Copyright Materials

This presentation is protected by US and International Copyright laws. Reproduction, distribution, display and use of the presentation without written permission of AWC is prohibited.

© American Wood Council 2014

Course Description

- Based on the new American Wood Council/International Code Council publication, Code Conforming Wood Design (CCWD), this presentation takes the mystery out of International Building Code (IBC) parameters for wood in non-residential and multi-residential construction. Topics will include maximum building sizes (participants will receive pre-calculated tables for eight occupancies, with and without frontage and sprinkler increases); alternatives for establishing required fire resistance; special provisions for pedestal buildings; precautionary recommendations for buildings under construction; criteria for finishes, exterior coverings, appendages, and other wood features; and the use of American Wood Council design standards and other publications in relation to the IBC. Participants may download a complimentary copy of the CCWD at: http://www.awc.org/codes/ccwdindex.html
Upon completion, participants will be better able to:

1. Identify building size and use parameters for wood as the primary structural elements.
2. Identify methods specified by the code for establishing fire resistance of wood assemblies and elements, and fire precautions during construction.
3. Apply special provisions for design of wood structures that involve compartmentalization and sprinkler systems.
4. Apply code provisions for the non-structural use of wood in buildings, such as for finishes, appendages, siding, and trim.

CCWD Document

- This program is based on the Code Conforming Wood Design (CCWD) document
- The CCWD is intended as a brief yet comprehensive resource for wood design in accordance with the IBC
- Download at [link] (go to “Codes and Standards” and then “Codes”; or just type “CCWD” in the search box)

Classifications

- Group A, Assembly occupancies
- Group B, Business occupancies
- Group E, Educational occupancies
- Group F, Factory/Industrial occupancies
- Group I, Institutional occupancies
- Group M, Mercantile occupancies
- Group R, Residential occupancies
- Group S, Storage occupancies
Types of Construction

- IBC Chapter 6
  - Defines types of construction
    - Type I & II Non-combustible
    - Type III Non-combustible & Combustible
    - Type IV & V Combustible
  - Wood frame construction is typical in Types III, IV, and V

Allowable Heights and Areas

- IBC Chapter 5 contains the general criteria for wood building size
  - Size thresholds for wood structures are often determined by structural considerations rather than code limitations
### Table 503 Excerpt, Allowable Building Heights and Areas

<table>
<thead>
<tr>
<th>Group</th>
<th>Height (ft)</th>
<th>Type of Construction</th>
<th>Type III A</th>
<th>Type IV B</th>
<th>Type V C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>65</td>
<td></td>
<td>65</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>B</td>
<td>55</td>
<td></td>
<td>55</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>E</td>
<td>40</td>
<td>HT</td>
<td>40</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>M</td>
<td>25</td>
<td>HT</td>
<td>25</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>R-1</td>
<td>20</td>
<td>S3</td>
<td>20</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>R-2</td>
<td>15</td>
<td>S3</td>
<td>15</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>S-1</td>
<td>10</td>
<td>S3</td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stories (S)</th>
<th>Area (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14,000</td>
</tr>
<tr>
<td>B</td>
<td>28,500</td>
</tr>
<tr>
<td>E</td>
<td>23,500</td>
</tr>
<tr>
<td>M</td>
<td>18,000</td>
</tr>
<tr>
<td>R-1</td>
<td>24,000</td>
</tr>
<tr>
<td>R-2</td>
<td>18,000</td>
</tr>
<tr>
<td>S-1</td>
<td>26,000</td>
</tr>
</tbody>
</table>

### Maximum Allowable Area

**Section 506**

*Allowable building area per story*

\[ A_n = \{A_1 + [A_1 \times I_f] + [A_1 \times I_s]\} \]  
(Equation 5-1, base equation)

\[ I_f = \left( \frac{F}{P} - 0.25 \right) \times \frac{W}{30} \]  
(Equation 5-2, factor for open frontage)

\[ W = \frac{L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 \cdots}{F} \]  
(Equation 5-3, weighted average for the width of the open space)

