BCD420 - 2015 IBC Essentials for Wood Construction


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Course Description

Based on the popular *Code Conforming Wood Design (CCWD)*, a joint publication of the American Wood Council (AWC) and the International Code Council (ICC), this presentation concisely summarizes the 2015 IBC for commercial and multi-family residential construction. It will explain the determination of maximum building size for eight common use groups using the new height and area tables of the 2015 IBC and pre-calculated tables provided in the CCWD. It will also address establishing fire resistance for wood assemblies and heavy timber; special provisions for pedestal buildings; criteria for finishes, appendages, and other wood features; the scoping of referenced wood design standards; an overview of structural provisions in Chapter 23; and requirements for precautions during construction.

- The CCWD includes:
  - Allowable building size
  - Special occupancies
  - Fire resistance
  - Building features
  - Wood in noncombustible construction types
  - Structural considerations
  - Precautions during construction

Objectives

Upon completion, participants will be better able to:

- Apply 2015 IBC provisions for building size limits when wood is used as the primary structural element for buildings within its scope.
- Identify IBC methods for establishing fire resistance of wood assemblies and elements.
- Identify IBC requirements for fire precautions during construction.
- Apply IBC provisions for the use of wood in finishes and trim; in building appendages such as balconies; in noncombustible construction types; and in other building features.
- Locate the fundamental IBC structural provisions for wood design and identify the IBC-referenced wood design standards.
About American Wood Council (AWC)

Provides engineering data, consensus standards and information on traditional and engineered wood products.

More info at awc.org.

International Code Council (ICC)

- The ICC is a member-focused association.

- It is dedicated to developing model codes and standards used in the design, build and compliance processes to construct safe, sustainable, affordable and resilient structures.

- More info at iccsafe.org.
Polling Question

1. What is your profession?
   a) Architect
   b) Engineer
   c) Code Official
   d) Building Designer
   e) Other

Introduction

- Wood has distinct economic, environmental and design advantages.

- More buildings are constructed of wood than any other structural material.
Use and Occupancy Classification

- Building code requirements
  - Appropriate building classification
    - Design purpose
    - Current occupancy
Use and Occupancy Classification

- **Eight occupancy classifications:**
  - Group A, Assembly
  - Group B, Business
  - Group E, Educational
  - Group F, Factory/Industrial
  - Group I, Institutional
  - Group M, Mercantile
  - Group R, Residential
  - Group S, Storage

Use and Occupancy Classification

- **Structure’s purpose not listed**
  - Classified as most nearly resembled occupancy
  - Section 302.1.
Assembly, Group A-1

- **Group A-1 includes:**
  - Fixed seating occupancies for viewing performing arts
  - Television studios with audience seating
  - Motion pictures

Assembly, Group A-2

- **Group A-2 includes:**
  - Buildings in which food and drink consumption occurs.
    - Restaurants
    - Banquet halls
    - Casinos
    - Bars
    - Nightclubs
Assembly, Group A-3

- Group A-3 includes:
  - Places of worship
  - Recreation
  - Amusement
  - Other assembly uses not included in the other groups

Assembly, Group A-4

- Group A-4 includes:
  - Indoor arenas
  - Skating rinks
  - Swimming pools
  - Tennis courts
Assembly, Group A-5

- Group A-5 includes:
  - Outdoor grandstands
  - Stadiums
  - Amusement park structures

Business, Group B

- Group B uses include office, professional or service-type transactions.
- It is a broad use group that often is chosen when a use does not fit another Use Group description.
- See examples of these in Section 304.1.
Educational, Group E

- Group E includes any buildings or portions of a structure used:
  - To educate six or more people through the 12th grade
  - For supervision, personal care or education of more than five children at least 2 ½ years old

Factory/Industrial, Group F

- Group F-1, moderate hazard industry, includes buildings or portions of buildings used for manufacturing.
- Group F-2 includes low-hazard fabrication or manufacturing of noncombustible materials.
- See examples of these listed in Section 306.
Institutional, Group I

- **Group I is divided into four subcategories:**
  - **Group I-1**
    - Residential and custodial care for more than 16 people (24-hour care)
  - **Group I-2**
    - Hospitals
    - Child care facilities (24-hour care)
    - Nursing homes
    - Detoxification facilities
  - **Group I-3**
    - Jails
    - Detention centers
    - Prisons
  - **Group I-4**
    - Day care facilities for more than five adults or children (less than 24-hour care)

- Groups I-1 through I-3 occupancies are further broken into conditions based upon the occupants’ ability to respond to an emergency.

Mercantile, Group M

- **Group M includes:**
  - Department stores
  - Drugstores
  - Markets
  - Motor fuel-dispensing facilities
  - Retail or wholesale stores
  - Salesrooms
Residential, Group R-1

- **Group R-1 includes:**
  - Hotels
  - Motels
  - Boarding houses

Residential, Group R-2

- **Group R-2 includes:**
  - Apartments
  - Dormitories
  - Live/ work units
  - Timeshare properties
  - Nontransient hotels, motels and boarding houses
Residential, Group R-3

- **Group R-3 includes:***
  - Single- and two-family dwellings
  - Adult and child day care facilities with less than six occupants
  - Boarding houses
    - Transient (10 or fewer occupants)
    - Nontransient (16 or fewer occupants)

Residential, Group R-4

- **Group R-4 includes:***
  - Residential care and assisted living facilities for six to 16 clients

**Two Conditions:**
- **Condition 1** - occupants are capable of responding to an emergency without assistance
- **Condition 2** - limited assistance may be necessary for any single occupant
**Storage, Group S**

