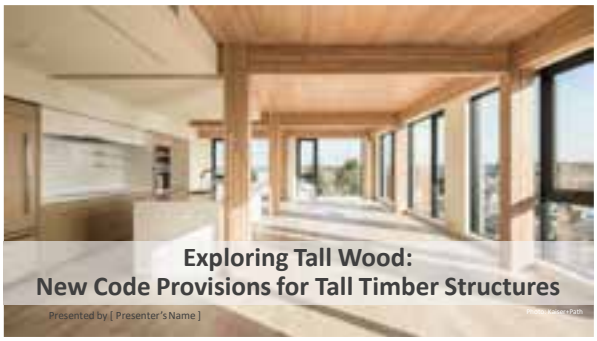


Exploring Tall Wood: New Code Provisions for Tall Timber Structures

Presented by [Presenter's Name]

Photo: Kaskey Path

"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.

Course Description

As interest in and use of mass timber in the U.S. has grown, so too has interest in pushing these timber structures to greater heights. Using international examples of successful tall wood buildings as precedent, some designers have proposed tall wood projects in the states using a project-specific performance-based design approach. In order to provide a uniform set of code provisions for these tall wood buildings, the International Code Council established an ad hoc committee on tall wood buildings that proposed a set of code changes allowing up to 18 stories of mass timber construction. Those code changes were announced as approved in January 2019 and will become part of the 2021 International Building Code. Following a brief discussion of history and motivators, this presentation will introduce the new tall wood code provisions and construction types, 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 14 new code provisions for the 2021 IBC that address tall wood construction.
3. Discuss differences between the new tall wood mass timber construction types and existing construction types.
4. Identify the key passive fire-resistance construction requirements and active systems that enable taller wood buildings to be built safely.

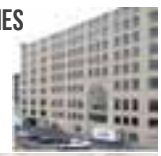
Questions we'll answer:

- 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?

Photo: Michael Green Architecture

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 Limtre


Photo: naturally wood


Photo: Hugo Lainer + Partner

TALL WOOD IN THE US CIRCA 2019

8 STORIES

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman | Architect: PATH Architecture

HEAVY TIMBER

Federal Center South, Seattle, WA
Photo: Benjamin Benschneider

MASS TIMBER

Bullitt Center, Seattle, WA
Photo: John Stamets

GLULAM


Photo: StructureCraft

CROSS-LAMINATED TIMBER (CLT)


Photo: Lendlease

NAIL-LAMINATED TIMBER (NLT)


Photo: Think Wood


Photo: Ema Peter

DOWEL-LAMINATED TIMBER (DLT)


Photo: StructureCraft


Photo: StructureCraft

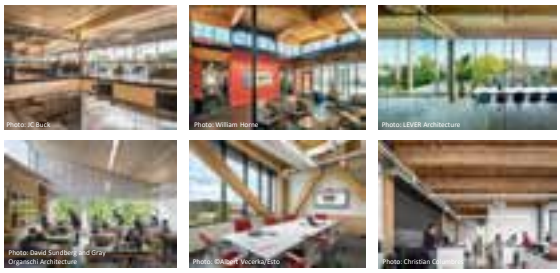
MASS PLYWOOD PANELS (MPP)


Photo: LEVER Architecture

DECKING


Photo: Bernard André Photography

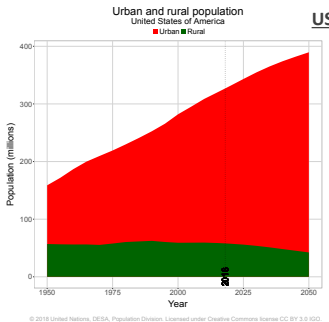
OFFICES | MULTI-FAMILY | COMMERCIAL | EDUCATIONAL



GLOBAL POPULATION BOOM

Global Population
7.6 billion now
9.8 billion by 2050
30% increase

Source: United Nations Department of Economic and Social Affairs



US URBAN POPULATION BOOM

	URBAN	RURAL
2019	271.4 M	57.7 M
2030	301 M	53.7 M
2050	347.3 M	42.2 M

Construction Traffic & Noise
Material Stockpiles
Labor Costs
Labor Availability
Weather Risks

