

1.1.1 Practice Defined

1.1.1.1 This Specification defines the methods to be followed in structural design with the following wood products:
- visually graded lumber
- mechanically graded lumber
- structural glued laminated timber
- timber piles
- timber poles
- prefabricated wood I-joists
- structural composite lumber
- wood structural panels
- cross-laminated timber

1.1.1.2 This Specification defines the practices to be followed in the design and fabrication of single and multiple fastener connections using the fasteners described herein.

1.1.1.3 Structural assemblies utilizing metal connector plates shall be designed in accordance with accepted engineering practice (see Reference 9).

1.1.1.4 Shear walls and diaphragms shall be designed in accordance with the Special Design Provisions for Wood and Masonry (see Reference 6).

1.1.1.5 This Specification is not intended to preclude the use of materials, assemblies, structures or designs not meeting the criteria herein, where it is demonstrated by analysis based on recognized theory, full-scale or prototype testing, studies, or extensive experience in use that assembly, structure or design will perform in its intended end use.

1.1.2 Competent Supervision

The reference design values, design checks, and structural design calculations shall be performed by a qualified design professional.
2015 NDS

Format Conversion Factor $K_F$

ASD

$$R_N = C_D R_{ASD}$$

LRFD

$$R_N = \phi \lambda K_F R_{ASD}$$

$R_{ASD}$ reference strengths

Chapter 2 – CLT Design Values

2.2 Reference Design Values

Reference design values and design value adjustments for wood products in 11.1.1 are based on methods specified in each of the wood product chapters. Chapters 4 through 10 contain design provisions for sawn lumber, glued laminated timber, poles and piles, prefabricated wood I-joints, structural composite lumber, wood structural panels, and cross-laminated timber, respectively. Chapters 11 through 14 contain design provisions for connections. Reference design values are for normal load duration under the moisture service conditions specified.

2.3 Adjustment of Reference Design Values

2.3.1 Applicability of Adjustment Factors

Reference design values shall be multiplied by all applicable adjustment factors to determine adjusted design values. The applicability of adjustment factors to sawn lumber, structural glued laminated timber, poles and piles, prefabricated wood I-joints, structural composite lumber, wood structural panels, cross-laminated timber, and connection design values is defined in 4.4, 5.3, 6.3, 7.3, 8.3, 9.3, 10.3, and 11.3, respectively.
Chapter 3 – CLT Design Equations

3.5 Bending Members – Deflection

3.5.1 Deflection Calculations

If deflection is a factor in design, it shall be calculated by standard methods of engineering mechanics considering bending deflections and, when applicable, shear deflections. Consideration for shear deflection is required when the reference modulus of elasticity has not been adjusted to include the effects of shear deflection (see Appendix F).

3.5.2 Long-Term Loading

Where total deflection under long-term loading is the sum of initial design member size is one way to provide extra stiffness to allow for this time dependent deformation (see Appendix F). Total deflection, $\Delta_t$, shall be calculated as follows:

$$\Delta_t = K_e \times \Delta_e + \Delta_{cr}$$ \hspace{1cm} (3.5-1)

where:

$K_e = $ time dependent deformation (creep) factor
- \(\Delta_e\) for seasoned lumber, structural glued laminated timber, prefabricated wood joists, or structural composite lumber used in dry service conditions as defined in 4.1.4, 5.1.4, 7.1.4, and 8.1.4, respectively.
- \(\Delta_{cr}\) is 2.0 for cross-laminated timber used in dry service conditions as defined in 10.1.5.
Chapter 3 – CLT Design Equations

3.7.1.5 The column stability factor shall be calculated as follows:

\[ C_n = \frac{1 + (F_e/F_a)}{2c} - \sqrt{\frac{1 + (F_e/F_a)}{2c} - \frac{F_e}{F_a} - \frac{F_e}{c}} \]  

(3.7-1)

\[ F_e = 0.822 \cdot \frac{F_a}{(c_s / d)^2} \]

\[ c = 0.8 \text{ for sawn lumber} \]

\[ c = 0.9 \text{ for structural glued laminated timber, structural composite lumber, and cross-laminated timber} \]

New

NDS Commentary – guidance on \( C_P \)