- Group S-1, moderate hazard storage, includes buildings or portions of buildings used for nonhazardous storage.
- Group S-2, low hazard storage, includes storage of noncombustible materials in combustible packaging.
- See examples of these listed in Section 311.
Referenced Codes and Standards

- **IBC Chapter 35**
  - List of referenced standards
    - Agency that writes the standard
    - Identification and title of the standard
    - Effective date

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Standards

- **American Wood Council (AWC) Standards**
  - 2015 AWC Span Tables for Joists and Rafters (STJR-2015)
Types of Construction

Introduction

- IBC Chapter 6
  - Defines types of construction
  - Wood frame construction is typical in Types V, IV and III
  - Specific applications permitting use of wood in Types I and II
    - Addressed in Sections 5 and 6 of the CCWD
Type V Construction

- Permits the use of wood or other approved materials for loadbearing and nonloadbearing structural elements.

Type IV Construction

- Heavy Timber (HT)
  - Exterior walls made of noncombustible materials, fire-retardant-treated wood (FRTW) or protected cross-laminated timber (CLT)
  - Interior building elements made of solid or laminated wood without concealed spaces
- Columns
  - Minimum of 6” × 8” when supporting roof and ceiling loads
  - Minimum of 8” × 8” when supporting floor loads
- Beams and girders
  - Minimum 6” × 10” for floors
  - Minimum 4” × 6” for roofs
Type IV Construction

- **Flooring**
  - Minimum 3-inch thickness covered with 1-inch nominal dimension tongue and groove flooring or 4-inch thick CLT

- **Roof decking**
  - Minimum 2-inch thickness, 11/8-inch wood structural panels, or 3-inch thick CLT

- **Partitions**
  - 1-hour-fire-resistance-rated; or
  - Minimum two layers of 1-inch nominal board; or
  - Laminated construction 4-inches thick

Cross-Laminated Timber (CLT)
Cross-Laminated Timber (CLT)

- Introduced in the 2015 IBC
  - Type IV buildings
  - The AWC NDS contains new provisions for CLT
  - A product standard, ANSI/APA 190.1-12
  - E119 test report available

Type III Construction

- Requires exterior walls to be noncombustible material or FRTW and have a minimum 2-hour fire-resistance rating (bearing walls).
- Type IIIA requires 1-hour fire-resistance rating for all building elements other than nonbearing walls.
- Type IIIB does not require any fire-resistance rating other than exterior loadbearing wall.
Type I and II Construction

- Type I and II construction requires most structural loadbearing building elements to be of noncombustible materials.
Introduction

- IBC Chapter 5
  - Size thresholds for wood structures are often determined by structural considerations rather than code limitations.

### Tables 504.3, 504.4 and 506.2, Allowable Building Heights and Areas

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<thead>
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| A-1, A-2, A-3, A-4       | F                    | 3        | 2       | 3      |
| B                        | G                    | 3        | 3       | 3      |
| E                        | H                    | 3        | 2       | 3      |
| M                        | I                    | 4        | 4       | 4      |
| D-2                      | J                    | 4        | 4       | 4      |
| R-1                      | K                    | 4        | 4       | 3      |
| R-2                      | L                    | 4        | 4       | 4      |

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SH66  Update image to updated table from complete document.
SHyde, 9/14/2015

PC194  I replaced the figure from the one from the final PDF of document
Paul Coats, 9/24/2015
### Tables 504.3, 504.4 and 506.2, Allowable Building Heights and Areas

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### Allowable Building Area – Single Occupancy, One-Story Buildings (506.2.1)

\[ D_d \times D_w \times Q \times V \times L_d \times 1 \]

\[ Z_{kh} = \]

\[ D_d \times D_w \times Q \times V \times L_d \times 1 \]

\[ Z_{kh} = \]

\[ D_d \times D_w \times Q \times V \times L_d \times 1 \]

\[ Z_{kh} = \]

\[ D_d \times D_w \times Q \times V \times L_d \times 1 \]
Slide 45

SH67  Update image to updated table from complete document.
      SHyde, 9/14/2015

PC195  I replaced the image with the final from the PDF doc
       Paul Coats, 9/24/2015

Slide 46

PC180  removed "or SM" . . . this is for one-story buildings
       Paul Coats, 9/24/2015

PC179  made font uniform color (I hope)
       Paul Coats, 9/24/2015

PC184  I italicized "NS"
       Paul Coats, 9/24/2015
Allowable Building Area – Single Occupancy, Multi-story Buildings (506.2.3)

\[ A_a = \frac{D_d \times D_w \times V_d}{I_a \times V_a} \]

Where:
- \( A_a \) = Allowable building area (square feet).
- \( A_t \) = Tabular building area factor (NS, S13R, or SM value, as applicable) in accordance with Table 506.2 (square feet).
- \( V_s \) = Tabular allowable area factor in accordance with Table 506.2 for a nonsprinklered building (regardless of whether the building is sprinklered).
- \( I_f \) = Area factor increase due to frontage (percent) as calculated in accordance with Section 506.3.
- \( S_a \) = Actual number of building stories above grade plane, not to exceed three. For buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (NFPA 13R system), use the actual number of building stories above grade plane, not to exceed four.

