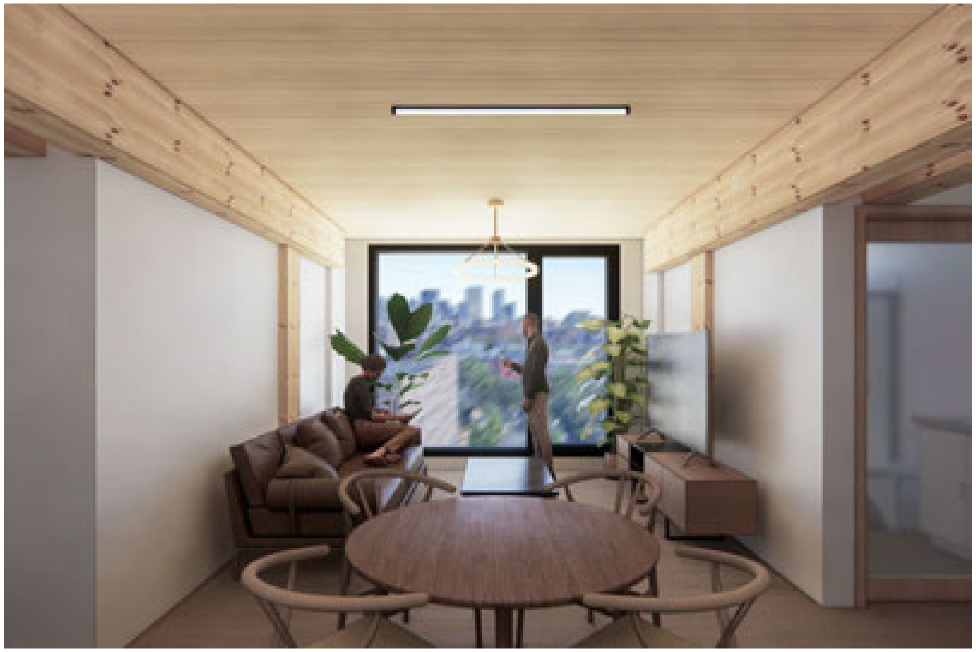
Mass Timber in Multi-Family Housing: Is It a Good Fit for Your Project?



Credit: Monte French Design Studio, Haycon

EMMY TRAN, PE | REGIONAL DIRECTOR

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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 often attached to the stigma of being more expensive than other building materials. Because of this, some people assume it only makes sense for one-off projects where innovation is celebrated but repeatability is not. Is this true, or do its other benefits result in overall cost efficiency? If it is true, how can we expect to build the number of new housing units needed across our country in a sustainable and affordable manner? Typical multi-family housing developments are in the range of 4-6 stories, often utilizing podium or pedestal construction with 1-2 stories of steel and concrete topped with 3-5 stories of light wood framing. Beyond these heights, building codes have historically required steel or concrete framing and, to justify the added costs of these materials, projects often go much taller. This has created a critical gap in housing developments in the range of 6-12 stories. Can mass timber multi-family projects make financial sense in the 4-6 story range, used in conjunction with light wood-frame systems? What new opportunities will the 2021 International Building Code create for mass timber housing in the 6-18 story range? This presentation will answer these questions and much more.

Learning Objectives

1. Evaluate the code opportunities for mass timber structures in residential mid-rise projects.
2. 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.
3. Review code requirements unique to hybrid mass timber and light-frame housing projects, and emphasize solutions for criteria such as construction type, fire-resistance ratings and acoustics design.
4. Highlight the unique benefits of using exposed mass timber in taller multi-family buildings.

Outline

- Introduction
- Multi-Family Typologies
- Construction Types
- Building Codes
- Key Design Considerations
  - MEP
  - Fire Design
  - Acoustics and Sound Control
  - Early Design Decisions Examples
- Final Considerations

Is Mass Timber a Good Fit for Your Multi-Family Project?

