



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



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Participants may download the presentation here:
<http://www.awc.org/education/resources>

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

COURSE DESCRIPTION



We are at an exciting confluence in timber construction. The need for sustainable, urban construction has never been higher. Concurrently, mass timber products such as CLT have opened the door to many new opportunities for construction, one of which is tall wood. In January 2019, the International Code Council (ICC) approved a set of proposals to allow tall wood buildings of up to 18 stories as part of the 2021 International Building Code (IBC). This presentation will introduce the new tall wood code provisions in depth. Starting with a review of the technical research and testing that supported their adoption, it will then take a detailed look at the new code provisions and methods of addressing the new requirements. Topics will include fire-resistance ratings and allowances for exposed timber, penetrations, sprinklers, connections, exterior walls and much more. Designers can expect to take away the knowledge they need to start exploring tall wood designs on their projects.

Learning Objectives

Upon completion, participants will be better able to

1

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

3

Discuss code-compliant options for exposing mass timber, where up to 2-hour fire-resistance ratings are required, and demonstrate design methodologies for achieving these ratings.

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.

4

Review code requirements unique to tall wood buildings, focusing on items such as sprinklers, shaft construction and concealed spaces.

TALL WOOD HISTORY IN THE U.S.

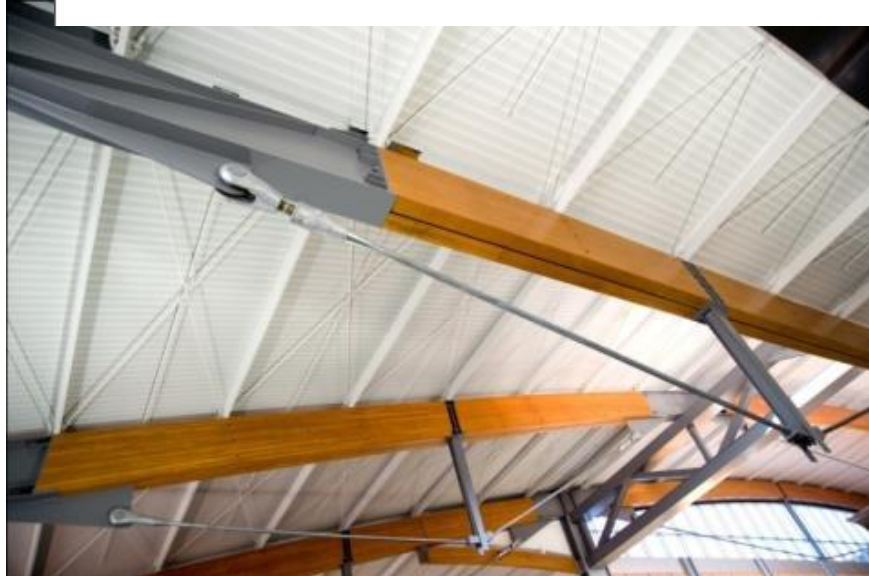
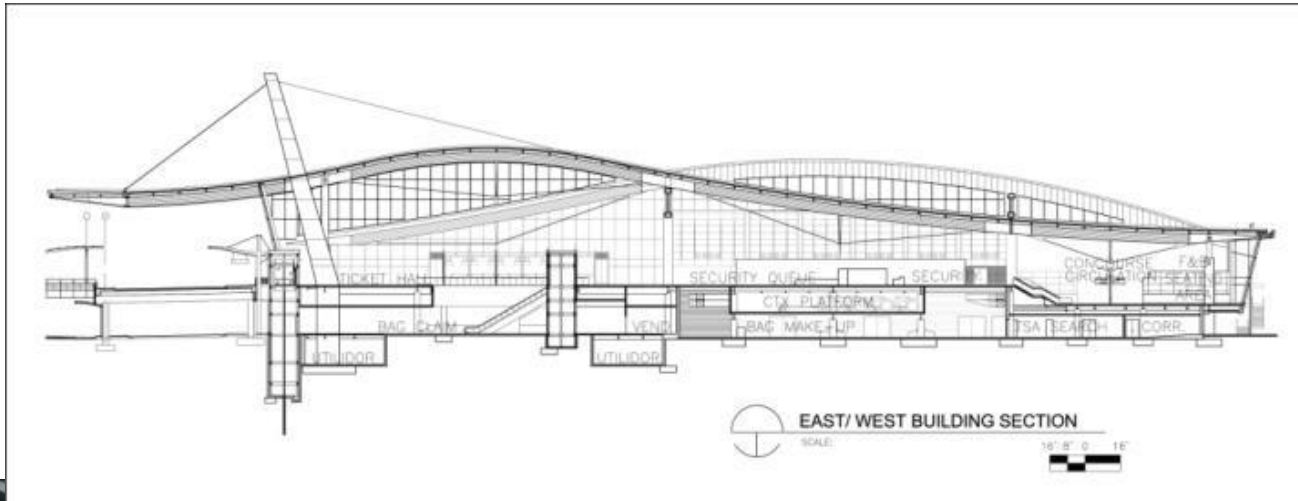


TRADITIONAL STICK FRAMED CONSTRUCTION



Tall Wood Construction: Code Provisions and Design Steps

RALEIGH DURHAM AIRPORT, NORTH CAROLINA



WARNER DRIVE – CULVER CITY, CA



- Nail-Laminated Timber – 2x12 vertical mechanically connected w/nails
- NDS principles of mechanics



Architect: Profeta Royalty Architecture
Structural Engineer: Structural Focus
Completed: 2011

BULLITT CENTER – SEATTLE, WA



250 YEAR STRUCTURE
HEAVY TIMBER, CONCRETE & STEEL

Architect: Miller Hill Partnership
Structural Engineer: DCI Engineers
Photo Credit: Miller Hull Partnership



