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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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

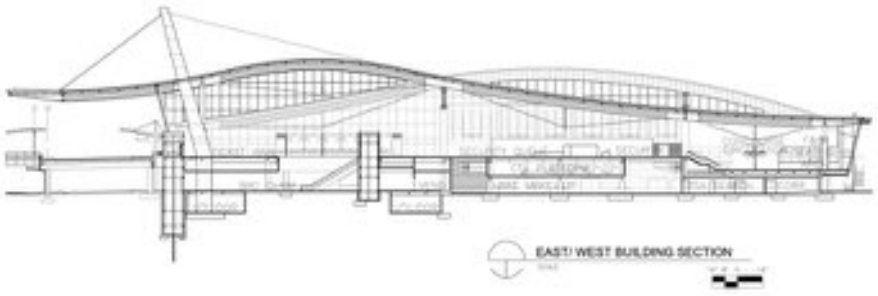
Upon completion, participants will be better able to:

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

Raleigh Durham Airport, North Carolina

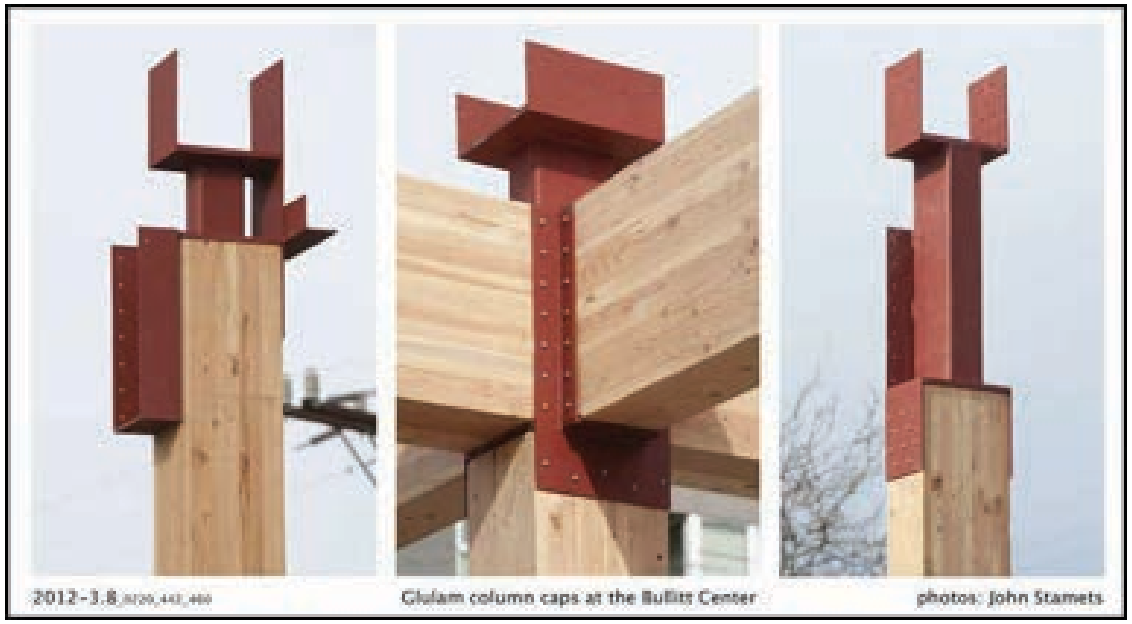


