Designing and Engineering Mass Timber Buildings in California

February 16, 2023

Presented by
Chelsea Drenick, SE, WoodWorks
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New Code Provisions for Tall Timber Structures in California

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Apex Plaza / Courtesy William McDonough + Partner
Designing a wood building? Ask us anything.

FREE PROJECT SUPPORT / EDUCATION / RESOURCES

Nationwide support for the code-compliant design, engineering and construction of non-residential and multi-family wood buildings.

- Allowable Heights/Areas
- Construction Types
- Structural Detailing
- Wood-Framed & Hybrid Systems
- Fire/Acoustic Assemblies
- Lateral System Design
- Alternate Means of Compliance
- Energy-Efficient Detailing
- Building Systems & Technologies

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Regional Directors: One-on-One Project Support
Need Project Support?
<table>
<thead>
<tr>
<th>Building Systems</th>
<th>Building Types</th>
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</thead>
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<td>Light-Frame</td>
<td>Multi-Family / Mixed Use</td>
</tr>
<tr>
<td>Mass Timber / CLT</td>
<td>Education</td>
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<tr>
<td>Off-Site / Panelized Construction</td>
<td>Office</td>
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<td>Hybrid</td>
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<td>Industrial</td>
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<td>Civic / Recreational</td>
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<td>Institutional / Healthcare</td>
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On Demand Education
Find over 140 continuing education courses on wood topics for architects, engineers, general contractors, and code officials.

WoodWorks Innovation Network
Discover mass timber projects across the US and connect with their teams.

WoodWorks is your go-to resource for commercial and multi-family wood building design, engineering, and construction. We’re here to support you with free one-on-one expert consultations.
Acoustics and Mass Timber: Room-to-Room Noise Control
This paper covers key aspects of mass timber acoustical design, including rules of thumb for optimal design, common assemblies, detailing strategies, and flanking paths. Companion to the Inventory of Mass Timber Acoustic Assemblies.

Designing Mass Timber Floor Assemblies for Acoustics
The growing availability and code acceptance of mass timber for construction has given designers a low-carbon alternative.

Impact of Wall Stud Size and Spacing on Fire and Acoustic Performance
Interior wall partitions in a wood-frame building—such as unit demising and corridor walls in a multi-family project—must meet several design objectives simultaneously. Two primary functions are fire resistance and acoustical separation. Having to cite two tested wall assemblies, one for fire-resistance endurance results and another for acoustic results, is common.

Firehouse 12
The continuous plywood shell that creates varying acoustic conditions within the performance space forms the exterior of the auditorium.

Acoustical Considerations for Mixed-Use Wood-Frame Buildings
This paper will help you understand the effects of acoustics in the context of other performance areas, enabling you to more easily navigate the decisions and trade-offs required when evaluating assembly options.

Holes and Penetrations in Mass Timber Floor and Roof Panels
Guidance for the design of mass timber floor and roof panels with openings, including structural, fire resistance, and acoustic impacts, and tips for reinforcement.
Current State of Mass Timber Projects

As of December 2022, in the US, 1,667 multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.
WoodWorks is supporting **189 tall wood projects**

- **Minnesota Places**, rendering Wright Architecture; Carbon 12, Kaiser+Path, photo Andrew Pogue; Heartwood, rendering Atelier Jones; INTRO Cleveland, Harbor Bay Real Estate Advisors, HPA Architecture; Ascent, Korb + Associates Architects, Thornton Tomasetti; 11 E Lenox, rendering Monte French Design Studio; 80 M Street, Hickok Cole Architects, Columbia Property Trust; Apex Plaza, rendering William McDonough + Partners

**TALL WOOD**

- **INTRO Cleveland**
  - Cleveland, OH
  - 9 stories – 8 mass timber

- **Heartwood**
  - Seattle, WA
  - 8 stories mass timber

- **Carbon 12**
  - Portland, OR
  - 8 stories mass timber

- **Ascent**
  - Milwaukee, WI
  - 25 stories – 19 mass timber

- **11 E Lenox**
  - Boston, MA
  - 7 stories mass timber

- **80 M Street**
  - Washington DC
  - 10 stories – 3-story mass timber vertical addition

