A New Path Forward for Tall Wood Construction: Code Provisions and Design Steps

Presented by:
Mark Bartlett, PE – WoodWorks
August 22, 2023
Regional Directors: One-on-One Project Support

Kate Carrigg, PE
Eric Gu, PhD, PE, LEED GA
Tino Kalayil, PE
Anthony Harvey, PE
Chelsea Drenick, SE
Mike Romanowski, SE
Jessica Scarlett, EIT
Momo Sun, PE, PEng, LEED GA
John O'Donald II, PE
Jason Bahr, PE
Mark Bartlett, PE
Laura Cullen, PE
Jeff Peters, PE, CGC
Solutions Team

Scott Breneman, PhD, PE, SE
Ashley Cagle, PE, SE
Karen Gesa, PE
Erin Kinder, PE, SE, LEED AP
Melissa Kroskey, AIA, SE
Taylor Landry, PE, MLSE
Bruce Lindsey
Terry Malone, PE, SE
Ricky McLain, PE, SE
<table>
<thead>
<tr>
<th>Building Systems</th>
<th>Building Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light-Frame</td>
<td>Multi-Family / Mixed Use</td>
</tr>
<tr>
<td>Mass Timber / CLT</td>
<td>Education</td>
</tr>
<tr>
<td>Off-Site / Panelized Construction</td>
<td>Office</td>
</tr>
<tr>
<td>Hybrid</td>
<td>Commercial Low-Rise</td>
</tr>
<tr>
<td></td>
<td>Industrial</td>
</tr>
<tr>
<td></td>
<td>Civic / Recreational</td>
</tr>
<tr>
<td></td>
<td>Institutional / Healthcare</td>
</tr>
</tbody>
</table>

Our experts can help—ask us anything. Get Free Project Support

**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 consulting, educational resources, and much more.
<table>
<thead>
<tr>
<th>Building Systems</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass Timber / CLT</td>
<td>24</td>
</tr>
<tr>
<td>Light-Frame</td>
<td>9</td>
</tr>
<tr>
<td>Panelized Construction</td>
<td>7</td>
</tr>
<tr>
<td>Hybrid</td>
<td>5</td>
</tr>
<tr>
<td><strong>Building Types</strong></td>
<td></td>
</tr>
<tr>
<td>Multi-Family / Mixed-Use</td>
<td>16</td>
</tr>
<tr>
<td>Education</td>
<td>10</td>
</tr>
<tr>
<td>Office</td>
<td>10</td>
</tr>
<tr>
<td>Commercial Low-Rise</td>
<td>6</td>
</tr>
<tr>
<td>Civic / Recreational</td>
<td>6</td>
</tr>
<tr>
<td>Industrial</td>
<td>6</td>
</tr>
<tr>
<td>Institutional / Healthcare</td>
<td>6</td>
</tr>
<tr>
<td><strong>Project Roles</strong></td>
<td></td>
</tr>
<tr>
<td>Architect</td>
<td>14</td>
</tr>
<tr>
<td>Developer/Owner</td>
<td>11</td>
</tr>
<tr>
<td>Structural Engineer</td>
<td>10</td>
</tr>
<tr>
<td>Contractor/Installer</td>
<td>6</td>
</tr>
<tr>
<td><strong>Resource Types</strong></td>
<td></td>
</tr>
<tr>
<td>Expert Tips</td>
<td>10</td>
</tr>
<tr>
<td>Solution Papers</td>
<td>2</td>
</tr>
<tr>
<td>Calculators</td>
<td>1</td>
</tr>
<tr>
<td>Guides, Manuals &amp; Inventories</td>
<td>1</td>
</tr>
<tr>
<td><strong>Regions</strong></td>
<td></td>
</tr>
<tr>
<td>National</td>
<td>20</td>
</tr>
<tr>
<td>Midwest</td>
<td>5</td>
</tr>
<tr>
<td>South</td>
<td>4</td>
</tr>
<tr>
<td>West</td>
<td>4</td>
</tr>
<tr>
<td><strong>Solution Papers</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustics and Mass Timber: Room-to-Room Noise Control</td>
<td></td>
</tr>
<tr>
<td>This paper covers key aspects of mass timber acoustical design, including rules of thumb for optimal design, common assemblies, detailing strategies, and flanking paths. Companionship to the Inventory of Mass Timber Acoustic Assemblies.</td>
<td></td>
</tr>
<tr>
<td>Expert Tips</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Designing Mass Timber Floor Assemblies for Acoustics</td>
<td></td>
</tr>
<tr>
<td>The growing availability and code acceptance of mass timber for construction has given designers a low-carbon alternative.</td>
<td></td>
</tr>
<tr>
<td>Expert Tips</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact of Wall Stud Size and Spacing on Fire and Acoustic Performance</td>
<td></td>
</tr>
<tr>
<td>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 acoustical results, is common.</td>
<td></td>
</tr>
<tr>
<td>Expert Tips</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Firehouse 12</td>
<td></td>
</tr>
<tr>
<td>The continuous plywood shell that creates varying acoustic conditions within the performance space forms the exterior of the auditorium.</td>
<td></td>
</tr>
<tr>
<td>Award Winner</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustical Considerations for Mixed-Use Wood-Frame Buildings</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Expert Tips</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Holes and Penetrations in Mass Timber Floor and Roof Panels</td>
<td></td>
</tr>
<tr>
<td>Guidance for the design of mass timber floor and roof panels with openings, including structural, fire resistance, and acoustic impacts, and tips for reinforcement.</td>
<td></td>
</tr>
<tr>
<td>Expert Tips</td>
<td></td>
</tr>
</tbody>
</table>
See innovative wood projects + their design teams.
Who are you looking for?

Search by name or keyword...