Warner Drive – Culver City, CA

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

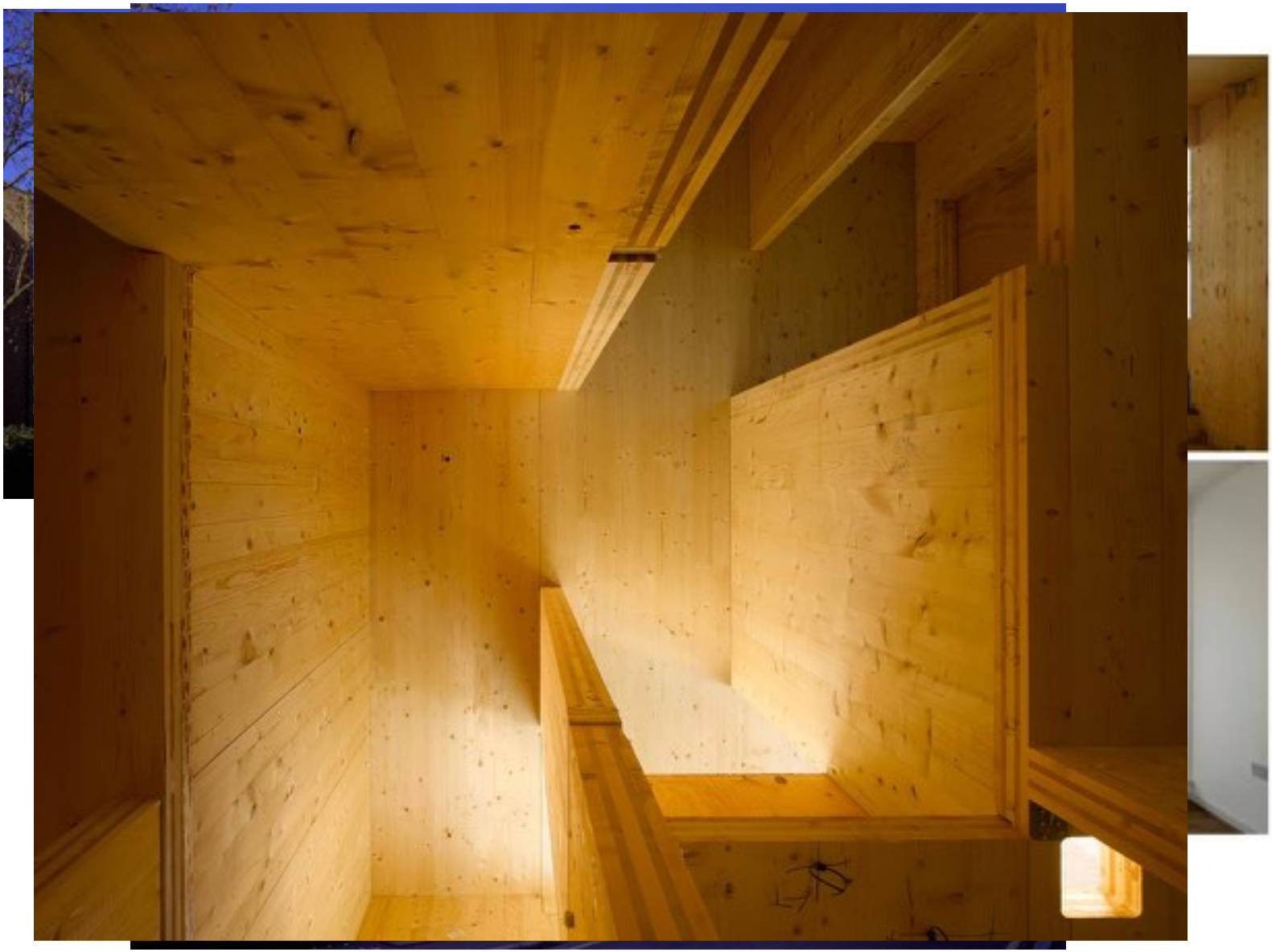
Architect: Profeta Royalty Architecture
Structural Engineer: Structural Focus
Completed: 2011

Bullitt Center – Seattle, WA



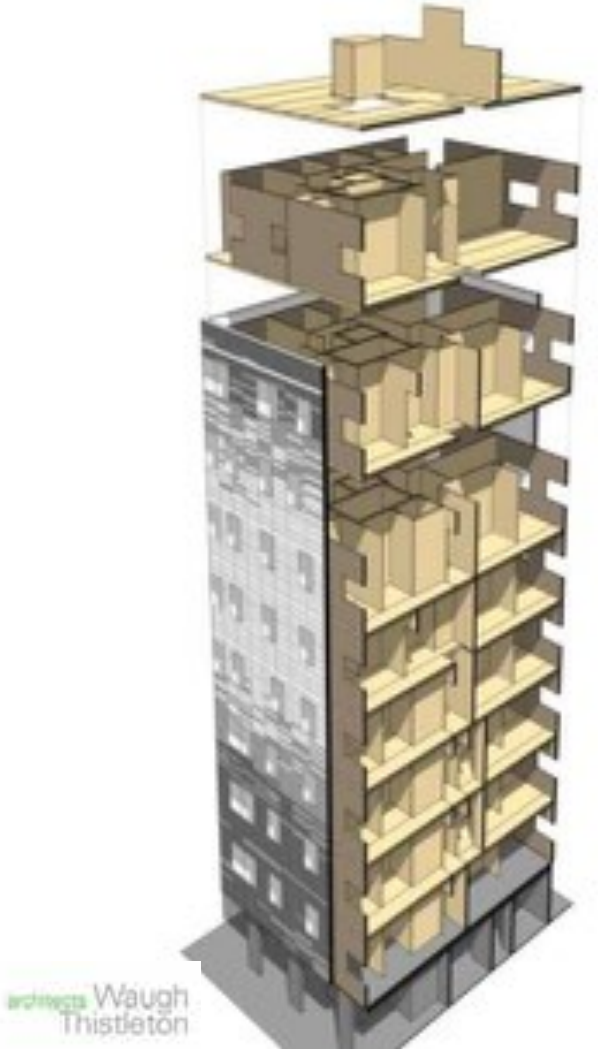
Architect: Miller Hill Partnership
Structural Engineer: DCI Engineers
Photo Credit: Miller Hull Partnership