(w = 20’ min. & 30’ max unless public way) **NEW EQ.**

### Maximum Allowable Area

#### W vs. Fire Separation Distance

See p. 11 of CCWD
Sprinkler system increases

- When a building is equipped throughout with an NFPA 13-compliant automatic sprinkler system (Section 903.3.1.1), the allowable floor area is permitted to be increased:
  - $I_s$
    - Single-story building – 3x
    - Multistory building – 2x

Allowable Building Area Calculation

- Given: Single-story Type VB grade school
  - Provided with an NFPA 13-compliant automatic sprinkler system throughout and located on lot as shown.

Determine:
- Maximum allowable building area

(see pg. 12 of CCWD)

Maximum Allowable Area

- $A_a = (A_t + [A_t \times I_s] + [A_t \times If])$ (Equation 5-1)
- $A_a = (9500 + [9500 \times If] + [9500 \times I_s])$ (Table 503)
- $If = (F/P – 0.25) \times W/30$ (Equation 5-2)
- $If = (0.750/30 – 0.25) \times 30/30 = 0.25$ (where $W > 30$, use 30)
Maximum Allowable Area

\[ A_a = \{A_t + [A_t \times I_f] + [A_t \times I_s]\} \quad \text{(Equation 5-1)} \]

\[ A_a = \{9,500 + [9,500 \times I_f] + [9,500 \times I_s]\} \quad \text{(Table 503)} \]

\[ I_f = \left(\frac{F}{P - 0.25}\right) \times \frac{W}{30} \quad \text{(Equation 5-2)} \]

\[ I_f = \left(\frac{350}{700} - 0.25\right) \times \frac{30}{30} = .25 \quad \text{(where W > 30, use 30)} \]

\[ I_s = 3 \quad \text{for single story} \quad \text{(Section 506.3)} \]

\[ A_a = \{9,500 + [9,500 \times .25] + [9,500 \times 3]\} \]

\[ A_a = 40,375 \]

Actual area = (250)(100) = 25,000

\[ \checkmark \quad \text{OK} \]

---

Table 503 Excerpt, Allowable Building Heights and Areas

<table>
<thead>
<tr>
<th>Group</th>
<th>Height (ft)</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>HT</td>
<td>A</td>
</tr>
<tr>
<td>A-1</td>
<td>S</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>14,000</td>
<td>9,500</td>
<td>15,000</td>
</tr>
<tr>
<td>A-2</td>
<td>S</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>14,000</td>
<td>9,500</td>
<td>15,000</td>
</tr>
<tr>
<td>A-3</td>
<td>S</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>14,000</td>
<td>9,500</td>
<td>15,000</td>
</tr>
<tr>
<td>A-4</td>
<td>S</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>14,000</td>
<td>9,500</td>
<td>15,000</td>
</tr>
<tr>
<td>A-5</td>
<td>S</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>28,500</td>
<td>19,900</td>
<td>36,000</td>
</tr>
<tr>
<td>E</td>
<td>A</td>
<td>23,500</td>
<td>14,500</td>
<td>25,500</td>
</tr>
</tbody>
</table>
Exception

- In addition to the area increase, Section 504.2 also permits the Table 503 building heights to be increased:
  - 20 feet
  - 1 story above grade.

NFPA 13

Height Increases for Sprinklers

Table 503 limit

Height Increases for Sprinklers

+ 1 story and 20 ft.