NDS – Chapter 4

SAWN LUMBER

4.2 Reference Design Values

4.3 Adjustment of Reference Design Values

4.4 Special Design Considerations

4.5 Structural Design of Joist Girders

4.6 Deflection Calculations

4.7 Drift Analysis
Chapter 4 – Lumber

**Design values**
- Visually graded lumber
- MSR / MEL
- Timber
- Decking

---

Chapter 4 – Lumber

**Lumber adjustment factors**

### Table 4.3.1 Applicability of Adjustment Factors for Sawn Lumber

<table>
<thead>
<tr>
<th>ASD only</th>
<th>ASD and LRFD</th>
<th>LRFD only</th>
</tr>
</thead>
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<tr>
<td>ASD</td>
<td>ASD</td>
<td>LRFD</td>
</tr>
<tr>
<td>Load Category</td>
<td>Factor</td>
<td>Factor</td>
</tr>
<tr>
<td>W</td>
<td>C</td>
<td>D</td>
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<tr>
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</tbody>
</table>

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NDS – Chapter 5, 6, and 7

NDS – Chapter 8
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Chapter 9 – Wood Structural Panels

Design values – obtain from an approved source

- $F_{bS}$
- $F_A$
- $F_{tv}$
- $F_S$
- $F_C$
- $E_l$
- $E_A$
- $G_{tv}$
- $F_{CL}$
Chapter 9 – Wood Structural Panels

Adjustment factors

Table 9.3.1 Applicability of Adjustment Factors for Wood Structural Panels

<table>
<thead>
<tr>
<th>Factor</th>
<th>ASD only</th>
<th>ASD and LRFD</th>
<th>LRFD only</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{S} ) = ( F_{S} )</td>
<td>x</td>
<td>C_D, C_M, C_t, C_s</td>
<td>2.54, 0.85, ( \lambda )</td>
</tr>
<tr>
<td>( F_{A} ) = ( F_{A} )</td>
<td>x</td>
<td>C_D, C_M, C_t, C_s</td>
<td>2.70, 0.80, ( \lambda )</td>
</tr>
<tr>
<td>( F_{n} ) = ( F_{n} )</td>
<td>x</td>
<td>C_D, C_M, C_t, C_s</td>
<td>2.88, 0.75, ( \lambda )</td>
</tr>
<tr>
<td>( F_{L/D} = F_{L/D} )</td>
<td>x</td>
<td>C_D, C_M, C_t, C_s</td>
<td>2.88, 0.75, ( \lambda )</td>
</tr>
<tr>
<td>( F_{A} ) = ( F_{A} )</td>
<td>x</td>
<td>C_D, C_M, C_t, C_s</td>
<td>2.40, 0.90, ( \lambda )</td>
</tr>
<tr>
<td>( F_{uA} = F_{uA} )</td>
<td>x</td>
<td>- C_M, C_t, C_s</td>
<td>1.67, 0.90, -</td>
</tr>
<tr>
<td>( E_{L} = E_{L} )</td>
<td>x</td>
<td>- C_M, C_t, C_s</td>
<td>- - -</td>
</tr>
<tr>
<td>( E_{A} = E_{A} )</td>
<td>x</td>
<td>- C_M, C_t, C_s</td>
<td>- - -</td>
</tr>
<tr>
<td>( G_{L/8} = G_{L/8} )</td>
<td>x</td>
<td>- C_M, C_t, C_s</td>
<td>- - -</td>
</tr>
</tbody>
</table>

NDS – Chapter 10

CROSS-LAMINATED TIMBER

New
What is Cross Laminated Timber (CLT)?

Photos provided by FPInnovations

Chapter 10 – Cross-Laminated Timber

10.1 General

10.1.1 Application
10.1.1.1 Chapter 10 applies to engineering design with performance-rated cross-laminated timber.

10.1.2 Definition
Cross-Laminated Timber (CLT) – a prefabricated engineered wood product consisting of at least three layers of solid-sawn timber or structural composite lumber where the adjacent layers are cross-oriented and bonded with structural adhesive to form a solid wood element.

10.1.3 Standard Dimensions
10.1.3.1 The net thickness of a lamination for all layers at the time of gluing shall not be less than 5/8 inch or more than 2 inches.