Stadhaus, London, UK



Cross-laminated timber

Stradthaus – 24 Murray Grove –Tallest Modern Mixed Use Timber Structure

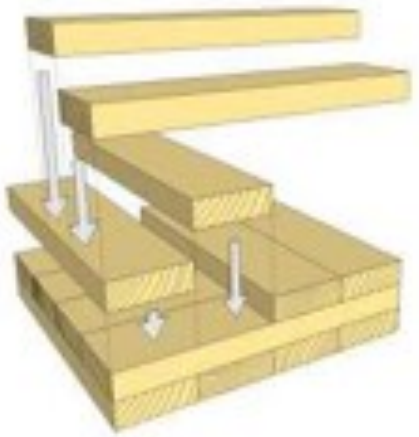


London infill project
29 flats (mixed affordable and private)
Ground floor office
4x less weight than precast concrete
~1/2 the construction time of precast concrete
(saved 22 weeks vs. conc. 30%)
Saves 300 metric tons of CO2
21 years of energy usage for the building

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

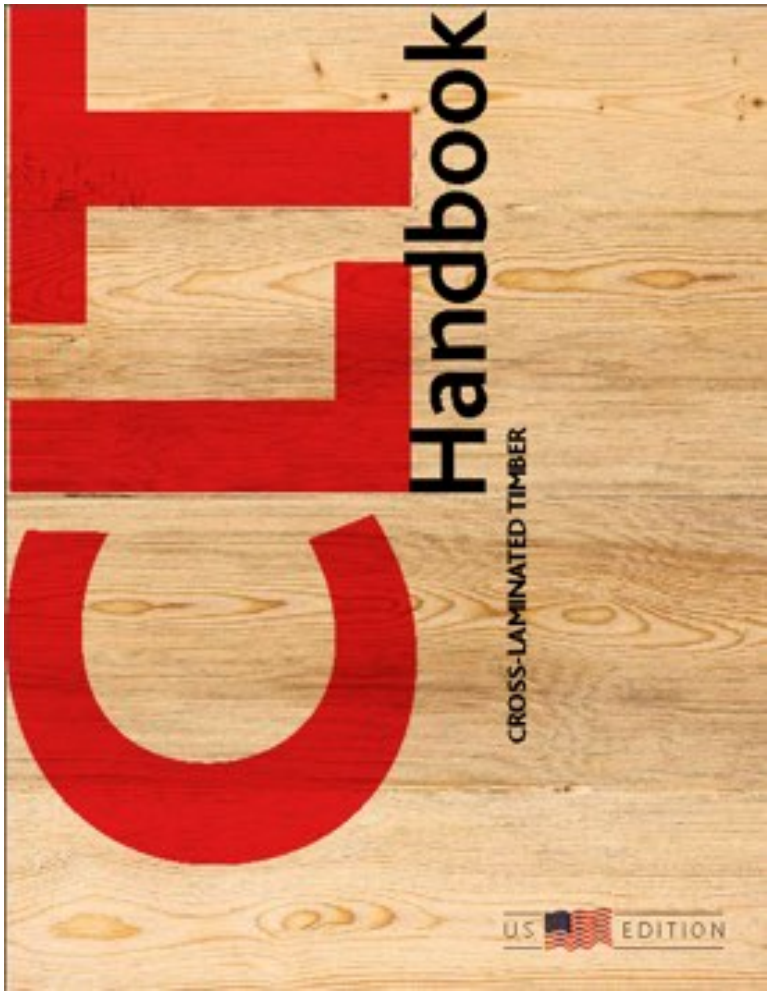
Concept of Cross-Laminated Timber



Photos provided by FPInnovations

CLT Handbook

- **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, Canada
  - 18 Stories
  - Mixed use student housing

Tall Wood Worldwide

reTHINK WOOD®

TALL WOOD GALLERY

Over the past several years, a number of tall wood projects have been completed around the world, demonstrating successful applications of new wood and mass timber technologies. Here are several of the most recent projects.

If you know of any new tall wood projects, please let us know at info@reThinkWood.com.