Table 503 limit

CCWD

- About Chapter 9 sprinkler thresholds . . .
Chapter 9 Area Limits for Nonsprinklered Buildings

• Many occupancies have floor area limits allowed by Chapter 5 that are greater than those permitted in Chapter 9 for nonsprinklered buildings
• The same thresholds apply to all construction types, not just wood. The allowable area per story can exceed allowable fire areas and a sprinkler system may be required

Sprinkler Trade-offs

• Reductions in corridor ratings and corridor opening protection
• Flexibility in means of egress (travel distance to exits, number and separation of exits, common path of travel)
• Reductions in dwelling unit separations
• Alternate to emergency escape openings
• Alternate to certain fire and smoke damper requirements
• Interior finish flexibility
• Other trade-offs

Chapter 9 Area Limits for Nonsprinklered Buildings

[F] 903.2.7 Group M. An automatic sprinkler system shall be provided throughout buildings containing a Group M occupancy where one of the following conditions exists:
1. A Group M fire area exceeds 12,000 square feet (1115 m²).
2. A Group M fire area is located more than three stories above grade plane.
3. The combined area of all Group M fire areas on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m²).
4. A Group M occupancy used for the display and sale of upholstered furniture or mattresses exceeds 5,000 square feet (464 m²).

[CCWD] 903.2.7.1 High-piled storage. An automatic sprinkler system shall be provided in accordance with the

CCWD

• About total building area limits...
Buildings three or more stories above grade have a total building area of the allowable building area per story \( (A_a) \) multiplied by three (Section 506.4).

**Single Occupancy**

Based on Single Story Maximum Area
- Assume a maximum area \( (A_a) \) of 37,500 ft per story

**Building Area**
- Two story building:
  - Total allowable building area \( A_{total} = 2(A_a) \)

\[
\begin{align*}
37,500 + 37,500 & = 37,500 \\
37,500 + 37,500 & = 37,500 \\
37,500 + 37,500 & = 37,500
\end{align*}
\]

- Three story building:
  - Total allowable building area \( A_{total} = 3(A_a) \)

\[
\begin{align*}
37,500 + 37,500 + 37,500 & = 37,500 \\
37,500 + 37,500 + 37,500 & = 37,500 \\
37,500 + 37,500 + 37,500 & = 37,500
\end{align*}
\]
- Four story building
  - Total allowable building area $A_{\text{total}}$ remains $3(Aa)$

(total building area $= (3)(37,500) = 112,500$; $112,500/4 = 28,125$ per story)
Building Area

• Four story building of unequal stories:
  • $A_{total} = 3(Aa)$, and no single story > (Aa)

Building Area

• Four story building of unequal stories:
  • $A_{total} = 3(Aa)$, and no single story > (Aa)

Building Area

• Four story building of unequal stories:
  • $A_{total} = 3(Aa)$, and no single story > (Aa)

CCWD

• Now using the CCWD tables . . .
### Table 5 (p. 32) – Group E Nonsprinklered Buildings – Maximum floor area per story a, b, c

<table>
<thead>
<tr>
<th># of stories</th>
<th>% frontage</th>
<th>Group E Nonsprinklered Buildings a, b, c</th>
<th>Maximum floor area per story (sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IIIA</td>
<td>IIIIB</td>
</tr>
<tr>
<td>1</td>
<td>0-25</td>
<td>23,500</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>29,370</td>
<td>25,370</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>41,120</td>
<td>33,250</td>
</tr>
<tr>
<td>2</td>
<td>0-25</td>
<td>23,500</td>
<td>14,500</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>29,370</td>
<td>18,120</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>41,120</td>
<td>25,370</td>
</tr>
<tr>
<td>3</td>
<td>0-25</td>
<td>23,500</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>29,370</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>41,120</td>
<td>NP</td>
</tr>
</tbody>
</table>

**Footnotes – Table 5 (p. 32) Group E, Nonsprinklered Buildings**

- Footnotes
  - Frontage based on open space widths of 30 feet or more.
  - Interpolation permitted.
  - Sprinklers must be provided for Group E occupancies when the fire area exceeds 12,000 square feet in accordance with Section 903.2.3, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 12,000 square feet can be provided with fire-resistance-rated construction in accordance with Chapter 7.