Companies and PROs

- StructureCraft
  - Manufacturer Partner
- SmartLam NA
  - Manufacturer Partner
- Sanssin
  - Manufacturer Partner
- Simpson Strong-Tie
  - Manufacturer Partner
- DR Johnson
  - Manufacturer Partner
- HASSLACHER Group
Funding Partners

SLB
SOFTWOOD LUMBER BOARD

Forest Service
U.S. Department of Agriculture

Forestry Innovation Investment®
Supporting Partner

Advancing Mass Timber Construction 2023

September 11 – 13 | Atlanta, GA

woodworks.org/events/
In order to receive a certificate of completion, stay in the presentation for the duration of the AIA course.

presentation slides in pdf:
woodworks.org/presentation-archive/
## Agenda

### A New Path Forward for Tall Wood Construction: Code Provisions and Design Steps

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:00 – 2:05 pm</td>
<td>Welcome and Introduction</td>
</tr>
<tr>
<td>2:05 – 3:05 pm</td>
<td><strong>A New Path Forward for Tall Wood Construction: Code Provisions and Design Steps, part 1</strong></td>
</tr>
<tr>
<td>3:05 – 3:20 pm</td>
<td><strong>15-minute break</strong></td>
</tr>
<tr>
<td>4:20 – 4:30 pm</td>
<td>Q&amp;A</td>
</tr>
<tr>
<td>4:30 – 6:00 pm</td>
<td><strong>Networking/happy hour on the lawn</strong></td>
</tr>
</tbody>
</table>
“The Wood Products Council” is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.
The What, Why and How of Tall Mass Timber
TALL MASS TIMBER
ASSESSING THE WHAT
BROCK COMMONS, BRITISH COLUMBIA

18 STORIES | 174 FT
MJOSTARNET, NORWAY

18 STORIES | 280 FT
HOHO, AUSTRIA

24 STORIES | 275 FT
Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman | Architect: PATH Architecture

CARBON12, PORTLAND, OR

8 STORIES | 85 FT
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
80 M ST, WASHINGTON, DC
80 M ST, WASHINGTON, DC

3 STORY VERTICAL ADDITION
7 STORY EXISTING BUILDING

Photo: WoodWorks Architect: Hickok Cole
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

PRIMARILY OFFICE SPACE
APEX PLAZA
CHARLOTTESVILLE, VA

187,000 SF

Photo: WoodWorks | Architect: William McDonough + Partners
Tallhouse, Boston

Source: Generate Architecture
GLOBAL WARMING POTENTIAL & MATERIAL MASS
(PER BUILDING ASSEMBLY)

Source: Generate Architecture

The total global warming potential (GWP) of each option is shown with a breakdown by building assembly. The Concrete With Steel Frame and Concrete Flat Slab options have a higher GWP with the bulk of the impact embodied in the floor slabs. The Timber Use 1 (Floor Slabs: Steel Frame) option offers a slight reduction in GWP with the most of the savings also embodied in the floor slabs. The Timber Use 2 (Post, Beam, and Plate) option offers a relatively typical approach to building with timber, showing savings in floor slabs, beams, and columns. Since Timber Use 3 and 4 are cellular approaches with load-bearing walls, these options included steel podiums to accommodate the ground floor program. Timber Use 3 shows a hybrid approach with light gauge metal walls. GWP savings in structural walls and exterior walls, despite the addition of the podium. Lastly, Timber Use 4 emphasizes how a completely cellular CLT option offers a 52% lower GWP compared to other options.
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
ASCENT, MILWAUKEE

25 STORIES

19 TIMBER OVER 6 PODIUM, 284 FT

Photo: Korb & Associates Architects | Architect: Korb & Associates Architects
TALL MASS TIMBER
UNDERSTANDING THE WHY
Global Population Increase

2019 = 7.7 billion people

2050 = 11.2 billion people

Source: https://ourworldindata.org/future-population-growth
US URBAN POPULATION BOOM

- **2019**: Urban 271.4 M, Rural 57.7 M
- **2030**: Urban 301 M, Rural 53.7 M
- **2050**: Urban 347.3 M, Rural 42.2 M
New Buildings & Greenhouse Gasses

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)
Climate Change – Impacts on Forests and Planet
Carbon Storage
Wood ≈ 50% Carbon (dry weight)
Biophilic Design, Connection to Forests

George Fox University – Canyon Commons
Hacker | Photo: Jeremy Bittermann
Construction Impacts: Labor Availability

Photo: Lendlease
Construction Impacts: Schedule

Tall Mass Timber: Structural Warmth is a Value-Add
TALL MASS TIMBER
DEMONSTRATING THE HOW
Glue Laminated Timber (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo: StructureCraft
Photo: LendLease
Photo: Freres Lumber
Photo: LEVER Architecture
Dowel-Laminated Timber (DLT)

Nail-Laminated Timber (NLT)

Glue-Laminated Timber (GLT)

Plank orientation

Photos: StructureCraft, Think Wood, Ema Peter, Manasc Isaac Architects/Fast + Epp
Concealed Connectors

Self Tapping Screws

Photos: Rothoblaas
Mass Timber Connections

Beam to Column

Photo: StructureCraft

Photo: Structurlam
Efficiency found in understanding supply chain, designing according to its capabilities.
TALL WOOD IN THE CODE
2018 IBC and All Previous Editions:

» 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

Source: ICC
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.
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.
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.
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
<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>
TEST 1

Ignition

Living Room / Kitchen Flashover

Bedroom Flashover

Decay Phase

Living Room / Kitchen

Bedroom

Photos provided by U.S. Forest Products Laboratory, USDA

Source: AWC
TEST 3

Ignition

Living Room/Kitchen Flashover

Bedroom Flashover

Decay Phase

Wall

Wall

Photos provided by U.S. Forest Products Laboratory, USDA

Source: AWC
TEST 4

All mass timber surfaces fully exposed in bedroom and living room.

Sprinkler – normal activation

Source: AWC
Photos provided by U.S. Forest Products Laboratory, USDA
TEST 5

All mass timber surfaces fully exposed in bedroom and living room.

Sprinkler – activation delayed for 20 minutes after smoke detector activation...approximately 23-1/2 minutes from ignition

Source: AWC
MASS TIMBER CERTIFICATION

- ANSI/APA PRG 320 standard for CLT
- 2018 edition (referenced in 2021 IBC) added new elevated temperature adhesive performance requirements
- Testing ensures CLT does not exhibit fire re-growth
- When designing tall wood – specify CLT per PRG 320-18 (req’d in IBC 2021 for all CLT)

ANNEX B. PRACTICE FOR EVALUATING ELEVATED TEMPERATURE PERFORMANCE OF ADHESIVES USED IN CROSS-LAMINATED TIMBER (MANDATORY)
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
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
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>IB 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-C

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

Credit: Susan Jones, atelierjones
Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman
# 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**
Type IV-C Protection vs. Exposed

All Mass Timber surfaces may be exposed

Exceptions: Shafts, concealed spaces, outside face of exterior walls
All timber surfaces may be exposed
Type IV-B

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

Credit: Susan Jones, atelierjones
Credit: LEVER Architecture
### 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-B Protection vs. Exposed

IV-B

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

~20% of Ceiling or ~40% of Wall can be exposed

Credit: Susan Jones, atelierjones
Some timber surfaces may be exposed
Limited Exposed MT allowed in Type IV-B for:

- MT beams and columns which are not integral part of walls or ceilings, no area limitation applies
- MT ceilings and beams up to 20% of floor area in dwelling unit or fire area, or
- MT walls and columns up to 40% of floor area in dwelling unit or fire area, or
- Combination of ceilings/beams and walls/columns, calculated as follows:
Mixed unprotected areas, exposing both ceilings and walls:

- In each dwelling unit or fire area, max. unprotected area =
  \[ \frac{U_{tc}}{U_{ac}} + \frac{U_{tw}}{U_{aw}} \leq 1.0 \]

- \( U_{tc} \) = Total unprotected MT ceiling areas
- \( U_{ac} \) = Allowable unprotected MT ceiling areas
- \( U_{tw} \) = Total unprotected MT wall areas
- \( U_{aw} \) = Allowable unprotected MT wall areas
Design Example: Mixing unprotected MT walls & ceilings

800 SF dwelling unit

- $U_{ac} = (800 \text{ SF})*(0.20) = 160 \text{ SF}$
- $U_{aw} = (800 \text{ SF})*(0.40) = 320 \text{ SF}$
- Could expose 160 SF of MT ceiling, OR 320 SF of MT Wall, OR
- If desire to expose 100 SF of MT ceiling in Living Room, determine max. area of MT walls that can be exposed

Credit: AWC
Design Example: Mixing unprotected MT walls & ceilings

\[
\left( \frac{U_{tc}}{U_{ac}} \right) + \left( \frac{U_{tw}}{U_{aw}} \right) \leq 1.0
\]

\[
\left( \frac{100}{160} \right) + \left( \frac{U_{tw}}{320} \right) \leq 1.0
\]

\[U_{tw} = 120 \text{ SF}\]

- Can expose 120 SF of MT walls in dwelling unit in combination with exposing 100 SF of MT ceiling
Type IV-B Protection vs. Exposed

Credit: AWC
Type IV-B Protection vs. Exposed

Credit: AWC
Horizontal separation of unprotected areas:

- Unprotected portions of mass timber walls and ceilings shall be not less than 15 feet from unprotected portions of other walls and ceilings, measured horizontally along the ceiling and from other unprotected portions of walls measured horizontally along the floor.
Type IV-B Protection vs. Exposed

15’ min

15’ min

Credit: AWC
2019-2022: REFINING THE CODE ROADMAP

100% Timber Ceiling Exposure Up to 12 Stories

2024 IBC

TYPE IV-B - WITHOUT SOFFITS

STUDIO
380 SF
360 SF EXPOSED MASS TIMBER (100%)

ONE BEDROOM
482 SF
450 SF EXPOSED MASS TIMBER (100%)

EXPOSED MASS TIMBER CEILING
EXPOSED GLULAM BEAM
EXPOSED GLULAM COLUMN
GRIB SOFFIT

1. Unprotected portions of mass timber ceilings, including attached beams, shall be permitted and shall be limited to an area less than or equal to 100 percent of the floor area in any dwelling unit or fire area; or

2. Unprotected portions of mass timber walls, including attached columns, shall be permitted and shall be limited to an area less than or equal to 40 percent of the floor area in any dwelling unit or fire area; or
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
## 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>

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

Areas exclude potential frontage increase

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

100% NC protection on all surfaces of Mass Timber

Credit: Susan Jones, atelierjones
IV-A

No timber surfaces may be exposed
Tall Wood Buildings in the 2021 IBC  
Up to 18 Stories of Mass Timber

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 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 have been a number of successful projects using mass timber and the potential for the industry to scale has been encouraging.

WoodWorks Tall Wood Design Resource
# Tall Wood Building Size Limits

## Construction Type (All Sprinklered Values)

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)</th>
<th>Allowable Number of Stories above Grade Plane (IBC Table 505.4)</th>
<th>Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-A</td>
<td>I-B</td>
<td>IV-A</td>
</tr>
<tr>
<td>A, B, R</td>
<td>Unlimited</td>
<td>180</td>
<td>270</td>
</tr>
<tr>
<td>A-2, A-3, A-4</td>
<td>Unlimited</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>R-2</td>
<td>Unlimited</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>A-2, A-3, A-4</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>135,000</td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>324,000</td>
</tr>
<tr>
<td>R-2</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>184,500</td>
</tr>
</tbody>
</table>
## Tall Wood Building Size Limits

### Occupancies

<table>
<thead>
<tr>
<th>Construction Type (Unsprinklered Values)</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>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, R</td>
<td>Unlimited</td>
<td>160</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>A-2, A-3, A-4</td>
<td>Unlimited</td>
<td>11</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td>11</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>R-2</td>
<td>Unlimited</td>
<td>11</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>A-2, A-3, A-4</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>45,000</td>
<td>30,000</td>
<td>18,750</td>
<td>15,000</td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>108,000</td>
<td>72,000</td>
<td>45,000</td>
<td>36,000</td>
</tr>
<tr>
<td>R-2</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>61,500</td>
<td>41,000</td>
<td>25,625</td>
<td>20,500</td>
</tr>
</tbody>
</table>

Even so, Sprinklers may be required by 903.2 (all occupancies) and definitely for residential (420.4)
### Tall Wood Building Size Limits

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)</th>
<th>Construction Type (Unsprinklered Values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, R</td>
<td>160 In almost all cases, sprinklers will be required</td>
<td>I-A I-B IV-A IV-B IV-C IV-HT</td>
</tr>
<tr>
<td>A-2, A-3, A-4</td>
<td>Unlimited 65 65 65 65</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Unlimited</td>
<td></td>
</tr>
<tr>
<td>R-2</td>
<td>Unlimited</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Allowable Number of Stories above Grade Plane (IBC Table 505.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2, A-3, A-4</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>R-2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2, A-3, A-4</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>R-2</td>
</tr>
</tbody>
</table>

Even so, Sprinklers may be required by 903.2 (all occupancies) and definitely for residential (420.4)
## Non-Tall Opportunities – Large Area

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)</th>
<th>Allowable Number of Stories above Grade Plane (IBC Table 505.4)</th>
<th>Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, R</td>
<td>180 270 180 85 85 85</td>
<td>12 18 12 6 4 4</td>
<td>135,000 90,000 56,250 45,000 42,000</td>
</tr>
<tr>
<td>A-2, A-3, A-4, B, R-2</td>
<td>Unl...</td>
<td>12 18 12 9 6 6</td>
<td>324,000 216,000 135,000 108,000 85,500</td>
</tr>
<tr>
<td>A-2, A-3, A-4, B, R-2</td>
<td>Unl...</td>
<td>12 18 12 8 5 5</td>
<td>184,500 123,000 76,875 61,500 72,000</td>
</tr>
</tbody>
</table>
What’s the ‘Sweet Spot’ for Tall Mass Timber?

Depends on many factors:

- Project Use
- Site Constraints
- Local Zoning & FAR Limitations
- Budget
- Client Objectives for Sustainability, Exposed Timber
- And More...

