Overview of Codes and Standards Affecting Mid-rise Construction
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Outline

- Background Mid-rise
- Significant Codes and Standards Changes
- Special Design Considerations
- Future Code Changes
- What’s happening in other countries?

MID-RISE
5-Story Type III

Horyu-ji temple, Ikaruga, Nara Prefecture, Japan, (c. 711)
Urnès stave church, Sogn og Fjordane County, Norway (c. 1150)
Government Buildings Historic Reserve in Wellington, NZ (c. 1876)
Kelly, Douglas and Co. Warehouse; Vancouver, BC (c. 1905)
The Purse Building, Dallas, TX, (c. 1905)
Leckie Building, Vancouver, BC (c. 1908)

2014
7 billion people

2025
8 billion people
1,000,000,000 People
Need homes by 2025

IBC AND STANDARDS
International Building Code

- 2012 IBC
- Cycle just ended for 2015 IBC
  - Contents are known
  - Sneak peek at a few changes

Significant Changes to 2009 IBC

- 509.2 Horizontal Separation of Buildings

  509.2.  Group S-2 enclosed or open parking garage with Group A, B, M, R or S above. Horizontal Building Separation Allowance.
  1. Focus taken off Parking Garages
  2. Re-directs to Occupancy Classification
  3. Structure as two separate and distinct buildings for
     - Height and Area limitations
     - Types of construction
     - Fire wall continuity
  4. Occupancies below 3-hour horizontal assembly:
     - Group R, A, B, S-2 and M
Significant Changes to 2012 IBC

• 509.2 510.2 Horizontal Separation of Buildings

510.2 Horizontal building separation allowance. A building shall be considered as separate and distinct buildings for the purpose of determining area limitations, continuity of fire walls, limitation of number of stories and type of construction where all of the following conditions are met:

1. The buildings are separated with a horizontal assembly having a fire-resistance rating of not less than 3 hours.
2. The building below the horizontal assembly is not greater than one story above grade plane.
3. The building below the horizontal assembly is of Type IA construction.

ASCE 7-10
Ch. 11 Seismic Design Criteria - NEW

STRUCTURAL HEIGHT: The vertical distance from the base to the highest level of the seismic force-resisting system of the structure. For pitched or sloped roofs, the structural height is from the base to the average height of the roof.

Significant Changes to 2012 IBC

• Anchor Bolts ACI 318 Appendix D and NDS

(was 1911.1 IBC 2009)

SECTION 1908 ANCHORAGE TO CONCRETE—ALLOWABLE STRESS DESIGN

1908.1 Scope. The provisions of this section shall govern the allowable stress design of headed bolts and headed stud anchors cast in normal weight concrete for purposes of transmitting structural loads from one connected element to the other. These provisions do not apply to anchors installed in hardened concrete or where load combinations include earthquake loads or effects. The bearing area of headed anchors shall be not less than one and one-half times the shank area. Where strength design is used, or where load combinations include earthquake loads or effects, the design strength of anchors shall be determined in accordance with Section 1600. Bolts shall conform to ASTM A 307 or an approved equivalent.
Significant Changes to 2012 IBC

• Anchor Bolts
• ACI 318 Appendix D and NDS

( was 1912.1 IBC 2009)

SECTION 1909
ANCHORAGE TO CONCRETE—STRENGTH DESIGN

1909.1 Scope. The provisions of this section shall govern the strength design of anchors installed in concrete for purposes of transmitting structural loads from one connected element to the other. Headed bolts, headed studs and hooked (J- or L-) bolts cast in concrete and expansion anchors and undercut anchors installed in hardened concrete shall be designed in accordance with Appendix D of ACI 318 as modified by Sections 1905.1.9 and 1905.1.10, provided they are within the scope of Appendix D.

The strength design of anchors that are not within the scope of Appendix D of ACI 318, and as amended in Sections 1905.1.9 and 1905.1.10, shall be in accordance with an approved procedure.