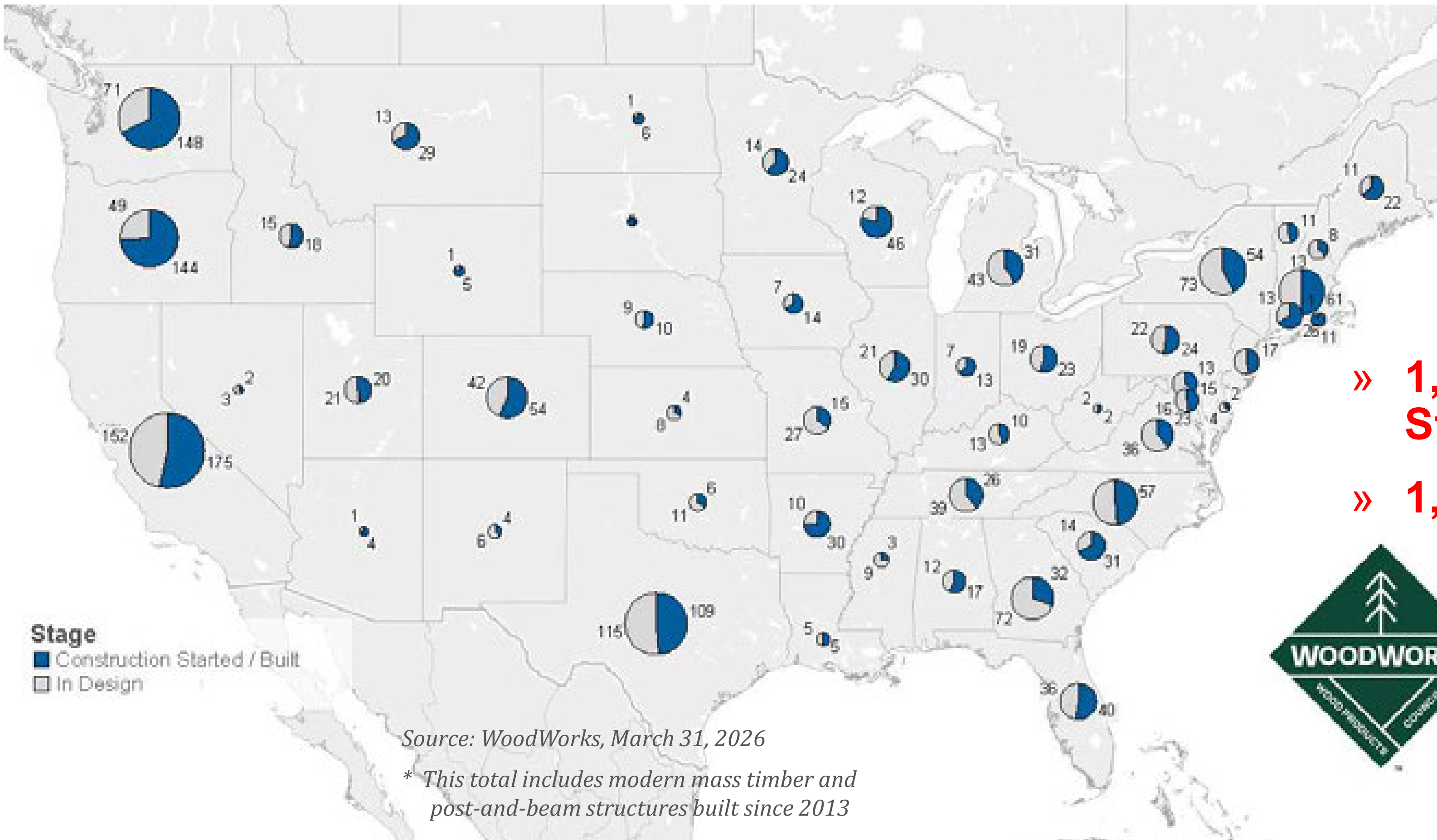
Ascent, Milwaukee, WI
Source: VRX Media Group

Current State of Mass Timber Projects

As of Q1 2026, in the US, **2,746** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.

Scan this code or use the url to find the map and more details online.

www.woodworks.org/resources/mapping-mass-timber/



Source: WoodWorks, March 31, 2026

* *This total includes modern mass timber and post-and-beam structures built since 2013*

- » **1,485 Construction Started / Built**
- » **1,261 In Design**

WOODWORKS

WOOD PRODUCTS COUNCIL

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- Final Considerations

Multi-Family Typologies

Credit: WGI

Low- and Mid-Rise Multi-Family

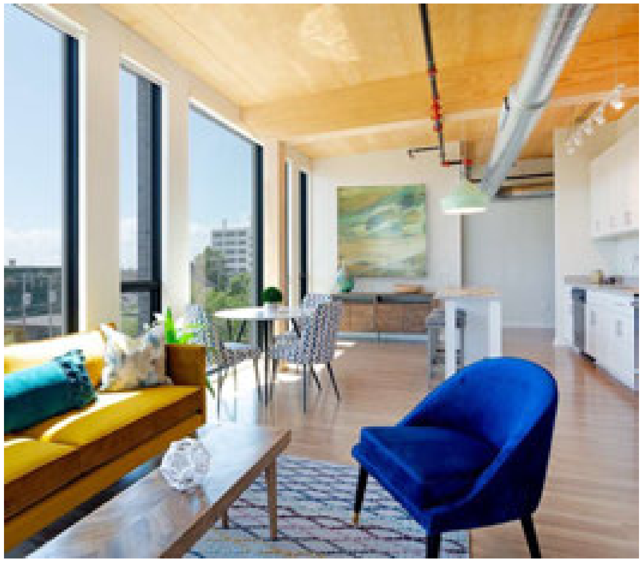
Credit: ADX Creative and Engberg Anderson

Multi-Family Typologies

MT Floors & Roofs on LWF Bearing Walls

Credit: KL&A Engineers & Builders

MT Floors & Roofs on Post & Beam Framing



Credit: ADX Creative and Engberg Anderson

MT Floors & Roofs on MT Bearing Walls

Credit: Grey Organschi Architecture and Spiritos Properties

Hybrid Light-Frame and Mass Timber

Photo: John Klein

Condominiums on the Marina at Lost Rabbit

Madison, MS

» First in Mississippi to use CLT
» Project was able to meet height requirements and have a third floor due to CLT

