Mass Timber Fire Design: Code Requirements, Design Strategies and Case Studies

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WOODWORKS
WOOD PRODUCTS COUNCIL

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South San Francisco Wellness Center; Photo by WoodWorks

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

AIA Approved Continuing Education

Course Description

Mass timber is transforming the built environment, and with this innovation comes the need for new strategies, precision, and code compliance. This course explores the fundamental principles of mass timber construction, equipping professionals with the knowledge necessary to navigate building codes and design fire-resistance solutions. Participants will delve into code provisions related to mass timber, including allowable building heights, fire-resistance ratings, fire design of connections, and fire protection measures, while learning how to design and expose mass timber elements safely and effectively. Real-world case studies will bring theory into practice, illustrating how design teams have overcome challenges to create safe, innovative, and code-compliant mass timber buildings.

Learning Objectives

1. Explore options for mass timber construction, including discussing construction types and code provisions such as allowable heights and fire-resistance ratings.

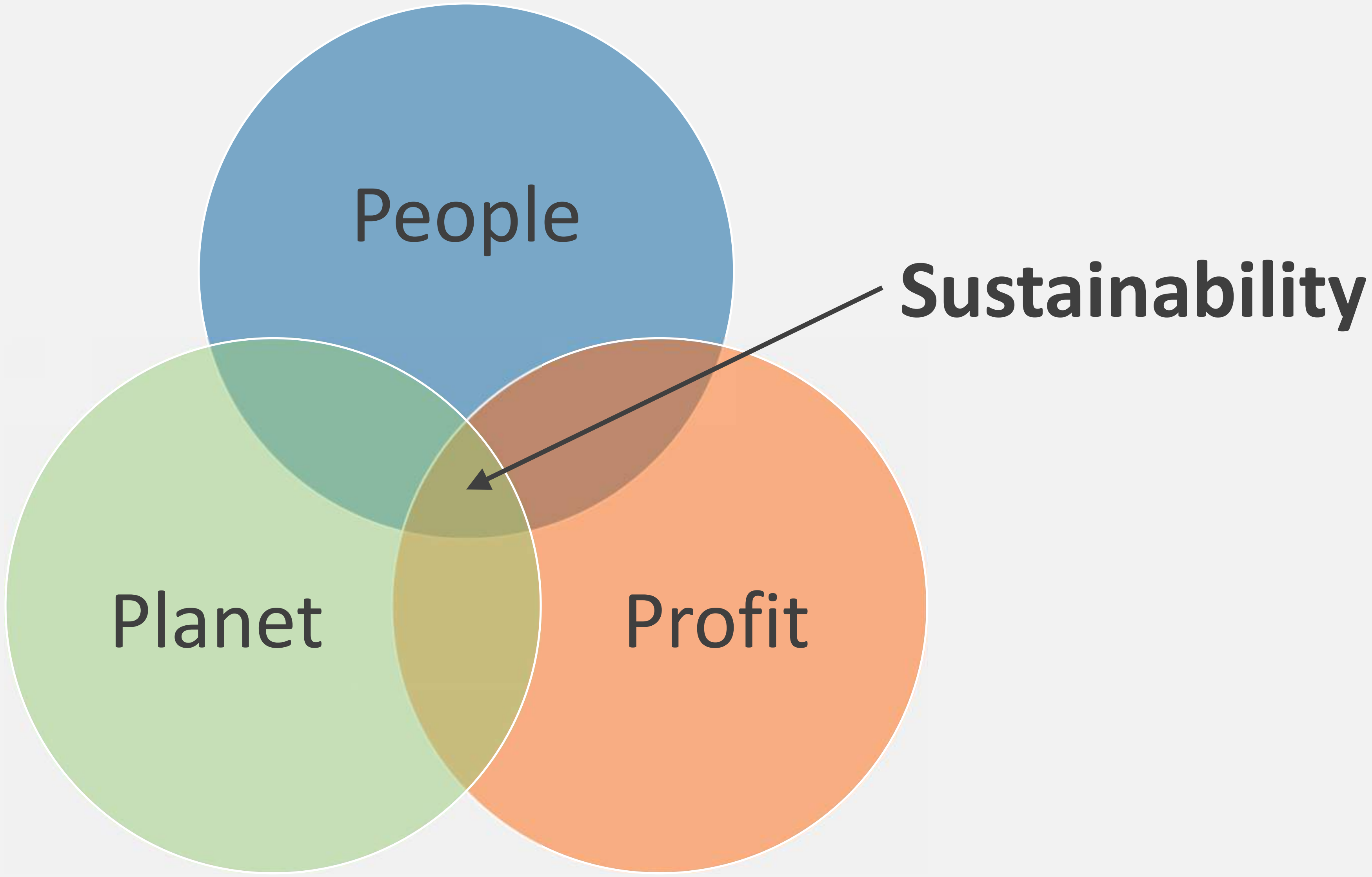
2. Discuss code-compliant options for exposing mass timber, where fire-resistance ratings are required, and demonstrate design methodologies for achieving these ratings.

3. Assess mass timber exposure strategies, emphasizing code compliance topics such as exposure are limits and connection design.

4. Review real-world project case studies, highlighting the design considerations and strategies utilized to achieve safe, code-compliant designs.


We need a better way
to build.
Freedom House Expansion | Berners Schober | RA Smith Inc | Photo Tricia Shay Photography

The Triple Bottom Line

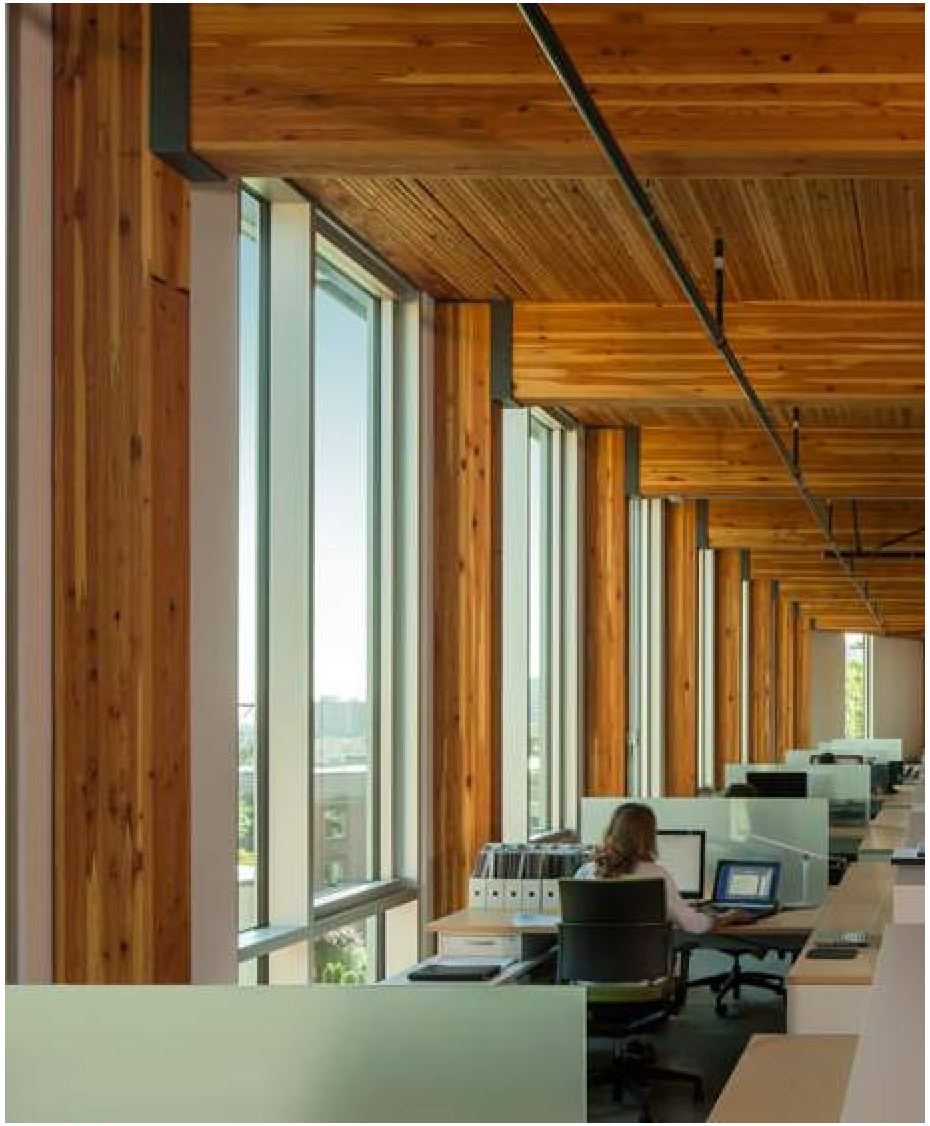


Timber House | MESH Architectures | Photo Travis Mark

Potential Benefits	Project Goal ✓	Value Add ✓
Fast construction		
Aesthetic Value (Leasing velocity/ premiums) Healthy Building / Biophilia		
Lightweight structure		
Labor shortage solution • small crews • entry level workers		
Just-in-time delivery (ideal for dense urban sites)		
Environmentally friendly (low carbon footprint)		
Healthy forests/ wildfire resiliency & support rural economies		

Light-Frame Wood
Photo: WoodWorks

Heavy Timber
Photo: Benjamin Benschneider



Mass Timber
Photo: John Stamets

Glue Laminated Timber (Glulam)

Beams & columns

Photo: StructureCraft

Cross-Laminated Timber (CLT)

Solid sawn laminations

Photo: LendLease

Cross-Laminated Timber (CLT)

SCL laminations

Photo: Freres Lumber

Photo: LEVER Architecture

Mass Timber Building Options

Post and Beam

Flat Plate

Honeycomb

Mass Timber Building Options

Hybrid: Light-frame **Hybrid: Steel framing**

Mass Timber in the IBC: Cross-Laminated Timber (CLT)

- CLT was first recognized in the 2015 IBC
- CLT in the 2022 CBC/ 2021 IBC:
  - Chapter 2: Definitions

[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.

  - Chapter 23: Wood

2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.

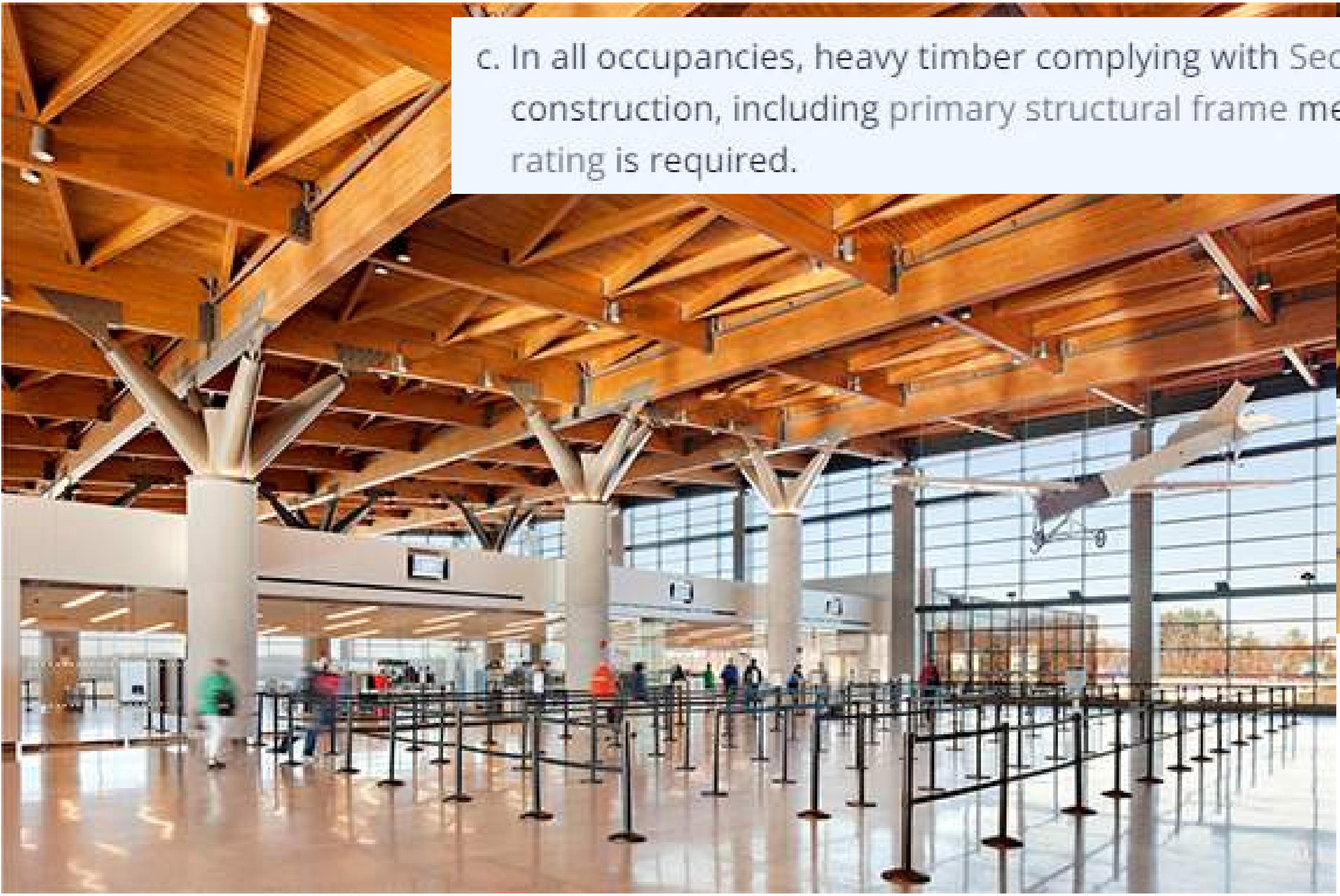
Construction Types – Allowable Materials