But Some General Trends Could Be:
Type IV-C Tall Mass Timber

Example R-2, Type IV-C Building

8 Stories
85 ft

76,875 SF max per floor

230,625 SF bldg.

(area noted assume no frontage increase)

Not Likely to Utilize Podium Due to Overall Building Height Limit (85 ft) Relative to # of Timber Stories (8)

Same Overall Building Height Limit as IV-HT (85 ft) but higher Fire-Resistance Ratings Req’d

3 Additional Stories Permitted Compared to IV-HT

All Timber Exposed
Type IV-B Tall Mass Timber

<table>
<thead>
<tr>
<th>Timber, R-2: 12 Stories</th>
</tr>
</thead>
<tbody>
<tr>
<td>123,000 SF max per floor</td>
</tr>
<tr>
<td>369,000 SF bldg.</td>
</tr>
<tr>
<td>(areas noted assume no frontage increase)</td>
</tr>
</tbody>
</table>

Example Mixed-Use, Type IV-B Building

- Likely to Utilize Podium Due to Overall Building Height Limit (180 ft) Relative to # of Timber Stories (12)
- Same Fire-Resistance Ratings Req’d as IV-C But Limitations on Timber Exposed
- 4 Additional Stories Permitted Compared to IV-C
- Limited Timber Exposed

Multi-Story Type IA Podium
Type IV-A Tall Mass Timber

- Timber, R-2: 18 Stories
- 184,500 SF max per floor
- 553,500 SF bldg.
  (areas noted assume no frontage increase)

Example Mixed-Use, Type IV-A Building

- Likely to Utilize Podium Due to Overall Building Height Limit (270 ft) Relative to # of Timber Stories (18)
- Higher Fire-Resistance Ratings Req’d than IV-B For Primary Frame
- 6 Additional Stories Permitted Compared to IV-B
- No Exposed Timber Permitted

Multi-Story Type IA Podium

270 ft Grade to Roof
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
## Type IV Minimum Sizes - Framing

<table>
<thead>
<tr>
<th>Framing</th>
<th>Solid Sawn (nominal)</th>
<th>Glulam (actual)</th>
<th>SCL (actual)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Floor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columns</td>
<td>8 x 8</td>
<td>6(\frac{3}{4}) x 8(\frac{3}{4})</td>
<td>7 x 7(\frac{1}{2})</td>
</tr>
<tr>
<td>Beams</td>
<td>6 x 10</td>
<td>5 x 10(\frac{1}{2})</td>
<td>5(\frac{1}{4}) x 9(\frac{1}{2})</td>
</tr>
<tr>
<td><strong>Roof</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columns</td>
<td>6 x 8</td>
<td>5 x 8(\frac{3}{4})</td>
<td>5(\frac{1}{4}) x 7(\frac{1}{2})</td>
</tr>
<tr>
<td>Beams*</td>
<td>4 x 6</td>
<td>3 X 6(\frac{7}{8})</td>
<td>3(\frac{1}{2}) X 5(\frac{1}{2})</td>
</tr>
</tbody>
</table>

**Minimum Width by Depth in Inches**
See IBC 2018 2304.11 or IBC 2015 602.4 for Details

*3” nominal width allowed where sprinklered*
Type IV Minimum Sizes – Floor/Roof Panels

Floor Panels/Decking:
- 4” thick CLT (actual thickness)
- 4” NLT/DLT/GLT (nominal thickness)
- 3” thick (nominal) decking covered with:
  - 1” decking or 15/32” WSP or ½” particleboard

Roof Panels/Decking:
- 3” thick CLT (nominal thickness)
- 3” NLT/DLT/GLT (nominal thickness)
- 2” decking (nominal thickness)
- 1-1/8” WSP
MT Type IV Minimum Sizes – Walls

Exterior Walls for Type IV-A B C
• CLT or Non-combustible

Exterior Walls for Type IV-HT
• CLT or FRTW or Non-combustible
• IBC 2018 - 6” Thick Wall (FRTW or CLT)
• IBC 2021 - 4” Thick CLT
MT Type IV Minimum Sizes – Walls

MT Interior Walls in all Type IV:
• Laminated construction 4” thick
• Solid wood construction min. 2 layers of 1” matched boards

Other Interior Walls in Type IV A,B,C
• Non-combustible (0 hr for nonbearing)

Other Interior Walls in Type IV HT
• Non-combustible (1 hr min)
• Wood stud wall (1 hr min)

Verify other code requirements for FRR (eg. interior bearing wall; occupancy separation)
# Interior Wall Construction Recap

**Fire Rating (bearing wall)**
- **IV-A**: 3 Hr
- **IV-B**: 2 Hr
- **IV-C**: 2 Hr
- **IV-HT**: 1 Hr or HT*

**Construction – MT**
- Laminated construction 4” thick (CLT, NLT, etc)
- Solid wood construction min. 2 layers of 1” matched boards

**NC Protection**
- Per Interior Requirements: No

**Noncombustible non-bearing wall**
- 0 Hr: 1 Hr
- No: 1 Hr

**Wood Stud Wall**
- *IBC 2021 requires at least 1 Hr FRR for HT walls supporting 2 levels*
# Exterior Wall Construction Recap

<table>
<thead>
<tr>
<th>Fire Rating (bearing wall)</th>
<th>Mass Timber</th>
<th>Exterior NC Protection</th>
<th>Interior NC Protection</th>
<th>Light Frame FRTW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IV-A</strong> 3 Hr</td>
<td>Mass Timber/CLT</td>
<td>40 Min NC &amp; No Exterior Combustible Coverings</td>
<td>Per Interior Requirements</td>
<td>Light Frame FRTW</td>
</tr>
<tr>
<td><strong>IV-B</strong> 2 Hr</td>
<td>4” min thick CLT*</td>
<td>FRT Sheathing, Gyp or other NC</td>
<td>Not Required</td>
<td></td>
</tr>
<tr>
<td><strong>IV-C</strong> 2 Hr</td>
<td>6” Wall*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IV-HT</strong> 2 Hr</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Changes in IBC 2015, 2018, and 2021 editions*
## Tall Wood Fire Resistance Ratings (FRR)

### FRR Requirements for Tall Mass Timber Structures (hours)

<table>
<thead>
<tr>
<th>Building Element</th>
<th>IV-A</th>
<th>IV-B</th>
<th>IV-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Frame</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Exterior Bearing Walls</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Interior Bearing Walls</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Roof Construction</td>
<td>1.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Primary Frame at Roof</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Floor Construction</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*Source: 2021 IBC Table 601*
Noncombustible Protection (NC)