Photos: Andrew Welch

dunaway/WILLIAMS Architects
McQueen Structural Engineers

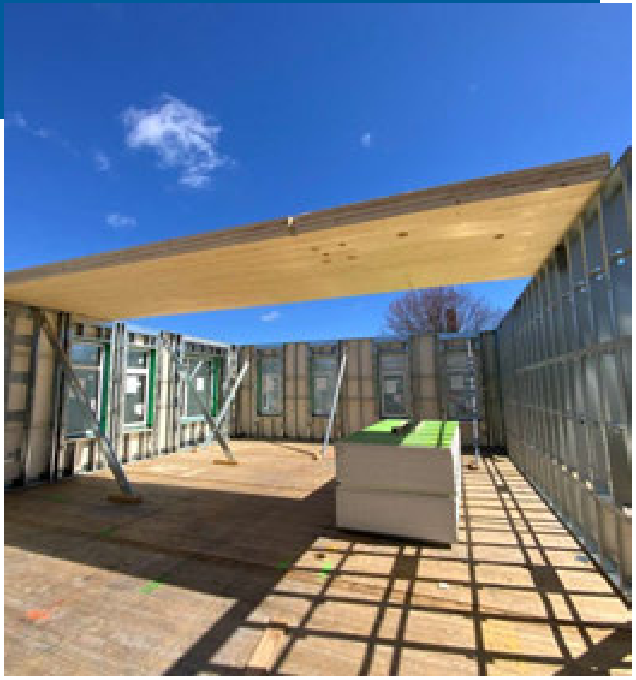
Bunker Hill Housing Redevelopment – Stellata

Boston, MA

» First of 15 residential buildings offering 2,699 units

» All buildings designed to Passive House standards

» Prefabricated Light-Gauge metal and CLT panels



Photos: Courtesy Stantec

Architect: Stantec
Engineer: McNamara • Salvia

Post & Beam

Photo: Ema Peter

Timber House

Brooklyn, NY

- 24,000 sf, 6 stories
- Type III-A

Photos: Travis Mark

MESH architectures
Silman

11 E Lenox

Boston, MA

- 7-story CLT multifamily project.
- Promoted as the first ground-up mass timber Passive House project in the City of Boston

Photos: Jane Messinger

Monte French Design Studio
H+O Structural Engineers

Mass Timber Bearing Walls

Photo: Lendlease

Candlewood Suites Redstone Arsenal

Redstone Arsenal, AL

- CLT utilized for walls, roof panels, and floor panels
- 1,557 CLT Panels; Typical floor panel is 8'x50' & weighs 8,000 lbs
- First U.S. Hotel built with CLT

Photos: Schaefer

Architect: Lendlease
Engineer: Schaefer

340+ Dixwell Ave

New Haven, CT

87,000 sf, 4 stories

Type V-A

Multi-Family

Completed 2024

WN PROFILE

Gray Organschi Architecture
WSP USA Building Structures
Photo: Gray Organschi Architecture

Outline

Construction Types

When does the code allow mass timber to be used in low- and mid-rise multi-family projects?

IBC defines mass timber systems in IBC Chapter 2 and notes their acceptance and manufacturing standards in IBC Chapter 23

Permitted anywhere that combustible materials and heavy timber are allowed, plus more

Construction Types

IBC defines 5 construction types: I, II, III, IV, V

A building must be classified as one of these

Construction Types I & II:

All elements required to be non-combustible materials

However, there are exceptions…

including several for mass timber

Construction Types

All wood framed building options:

Type III

Exterior walls non-combustible (may be FRTW)

Interior elements any allowed by code, including mass timber

Type V

All building elements are any allowed by code, including mass timber

Types III and V are subdivided to A (protected) and B (unprotected)

Type IV (Heavy Timber)

Exterior walls non-combustible (may be FRTW OR CLT)

Interior elements qualify as Heavy Timber (min. sizes, no concealed spaces except in 2021 IBC)

Where does the code allow MT to be used?

Type III: Interior elements (floors, roofs, partitions/shafts) and exterior walls if FRT