2012-3.8_0220_442_460



Glulam column caps at the Bullitt Center



photos: John Stamets

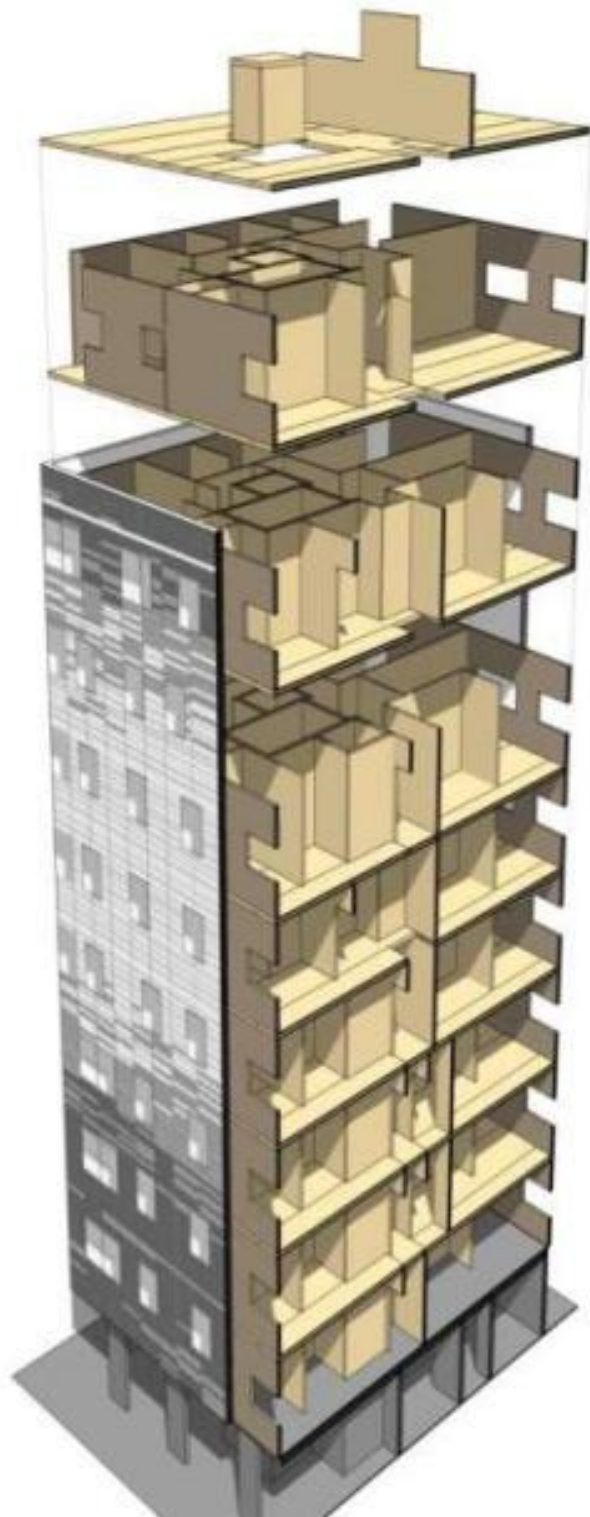
STADHAUS, LONDON, UK



CROSS-LAMINATED TIMBER



STRADTHAUS – 24 MURRAY GROVE



architects Waugh
Thistleton

London infill project
29 flats (mixed affordable and private)
Ground floor office
4x less weight than precast concrete
~1/2 the construction time of precast concrete
(saved 22 weeks vs. conc. 30%)
Saves 300 metric tons of CO2
21 years of energy usage for the building



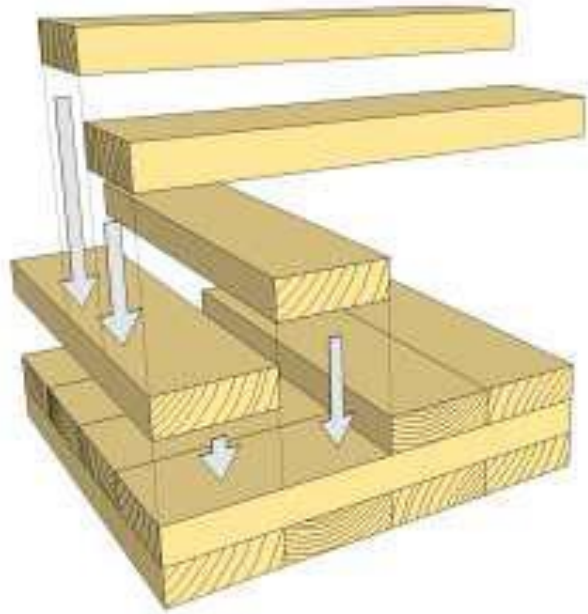
architects Waugh
Thistleton

HISTORY OF CLT

- 1985 First patent for CLT in France
- 1993 First projects in CLT in Switzerland and Germany
- 1995-1996 Development of press technology
- 1998 First multi-story residential building in Styria, Austria
- CLT use (Europe) increased significantly in the early 2000s
 - Driven by the green building movement
 - Due to better efficiencies, product approvals, and improved marketing and distribution channels
 - Over 500 CLT buildings in England
- US and Canadian use of CLT