Click on the building images below for more details.

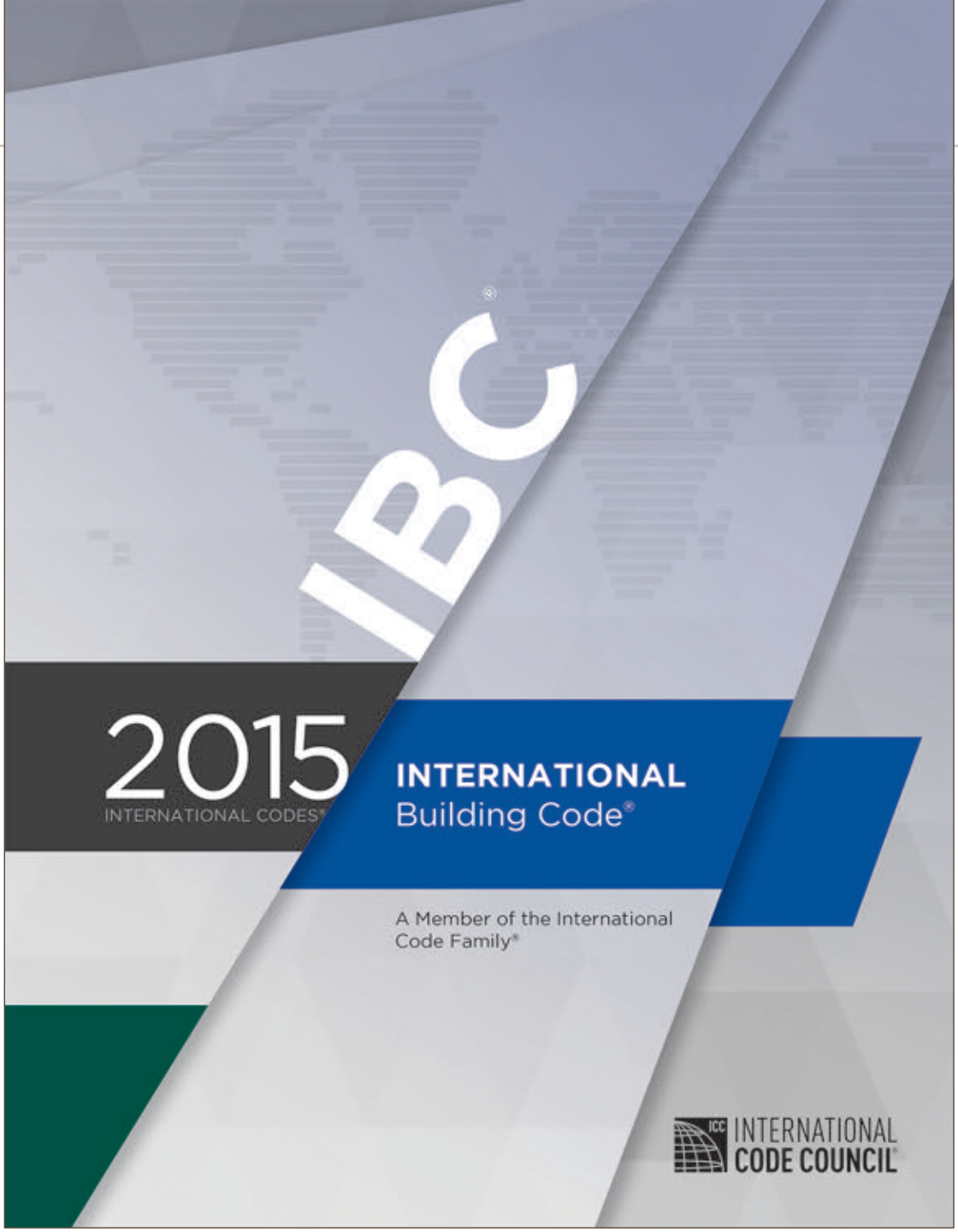
http://www.rethinkwood.com/tall-wood-mass-timber/tall-wood-gallery

Exterior Wall Fire Test

American Wood Council
ASTM E119 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


IBC®
2015
INTERNATIONAL CODES®
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A Member of the International
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TALL WOOD HISTORY IN THE U.S.