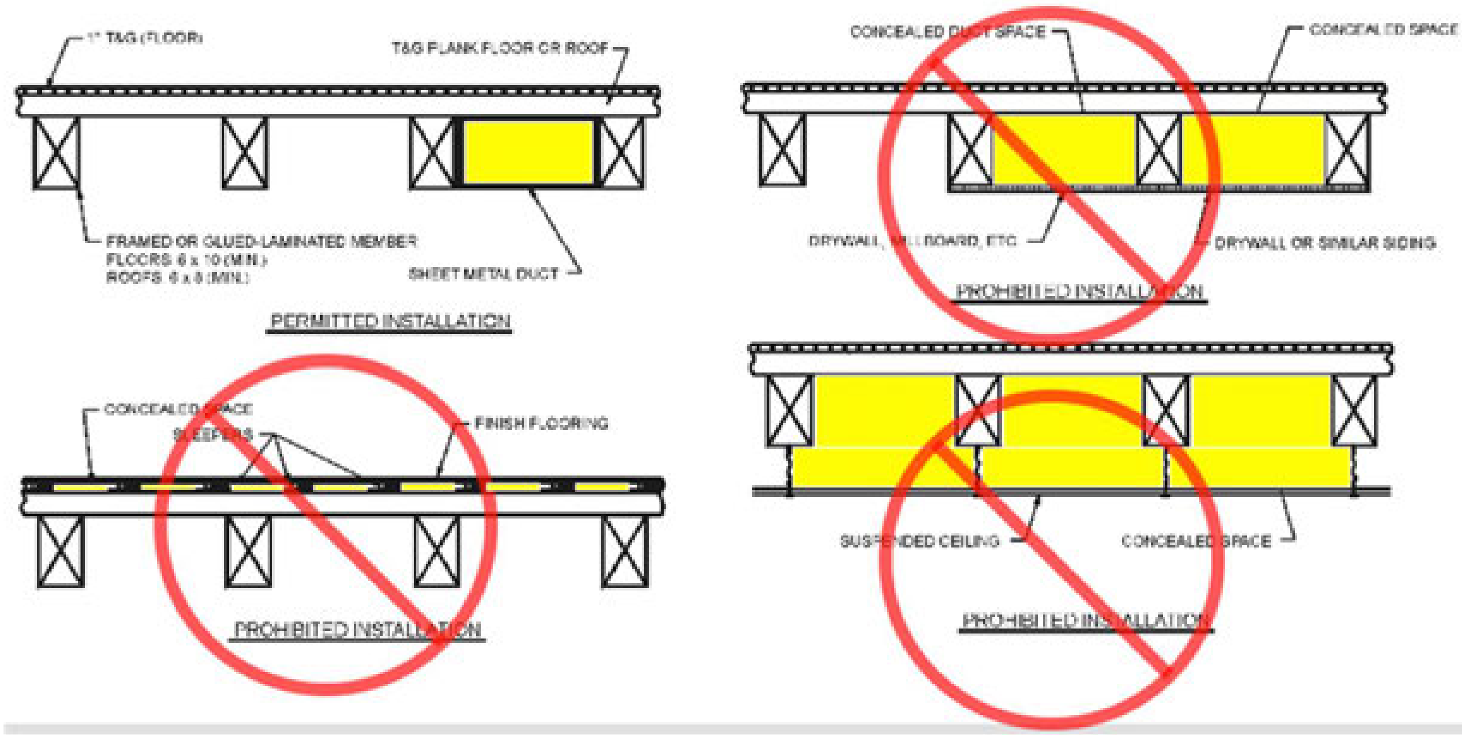
Type IV: Any exposed interior elements & roofs, must meet min. sizes; exterior walls if CLT or FRT. Concealed space limitations (varies by code version)

Image: Perkins + Will

ICE Block I, RMW Architecture & Interiors, Buehler Engineering, Bernard André Photography

Type IV concealed spaces

Until 2021 IBC, Type IV-HT provisions prohibited concealed spaces



Credit: IBC

Concealed spaces solutions paper

Richard McLain, PE, SE
Senior Technical Director – Tall Wood
WoodWorks – Wood Products Council

WOODWORKS

Concealed Spaces in Mass Timber and Heavy Timber Structures

Concealed spaces, such as those created by a dropped ceiling in a floor/ceiling assembly or by a stud wall assembly, have unique requirements in the International Building Code (IBC) to address the potential of fire spread in non-visible areas of a building. Section 718 of the 2018 IBC includes prescriptive requirements for protection and/or compartmentalization of concealed spaces through the use of draft stopping, fire blocking, sprinklers and other means. For information on these requirements, see the WoodWorks Q&A, *Are sprinklers required in concealed spaces such as floor and roof cavities in multi-family wood-frame buildings?*[1]

For mass timber building elements, the choice of construction type can have a significant impact on concealed space requirements. Because mass timber products such as cross-laminated timber (CLT) are prescriptively recognized for Type IV construction, there is a common misperception that exposed mass timber building elements cannot be used or exposed in other construction types. This is not the case.

In addition to Type IV buildings, structural mass timber elements—including CLT, glue-laminated timber (glulam), nail-laminated timber (NLT), structural composite lumber (SCL), and tongue-and-groove (T&G) decking—can be utilized and exposed in the following construction types, whether or not a fire-resistance rating is required:

- **Type III** – Floors, roofs and interior walls may be any material permitted by code, including mass timber; exterior walls are required to be noncombustible or fire retardant-treated wood.
- **Type V** – Floors, roofs, interior walls and exterior walls (i.e., the entire structure) may be constructed of mass timber.
- **Types I and II** – Mass timber may be used in select circumstances such as roof construction—including the primary frame in the 2021 IBC—in Types I-B, II-A or II-B; exterior columns and arches when 20 feet or more of horizontal separation is provided; and balconies, canopies and similar projections.

INTRO, Cleveland | Cleveland, Ohio
Harbor Bay Real Estate Advisors
HPA Architecture

The John W. Olver Design Building at UMass Amherst includes exposed wood structure in some areas and dropped ceilings in others. Architect: Leers Weinzapfel Associates

https://www.woodworks.org/wp-content/uploads/wood_solution_paper-Concealed_Spaces_Timber_Structures.pdf

Where does the code allow MT to be used?