Area Factor Increases for Frontage (506.3)

\[ I_f = \frac{F \times P}{W} \]

Where:
- \( I_f \) = Area factor increase due to frontage (percent) as calculated in accordance with Section 506.3.
- \( F \) = Building perimeter that fronts on a public way or open space having 20 feet open minimum width (feet).
- \( P \) = Perimeter of entire building (feet).
- \( W \) = Width of public way or open space (feet) in accordance with Section 506.3.2.
remove "S1" . . . this is for multi-story buildings
Paul Coats, 9/24/2015

italicized "NS"
Paul Coats, 9/24/2015
Weighted Average (506.3.2)

\[ Z_{\text{AVG}} = \frac{\sum \text{wtd} \cdot \text{avg}}{\text{total wtd}} \]

\[ Z_{\text{AVG}} = \frac{w_4 \cdot z_4 + w_5 \cdot z_5 + \ldots + w_n \cdot z_n}{w_4 + w_5 + \ldots + w_n} \]

- **Omg**
  \[ w_4 \cdot z_4 + w_5 \cdot z_5 + \ldots + w_n \cdot z_n \]

- **Lrg**
  \[ w_4 \cdot z_4 + w_5 \cdot z_5 + \ldots + w_n \cdot z_n \]
Weighted Average (506.3.2)

\[ W = \frac{L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4}{F} \]

\[ W = \frac{(200 \times 22 + 200 \times 30 + 200 \times 30 + 200 \times 30)}{800} = 28 \text{ ft} \]

Frontage Increase (506.3)

- **Given:**
  - Two-story restaurant
  - Type IIIA construction
  - Street width of 22 feet

- **Determine:**
  - Area limitation
Fixed the 28 = ft to the correct order.

SHHyde, 9/28/2015
Frontage Increase (506.3)

Solution cont.:

\[ F = L_2 + L_3 + L_4 = 180 + 120 + 180 = 480 \text{ ft} \]

\[ W = \frac{L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4}{F} \]

\[ W = \frac{0 + 180 \times 25 + 120 \times 30 + 180 \times 30}{480} = 28 \text{ ft} \]
replaced this figure with final from PDF, there was a sign mistake on the slide

Paul Coats, 9/24/2015
Frontage Increase (506.2.3)

Solution cont.:

\[ D_w \cdot QV \cdot 7/333 \cdot A \cdot 1 \cdot 1 \]
\[ I_2 \cdot #I \cdot 1358 \cdot \#1 \cdot \#3 \]
\[ V_d \cdot #\#wruhv \]

\[ D_d \cdot #D_w \cdot #QV \cdot #_2 \cdot \#V_d \]
\[ D_d \cdot #47/333 \cdot #47/333 \cdot #B4 \cdot #B4 \cdot 5/5 \cdot 3 \cdot w \cdot d \]

Frontage Increase (506.2.3)

Solution cont.:

- 42,280 < 43,200 (actual area), so no good

- Note: A-2 above the level of exit discharge or > 5,000 sq. ft. require sprinklers per Chapter 9 (this example assumed a nonsprinklered building).
Allowable Increases for Automatic Sprinkler Systems

- When a building is equipped throughout with an NFPA 13-compliant automatic sprinkler system, the allowable floor area is permitted to be increased:
  - Single-story building - 3x
  - Multi-story 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
Allowable Building Area Calculation

Solution:

\[
\text{Allowable Building Area Calculation}
\]

- **Solution:**

\[
\text{QV}^\text{36} \div 833^\text{#} \quad \text{Andys} \div 3915^\text{,}
\]

- **Frontage Increase:** (Section 506.3)

\[
L_y \div 3158^\text{,} \\
L_z \div 55^6
\]

- **Tabular Allowable Area Factor:** (Table 506.2)

\[
D_w \div 33^\text{,}
\]

Solution cont.:

**Total Allowable Area** (Section 506.2.1)

\[
A_a = A_t + (NS \times I_t) \\
A_a = 38,000 + (9,500 \times 0.25) = 40,375 \text{ square feet}
\]

Actual area = 250 \div 100 = 25,000 square feet

✓ OK
Chapter 9 – Area Limits for Nonsprinklered Buildings

For many occupancies, Chapter 5 will yield floor area limits that exceed those permitted in Chapter 9 for nonsprinklered buildings.

The same thresholds apply to all construction types, not just wood. The allowable area per story must not exceed allowable fire areas and a sprinkler system may be required.
Sprinkler Trade-offs in Addition to Building Size Increases

- Reductions in corridor ratings and corridor opening protection
- Flexibility in means of egress (e.g., 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
- Several others

Polling Question

2. When a building has an approved automatic sprinkler system per 903.3.1.1 the max. no. of stories may be increase by two.

True/ False
Total Building Area Limit

Single Occupancy (506.2.1)

- Buildings three or more stories above grade have a total building area per story found in \( A_a \) calculated by Equation 5-2 with a value of three for the number of stories \( S_a \).
- This is built-in to new \( A_a = A_t + (NS \times I_f) \) Equation 5-1 and \( A_a = [A_t + (NS \times I_f)] \times S_a \) Equation 5-2 of the 2015 Code.
- The following illustrates that the results are the same as the 2012 Code.

\[ S_a = \text{Actual number of building stories above grade plane, not to exceed three. For buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2, use the actual number of building stories above grade plane, not to exceed four.} \]
I made stylistic corrections (only) to these inserted equations

Paul Coats, 9/24/2015
Building Area

Based on Single Story Maximum Area

- Assume a maximum single-story area of 37,500 ft.

![Diagram of 1-story building with maximum area of 37,500 sq. ft.]

Building Area – 2-Stories

2-Story Building

- Total Allowable Building Area
  - \( A_a = 2 \times A_t \) (single story)

where:

- \( A_a \) = allowable building area
- \( A_t \) = allowable building area per story

![Diagram of 2-story building with maximum areas of 37,500 sq. ft. and total 75,000 sq. ft.]