Where timber is required to be protected, NC must contribute at least 2/3 FRR

<table>
<thead>
<tr>
<th>FRR of Building Element (hours)</th>
<th>Minimum from Noncombustible Protection (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>3 or more</td>
<td>120</td>
</tr>
</tbody>
</table>

Source: 2021 IBC Section 722.7
Noncombustible Protection (NC)

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).
Noncombustible Protection (NC)

**Prescriptive Noncombustible Contributions to FRR**

<table>
<thead>
<tr>
<th>Type of Protection</th>
<th>Contribution per Layer (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; Type X gypsum board</td>
<td>25</td>
</tr>
<tr>
<td>5/8&quot; Type X gypsum board</td>
<td>40</td>
</tr>
</tbody>
</table>

*Source: 2021 IBC Section 722.7.1*

**Required Noncombustible Contribution to FRR**

<table>
<thead>
<tr>
<th>FRR of Building Element (hours)</th>
<th>Minimum from Noncombustible Protection (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>3 or more</td>
<td>120</td>
</tr>
</tbody>
</table>

*Source: 2021 IBC Section 722.7*

1 layer 5/8 Type X
2 layers 5/8 Type X
3 layers 5/8 Type X
### Min. 1” NC

<table>
<thead>
<tr>
<th>Mass Timber Floor Panel</th>
</tr>
</thead>
</table>

*Min. 1” thick NC protection required on mass timber floors in IV-A and IV-B. Not required in IV-C*
### Noncombustible Protection Requirements Per new 602.4

- **Roof below Mass Timber**
  - IV-A: 60 min, 40 min*
  - IV-B: 80 min, 40 min*
  - IV-C: Not Req.
  - IV-HT: Not Req.

- **Primary Frame @ Roof**
  - IV-A: 80 min, 40 min*
  - IV-B: 120 min, 80 min*
  - IV-C: Not Req.
  - IV-HT: Not Req.

- **Primary Frame**
  - IV-A: 80 min, 80 min*
  - IV-B: 80 min, 80 min*
  - IV-C: Not Req.
  - IV-HT: Not Req.

- **Below Mass Timber Floor**
  - IV-A: 1” Min NC Material
  - IV-B: 1” Min NC Material
  - IV-C: Not Req.
  - IV-HT: Not Req.

- **Above Mass Timber Floor**
  - IV-A: Not Req.
  - IV-B: Not Req.
  - IV-C: Not Req.
  - IV-HT: Not Req.

* Some MT permitted to be exposed.

---

**Note:** The table above outlines the noncombustible protection requirements for different conditions and locations. The asterisk (*) indicates that some Mass Timber (MT) is permitted to be exposed.
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.
However, FRR Doesn’t always need to be from a combination of MT + NC. In some cases, just NC can be used, in other cases, just MT can be used:

**IBC 602.4**
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.
Type IV-A Fire Resistance Ratings (FRR)

Primary Frame (3-hr) + Floor Panel Example (2-hr):

- Minimum 1" noncombustible material
- Mass timber floor panel
- 40 minutes of MT FRR
- Two layers 5/8" Type X gypsum
- Glulam beam (primary structural frame)
- 60 minutes of MT FRR
- Three layers 5/8" Type X gypsum
Type IV-B Fire Resistance Ratings (FRR)

**Primary Frame (2-hr) + Floor Panel (2-hr)**

- Minimum 1" noncombustible material
- Mass timber floor panel
- 40 minutes of MT FRR
- 2 layers 5/8" Type X gypsum

**Glulam beam (primary structural frame)**

- 40 minutes of MT FRR
- Two layers 5/8" Type X gypsum
Primary Frame (2-hr) + Floor Panel Example (2-hr)

- Minimum 1" noncombustible material
- Mass timber floor panel
- 2-hr of MT FRR; noncombustible material not required
- Glulam beam (primary structural frame)
- 2-hr of MT FRR; Noncombustible material not required
Type IV-C Fire Resistance Ratings (FRR)

Primary Frame (2-hr) + Floor Panel Example (2-hr)

Noncombustible material not required

Mass timber floor panel

2-hr of MT FRR; noncombustible material not required

Glulam beam (primary structural frame)

2-hr of MT FRR; Noncombustible material not required
MT Fire Resistance Ratings (FRR)

How do you determine FRR of MT?

2 Options:

1. Calculations in Accordance with IBC 722 → NDS Chapter 16
2. Tests in Accordance with ASTM E119
MT FRR Calculations Method:
• IBC 703.3 allows several methods of determining FRR. One is calculations per 722.
• 722.1 refers to NDS Chapter 16 for exposed wood FRR

703.3 Methods for determining fire resistance. The application of any of the methods listed in this section shall be based on the fire exposure and acceptance criteria specified in ASTM E119 or UL 263. The required fire resistance of a building element, component or assembly shall be permitted to be established by any of the following methods or procedures:

3. Calculations in accordance with Section 722.

722.1 General. The provisions of this section contain procedures by which the fire resistance of specific materials or combinations of materials is established by calculations. These procedures apply only to the information contained in this section and shall not be otherwise used. The calculated fire resistance of concrete, concrete masonry and clay masonry assemblies shall be permitted in accordance with ACI 216.1/TMS 0216. The calculated fire resistance of steel assemblies shall be permitted in accordance with Chapter 5 of ASCE 29. The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/AF&PA National Design Specification for Wood Construction (NDS).
NDS Chapter 16 includes calculation of fire resistance of NLT, CLT, Glulam, Solid Sawn and SCL wood products.
Nominal char rate of 1.5”/HR is recognized in NDS. Effective char depth calculated to account for duration, structural reduction in heat-affected zone.

Table 16.2.1A Char Depth and Effective Char Depth (for $\beta_n = 1.5$ in./hr.)

<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>1 1/2-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>

Table 16.2.1B Effective Char Depths (for CLT with $\beta_n=1.5$in./hr.)

<table>
<thead>
<tr>
<th>Required Fire Endurance (hr.)</th>
<th>Effective Char Depths, $a_{char}$ (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lamination thicknesses, $h_{lam}$ (in.)</td>
</tr>
<tr>
<td></td>
<td>5/8</td>
</tr>
<tr>
<td>1-Hour</td>
<td>2.2</td>
</tr>
<tr>
<td>1 1/2-Hour</td>
<td>3.4</td>
</tr>
<tr>
<td>2-Hour</td>
<td>4.4</td>
</tr>
</tbody>
</table>
MT Fire Resistance Ratings (FRR)

Tested Assemblies Method:

• Many successful Mass Timber ASTM E119 fire tests have been completed by industry & manufacturers

Contact WoodWorks for Inventory of Tests
Fire-Resistive Design
of Mass Timber Members
Code Applications, Construction Types and Fire Ratings

For many years, exposed mass timber framing elements have been permitted in U.S. buildings due to their inherent fire-resistance properties. The predictability of wood’s char rate has been well-established for decades and has long been recognized in building codes and standards.