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Significant Changes to 2012 IBC

• Anchor Bolts
• 1905.1.9 ACI 318 Appendix D and NDS

1905.1.9 ACI 318, Section D.3.3. Delete ACI 318 Sections D.3.3.4 through D.3.3.7 and replace with the following:

D.3.3.4 - The anchor design strength associated with concrete failure modes shall be taken as 0.75V_c and 0.75V_e, where α is given in D.4.3 or D.4.4 and N, and

V_c are determined in accordance with D.8.2, D.9.2, D.9.3, D.10.2 and D.6.3, assuming the concrete is cracked unless it can be demonstrated that the concrete remains uncracked.

D.3.3.5 - Anchors shall be designed to be governed by the steel strength of a ductile steel element as determined in accordance with D.5.1 and D.6.1, unless either D.3.3.6 or D.3.3.7 is satisfied.

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Significant Changes to 2012 IBC

- Anchor Bolts – ACI Appendix D and NDS
- SEAOC Seismology Committee


Significant Changes to 2012 IBC

- Anchor Bolts
- 1905.1.9 ACI 318 Appendix D and NDS

Exceptions:

1. Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the forces determined in accordance with ASCE 7 Equation 12.11-1 or 12.14.10 need not satisfy Section D.3.3.5. This is not applicable to anchor bolts attaching wood sill plates of bearing or nonbearing walls of light frame wood structures to foundations or foundation sill walls provided all of the following are satisfied:

- The allowable in-plane shear strength of the anchor is determined in accordance with ACI/ASCE NDS Table 11E for lateral design values parallel to grain.
- The maximum anchor nominal diameter is 3/4 inches (16 mm).
- Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).
- Anchor bolts are located a minimum of 4 inches (102 mm) from the edge of the concrete parallel to the length of the wood sill plate.
- Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.
- The sill plate is of 2-inch or 3-inch nominal thickness.
Significant Changes to 2012 IBC

2009 IBC

2303.1.1 Sawn lumber. Sawn lumber used for load-supporting purposes, including end joined or edge-glued lumber, machine-stress-rated or machines-rated lumber, shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with DOC PS 20 or equivalent. Grading practices and identification shall comply with rules published by an agency approved in accordance with the procedures of DOC PS 20 or equivalent procedures. In lieu of a grade mark on the material, a certificate of inspection as to species and grade, issued by a lumber grading or inspection agency meeting the requirements of this section, is permitted to be accepted for precut, remanufactured or rough-sawn lumber and for sizes larger than 3 inches (76 mm) nominal thickness.

Approved end-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade.

2012 IBC

2303.1.1.1 Certificate of inspection. In lieu of a grade mark on the material, a certificate of inspection as to species and grade, issued by a lumber grading or inspection agency meeting the requirements of this section, is permitted to be accepted for precut, remanufactured or rough-sawn lumber and for sizes larger than 3 inches (76 mm) nominal thickness.

2303.1.1.2 End-jointed lumber. Approved end-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required to have a fire-resistance rating shall have the designation “Heat Resistant Adhesive” or “HRA” included in its grade mark.

Significant Changes to 2012 IBC

Finger Jointed Sawn Lumber

• 2303.1.2 Sawn lumber - Approved end-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade.

• Note HRA fire resistance rating
Finger Jointed Sawn Lumber

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

Finger Jointed Sawn Lumber

- AWC FAQ

Frequently Asked Questions

What are the Requirements for Finger-Jointed Lumber used in Fire-Resistanced Rated Assemblies?

The 2012 IBC Section 2303.1.2 states: Approved finger-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required to have a fire-resistance rating shall have the designation “Heat Resistant Adhesive” or “HRA” recorded on the grade stamp. In 2009 the American Lumber Standards Committee (ALSC) modified the ALSC Glued Lumber Policy to add elevated temperature performance requirements for end-jointed lumber adhesives intended for use in fire-resistance-rated assemblies. End-jointed lumber manufactured with adhesives which meet the new requirements is being designated as “Heat Resistant Adhesive” or “HRA” on the grade stamp.