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to be consistent with 2015 variable nomenclature, I switched the subscripts so $A_{\text{sub-a}}$ is total building area and $A_{\text{sub-t}}$ is area per story which parallels the tabular factor in the 2015 code.

Paul Coats, 9/24/2015
Building Area – 3-Stories

3-Story Building
• Total Allowable Building Area
• \( A_a = 3 \times A_t \) (single story)

where:
• \( A_a \) = allowable building area
• \( A_t \) = allowable building area per story

Building Area – More Than 3-Stories

4 and 4+ Story Building
• Total Allowable Building Area
• \( A_a = 3 \times A_t \) (single story)

where:
• \( A_a \) = allowable building area
• \( A_t \) = allowable building area per story
Mixed Occupancy (508)

- Mixed occupancy buildings are permitted a total allowable building area calculated in accordance with Section 508.

- Single-story basement does not need to be included in the total allowable building area when the basement does not exceed the area permitted for a single-story per Section 506.1.3.

Mixed Occupancy (508)

- Section 508.3 Nonseparated occupancies
- Section 508.4 Separated occupancies
- Sections 506.2.2 - 506.2.4 single- and multi-story mixed occupancy buildings
### Table 5 – Group E Nonsprinklered Buildings – Maximum Floor Area per Story \(^a, b, c\)

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<thead>
<tr>
<th>Story</th>
<th>Plan A</th>
<th>Plan B</th>
<th>Plan C</th>
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<td>58,833</td>
<td>QS</td>
<td>QS</td>
</tr>
<tr>
<td>6</td>
<td>30/8</td>
<td>56,833</td>
<td>QS</td>
<td>58,833</td>
<td>QS</td>
<td>QS</td>
</tr>
</tbody>
</table>

\(^a\) Area limits are for buildings with heights up to 75 feet (22.8 m) Favorable ground bearing and soil conditions are assumed. \(^b\) The required area for Plan A, Plan B, Plan C, and Plan D may be exceeded if the building design ensures a fire-resistance rating and any other construction requirements as specified in the code. \(^c\) The required area for Plan E and Plan F may be exceeded if the building design ensures a fire-resistance rating and any other construction requirements as specified in the code.
I made all table field entries non-bolded
Paul Coats, 9/24/2015
Footnotes - Group E, Nonsprinklered Buildings

Footnotes

a. Frontage based on open space widths of 30 feet or more.

b. Interpolation permitted.

c. 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 506.3)

• 50 percent of the open space qualifies for the frontage increase.

![Diagram of building frontage increase]

Table 6–Group E NFPA 13-Compliant Sprinklered Buildings–Maximum floor area per story

<table>
<thead>
<tr>
<th>Story</th>
<th>(ft)</th>
<th>P 30ft x 50ft</th>
<th>P 40ft x 50ft</th>
<th>P 50ft x 50ft</th>
<th>P 60ft x 50ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3058</td>
<td>57/333</td>
<td>8/333</td>
<td>435/333</td>
<td>7/333</td>
</tr>
<tr>
<td></td>
<td>83</td>
<td>93/53</td>
<td>43/6/3</td>
<td>53/73/6/3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>433</td>
<td>444/953</td>
<td>9/6/3</td>
<td>454/453</td>
<td>78/453</td>
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<tr>
<td></td>
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<td>93/6/3</td>
<td>7/453</td>
<td>93/953</td>
<td>63/6/3</td>
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<tr>
<td>7</td>
<td>3058</td>
<td>85/3</td>
<td>QS</td>
<td>8/6/3</td>
<td>QS</td>
</tr>
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<td>83</td>
<td>95/83</td>
<td>QS</td>
<td>95/83</td>
<td>QS</td>
</tr>
<tr>
<td></td>
<td>433</td>
<td>99/5&lt;3</td>
<td>QS</td>
<td>4/43</td>
<td>QS</td>
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</tbody>
</table>
I made these superscript
Paul Coats, 9/24/2015
### Table 10 – Group I-1 Condition1 NFPA 13R-Compliant Sprinklered Buildings – Maximum Floor Area per Story

<table>
<thead>
<tr>
<th>Floor Area</th>
<th>#</th>
<th>Condition</th>
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<td>308</td>
<td>49,833</td>
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<tr>
<td></td>
<td>83</td>
<td>53,953</td>
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<tr>
<td></td>
<td>433</td>
<td>5;:3</td>
</tr>
<tr>
<td>7</td>
<td>308</td>
<td>49,833</td>
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<tr>
<td></td>
<td>83</td>
<td>53,953</td>
</tr>
<tr>
<td></td>
<td>433</td>
<td>5;:3</td>
</tr>
</tbody>
</table>

**Footnotes – Group I-1, NFPA 13R-Compliant Buildings**

**NP = Not Permitted**

a. The maximum floor area for four stories above grade plane was determined in accordance with Section 506.2.3 and using a value of \( S_a = 4 \) as permitted when using an NFPA 13R sprinkler system.

b. Frontage based on open space widths of 30 feet or more.

c. Interpolation permitted.

d. Section 903.2.6 permits Group I-1 occupancies to be sprinklered with an NFPA 13R-compliant system. The occupancies do not qualify for area increases due to sprinklers.

e. Type VB construction does not permit three stories above grade plane.
I un-bolded certain table entries

Paul Coats, 9/24/2015
Example – Group I-1

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

Determine: Maximum allowable building area

Frontage Increase:
50 percent of the open space qualifies for the frontage increase