- **Apex Plaza**
  - Charlottesville, VA
  - 8 stories – 6 mass timber

**= 20 in-design tall wood projects**

**= tall wood project in construction or completed**
### Membership Type
- **Professionals**
  - Verified by Project Experience: 115
- **Community Members**
  - 14
- **Manufacturers & Suppliers**
  - WoodWorks Partners

### Companies and PROs
- **StructureCraft**
  - Manufacturer Partner
- **SmartLam NA**
  - Manufacturer Partner
- **Sansin**
  - Manufacturer Partner
- **Simpson Strong-Tie**
  - Manufacturer Partner
- **DR Johnson**
  - Manufacturer Partner
- **HASLACHER Group**
  - Manufacturer Partner

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*Note: The interface is a screenshot from the WoodWorks Innovation Network website, showing search filters for membership types and companies.*
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presentation slides in pdf:
woodworks.org/presentation-archive/
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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.
As awareness of mass timber’s potential for tall wood structures has grown, there has been a push among U.S. building designers to achieve greater heights with these materials. Initially, tall wood buildings in the U.S. were proposed using international examples as precedent, with a project-specific performance-based design approach used. However, a uniform set of tall wood code provisions has begun going into effect in many States with adoption of the 2021 International Building Code (IBC), which will allow up to 18 stories of mass timber construction. The 2022 California Building Code (CBC) has now also been adopted with a series of tall wood code changes based on the new IBC provisions, but with California-specific modifications. Following a brief discussion of history and motivators, this presentation will introduce the new IBC and CBC tall wood code provisions, as well as the technical research and testing that supported their adoption.
Learning Objectives

1. Review the global history of tall wood construction and highlight the mass timber products used in these structures.

2. Explore the work and conclusions of the ICC Ad Hoc Committee on Tall Wood Buildings in establishing 17 new code provisions for the 2021 IBC.

3. Identify differences between the 2021 IBC and 2022 CBC relative to code allowances for tall timber structures.

4. Discuss differences between the new tall wood mass timber construction types and existing construction types.
The What, Why and How of Tall Mass Timber
TALL MASS TIMBER
ASSESSING THE WHAT
BROCK COMMONS, BRITISH COLUMBIA

18 STORIES | 174 FT

Photos: Michael Elkan | NaturallyWood | UBC
CARBON12, PORTLAND, OR

8 STORIES | 85 FT

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman | Architect: PATH Architecture
INTRO, CLEVELAND

9 Stories | 115 ft
8 Timber Over 1 Podium

512,000 SF
297 Apartments, Mixed-Use

Photo: Harbor Bay Real Estate Advisors, Purple Film | Architect: Hartshorne Plunkard Architecture
INTRO, CLEVELAND

Type IV-B
Variance to expose ~50% ceilings

Photo: Harbor Bay Real Estate Advisors, Image Fiction | Architect: Hartshorne Plunkard Architecture
ASCENT, MILWAUKEE

493,000 SF
259 APARTMENTS, MIXED-USE

Photo: Korb & Associates Architects | Architect: Korb & Associates Architects
ASCENT, MILWAUKEE

Tallest Mass Timber Building in the World

Photo: CD Smith Construction | Architect: Korb & Associates Architects
25 STORIES

19 TIMBER OVER 6 PODIUM, 284 FT

Photo: Korb & Associates Architects | Architect: Korb & Associates Architects
3 STORY VERTICAL ADDITION
ON EXISTING 7-STORY CONCRETE BUILDING
80 M ST, WASHINGTON, DC