Resiliency
Sustainability
Fire & Life Safety

Source: Naturally:Wood9

Reduced Embodied Carbon

Brock Commons, Vancouver, BC

Photo Credit: UBC

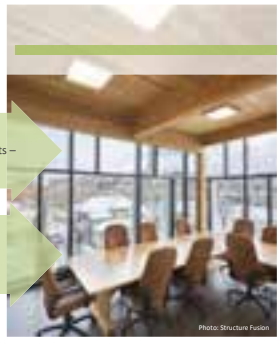
MARKET DRIVERS FOR MASS TIMBER

PRIMARY DRIVERS

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

SECONDARY DRIVERS

- Carbon Reductions
- Structural Performance – lightweight



Market Opportunity by Project Type

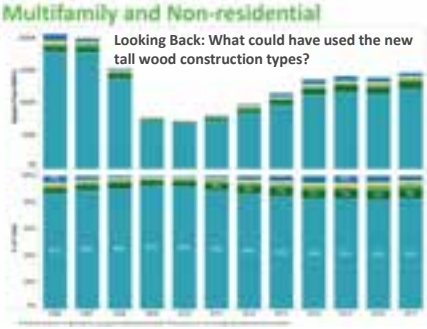
Forecast: Mass Timber "Type" Projects

All stories (not just tall wood)

~1 Billion SF per Year

All Multifamily and Non-residential

Looking Back: What could have used the new tall wood construction types?



2021 IBC Construction Types

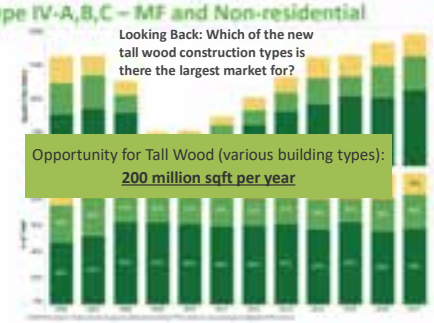
- 19+
- IV-A
- IV-B
- IV-C
- III, IV, V

Estimated construction types calculated using building stories and occupancy

Type IV-A,B,C – MF and Non-residential

Looking Back: Which of the new tall wood construction types is there the largest market for?

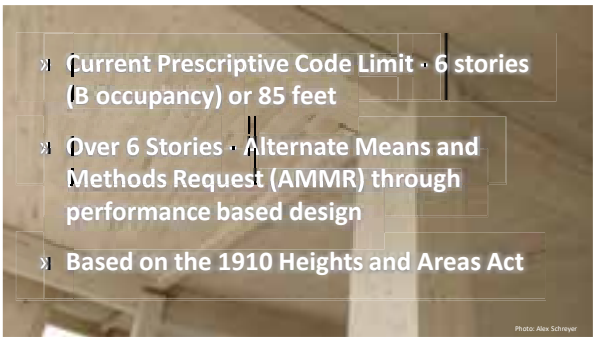
Opportunity for Tall Wood (various building types): **200 million sqft per year**



2021 IBC Construction Types

- IV-A
- IV-B
- IV-C

Estimated construction types calculated using building stories and occupancy



TYPE III CONSTRUCTION, RESIDENTIAL OCCUPANCY: 5 STORIES

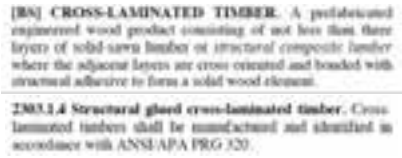
LIGHT-FRAME WOOD
MASS TIMBER

ICC INTERNATIONAL CODE COUNCIL®

3 YEAR CODE CYCLE

U.S. TALL WOOD
DEVELOPMENT AND CHANGES

Seen as the catalyst for the mass timber revolution, CLT first recognized in US codes in the 2015 IBC


[BS] 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.