CONCEPT OF CROSS-LAMINATED TIMBER

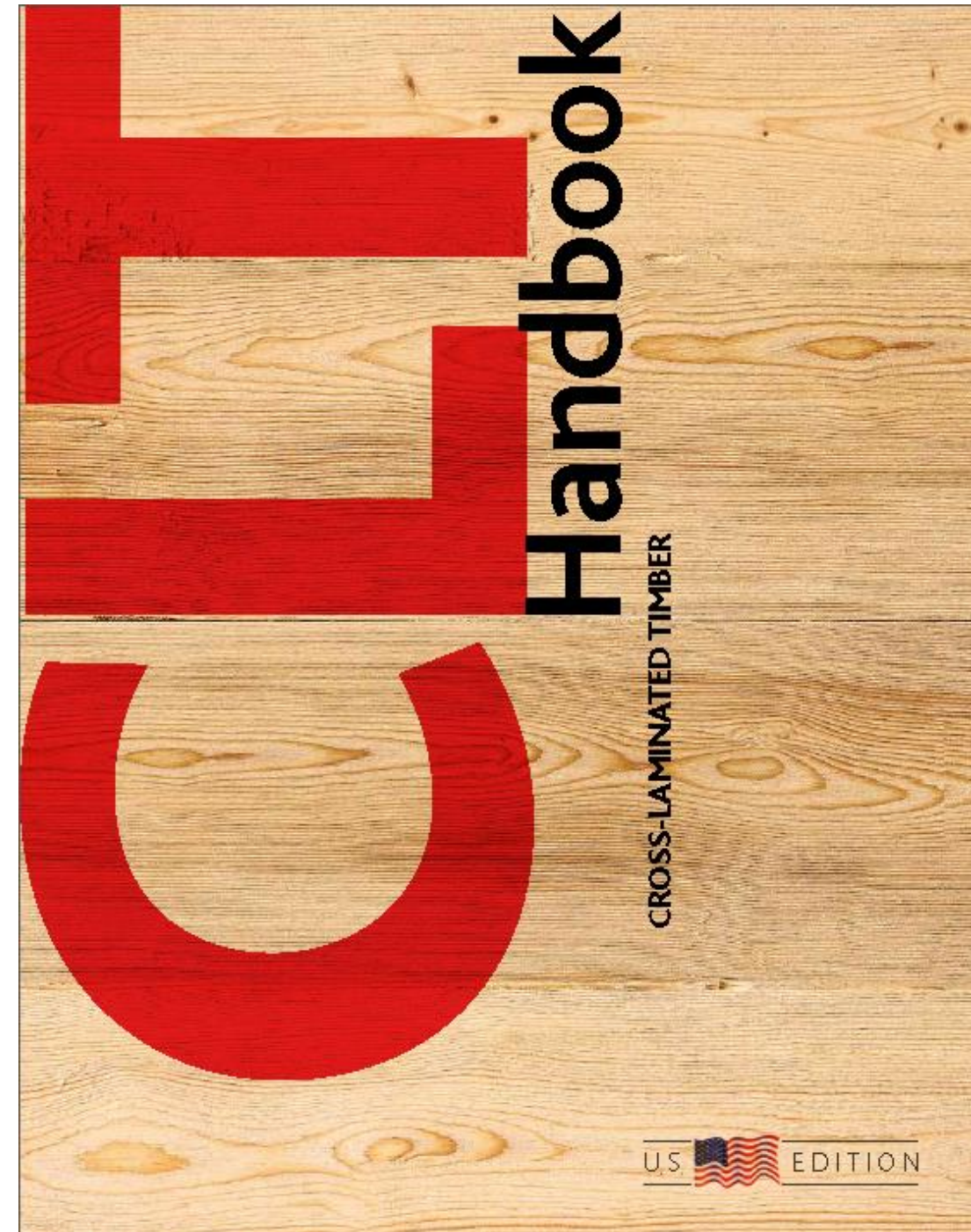


Photos provided by FPInnovations



Additional information on issues not yet covered in NDS or IBC

- Energy
- Sound
- Vibration
- Enclosures
- Handling



FORTE', MELBOURNE



10 stories, 23 apartments
<https://youtu.be/pHpthNBiYqE>

CANADIAN PROJECTS

Brock Commons

Vancouver, British Columbia

- 18 Stories
- Mixed use student housing

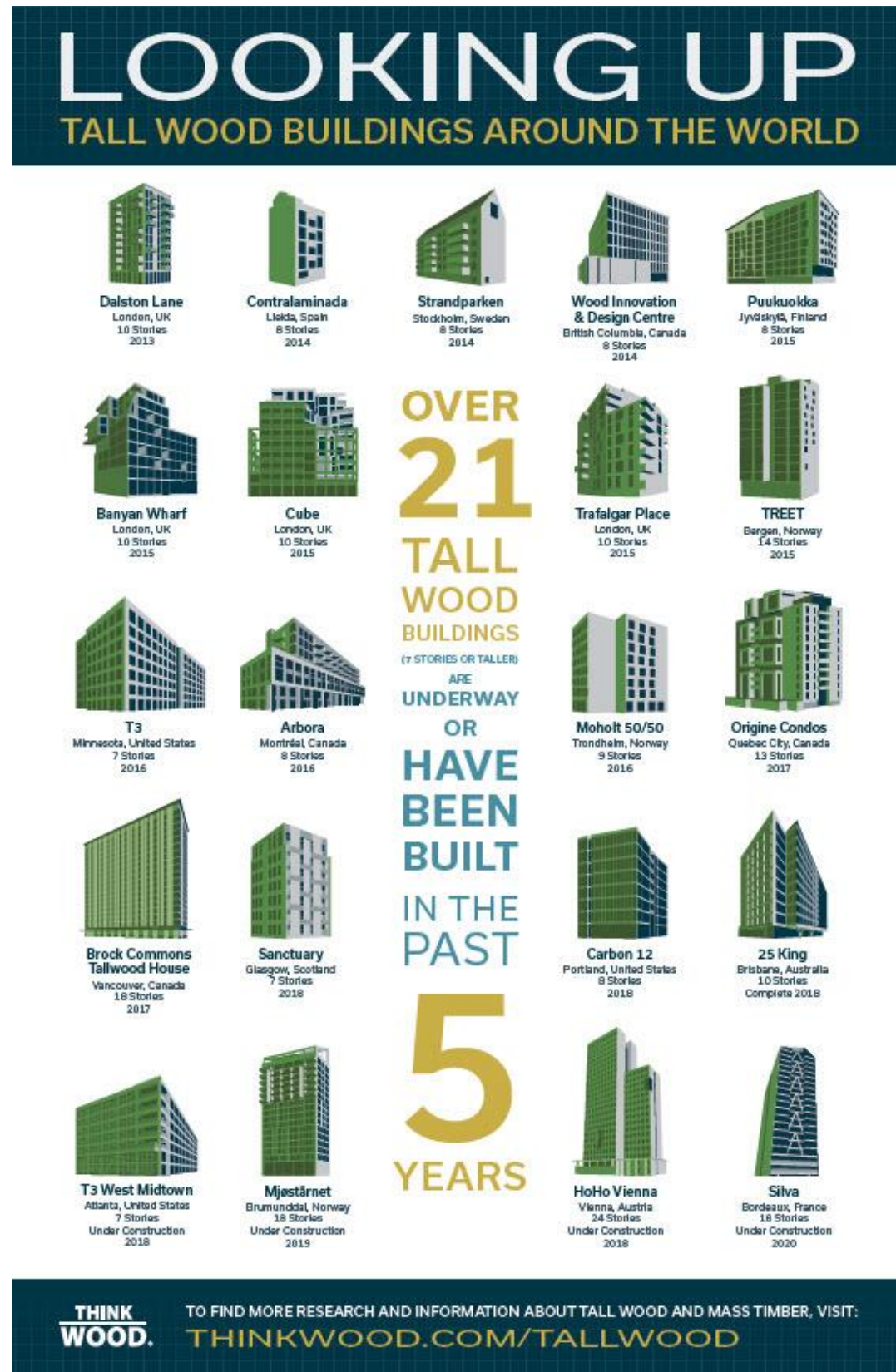


TALL WOOD WORLDWIDE

HoHo Vienna

Austria

- 24 Stories
- Mixed use
- June 2019



EXTERIOR WALL FIRE TEST

American Wood Council ASTM E119 fire test

- 5-Ply CLT (approx. 7" thick)
- 5/8" Type X GWB each side
- Sought 2 hour rating
- RESULTS: 3 hours 6 minutes