10.1.4 Specification
All required reference design values shall be identified in accordance with NDS® and shall be proven to be sufficient.
Chapter 10 – Cross-Laminated Timber

10.2 Reference Design Values

10.2.1 Reference Design Values

Reference design values for cross-laminated timber shall be obtained from the cross-laminated timber manufacturer's literature or code evaluation report.

10.2.2 Design Section Properties

Reference design values shall be used with design section properties provided by the cross-laminated timber manufacturer based on the actual layup used in the manufacturing process.

10.3 Adjustment of Reference Design Values

10.3.1 General

Reference design values: $F_{d}(S_{O,0})$, $F_{d}(M_{O,0})$, $F_{d}(V_{O})$, $F_{d}(Q_{O})$, $F_{d}(S_{O})$, $F_{d}(M_{O})$, $F_{d}(V)$, $F_{d}(Q)$, $F_{d}(S)$, $F_{d}(M)$, $F_{d}(V)$, $F_{d}(Q)$ provided in 10.2 shall be multiplied by the adjustment factors specified in Table 10.3.1 to determine adjusted design values: $F_{d}(S_{O,0})$, $F_{d}(M_{O,0})$, $F_{d}(V_{O})$, $F_{d}(Q_{O})$, $F_{d}(S_{O})$, $F_{d}(M_{O})$, $F_{d}(V)$, $F_{d}(Q)$.

10.3.2 Load Duration Factor, $C_{D}$ (ASD only)

All reference design values except stiffness, $F_{d}(V)$ and $F_{d}(Q)$, rolling shear, $F_{d}(V)$, and compression perpendicular to grain, $F_{d}(V)$, shall be multiplied by load duration factor, $C_{D}$, as specified in 2.3.2.

---

Chapter 10 – Cross-Laminated Timber

Table 10.3.1 Applicability of Adjustment Factors for Cross-Laminated Timber

<table>
<thead>
<tr>
<th>ASD only</th>
<th>ASD and LRFD</th>
<th>LRFD only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Duration Factor</td>
<td>Shear Force Factor</td>
<td>Temperature Factor</td>
</tr>
<tr>
<td>$F_{d}(S_{O,0}) = F_{d}(S_{O})$</td>
<td>$C_{O}$</td>
<td>$C_{O}$</td>
</tr>
<tr>
<td>$F_{d}(M_{O,0}) = F_{d}(M_{O})$</td>
<td>$C_{O}$</td>
<td>$C_{O}$</td>
</tr>
<tr>
<td>$F_{d}(V) = F_{d}(V)$</td>
<td>$C_{O}$</td>
<td>$C_{O}$</td>
</tr>
<tr>
<td>$F_{d}(Q) = F_{d}(Q)$</td>
<td>$C_{O}$</td>
<td>$C_{O}$</td>
</tr>
<tr>
<td>$F_{d}(S_{O,0}) = F_{d}(S_{O})$</td>
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<tr>
<td>$F_{d}(M_{O,0}) = F_{d}(M_{O})$</td>
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<tr>
<td>$F_{d}(V) = F_{d}(V)$</td>
<td>$C_{O}$</td>
<td>$C_{O}$</td>
</tr>
<tr>
<td>$F_{d}(Q) = F_{d}(Q)$</td>
<td>$C_{O}$</td>
<td>$C_{O}$</td>
</tr>
</tbody>
</table>
### Yield Limit Equations

**Table 11.3.1A  Yield Limit Equations**

<table>
<thead>
<tr>
<th>Yield Mode</th>
<th>Single Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;n&lt;/sub&gt;</td>
<td>$Z = \frac{D_0 \tau_{s} F_{am}}{R_d}$ (11.3-1)</td>
</tr>
<tr>
<td>I&lt;sub&gt;s&lt;/sub&gt;</td>
<td>$Z = \frac{D_0 \tau_{s} F_{am}}{R_g}$ (11.3-2)</td>
</tr>
<tr>
<td>II</td>
<td>$Z = \frac{k_s D_0 \tau_{s} F_{am}}{R_g}$ (11.3-3)</td>
</tr>
<tr>
<td>III&lt;sub&gt;n&lt;/sub&gt;</td>
<td>$Z = \frac{k_s D_0 \tau_{s} F_{am}}{(1+2R_g) R_g}$ (11.3-4)</td>
</tr>
<tr>
<td>III&lt;sub&gt;s&lt;/sub&gt;</td>
<td>$Z = \frac{k_s D_0 \tau_{s} F_{am}}{(2+R_g) R_g}$ (11.3-5)</td>
</tr>
<tr>
<td>IV</td>
<td>$Z = \frac{D_0^2 \sqrt{2F_{am} F_{ph}}}{R_g \sqrt{3(1+R_g)}}$ (11.3-6)</td>
</tr>
</tbody>
</table>