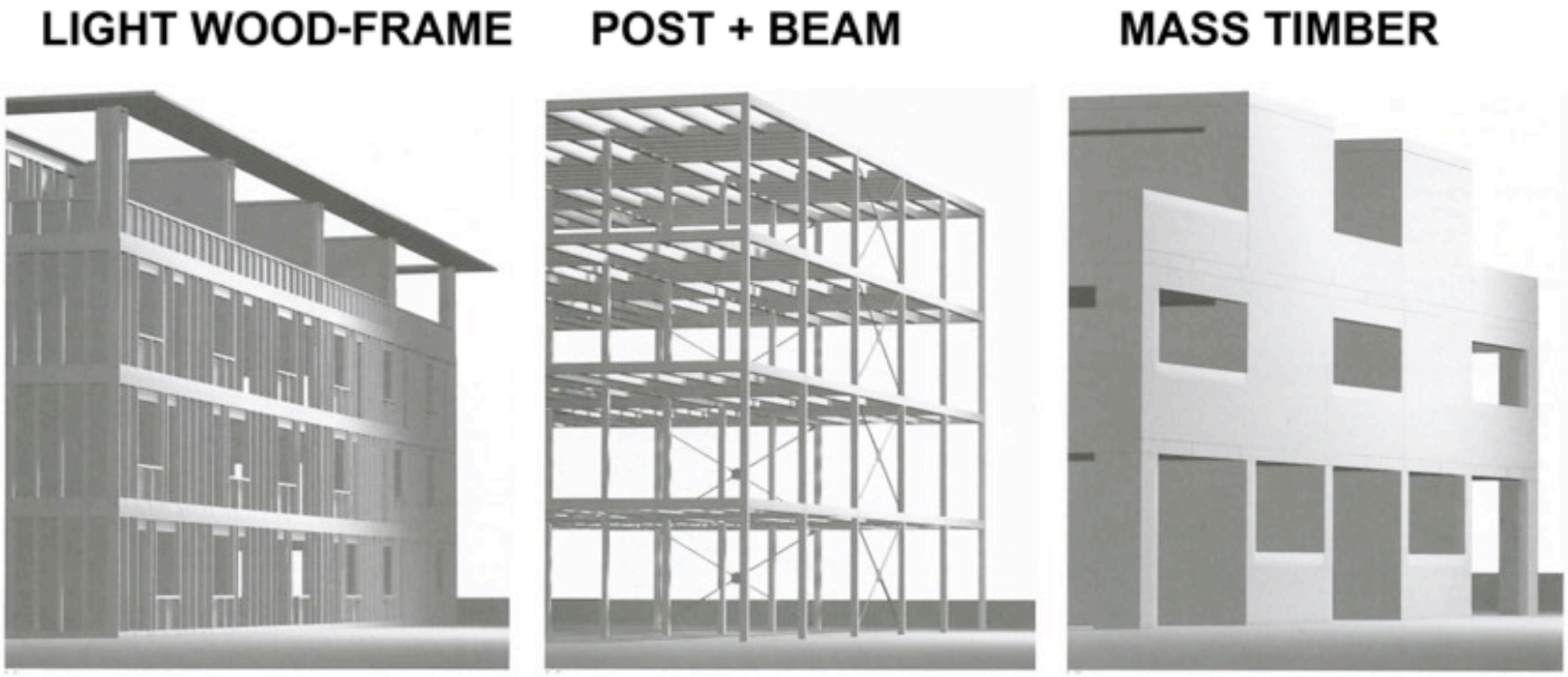
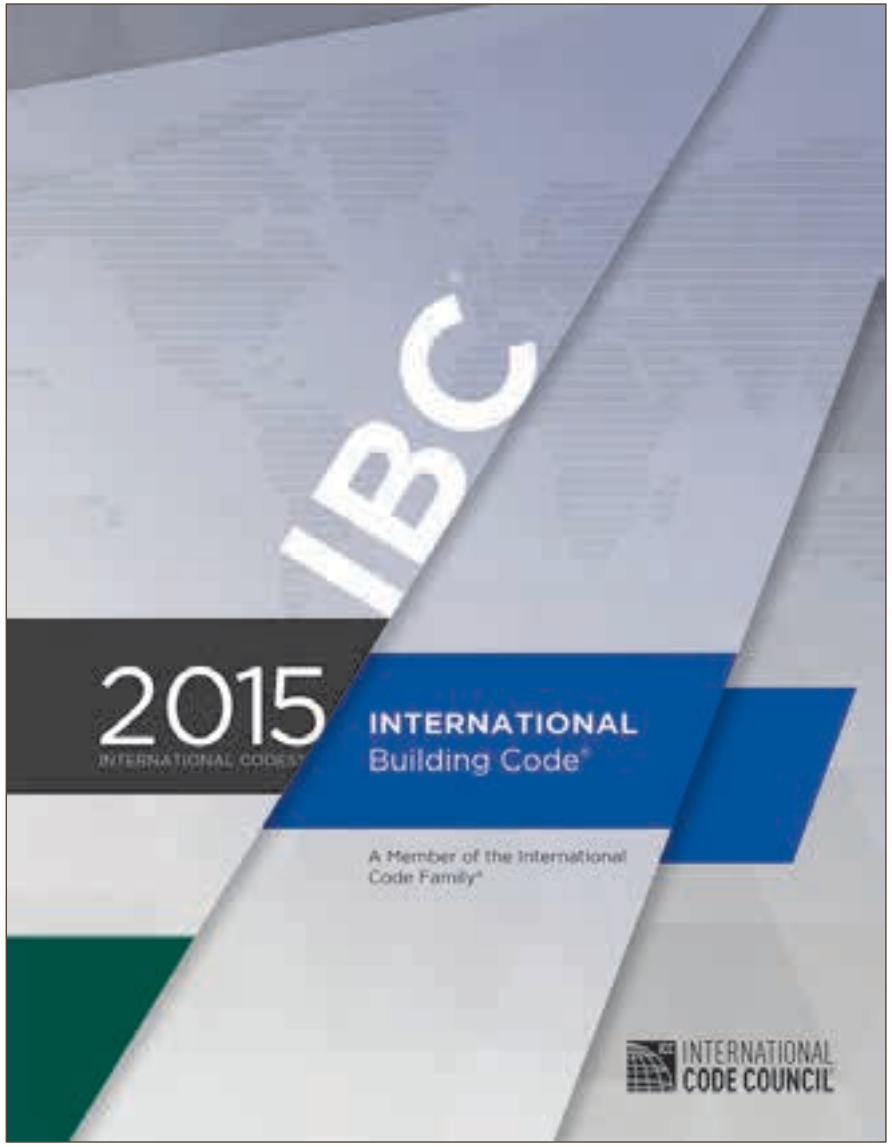