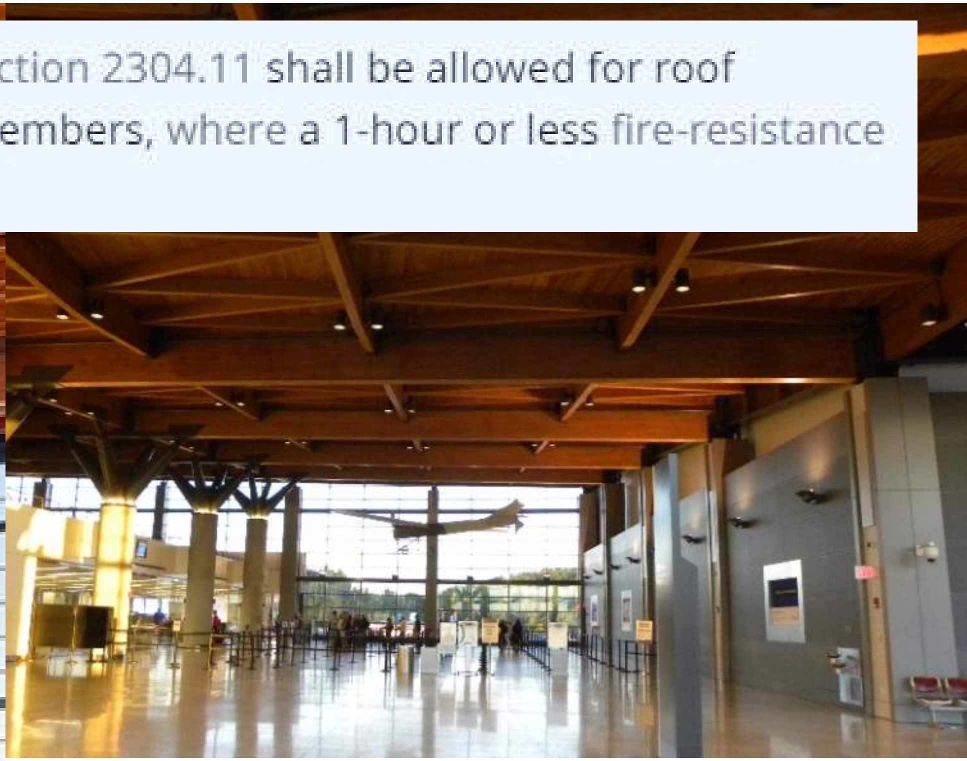
IBC/CBC defines 5 construction types: I, II, III, IV, V
A building must be classified as one of these

	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Exterior Wall Material	Non-combustible		Non-combustible		FRTW		CLT (protected)			FRTW (LF, MT), CLT (protected)	Any wood	
Interior Elements	Non-combustible		Non-combustible		Any wood		Heavy Timber			Heavy Timber	Any wood	

Construction Type IB, IIA, IIB (IBC Table 601 footnote c)

c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed for roof construction, including primary structural frame members, where a 1-hour or less fire-resistance rating is required.





Construction Type IB
Exposed Timber Roof Decking and Framing

Portland International Jetport

- LEED Gold
- Completed 2012

Design Team: Gensler, Oest Associates
Photo Credit: DeStafano & Chamberlain, Inc, Robert Benson Photography

Construction Types – Allowable Materials

	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Exterior Wall Material	Non-combustible		Non-combustible		FRTW		CLT (protected)			FRTW (LF, MT), CLT (protected)	Any wood	
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Construction Types – Allowable Materials

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Interior Elements	Non-combustible		Non-combustible		Any wood		Heavy Timber			Heavy Timber	Any wood	

Construction Type IV-A, B, and C

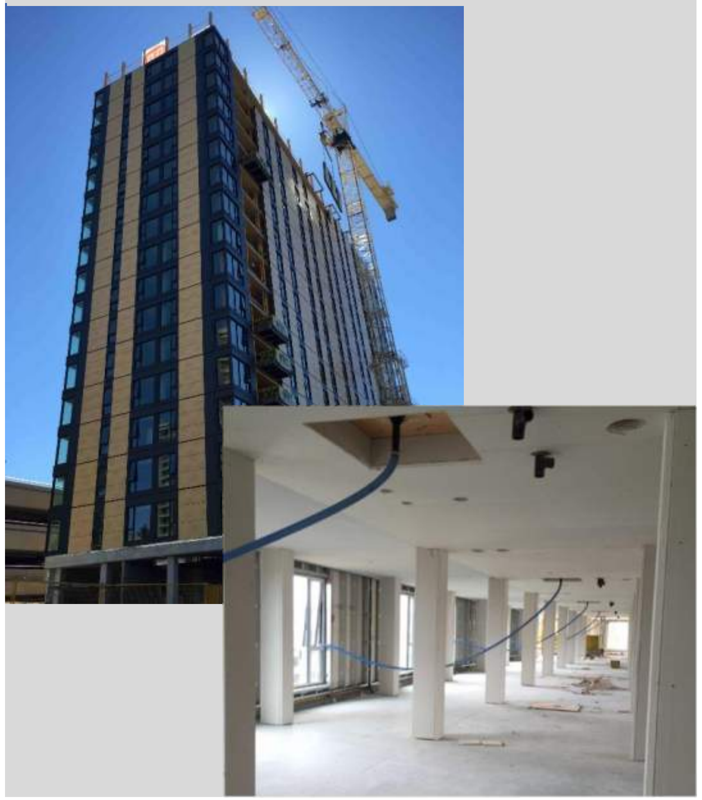
U.S. Building Codes, Tall Wood Ad Hoc Committee (2016-2018)

» Development of code change proposal for prescriptive code allowance of tall wood buildings.

Mass Timber Fire Testing at ATF Lab (2017)