100,000 SF
2 NEW LEVELS OF CLASS A OFFICE SPACE
OCCUPIED PENTHOUSE
17'-0" CEILING HEIGHTS
APEX PLAZA
CHARLOTTESVILLE, VA

8 STORIES
6 TIMBER OVER 2 PODIUM, 100 FT
187,000 SF

PRIMARILY OFFICE SPACE
11 E LENOX, BOSTON, MA

7 STORIES
70 FT
Passive House
Multi-Family

Credit: Monte French Design Studio
Credit: H + O Structural Engineering
11 E LENOX, BOSTON, MA

Credit: H + O Structural Engineering
HEARTWOOD, SEATTLE

8 STORIES
Workforce Housing

Photo: Atelier Jones | Architect: Atelier Jones

Type IV-C  66,000 SF
MINNESOTA PLACES, PORTLAND

8 STORIES
Affordable Housing

Type IV-C    72 Units    7 Stories of Timber over Podium
TALL MASS TIMBER
UNDERSTANDING THE WHY

Brock Commons, Vancouver, BC | Architect: Acton Ostry | Image Courtesy naturallywood
New Buildings & Greenhouse Gases

Buildings generate nearly 40% of annual global greenhouse gas emissions (building operations + embodied energy).

Embodied Energy (11%): Concrete, iron + steel produce approximately 9% of this (Architecture 2030).


Image: Architecture 2030
Embodied vs. Operational Energy
(High Performing Non-Wood Building)

Image Credit: Gray Organschi Architecture
Carbon Storage
Wood ≈ 50% Carbon (dry weight)
Biophilia - Structural Warmth is a Value-Add
Construction Impacts: Labor Availability

Photo: Lendlease
Construction Impacts: Schedule

Lightweight Structure
75% lighter weight than concrete
<table>
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<tr>
<th>Potential Benefits</th>
<th>Project Goal</th>
<th>Value Add</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast construction/shorter schedules; pre-fabricated and precise</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Exposed wood (structure is finish!)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>• Aesthetic value; potential for faster leasing and lease premiums; portfolio distinction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Biophilia; healthy indoor environment</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Lightweight structure, especially beneficial on sites with poor soils</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Labor shortage solutions</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>• Small crews for timber frame erection</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>• Utilize more entry-level laborers when MEP and fire protection systems are fully designed, coordinated and pre-planned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just-in-time delivery and small staging/lay-down areas; ideal for dense urban areas</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Natural, renewable material; environmentally friendly with a lighter carbon footprint</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Support healthy forests and rural economies</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>• Mass timber can be made from relatively small-diameter trees and those affected by insects or disease; creates a market incentive for forest thinning and other landscape restoration efforts that reduce the risk of high-severity wildfires</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
TALL MASS TIMBER DEMONSTRATING THE HOW
OVERVIEW | TERMINOLOGY

Light-Frame Wood
Photo: WoodWorks

Heavy Timber
Photo: Benjamin Benschneider

Mass Timber
Photo: John Stamets
Glue Laminated Timber (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo: StructureCraft
Photo: LendLease
Photo: LEVER Architecture

Photo: Freres Lumber
Dowel-Laminated Timber (DLT)

Nail-Laminated Timber (NLT)

Photo: Think Wood

Glue-Laminated Timber (GLT)

Plank orientation

Photo: StructureCraft

Photo: Manasc Isaac Architects/Fast + Epp

Photo: Ema Peter
NEW MASS TIMBER CONNECTIONS INDEX

A library of commonly used mass timber connections with designer notes and information on fire resistance, relative cost and load-carrying capacity.
MASS TIMBER DESIGN

FIRE RESISTANCE

Mass Timber’s Fire-Resistive Performance is Well-Tested, Documented and Recognized via Code Acceptance

<table>
<thead>
<tr>
<th>Required Fire Resistance (hr.)</th>
<th>Char Depth, $a_{char}$ (in.)</th>
<th>Effective Char Depth, $a_{eff}$ (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Hour</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>1½-Hour</td>
<td>2.1</td>
<td>2.5</td>
</tr>
<tr>
<td>2-Hour</td>
<td>2.6</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Source: AWC's NDS