U.S. TALL WOOD
DEVELOPMENT AND CHANGES

Interest in tall wood projects in the US was rapidly increasing. Some building officials were reluctant to approved proposed plans, primarily due to lack of code direction and precedent

U.S. TALL WOOD
DEVELOPMENT AND CHANGES

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.

U.S. BUILDING CODES
DEVELOPMENT AND CHANGES

Timeline:
Submission of code changes for the 2018 Group A Cycle (IBC) in January 2018 – changes for 2021 IBC

U.S. BUILDING CODES
DEVELOPMENT AND CHANGES

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:

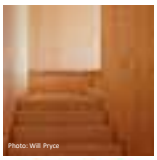
1. No collapse under reasonable scenarios of complete burn-out of fuel without automatic sprinkler protection being considered.
2. Highly reliable fire suppression systems to reduce the risk of failure during reasonably expected fire scenarios. The degree of reliability should be proportional to evacuation 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

Images: AWC

U.S. BUILDING CODES
Tall Wood Ad Hoc Committee

Tests on exposed mass timber, gypsum-covered mass timber; normal sprinkler protection, delayed sprinkler protection
Majority of flames seen are from contents, not structure

U.S. BUILDING CODES
Tall Wood Ad Hoc Committee

Test	Description	Construction Type
Test 1	All mass timber surfaces protected with 2 layers of 5/8" Type X Gypsum. No Sprinklers.	IV-A
Test 2	30% of CLT ceiling area in living room and bedroom exposed. No Sprinklers.	IV-B
Test 3	Two opposing CLT walls exposed – one in bedroom and one in living room. No Sprinklers.	IV-B
Test 4	All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – normal activation	IV-C
Test 5	All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – 20 minute delayed activation	IV-C

TEST 1

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

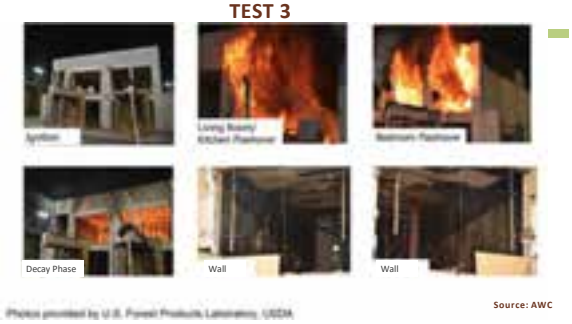
Source: AWC

TEST 2

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

Source: AWC

TEST 3



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

Photo: LendLease

Although not directly affiliated with the TWB AHC, other mass timber and tall wood testing & research was occurring, the results of which the AHC included in their final decisions

U.S. BUILDING CODES
DEVELOPMENT AND CHANGES

ICC TWB Ad Hoc Committee Group A proposals consisted of the following 14 parts

Requirements for the new Types of Construction

- IBC Section 602.4 – Type of Construction (E106-18)
- IBC Section 703.6 – Performance Method for Fire Resistance from Noncombustible Protection (FS5-18)
- IBC Section 722.1 – Prescriptive Fire Resistance from Noncombustible Protection (FS61-18)
- IBC Section 703.8 – Sealants at Edges (E58-18)
- IBC Section 714.3.1 – Fire and Smoke Protection (FS72-18)
- IBC Section 403.2.2 – High-Rise Sprinkler Water Supply (G28-18)
- IBC Section 701.6 – Element Responsibility (E98-18)

IFC Section 3309.4 – Fire Safety During Construction (F296-18)

Allowable building size limits

- IBC Table 504.3 – Building Height (G75-18)
- IBC Table 504.4 – Number of Stories (G80-18)
- IBC Table 506.2 – Allowable Area (G84-18)

Housekeeping changes

- IBC Section 3102 – Special Construction (G148-18)
- IBC Appendix D – Fire Districts (G152-18)
- IBC Section 508.4 and 509.4 – Fire Barriers (G83-18)