Construction Types IV-A, B, and C

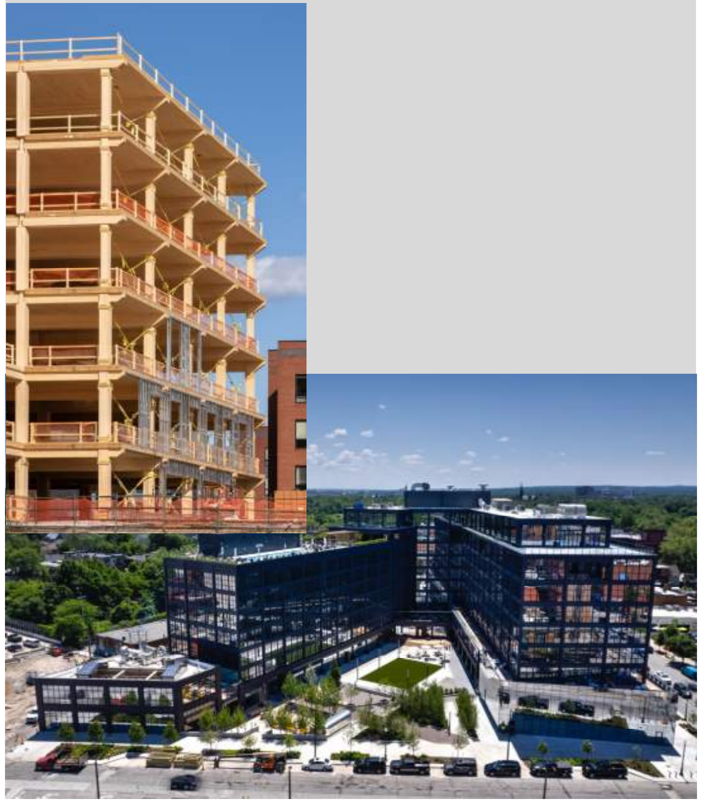
Type IV-A



Photos: Flor Projects

18 STORIES	
BUILDING HEIGHT	270’
PER STORY AREA	324,000 SF
BUILDING AREA	972,000 SF

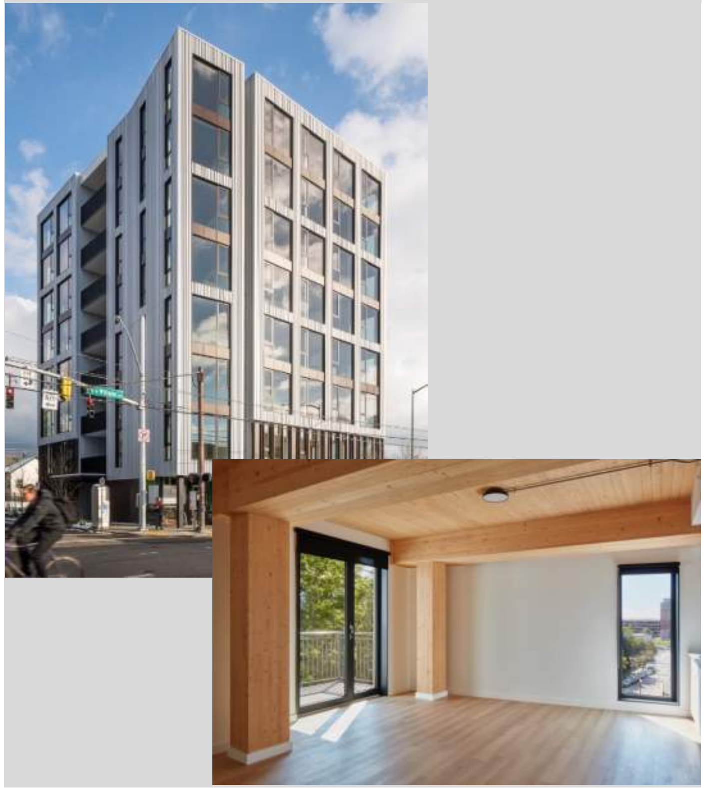
Type IV-B



Photos: ©Prakash Patel

12 STORIES	
BUILDING HEIGHT	180’
PER STORY AREA	216,000 SF
BUILDING AREA	648,000 SF

Type IV-C



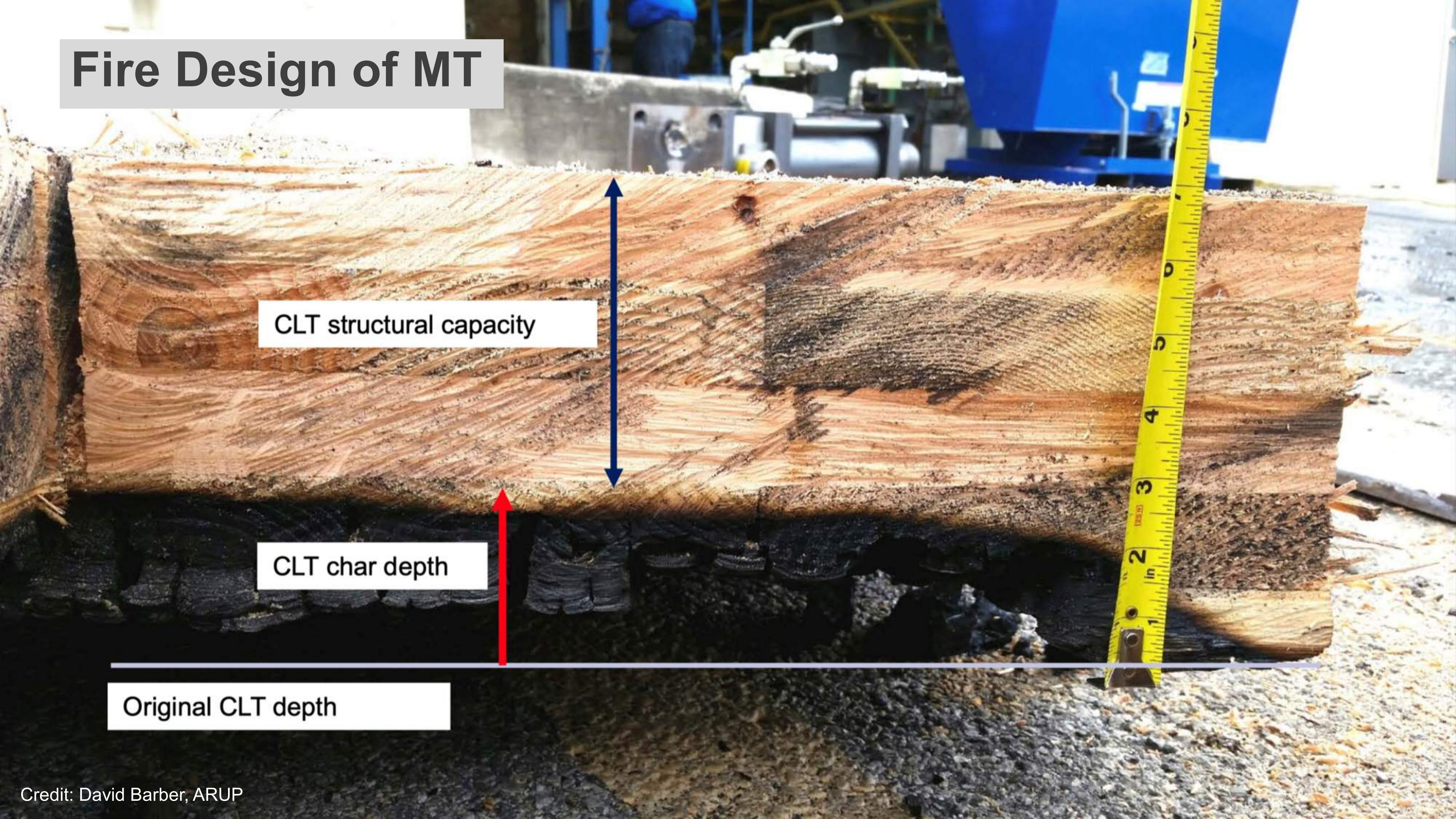
Monte French Design Studio, Photos: Jane Messinger

9 STORIES	
BUILDING HEIGHT	85’
PER STORY AREA	135,000 SF
BUILDING AREA	405,000 SF

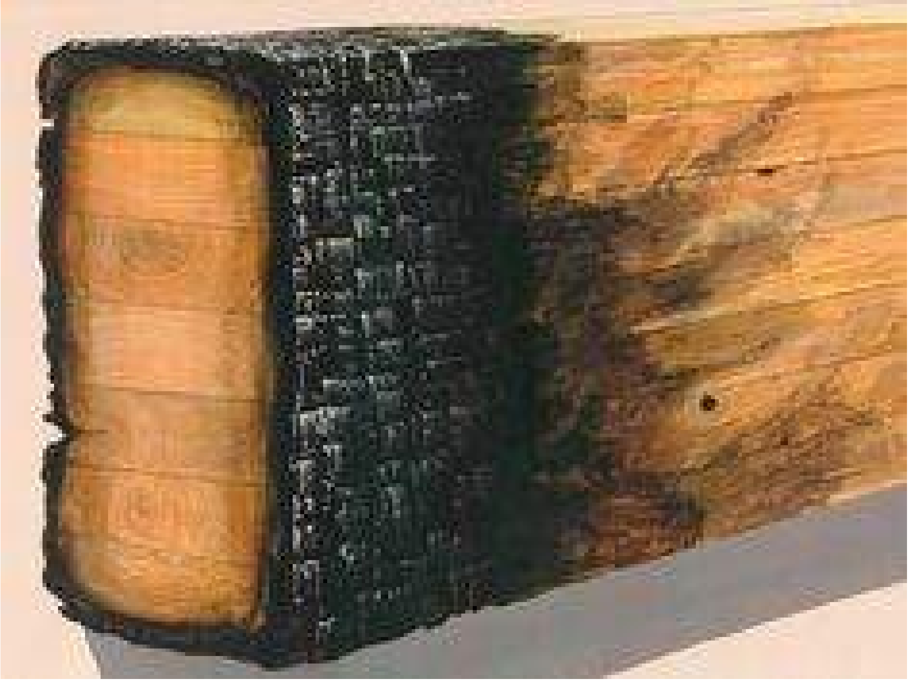
Construction Type – Primarily based on building size & occupancy

	Construction Type (All Sprinklered Values)							
	IV-A	IV-B	IV-C	IV-HT	III-A	III-B	V-A	V-B
Occupancies	Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)							
A, B, R	270	180	85	85	85	75	70	60
	Allowable Number of Stories above Grade Plane (IBC Table 505.4)							
A-2, A-3, A-4	18	12	6	4	4	3	3	2
B	18	12	9	6	6	4	4	3
R-2	18	12	8	5	5	5	4	3
	Allowable Area Factor (At) for SM, Feet^2 (IBC Table 506.2)							
A-2, A-3, A-4	135,000	90,000	56,250	45,000	42,000	28,500	34,500	18,000
B	324,000	216,000	135,000	108,000	85,500	57,000	54,000	27,000
R-2	184,500	123,000	76,875	61,500	72,000	48,000	36,000	21,000

Fire Design of MT



Credit: David Barber, ARUP



Mass Timber Design

Fire resistance

Nominal char rate for most wood products is 1.5”/hr

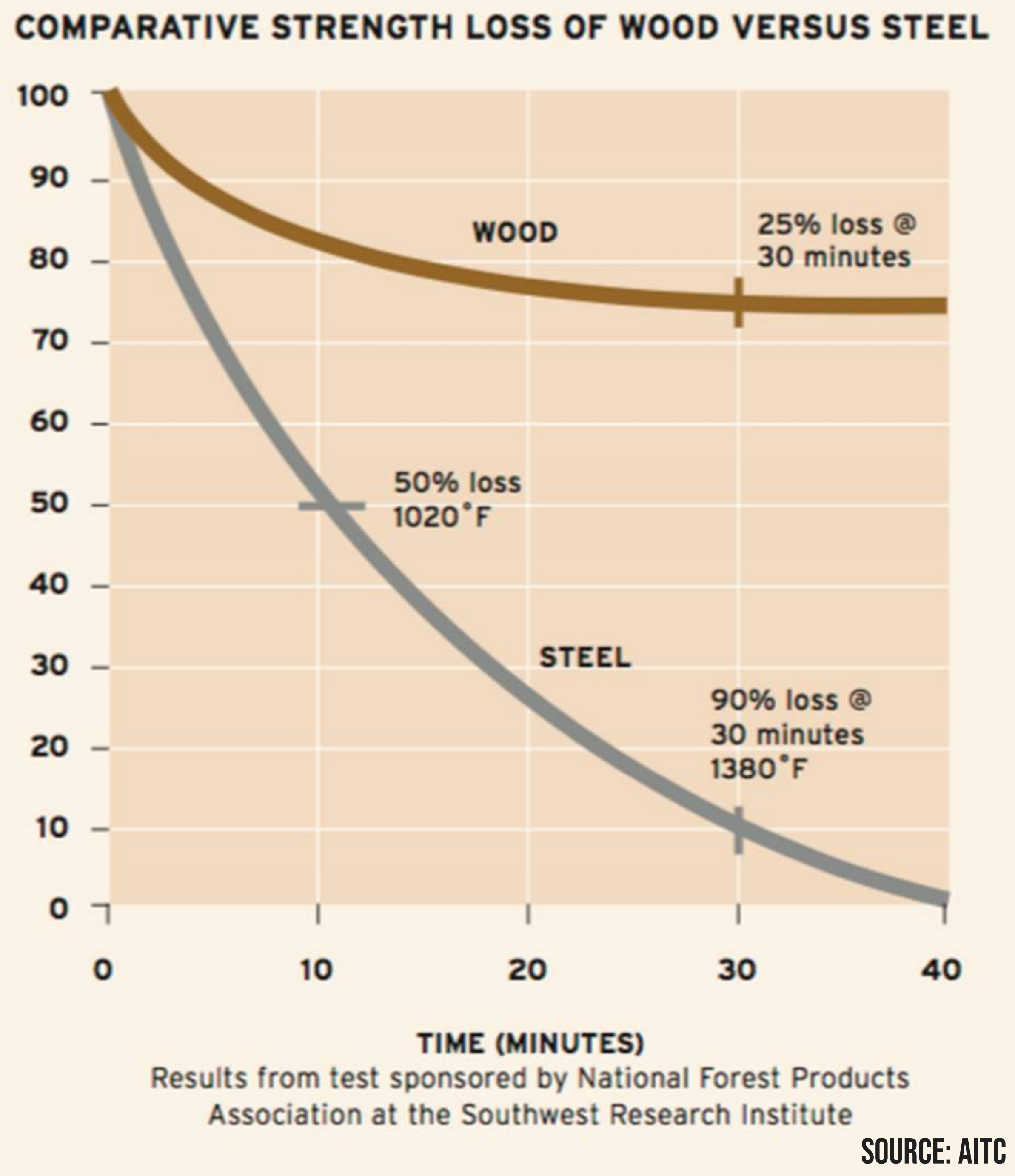
NDS Chapter 16 includes calculation of fire resistance of NLT, CLT, Glulam, Solid Sawn and SCL wood products

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

Required Fire Resistance (hr.)	Char Depth, a_{char} (in.)	Effective Char Depth, a_{eff} (in.)
1-Hour	1.5	1.8
1½-Hour	2.1	2.5
2-Hour	2.6	3.2

Mass Timber Design

Fire resistance



Choosing Fire Rated Assemblies

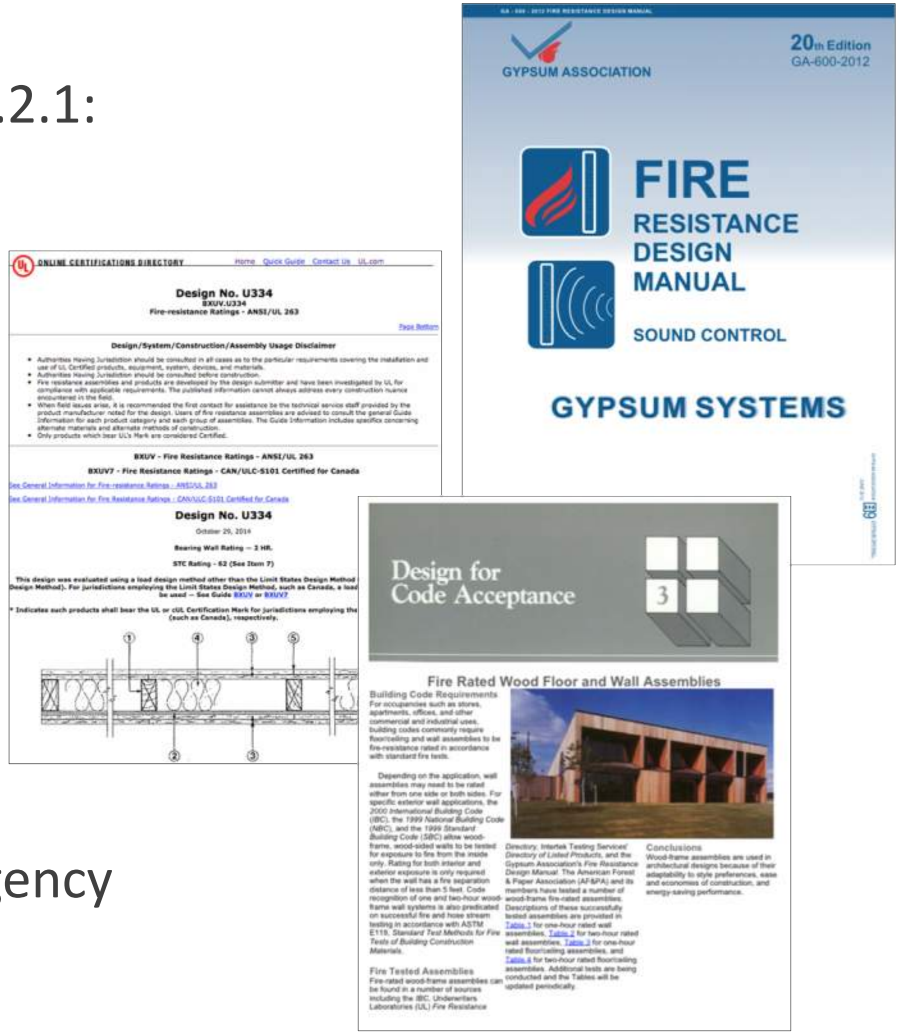
Common tested assemblies (ASTM E119) per IBC 703.2.1:

» UL Listings
» Gypsum Catalog
» Proprietary Manufacturer Tests
» Industry Documents: such as AWC's DCA3

Analytical Methods per IBC 703.2.2:

» Prescriptive designs per IBC 721.1
» Calculated Fire Resistance per IBC 722
» Fire-resistance designs documented in sources
» Engineering analysis based on a comparison
» Fire-resistance designs certified by an approved agency

