Navigating Code Requirements for Mass Timber

Significant Mass Timber Provisions in the 2015, 2018, and 2021 International Building and Fire Codes

Presented by Paul Coats, PE, CBO – American Wood Council

AMERICAN WOOD COUNCIL

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

Course Description

This presentation will examine how changes to the International Building Code (IBC) have significantly expanded the options for mass timber construction—starting with the prescriptive recognition of cross-laminated timber in the 2015 version, and building momentum with changes in the 2018 and 2021 editions. Discussion will include an overview of how the code defines mass timber products in terms of certification and manufacturing standards; fire and life safety aspects such as combustibility, flame spread and fire-resistance ratings; and applications for mass timber in multi-family and commercial buildings based on construction type, building size, and other criteria. Finally, it will explore significant code changes relative to the introduction of three new mass timber construction types for tall wood buildings up to 18 stories as part of the 2021 IBC.

Learning Objectives

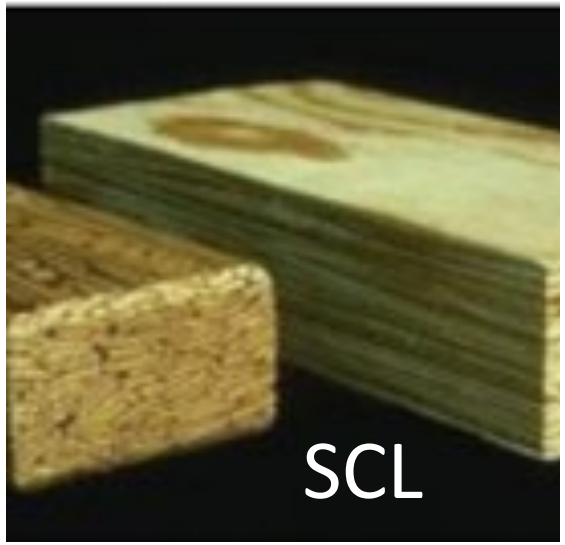
1. Review code-compliant applications of mass timber products under the 2015 and 2018 International Building Code (IBC).

2. Highlight available resources, including charring calculations and fire-tested mass timber assemblies, to aid designers in exposed timber building design.

3. Explore the work and conclusions of the ICC Ad Hoc Committee on Tall Wood Buildings in establishing 17 new code provisions for the 2021 IBC that address tall wood construction.

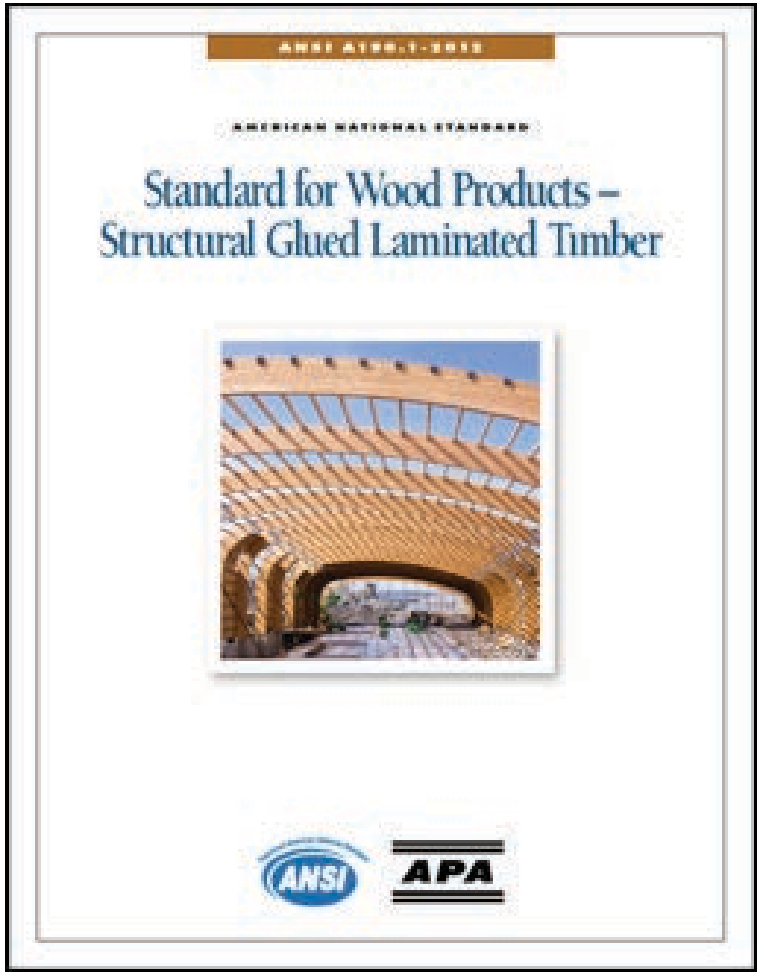
4. Explore the three new tall wood construction types and discuss related code provisions such as allowable heights and fire-resistance ratings.

MASS TIMBER



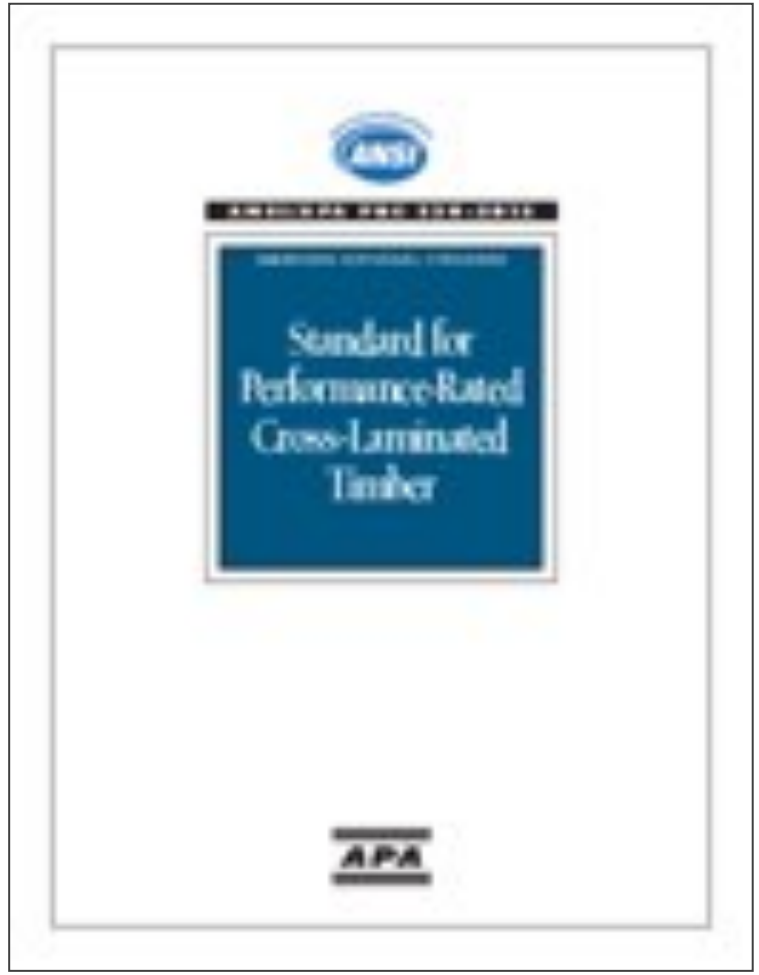
STANDARDS – GLUED-LAMINATED TIMBER

- Product qualification and quality assurance requirements are specified
- Third-party inspection is required on an on-going basis
- All glulam must bear a grade mark meeting ANSI A190.1 -2012