Image courtesy of Fast + Epp

INTERNATIONAL CODE COUNCIL
AD HOC COMMITTEE ON TALL WOOD BUILDINGS



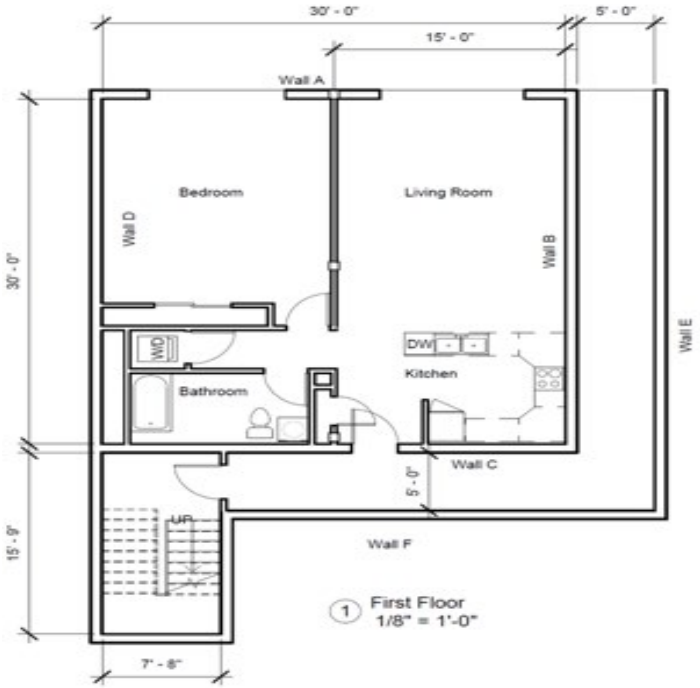
INTERNATIONAL CODE COUNCIL
AD HOC COMMITTEE ON TALL WOOD BUILDINGS

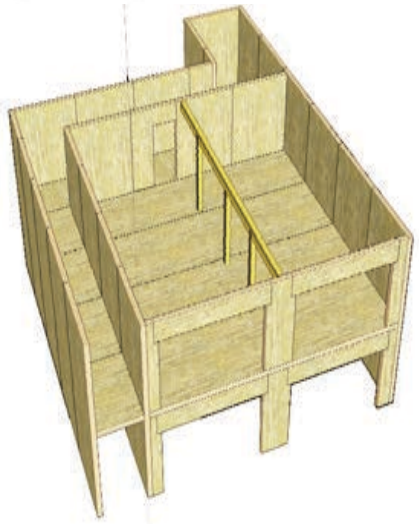
- Balanced committee: building officials, fire officials, architects, engineers, fire protection experts, materials groups, other stakeholders
- 4 Work Groups: Definitions and Standards, Fire, Structural, Codes
- 82 major issues identified, assigned to specific work groups, and investigated
- Hundreds of reports reviewed and collected
- Performance Objectives established: no collapse under reasonable scenarios of complete burn-out of fuel without automatic sprinkler protection being considered; and others related to 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 the 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/m^2
  - fuel load was approximately 95 percentile 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