Approved Alternate Method 703.2.3



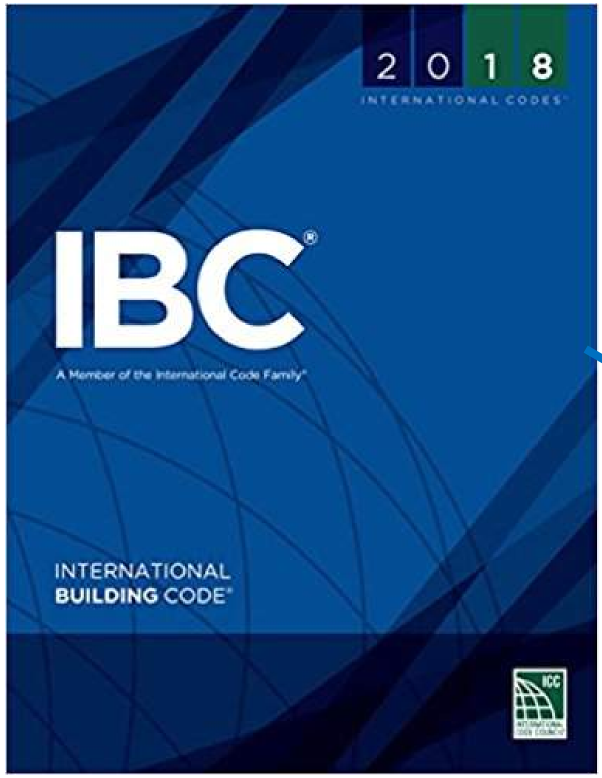
Fire-Resistance Ratings (FRR)

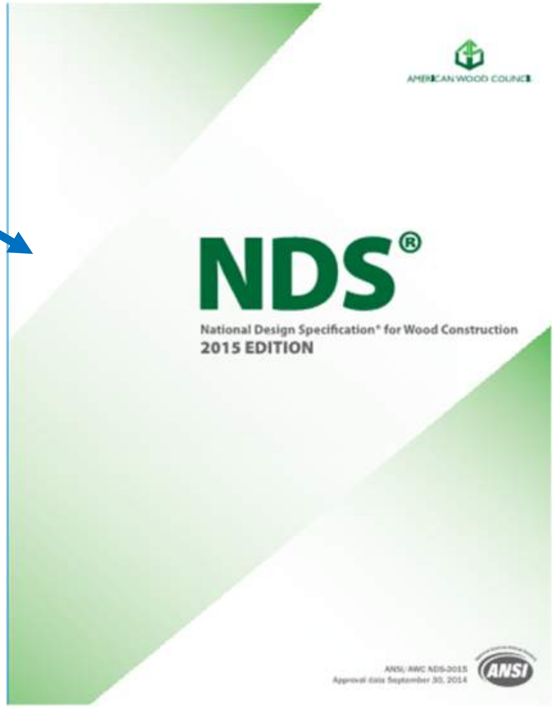
Driven primarily by construction type

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	A	B	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a,b]	2[a,b,c]	1[b,c]	0[c]	1[b,c]	0	3[a]	2[a]	2[a]	HT	1[b,c]	0
Bearing walls												
Exterior[a,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[g]	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
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 structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural 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

Calculated FRR of Exposed Mass Timber:
IBC/CBC to NDS code compliance path





Code Path for Exposed Wood Fire-Resistance Calculations

IBC 703.3
Methods for determining fire resistance
- Prescriptive designs per IBC 721.1
- ***Calculations in accordance with IBC 722***
- Fire-resistance designs documented in sources
- Engineering analysis based on a comparison
- Alternate protection methods as allowed by 104.11

IBC 722
Calculated Fire Resistance
"The calculated *fire resistance* of exposed wood members and wood decking shall be permitted in accordance with **Chapter 16 of ANSI/AWC National Design Specification for Wood Construction (NDS)**

NDS Chapter 16
Fire Design of Wood Members
- Limited to calculating fire resistance up to 2 hours
- Char depth varies based on exposure time (i.e., fire-resistance rating), product type and lamination thickness. Equations and tables are provided.
- TR 10 and NDS commentary are helpful in implementing permitted calculations.

Mass Timber Fire & Acoustic Database

< Back to Mass Timber Fire & Acoustic Database

Application Type

- Fire-Resistance Rated Mass Timber Floor/Roof Assemblies 30
- Fire-Resistance Rated Mass Timber Wall Assemblies 26
- Firestop Systems For Penetrations in Mass Timber Assemblies 57
- Fire-Resistance Rated Mass Timber Connections 19
- Perimeter Fire Containment Systems in Mass Timber Structures 5
- Noncombustible Protection of Mass Timber Building Elements 4

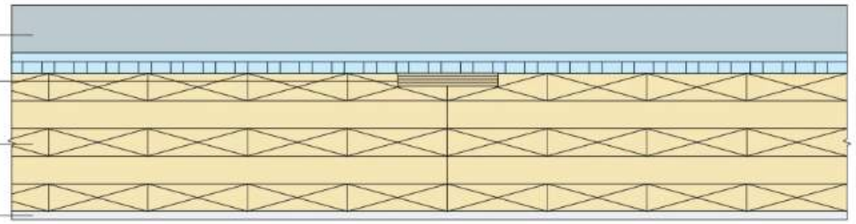
Mass Timber Panel

- CLT 108
- CLT (SCL) 1
- NLT 3
- DLT 3
- GLT 2
- SCL 1
- T&G

Number of Layers

- 1 to 3 39
- 4 to 5 77

Fire-Resistance Rated Mass Timber Floor/Roof Assemblies



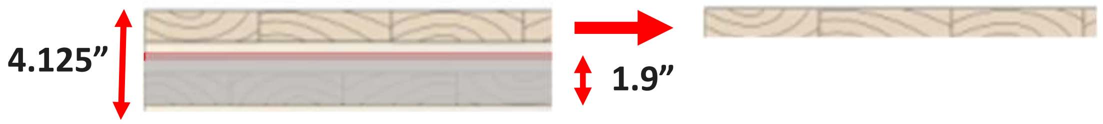
Fire-resistance ratings of assemblies are demonstrated through fire-resistance tests, recognized calculations, or approved alternatives. The IBC recognizes US testing standards ASTM E119 and UL 236 while the Canadian standard ULC S101 has the same fire exposure and performance criteria. Fire-resistance ratings developed using these standards may be acceptable to building officials in either country.

Mass Timber Panel	Structural Grade	Exposed Side Protection	Unexposed Side Protection	Panel Connection	Load Rating	Fire-Resistance Rating (Hours)	Test Protocol	Method of Compliance
5-layer 6.89" (175mm) CLT	E1M5 by Structurlam (Mercer)	None	1-1/2" Maxxon Cyp-Grete 2000 over Maxxon reinforcing mesh	Surface Spline	Loaded, See Report	2.5	ASTM E119 & ULC S101	Fire test by Intertek on Feb 22, 2017 Contact Mercer for more Information
5-layer 6.89" (175mm) CLT	V grade by Structurlam (Mercer)	None	None	Surface Spline	Loaded, See Report	2	ASTM E119	Fire test by SwRI on Jan 27, 2022 Contact Mercer for more Information
5-layer 6.89" (175mm) CLT	E grade by Structurlam (Mercer)	None	None	Surface Spline	Loaded, See Report	2	ASTM E119	Fire test by SwRI on Jan 31, 2022 Contact Mercer for more Information

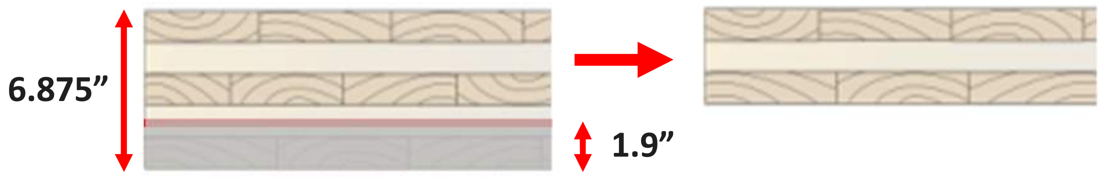
Fire Design of Mass Timber

- Fire Resistance Ratings (FRR)
  - Thinner panels (i.e. 3-ply) can be difficult to achieve 1+ hour FRR
  - 5-ply CLT panels can usually achieve 1- or 2-hour FRR
  - Construction Type -> FRR -> Member size -> Grid (order as needed)

Panel	Example Floor Span Ranges
3-ply CLT (4-1/8" thick)	Up to 12 ft
5-ply CLT (6-7/8" thick)	14 to 17 ft
7-ply CLT (9-5/8")	17 to 21 ft
2x4 NLT	Up to 12 ft
2x6 NLT	10 to 17 ft
2x8 NLT	14 to 21 ft
5" MPP	10 to 15 ft



3 ply (after 1-hour rating)



5 ply (after 1-hour rating)

Noncombustible Protection (NC)

> ***NONCOMBUSTIBLE PROTECTION (FOR MASS TIMBER).*** *Noncombustible material, in accordance with Section 703.5, designed to increase the fire-resistance rating and delay the combustion 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).

Credit: Urban One

MT Fire Resistance Ratings (FRR)

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.

+

Credit: Urban One

= **FRR**

Fire Design of Mass Timber

Woodworks Bay Area Mass Timber

Presented by Parisa Nassiri

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.

Holmes – Who We Are

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Years	Staff	Offices	Countries
60+	500+	15	4

Holmes

HISTORIC/SEISMIC RETROFIT

NEW CONSTRUCTION

TENANT IMPROVEMENTS

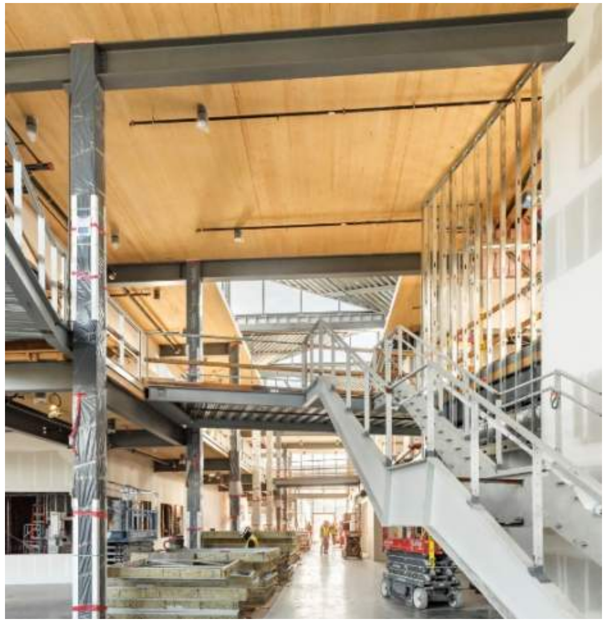
STRUCTURAL/CIVIL ENGINEERING

FIRE & LIFE SAFETY

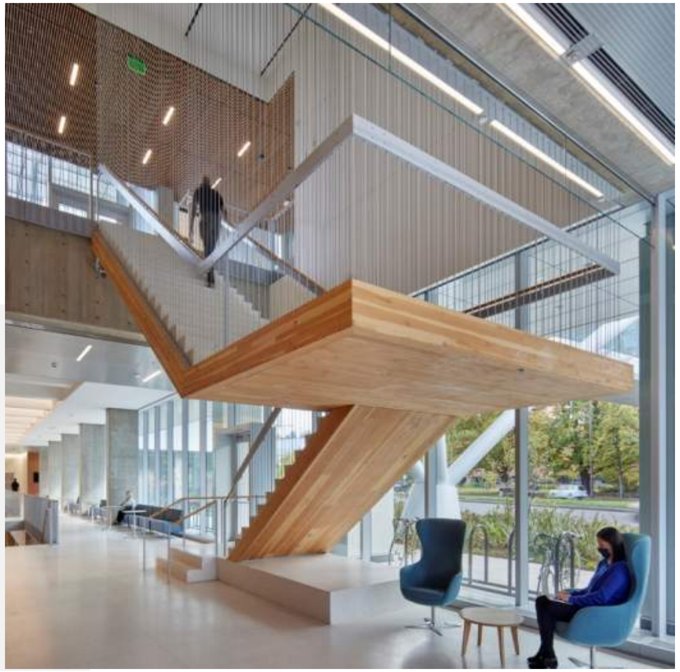
PRODUCT TESTING & DEVELOPMENT













U.S. Mass Timber Floor Vibration

DESIGN GUIDE

WOODWORKS

CLT Diaphragm Design for Wind and Seismic Resistance

Using SDPWS 2021 and ASCE 7-22

Cross-laminated timber (CLT) has become increasingly prominent in building construction and can be seen in buildings throughout the world. Specifically, the use of CLT floor and roof panels as a primary gravity force-resisting component has become relatively commonplace. Now, with availability of the 2021 *Special Design Provisions for Wind and Seismic* (SDPWS 2021) from the American Wood Council (AWC), U.S. designers have a standardized path to utilize CLT floor and roof panels