**Example – Group E**

- **Given:** Single-story Type VB grade school
  - Provided with an NFPA 13-compliant automatic sprinkler system throughout and located on lot as shown

**Determine:** Maximum allowable building area

**Example – Group E**

- **Frontage Increase** (Section 506.2)
  - 50% of the open space qualifies for the frontage increase

![Diagram](image-url)
Example – Group E

Table 6 (p. 32) – Group E NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

<table>
<thead>
<tr>
<th># of stories</th>
<th>% frontage</th>
<th>Maximum floor area per story (sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IIIA</td>
</tr>
<tr>
<td>1</td>
<td>0-25</td>
<td>94,000</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>99,870</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>111,620</td>
</tr>
<tr>
<td>2, 3</td>
<td>0-25</td>
<td>70,500</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>76,370</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>88,120</td>
</tr>
<tr>
<td>4</td>
<td>0-25</td>
<td>52,870</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>57,280</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>66,090</td>
</tr>
</tbody>
</table>

Example – Group I-1

Table 10 (p. 36) – Group I-1, NFPA 13R or 13D-Compliant Sprinklered Buildings – Maximum Floor Area per Story

<table>
<thead>
<tr>
<th># of stories</th>
<th>% frontage</th>
<th>Maximum floor area per story (sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IIIA</td>
</tr>
<tr>
<td>1, 2 &amp; 3*</td>
<td>0-25</td>
<td>16,500</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>20,620</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>28,870</td>
</tr>
<tr>
<td>4</td>
<td>0-25</td>
<td>12,370</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>15,460</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>21,650</td>
</tr>
</tbody>
</table>

(Table 10) Footnotes – Group I-1 (p. 36), NFPA 13R or 13D-Compliant Buildings

- NP = Not Permitted
  - The maximum floor area for four stories above grade plane was determined by dividing the maximum total allowable building area by the number of stories in accordance with Section 506.4. The floor area of the stories is assumed to be equal.
  - Frontage based on open space widths of 30 feet or more.
  - Interpolation permitted.
  - Section 903.2.6 permits Group I-1 occupancies to be sprinklered with NFPA 13R and NFPA 13D-compliant systems. The occupancy does not qualify for area increases due to sprinklers.
  - Type VB construction does not permit three stories above grade plane.
  - Use of NFPA 13D is allowed when specific conditions in Section 903.2.6 are met.

Example – Group I-1

- Given: Two-story Type IIIB NFPA 13-R compliant sprinklered nursing home

- Determine: Maximum allowable building area

  Frontage Increase: 50% of the frontage increase

  \[ \frac{80' \times 150'}{60'} \times 0.5 = 100' \times 75' \times 0.5 = 37.5' \times 37.5' = 1,406.25 \text{ sq. ft.} \]
Mixed Occupancy

- Mixed occupancy buildings are permitted a total allowable building area calculated in accordance with Section 506.5

  - Section 508.3 Nonseparated
  - Section 508.4 Separated
Mixed Occupancy

- Mixed occupancy buildings are permitted a total allowable building area calculated in accordance with Section 506.5
  - Section 508.3 Nonseparated
  - Section 508.4 Separated
  - Section 506.5 Single and multistory mixed occupancy buildings

Stacked Buildings

- Buildings of different types of construction and occupancy are allowed to be built on top of each other—they are commonly referred to as pedestal buildings

510.2 Horizontal Building Separation Allowance

- 3-hr rated Horizontal Assembly required between the lower and upper buildings
  - Limits in Section 510.2
  - Group B, M and R occupancies and Group S-2 open and enclosed parking garages are permitted in either building
  - Multiple Group A occupancies, each with an occupant load of less than 300, are also permitted in either building
  - Group S occupancies other than parking garages are permitted only in the upper building
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

\[
\text{Grade Plane} \quad \text{Upper Building Height} = 12 \times 5 = 60 \\
\text{Business Occupancy} = 2 \text{ thru } 5 \text{ floors} \quad \text{Upper Building Height} = 4 \\
\text{Closed Parking Garage} = 1^{st} \text{ floor}
\]