Today, one of the exciting trends in building design is the growing use of mass timber—a large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction. Unlike heavy timber, mass timber products have inherent fire resistance that allows them to be left exposed and still achieve a fire-resistance rating. Because of their strength and dimensional stability, these products also offer a revolution in aesthetics to steel, concrete, and masonry for many applications. It is the combination of exposed structure and strength that developers and designers across the country are leveraging to create innovative designs with a warm yet modern aesthetic, often for projects that go beyond traditional norms of wood design.

This paper has been written to support architects and engineers exploring the use of mass timber for commercial and multi-family construction. It focuses on how to meet fire-resistance requirements in the International Building Code (IBC), including calculation and testing based methods. Unless otherwise noted, references refer to the 2018 IBC.

Mass Timber & Construction Type

Before demonstrating fire-resistance ratings of exposed mass timber elements, it is important to understand under what circumstances the code currently allows the use of mass timber in commercial and multi-family construction.

A building’s assigned construction type is the main indicator of where and when all wood systems can be used. IBC Section 602 defines five construction Types I through V with all but Type IV having subcategories. In Type V-A and B systems, the use of wood framing throughout most of the structure and both interior and exterior walls is permitted in exterior walls with a fire-resistance rating of 2 hours or less.

Type IV–IBC 602.4: Commonly referred to as “Heavy Timber” construction, this option

Mass Timber Fire Design Resource

- Code compliance options for demonstrating FRR
- Updated as new tests are completed
- Free download at woodworks.org
# MT Fire Resistance Ratings (FRR)

## Inventory of Fire Tested MT 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 in Test</th>
<th>Floor Topping</th>
<th>Load Rating</th>
<th>Fire Resistance Achieved (Hours)</th>
<th>Source</th>
<th>Testing Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-ply CLT (141 mm 4.848 in)</td>
<td>Nortic</td>
<td>SPF 16/50 lb 1.5 ESMR x SPF 6</td>
<td>2 layers 1/2&quot; Type X Gypsum</td>
<td>Half-Lap</td>
<td>None</td>
<td>Balanced 30% Moment Capacity</td>
<td>1</td>
<td>1 (Test 1)</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>3-ply CLT (105 mm 3.35 in)</td>
<td>Structulum</td>
<td>SPF 61/30 x SPF 31/20</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Balanced 75% Moment Capacity</td>
<td>1</td>
<td>1 (Test 5)</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;</td>
<td>Nortic</td>
<td>EI</td>
<td>1 layer of 1/2&quot; Type X Gypsum under Z-channel and bartong strips with 3 5/8&quot; adhesive strips</td>
<td>Topside Spline</td>
<td>2 staggered layers of 1/2&quot; cement board</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>2</td>
<td>NRC Fire Laboratory March 2016</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Nortic</td>
<td>EI</td>
<td>None</td>
<td>Topside Spline</td>
<td>2 staggered layers of 1/2&quot; cement board</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>5</td>
<td>NRC Fire Laboratory Nov 2014</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Nordic</td>
<td>EI</td>
<td>None</td>
<td>Topside Spline</td>
<td>3/4 in. proprietary gypsum over Maxcon acoustical sheet or proprietary sound board</td>
<td>Balanced 50% Moment Capacity</td>
<td>1.5</td>
<td>3</td>
<td>UL</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer 1/2&quot; normal gypsum</td>
<td>Topside Spline</td>
<td>3/4 in. proprietary gypsum over Maxcon acoustical sheet or proprietary sound board</td>
<td>Balanced 50% Moment Capacity</td>
<td>2</td>
<td>4</td>
<td>UL</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer 1/2&quot; Type X Gypsum under Z-channel under 3 5/8&quot; j-hooks with 3 1/2&quot; Mineral Wood between Joist</td>
<td>Half-Lap</td>
<td>None</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>21</td>
<td>Intertek 8/24/2012</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Structulum</td>
<td>ESMS 2300 x SPF #6</td>
<td>None</td>
<td>Topside Spline</td>
<td>1/2&quot; Mecox with 1 1/2&quot; over Mecox Reinforcing Mesh</td>
<td>Loaded, See Manufacturer</td>
<td>2.5</td>
<td>6</td>
<td>Intertek, 2/22/2016</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>DR Johnson</td>
<td>VI</td>
<td>Half-Lap</td>
<td>Half-Lap</td>
<td>2&quot; gypsum taping</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>7</td>
<td>SwRI (May 2016)</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Nortic</td>
<td>SPF 19.5 Fb MSR x SPF #5</td>
<td>None</td>
<td>Topside Spline</td>
<td>Unreduced 100% Moment Capacity</td>
<td>1.5</td>
<td>1 (Test 3)</td>
<td>NRC Fire Laboratory</td>
<td></td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Structulum</td>
<td>SPF 91/2 x SPF 91/2</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Unreduced 100% Moment Capacity</td>
<td>2</td>
<td>1 (Test 6)</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Structulum</td>
<td>SPF 91/2 x SPF 91/2</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Unreduced 100% Moment Capacity</td>
<td>2.5</td>
<td>1 (Test 7)</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Smartlam</td>
<td>SL-V4</td>
<td>None</td>
<td>Half-Lap</td>
<td>nominal 1/2&quot; plywood with 8d nails</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>12 (Test 4)</td>
<td>Western Fire Center 10/25/2016</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>Smartlam</td>
<td>VI</td>
<td>None</td>
<td>Half-Lap</td>
<td>nominal 1/2&quot; plywood with 8d nails</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>12 (Test 5)</td>
<td>Western Fire Center 10/28/2016</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>DR Johnson</td>
<td>VI</td>
<td>Half-Lap</td>
<td>Half-Lap</td>
<td>None</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>12 (Test 6)</td>
<td>Western Fire Center 11/01/2016</td>
</tr>
<tr>
<td>5-ply CLT (156mm x 475&quot;)</td>
<td>KLI</td>
<td>CV3M1</td>
<td>None</td>
<td>Half-Lap &amp; Topside Spline</td>
<td>None</td>
<td>Loaded, See Manufacturer</td>
<td>1</td>
<td>18</td>
<td>SwRI, 10/2012</td>
</tr>
</tbody>
</table>
Demonstrating Fire-Resistance Ratings for Mass Timber Elements in Tall Wood Structures

Richard McLane, PE, SE • Senior Technical Director • Tall Wood, WoodWorks

Changes to the 2021 International Building Code (IBC) have created opportunities for wood buildings that are much larger and taller than prescriptively allowed in past versions of the code. Occupant safety, and the need to ensure fire performance in particular, was a fundamental consideration as the changes were developed and approved. The result is three new construction types—Type IV-A, IV-B, and IV-C—which are based on the previous Heavy Timber construction type (renamed Type IV-HTI), but with additional fire protection requirements.