Table 10 – Group I-1 NFPA 13R-Compliant Sprinklered Buildings – Maximum Floor Area per Story

<table>
<thead>
<tr>
<th>#</th>
<th>( # )</th>
<th>1st Floor</th>
<th>2nd Floor</th>
<th>3rd Floor</th>
<th>4th Floor</th>
<th>5th Floor</th>
<th>6th Floor</th>
<th>7th Floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>305 #</td>
<td>8</td>
<td>49,833</td>
<td>43,833</td>
<td>45,833</td>
<td>45,833</td>
<td>45,833</td>
<td>45,833</td>
<td>45,833</td>
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<tr>
<td>83 #</td>
<td>53,953</td>
<td>45,833</td>
<td>55,833</td>
<td>46,833</td>
<td>8,953</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>433 #</td>
<td>5</td>
<td>4,833</td>
<td>4,833</td>
<td>64,833</td>
<td>4,633</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>305 #</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>49,833</td>
<td>45,833</td>
<td>45,833</td>
</tr>
<tr>
<td>83</td>
<td>53,953</td>
<td>QS</td>
<td>4,833</td>
<td>QS</td>
<td>QS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>433</td>
<td>5</td>
<td>QS</td>
<td>64,833</td>
<td>QS</td>
<td>QS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I unbolded certain table entries

Paul Coats, 9/24/2015
### Table 13 – Group M NFPA 13-Compliant Sprinklered Buildings – Maximum Floor Area per Story a, b, c cont.

<table>
<thead>
<tr>
<th># of stories</th>
<th>% frontage</th>
<th>Maximum floor area per story (sq. ft.)</th>
<th>IIA</th>
<th>IIB</th>
<th>IV</th>
<th>VA</th>
<th>VB</th>
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</thead>
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<tr>
<td>1</td>
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<td>58,009</td>
<td>36,009</td>
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<td>50</td>
<td>76,020</td>
<td>53,120</td>
<td>87,120</td>
<td>59,500</td>
<td>38,250</td>
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<tr>
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<td>100</td>
<td>87,870</td>
<td>59,370</td>
<td>97,370</td>
<td>65,500</td>
<td>42,750</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 (80)%</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0-25</td>
<td>55,500</td>
<td>37,500</td>
<td>61,500</td>
<td>42,000</td>
<td>27,000</td>
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</tr>
<tr>
<td></td>
<td>50</td>
<td>40,120</td>
<td>49,620</td>
<td>68,620</td>
<td>48,800</td>
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<td>100</td>
<td>60,270</td>
<td>48,970</td>
<td>76,970</td>
<td>52,900</td>
<td>33,750</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 (80)%</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
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</tr>
<tr>
<td>3</td>
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<td>37,500</td>
<td>61,500</td>
<td>42,000</td>
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<td>100 (80)%</td>
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<td>4</td>
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<td>52,550</td>
<td>NP</td>
<td>57,550</td>
<td>39,370</td>
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</tr>
<tr>
<td></td>
<td>100 (80)%</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td></td>
</tr>
<tr>
<td>5</td>
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</tr>
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<td>NP</td>
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<tr>
<td></td>
<td>100</td>
<td>41,620</td>
<td>NP</td>
<td>48,120</td>
<td>NP</td>
<td>NP</td>
<td></td>
</tr>
</tbody>
</table>

NP = Not Permitted
UL = Unlimited

a. The maximum floor area for four or more stories above grade plus was determined by dividing the maximum total allowable building area by the number of stories in accordance with Section 506.2.3. The floor area of the stories is assumed to be equal.
b. Frontage based on open space widths of 30 feet or more.
c. Interpolation permitted.
d. Sprinklered Group M buildings of one or two stories may be unlimited in area if the frontage width is at least 60 feet in accordance with Sections 507.3 and 507.5.
One-Story Buildings – Sprinklered

- **Unlimited area Group B, F, M and S**
  - Limits in Section 507.4.
  - 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.

One-Story Buildings – 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 507.4.1.
  - 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 Buildings – Sprinklered

- **Unlimited area Group A-3 buildings**
  - Limits in Section 507.7.
  - Type III or IV construction.
  - 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 507.4.
  - Type IIIA, IIIB and IV construction.
  - Used for tennis, swimming, skating and equestrian venues.

---

One-Story Buildings – Sprinklered

- **Unlimited area Group E buildings**
  - Limits in Section 507.11.
  - 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.
### One-Story Buildings – Nonsprinklered

- **Unlimited area Group F-2 or S-2 buildings**
  - Limits in Section 507.3.
  - Must be surrounded on all sides by public ways or yards not less than 60 feet wide.

### Two-Story Buildings – Sprinklered

- **Unlimited area Group B, F, M or S buildings**
  - Limits in Section 507.5.
  - Requires NFPA 13-compliant automatic sprinkler.
  - Must be surrounded on all sides by public ways or yards not less than 60 feet wide.
Reduced Open Space (507.2.1)

- **Up to 75 percent of the perimeter open space may be < 60 feet in width, provided:**
  - There is at least 40 feet open width provided and the exterior wall and all openings on those portions 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
  - Table 706.4 gives required ratings based on occupancies separated

---

Fire Walls (706.3)

- **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.
Stacked Buildings

Stacked Buildings (510)

- 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.
Horizontal Building Separation Allowance (510.2)

- 3-hour 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 the upper building.
  - Multiple Group A occupancies, each with an occupant load of less than 300, are also permitted in the upper building.
  - Lower building is permitted to be any occupancy except Group H.