- 4 Modes of failure
- 6 Yield equations
- Single & double shear
- Wood-to-wood
- Wood-to-Steel
- Wood-to-Concrete

### Chapter 12 – Dowel-type Fasteners

12.2.1.5 Where lag screws are loaded in withdrawal from the narrow edge of cross-laminated timber, the reference withdrawal value, $W$, shall be multiplied by the end grain factor, $C_{eg}=0.75$, regardless of grain orientation.
Chapter 12 – Dowel-type Fasteners

12.2.2.4 Wood screws shall not be loaded in withdrawal from end-grain of laminations in cross-laminated timber ($C_{ew}=0.0$).

12.2.3.6 Nails, and spikes shall not be loaded in withdrawal from end-grain of laminations in cross-laminated timber ($C_{es}=0.0$).

Chapter 12 – Dowel-type Fasteners

12.3.3 Dowel Bearing Strength

12.3.3.5 Dowel bearing strengths, $F_d$, for dowel-type fasteners installed into the panel face of cross-laminated timber shall be based on the direction of loading with respect to the grain orientation of the cross-laminated timber ply at the shear plane.

12.3.3.6 Where dowel-type fasteners are installed in the narrow edge of cross-laminated timber panels, the dowel bearing strength shall be $F_d$ for $D \geq 1/4”$ and $F_e$ for $D < 1/4”$.

<table>
<thead>
<tr>
<th>Specific Gravity</th>
<th>$F_d$</th>
<th>$F_e$</th>
<th>$F_n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.55</td>
<td>5520</td>
<td>6150</td>
<td>5150</td>
</tr>
<tr>
<td>0.54</td>
<td>5350</td>
<td>6050</td>
<td>5000</td>
</tr>
<tr>
<td>0.53</td>
<td>5150</td>
<td>5950</td>
<td>4850</td>
</tr>
</tbody>
</table>

Dowel bearing strength in pounds per square inch (psf)².
Chapter 12 – Dowel-type Fasteners

12.3.5 Dowel Bearing Length

12.3.5.1 Dowel bearing length in the side member(s) and main member, \( \ell_m \) and \( \ell_m \), shall be determined based on the length of dowel bearing perpendicular to the application of load.

12.3.5.2 For cross-laminated timber where the direction of loading relative to the grain orientation at the shear plane is parallel to grain, the dowel bearing length in the perpendicular plies shall be reduced by multiplying the bearing length of those plies by the ratio of dowel bearing strength perpendicular to grain to dowel bearing strength parallel to grain \( (F_{\perp} / F_{\parallel}) \).

\[ \ell_m = t_{1\parallel} + t_{2\perp} + t_{3\parallel} = 3(1.5) = 4.5" \]

\[ \ell_{m \text{-adj}} = t_{1\parallel} + t_{2\perp} (F_{\perp} / F_{\parallel}) + t_{3\parallel} = 1.5 + 1.5(3650/6150) + 1.5 = 3.9" \]

Chapter 12 – Dowel-type Fasteners

- Adjust \( \ell_m \) or \( \ell_s \) to compensate for orthogonal grain orientations in adjacent layers
- Parallel to grain: \( F_{\perp} / F_{\parallel} \)
  
  Example: \( \frac{1}{2} " \) bolt in southern pine 3-ply CLT with 1-\( \frac{1}{2} " \) laminations

\( \ell_m = t_{1\parallel} + t_{2\perp} + t_{3\parallel} = 3(1.5) = 4.5" \)

\( \ell_{m \text{-adj}} = t_{1\parallel} + t_{2\perp} (F_{\perp} / F_{\parallel}) + t_{3\parallel} = 1.5 + 1.5(3650/6150) + 1.5 = 3.9" \)