Credit: David Barber, ARUP
FRR Design of MT

Calculated FRR of Exposed MT: IBC to NDS code compliance path

IBC 703.3
Methods for determining fire resistance
- Prescriptive designs per IBC 721.1
- Calculations in accordance with IBC 722
- Fire-resistance designs documented in sources
- Engineering analysis based on a comparison
- Alternate protection methods as allowed by 104.11

IBC 722
Calculated Fire Resistance
*The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/AWC National Design Specification for Wood Construction (NDS)*

NDS Chapter 16
Fire Design of Wood Members
- Limited to calculating fire resistance up to 2 hours
- Char depth varies based on exposure time (i.e., fire-resistance rating), product type and lamination thickness. Equations and tables are provided.
- TR 10 and NDS commentary are helpful in implementing permitted calculations.
Key Early Design Decisions

Fire-Resistance Ratings (FRR)

- Thinner panels (i.e. 3-ply) generally difficult to achieve a 1+ hour FRR
- 5-ply CLT / 2x6 NLT & DLT panels can usually achieve a 1- or 2-hour FRR
- Construction Type | FRR | Member Size | Grid (or re-arrange that process but follow how one impacts the others)

<table>
<thead>
<tr>
<th>Panel</th>
<th>Example Floor Span Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-ply CLT (4-1/8” thick)</td>
<td>Up to 12 ft</td>
</tr>
<tr>
<td>5-ply CLT (6-7/8” thick)</td>
<td>14 to 17 ft</td>
</tr>
<tr>
<td>7-ply CLT (9-5/8”)</td>
<td>17 to 21 ft</td>
</tr>
<tr>
<td>2x4 NLT</td>
<td>Up to 12 ft</td>
</tr>
<tr>
<td>2x6 NLT</td>
<td>10 to 17 ft</td>
</tr>
<tr>
<td>2x8 NLT</td>
<td>14 to 21 ft</td>
</tr>
<tr>
<td>5” MPP</td>
<td>10 to 15 ft</td>
</tr>
</tbody>
</table>

Credit: David Barber, ARUP
### FRR Design of MT

**WoodWorks Inventory of Fire Tested MT Assemblies**

#### Table 1: North American Fire Resistance Tests of Mass Timber Floor / Roof Assemblies

<table>
<thead>
<tr>
<th>CLT Panel</th>
<th>Manufacturer</th>
<th>CLT Grade or Major x Minor Grade</th>
<th>Ceiling Protection</th>
<th>Panel Connection to Test</th>
<th>Floor Tapping</th>
<th>Load Rating</th>
<th>Fire Resistance Achieved [Hours]</th>
<th>Source</th>
<th>Testing Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 ply CLT (175mm x 875mm)</td>
<td>Nordic</td>
<td>SPF 1400 Fi 13-1000 x SPF 83.2</td>
<td>None</td>
<td>Half Lay</td>
<td>None</td>
<td>Reduced 39% Moment Capacity</td>
<td>1</td>
<td>(Test 1)</td>
<td>NRC Fire Laboratory</td>
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<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 875mm)</td>
<td>Nordic</td>
<td>EI</td>
<td>None</td>
<td>Topside splice</td>
<td>2 staggered layers of 1/2” cement boards</td>
<td>Reduced 50% Moment Capacity</td>
<td>1</td>
<td>Test 5</td>
<td>NRC Fire Laboratory</td>
</tr>
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<td>5 ply CLT (175mm x 875mm)</td>
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<td>Reduced 50% Moment Capacity</td>
<td>1</td>
<td>Test 5</td>
<td>NRC Fire Laboratory</td>
</tr>
</tbody>
</table>
Common mass timber floor assembly:

- Finish floor (if applicable)
- Underlayment (if finish floor)
- 1.5” to 4” thick concrete/gypcrete topping
- Acoustical mat
- WSP (if applicable)
- Mass timber floor panels