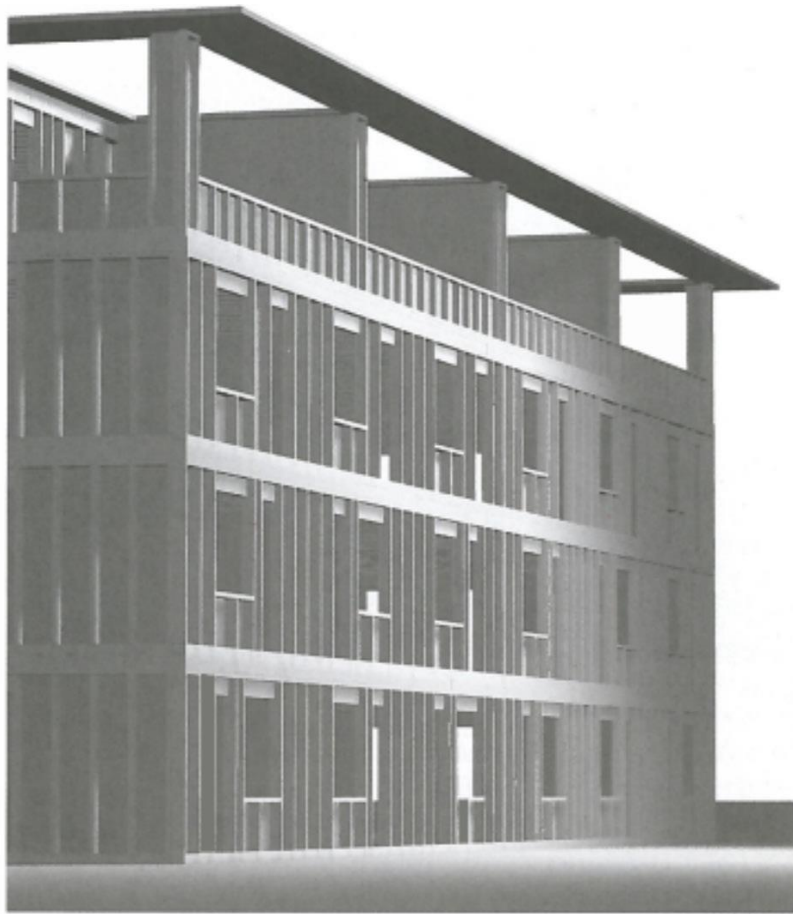


COMPARTMENT FIRE TESTS

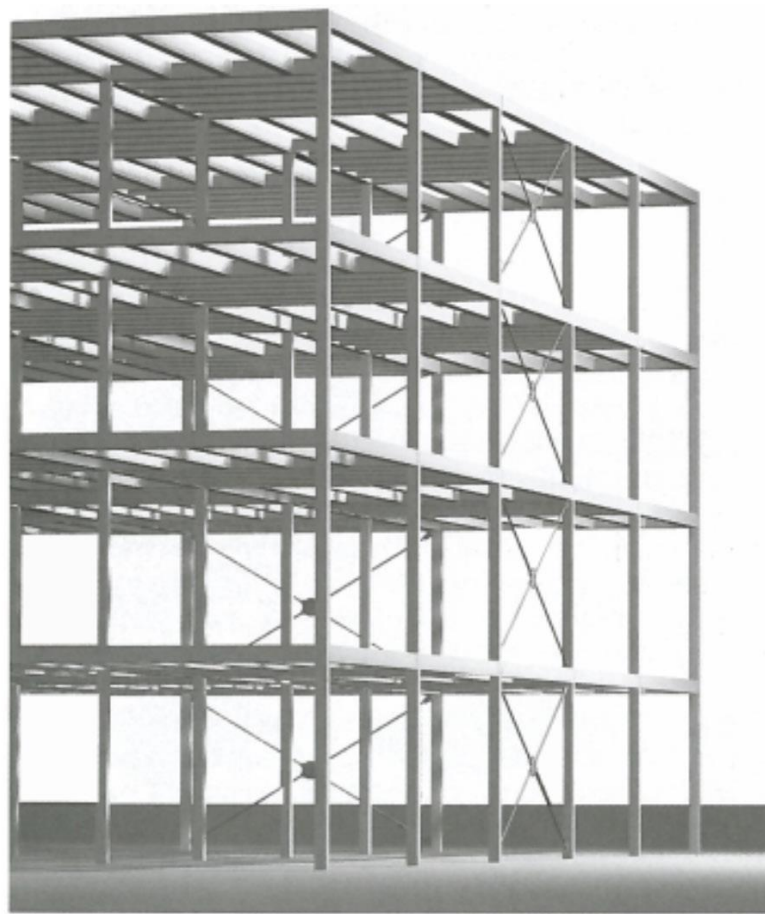


TALL WOOD HISTORY IN THE U.S.

LIGHT WOOD-FRAME



POST + BEAM



MASS TIMBER

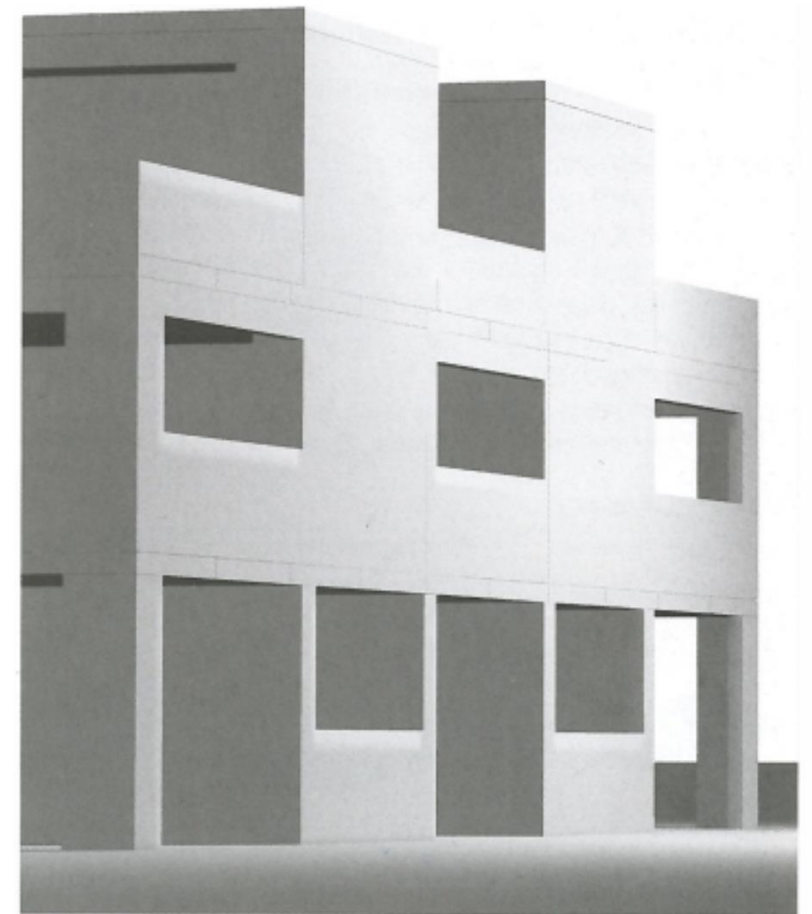


Image courtesy of Fast + Epp

ICC TALL WOOD BUILDINGS AD HOC COMMITTEE



ICC TALL WOOD BUILDINGS AD HOC COMMITTEE

- Balanced Committee
 - Building Officials
 - Fire Officials
 - Architects
 - Engineers
 - Fire Protection Experts
 - Materials Groups
 - Other Stakeholders
- 4 Work Groups
 - Definitions and Standards
 - Fire
 - Structural
 - Codes