STANDARDS – CROSS-LAMINATED TIMBER

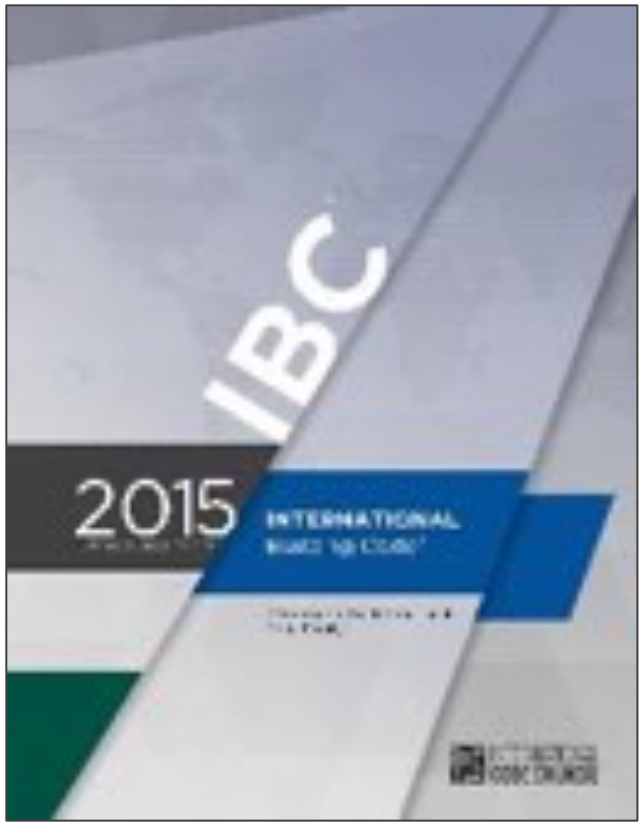
- Product qualification and quality assurance requirements are specified
- Third-party inspection is required on an on-going basis
- All CLT must bear a grade mark meeting ANSI/APA PRG 320-18



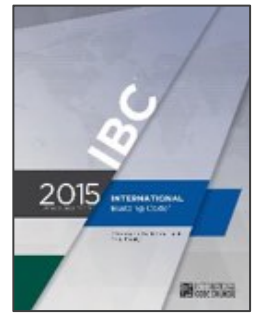
STANDARDS

- Solid sawn – DOC PS 20
- Structural Composite Lumber – ASTM D5456
- Nail-laminated timber – DOC PS 20 and Section 2304.9
- Dowel-laminated timber – a proprietary product approved by the code official, usually with the help of approved evaluation service agencies
- Product standards have many secondary referenced standards cited within that become mandatory; for instance standards for adhesives in glulam and CLT

INTERNATIONAL BUILDING CODE



INTERNATIONAL BUILDING CODE



FIRE TEST – AWC

ASTM E119 Fire Endurance Test

- 5-Ply CLT (approx. 7” thick)
- One layer of 5/8” Type X GWB each side
- RESULTS: 3 hours 6 minutes (sought 2 hours)

2015 IBC

Cross-laminated timber (CLT) is first mentioned in the 2015 IBC as a permissible material for exterior walls in Type IV construction, the product standard is referenced, it is assigned minimum dimension for use in Type IV walls, floors, and roofs.

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	 3 3[a]	 2 2[a]	 1 1	 0 0	 2 1	 2 0	 2 1/HT	 1 1	 0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	$1\frac{1}{2}$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

2015 IBC – CLT IN EXTERIOR WALLS OF TYPE IV

602.4.2 Cross-laminated timber in exterior walls. Cross-laminated timber complying with Section 2303.1.4 shall be permitted within exterior wall assemblies with a 2-hour rating or less, provided the exterior surface of the cross-laminated timber is protected by one the following:

1. Fire-retardant-treated wood sheathing complying with Section 2303.2 and not less than $^{15}/_{32}$ inch (12 mm) thick;
2. Gypsum board not less than $^{1}/_{2}$ inch (12.7 mm) thick; or
3. A noncombustible material.

CONSTRUCTION TYPES

Mass timber can be used as structural members in all the combustible construction types (Types III, IV, and V), within their normal building size and materials limits.

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Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
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Roof construction and associated secondary members (see Section 202)	$1\frac{1}{2}$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

2018 IBC – HEAVY TIMBER REORGANIZATION

2018 IBC	2015 IBC	Provision
602.4	602.4	Type IV construction
602.4.1, 602.4.2	602.4.1	Wall assembly thickness
602.4.3	602.4.9	Exterior structural members
2304.11	2304.11	Heavy timber construction
Table 2304.11	Table 602.4	Minimum dimensions
2304.11.1	New	Details of heavy timber structural members
2304.11.1.1	602.4.3, 2304.11.1	Columns
2304.11.1.2	602.4.4, 2304.11.2	Floor framing
2304.11.1.3	602.4.5, 2304.11.3	Roof framing
2304.11.2.1	602.4.8.2	Exterior walls
2304.11.2.2	602.4.8.1	Partitions and interior walls
2304.11.3	602.4.6	Floors
2304.11.3.1	602.4.6.2	CLT floors
2304.11.3.2	602.4.6.1, 2304.11.4	Sawn or glued-laminated plank floors
2304.11.4	2304.11.5	Roof decks

2018 IBC – NAIL-LAMINATED TIMBER

TABLE 2304.9.3.2
FASTENING SCHEDULE FOR MECHANICALLY LAMINATED DECKING USING LAMINATIONS OF 2-INCH NOMINAL THICKNESS

MINIMUM NAIL SIZE (Length x Diameter) (inches)	MAXIMUM SPACING BETWEEN FACE NAILS [a, b] (inches)		NUMBER OF TOENAILS INTO SUPPORTS[c]
	Decking Supports ≤ 48 inches o.c.	Decking Supports > 48 inches o.c.	
4 × 0.192	30	18	1
4 × 0.162	24	14	2
4 × 0.148	22	13	2
$3^1/_2$ × 0.162	20	12	2
$3^1/_2$ × 0.148	19	11	2
$3^1/_2$ × 0.135	17	10	2
3 × 0.148	11	7	2
3 × 0.128	9	5	2
$2^3/_4$ × 0.148	10	6	2
$2^3/_4$ × 0.131	9	6	3
$2^3/_4$ × 0.120	8	5	3

MINIMUM SIZES FOR MASS TIMBER

(TRUNCATED) Table 2304.11 MINIMUM DIMENSIONS OF HEAVY TIMBER STRUCTURAL MEMBERS (see this table in the code book for exact row descriptions)							
Supporting		Min. Nom. Solid Sawn Size		Min. Glulam Net Size		Min. SCL Net Size	
		Width (in.)	Depth (in.)	Width (in.)	Depth (in.)	Width (in.)	Depth (in.)
Floor or Floor/Roof	Columns	8	8	6¾	8¼	7	7½
	Beams	6	10	5	10½	5¼	9½
Roof Only	Columns	6	8	5	8¼	5¼	7½
	Arches	6	6	5	6	5¼	5½
	Trusses	4	6	3	$6^{7}/_{8}$	3½	5½

- CLT minimum thicknesses
  - **Floors – 4” actual**
  - **Roofs – 3” actual**
  - **CLT in exterior walls of Type IV—4 inches actual (2021 code)**