Image credit: AcoustiTECH
Know The Supply Chain

Efficiency found in understanding supply chain, designing according to its capabilities.
TALL WOOD IN THE U.S.
BEFORE 2021 IBC Code Limit for wood - 6 stories (business) 5 stories (residential) and 85 feet

Over 6 Stories:
Alternate Means and Methods Request (AMMR) through performance based design

Type V  Type III  Type IV (HT)  + Mezzanines  + Podiums
Seen as the catalyst for the mass timber revolution, CLT first recognized in US codes in the 2015 IBC

[B3] CROSS-LAMINATED TIMBER. A prefabricated engineered wood product consisting of not less than 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.

2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.
In December 2015, the ICC Board established the ICC Ad Hoc Committee on Tall Wood Buildings. Objectives:
1. Explore the building science of tall wood buildings
2. Investigate the feasibility, and
3. Take action on developing code changes for tall wood buildings.
Taller wood buildings create new set of challenges to address:

AHC established 6 performance objectives:

1. No collapse under reasonable scenarios of complete burn-out of fuel without automatic sprinkler protection being considered.
2. Highly reliable fire suppression systems to reduce the risk of failure during reasonably expected fire scenarios. The degree of reliability should be proportional to evacuation time (height) and the risk of collapse.
AHC established 6 performance objectives:

3. No unusually high radiation exposure from the subject building to adjoining properties to present a risk of ignition under reasonably severe fire scenarios.

4. No unusual response from typical radiation exposure from adjacent properties to present a risk of ignition of the subject building under reasonably severe fire scenarios.
AHC established 6 performance objectives:

5. No unusual fire department access issues
6. Egress systems designed to protect building occupants during the design escape time, plus a factor of safety.
Commissioned series of 5 full-scale tests on 2-story mass timber structure at ATF lab in MD, May-June 2017
Tests on exposed mass timber, gypsum-covered mass timber; normal sprinkler protection, delayed sprinkler protection

 Majority of flames seen are from contents, not structure
TALL WOOD APPROVED!
Unofficial results posted Dec 19, 2018
Final votes ratified Jan 31, 2019

AWC: Tall Mass Timber code changes get final approval
Dec 19, 2018

LEESBURG, VA. – The International Code Council (ICC) has released the unofficial voting results on code change proposals considered in 2018, including passage of the entire package of 14 tall mass timber code change proposals. The proposals create three new types of construction (Types IV-A, IV-B and IV-C), which set fire safety requirements, and allowable heights, areas and number of stories for tall mass timber buildings. Official results are expected to be announced during the first quarter of 2019. The new provisions will be included in the 2021 International Building Code (IBC).

“Mass timber has been capturing the imagination of architects and developers, and the ICC result means they can now turn sketches into reality. ICC’s rigorous study, testing and voting process now means these new and modern fire-safe buildings are on the market,” said N. William Steele, ICC’s Executive Director/CEO. The AWC proposal included 14 separate code change proposals.
2021 IBC Introduces 3 new tall wood construction types: IV-A, IV-B, IV-C
Previous type IV renamed type IV-HT
New Building Types

Credit: Susan Jones, atelierjones
Type IV-A

18 STORIES
BUILDING HEIGHT 270'
ALLOWABLE BUILDING AREA 972,000 SF
AVERAGE AREA PER STORY 54,000SF

Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp, Urban One
Type IV-A Protection vs. Exposed

100% NC protection on all surfaces of Mass Timber

Credit: Susan Jones, atelierjones
Type IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture
Type IV-B Protection vs. Exposed

NC protection on all surfaces of Mass Timber except limited exposed areas

~20% of Ceiling or ~40% of Wall can be exposed, see code for requirements
Type IV-B Protection vs. Exposed

2021 IBC Allowances

Ceiling Exposed (<20%)
Wall Exposed (<40%)
Min. 15 ft Separation

Ceiling Exposed (<20%)
Min. 15 ft Separation
Type IV-B Protection vs. Exposed

2024 IBC Allowances

Ceiling Exposed (<100%)

Wall Exposed (<40%)

Ceiling Exposed (100%)

No separation req’d between wall & ceiling

Credit: AWC
Type IV-C

Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman
Type IV-C Protection vs. Exposed

All Mass Timber surfaces may be exposed

Exceptions: Shafts, concealed spaces, outside face of exterior walls
Mid-Rise vs. High-Rise

If this dimension exceeds 75 feet, building is considered a high rise.