Building Height – Stacked Buildings

- Building Height – in feet
  - Upper building height (feet) is measured from grade plane
- Building Height – in stories
  - Upper building height (stories) – measured from top of lower building
Group R-1 and R-2 Buildings (510.5)

- **Height increase to six stories and 75 feet allowed**
  - Limits in Section 510.5
  - Type IIIA Construction only
  - Involves subdivision with fire walls

Parking Beneath Group R (510.4)

- **Single-story Group S-2 parking garage**
  - Type I construction or open parking garage of Type IV construction
  - Grade entrance to parking
  - Limits in Section 510.4
Open Parking Garage Beneath Groups A, B, I, M and R (510.7)

- Open parking garage beneath Groups A, B, I, M and R
  - Limits in Section 510.7
  - Height of the upper building is measured from the grade plane and includes the open parking garage level
  - Open parking garage of Type IV construction permitted
Table 601 Fire-Resistance Rating Requirements For Building Elements (hr)

<table>
<thead>
<tr>
<th>EX</th>
<th>DG</th>
<th>HG</th>
<th>HP</th>
<th>HQ</th>
<th>W</th>
<th>SH</th>
<th>E</th>
<th>D#</th>
<th>R</th>
<th>D#</th>
<th>E</th>
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<tbody>
<tr>
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<td>E</td>
<td>D#</td>
<td>R</td>
<td>D#</td>
<td>E</td>
<td>KW</td>
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<td>E</td>
<td>E</td>
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<td>4</td>
<td>E</td>
<td>E</td>
<td>3</td>
<td>KW</td>
<td>4</td>
<td>E</td>
</tr>
</tbody>
</table>

Methods for Determining Fire Resistance (703)

- **Seven methods to determine fire resistance:**
  - Tested fire assembly (ASTM E119 or UL 263)
  - Fire resistance designs documented in approved sources
  - Prescriptive assemblies using of fire-resistance-rated designs in Section 721
  - Calculation of fire resistance per Section 722
  - Engineering analysis based on a comparison of building element, component or assembly designs that have been tested
  - Alternative protection methods per Section 104.11
  - Fire-resistance designs certified by an approved agency
Tested Assembly (703.2)

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

Prescriptive Assembly (703.3)

- Fire-resistance designs documented in approved sources
- Fire resistance of certain wood assemblies is prescribed in Section 721 based on testing using ASTM E 119 or UL 263
Calculated Fire Resistance (703.3)

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

Calculated Resistance (703.3)

- AWC’s Technical Report No. 10 (TR10), Calculating the Fire Resistance of Exposed Wood Members, contains explanations and examples of the method.
Calculated Resistance (703.3)

- 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.

Calculated Resistance (703.3)

- Table 722.6.2 (1)
  Time Assigned to Wallboard Membranes

<table>
<thead>
<tr>
<th>Description of Finish</th>
<th>Time Assigned (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch wood structural panel bonded w/ exterior glue</td>
<td>3</td>
</tr>
<tr>
<td>7/32 inch wood structural panel bonded w/ exterior glue</td>
<td>10</td>
</tr>
<tr>
<td>1/8 inch wood structural panel bonded w/ exterior glue</td>
<td>15</td>
</tr>
<tr>
<td>1/4 inch gypsum wallboard</td>
<td>15</td>
</tr>
<tr>
<td>1/2 inch gypsum wallboard</td>
<td>30</td>
</tr>
<tr>
<td>1/2 inch Type X gypsum wallboard</td>
<td>40</td>
</tr>
<tr>
<td>Double 1/2 inch gypsum wallboard</td>
<td>25</td>
</tr>
<tr>
<td>1 inch x 1/4 inch gypsum wallboard</td>
<td>35</td>
</tr>
<tr>
<td>Double 1/2 inch gypsum wallboard</td>
<td>40</td>
</tr>
</tbody>
</table>

For 1/4 inch x 1/4 inch wood structure, the time assigned is not a finished rating.
Calculated Resistance (703.3)

• 703.3 Alternative Methods for Determining Fire Resistance
  • Item 4: Engineering analysis based on a comparison of building element, component or assemblies designs having fire-resistance ratings as determined by the test procedures set forth in ASTM E 119 or UL 263.

Polling Question

3. Which of the following is NOT a method of establishing fire resistance?
   a) Prescriptive assemblies found in the building code
   b) Calculations in accordance with Section 722 or the NDS
   c) Engineering analysis based on a comparison of tested assemblies
   d) Nondestructive field testing per ASTM E84
Wood Use in Noncombustible Construction

Type I and II Applications

- Require the use of noncombustible materials
- Section 603 specifies 26 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 (603)
  - Permitted in nonbearing partitions where the fire-resistance rating does not exceed two hours.
  - Nonbearing exterior walls (unrated).
  - Roof construction, including structural framework, permits FRTW, except for Type IA 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 noncombustible construction (Table 601 footnote c, except Type IA buildings)
Type I and II Applications

- Some other examples (Section 603):
  - Interior finishes, millwork, trim, flooring, windows and doors
  - Partitions of limited height, platforms, blocking for fixtures
  - Exterior wall coverings, balconies and projections
Wood Foundations (1807.1.4)

- Wood foundations for buildings are permitted when designed and installed in accordance with the AWC Permanent Wood Foundation Design Specification (PWF).

Wood Walls and Partitions

- Type I and II
  - Partitions dividing single-tenant offices or retail and not creating corridors serving 30 or more occupants are permitted to be FRTW, 1-hour FRR construction or of wood panels or similar light construction up to six feet in height. (Section 603.1, Item 11).
Wood Walls and Partitions

- **Type III and V**
  - Wood stud framing is permitted for all load-bearing and nonload-bearing interior walls and partitions.