Type V: All interior elements, roofs & exterior walls

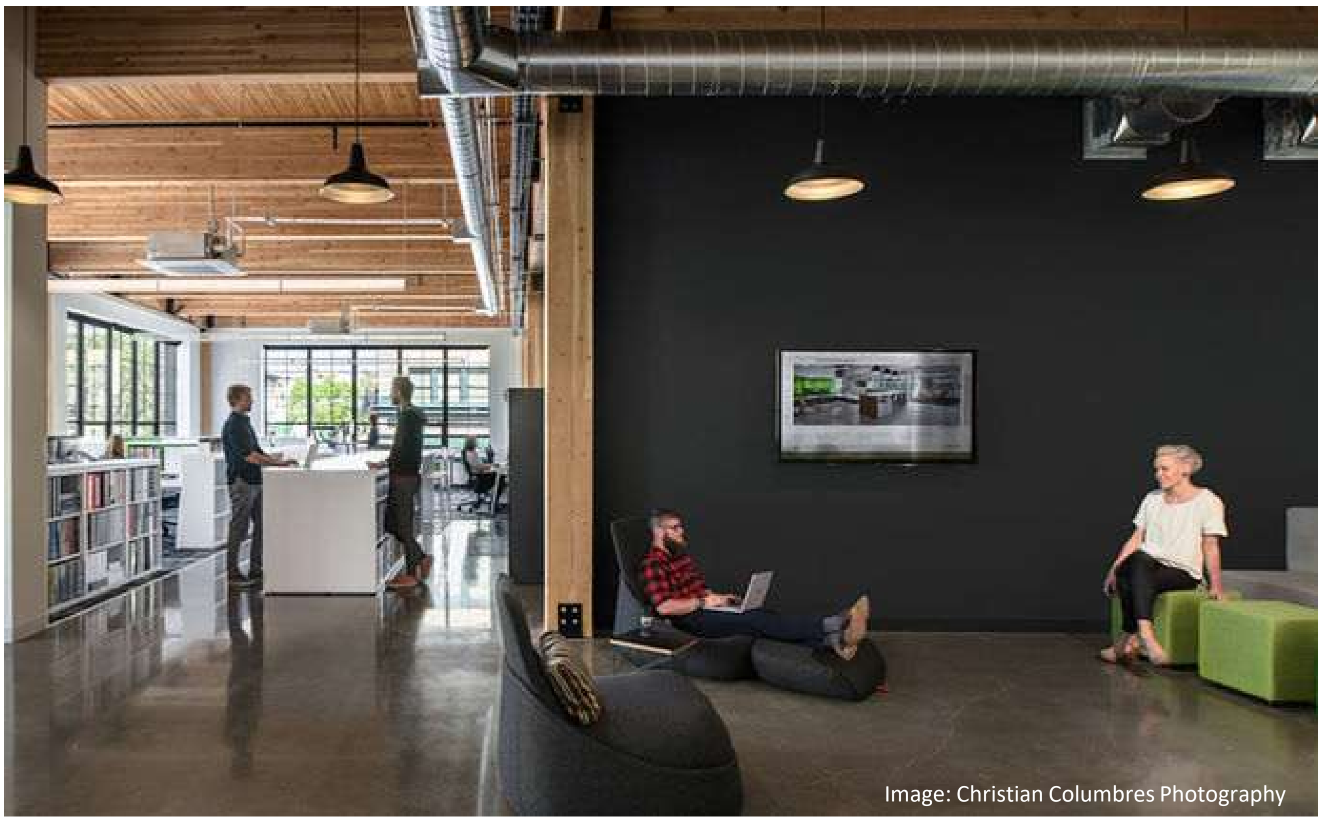


Image: Christian Columbres Photography

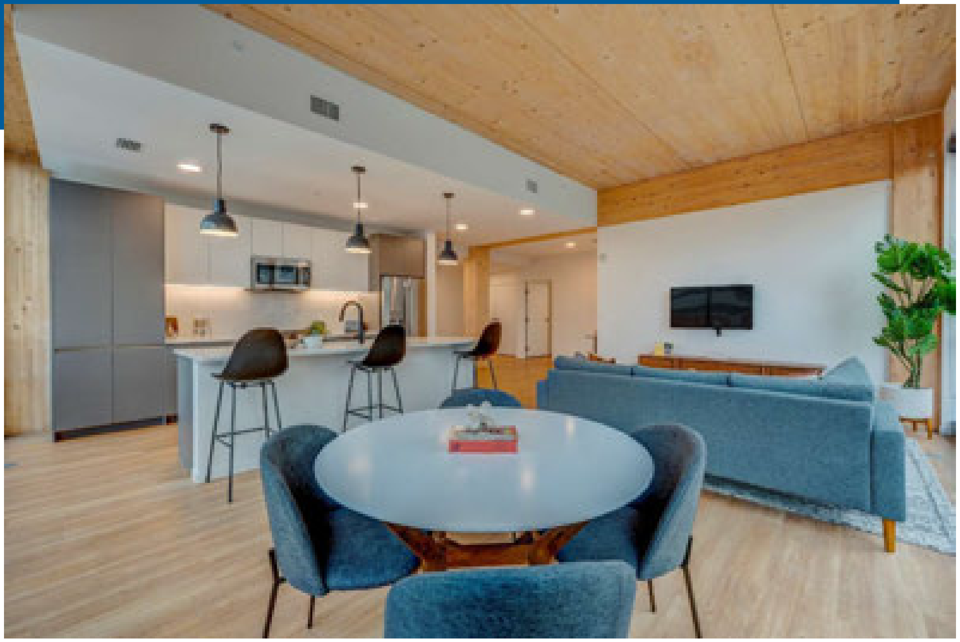
Tall Mass Timber Multi-Family

Ascent – Photo: CD Smith Construction

INTRO

Cleveland, OH

- One of the first to utilize new IV-B construction type.
- Worked with the city to expose 50% of MT ceilings.
- 8 Stories MT over 1-story podium