The ALSC Glued Lumber Policy requires that Heat Resistant Adhesives be qualified in accordance with one of two new ASTM standards, D1774-06 Practice for Evaluating Elevated Temperature Performance of Adhesives Used in End-Jointed Lumber and D1775-05 Practice for Evaluating Elevated Temperature Performance of End-Jointed Lumber Stud. Both standards require a wall assembly, made with end-jointed lumber to be subjected to the ASTM E119 fire test. The tested-adhesive qualifies as a Heat Resistant Adhesive if the wall assembly achieves a one-hour fire resistance rating. End-jointed lumber manufactured with a Heat Resistant Adhesive under an auditing program of an ALSC-accredited granting agency is allowed to carry the HRA mark on the grade stamp. End-jointed lumber manufactured with an adhesive not qualified as a Heat Resistant Adhesive will be designated as “Non-Heat Resistant Adhesive” or “non-HRA” on the grade stamp. Lumber carrying the HRA mark is permitted to be used interchangeably with solid-sawn members of the same species and grade in fire-rated applications.

For more information, please contact AWC at 202-463-4713 or info@awc.org.

Back To FAQ Home Page
CURRENT AWC STANDARDS

Wood Design Standards
Wood Design Standards

- Standards become part of the code “to the prescribed extent” of the reference only
- Editions are specific
  - 2009 IBC references 2005 NDS
  - 2012 IBC reference 2012 NDS

Significant Changes—2012 NDS

- New equation for bending and axial compression
- Chapter 5 glulam provisions
- Chapter 6 poles and piles
- Chapter 12 split ring and shear plate provisions
Chapter 3 – Behavioral Equations

• Combined bi-axial bending and axial compression

\[
\frac{f_c}{F_{ce}} + \frac{f_{b1}}{F_{b1}' \left[ 1 - \left( \frac{f_c}{F_{ce}} \right) \right]} + \frac{f_{b2}}{F_{b2}' \left[ 1 - \left( \frac{f_c}{F_{ce}} \right) - \left( \frac{f_{b2}}{F_{be}} \right)^2 \right]} \leq 1.0 \quad (3.9-3)
\]

Chapter 3 – Behavioral Equations

• Combined bi-axial bending and axial compression (* if this new third term is negative see C 15.4)

\[
\frac{f_c}{F_{ce2}} + \left( \frac{f_{b1}}{F_{be}} \right)^2 < 1.0 \quad (3.9-4)
\]
Chapter 1 - Design Loads

- Reference loads
- Minimum load standards
  - ASCE 7 - 10

Chapter 11 - Dowels

11.3.6 Dowel Diameter

11.3.6.1 When used in Tables 11.3-1A and 11.3-1B, the fastener diameter shall be taken as D for unthreaded full-body diameter fasteners and D₂ for reduced body diameter fasteners or threaded fasteners except as provided in 11.3.6.2. For bolts meeting the requirements of ANSI/ASME Standard B18.2.1 for full-body diameter bolts, the fastener diameter shall be taken as D (see Appendix L).
Chapter 11-Dowels

Appendix L (Non-mandatory) Typical Dimensions for Dowel-Type Fasteners and Washers

Table L1  Standard Hex Bolts

<table>
<thead>
<tr>
<th>D</th>
<th>D₀</th>
<th>T</th>
<th>L</th>
<th>F</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>D₀</td>
<td>T</td>
<td>L</td>
<td>F</td>
<td>H</td>
</tr>
</tbody>
</table>

Full-Body Fastener

Table L2  Standard Hex Lag Screws

<table>
<thead>
<tr>
<th>D</th>
<th>D₀</th>
<th>S</th>
<th>T</th>
<th>E</th>
<th>L</th>
<th>N</th>
<th>F</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>D₀</td>
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<td>T</td>
<td>E</td>
<td>L</td>
<td>N</td>
<td>F</td>
<td>H</td>
</tr>
</tbody>
</table>

Reduced Body Diameter  Full-Body Diameter

11.3.7 Dowel Diameter

11.3.7.1 Where used in Tables 11.3.1A or 11.3.1B, the fastener diameter shall be taken as D for unthreaded full-body diameter fasteners and D₀ for reduced body diameter fasteners or threaded fasteners except as provided in 11.3.7.2.