AWC SDPWS 2021

SDPWS 2021 is the first edition to provide direct provisions for CLT to be used as an element in a diaphragm or shear wall. To differentiate between CLT and light-frame lateral force-resisting systems, it adopts the terminology *sheathed wood-frame* for light-frame diaphragms (SDPWS §4.2) and shear walls (SDPWS §4.3), and includes new sections for CLT diaphragms (SDPWS

ASCE

Check for updates

Prescriptive Seismic Design Procedure for Post-Tensioned Mass Timber Rocking Walls

A. Busch, S.M.ASCE[1]; R. B. Zimmerman, M.ASCE[2]; S. Pei, M.ASCE[3]; E. McDonnel, M.ASCE[4]; P. Line, M.ASCE[5]; and D. Huang, S.M.ASCE[6]

Abstract: In this study, a prescriptive seismic design procedure for post-tensioned mass timber rocking wall lateral force–resisting systems is proposed. Unlike performance-based design approaches that employ nonlinear analysis, this procedure utilizes techniques and analysis procedures that are routinely applied in design industry practice as well as adhering to traditional approaches contained in current US standards. The design procedure targets providing a basis for prescriptive design of mass timber rocking wall lateral force–resisting systems and their future adoption into model codes. For illustration, the design approach is applied to an example building, with the building's performance validated through a nonlinear numerical model simulation. DOI: 10.1061/(ASCE)ST.1943-541X.0003240. © *2021 American Society of Civil Engineers.*

Background

With the growing popularity of mass timber construction and proposed building code changes in the US, the number of mass timber building projects is expected to increase. Although most of these buildings can be erected using a concrete or steel lateral force–resisting system (LFRS), researchers have also been pursuing lateral system solutions using mass timber materials, such as panelized cross-laminated timber (CLT) shear walls (Amini et al. 2018; van de Lindt et al. 2020) and post-tensioned rocking wall systems (Iqbal et al. 2015). Although mass timber LFRS are gaining traction in research and development through testing and in constructed projects through performance-based design applications, there are no mass timber LFRS that are fully recognized in the US building code and its reference design standards as of the end of 2020. Prescriptive design procedures will make such systems more accessible to the wider design community in the US.

Among many potential mass timber LFRS, post-tensioned rocking walls are viewed by the research and design community to be a low-damage lateral system that can be competitive for mass timber building projects in regions with high seismicity. This system is an adaptation of the precast concrete rocking wall system, heavily researched and tested in the 1990s and codified via American Concrete Institute (ACI) standards ACI ITG 5.1-07 and 5.2-09 (ACI 2007, 2009). The timber version of this system was originally conceptualized in New Zealand using laminated veneer lumber (LVL) walls with several real project applications (Palermo et al. 2012). Post-Tensioned rocking walls made of CLT panels were tested in the US both at the component (Ganey et al. 2017; Akbas et al. 2017) and system levels (Pei et al. 2019; Blomgren et al. 2019). The system was also adopted in real projects in the US that were either permitted (Zimmerman and McDonnell 2018) or built (Sarti et al. 2017b; Baas et al. 2019).

All of these existing designs and analyses were conducted using fairly advanced tools and procedures (such as performance-based design and nonlinear response history analysis), which are more sophisticated than those currently used in the average design office. These pioneer research activities and actual projects generated a wealth of data and experience on the behavior and design of post-tensioned mass timber rocking wall LFRS. This has enabled the development of a prescriptive design approach to mirror that of post-tensioned precast concrete rocking walls, which is the focus of this study.

In the following sections, seismic design limit states for post-tensioned mass timber rocking walls are listed. The procedure and design calculations to conduct these limit-state checks are described. An example design of a mass timber rocking wall LFRS in a 6-story office building is also presented. The procedures presented here are part of an effort seeking to introduce mass timber

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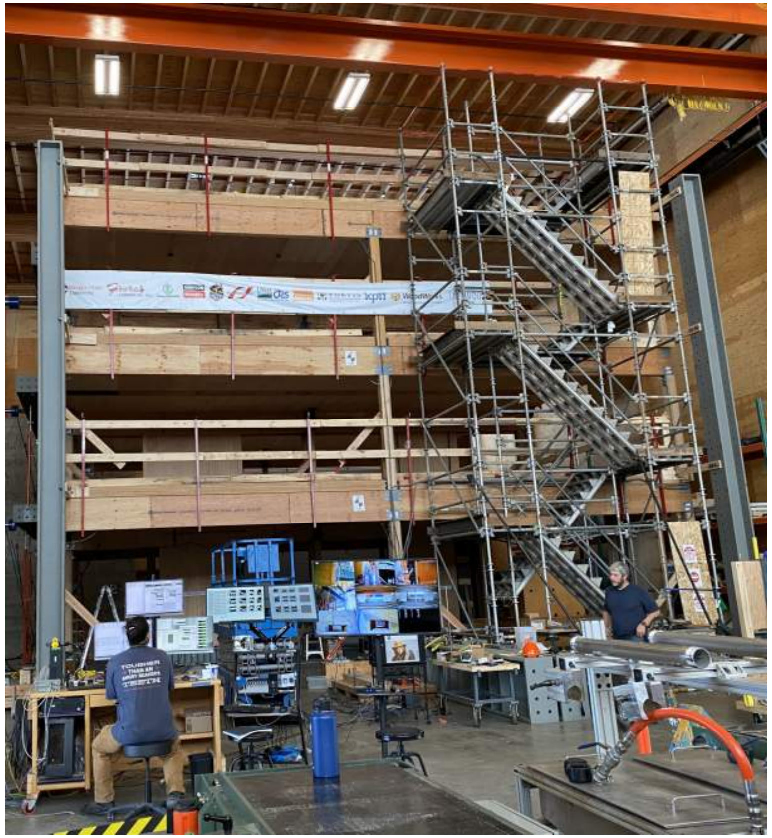


TALLWOOD

DESIGN INSTITUTE

REACTS

CONSORTIUM

Research on Engineering, Architecture & Construction of Timber Structures

Great Fire of London, 1666

The Great Chicago Fire, 1871


MGM GRAND



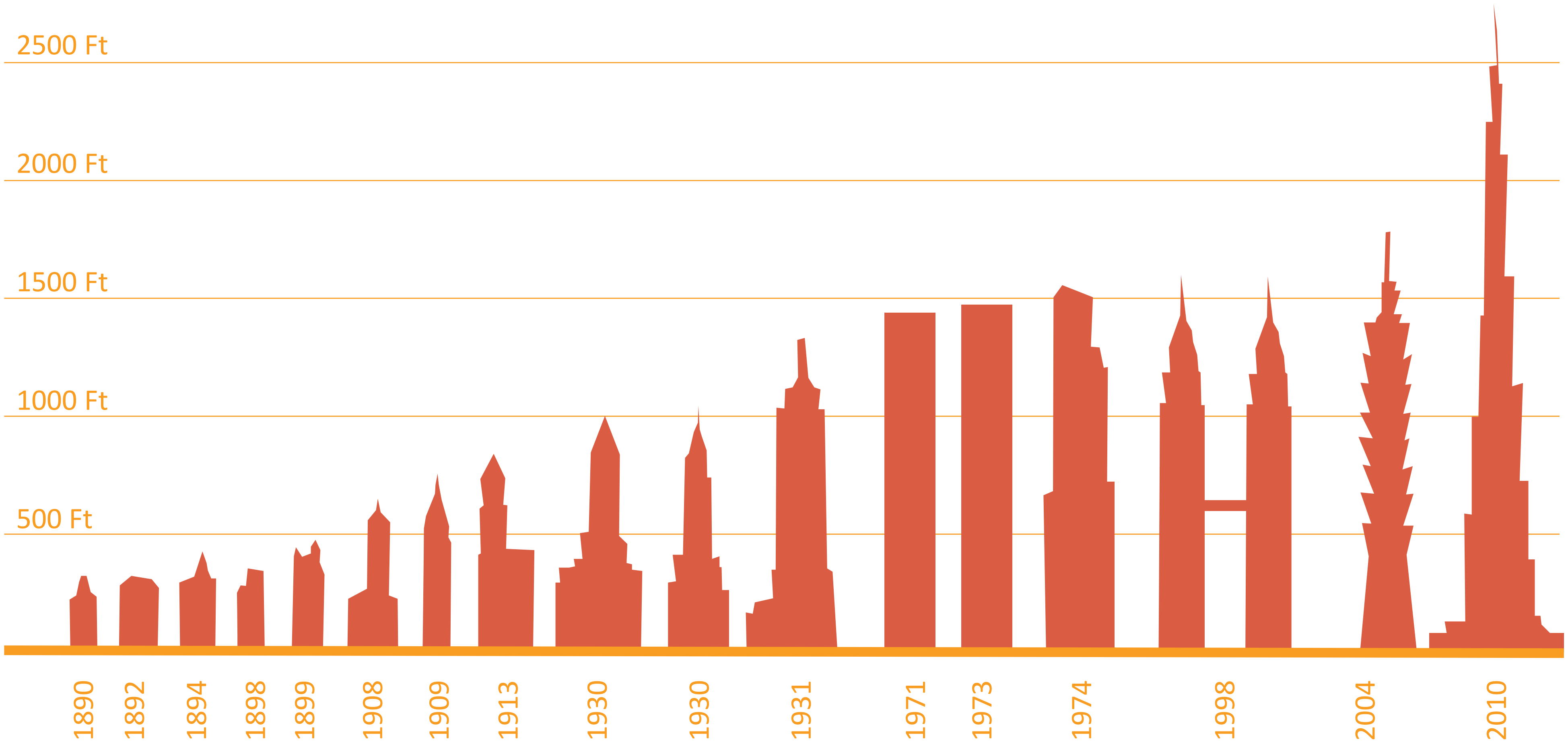
Building Codes

- Reactive in Nature
- Based on Historic Fires
- Disaster Driven
- Perceived Risk