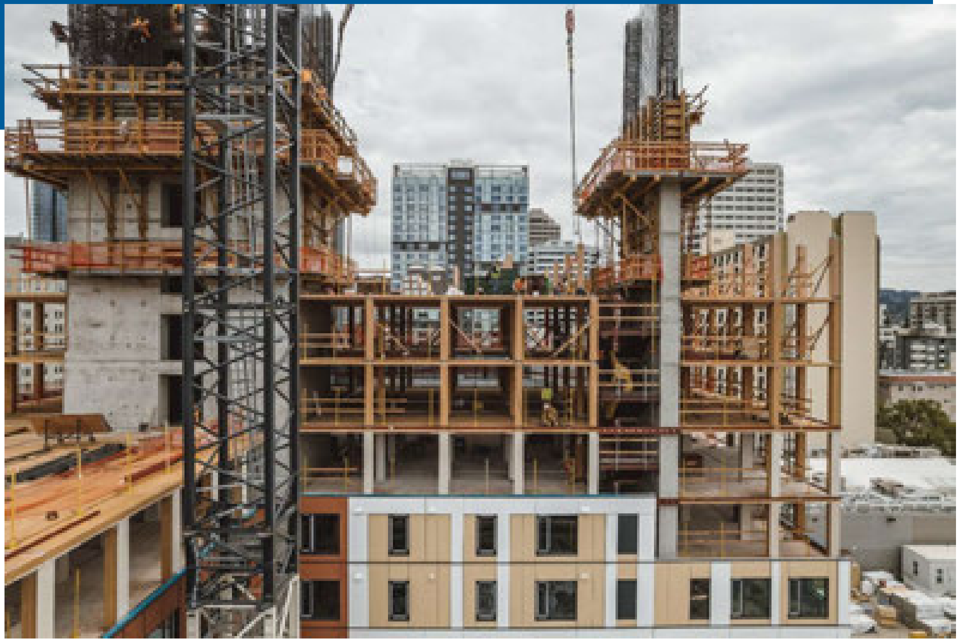
Photos: Nick Johnson, Tour D Space

Hartshorne Plunkard Architecture
Forefront Structural Engineers

1510 Webster

Oakland, CA

- 18 stories mass timber over one-level concrete
- Designed with Tall Wood code provisions in the 2021 IBC. Mass Timber with concrete cores and staircases.