Stacked Buildings

- See other alternatives for stacked buildings in subsections 510.3 through 510.9

One or Two-story - Sprinklered

- Unlimited area Group B, F, M and S
- Limits in Section 507.3
- Building must be equipped throughout with an NFPA 13-compliant automatic sprinkler system
- Must be surrounded on all sides by public ways or yards not less than 60 feet wide

UNLIMITED AREA BUILDINGS

p. 14 of the CCWD
One-story - Sprinklered

- Group A-1 and A-2 occupancies are allowed in unlimited area mixed occupancy buildings containing Group B, F, M or S occupancies
  - Limits in Section 507.3.1
  - Type III or IV construction
  - Occupancies are separated as required in Section 508.4.4
  - All exit doors from Group A-1 and A-2 occupancies must discharge directly to the exterior of the building

One-story - Sprinklered

- Unlimited area Group A-3 buildings
  - Limits in Section 507.7
  - Type III or IV construction
  - Building used for religious worship, community hall, dance hall, exhibition hall, gymnasium, lecture hall, indoor swimming pool or tennis court

- Unlimited area Group A-4 buildings
  - Limits in Section 507.3
  - Type IIIA, IIIB and IV construction

One-story - Sprinklered

- Unlimited area Group E buildings
  - Limits in Section 507.10
  - Type IIIA or IV construction
  - Each classroom must have two means of egress, with one means of egress a direct exit to the outside of the building
  - Must be surrounded on all sides by public ways or yards not less than 60 feet wide

Reduced Open Space

- There must be at least 40 feet open width provided and the exterior wall and all openings on those portions will require 3-hour minimum fire-resistance and fire protection ratings.
Fire Walls

- Fire walls define separate buildings for allowable building size (706)
  - Not fire barriers (707)
  - Not fire partitions (708)
  - Not smoke barriers, smoke partitions, or horizontal assemblies

Fire Walls

- Type V construction:
  - Fire walls may be wood frame
- Types III and IV construction:
  - Fire walls must be of noncombustible materials in accordance with Section 706.3

**TABLE 706.4**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FIRE-RESISTANCE RATING (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, E, H-4, I, R-1, R-2, U</td>
<td>3h</td>
</tr>
<tr>
<td>F-1, H-3, H-5, M, S-1</td>
<td>3</td>
</tr>
<tr>
<td>H-1, H-2</td>
<td>4h</td>
</tr>
<tr>
<td>F-2, S-2, R-3, R-4</td>
<td>2</td>
</tr>
</tbody>
</table>

a. In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.
b. For Group H-1, H-2 or H-3 buildings, also see Sections 415.6 and 415.7.
FIRE RESISTANCE

Table 601

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A'</td>
<td>B'</td>
<td>A''</td>
</tr>
<tr>
<td>Primary structural frame* (see Section 202)</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bearing walls, Exterior*</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Bearing walls, Interior*</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nonbearing walls and partitions, Exterior*</td>
<td>See Table 602</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions, Interior*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor construction and associated secondary members (see Section 202)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Roof construction and associated secondary members (see Section 202)</td>
<td>1-1/2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 601 Fire-resistance Rating Requirements For Building Elements (hr)

702.3 and 703.3 Methods for Determining Fire Resistance

- Five methods to determine fire resistance:
  - Tested fire assembly (per ASTM E119 or UL 263)
  - Prescriptive designs in Section 721 or approved sources
  - Calculation of fire resistance per Section 722
  - Engineering analysis based on a comparison of building element, component or assembly designs
  - Alternative protection methods per 104.11 as approved by the code official

Tested Assembly

- Tested to the ASTM E 119 or UL 263 standard
- Choose listed assemblies from fire-resistance publications or directories
Prescriptive Assembly