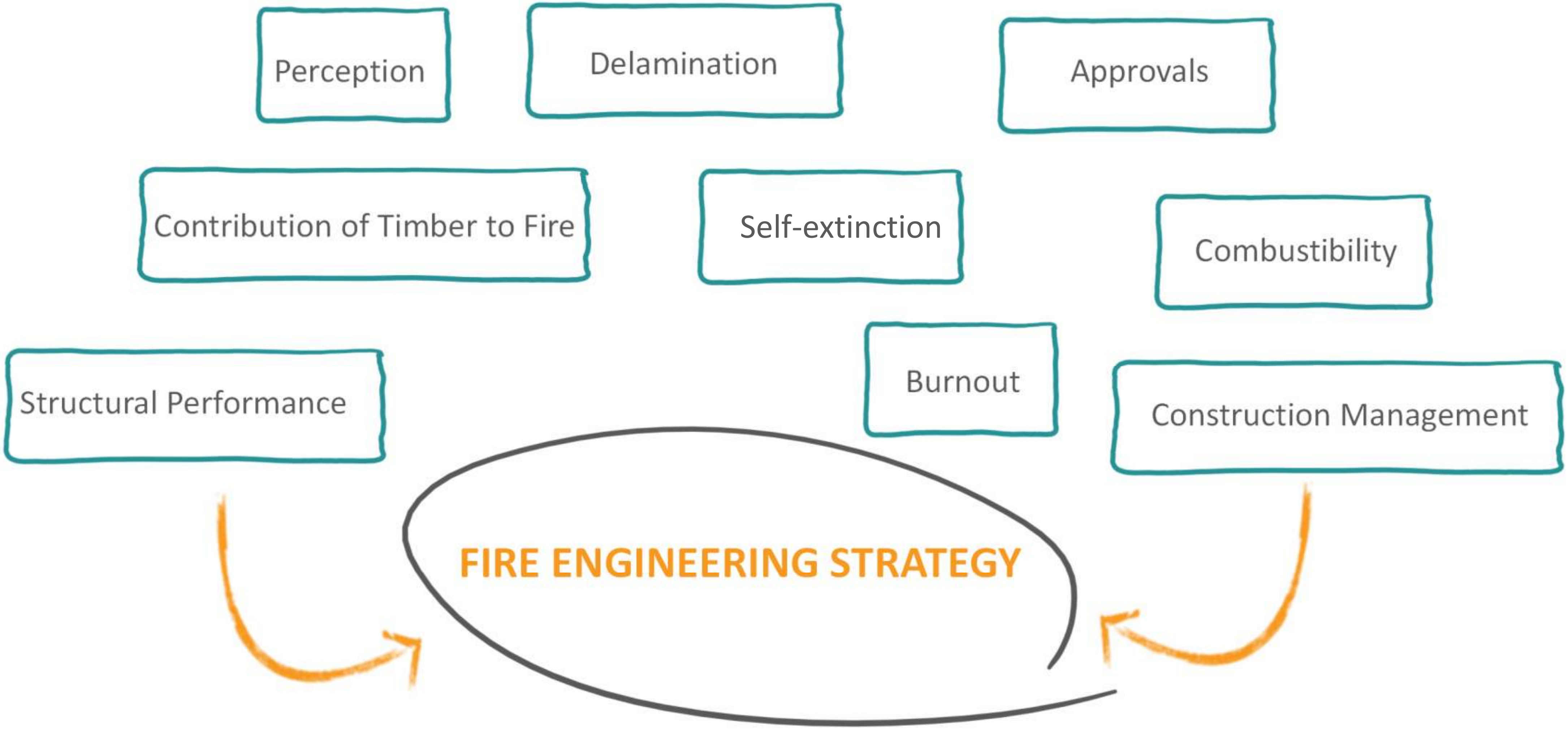
MGM Grand - National Archives


Grenfell Tower - The Independent

World's Tallest Towers



Key Issues Designing with Timber



Fire Safety Objectives

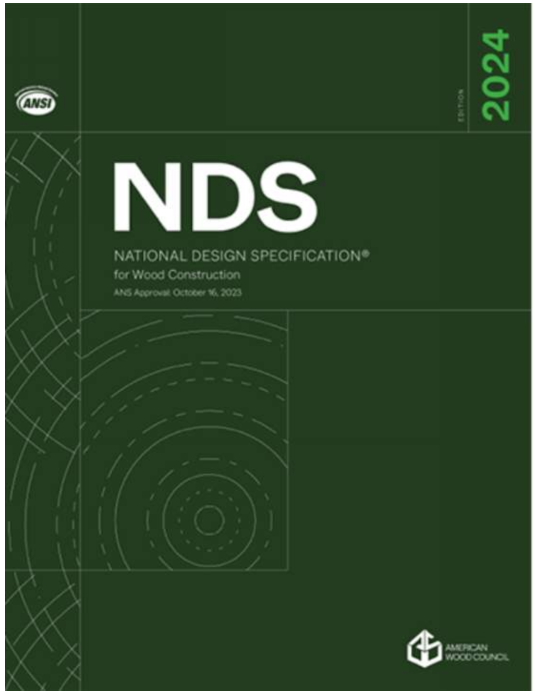
- Life Safety
- Property Protection
- Environmental Protection

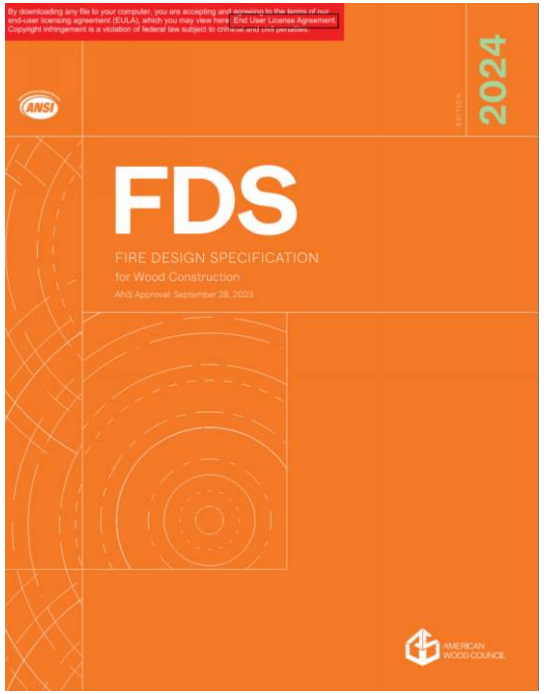
Fire Safety Strategies

- Evacuation
- Firefighting Response
- Compartmentation
- Structural Integrity

Mass Timber Design

Fire Design of Mass Timber





2024 IBC

AWC

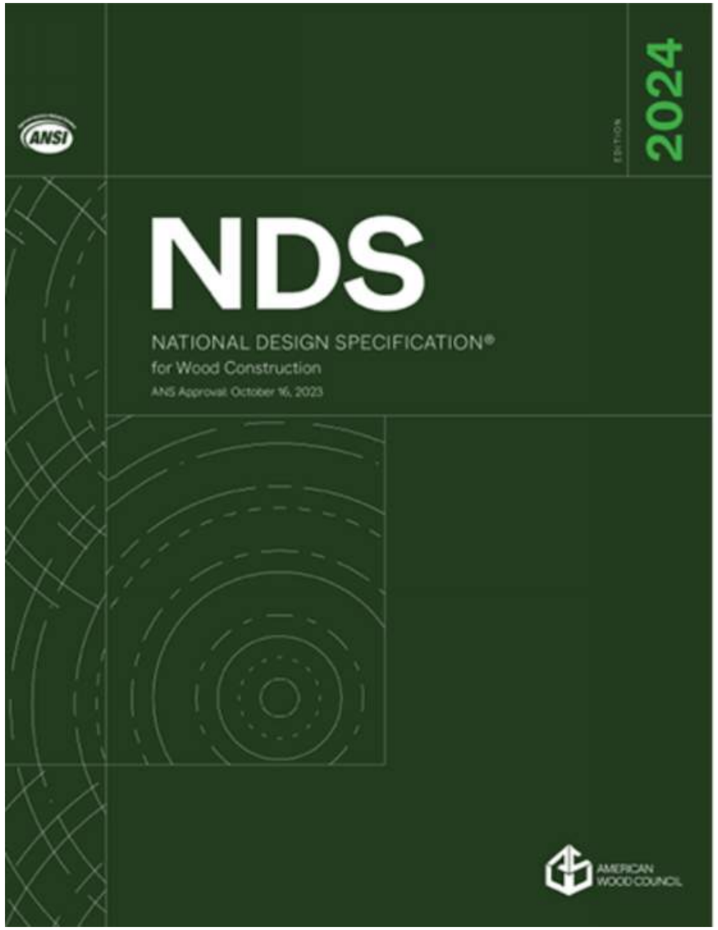
American Wood Council
222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175

ANSI/AWC NDS—2024	National Design Specification (NDS) for Wood Construction—with 2018 NDS Supplement 202, 722.1, Table 1404.5.3.2, Table 1604.3, 1809.12, 1810.3.2.4, Table 1810.3.2.6, 1905.7.2, Table 2304.6.1, Table 2304.10.2, 2304.13, 2305.1.2, 2306.1, Table 2306.2(1), Table 2306.2(2), Table 2306.3(1), Table 2306.3(2), 2307.1

2024 NDS is now available online

16.1 General

Chapter 16 establishes fire resistance provisions for use where the required fire resistance of wood construction covered under this Specification is established by calculation. Reference design values and specific design provisions applicable to particular wood products or connections to be used with the provisions of this chapter are given in other chapters of this Specification. Reduced cross-sectional dimensions shall be determined in accordance with 16.3 based on char depth in accordance with 16.2. Where determinations of thermal separation and burn-through resistance are required, calculations shall be in accordance with the *Fire Design Specification for Wood Construction* (FDS).

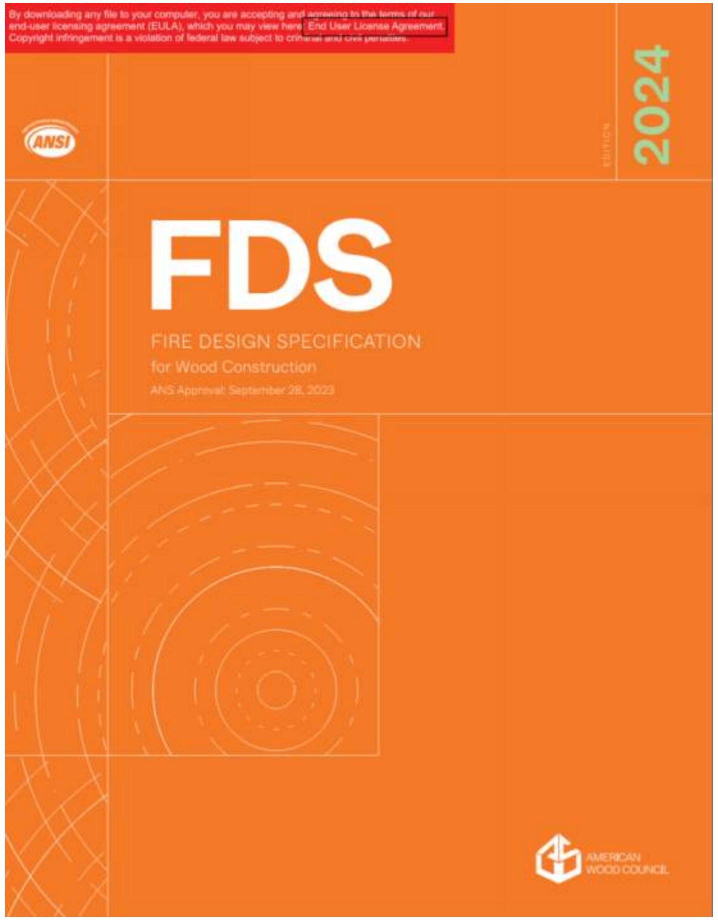


https://awc.org/publications/2024-nds/

2024 FDS is now available online

1.1.1 Scope

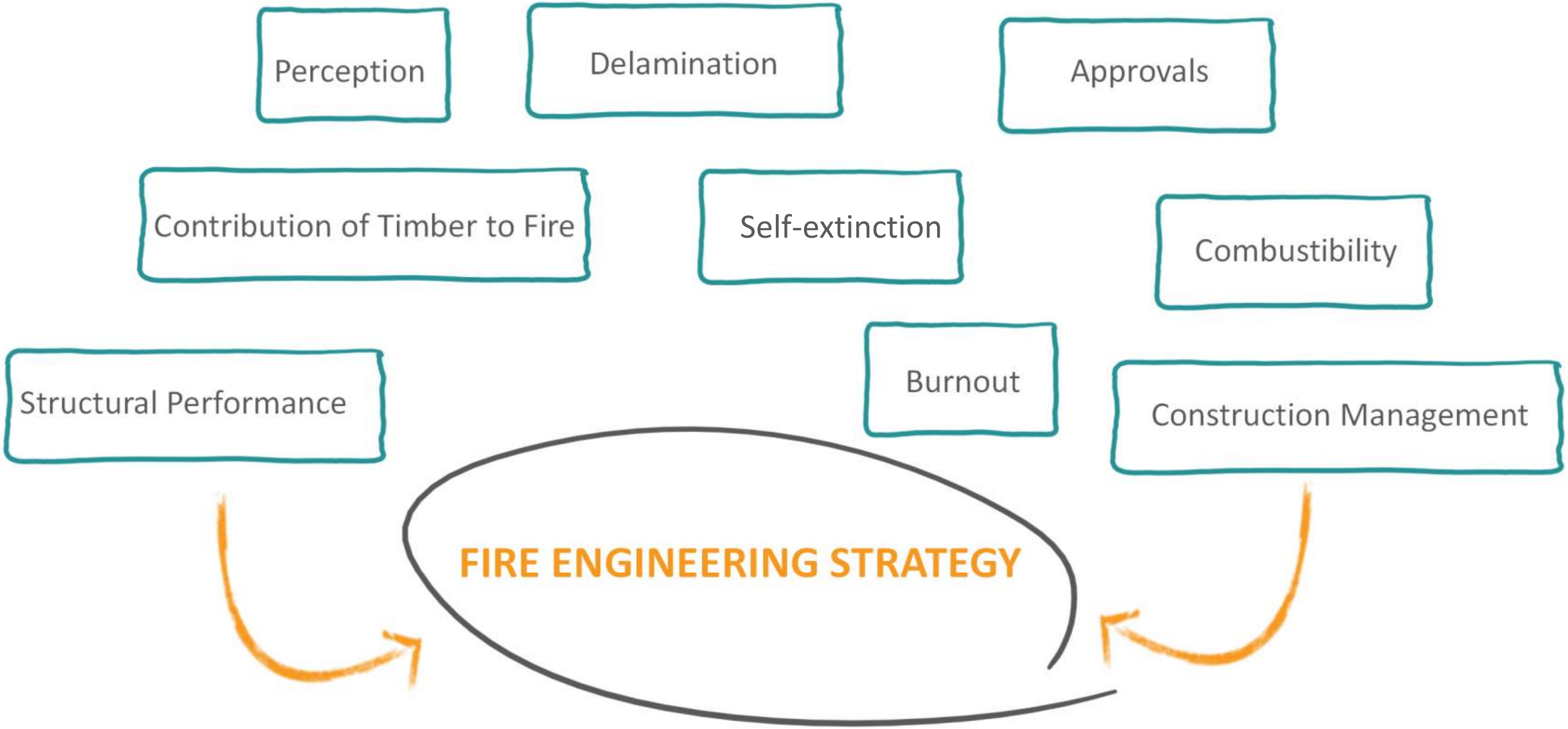
Where fire design is required by the applicable building code, this standard establishes fire design provisions for wood construction covered under the ANSI/AWC *National Design Specification (NDS) for Wood Construction.*