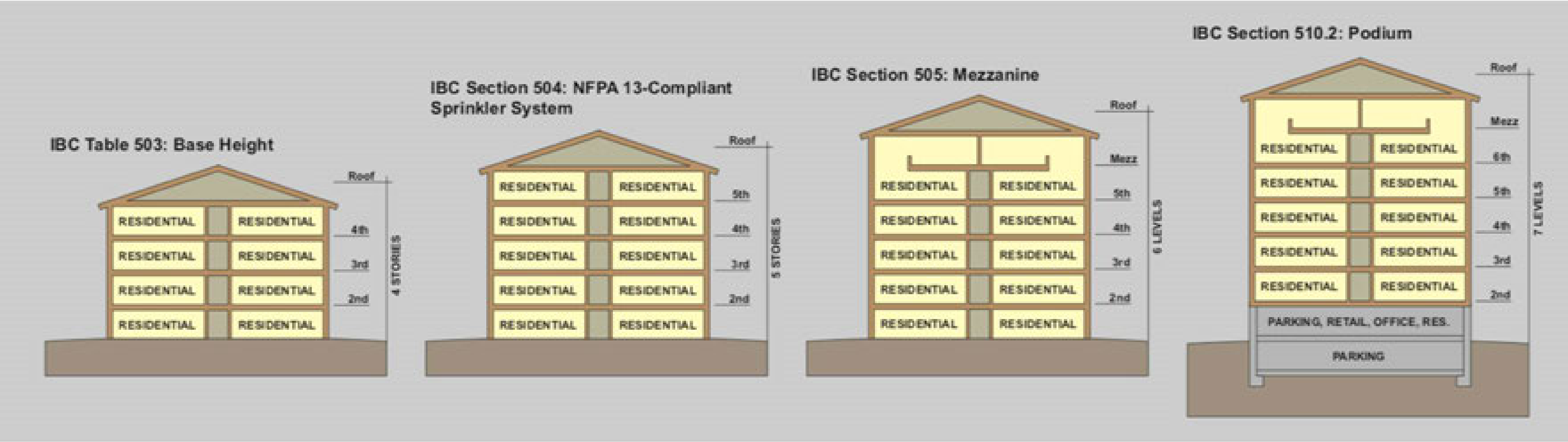


Photos: Flor Projects

oWow
DCI Engineers

Outline

Prescriptive Building Codes



3-Year Code Cycle

ICC INTERNATIONAL CODE COUNCIL®

Source: ICC

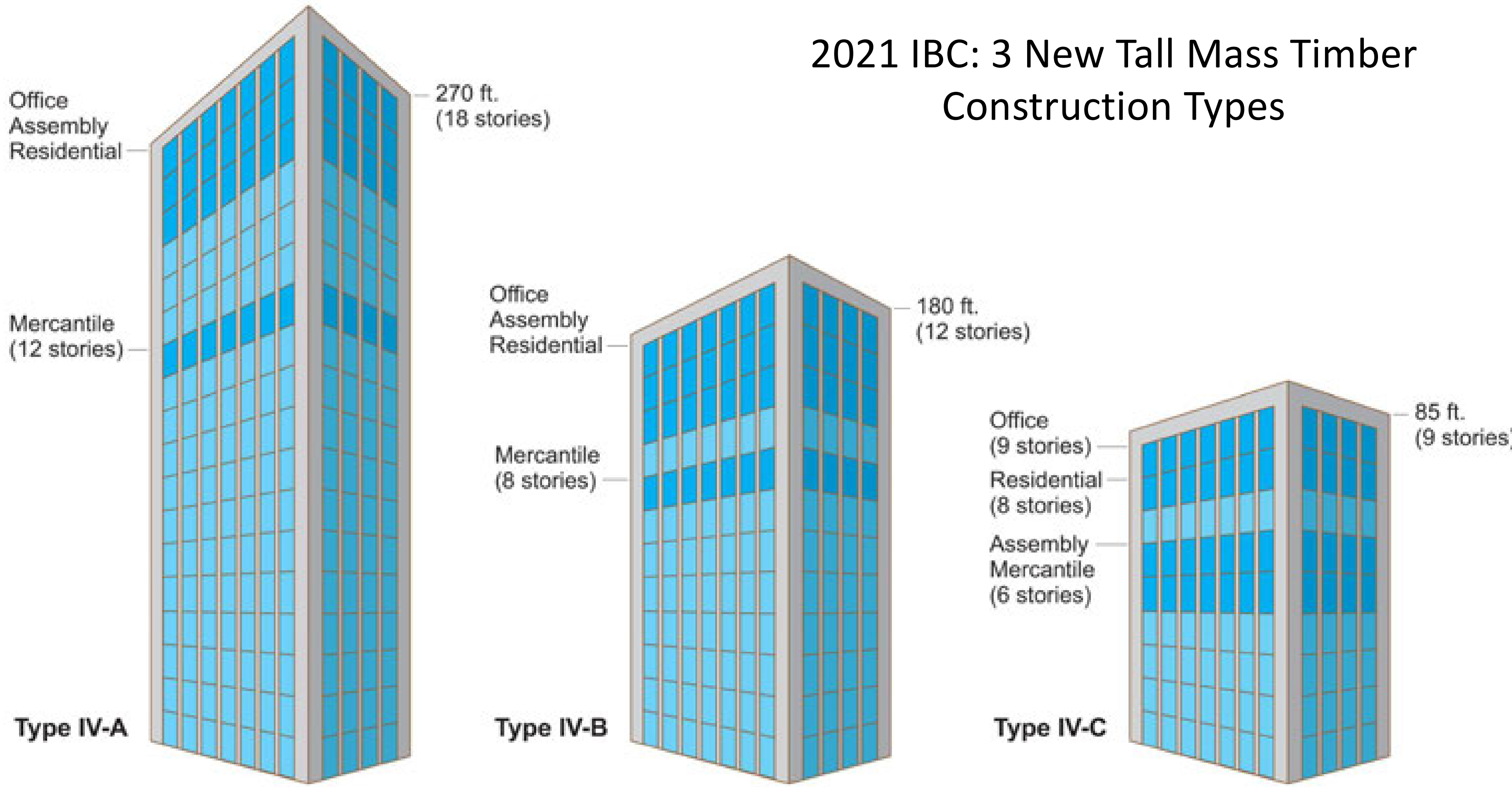
ATF Lab Tests, 2017
Photo: LendLease


ATF Lab Tests, 2017
Photo: LendLease


ATF Lab Tests, 2017
Photo: LendLease

Tall Mass Timber

2021 IBC: 3 New Tall Mass Timber Construction Types



Type IV-C Height and Area Limits

In most cases, Type IV-C height allowances = Type IV-HT height allowances, but additional stories permitted due to enhanced FRR

Type IV-C area = 1.25 * Type IV-HT area

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

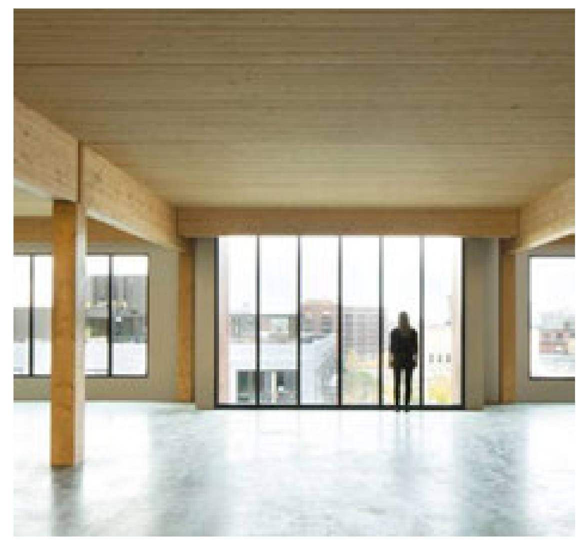
Type IV-C Protection vs. Exposed

All Mass Timber surfaces may be exposed

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

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path



Credit: Ema Peter

Type IV-B Height and Area Limits

In most cases, Type IV-B height & story allowances = Type I-B height & story allowances