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

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 TESTS

Fire Test #2

30% of CLT ceiling area in living room and bedroom exposed

www.awc.org/tallmasstimber

Link to you tube videos available on this page

TEST #2 – 30% CLT CEILINGS EXPOSED

Fire Test 2 Video

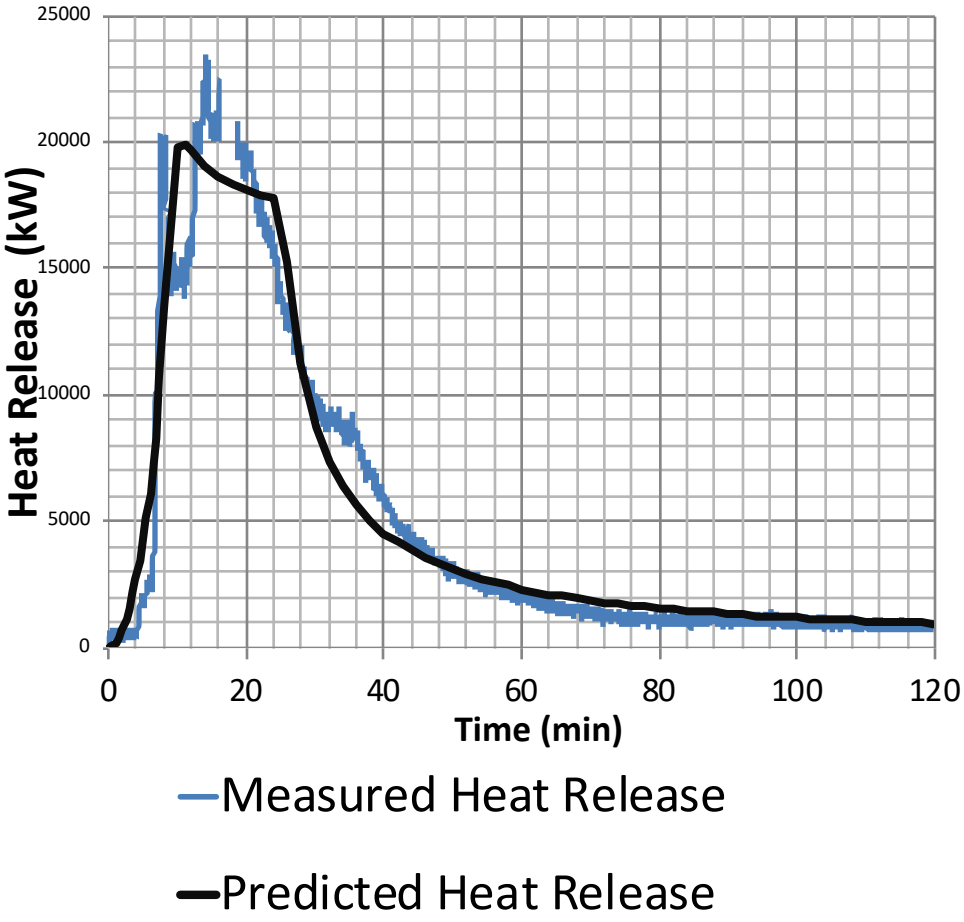
https://www.youtube.com/watch?v=4Ji2eljkchA&list=PL_sDiz8JiMIwby77vfpPSPucEhBuEK22P&index=2

..\..\..\ICC Tall Wood Ad Hoc\ATF Test Videos\ATF Test 2 Superfast HD.mp4

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



SECTION OF EXPOSED CEILING (90º ANGLE)