- Fire-resistance of certain wood assemblies is prescribed in Section 721 based on testing using ASTM E 119 or UL 263
- Fire-resistance designs documented in approved sources (DCA 3)

Calculated Resistance

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

Chapter 16 – Fire (ASD)

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

SECTION 140
CALCULATED FIRE RESISTANCE

Calculation of fire resistance uses an approach that considers the following:
- The resistance of materials
- The method of construction
- The design and configuration of the structure

The fire resistance of a structure is determined by the time it takes for the structural elements to lose their integrity or服务能力.

Fire Resistant Glulam Steel
Chapter 16 – Fire (ASD)

Technical Report No. 10

Design of Fire-Resistive Exposed Wood Members

Simplified approach
Beams/Columns

Code Updates - Design of Fire-Resistive Exposed Wood Members

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

- Fire resistance of wood frame assemblies also may be calculated based on the known fire resistance of the components, using the provisions of Section 722.6 (Component Additive Method)

<table>
<thead>
<tr>
<th>Description</th>
<th>Time(hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior wallboard</td>
<td>2</td>
</tr>
<tr>
<td>1/2 in. wood strand panel bonded with exterior ply</td>
<td>10</td>
</tr>
<tr>
<td>1/2 in. wood strand panel bonded with interior ply</td>
<td>15</td>
</tr>
<tr>
<td>Interior wallboard</td>
<td>15</td>
</tr>
<tr>
<td>Interior gypsum wallboard</td>
<td>30</td>
</tr>
<tr>
<td>Inside Type 5 gypsum wallboard</td>
<td>50</td>
</tr>
<tr>
<td>Inside Type T gypsum wallboard</td>
<td>60</td>
</tr>
<tr>
<td>Inside Type R gypsum wallboard</td>
<td>90</td>
</tr>
<tr>
<td>Inside Type S gypsum wallboard</td>
<td>120</td>
</tr>
<tr>
<td>Interior lath and plaster</td>
<td>240</td>
</tr>
</tbody>
</table>

Calculated Resistance

- Document of origin in AWC’s DCA-4, containing all the same provisions, with background

- Ten Rules of Fire Resistance Rating (Harmathy's Rules)

Engineering Analysis Based on Comparisons of Tested Elements

- Engineering analysis—one of the original five alternatives for establishing ratings
- Based on comparison of tested elements
- DCA-3 embodies this for 1-hour assemblies
- It can be applied to other elements and other ratings with appropriate and qualified fire protection engineering judgment

TYPE OF CONSTRUCTION

p. 5-6 of the CCWD
Type V Construction

- Permits the use of wood or other approved materials for structural elements

Type IV Construction

- Heavy Timber (HT) has …
  - Exterior walls made of noncombustible materials or fire-retardant-treated wood (FRTW)
  - Interior building elements of heavy timber or laminated wood meeting minimum dimensions and without concealed spaces

Type III Construction

- Requires exterior walls to be noncombustible material or FRTW and have a minimum 2-hour fire-resistance rating (bearing walls)

Type I and II Construction

- Type I and II construction require building elements constructed of noncombustible materials
WOOD USE IN NONCOMBUSTIBLE CONSTRUCTION

Type I and II Applications
- Require the use of noncombustible materials
- Section 603 specifies 25 applications where combustible materials are permitted

Fire-Retardant-Treated Wood (FRTW)
- There are many additional applications for fire-retardant-treated wood (FRTW) in Type I and II construction
  - Permitted in nonbearing partitions where the fire-resistance rating does not exceed 2 hours
  - Nonbearing exterior walls (unrated)
  - Roof construction, including structural framework, permits FRTW, except for Type I A construction of three stories or more where the lowest roof member is less than 20 feet measured vertically from the upper floor
  - (can be used in exterior walls of Types III and IV)