MASS TIMBER FIRE RESISTANCE

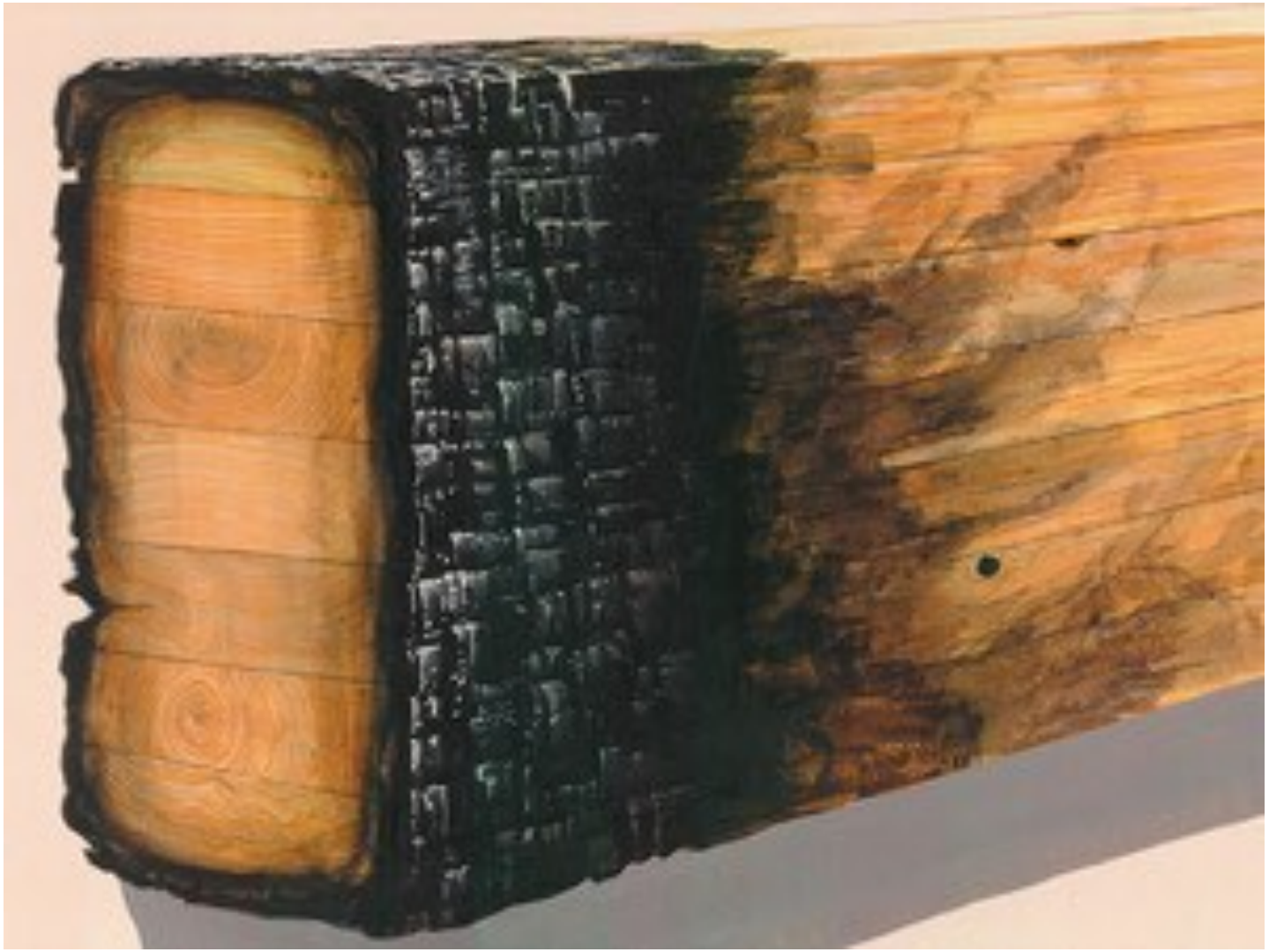

Photo by Structure Magazine

MASS TIMBER FIRE RESISTANCE

Noncombustible ≠ fire resistant

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

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Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
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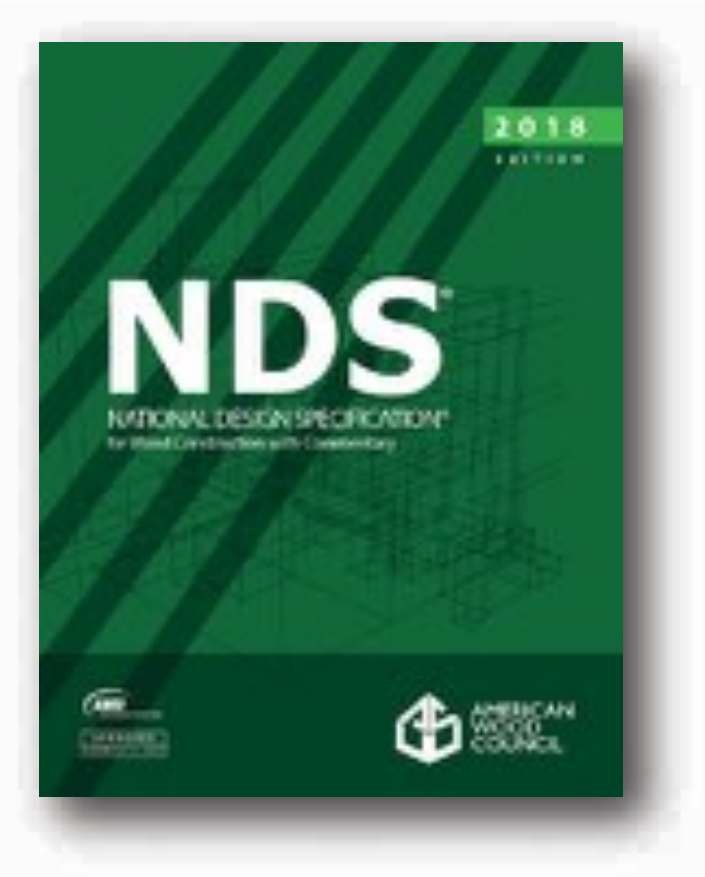
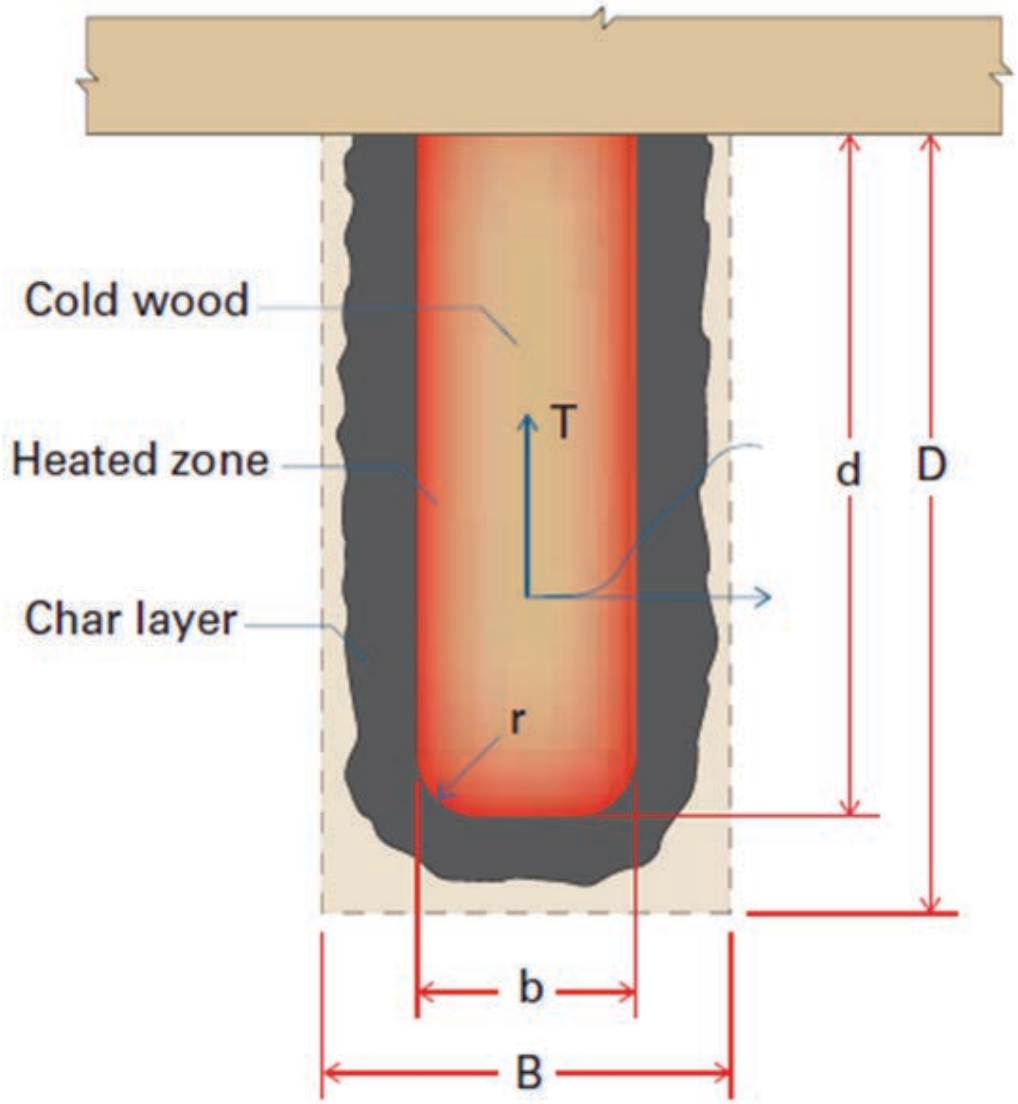
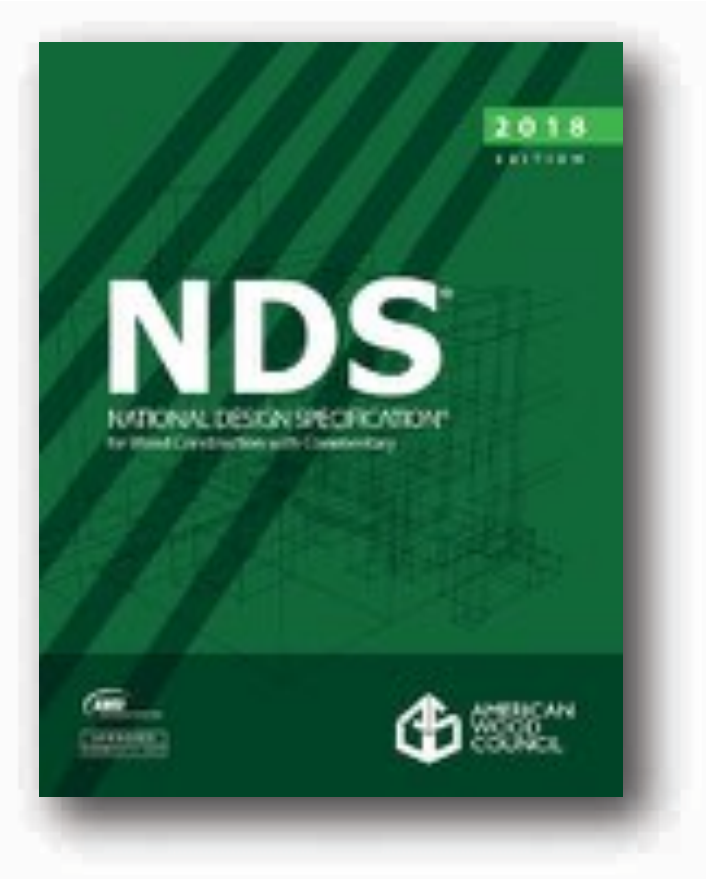
EXPOSED MASS TIMBER FIRE RESISTANCE