https://awc.org/wp-content/uploads/2023/11/AWC_FDS2024_20231219_AWCWEBSITE.pdf

Reliability-Based Design

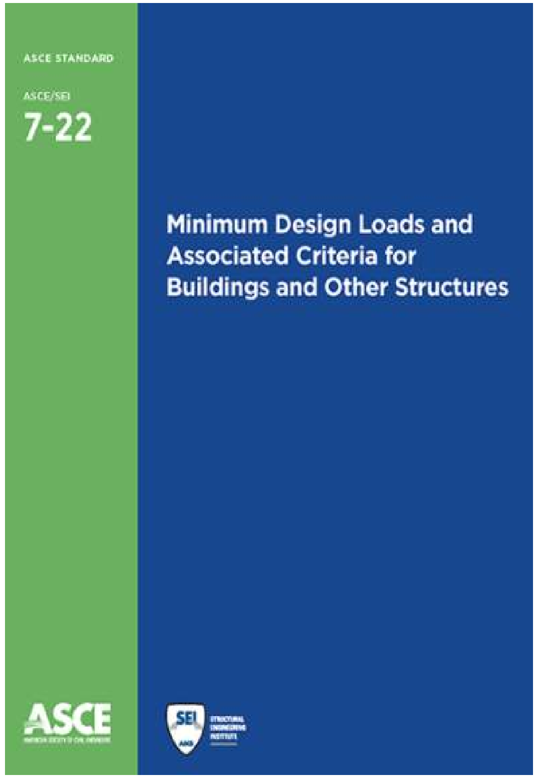
Key Issues Designing with Timber

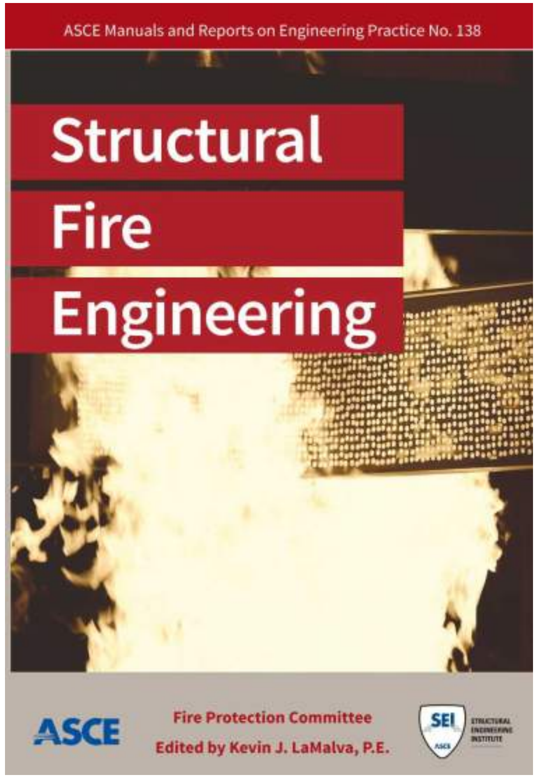


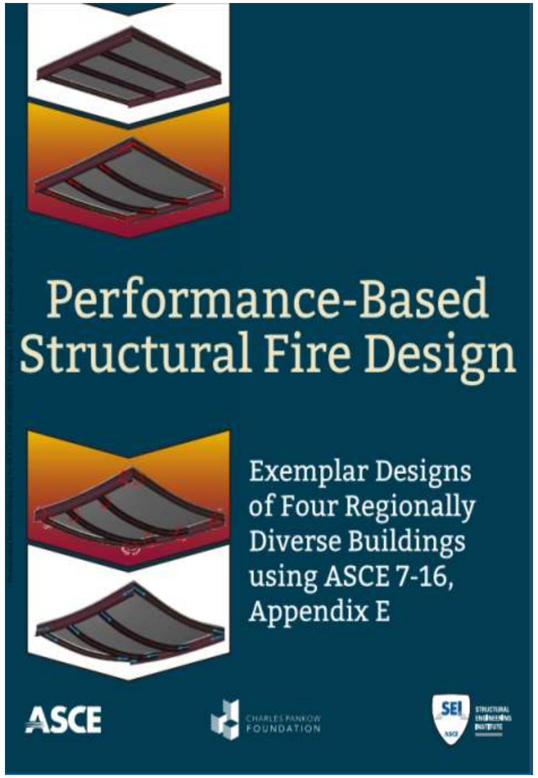
Code Alternates

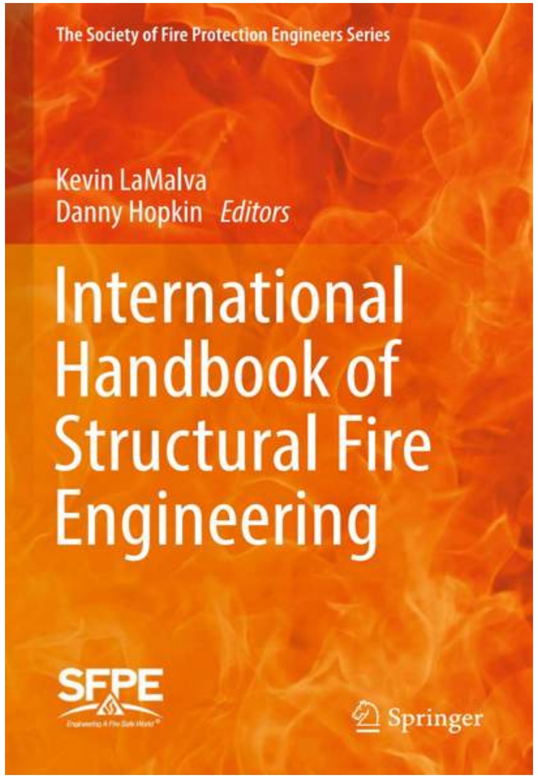
- Equivalency criteria:
  - Quality.
  - Strength.
  - Effectiveness.
  - Durability.
  - Safety, other than fire safety.
  - ~~Fire resistance~~
  - Fire safety
- Exception:
  - Performance-based alternative materials, designs or methods of construction and equipment complying with the International Code Council Performance Code.

Reliability-Based Design





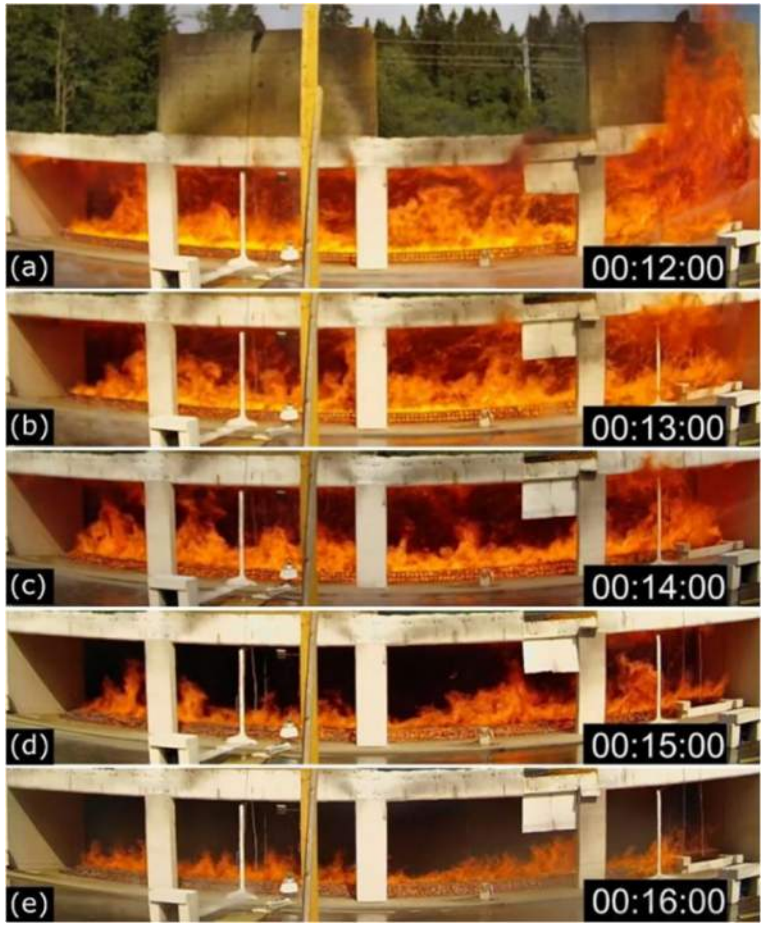




Timber Structures in Fire

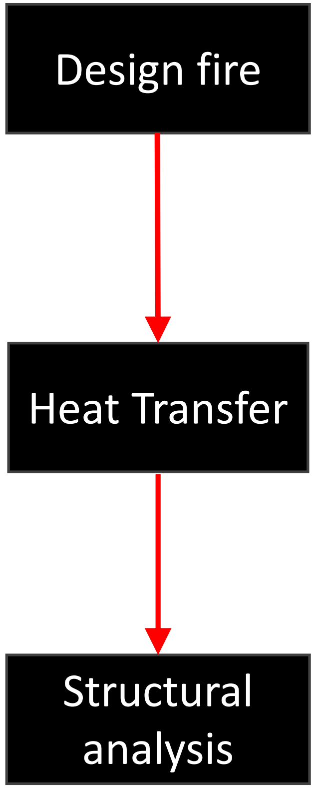
Exposed CLT

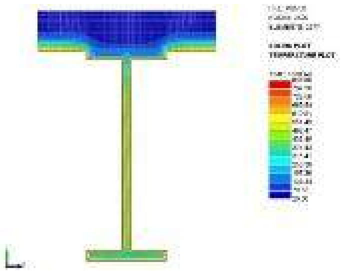
- Complex fire dynamics
- Increased speed of fire spread
- Increased contribution of energy
- Prolonged smoldering
- Self-extinction
- Structural performance
- Fire fighter access to high rise structure
- Lots of ongoing research

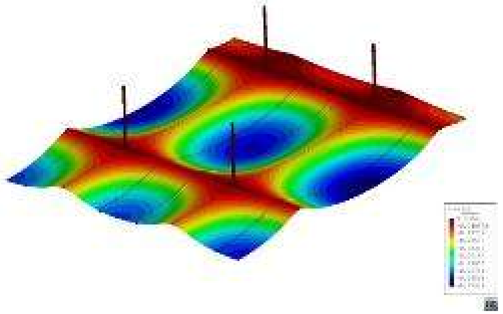


Fire protection strategy depends on all the above

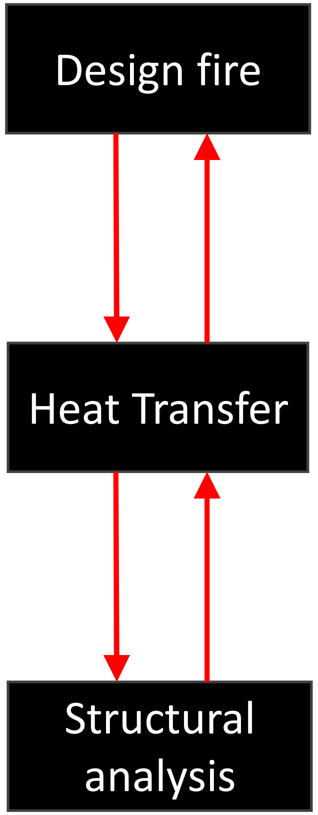
Structural Fire Analysis – Concrete and Steel Structures







Structural Fire Analysis – Timber Structures

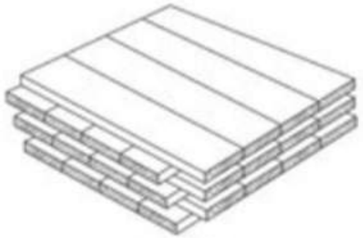



CERIB, Arup, Imperial College Fire tests

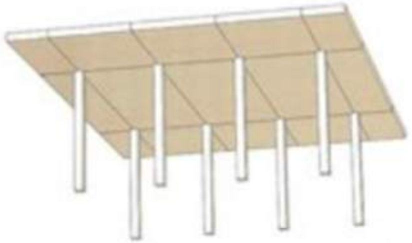
Mass Timber Metal Connectors

Case Study

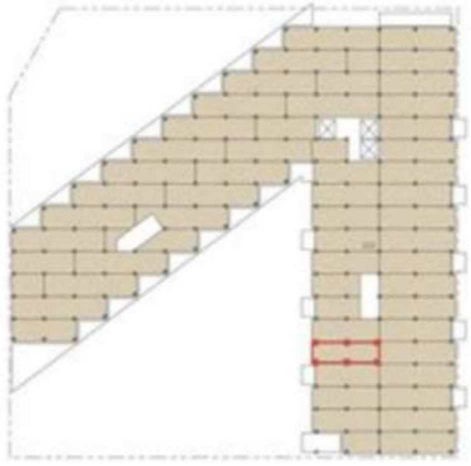
Credentials: Lever Architecture



CLT DECK



POINT SUPPORTED FLOORS



Credentials: Lever Architecture

Most Recent Code Changes

602.4.2.2.2 Protected area. Interior faces of mass timber elements, including the inside face of exterior mass timber walls and mass timber roofs, shall be protected in accordance with Section 602.4.2.2.1.