Lowest Level of Fire Dept. Vehicle Access

10' floor to floor

FIGURE 6-6 Determination of high-rise building
Sprinklers in High Rises

- Two Water Mains Required if:
  - Building Height Exceeds 420 ft, or
  - Type IV-A and IV-B buildings that exceed 120 ft in height
**602.4 Type IV.** Type IV construction is that type of construction in which the building elements are mass timber or noncombustible materials and have fire resistance ratings in accordance with Table 601. Mass timber elements shall meet the fire resistance rating requirements of this section based on either the fire resistance rating of the noncombustible protection, the mass timber, or a combination of both and shall be determined in accordance with Section 703.2 or 703.3. The minimum dimensions and permitted materials for building elements shall comply with the provisions of this section and Section 2304.11. Mass timber exterior load-bearing walls and nonload-bearing walls shall be mass timber construction, or shall be of noncombustible construction.

**Exception:** Type IV-HT Construction in accordance with Section 602.4.4.

The interior building elements, including nonload-bearing walls and partitions, shall be of mass timber construction or of noncombustible construction.

**Exception:** Type IV-HT Construction in accordance with Section 602.4.4.
MT Type IV Minimum Sizes

In addition to meeting FRR, all MT elements must also meet minimum sizes.

These minimum sizes have been in place for old type IV (current type IV-HT) construction and the same minimums sizes also apply to MT used in new types IV-A, IV-B and IV-C.

Contained in IBC 2304.11
The definition of “Noncombustible Protection (For Mass Timber)” is created to address the passive fire protection of mass timber.

Mass timber is permitted to have its own fire-resistance rating (e.g., Mass Timber only) or have a fire resistance rating based on the fire resistance through a combination of the mass timber fire-resistance plus protection by non-combustible materials as defined in Section 703.5 (e.g., additional materials that delay the combustion of mass timber, such as gypsum board).
**Tall Wood Materials & Protection**

**Exterior Walls**

Mass Timber, exterior surface protected with 1 layer 5/8” type X gyp

**Structural Materials**

Mass Timber or Non-combustible

Permitted, requires NC protection on MT surfaces

All MT is protected
3 HR: 3 layers 5/8” type X gyp
2 HR or less: 2 layers 5/8” type X gyp

**Concealed Spaces**

Same as IV-A for protected MT. Limited exposed MT permitted, FRR still applies

**Gypsum Protection**

All MT permitted may be exposed except as noted
## Tall Wood Fire Resistance Ratings (FRR)

### Primary Frame or Brng Wall FRR

- **IV-A**: 3 HR (2 HR at Roof)
- **IV-B**: 2 HR (1 HR at Roof)
- **IV-C**: 2 HR (1 HR at Roof)

### Floor Construction FRR

<table>
<thead>
<tr>
<th></th>
<th>3 HR (2 HR at Roof)</th>
<th>2 HR (1 HR at Roof)</th>
<th>2 HR (1 HR at Roof)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 HR</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.5 HR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 inch of NC protection</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Roof Construction FRR

<table>
<thead>
<tr>
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<th>3 HR (2 HR at Roof)</th>
<th>2 HR (1 HR at Roof)</th>
<th>2 HR (1 HR at Roof)</th>
</tr>
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<tbody>
<tr>
<td>2 HR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 HR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 inch of NC protection</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Floor Surface Protection

<table>
<thead>
<tr>
<th></th>
<th>3 HR (2 HR at Roof)</th>
<th>2 HR (1 HR at Roof)</th>
<th>2 HR (1 HR at Roof)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No protection req’d</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MT Fire Resistance Ratings (FRR)