11.3.7.2 For threaded full-body fasteners (see Appendix L), D shall be permitted to be used in lieu of D₀ where the bearing length of the threads does not exceed ¼ of the full bearing length in the member holding the threads. Alternatively, a more detailed analysis accounting for the moment and bearing resistance of the threaded portion of the fastener shall be permitted (see Appendix L).
Chapter 11-Dowels

Threaded length $\leq \frac{l_m}{4}$

Dia. Fastener = D

Chapter 11-Dowels

Dia. Fastener = D

Threaded length $\leq \frac{l_m}{4}$
Chapter 11 - Dowels


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 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 5 of ASCE 7. The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 10 of ANSI/AF&PA National Design Specification for Wood Construction (NDS).
Calculated Resistance

- Fire resistance of exposed wood members may be calculated using the provisions of Chapter 16 of the National Design Specification® (NDS®)

![Diagram of fire resistance calculation]

Fire Resistant

- Glulam
- Steel
Performance of Wood vs. Steel

Comparative Strength Loss of Wood Versus Steel

Chapter 16 – Fire (ASD)

Technical Report No. 10

Calculating the Fire Resistance of Exposed Wood Members

© American Wood Council 2014
Chapter 16 – Fire (ASD)

Code Updates - Design of Fire-Resistive Exposed Wood Members

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

SPECIAL DESIGN CONSIDERATIONS-SHRINKAGE
2304.3.3 Shrinkage. Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems, or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall also show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

Moisture Changes In Wood

- Causes dimensional changes perpendicular to grain

Growing tree is filled with water

As wood dries, it shrinks perp. to grain
Wood Shrinks

- Shrinkage occurs primarily in horizontal members such as wall plates and floor joists.
Grade Stamps

**GRADE MARKS:**

a) Certification mark  

b) Mill Identification  

c) Grade designation  

d) Species identification  

e) Condition of seasoning  

- MC-15 or KD-15 - 15% max. MC  
- S-DRY, KD or KD HT - 19% max. MC  
- S-GRN, over 19% MC  
- HT S-GRN - (unseasoned)

**BASIC INFORMATION FROM STAMP:**

1. Who made it  
2. How strong is it

---

Grade Stamps

- Condition of seasoning at the time of surfacing:

  - S-GRN (Surfaced Green), HT S-GRN (Heat Treated Surface Green) - over 19% MC  
  - S-DRY (Surface Dry), KD (Kiln Dried) or KD HT (Kiln Dried and Heat Treated) - Maximum 19% MC  
  - MC 15 or KD 15 - Maximum 15% MC

- Varies on region and market conditions  
- In Southwest region “green” (S-GRN) is common.  
- Other parts of country “dry” (S-DRY) is common.  
- Engineer should consider the availability of kiln dried lumber.
Overview

Key factors influencing the magnitude of wood frame shrinkage

• Pre-construction moisture content (MC) will typically be higher than equilibrium (in-service) moisture content (EMC). For example: MC 19% or 15% kiln-dried for commercial construction vs. in-service 8-10%.

• Wood species has relatively little impact since most species used in commercial construction have similar shrinkage properties.

M4.4 Special Design Considerations

• 1% change in dimension per 4% change in MC.