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)

www.awc.org/tallmasstimber

TWB COMMITTEE PROPOSALS

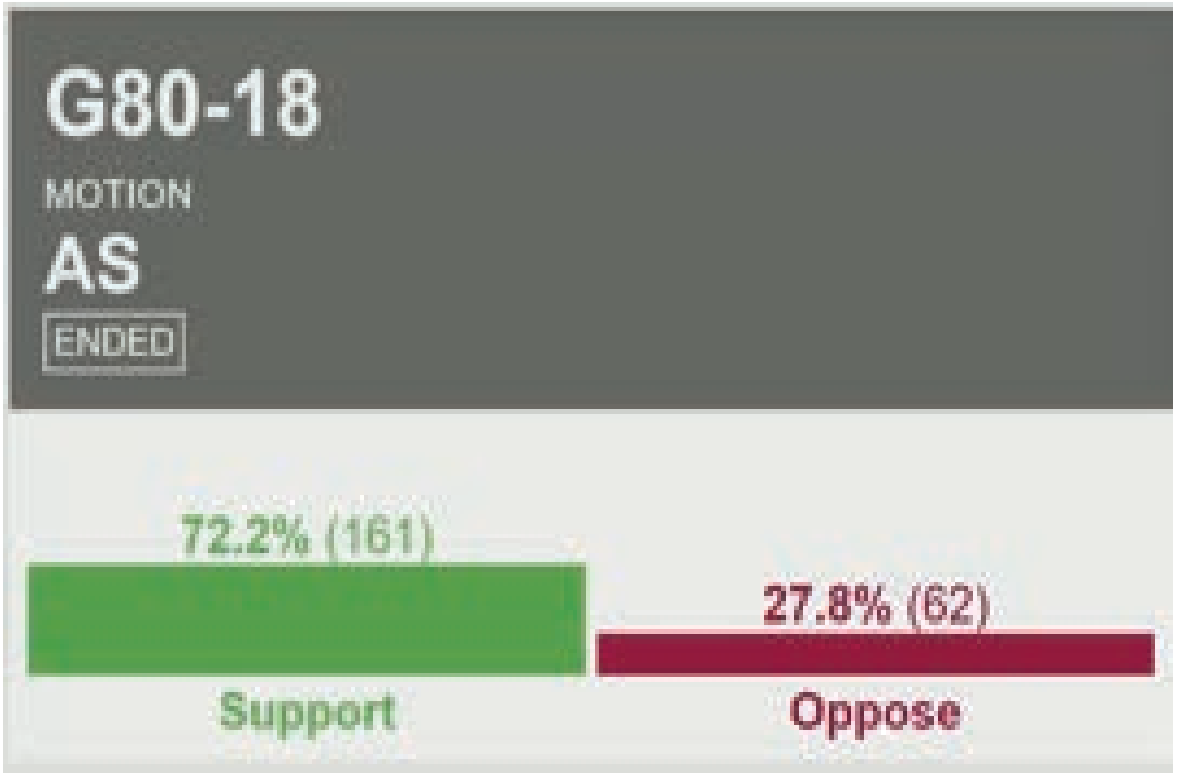
TWB PRODUCT

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

RICHMOND ICC
INTERNATIONAL CODE COUNCIL 2018
ANNUAL CONFERENCE
October 21-29

TWB COMMITTEE PROPOSALS

TWB COMMITTEE PROPOSALS



Allowable Number of Stories

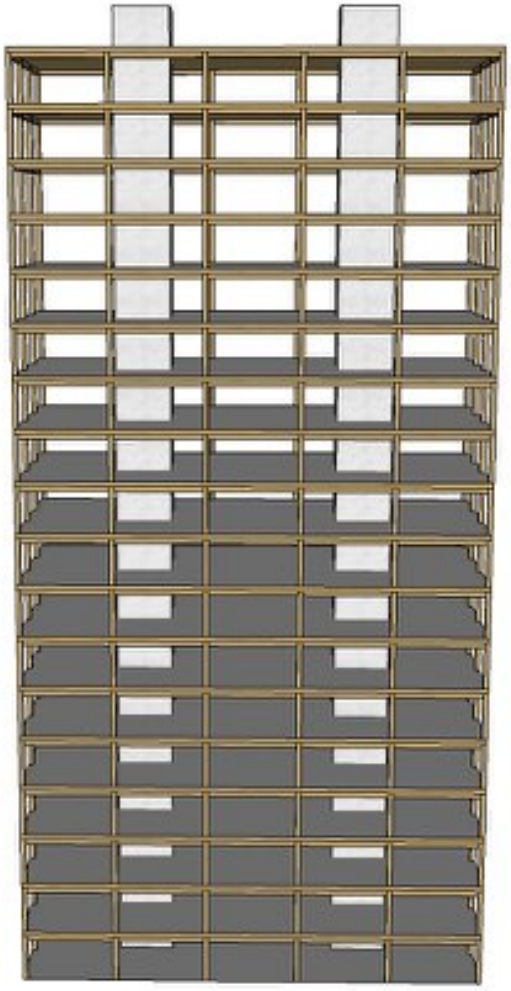
TYPE OF CONSTRUCTION IV-C

Building Element	
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

Building Element	
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



Building Element	
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

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