IBC 722.7
The fire resistance rating of the mass timber elements shall consist of the fire resistance of the unprotected element (MT) added to the protection time of the noncombustible (NC) protection.
New code provisions in International Fire Code (IFC) address construction fire safety of tall wood buildings

IFC 3308.4 Fire safety requirements for buildings of Types IV-A, IV-B, and IV-C construction. Buildings of Types IV-A, IV-B, and IV-C construction designed to be greater than six stories above grade plane shall meet the following requirements during construction unless otherwise approved by the fire code official.

1. Standpipes shall be provided in accordance with Section 3313.
2. A water supply for fire department operations, as approved by the fire chief.
Fire Safety During Construction

IFC/CFC 3313 Standpipe Requirements

SECTION 3313 STANDPIPES

3313.1 Where required.
In buildings required to have standpipes by Section 905.3.1, not less than one standpipe shall be provided for use during construction. Such standpipes shall be installed prior to construction exceeding 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipe shall be provided with fire department hose connections at accessible locations adjacent to usable stairways. Such standpipes shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.

3313.2 Buildings being demolished.
Where a building is being demolished and a standpipe is existing within such a building, such standpipe shall be maintained in an operable condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

3313.3 Detailed requirements.
Standpipes shall be installed in accordance with the provisions of Section 905.

Exception: Standpipes shall be either temporary or permanent in nature, and with or without a water supply, provided that such standpipes comply with the requirements of Section 905 as to capacity, outlet, and materials.
3. Where building construction exceeds six stories above grade plane, at least one layer of noncombustible protection where required by Section 602.4 of the International Building Code shall be installed on all building elements more than 4 floor levels, including mezzanines, below active mass timber construction before erecting additional floor levels.

4. Where building construction exceeds six stories above grade plane required exterior wall coverings shall be installed on all floor levels more than 4 floor levels, including mezzanines, below active mass timber construction before erecting additional floor level.

**Exception:** Shafts and vertical exit enclosures
Fire Safety During Construction

Examples of Protection During Construction
For Mass Timber Buildings Greater Than 6 Stories Above Grade Plane

Figure 1

Prior to placement of mass timber floor panels, all building elements more than 4 floor levels below the level of active mass timber construction shall be protected as required by this section.

Floor level of active mass timber construction.

Noncombustible floor covering required at this level and all lower floor levels.

Heavy bold lines indicate elements one layer of noncombustible protection on building elements of mass timber when required by Section 604.2.

Shading indicates where exterior wall covering is required.

Figure 2

Credit: ICC
WoodWorks Tall Wood Design Resource

TALL WOOD CODE ADOPTION IN CALIFORNIA
The CBC has historically not allowed “double-dipping” for sprinkler increases of building height and area for A, E, H, I, L or R occupancies. The IBC has no such restriction.

Also specific to the CBC, for multi-story buildings that are A, E, H, I, L or R occupancies, the total allowable building area is equal to the allowable floor area multiplied by the number of stories, not to exceed 2. In the IBC, this value is 3 for all occupancies.

This is also the case for Tall Wood.
CBC Tall Wood Building Size Limits

For example, if using the sprinkler area increases, the allowable height in the CBC is 20 ft and 1 story less than the IBC limits for Type IV-A, IV-B and IV-C construction for A, E, H-4, I-4, R-1 and R-2 occupancies.

