Exploring Tall Wood: New Code Provisions for Tall Timber Structures
Questions we’ll answer:
• What is tall wood?
• How tall is tall?
• What has been done?
• What wood products are used in tall wood?
• What does the code allow now?
• How did we arrive at the proposed tall wood code changes?
• What are the new tall wood code provisions?
TALL WOOD IN NORTH AMERICA Circa 1906
9 STORIES

THE LANDING, VANCOUVER

BUTLER SQUARE, MINNEAPOLIS
GLOBAL TALL WOOD CIRCA 2015
7-14 STORIES
GLOBAL TALL WOOD CIRCA 2019
18-24 STORIES

Photo: Moelven Lístre

Photo: naturally:wood

Photo: Rudiger Lainer + Partner
TALL WOOD IN THE US CIRCA 2019

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman  |  Architect: PATH Architecture
OFFICES | MULTI-FAMILY | COMMERCIAL | EDUCATIONAL

Photo: JC Buck
Photo: William Horne
Photo: LEVER Architecture

Photo: David Sundberg and Gray Organisci Architecture
Photo: ©Albert Vecerka/Esto
Photo: Christian Columbres
WHY TALL WOOD?
### Estimated Environmental Impact of Wood Use

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Volume of wood products used" /></td>
<td>Volume of wood products used: 2,233 cubic meters of CLT and Glulam</td>
</tr>
<tr>
<td><img src="image" alt="U.S. and Canadian forests grow this much wood in" /></td>
<td>U.S. and Canadian forests grow this much wood in: 6 minutes</td>
</tr>
<tr>
<td><img src="image" alt="Carbon stored in the wood" /></td>
<td>Carbon stored in the wood: 1,753 metric tons of CO₂</td>
</tr>
<tr>
<td><img src="image" alt="Avoided greenhouse gas emissions" /></td>
<td>Avoided greenhouse gas emissions: 679 metric tons of CO₂</td>
</tr>
<tr>
<td><img src="image" alt="Total potential carbon benefit" /></td>
<td>Total potential carbon benefit: 2,432 metric tons of CO₂</td>
</tr>
</tbody>
</table>

**THE ABOVE GHG EMISSIONS ARE EQUIVALENT**

- 511 cars off the road for a year
- Energy to operate a home for 222 years

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**Reduced Embodied Carbon**

**Brock Commons, Vancouver, BC**

Photo Credit: UBC

Source: Naturally:Wood9


*CO₂ in this case study refers to CO₂ equivalent.
MARKET DRIVERS FOR MASS TIMBER

PRIMARY DRIVERS
- Construction Efficiency & Speed
- Construction site constraints – Urban Infill
- Innovation/Aesthetic

SECONDARY DRIVERS
- Carbon Reductions
- Structural Performance – lightweight
TALL WOOD IN THE U.S.
» Current Prescriptive Code Limit - 6 stories (B occupancy) or 85 feet

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

» Based on the 1910 Heights and Areas Act
3 YEAR CODE CYCLE
Seen as the catalyst for the mass timber revolution, CLT first recognized in US codes in the 2015 IBC

[B5] 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.
Interest in tall wood projects in the US was rapidly increasing. Some building officials were reluctant to approve proposed plans, primarily due to lack of code direction and precedent.
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.
5 Working Groups Created

- July 2016 – November 2017: 5 in-person meetings, numerous conference calls
- 82 issues addressed, one primary topic was fire performance and life safety
Fire resistance of mass timber for low- to mid-rise structures well understood, codified
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.
U.S. BUILDING CODES
Tall Wood Ad Hoc Committee

Commissioned series of 5 full-scale tests on 2-story mass timber structure at ATF lab in MD, May-June 2017

Figure 1. General plan view of cross-laminated timber test structure.

Figure 2. Elevation view of the front of the cross-laminated timber test structure.
Tests on exposed mass timber, gypsum-covered mass timber; normal sprinkler protection, delayed sprinkler protection
Majority of flames seen are from contents, not structure
<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Construction Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>All mass timber surfaces protected with 2 layers of 5/8” Type X Gypsum. No Sprinklers.</td>
<td>IV-A</td>
</tr>
<tr>
<td>Test 2</td>
<td>30% of CLT ceiling area in living room and bedroom exposed. No Sprinklers.</td>
<td>IV-B</td>
</tr>
<tr>
<td>Test 3</td>
<td>Two opposing CLT walls exposed – one in bedroom and one in living room. No Sprinklers.</td>
<td>IV-B</td>
</tr>
<tr>
<td>Test 4</td>
<td>All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – normal activation</td>
<td>IV-C</td>
</tr>
<tr>
<td>Test 5</td>
<td>All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – 20 minute delayed activation</td>
<td>IV-C</td>
</tr>
</tbody>
</table>
Tall Mass Timber Building Code Changes Pass First Hurdle

The highly-anticipated International Code Council (ICC) Tall Mass Timber Building code changes passed a first hurdle in April with approval by the ICC code changes committee responsible for this part of the process. By wide margins a series of 14 proposals was each approved. The Hearings brought together code and fire officials, along with engineers, architects, builders, and other construction professionals as part of the first public step in approving code change proposals for the 2021 set of ICC codes. The proposals submitted by the ICC Ad Hoc Committee on Tall Wood Buildings (TWB), once officially approved by year-end, would allow mass timber buildings to be constructed up to 18 stories in height. AWC had a significant number of staff in attendance at the Hearings who spoke in support of the Ad Hoc Committee proposals. For more information see www.awc.org/tallmasstimber.
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 gives architects, developers and codes officials a proven alternative to traditional tall building materials used for the buildings.”
Since its debut, IBC has contained 9 construction type options. 5 Main Types (I, II, III, IV, V) with all but IV having sub-types A and B.
Three Main Categories:

1. Noncombustible (Types I and II)
2. Light-Frame (Types III and V)
3. Heavy/Mass Timber (Type IV)

Although use of mass timber products in low- to mid-rise in types III and V is very common
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

<table>
<thead>
<tr>
<th>TYPE IV-A</th>
<th>TYPE IV-B</th>
<th>TYPE IV-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBC 2021</td>
<td>IBC 2021</td>
<td>IBC 2015</td>
</tr>
</tbody>
</table>

Business Occupancy [Group B]

*Building floor-to-floor heights are shown at 12'-0" for all examples for clarity in comparison between 2015 to 2021 IBC codes.

Credit: Susan Jones, atelierjones
Type IV-A

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-A Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>18</td>
<td>270 ft</td>
<td>135,000 SF</td>
<td>405,000 SF</td>
</tr>
<tr>
<td>B</td>
<td>18</td>
<td>270 ft</td>
<td>324,000 SF</td>
<td>972,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>12</td>
<td>270 ft</td>
<td>184,500 SF</td>
<td>553,500 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>18</td>
<td>270 ft</td>
<td>184,500 SF</td>
<td>553,500 SF</td>
</tr>
</tbody>
</table>

Areas exclude potential frontage increase

In most cases, Type IV-A height & story allowances = 1.5 * Type I-B height & story allowances

Type IV-A area = 3 * Type IV-HT area
Type IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

12 STORIES
BUILDING HEIGHT 180 FT
ALLOWABLE BUILDING AREA 648,000 SF
AVERAGE AREA PER STORY 54,000 SF

TYPE IV-B
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 Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>12</td>
<td>180 ft</td>
<td>90,000 SF</td>
<td>270,000 SF</td>
</tr>
<tr>
<td>B</td>
<td>12</td>
<td>180 ft</td>
<td>216,000 SF</td>
<td>648,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>8</td>
<td>180 ft</td>
<td>123,000 SF</td>
<td>369,000 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>12</td>
<td>180 ft</td>
<td>123,000 SF</td>
<td>369,000 SF</td>
</tr>
</tbody>
</table>

Areas exclude potential frontage increase

**In most cases, Type IV-B height & story allowances = Type I-B height & story allowances**

**Type IV-B area = 2 * Type IV-HT area**
Type IV-C

9 STORIES
BUILDING HEIGHT 85’
ALLOWABLE BUILDING AREA 405,000 SF
AVERAGE AREA PER STORY 45,000 SF

Photos: Baumberger Studio/PATH
Architecture/Marcus Kauffman

Credit: Susan Jones, atelierjones
Type IV-C Protection vs. Exposed

All Mass Timber surfaces may be exposed

Exceptions: Shafts, concealed spaces, outside face of exterior walls

Credit: Susan Jones, atelierjones
### Type IV-C Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>6</td>
<td>85 ft</td>
<td>56,250 SF</td>
<td>168,750 SF</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>85 ft</td>
<td>135,000 SF</td>
<td>405,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>6</td>
<td>85 ft</td>
<td>76,875 SF</td>
<td>230,625 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>8</td>
<td>85 ft</td>
<td>76,875 SF</td>
<td>230,625 SF</td>
</tr>
</tbody>
</table>

Areas exclude potential frontage increase

In most cases, Type IV-C height allowances = Type IV-HT height allowances, but add’l stories permitted due to enhanced FRR

Type IV-C area = 1.25 * Type IV-HT area
**Tall Wood Materials & Protection**

- **Exterior Walls**
- **Structural Materials**
- **Concealed Spaces**
- **Gypsum Protection**

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

- **IV-A**

### Mass Timber or NC

- **IV-B**

### Permitted, requires NC protection on MT surfaces

<table>
<thead>
<tr>
<th>All MT is protected</th>
<th>Same as IV-A for protected MT. Limited exposed MT permitted, FRR still applies</th>
<th>All MT permitted may be exposed except as noted</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 HR: 3 layers 5/8” type X gyp</td>
<td>2 HR or less: 2 layers 5/8” type X gyp</td>
<td></td>
</tr>
</tbody>
</table>
Tall Wood Buildings in the 2021 IBC
Up to 18 Stories of Mass Timber

Scott Breneman, Ph.D., SE, WoodWorks – Wood Products Council • Matt Timmers, SE, John A. Martin & Associates
• Dennis Richardson, PE, CBO, CASp, American Wood Council

In January 2019, the International Code Council (ICC) approved a set of proposals to allow tall wood buildings as part of the 2021 International Building Code (IBC). Based on these proposals, the 2021 IBC will include three new construction types—Type IV-A, IV-B and IV-C—allowing the use of mass timber or noncombustible materials. These new types are based on the previous Heavy Timber construction type (renamed Type IV-HT) but with additional fire-resistance ratings and levels of required noncombustible protection. The code will include provisions for up to 18 stories of Type IV-A construction for Business and Residential Occupancies.

Based on information first published in the Structural Engineers Association of California (SEAOC) 2018 Conference Proceedings, this paper summarizes the background to these proposals, technical research that supported their adoption, and resulting changes to the IBC and product-specific standards.

Background: ICC Tall Wood Building Ad Hoc Committee

Over the past 10 years, there has been a growing interest in tall buildings constructed from mass timber materials (Breneman 2013, Timmers 2015). Around the world there

WoodWorks Tall Wood Design Resource