Calculating Shrinkage

- Shrinkage Calculator: www2.wwpa.org

http://www2.wwpa.org/Portals/9/docs/PDF/TN10.pdf

Overview

Key factors influencing the magnitude of wood frame shrinkage are:
- "settling" or "settlement of construction gaps" or "framing take-up"
  - 1/8 inch per floor
  - ½ to ¾ inch total at the top floor of a high-rise
- "creep" (long term movement under sustained loading)
  - 1/8 to ¼ inch per story with magnitude progressively increasing from lower to upper stories).
So What?

Tie-Down Rods
So What?

Take-up Devices

- Ratcheting Type Device
- Spring Type Device

Deflection

4.3.2 Deflection

Calculations of shear wall deflection shall account for bending and shear deflections, fastener deformation, anchorage slip, and other contributing sources of deflection.

The shear wall deflection, $\delta_{sw}$, shall be permitted to be calculated by use of the following equation:

$$\delta_{sw} = \frac{8wh^3}{EAb} + \frac{vh}{1000G_s} + \frac{h\Delta_a}{b}$$  \hspace{1cm} (4.3-1)

- (bending, chord deformation excluding slip)
- (shear, panel shear and nail slip)
- (bending, chord splice slip)
Shear Wall Rotation

\[ \delta = \Delta_a \left( \frac{h}{b} \right) \]

- Rod Elongation
- Bearing plate crushing
- Sill plate crushing
- Shrinkage & settlement
- Take-up device displacement

So What?

• Non-structural Challenges:
  • MEP
  • Architectural Finishes
  • Drywall
  • Different Materials
Mitigation

• Construction Considerations:
  • Sequencing
  • Framing
  • Finishes

Site and Framing Timeline Guidelines

• Minimize storage of material on site where rain and standing water can increase moisture content
• Keep unused framing material covered, especially at night when relative humidity increases
• Inspect pre-built wall panels prior to installation for proper material and quality of mechanical fasteners
• “Dry-in” the structure as quickly as possible
• Immediately remove any standing water from floor framing after rain showers
Framing Tips

- Detail to reduce cumulative shrinkage
  - Minimize depth of framing members subject to (cross-grain) shrinkage
- Specify material less subject to shrinkage
  - Lumber with lower moisture content
    - Kiln dried
    - Treated wood

Platform Framing
Semi-balloon Framing

No Scale

Differential Movement in Trusses

Float Gypsum at Wall Corners as Shown Above.

Slotted Anchor at Non-Bearing Walls

Drywall Clips

www.sbcindustry.com
Panelized Walls

- Prefabricated or Factory Manufactured
  - Lumber components cut & pre-assembled
  - Delivered to building site.
COMPONENT ASSEMBLY TABLE

INTERIOR WALLS REMOVED FROM WALL LINE IMMEDIATELY AFTER FRAMING TABLE
Panelized Walls

Possible benefits:
- Wall panels constructed in a controlled environment
- Decrease in construction time at the job site
- Less material waste on the job site
- More accurately constructed walls
Site and Framing – Timing Guidelines

- Fully compress wall framing by completing all dead load potential.
- Complete all interior wall framing, roof framing, sheathing, floor toppings and roofing PRIOR to brick or stucco work.

Allow for Differential Movement

1” wide sealant joint sized to allow for shrinkage of wood frame and expansion of brick veneer

Flexible membrane flashing detailed to maintain positive slope after frame shrinkage
Site and Framing – Plumbing

• Fully compress wall framing by completing all dead load potential PRIOR to mechanical installations.

• Avoid rigid vertical piping in mechanical and plumbing systems. Flexible members allow for shrinkage between floors.

Site and Framing – Timing Guidelines

• Vertical vent stacks should not be installed prior to full completion of framing.