<table>
<thead>
<tr>
<th>Specific Gravity</th>
<th>( F_m )</th>
<th>( F_s )</th>
<th>( F_{\perp} )</th>
<th>Dowel bearing strength in pounds per square inch (psi)</th>
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</thead>
<tbody>
<tr>
<td>0.55</td>
<td>3050</td>
<td>3500</td>
<td>4500</td>
<td>5950</td>
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<td>0.54</td>
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<td>0.53</td>
<td>4000</td>
<td>4500</td>
<td>5500</td>
<td>5950</td>
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</table>
Chapter 12 – Dowel-type Fasteners

12.5.2 End Grain Factor, $C_{eg}$

12.5.2.2 Where dowel-type fasteners are inserted in the end grain of the main member, with the fastener axis parallel to the wood fibers, reference lateral design values, $Z$, shall be multiplied by the end grain factor, $C_{eg} = 0.67$.

12.5.2.3 Where dowel-type fasteners with D≥1/4” are loaded laterally in the narrow edge of cross-laminated timber, the reference lateral design value, $Z$, shall be multiplied by the end grain factor, $C_{eg} = 0.67$, regardless of grain orientation.

- Lateral – any end grain
- D<1/4” $C_{eg} = 0.67$
- Lateral – any CLT edge
- D≥1/4” $C_{eg} = 0.67$
Chapter 15 – Special Loading

SPECIAL LOADING CONDITIONS

15.1 Lateral Distribution of a Concentrated Load 542
15.2 Special Columns 543
15.3 Built-Up Columns 544
15.4 Wood Columns with Side Loads and Eccentricity 547

Figure 15A Mechanically Laminated Built-Up Columns

Figure 15E Eccentrically Loaded Column
Chapter 16 – Fire (ASD)

- Fire resistance up to **two hours**
  - Columns
  - Beams
  - Tension Members
  - ASD only
- Products
  - Lumber
  - Glulam
  - SCL
  - Decking
  - CLT - NEW

**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 calculations. 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 8 of ASCE 19. The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/SPFA National Design Specifications for Wood Construction (NDS).
Chapter 16 – Calculated Resistance

- Fire resistance of exposed wood members may be calculated using the provisions of NDS Chapter 16

Chapter 16 – Fire (ASD)

Technical Report No. 10
- Background on NDS provisions
- Design examples
- Floor assembly lumber joist provisions

TR-10 currently being updated which will include CLT
Chapter 16 – Fire (ASD)

Code Updates - Design of Fire-Resistive Exposed Wood Members

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

Outline

• Overview & Building Code Allowances
• Nail-laminated Timber
• Glued-laminated Timber
• Cross-laminated Timber
• Fire

Resource: StructureCraft
What is Nail-Laminated Timber?

• **2304.8.3 Mechanically laminated decking.** Mechanically laminated decking shall comply with Sections 2304.8.3.1 through 2304.8.3.3.

• **2304.8.3.1 General.** Mechanically laminated decking consists of square-edged dimension lumber laminations set on edge and nailed to the adjacent pieces and to the supports.

• **2304.8.3.2 Nailing.** The length of nails connecting laminations shall not be less than two and one-half times the net thickness of each lamination. Where decking supports are 48 inches (1219 mm) on center (o.c.) or less, side nails shall be installed not more than 30 inches (762 mm) o.c., alternating between top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 48 inches (1219 mm) o.c., side nails shall be installed not more than 18 inches (457 mm) o.c. alternating between top and bottom edges and staggered one-third of the spacing in adjacent laminations. Two side nails shall be installed at each end of butt-jointed pieces.

Laminations shall be toenailed to supports with 20d or larger common nails. Where the supports are 48 inches (1219 mm) o.c. or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) o.c., alternate laminations shall be toenailed to every support.