Heavy Timber (HT)
- Permitted in roof construction as an alternative to 1-hour or less fire-resistance rated (FRR) noncombustible construction
Type I and II Applications

- Some other examples:
  - Interior finishes, millwork, trim, flooring, windows, and doors
  - Partitions of limited height, platforms, blocking for fixtures
  - Exterior wall coverings, balconies and projections

Wood Interior Finish

- Wood materials may be used as interior finish in almost all occupancies

Wood Interior Finish – Nonsprinklered Buildings (p. 20, CCWD; T803.9 IBC)

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum Interior Finish Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit enclosures and exit passageways</td>
<td>A, B, E, I, M, R-1, R-4</td>
</tr>
<tr>
<td></td>
<td>F, S, R-2</td>
</tr>
<tr>
<td></td>
<td>R-3</td>
</tr>
<tr>
<td>Corridors</td>
<td>A, I-2, I-3, I-4</td>
</tr>
<tr>
<td></td>
<td>B, E, M, S, I-1, R-1, R-2, R-4</td>
</tr>
<tr>
<td></td>
<td>F, R-3</td>
</tr>
<tr>
<td>Enclosed spaces and rooms</td>
<td>I, A-1, A-2, R-4</td>
</tr>
</tbody>
</table>

Flame spread

- (0-25)
- (26-75)
- (76-100)
Wood Interior Finish – Sprinklered Buildings
(p. 21, CCWD; T803.9, IBC)

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum Interior Finish Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit enclosures and exit passageways</td>
<td>I-3, A, B, E, M, R-1, R-4, I-1, I-2, I-4</td>
</tr>
<tr>
<td>Corridors</td>
<td>I-3, A, I-2, I-4</td>
</tr>
<tr>
<td>Enclosed spaces and rooms</td>
<td>I-2, I-4</td>
</tr>
</tbody>
</table>

Wood Interior Finish

803.1
- Class C - wood species
- Class B - some, such as cedar, west coast hemlock, Idaho white pine, redwood, and spruce
- Class A - wood boards and panels when pressure treated with a fire-retardant chemical.

DCA 1
http://www.awc.org/codes/dcaindex.php

Wood Interior Trim

- Trim is required to meet a Class C classification
- Guards, cannot exceed 10 percent of the wall of ceiling area to which it is attached (806.5)
- Combustible trim, excluding handrails and guards, cannot exceed 10 percent of the wall or ceiling area to which it is attached (806.5)
Windows and Doors

- Exterior openings are required to be protected with fire protection rated window or door assemblies when the exterior wall is within given distances of a lot line (705.8).

Windows and Doors

- Unlimited amounts of unprotected openings are permitted by Table 705.8
  - Exterior walls ≥ 30 feet from lot line, or
  - ≥ 10 feet from the lot line (Type IIB or VB construction)

- No unprotected openings are permitted in the exterior wall
  - Within 5 feet of the lot line (nonsprinklered buildings)
  - No openings
  - < 3 feet from the lot line

Windows and Doors

- Interior wood door assemblies are required to be fire-protection rated when the wall assembly they are in requires a FRR and opening protection (Table 716.5)

Wood Siding

- Wood siding is regulated in 1406 (see height limits as combustible exterior wall covering)
  - Minimum thicknesses in Table 1405.2
  - See Chapter 23 for wood siding as a structural building material
Exterior Wood Veneer (1405.5)

- Type I, II, III or IV -
  - allowed up to 40 feet above grade, 60 feet if FRTW, provided:
    - veneer is 1-inch nominal thickness,
    - 7/16-inch exterior hardboard siding
    - 3/8-inch exterior-type wood structural panels or particleboard.