EXPOSED MASS TIMBER FIRE RESISTANCE



2018 NDS

1. General Requirements for Building Design
2. Design Values for Structural Members
3. Design Provisions and Equations
4. Sawn Lumber
5. Structural Glued Laminated Timber
6. Round Timber Poles and Piles
7. Prefabricated Wood I-Joists
8. Structural Composite Lumber
9. Wood Structural Panels
10. **Cross-laminated Timber**
11. Mechanical Connections
12. Dowel-Type Fasteners
13. Split Ring and Shear Plate Connectors
14. Timber Rivets
15. Special Loading Conditions
16. **Fire Design of Wood Members**

AWC TR10 – FIRE RESISTANCE OF WOOD MEMBERS

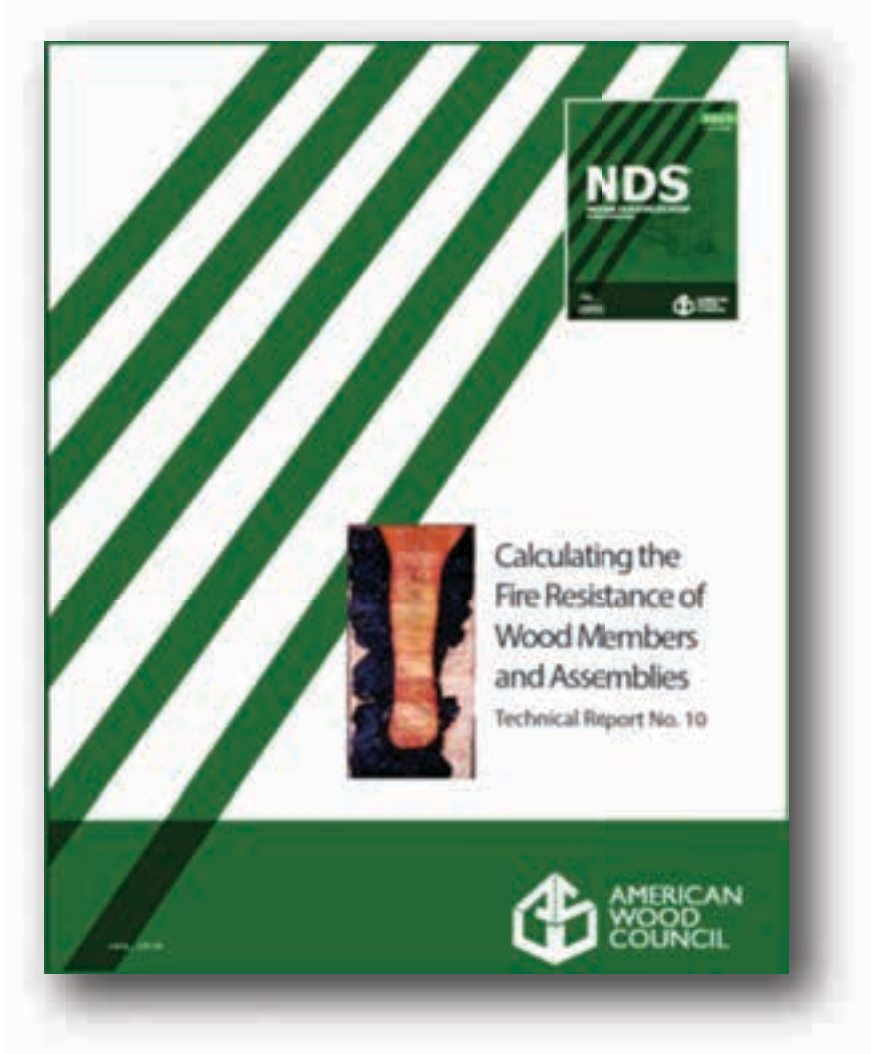


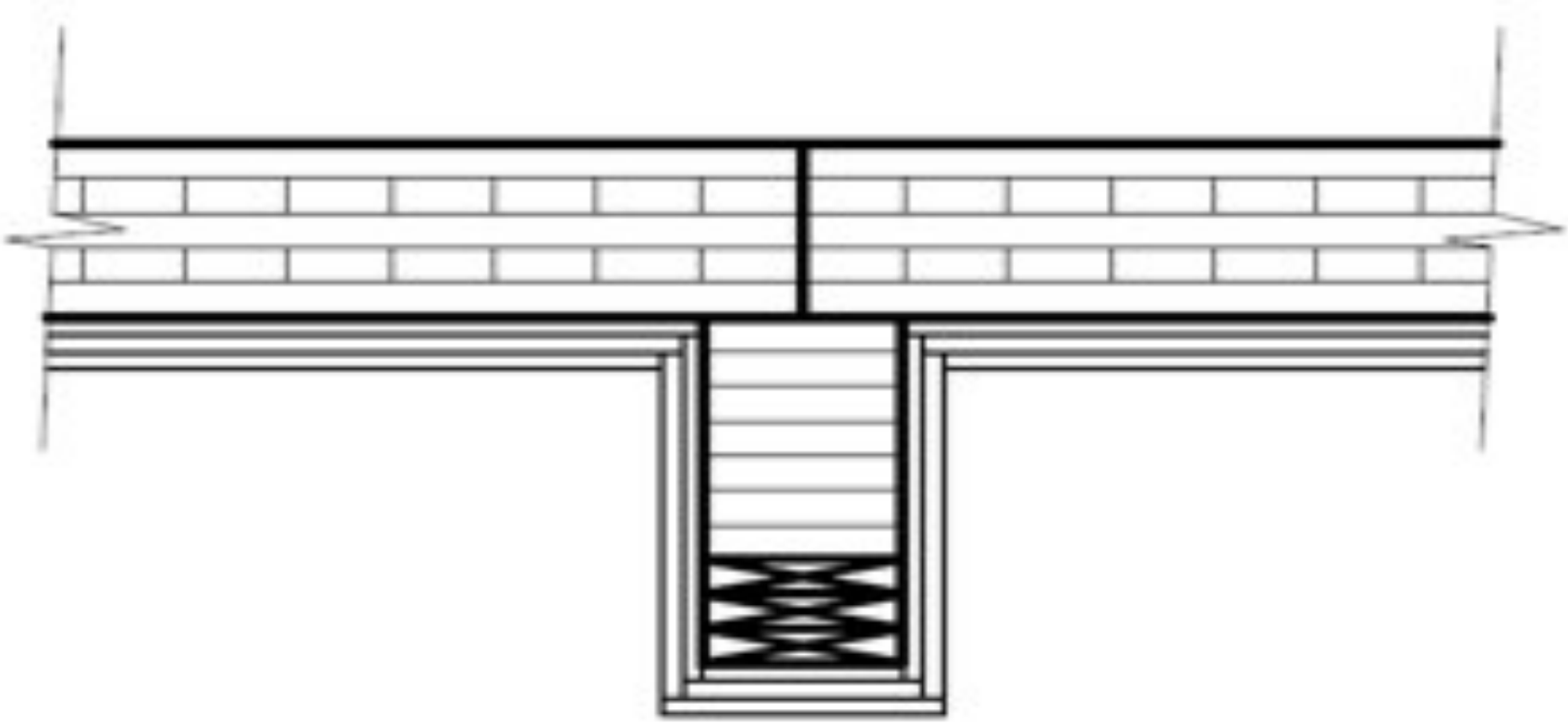
TABLE OF CONTENTS

1. Development of (Fire) Design Procedures for Exposed Wood Members
2. Comparison of Calculation Methods and Experiments
3. Protection of Structural Members and Connections
4. Design Procedures for Exposed and Protected Wood Members
5. Application Guidelines and Design Examples

COMPARTMENT FIRE TESTS

INCREASING FIRE RESISTANCE WITH NONCOM PROTECTION

Noncombustible protection can increase the fire resistance



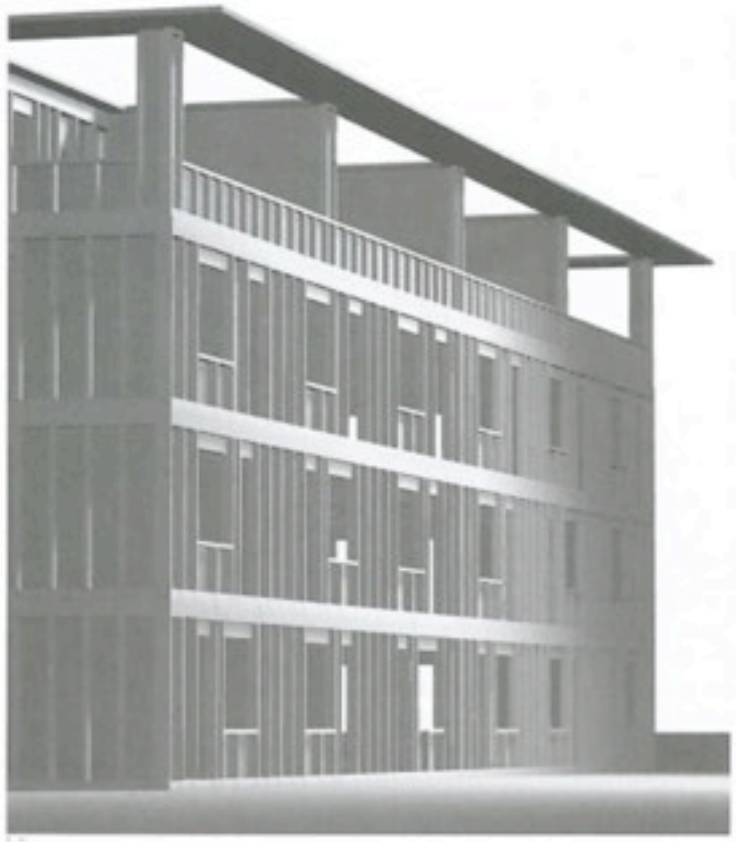
ICC AD HOC COMMITTEE ON TALL WOOD BUILDINGS

ICC Board established the ICC Ad Hoc Committee on Tall Wood Buildings to:

- Explore science of tall wood buildings
- Investigate feasibility
- Develop code changes for tall mass timber buildings