Wood Walls and Partitions

- **Type IV**
  - Permits wood stud framed partitions of 1-hour FRR construction or solid wood at least two layers of 1-inch matched boards or 4-inch-thick laminated construction. (Section 602.4.8)
Wood Interior Finish (Chapter 8)

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

Wood Interior Finish Classification System – Nonsprinklered Buildings (Table 803.11)
PC193 made slight stylistic corrections only to make superscripts work
Paul Coats, 9/24/2015
# Wood Interior Finish Classification System – Sprinklered Buildings (Table 803.11)

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<thead>
<tr>
<th>Wood Type</th>
<th>Class</th>
<th>Classification</th>
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### Wood Interior Finish (803)

- Most wood species qualify as Class C, and some as Class B.
- Wood boards and panels may meet Class A criteria when pressure treated with a fire-retardant chemical.
- AWC’s DCA-1 documents the performance.
PC196 made slight spacing corrections
Paul Coats, 9/24/2015
Wood Interior Finish – Exceptions

- Traditional wood floor covering is exempt from interior floor finish requirements (804.1).
- Exposed portions of Type IV structural members also exempt (803.3).

Wood Interior Trim (806)

- Trim is required to meet a Class C classification.
- Combustible trim, excluding handrails and guards, cannot exceed 10 percent of the wall or ceiling area to which it is attached. (806.7)
Exterior 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)

- Unlimited amounts of unprotected openings are permitted by Table 705.8
  - When exterior walls are 30 feet or more from the lot line
  - 20 feet or more from the lot line (sprinklered buildings)
  - 10 feet or more from the lot line (Types IIB or VB construction) (705.8.1 exception 2)

- No unprotected openings are permitted in the exterior wall
  - Within five feet of the lot line (nonsprinklered buildings)

- No openings
  - When wall is closer than three feet from the lot line
Exterior Windows and Doors

- Bay and oriel windows must conform to the type of construction required for the building (1406.4)
- FRTW may be used for buildings under four stories

Interior 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 for wood siding in 1405.2 and restrictions for exterior wood veneers in 1405.5
- See Chapter 23 for wood siding as a structural building material

Wood Balconies (1406.3)

- Exterior balconies may be of Type IV construction or of wood construction that provides a fire-resistance rating equal to the floor rating required by Table 601.
  - Length limited to 50 percent 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 the building is of Type IV and V construction (Sections 1011.7 and 1012.7).
- Buildings up to six stories and no high-rise

Wood Roof Covering

- Roof assemblies and coverings are divided into three (A, B & C) classifications by testing to the ASTM E 108 or UL 790 standard. (Table 1505.1)
Wood Roof Covering (1505)

- Table 1505.1 requires a minimum Class B roof covering for all types of construction except Types IIB, IIIIB and VB.

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Wood Projections – Limits (705.2)

- Types III, IV and V construction
  - Projections of any material are permitted, subject to the limitation of Section 705.2.3.
  - Combustible projections located where protection of some openings is required or within five feet of the lot line (or other line used to determine the fire separation distance) must be one of the following:
    - Minimum 1-hour fire-resistance-rated construction
    - Type IV construction
    - FRTW
Wood Projections – Limits (705.2)

- Wood penthouses of FRTW may be placed on:
  - Type I construction two stories or less above grade plane
  - Type II construction with the penthouse at least five feet from the lot line

Wood Rooftop Structures (1510)
I replaced this figure with the final one from the PDF.
Wood Rooftop Structures (1510)

- Type III, IV and VA construction permits the penthouse to be Type IV construction or FRTW when 20 feet or more from the lot line (1510.2.5 Exc. 3).
- Wood towers, spires, domes and cupolas are permitted on buildings of Type III, IV and V (see limitations in 1510.5).

Wood in Locations Subject to Decay or Termites

- Wood must be naturally durable wood species or preservative-treated wood using water-borne preservatives, in accordance with AWPA U1.
- Locations are listed in Section 2304.12
Polling Question

True/False

Structural Considerations
Structural Considerations – Chapter 23

- For design of buildings and structures that use wood and wood-based products in framing and fabrication
- Covered:
  - Minimum Standards and Quality
  - Design Considerations and Standard
  - General Construction Requirements
  - Conventional Light-Frame Construction

Compliance Paths – Chapter 23

- Permits five design paths – compliance with one or more is required.
  - Allowable Stress Design (ASD)
  - Load and Resistance Factor Design (LRFD)
  - Conventional Light Frame Construction
  - AWC Wood Frame Construction Manual (WFCM)
  - ICC 400 for Log Structures
Materials that have production and quality control standards include:

- Structural sawn lumber
- End-jointed lumber
- Prefabricated wood I-joists
- Structural glued-laminated timber
- Structural glued cross-laminated timber
- Wood structural panels
- Fiberboard sheathing
- Hardboard siding
- Particleboard
- Preservative-treated and fire-retardant-treated wood
- Structural log members
- Structural composite lumber
- Round timber poles and piles
- Engineered wood rim board
- Wood trusses
- Joist hangers
- Nails
- Staples

Framing (2304)

- Conventional light-frame construction does not require computations to determine the size of members or fasteners.
- ASD and LRFD designs assume actual member sizes rather than nominal sizes.
- Section 2304 applies to all design methods
Structural Panels and Sheathing (2304.6)

- Defined as being plywood, oriented strand board (OSB) and composite panel.
- Exterior sheathing is required to be manufactured with exterior glue (Exposure 1 or Exterior).
  - When exposed to the weather must have an exterior exposure durability classification.
- Tables in 2304.6 show minimum spans and connections for wind design.