<table>
<thead>
<tr>
<th>OCCUPANCY CLASSIFICATION</th>
<th>TYPE OF CONSTRUCTION</th>
<th>TYPE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SEE FOOTNOTES</td>
<td>A</td>
</tr>
<tr>
<td>B, F, M, S, U</td>
<td>NS&lt;sup&gt;e&lt;/sup&gt;</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>270</td>
</tr>
<tr>
<td>A, E</td>
<td>NS&lt;sup&gt;b&lt;/sup&gt;</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>S (without area increase)</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>S (with area increase)</td>
<td>250</td>
</tr>
</tbody>
</table>
## CBC Tall Wood Building Size Limits

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>I-A</th>
<th>I-B</th>
<th>IV-A</th>
<th>IV-B</th>
<th>IV-C</th>
<th>IV-HT</th>
<th>III-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>B, F, M, S, U, R-3, R-4</td>
<td>Unlimited</td>
<td>180*</td>
<td>270</td>
<td>180</td>
<td>85</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>A, E, R-1, R-2 (w/ area increase)</td>
<td>Unlimited</td>
<td>180 (160)</td>
<td>270 (250)</td>
<td>180 (160)</td>
<td>85 (65)</td>
<td>85 (65)</td>
<td>85 (65)</td>
</tr>
</tbody>
</table>

### Allowable Building Height above Grade Plane, Feet (CBC Table 504.3)

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>I-A</th>
<th>I-B</th>
<th>IV-A</th>
<th>IV-B</th>
<th>IV-C</th>
<th>IV-HT</th>
<th>III-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2, A-3, A-4 (w/ area increase)</td>
<td>Unlimited</td>
<td>12 (11)</td>
<td>18 (17)</td>
<td>12 (11)</td>
<td>6 (5)</td>
<td>4 (3)</td>
<td>4 (3)</td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td>12</td>
<td>18</td>
<td>12</td>
<td>9</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>R-1, R-2 (w/ area increase)</td>
<td>Unlimited</td>
<td>12 (11)</td>
<td>18 (17)</td>
<td>12 (11)</td>
<td>8 (7)</td>
<td>5 (4)</td>
<td>5 (4)</td>
</tr>
</tbody>
</table>

### Allowable Number of Stories above Grade Plane (CBC Table 504.4)

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>I-A</th>
<th>I-B</th>
<th>IV-A</th>
<th>IV-B</th>
<th>IV-C</th>
<th>IV-HT</th>
<th>III-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1, A-2, A-3, A-4 (w/ height increase)</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>135,000</td>
<td>90,000</td>
<td>56,250</td>
<td>45,000</td>
<td>42,000</td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>324,000</td>
<td>216,000</td>
<td>135,000</td>
<td>108,000</td>
<td>85,500</td>
</tr>
<tr>
<td>R-1, R-2 (w/ height increase)</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>184,500</td>
<td>123,000</td>
<td>76,875</td>
<td>61,500</td>
<td>72,000</td>
</tr>
</tbody>
</table>

### Allowable Area Factor (At) for SM, Feet² (CBC Table 506.2)

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>I-A</th>
<th>I-B</th>
<th>IV-A</th>
<th>IV-B</th>
<th>IV-C</th>
<th>IV-HT</th>
<th>III-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2, A-3, A-4 (w/ area increase)</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>135,000</td>
<td>90,000</td>
<td>56,250</td>
<td>45,000</td>
<td>42,000</td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>324,000</td>
<td>216,000</td>
<td>135,000</td>
<td>108,000</td>
<td>85,500</td>
</tr>
<tr>
<td>R-1, R-2 (w/ area increase)</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>184,500</td>
<td>123,000</td>
<td>76,875</td>
<td>61,500</td>
<td>72,000</td>
</tr>
</tbody>
</table>
CBC Tall Wood – Sprinkler Increase Options

Example: R-2, Type IV-B Building

- 11 Stories
  - 160 ft
  - 123,000 SF per floor
  - 246,000 SF total bldg

- 12 Stories
  - 180 ft
  - 41,000 SF per floor
  - 82,000 SF total bldg

w/ area increase

w/ height increase
Example: R-2, Type IV-B Building

- 11 Stories
- 160 ft
- 123,000 SF per floor
- 246,000 SF total bldg

w/ area increase + podium

- 11 Stories
- 160 ft
- 123,000 SF per floor
- 246,000 SF total bldg
- Type IA Podium (1 or more stories)