ICC AD HOC COMMITTEE ON TALL WOOD BUILDINGS

LIGHT WOOD-FRAME



POST + BEAM

MASS TIMBER

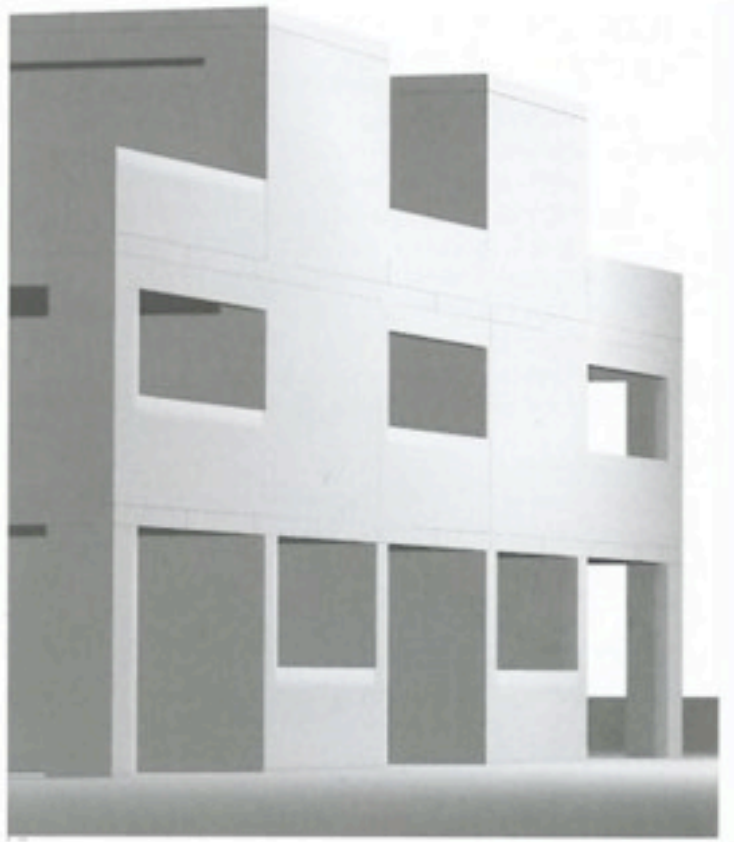


Image courtesy of Fast + Epp

ICC AD HOC COMMITTEE ON TALL WOOD BUILDINGS

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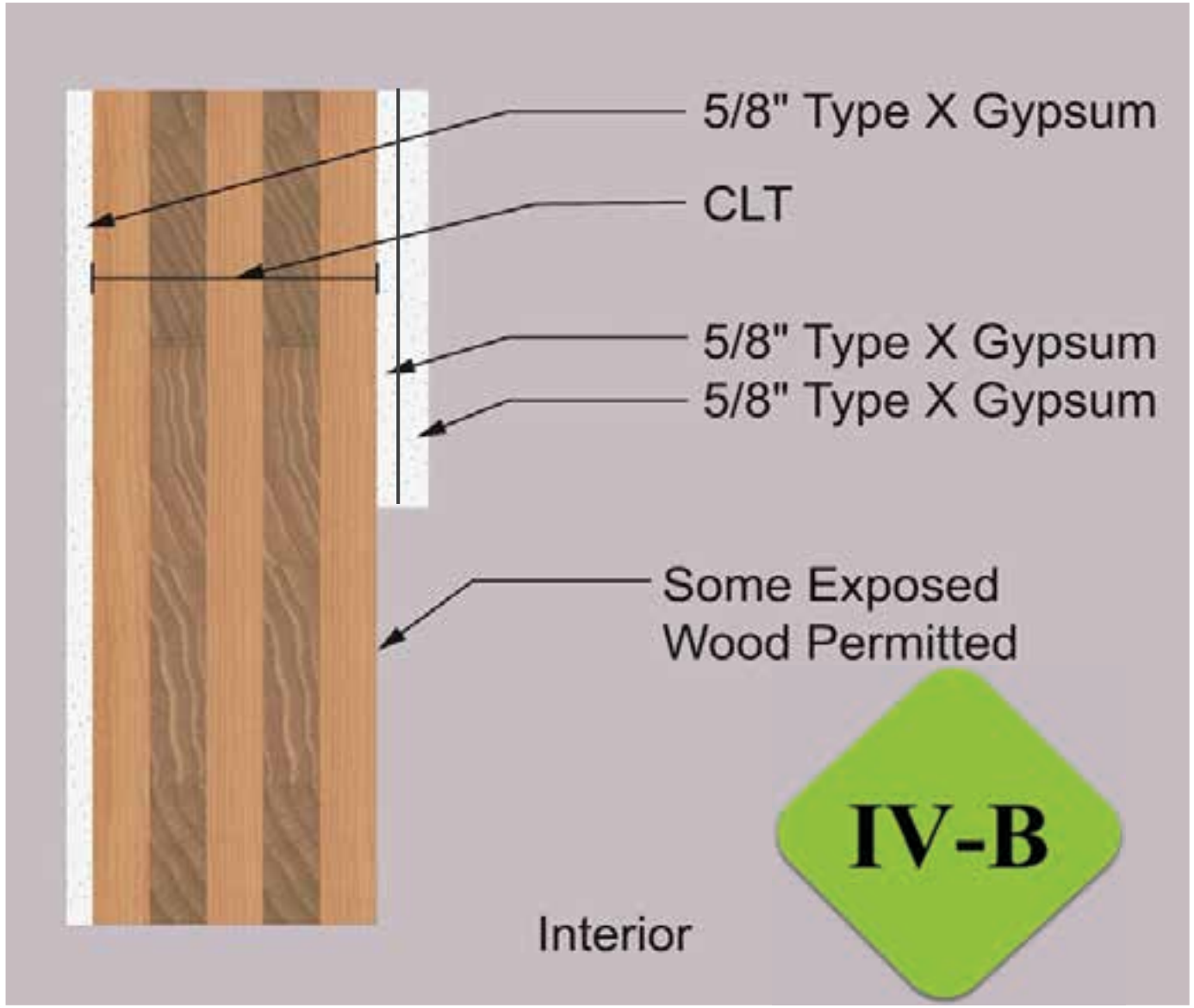
ICC AD HOC COMMITTEE ON TALL WOOD BUILDINGS

NEW CONSTRUCTION TYPES

TABLE 601

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame [f] (see Section 202)	3[a]	2[a]	1	0	1	0	3[a]	2[a]	2[a]	HT	1	0
Bearing walls												
Exterior [e, f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT	1	0
Nonbearing walls and partitions Exterior	See Table 602											
Nonbearing walls and partitions Interior [d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 1/2 [b]	1[b, c]	1[b, c]	0[c]	1[b, c]	0	1 1/2	1	1	HT	1[b, c]	0

NEW CONSTRUCTION TYPES



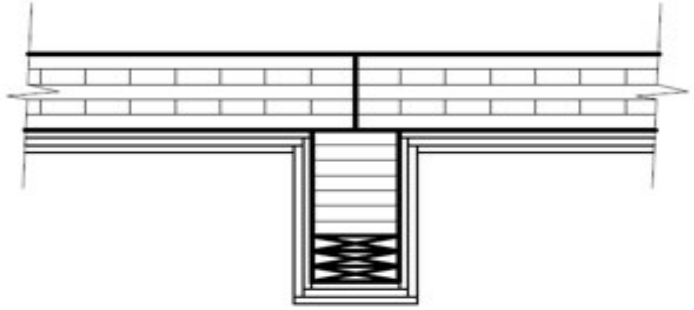
NEW CONCEPT IN FIRE RESISTANCE

TABLE 722.7.1(1)
PROTECTION REQUIRED FROM NONCOMBUSTIBLE COVERING MATERIAL

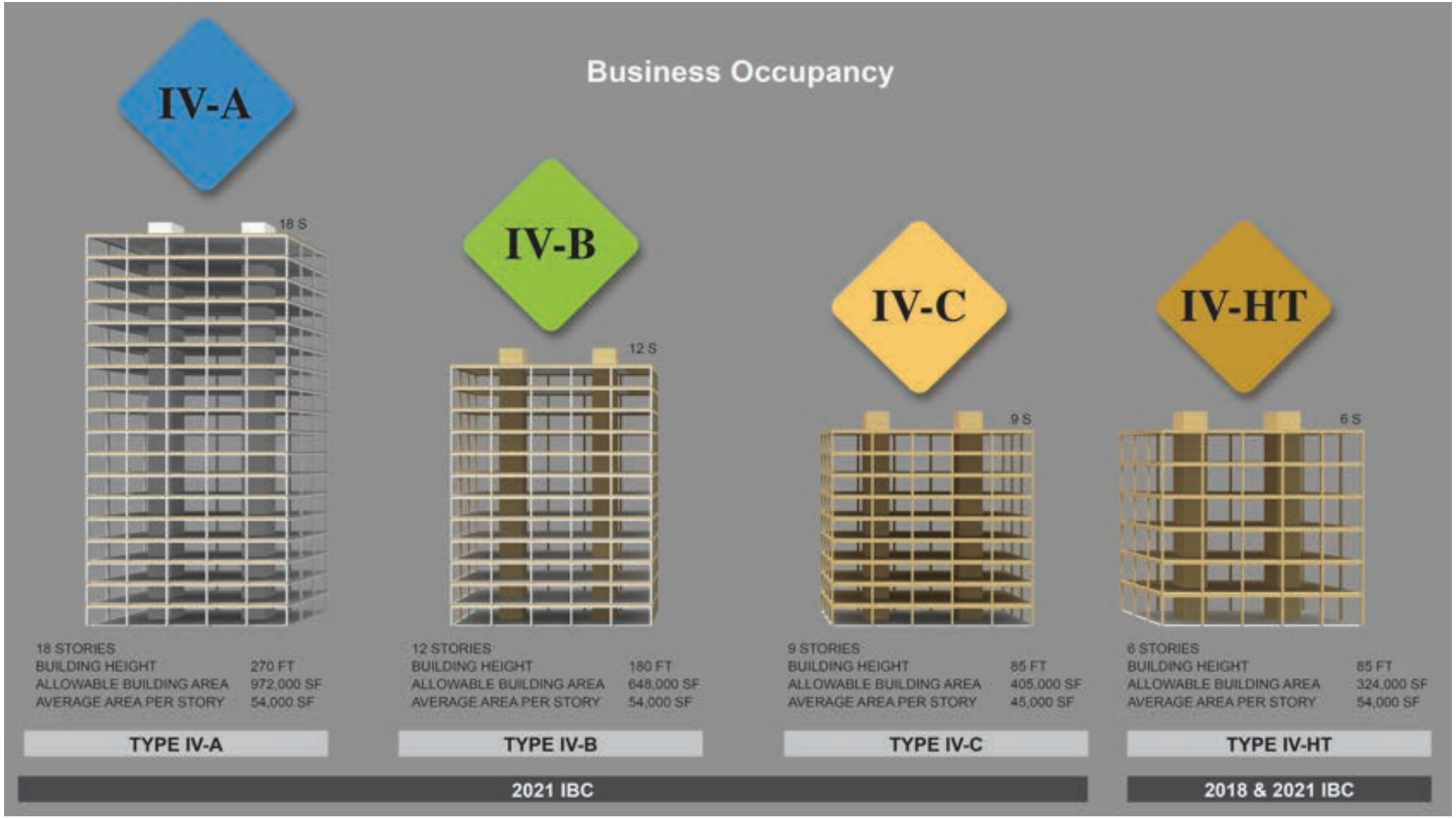
Required Fire-Resistance Rating of Building Element per Tables 601 and 705.5 (hours)	Minimum Protection Required from Noncombustible Protection (minutes)
1	40
2	80
3 or more	120