Lumber Decking (2304.9)

- Method of floor constructions
  - Employs individual wood members set on edge and connected
- Required to be square-end trimmed and supported in one of five layup patterns
  - Simple span
  - Two-span continuous
  - Combination simple and two-span continuous
  - Cantilevered pieces intermixed
  - Controlled random
Connectors and Fasteners (2304.10)

- Common for designed structures to have greater fastening requirements than to those prescribed in Table 2304.10.1.
- Where wall framing members are not continuous from the foundation sill to the roof, a continuous load path using sheet metal clamps, ties or clips must be provided and must be corrosion resistant (often galvanized steel) if they are subject to moisture.
- Joist and framing anchors may be used in accordance with the manufacturer’s instructions, and other fasteners such as clips, staples, and glues are permitted when approved by the building official.
- Fasteners in contact with preservative-treated and fire-retardant wood are required to be corrosion resistant.

Lateral Force-Resisting System

- Applies to structures using wood-framed shear walls or wood-framed diaphragms to resist wind, seismic or other lateral loads.
- References SDPWS except for designs using staples.
Engineered Design - Allowable Stress and Load and Resistance Factor (2306 and 2307)

- When designed and built in accordance with the standards listed in these sections, a building or structure is deemed to comply with the code.

Conventional Light Frame (2308)

- The provisions of Section 2308 are prescriptive and limited in scope and application—generally building construction having closely spaced framing (not exceeding 24 inches on center) with studs up to 2 x 6 inches in size and rafters up to 2 x 12 inches in size.
- Height limits range from one story in Categories D and E to three stories in Categories A and B.
- Maximum floor-to-floor height is 11-feet, 7-inches in all seismic zones.
- Exterior bearing walls and interior bracing walls are limited to a stud height of 10 feet.
- Allowable loads and wind speeds are limited (e.g., live loads not exceeding 40 psf, $V_{ult} < 130$ mph).
Span Tables (2308)

- Provided for girders, floor joists, ceiling joists and rafters.
- Tables reflect the revised design values for Southern Pine.

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Prescriptive Framing Details (2308)

- Sections 2308.4, 2308.5 and 2308.7 contain many subsections describing required framing details for conventional construction, including minimum bearing, notches and holes, lateral support and framing around openings.
Need large, clear image of table.
S Hyde, 9/28/2015
Wind Uplift (2308.7.5)

- Requires compliance with both Table 2304.10.1, which is the fastening schedule, and Table 2308.7.5, which specifies the minimum uplift resistance to be provided between the roof framing and wall below in conventional construction.
- When ties are required by the table, a tie is required on every rafter or truss to the stud below, assuming the roof framing is spaced 24 inches on center. Notes to Table 2308.7.5 permit adjustments for other spacings, wind exposures, and mean roof heights.

Wall Framing (2308.5)

- Size, height and spacing of studs in conventional construction are required to be in accordance with Table 2308.5.1.
- When stud heights exceed 10 feet or the structure is outside the scope of applicability of the conventional construction requirements, studs must be designed in accordance with accepted engineering practice.
- Studs in non load-bearing walls and partitions are permitted to be spaced at 24-inches on center.
- 2308.5 contains common framing details, including cripple walls.
Wall Bracing (2308.6)

- Prescriptive braced walls lines in conventional construction must be located in accordance with Figure 2308.6.1 and Table 2308.6.1 based on SDC and story height.
- Possible bracing methods and materials are listed in Table 2308.6.3(1)

WFCM Scoping (2309)

- The Wood Frame Construction Manual may be used for commercial buildings within its scope and the following limitations:
  - Risk Category I and II buildings only
  - The maximum building dimensions and load limitations of Section 1.1.3 of the WFCM
Precautions During Construction—Chapter 33

Fire Extinguisher (3309)

- **During construction, one portable fire extinguisher must be placed at:**
  - Each stairway on all floor levels with combustible materials
  - 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 is installed before the construction is 40 feet above fire department access.
Sprinkler System Commissioning (3312)

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

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)
Requirements of the IFC Chapter 33

- Additional requirements for fire safety during construction are contained in the IFC.
- Temporary heating equipment must be listed and labeled (3303).
- Smoking is prohibited except in approved areas with posted signage (3304.1).
- A fire watch must be maintained with qualified personnel if required by the fire code official (3304.5).

Requirements of the IFC

- Welding operations must follow the provisions of IFC Chapter 35. Electrical wiring must comply with NFPA 70 (IFC 3304).
- The owner must designate a fire prevention superintendent responsible for the fire prevention program during construction (3308).
- An accessible emergency phone must be provided in an approved location at the construction site (3309).
Requirements of the IFC

- Fire-fighting vehicle access must be provided within 100 feet of temporary or permanent fire department connections (3310).
- An approved water supply for fire protection must be available when combustible material is at the construction site (3312).
- Requirements for safeguards during roofing operations 3317).
American Wood Council Standards


- Special occupancies
- Fire resistance
- Building features
- Wood in noncombustible construction types
- Structural considerations
- Precautions during construction

- Also available for 2009 and 2012 IBC

http://awc.org/codes-standards/buildingcodes/ccwd
corrected table entry spacings
Paul Coats, 9/24/2015
Design for Code Acceptance

The Design for Code Acceptance documents can be downloaded for free at: www.awc.org/codes-standards/publications.
Other Associations Publishing Referenced Standards

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Questions?

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

American Wood Council

info@awc.org

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