ICC TALL WOOD BUILDINGS AD HOC COMMITTEE

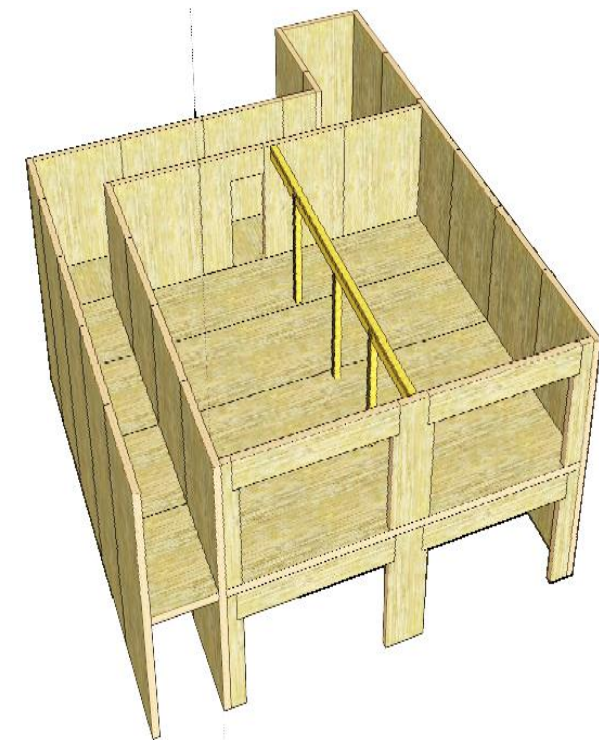
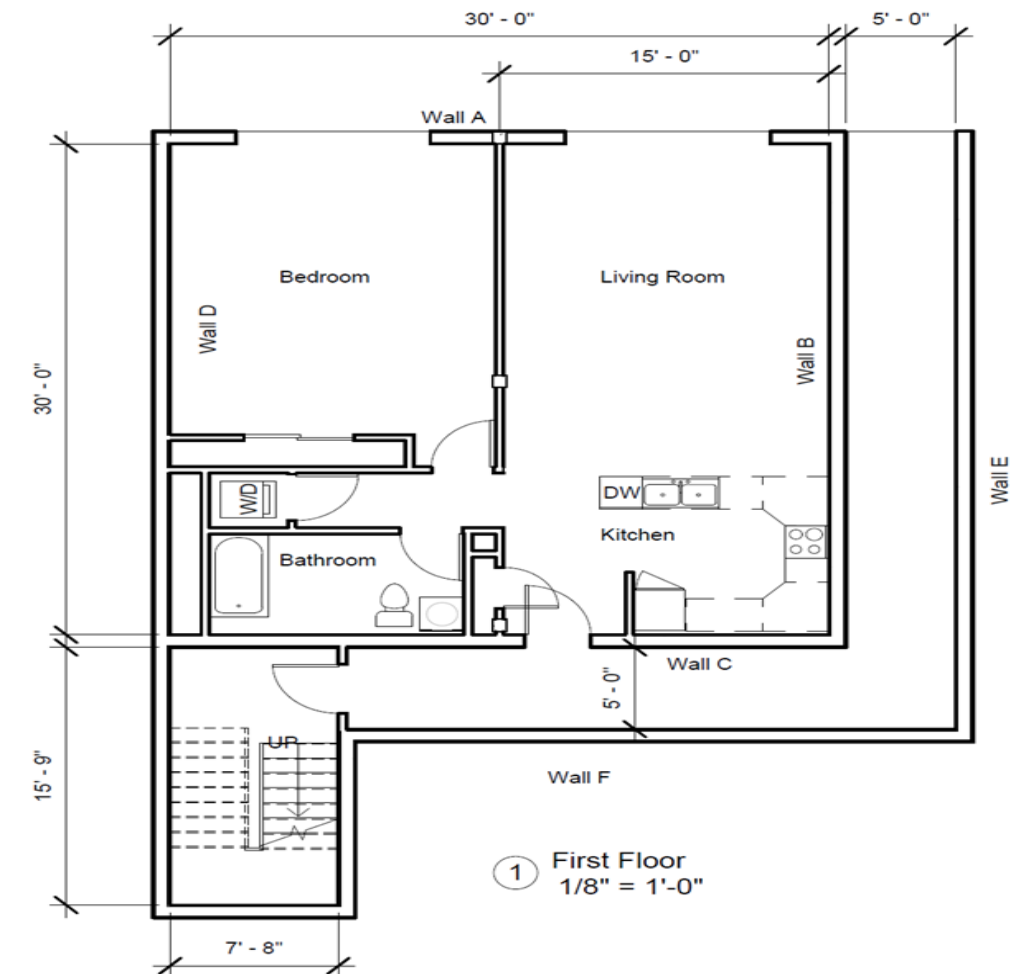
- 82 major issues identified, assigned to specific work groups, and investigated
- Performance Objectives
 - no collapse under reasonable scenarios of complete burn-out of fuel without automatic sprinkler protection being considered
 - radiation exposure
 - fire department access
 - egress with factor of safety
 - reliability of fire suppression systems



TWB COMMITTEE

Fire Work Group created fire test scenarios to study and validate TWB code change proposals

- 2-story condo situation
- 30 ft x 30 ft interior dimensions
- Corridor and stair included in the structure
- UL “modern furnishings” fuel load imposed → 570 MJ/m²
 - fuel load approximately 95% of Group R fuel loads from survey of Group R's



TWO-STORY FIRE TESTS

- Purpose: Perform tests of realistic fire scenarios applicable to tall wood construction in order to evaluate occupant and firefighter tenability for egress and suppression efforts, and to provide data necessary to guide further development of relevant code and standard provisions
- Conducted at U.S. government facilities (ATF)
- Supervised by U.S. Forest Product Laboratory staff



APARTMENT FURNISHINGS – KITCHEN & LIVING RM



ATF FIRE TEST SCENARIOS

Test	Description	Date	Duration
Test 1	All mass timber surfaces protected with 2 layers of 5/8" Type X GWB	5/23/17	3 hours
Test 2	30% of CLT ceiling area in living room and bedroom exposed	5/31/17	4 hours
Test 3	Two opposing CLT walls exposed – one in bedroom and one in living room (there is a partition wall)	6/20/17	4 hours
Test 4	All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – normal activation	6/27/17	6 minutes
Test 5	All mass timber surfaces fully exposed in bedroom and living room (except bathroom). Sprinklered – 20 min delayed activation	6/29/17	30 minutes

ATF FIRE TEST #2 – 30% CLT CEILINGS EXPOSED

Post-Fire Condition of Glulam After Gypsum Removal

- Fire intensity decreased subsequent to consumption of furnishings and contents (known as *decay phase*)
- Exposed mass timber surfaces self-extinguished in the decay phase
- Mass timber surfaces protected with 2 layers of 5/8" Type X GWB remained mostly uncharred