TABLE 722.7.1(2)
PROTECTION PROVIDED BY NONCOMBUSTIBLE COVERING MATERIAL

Noncombustible Protection	Protection Contribution (minutes)
1/2 inch Type X Gypsum Board	25
5/8 inch Type X Gypsum Board	40



NEW CONSTRUCTION TYPES



CONCEALED SPACES

TYPE IV-A: noncombustible protection as for interior spaces

TYPE IV-B: noncombustible protection as for interior spaces

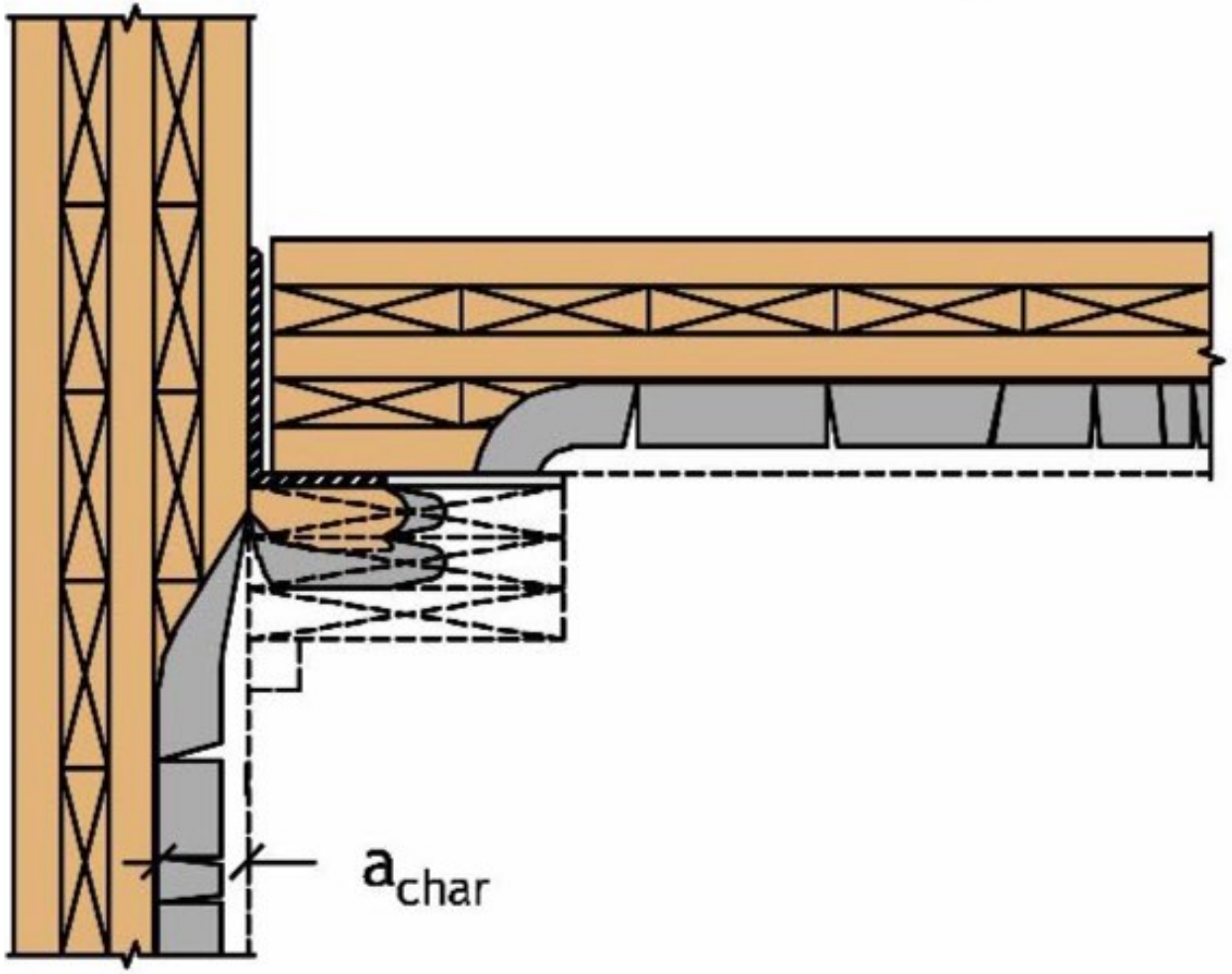
TYPE IV-C: noncombustible protection of 40 minutes

(all furring or light framing--noncombustible materials only)

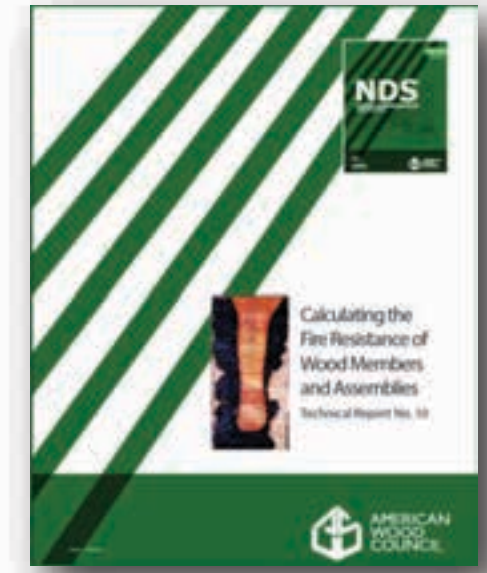
TYPE IV-HT (new alternatives):

- sprinkler protection in a fully sprinklered building
- filled completely with noncombustible insulation
- mass timber surfaces fully sheathed with 5/8-inch Type X gyp

AWC TR10 – PROTECTION OF CONNECTIONS



AWC TR10 Figure 8-3. Char pattern with wood strip added



OTHER REQUIREMENTS – NEW CONSTRUCTION TYPES

APA PRG-320 2018 adhesives

No light wood framing (must be noncombustible)

Exit and elevator shafts noncombustible for buildings above 12 stories/180 ft.

No combustible material outboard of exterior walls

Noncombustible protection for shafts, concealed spaces

Sealing of abutting mass timber elements

Certain additional and special inspections

Protection of lower floors with noncombustible material as the building goes up during construction