U.S. BUILDING CODES
DEVELOPMENT AND CHANGES

ICC INTERNATIONAL CODE COUNCIL®

2018 TIMELINE:

Step 1: January 8 – Final Proposed Language submitted to ICC
Step 2: February 28 – Changes are posted for Public Viewing
Step 3: April 15-25 – Committee Action Public Hearing – Columbus, OH

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

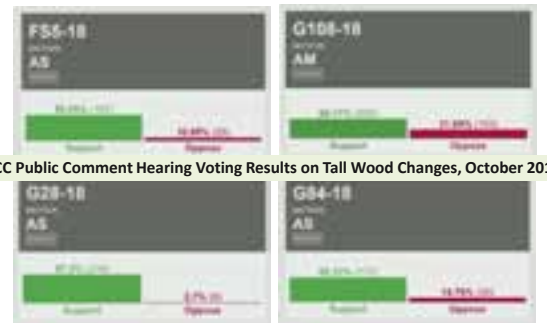
Credit: AWC

U.S. BUILDING CODES
DEVELOPMENT AND CHANGES

ICC INTERNATIONAL CODE COUNCIL®

2018 (& BEYOND) TIMELINE:

Step 4: May 30 – Committee Action Hearing results posted
Step 5: June 1 - July 16 – Public Comments Sought on Committee Action Hearing Results
Step 6: August 31 – Public Comments Posted
Step 7: October 24-31 – Public Comment Hearing and Vote
Step 8: November 19 – December 7 Final Online Vote
Step 9: Fall 2020 – New Edition is Published



ICC Public Comment Hearing Voting Results on Tall Wood Changes, October 2018

TALL WOOD APPROVED!

Unofficial results posted Dec 19, 2018

Final votes ratified Jan 31, 2019

AWC: Tall Mass Timber code changes get final approval

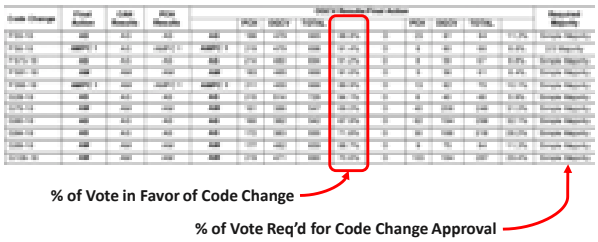
Dec 19, 2018

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

ICC Online Governmental Consensus Voting Results, Ratified January 2019

Tall Wood Code Changes as submitted by TWB Ad Hoc Committee



% of Vote in Favor of Code Change

% of Vote Req'd for Code Change Approval

SO WHAT'S CHANGED??

ICC INTERNATIONAL CODE COUNCIL

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

TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
A	B	A	B	A	B	HT	A	B

U.S. BUILDING CODES
Tall Wood Construction Types

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

U.S. BUILDING CODES
Tall Wood Ad Hoc Committee

2021 IBC Introduces 3 new tall wood construction types:

IV-A, IV-B, IV-C

Previous type IV renamed type IV-HT

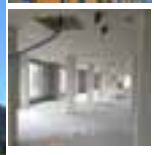
BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B

New Building Types

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

Credit: Susan Jones, atelierjones

Credit: Acton Ostry Architects, Fast + Epp

100% NC protection on all surfaces of Mass Timber

Type IV-A Height and Area Limits

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	18	270 ft	135,000 SF	405,000 SF
B	18	270 ft	324,000 SF	972,000 SF
M	12	270 ft	184,500 SF	553,500 SF
R-2	18	270 ft	184,500 SF	553,500 SF

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

Type IV-B Protection vs. Exposed

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path

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

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	12	180 ft	90,000 SF	270,000 SF
B	12	180 ft	216,000 SF	648,000 SF
M	8	180 ft	123,000 SF	369,000 SF
R-2	12	180 ft	123,000 SF	369,000 SF

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

Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

Type IV-C Protection vs. Exposed

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path, Erna Peter

All Mass Timber surfaces may be exposed

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

Type IV-C Height and Area Limits

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	6	85 ft	56,250 SF	168,750 SF
B	9	85 ft	135,000 SF	405,000 SF
M	6	85 ft	76,875 SF	230,625 SF
R-2	8	85 ft	76,875 SF	230,625 SF