One of the main ways to demonstrate that a building will meet the required level of passive fire protection, regardless of structural materials, is through hourly fire-resistance ratings (FRRs) of its elements and assemblies. The IBC defines an FRR as the period of time a building element, component or assembly maintains the ability to confine a fire, continue to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 702.

FRRs for the new construction types are similar to those required for Type I construction, which is primarily steel and concrete. (See Table 1.) They are found in IBC Table 603, which includes FRR requirements for all construction types and building elements; however, other code sections should be checked for overriding provisions (e.g., occupancy separation, shaft enclosures, etc.) that may alter the requirements.

<table>
<thead>
<tr>
<th>Building Element</th>
<th>I-A</th>
<th>IV-A</th>
<th>I-B</th>
<th>IV-B</th>
<th>IV-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted stores, Max. 10 stories</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td>Max. 12 stories</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td>Max. 32 stories</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td>Max. 9 stories</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
<td>2h</td>
</tr>
</tbody>
</table>
What if I have a dropped ceiling? Can I have a dropped ceiling?
- Impact on FRR, NC placement, sprinkler requirements
Concealed Spaces in Type IV

Previous Type IV (now IV-HT) provisions prohibited concealed spaces

Credit: IBC
CONCEALED SPACES: TYPE IV-HT

Option 1:

Sprinklers in concealed spaces
Dropped ceiling
CONCEALED SPACES: TYPE IV-HT

Option 2:

Noncombustible insulation
Dropped ceiling
CONCEALED SPACES: TYPE IV-HT

Option 3:

5/8" Type X gypsum on all mass timber surfaces within concealed space

Dropped ceiling
Concealed Spaces in Type IV-A, IV-B

Without Dropped Ceiling

- Minimum 1" noncombustible material
- Mass timber floor panel
- Two layers 5/8" Type X gypsum

*Applicable to most locations; limited exposed mass timber permitted in IV-B

With Dropped Ceiling

- Minimum 1" noncombustible material
- Mass timber floor panel
- Two layers 5/8" Type X gypsum
- Dropped ceiling
Concealed Spaces in Type IV-C

**Without Dropped Ceiling**
- Noncombustible material not required
- Mass timber floor panel
- Noncombustible material not required

**With Dropped Ceiling**
- Noncombustible material not required
- Mass timber floor panel
- One layer 5/8" Type X gypsum covering all mass timber surfaces within concealed space
- Dropped ceiling
Concealed Spaces in Mass Timber and Heavy Timber Structures

Concealed spaces, such as those created by a dropped ceiling in a floor framing assembly or by a stud wall assembly, have unique requirements in the International Building Code (IBC) to address the potential for fire spread in non-visibility areas of a building. Section 718 of the 2018 IBC includes prescriptive requirements for protection and compartmentalization of concealed spaces through the use of draft stopping, fire blocking, spacers, and other means. For information on these requirements, see the WoodWorks GDA, "Use spacers required for concealed spaces such as floor and roof cavities in multi-family wood-frame buildings?"

For mass timber building elements, the choice of construction type can have a significant impact on concealed space requirements. Because mass timber products such as cross-laminated timber (CLT) and cross-laminated panel (CLP) are non-combustible or slow-burning materials, concealed spaces cannot be used or exposed in other construction types. This is not the case. In addition to Type IV buildings, structural mass timber elements—including CLT, glued-laminated timber (GLT), cross-laminated timber (CLT), structural composite lumber (SCL), and tongue-and-groove (T&G) decking—can be used and exposed in the following construction types, whether or not a fire-resistance rating is required:

- Type III—Floors, roofs, and exterior walls may be any material permitted by code, including mass timber; exterior walls are required to be non-combustible or the equivalent to other wood.
- Type IV—Floors, roofs, interior walls, and exterior walls (i.e., the entire structure) may be constructed of mass timber.
- Type V and II—Mass timber may be used in select circumstances such as roof construction—including the primary framing in the 2021 IBC—(Type I B, S A or II B; exterior columns and arches when 20 feet or more of horizontal separation is provided, and balconies, canopies and similar projections).
ADDRESSING CLT CHAR FALL OFF
CLT char fall off or heat induced delamination occurs when laminations (or pieces thereof) fall off the underside of a CLT panel under extended fire conditions.
In tall buildings, preventing fire re-growth is key. Fire re-growth is a phenomenon in which the heat-release rate of a fire intensifies following a decay phase. Fire re-growth can be initiated when delamination occurs, as this exposes un-charred wood surfaces, thereby resulting in an influx of fuel available for consumption by the fire.
Facts about CLT char fall off:

• Only an item to consider in tall buildings. Important to avoid in high-rise construction where required performance is containment of fire within compartment of origin with no sprinkler or fire service suppression

• Not applicable when discussing mid-rise mass timber (or any building under types II, III, IV-HT or V)

• Largely a function of adhesive performance under high temps

• Has been addressed in PRG 320-18 (required for all CLT under 2021 IBC, not just tall wood)
2021 IBC Section 602.4 added:
Cross-laminated timber shall be labeled as conforming to PRG 320 - 18 as referenced in Section 2303.1.4.
PRG 320 is manufacturing & performance standard for CLT.
2018 edition (referenced in 2021 IBC) added new elevated temperature adhesive performance requirements validated by full-scale and medium-scale qualification testing to ensure CLT does not exhibit fire re-growth

When designing tall wood – specify CLT per PRG 320-18 (req’d in IBC 2021 for all CLT)

ANNEX B. PRACTICE FOR EVALUATING ELEVATED TEMPERATURE PERFORMANCE OF ADHESIVES USED IN CROSS-LAMINATED TIMBER (MANDATORY)
DOES TALL WOOD = HIGH RISE?
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
LATERAL SYSTEMS IN TALL WOOD
INTRO, CLEVELAND
Concrete Core Shearwalls

Photo: Panzica Construction
CARBON12, PORTLAND

Buckling-Restrained Braced Frame

Photos: Marcus Kauffmann, ODF
ASCENT, MILWAUKEE
Concrete Core Shearwalls

Photos: Korb + Associates, Thornton Tomasetti
BROCK COMMONS, VANCOUVER
Concrete Core Shearwalls

Photos: Acton Ostry Architects
FUTURE POTENTIAL LATERAL SYSTEM FOR TALL WOOD

Mass Timber Rocking Shearwalls
CONSIDERATIONS FOR LATERAL SYSTEMS

Prescriptive Code Compliance

Concrete Shearwalls ✓
Steel Braced Frames ✓
CLT Shearwalls (65 ft max) ✓
CLT Rocking Walls ✗

2021 SDPWS
ASCE 7-22

IBC
2021

SDPWS
2021

Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASCE 7-16

Photo: WoodWorks
CONSIDERATIONS FOR LATERAL SYSTEMS

Connections to concrete core
- Tolerances & adjustability
- Drag/collector forces
CONSIDERATIONS FOR LATERAL SYSTEMS

Connections to steel frame
- Tolerances & adjustability
- Ease of installation

Photos: Marcus Kauffmann, ODF
Shaft Enclosures in Tall Timber...