• **2304.8.3.3 Controlled random pattern.** There shall be a minimum distance of 24 inches (610 mm) between end joints in adjacent courses. The pieces in the first and second courses shall bear on at least two supports with end joints in these two courses occurring on alternate supports. A maximum of seven intervening courses shall be permitted before this pattern is repeated.
Nail-Laminated Timber

General Contractor: EllisDon
Location: Richmond, British Columbia, Canada
Design Assist, Fabrication and Installation: StructureCraft
Completion: 2010

Resource: StructureCraft

Nail-Laminated Timber

Resource: StructureCraft
**GLT and CLT Adhesives**

CLT - ANSI/APA PRG 320-2011 references ANSI/AITC 405-2008
GLT - ANSI/AITC 405-2008 – references D7247

**GLT and CLT Adhesives**

CLT-ANSI/APA PRG 320-2012 references ANSI/APA 405-2008
GLT - ANSI/APA 405-2008 – references D7247
Chapter 16 – Fire Design - CLT

16.2.1.3 For cross-laminated timber, the effective char depth, \( \delta_{\text{e}} \), shall be calculated as follows:

\[
\delta_{\text{e}} = 1.2 \left( \frac{n_{\text{lam}} \cdot \beta_{0} \cdot \left( t - \frac{t_{p}}{\beta_{0}} \right)^{0.63}}{t_{p}} \right)^{0.55}
\]

New

<table>
<thead>
<tr>
<th>Table 16.2.1B Effective Char Depths (for CLT with ( \beta_{0} = 1.0 \text{ in/hr.} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Fire Endurance (hr.)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1-Hour</td>
</tr>
<tr>
<td>1/2-Hour</td>
</tr>
<tr>
<td>2-Hour</td>
</tr>
</tbody>
</table>

Calculated Fire Resistance?

- Chapter 16 NDS
  - Charring Rate and Char Depth
- Modified char depth model
  - Step-wise approach
Fire Performance

Calculated Fire Resistance?

- Net section properties
Recent Demonstration Fire Tests

Room after 60 minutes

Room after drywall removed following the three-hour test
CLT Test

Recent Demonstration Fire Tests

Heat Release Rate
Recent Demonstration Fire Tests


Connections

16.3 Wood Connections

Where fire endurance is required, connectors and fasteners shall be protected from fire exposure by wood, fire-rated gypsum board, or any coating approved for the required endurance time.
NDS – Appendices

APPENDIX

A. Construction and Design Practice: 101
B. Load Duration (LSD) Data: 106
C. Inhibitret Environments: 109
D. Lumber Quality: 110
E. Local Areas of Extreme Exposure: 110
F. Design for Strong and Critical Details: 116
G. Member Loads: 117
H. Lumber/Frame Quality: 118
I. Timber Quality: 118
J. Acceptable Deflection for Connections: 120
K. Member Size for Split Web and Shear Plate Connections: 122
L. Typical Deflection for Vertical Types: 124
M. Typical Deflection for Horizontal Types: 125
N. Typical Deflection for Splayed Connections: 126
O. Splayed Joint Deflection for Splayed Joint Connections: 126
P. Lumber and Splice Quality: 127

2015 NDS Supplement

• New Southern Pine Design Values
  • ALSC approves design values
    • June 1, 2013
  • AWC compiles them
    • NDS Supplement
  • More information
    • www.spib.org
    • www.southernpine.com

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2015 NDS – Summary

New Provisions to Address CLT

- Charging Language
- Design Values
- Design Equations
- Product Chapter
- Connection Design
- Fire Design

Code Acceptance of Standard

- 2012 IBC
  - References 2008 SDPWS in Section 2305 for lateral design and construction
- 2015 IBC
  - References 2015 SDPWS in Section 2305 for lateral design and construction
General Overview

Outline

- Chapter 1: Flowchart
- Chapter 2: General Design Requirements
- Chapter 3: Members and Connections
- Chapter 4: Lateral Force Resisting Systems

Outline

- Overview
- NDS
  - Chapter-by-chapter discussion
  - Changes from previous editions
- More Info
Availability

- [www.awc.org](http://www.awc.org)
  - PDF versions
    - Free view-only
    - Buy a printable PDF
  - Winter 2015
    - Commentary
    - Printed version

Technical Articles

- **Structure Magazine**
  - 2015 NDS
    - January 2015
  - 2015 SDPWS
    - July 2015

- [www.awc.org](http://www.awc.org)

[What's Changed?](http://www.awc.org)
Wind & Seismic Standards

- More details on changes
- Wood Design Focus papers
  - 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

Questions?

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