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 Building Size Limits

	Construction Type (All Sprinklered Values)						
	I-A	I-B	IV-A	IV-B	IV-C	IV-HT	III-A
Occupancies	**Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)**						
A, B, R	Unlimited	180	270	180	85	85	85
	Allowable Number of Stories above Grade Plane (IBC Table 505.4)						
A-2, A-3, A-4	Unlimited	12	18	12	6	4	4
B	Unlimited	12	18	12	9	6	6
R-2	Unlimited	12	18	12	8	5	5
	Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2)						
A-2, A-3, A-4	Unlimited	Unlimited	135,000	90,000	56,250	45,000	42,000
B	Unlimited	Unlimited	324,000	216,000	135,000	108,000	85,500
R-2	Unlimited	Unlimited	184,500	123,000	76,875	61,500	72,000

Tall Wood Fire Resistance Ratings (FRR)

	IV-A	IV-B	IV-C
Primary Frame or Brng Wall FRR	3 HR (2 HR at Roof)	2 HR (1 HR at Roof)	2 HR (1 HR at Roof)
Floor Construction FRR	2 HR	2 HR	2 HR
Roof Construction FRR	1.5 HR	1 HR	1 HR
Floor Surface Protection	1 inch of NC protection	1 inch of NC protection	No protection req'd
Roof Construction Protection	2 layers 5/8" type X gyp on inside face	2 layers 5/8" type X gyp on inside face	No protection req'd unless concealed space

Tall Wood Materials & Protection

	IV-A	IV-B	IV-C
Exterior Walls	Mass Timber, exterior surface protected with 1 layer 5/8" type X gyp		
Structural Materials	Mass Timber or NC		
Concealed Spaces	Permitted, requires NC protection on MT surfaces		
Gypsum Protection	All MT is protected 3 HR: 3 layers 5/8" type X gyp 2 HR or less: 2 layers 5/8" type X gyp	Same as IV-A for protected MT. Limited exposed MT permitted, FRR still applies	All MT permitted may be exposed except as noted

WoodWorks Tall Wood Design Resource

http://www.woodworks.org/wp-content/uploads/wood_solution_paper-TALL-WOOD.pdf

EARLY TALL WOOD CODE ADOPTION

Statewide Alternate Method
No. 18-01 Tall Wood Buildings – Background

Statewide Alternate Method (SAM) Number 18-01 provides prescriptive path elements for Tall Wood Buildings of mass timber construction. This alternate path includes scientific conclusions established by the International Code Council's Ad Hoc Committee on Tall Wood Buildings that were incorporated into fourteen national proposals and utilizes concrete, steel or masonry for the vertical elements of the seismic force-resisting system.

The provisions detailed in the SAM are crafted to coincide with the *2014 Oregon Structural Specialty Code* (OSSC) when selected for use.

Three new types of construction are introduced under this method, all three of which are organized under Type IV construction, typically referred to as heavy timber.

The new types of construction are:

- Type IV A
- Type IV B
- Type IV C

Washington state to allow mid and high-rise mass-timber buildings

State is first in the nation to alter building codes in support of a new generation of engineered wooden building materials with exciting properties of strength, durability and beauty. With mass timber, architects and builders acquire a new material to create with and rural areas gain the prospect of new high-skilled, high-paid jobs

SEATTLE (Dec. 5, 2019) (PRNewswire) – The Washington State Building Code Council (SBCC) has approved code changes that will allow for the structural use of mass timber in buildings as tall as 10 stories. This makes Washington the first state in the nation to allow tall mass timber buildings into its building code, without pursuing an alternate method.

© DLR Group

SEATTLE MASS TIMBER TOWER

SEATTLE MASS TIMBER TOWER

© DLR Group

- 12 Stories
- 135,000 SF
- Type IV-B Construction – 2 HR FRR (1 HR at Roof)
- 14 ft Floor to Floor
- 12.5 ft x 42 ft Structural Grid
- Retail on 1st level; 5 floors of office; 192-key hotel