• Vent stacks require special attention and must be designed to allow for vertical movement due to shrinkage between floors.
Site and Framing – Plumbing

Design Considerations

• Differential Movement at Balconies
• Multi-Story Wood-Frame Shrinkage Effects on Exterior Deck Drainage: A Case Study by Zeno Martin, Wood Design Focus Fall 2010
  http://www.forestprod.com/wdfindex.html
NEAR FUTURE...
2015 IBC

Coming in 2015 IBC

- Reformatted height and area provisions
- Provisions for Cross Laminated Timber

Coming in 2015 IBC

- Revise 510 levels above grade

**SECTION 510 SPECIAL PROVISIONS**

**510.2 Horizontal building separation allowance.** A building shall be considered as separate and distinct buildings for the purpose of determining area limitations, continuity of fire walls, limitation of number of stories and type of construction where all of the following conditions are met:

1. The buildings are separated with a horizontal assembly having a fire-resistance rating of not less than 3 hours.
2. The building below the horizontal assembly is not greater than one story above grade plane.

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**Building Height – Stacked Buildings**

- Building Height - in feet
  - Upper building height (feet) is measured from grade plane
- Building Height - stories
  - Upper building height (stories) – measured from top of lower building

![Diagram showing floor plans and building heights]

- Grade Plane
- Residential Occupancy - floors 2 thru 6
- Closed Parking Garage - 1st floor
- Upper Building Height - 4-5 stories
- NFPA 13 Sprinklers
Building Height – Stacked Buildings

- Building Height – in feet
  - Upper building height (feet) is measured from grade plane
- Building Height – stories
  - Upper building height (stories) – measured from top of lower building

Coming in 2015 IBC

- Cross Laminated Timber - Type IV
- ANSI/APA PRG 320-2012
What is Cross Laminated Timber (CLT)?

Photos provided by FPInnovations
Changes to the 2012 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 endurance 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
Fire Test

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


Building Code - CLT

CLT – included in the 2015 IBC
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 laminated 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
Where is CLT Allowed in IBC 2015?

- Type IV Construction – Exterior Walls

  602.4.1 Fire-retardant-treated wood framing complying with Section 2303.2 shall be permitted within exterior wall assemblies with a 2-hour rating or less.

  602.4.2 Cross-laminated timber complying with Section 2303.1.4 shall be permitted within exterior wall assemblies with a 2-hour rating or less provided:
  - Exterior surface of the cross-laminated timber is protected fire retardant treated wood sheathing complying with 2303.2 and not less than 15/32 inch thick;
  OR
  - gypsum board not less than ½ inch thick;
  OR
  - a noncombustible material.
Where is CLT Allowed in IBC 2015?

• Type IV Construction – Floors

602.4.6.2 CLT. Cross laminated timber shall be not less than 4 inches (102 mm) in thickness. It shall be continuous from support to support and mechanically fastened to one another. Cross laminated timber shall be permitted to be connected to walls without a shrinkage gap providing swelling or shrinking is considered in the design. Corbelling of masonry walls under the floor shall be permitted to be used.

Where is CLT Allowed in IBC 2015?

• Type IV Construction – Roofs

602.4.5-602.4.7 Roofs. Roofs shall be without concealed spaces and wood roof decks shall be sawn or glued laminated, splined or tongue-and-groove plank, not less than 2 inches (51 mm) nominal in thickness; 11/8-inch-thick (32 mm) wood structural panel (exterior glue), or of planks not less than 3 inches (76 mm) nominal in width, set on edge close together and laid as required for floors; or of cross laminated timber. Other types of decking shall be permitted to be used if providing equivalent fire resistance and structural properties. Cross laminated timber roofs shall be not less than 3 inch nominal in thickness and shall be continuous from support to support and mechanically fastened to one another.
Where is CLT Allowed in IBC 2015?

• Type IV Construction - Interior Walls & Partitions

602.4.8.1 Interior Walls and Partitions. Interior walls and partitions shall be of solid wood construction formed by not less than two layers of 1-inch (25 mm) matched boards or laminated construction 4 inches (102 mm) thick, or of 1-hour fire-resistance-rated construction.

602.4.8.2 Exterior walls. All exterior walls shall be of one of the following:

1. Noncombustible materials; or
2. Not less than 6 inches in thickness and constructed of one of the following:
   2.1 Fire retardant treated wood in accordance with 2303.2 and complying with 602.4.1 or
   2.2 Cross laminated timber complying with 602.4.2.