Redundant sprinkler water supply for buildings higher than 120 feet

RESOURCES

WoodWorks™
WOOD PRODUCTS COUNCIL

Tall Wood Buildings in the 2021 IBC
Up to 18 Stories of Mass Timber

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

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

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

Background: ICC Tall Wood Building Ad Hoc Committee

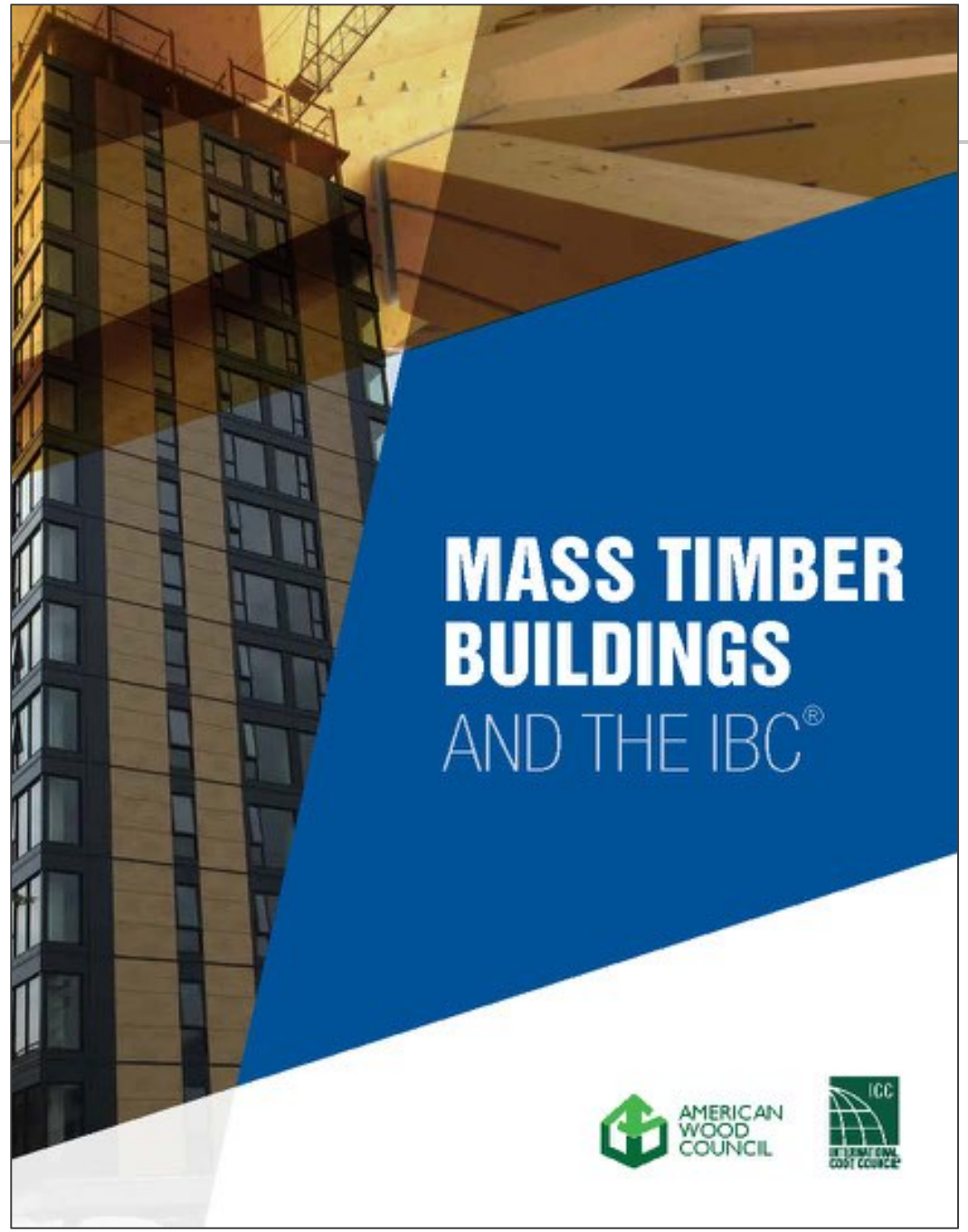
Over the past 10 years, there has been a growing interest in tall buildings constructed from mass timber materials (Breneman 2013, Timmers 2015). Around the world there are now dozens of timber buildings constructed above eight stories tall. Some international examples include:

Building Name	Location	Stories	Completion Date
Stadthaus at Murray Grove	London, UK	8-over-1	2008
Forté	Melbourne, Australia	8-over-1	2012
Via Cenni	Milan, Italy	9	2013
Treet	Bergen, Norway	14	2015
UBC Brock Commons	Vancouver, Canada	18	2016
Mjøstårnet	Norway	18	2019
HoHo Wien	Vienna, Austria	24	2019

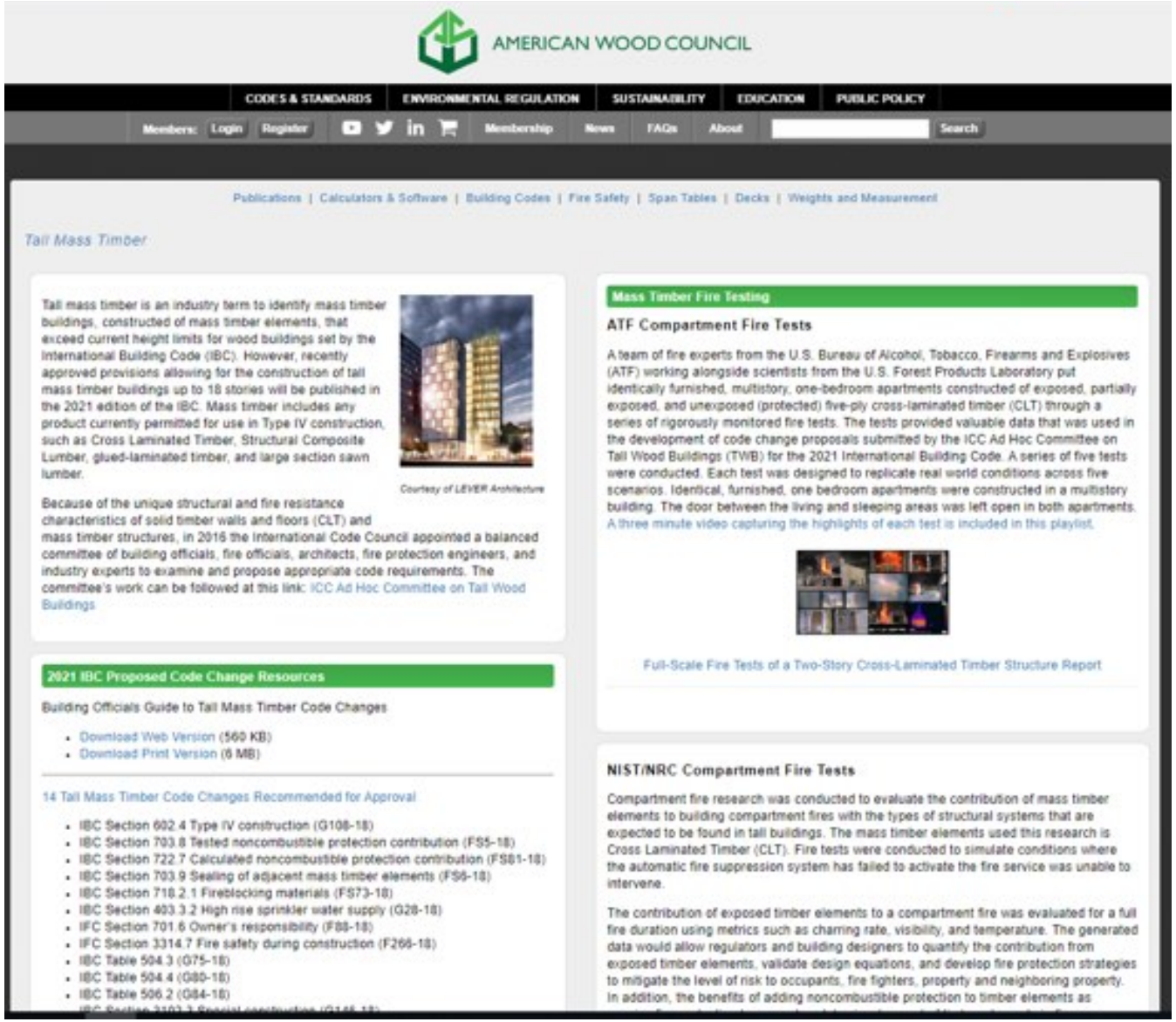
Carbon12
Portland, Oregon | Eight stories of mass timber
Kaiser Group and Path Architecture
Munzing Structural Engineering

Photo: Andrew Pogue

RESOURCES


MASS TIMBER
BUILDINGS
AND THE IBC®
AMERICAN
WOOD
COUNCIL
ICC

RESOURCES – WWW.AWC.ORG/TALLMASSTIMBER



QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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