Exceptions: Unprotected portions of mass timber ceilings and walls complying with Section 602.4.2.2.4 and the following:

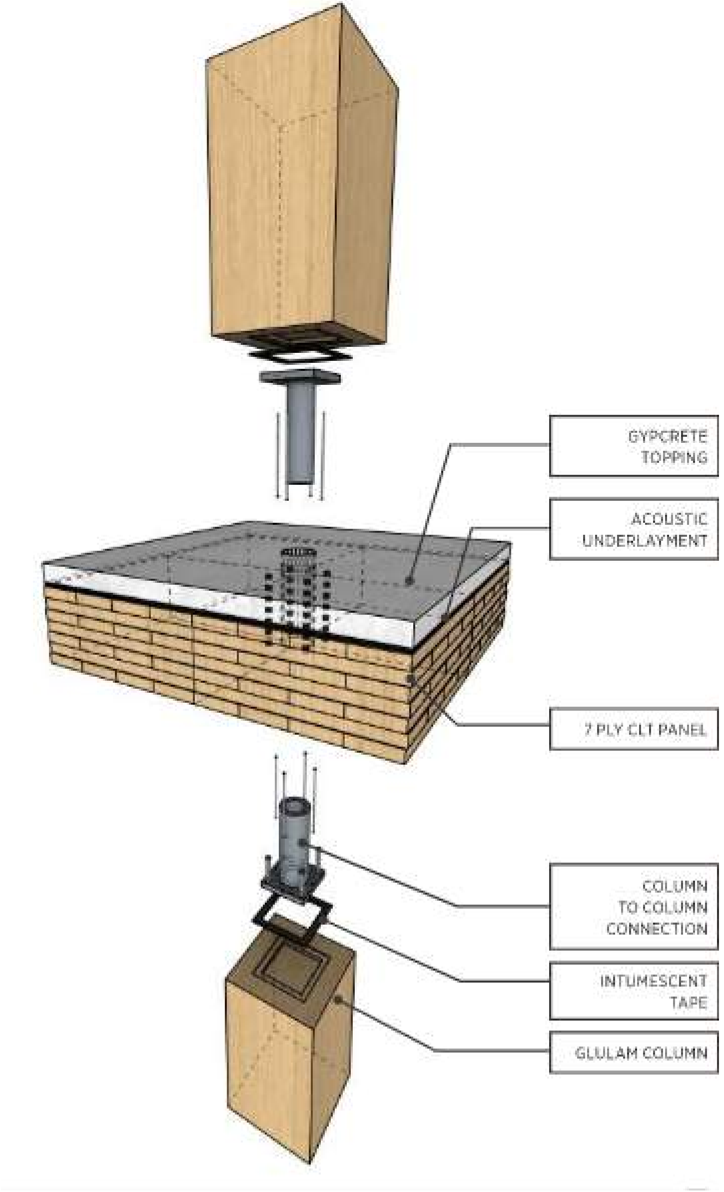
1. Unprotected portions of mass timber ceilings and walls complying with one of the following:

   1.1. Unprotected portions of mass timber ceilings, including attached beams, shall be permitted and shall be limited to an area less than or equal to ~~20~~ 100 percent of the floor area in any dwelling unit or fire area.

   1.2. 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.

   1.3. Unprotected portions of both walls and ceilings of mass timber, including attached columns and beams, in any dwelling unit or fire area shall be permitted in accordance with Section 602.4.2.2.3.

2. Mass timber columns and beams that are not an integral portion of walls or ceilings, respectively, shall be permitted to be unprotected without restriction of either aggregate area or separation from one another.



Credentials: Ankrom Moisan Architects

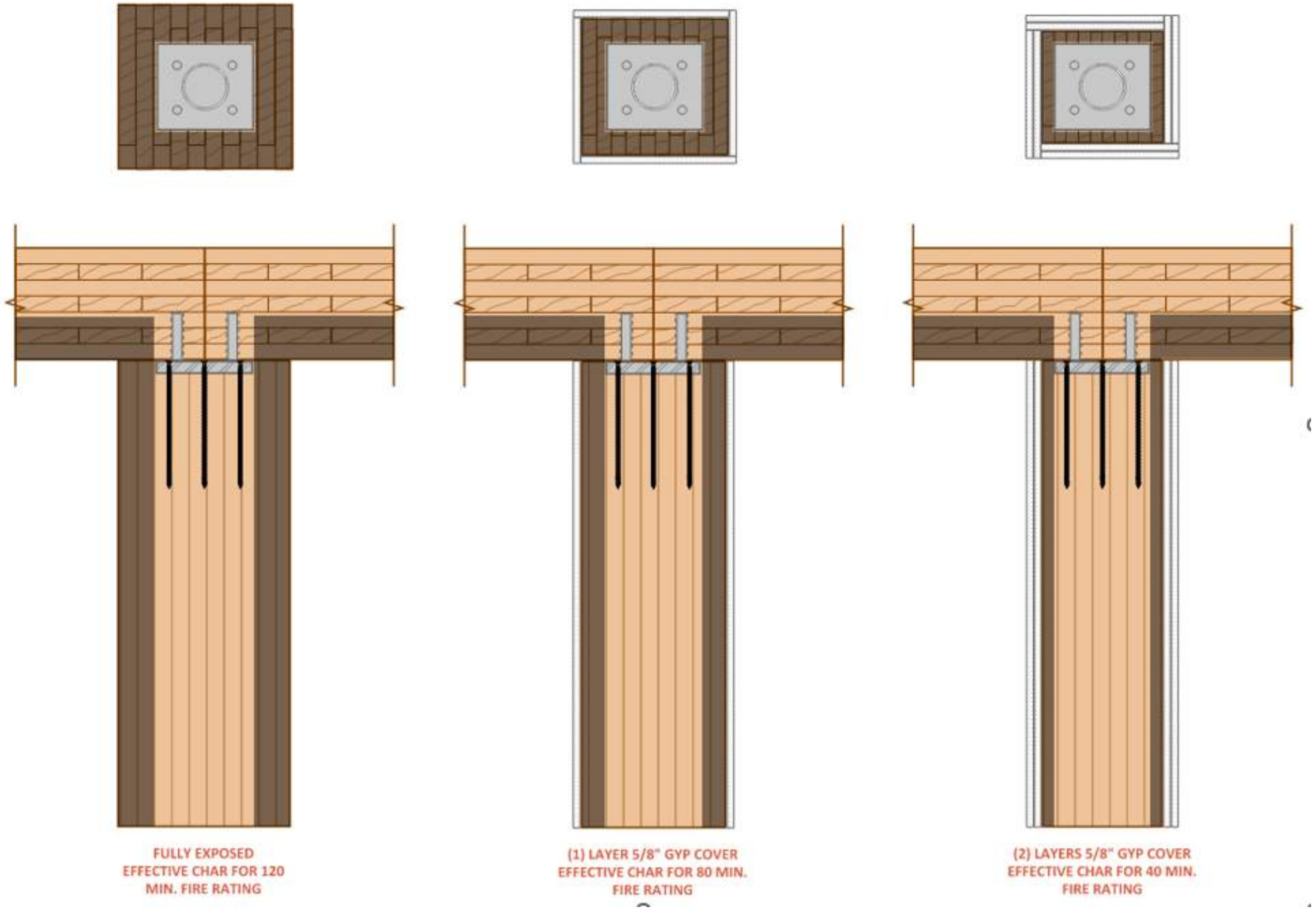
Connection Fire-Resistance Rating

FRR for connections in Type IV-A IV-B, or IV-C construction shall be determined by one of the following:

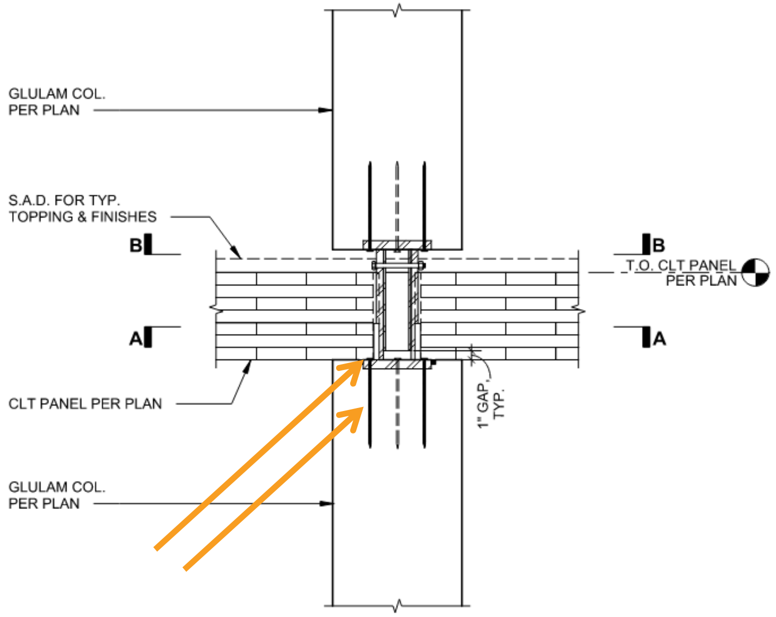
1. **Testing** in accordance with Section 703.2 where the connection is part of the fire resistance test.
2. **Engineering analysis** that demonstrates that the temperature rise at any portion of the connection is limited to an average temperature rise of 250°F (139°C) and a maximum temperature rise 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.

Mass Timber Metal Connectors (Fire Resistance)

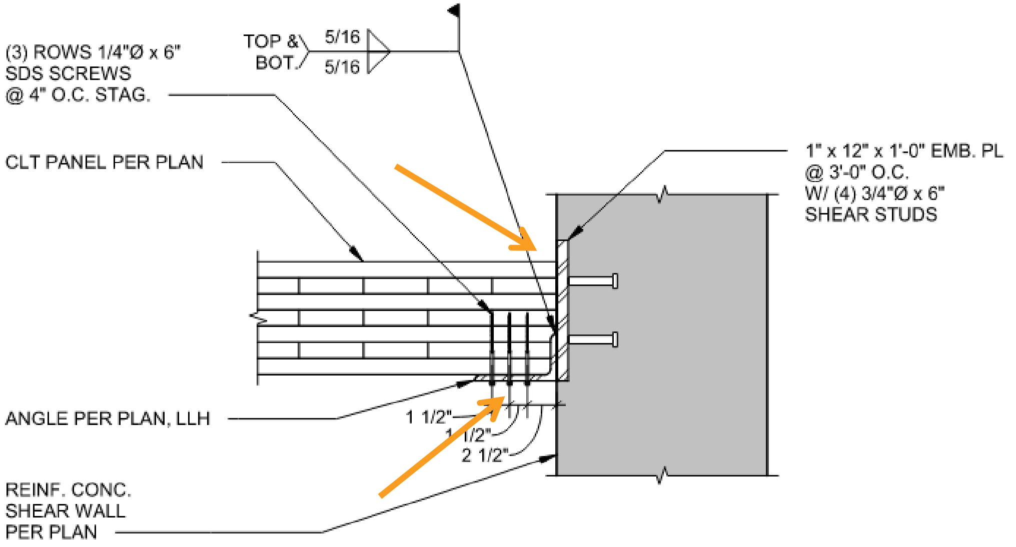


Connections



NOTE:
PANEL JOINTS SHALL BE LOCATED AT CENTER LINES OF GLULAM COLUMNS

3
S1.73
CLT PANEL TO GLULAM COLUMN CONNECTION
1" = 1'-0"



NOTES:
1. WALL REINF. NOT SHOWN FOR CLARITY
2. AT TOP OF WALL CONDITION, TOP OF EMB. PLATE TO BE FLUSH WITH T.O.C.

7
S7.11
TYPICAL CLT PANEL SUPPORT AT CONCRETE WALL
1" = 1'-0"

Thank you!

This concludes The American Institute of Architects Continuing Education Systems Course

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Platte Fifteen Oz Architecture photo JC Buck 17