Wood Balconies (1406.3)

- Exterior balconies may be of Type IV construction or construction that provides a fire-resistance rating equal to the floor rating required by Table 601
  - Length is limited to 50% of perimeter, each floor
  - See exceptions for sprinkler-protected balconies

Open Exterior Stairs and Ramps

- Open exterior exit stairs and ramps may be constructed of wood when: (1009.9 and 1010.8)
  - Building is of Type IV and V construction
  - Buildings up to six stories
  - no high-rise

Wood Rooftop Structures

- Wood penthouses of FRTW may be placed (1509):
  - On Type I construction two stories or less above grade plane
  - On Type II construction with the penthouse at least 5 feet from the lot line
Wood Rooftop Structures (1509)

- Type III, IV and VA
  - penthouse Type IV construction or FRTW
  - 20 feet or more from the lot line (1509.2.5 exception 3).
- Type III, IV and V (see limitations in Section 1509.5)
  - Wood towers, spires, domes and cupolas are permitted on buildings of.

PRECAUTIONS DURING CONSTRUCTION

- During construction, one portable fire extinguisher must be placed:
  - At each stairway on all floor levels with combustible materials,
  - At each storage or construction shed and where special hazards exist
Maintaining Means of Egress - 3310

- During construction, when a building height reaches 50 feet or four stories, a minimum of one temporary lighted stairway must be provided unless a permanent stairway is available for use at all times.

Standpipes - 3311

- A minimum of one standpipe must be available during construction for fire department use.
- The standpipe must be installed before the construction is 40 feet above fire department access; see other conditions.

Sprinkler System Commissioning - 3312

- Sprinkler system must be tested and approved before the certificate of occupancy is granted.

Requirements of the IFC

- Additional requirements for fire safety during construction are contained in the IFC (now directly referenced in Section 3302.3 of the IBC).
• Additional requirements for fire safety during construction are contained in the IFC.
  • Temporary heating equipment must be listed and labeled.
  • Smoking is prohibited except in approved areas with posted signage.
  • A fire watch must be maintained with qualified personnel if required by the fire code official.

• Welding operations must follow the provisions of IFC Chapter 35. Electrical wiring must follow the provisions of NFPA 70 (IFC 3304).
• The owner must designate a fire prevention superintendent responsible for implementing a fire prevention program during construction.
• An accessible emergency phone must be provided in an approved location at the construction site.

• Fire-fighting vehicle access must be provided within 100 feet of temporary or permanent fire department connections.
• An approved water supply for fire protection must be available when combustible material is at the construction site.
• Requirements for safeguards during roofing operations.

AWC Standards Referenced in the IBC

These standards and related code publications, design aids, technical reports and guides for wood design and construction can be purchased or downloaded for free at www.awc.org.
IBC Chapter 23

- 2301 General
- 2302 Definitions
- 2303 Minimum Standards and Quality
- 2304 General Construction Requirements
- 2305 General Design Requirements for Lateral Force-resisting Systems
- 2306 Allowable Stress Design
- 2307 Load and Resistance Factor Design
- 2308 Conventional Light-frame Construction
AWC Standards Referenced in the IBC

Coming in the 2015 IBC

- Slightly broader application of WFCM
- Re-organization of Conventional Wood Frame Construction Provisions (2308)
- Revised span tables based on new Southern Pine design values

Cross-laminated Timber

- Reformatted height and area provisions
- Provisions for Cross Laminated Timber
- New engineered wood rim board standard
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

---

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.

---

Cross-laminated Timber

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

Bridport House, London Borough

- 41 Units
- 8 stories
Bridport House, London Borough

Canadian Projects – 1st NA Multi-Family, Quebec

Changes to the 2012 IBC

The International Code Council (ICC) held its final action hearings October 21-26, 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

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


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

Scheduled completion date: Winter 2015

Source: LignaTerra

U.S. CLT Handbook

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

CLT Resources

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

- This concludes The American Institute of Architects Continuing Education Systems Course

Michelle Kam-Biron, PE, SE, SECB
American Wood Council
info@awc.org

This presentation was developed by a third party and is not funded by WoodWorks.