• When can shaft enclosures be MT?
• What FRR requirements exist?
• If shaft enclosure is MT, is NC req’d?
## Tall Wood Shaft Enclosures

### Exit & Hoistway Enclosures

- **IV-A**: Up to 12 Stories or 180 ft: MT protected with 2 layers 5/8” type X gyp (if 2 HR req’d) or 3 layers 5/8” type X gyp (if 3 HR req’d) both sides
- **IV-B**: Above 12 Stories or 180 ft: Noncombustible shafts (IBC 2021 602.4)
- **IV-C**: NC or MT protected with 2 layers 5/8” type X gyp (IBC 2021 602.4.2.6) both sides

<table>
<thead>
<tr>
<th>Exit &amp; Hoistway Enclosures</th>
<th>FRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>E&amp;H Enclosures FRR</td>
<td></td>
</tr>
</tbody>
</table>

| **2 HR (not less than FRR of floor assembly penetrated, IBC 713.4)** |
Shaft Wall Requirements in Tall Mass Timber Buildings

The 2021 International Building Code (IBC) introduced three new construction types—Type IV-A, IV-B, and IV-C—which allow tall mass timber buildings. For details on the new types and their requirements, see the WoodWorks paper: Tall Wood Buildings in the 2021 IBC—Up to 18 Stories of Mass Timber. This paper builds on that document with an in-depth look at the requirements for shaft walls, including when and where wood can be used.

Shaft Enclosure Requirements in the 2021 IBC

A shaft is defined in Section 262 of the 2021 IBC as “an enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and roof.” Therefore, shaft enclosure requirements apply to stairs, elevators, and mechanical/electrical/plumbing (MEP) shafts in multi-story buildings. While these applications may be similar in their fire design requirements, they tend to differ in terms of their assemblies, detailing, and construction constraints.

Shaft enclosures are specifically addressed in IBC Section 713. However, because shaft enclosure walls must be constructed as fire barriers per Section 713.2, many shaft wall requirements reference provisions for fire barriers found in Section 707.

Allowable Shaft Wall Materials

Provisions addressing materials permitted in shaft walls are included in the IBC.
CONNECTIONS IN TALL WOOD

Photo: Structurlam
In Construction Types IV-A, IV-B & IV-C, building elements are required to be FRR as specified in IBC Tables 601 and 602. Connections between these building elements must be able to maintain FRR no less than that required of the connected members.

### 16.3 Wood Connections

Wood connections, including connectors, fasteners, and portions of wood members included in the connection design, shall be protected from fire exposure for the required fire resistance time. Protection shall be provided by wood, fire-rated gypsum board, other approved materials, or a combination thereof.

Source: NDS
Steel hangers/hardware fully concealed within a timber to timber connection is a common method of fire protection.
2304.10.1 Connection fire resistance rating. Fire resistance ratings in Type IV-A, IV-B, or IV-C construction shall be determined by one of the following:

1. Testing in accordance with Section 703.2 where the connection is part of the fire resistance test.

2. Engineering analysis that demonstrates that the temperature rise at any portion of the connection is limited to an average temperature rise of 250°F (139°C), and a maximum temperature rise of 325°F (181°C), for a time corresponding to the required fire resistance rating of the structural element being connected. For the purposes of this analysis, the connection includes connectors, fasteners, and portions of wood members included in the structural design of the connection.
Connection Fire Protection

Many ways to demonstrate connection fire protection: calculations, prescriptive NC, test results, others as approved by AHJ
2017 Glulam Beam to Column Connection Fire Tests under standard ASTM E119 time-temperature exposure
## Fire Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Beam</th>
<th>Connector</th>
<th>Applied Load</th>
<th>FRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.75” x 18”</td>
<td>1 x Ricon S VS 290x80</td>
<td>3,905lbs (17.4kN)</td>
<td>1hr</td>
</tr>
<tr>
<td></td>
<td>(222mm x 457mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10.75” x 24”</td>
<td>Staggered double Ricon S VS 200x80</td>
<td>16,620lbs (73.9kN)</td>
<td>1.5hrs</td>
</tr>
<tr>
<td></td>
<td>(273mm x 610mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10.75” x 24”</td>
<td>1 x Megant 430</td>
<td>16,620lbs (73.9kN)</td>
<td>1.5hrs</td>
</tr>
<tr>
<td></td>
<td>(273mm x 610mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Softwood Lumber Board
Glulam Connection Fire Test
Summary Report

Issue | June 5, 2017

Full Report Available at:
Wood Connection Coverings for Fire-Resistance

110.3.5 **Type IV-A, IV-B, and IV-C connection protection inspection.** In buildings of Type IV-A, IV-B, and IV-C Construction, where connection fire resistance ratings are provided by wood cover calculated to meet the requirements of Section 2304.10.1, inspection of the wood cover shall be made after the cover is installed, but before any other coverings or finishes are installed.
# Tall Mass Timber Special Inspections

**TABLE 1705.5.3**

**REQUIRED SPECIAL INSPECTIONS OF MASS TIMBER CONSTRUCTION**

<table>
<thead>
<tr>
<th>Type</th>
<th>Continuous Special Inspection</th>
<th>Periodic Special Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2. Inspect erection of mass timber construction</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3. Inspection of connections where installation methods are required to meet design loads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1. Threaded fasteners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.1. Verify use of proper installation equipment</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.1.2. Verify use of pre-drilled holes where required</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.1.3. Inspect screws, including diameter, length, head type, spacing, installation angle, and depth.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.2. Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.3. Adhesive anchors not defined in 3.2.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.4. Bolted connections</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3.5. Concealed connections</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Source: International Building Code

Table is only required for **Type IV-A, IV-B, and IV-C**
Questions? Ask us anything.

Mark Bartlett, PE
Regional Director | TX
(214) 679-1874
mark.bartlett@woodworks.org

Please take our survey!