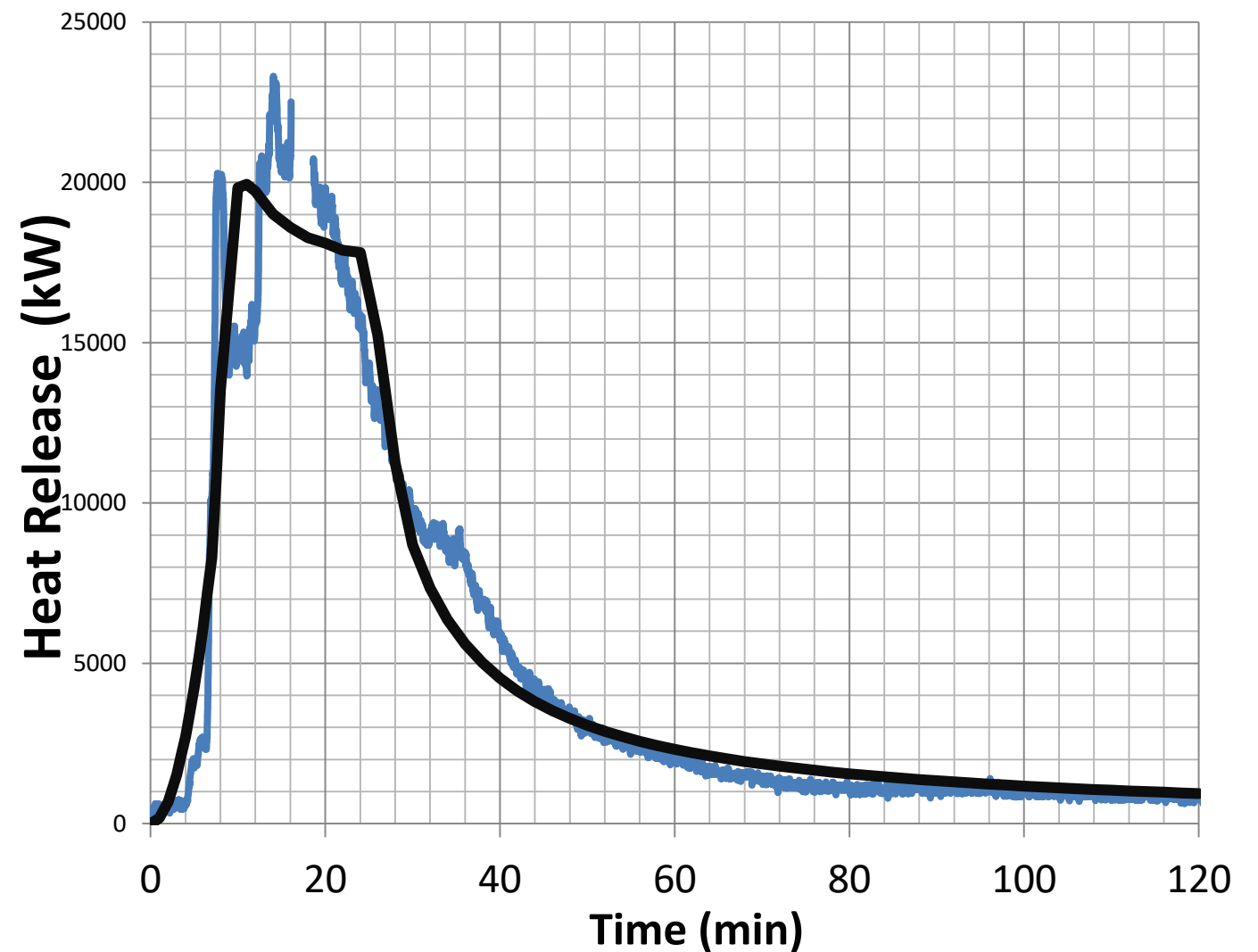


ATF FIRE TEST #2 – 30% EXPOSED CEILING

COMPARISON OF MODELING & MEASURED DATA

Comparison of Heat Release Data

- Modeling conducted by Research Institutes of Sweden (RISE)
- Measured data from ATF #2 with 30% Ceiling exposed



— Measured Heat Release

— Predicted Heat Release

SECTION OF EXPOSED CEILING



ATF FIRE TEST #5 – DELAYED SPRINKLERS

- All mass timber surfaces fully exposed in bedroom and living room
- Sprinkler – activation delayed for 20 minutes after smoke detector activation...approximately 23 minutes from ignition



14 TALL MASS TIMBER CODE CHANGES

IBC Section 602.4 Type IV construction (G108-18)

IBC Section 703.8 Tested noncombustible protection contribution (FS5-18)

IBC Section 722.7 Calculated noncombustible protection contribution (FS81-18)

IBC Section 703.9 Sealing of adjacent mass timber elements (FS6-18)

IBC Section 718.2.1 Fireblocking materials (FS73-18)

IBC Section 403.3.2 High rise sprinkler water supply (G28-18)

IFC Section 701.6 Owner's responsibility (F88-18)

IFC Section 3314.7 Fire safety during construction (F266-18)

IBC Table 504.3 (G75-18)

IBC Table 504.4 (G80-18)

IBC Table 506.2 (G84-18)

IBC Section 3102.3 Special construction (G146-18)

IBC Appendix D Fire Districts (G152-18)

IBC Sections 508.4.4.1 and 509.4.1.1 Fire barriers at separated occupancies and incidental uses (G89-18)

ALL APPROVED

www.awc.org/tallmasstimber

TWB COMMITTEE PROPOSALS

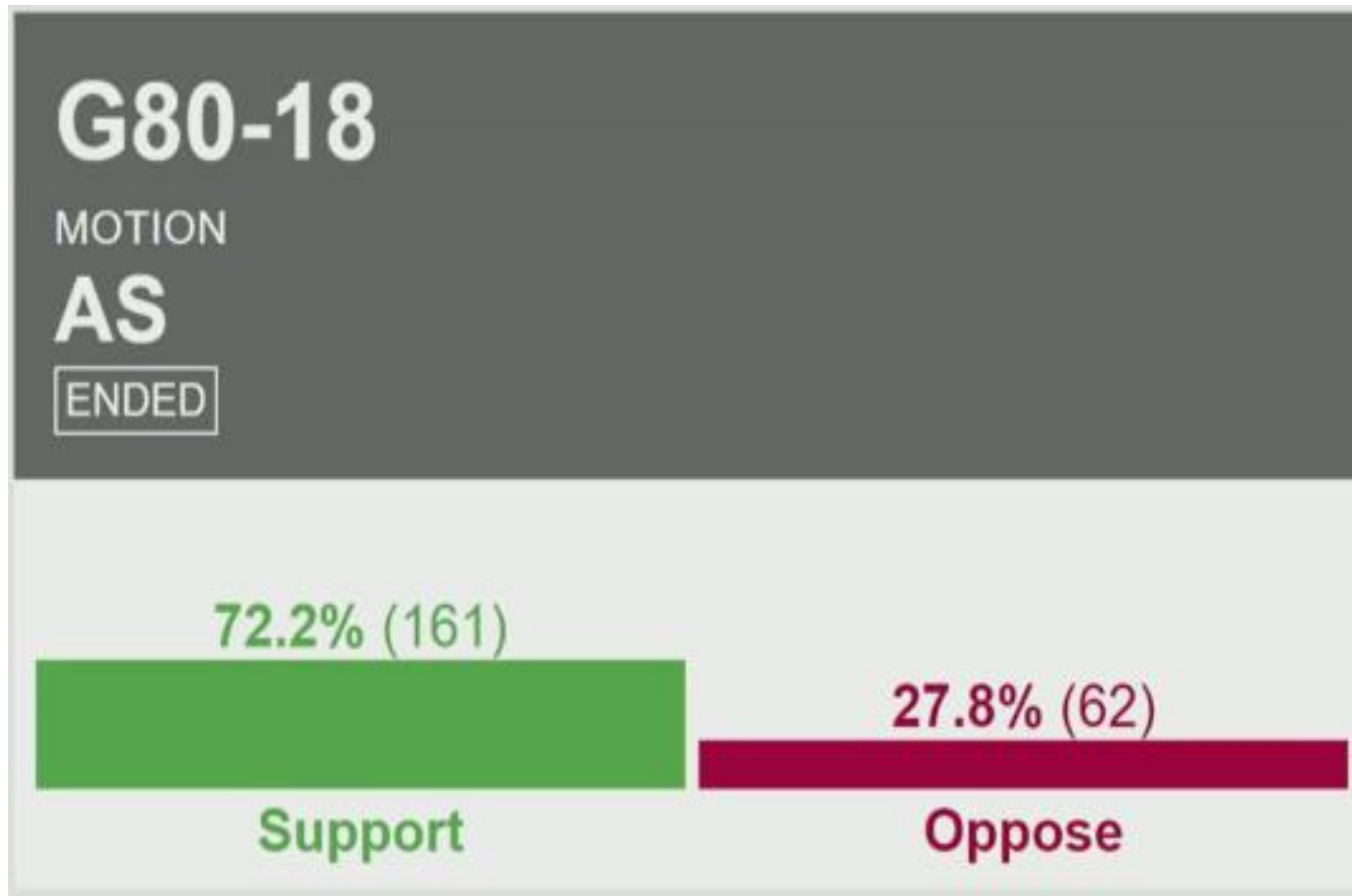
- 14 code change proposals
- 3 new types of construction approved
- New IBC entries in Height (feet & stories) and Area
- New requirements for construction safety
- Existing exterior wall test standard still required (currently NFPA 285 per IBC)