Franklin Elementary School

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

Source: LignaTerra
Franklin Elementary School

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

Source: LignaTerra

Franklin Elementary School

Source: LignaTerra
Franklin Elementary School

Scheduled completion date: Winter 2015

Cross Laminated Timber

- CLT Handbook now available
- www.masstimber.com
- Free download
Coming in 2015 IBC

- New standard referenced for engineered wood rim boards – ANSI/APA PRR 410-2011

Coming in 2015 NDS/SDPWS

- NDS
- CLT Provisions

- SDPWS
- Design Flexible and Open Front/Cantilever Diaphragms
• 2015 Special Design Provisions for Wind and Seismic

2015 SDPWS

Overview:
• Ch. 2
  • Removes definition of flexible and rigid diaphragms
  • Defines “Open-Front Structure” & “Subdiaphragm”
• Ch. 4
  • Clarification of concrete and masonry wall anchorage
  • Revised Horizontal Distribution of Shear
  • Clarification of shear wall Aspect ratio adjustments
2015 SDPWS

Doug Hohbach – 3pm
Not a Big House – Upcoming SDPWS Changes in Rationalizing Wood Diaphragm Analysis and Design in Multi-Story Light-Frame Residential Construction/Rigid Diaphragm WSTG 5
Canada

- 2009, the Province of British Columbia amended its own provincial building code and further increased the permissible height of light-frame wood construction for residential buildings to six stories (an increase from 4 stories)
6-Story Type V

Quattro, Surrey
Sails, UBC Remy

First 6-story
Critical Design Issues

- Cumulative shrinkage and differential movement
- Increased loads
- Increased fire-resistance ratings
- Sound transmission ratings required

6-Story

- This bulletin provides basic technical and practice guidance on structural, fire protection and building envelope professional engineering issues related to mid-rise buildings.

6-Story Similar to Type V

Mid-rise Construction in British Columbia

Critical Design Issues

- Cumulative shrinkage and differential movement
- Increased loads
- Increased fire-resistance ratings
- Sound transmission ratings required
• Differential Movement & Increased Fire and Sound Resistance

Wood Elevator Core

Credit: Sukh Johal c/o WoodWORKS!BC
Construction Site Methodology

- Systemized Construction?
- Evolution and refinement of prefabrication for walls and potentially other elements of the building envelope
Construction Site Methodology

- Systemized Construction?
- Pre-fabricate as much as possible to
  - Accelerate site construction
  - Ensure panels are tight, square, accurately framed, correct load-bearing, correctly nailed and exceptionally dry
  - Reduce wall compression (shrinkage) with precise materials
- Minimize material waste in the factory and at site
Construction Site Methodology

- Creates less waste
- Saves money
Canadian Projects – 1st NA Multi-family, Quebec

Canadian Projects – 1st NA Multi-family, Quebec
Condominiums – Chibougamau, QC

Project Description

- Location: Chibougamau
- Date on Site: 2011-10-10
- Materials Volume:
  - CLT: 1150 m³
  - Glulam: 70 m³
  - Steel: 7000 Kg
- Fabrication Time (Estimated): 5 weeks
- Erection Time (Estimated): 7-8 weeks for the structure

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

Norway
16-17 Stories

Austria
30 Stories

Canada
Proposed Canadian Tower

RESOURCES
Wood Design Standards

Resources

- 2012 IBC Changes for Wood Design
Resources

- 2008 SDPWS - Diaphragm Deflection Design - Webinar
  
  http://www.awc.org/helpoutreach/ecourses/index.html

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

- **2012 NDS Changes**
Resources

- Structural changes in the 2012 International Building Code

5 over 1 Story

6-Story

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6-Story Similar to Type V

Resources

Hard copies: info@awc.org

U.S. CLT Handbook

Resources