TWB COMMITTEE PROPOSALS

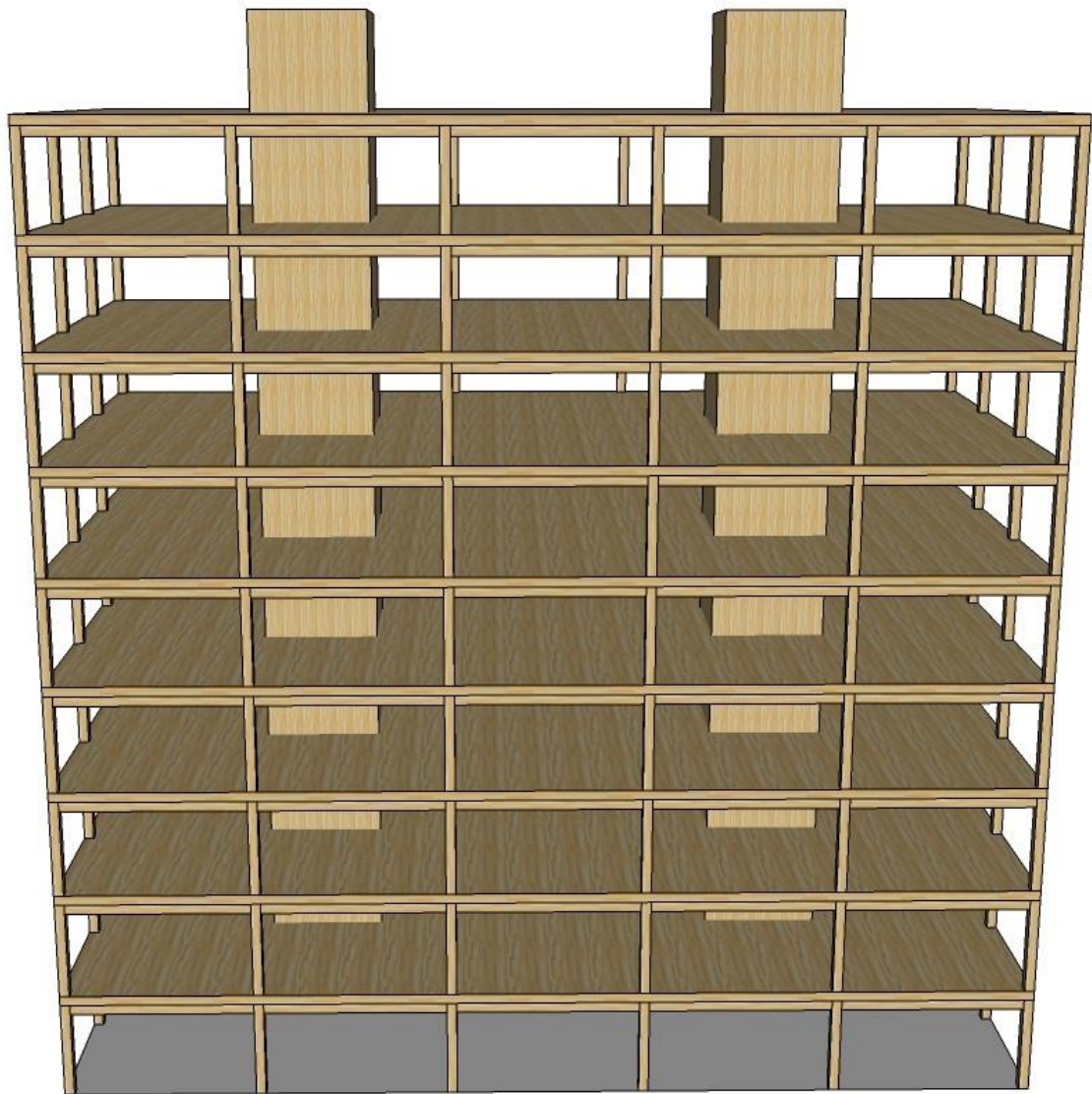


TWB COMMITTEE PROPOSALS



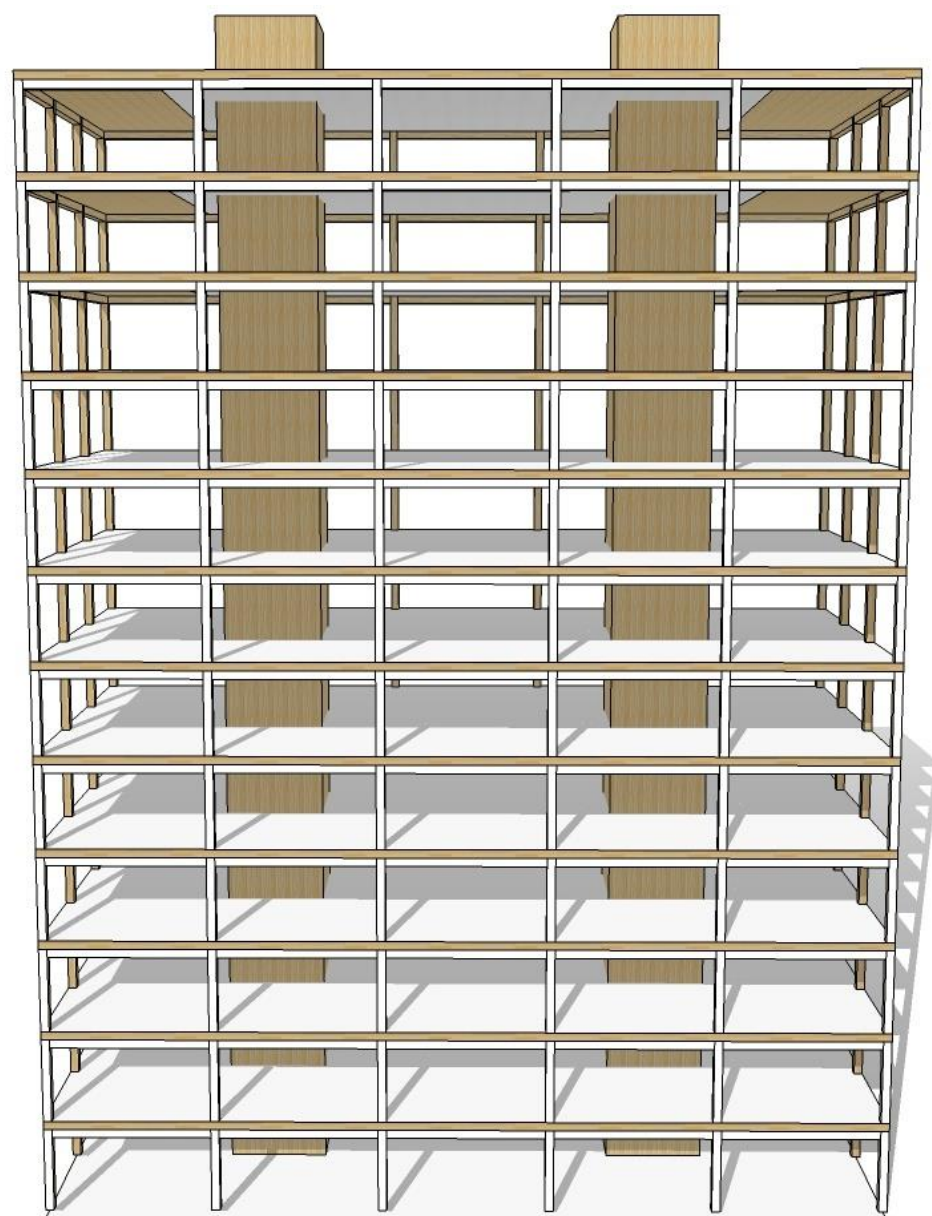
Allowable Number of Stories

TYPE OF CONSTRUCTION IV-C



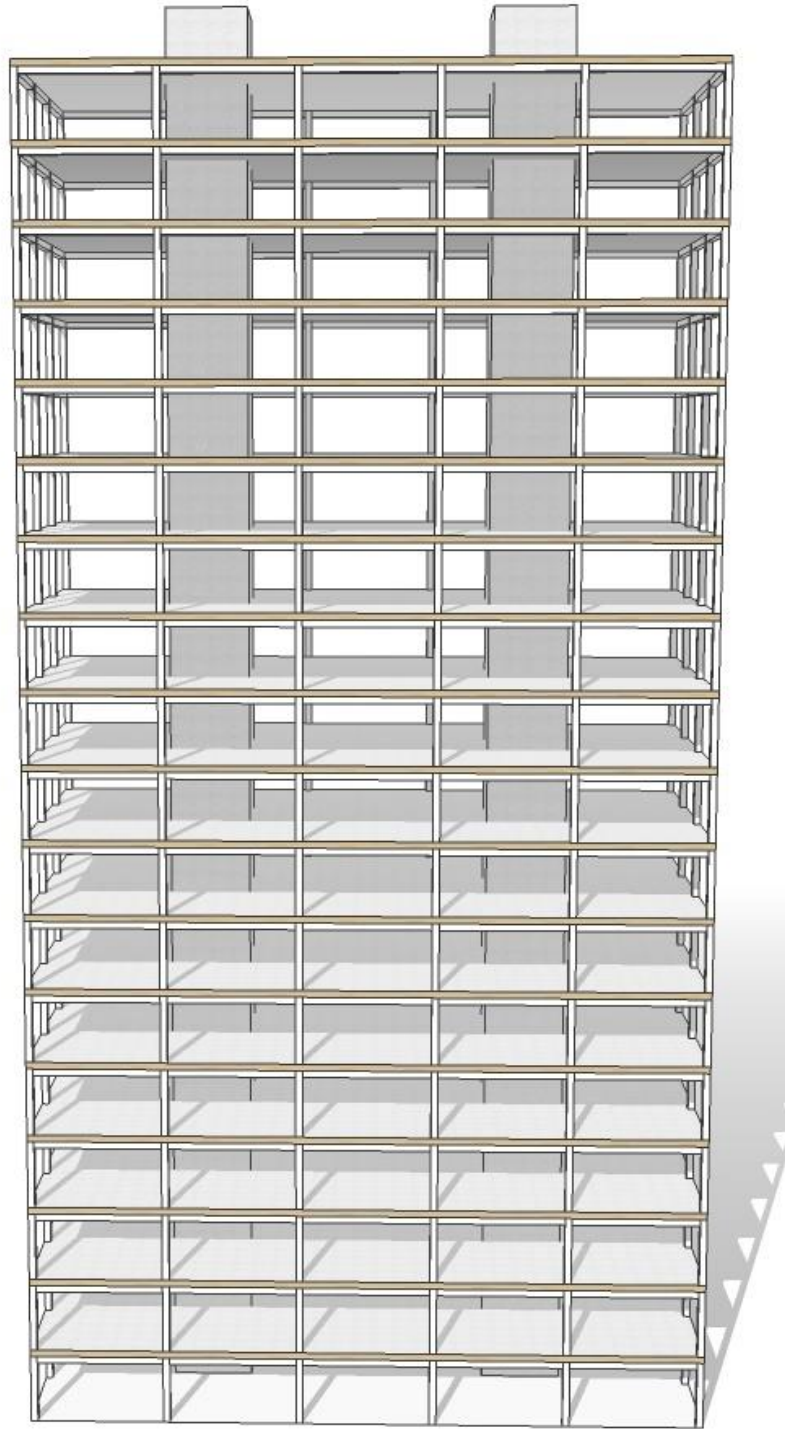
<u>Building Element</u>	
Maximum Height	85'
Number of Stories	≤9
Exposed Mass Timber	Fully Exposed
Sprinklers	Yes
Primary Frame FRR	2 hours
Floor FRR	2 hours
Stairs Tower	Mass Timber
Concealed Spaces	Permitted but must have protection

TYPE OF CONSTRUCTION IV-B



<u>Building Element</u>	
Maximum Height	180'
Number of Stories	≤12
Exposed Mass Timber	YES - Partially
Sprinklers	Yes
Primary Frame FRR	2 hours
Floor FRR	2 hours
Fire Resistance from Non-com	80 minutes
Stairs Tower	Mass Timber
Concealed Spaces	Permitted but must have protection

TYPE OF CONSTRUCTION IV-A



<u>Building Element</u>	
Maximum Height	270'
Number of Stories	≤18
Exposed Mass Timber	NONE - Fully Protected
Sprinklers	Yes
Primary Frame FRR	3 hours
Floor FRR	2 hours
Fire Resistance from Non-com	120 minutes
Stairs Tower	Non-combustible
Concealed Spaces	Permitted but must have protection

IBC TABLE 504.4 ALLOWABLE STORIES

Business Occupancy (Group B)



18 STORIES
BUILDING HEIGHT 270'
BUILDING AREA 432,000 SF

TYPE IV-A



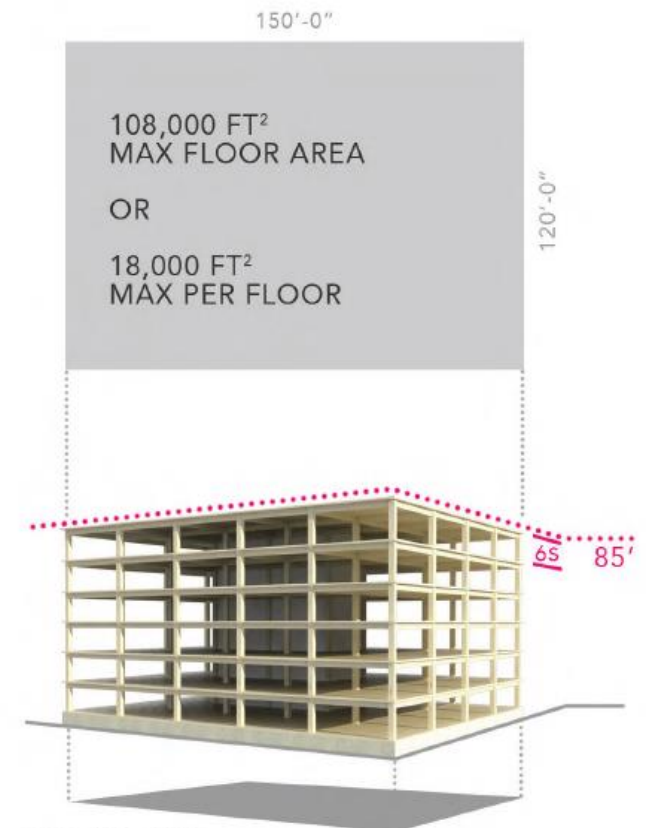
12 STORIES
BUILDING HEIGHT 180 FT
BUILDING AREA 288,000 SF

TYPE IV-B



9 STORIES
BUILDING HEIGHT 85'
BUILDING AREA 180,000 SF

TYPE IV-C



6 STORIES MAX
85'-0" MAX BUILDING HEIGHT
108,000 SQFT MAX AREA

TYPE IV- HT

IBC 2015

IBC 2021

Image courtesy of Susan Jones – Atelier Jones



AMERICAN WOOD COUNCIL

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