Type IV-B area = 2 * Type IV-HT area

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

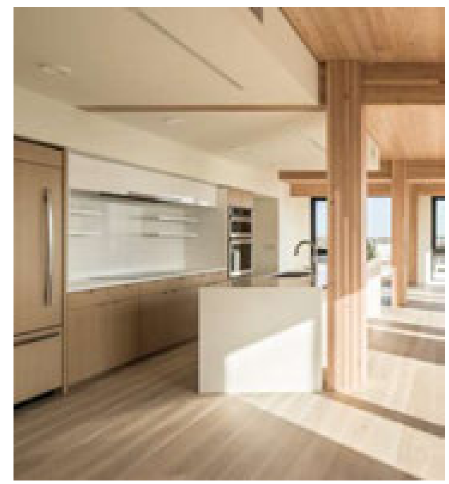
Areas exclude potential frontage increase

Type IV-B Protection vs. Exposed

NC protection on all surfaces of Mass Timber except limited exposed areas

~20% of Ceiling or ~40% of Wall can be exposed

Credit: Susan Jones, atelierjones



Credit: Kaiser+Path

Type IV-B Protection vs. Exposed

Limited Exposed MT allowed in Type IV-B for:

- MT beams and columns which are not integral part of walls or ceilings, no area limitation applies
- MT ceilings and beams up to 20% of floor area in dwelling unit or fire area, or
- MT walls and columns up to 40% of floor area in dwelling unit or fire area, or
- Combination of ceilings/beams and walls/columns, calculated as follows:

Credit: Kaiser+Path

Type IV-B Protection vs. Exposed

Mixed unprotected areas, exposing both ceilings and walls:

In each dwelling unit or fire area, max. unprotected area =

- $(U_{tc}/U_{ac}) + (U_{tw}/U_{aw}) \leq 1.0$
- U_{tc} = Total unprotected MT ceiling areas
- U_{ac} = Allowable unprotected MT ceiling areas
- U_{tw} = Total unprotected MT wall areas
- U_{aw} = Allowable unprotected MT wall areas

Credit: Kaiser+Path

Type IV-A Height and Area Limits

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

Credit: Susan Jones, atelierjones

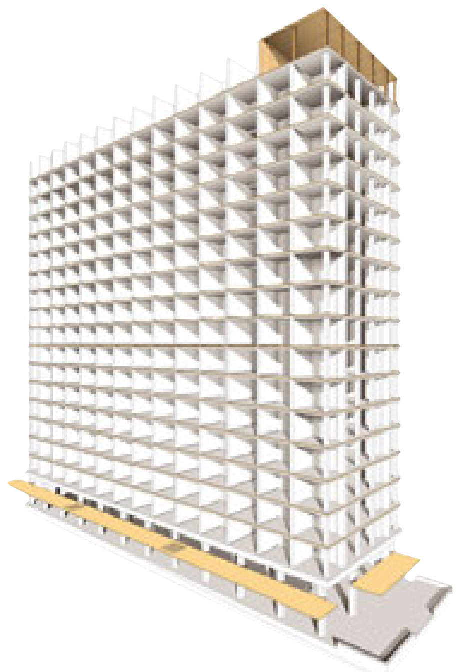
Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	18	270 ft	135,000 SF	405,000 SF
B	18	270 ft	324,000 SF	972,000 SF
M	12	270 ft	184,500 SF	553,500 SF
R-2	18	270 ft	184,500 SF	553,500 SF

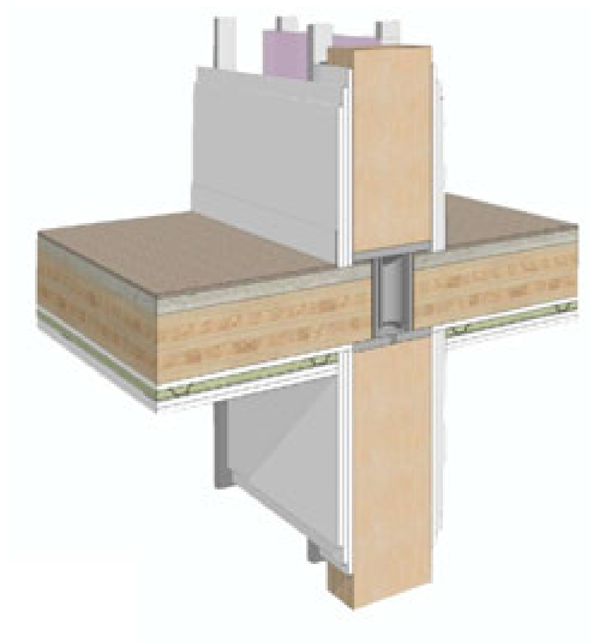
Areas exclude potential frontage increase

Type IV-A Protection vs. Exposed

100% NC protection on all surfaces of Mass Timber

Credit: Susan Jones, atelierjones





Credit: Acton Ostry Architects, Fast + Epp

Type IV-C

Type IV-C

Type IV-B

Type IV-B

Type IV-A

Outline

- » Introduction
- » Multi-Family Typologies
- » Construction Types
- » Building Codes
- Key Design Considerations
  - MEP
  - » Fire Design
  - » Acoustics and Sound Control
  - » Early Design Decisions Example
- » Final Considerations

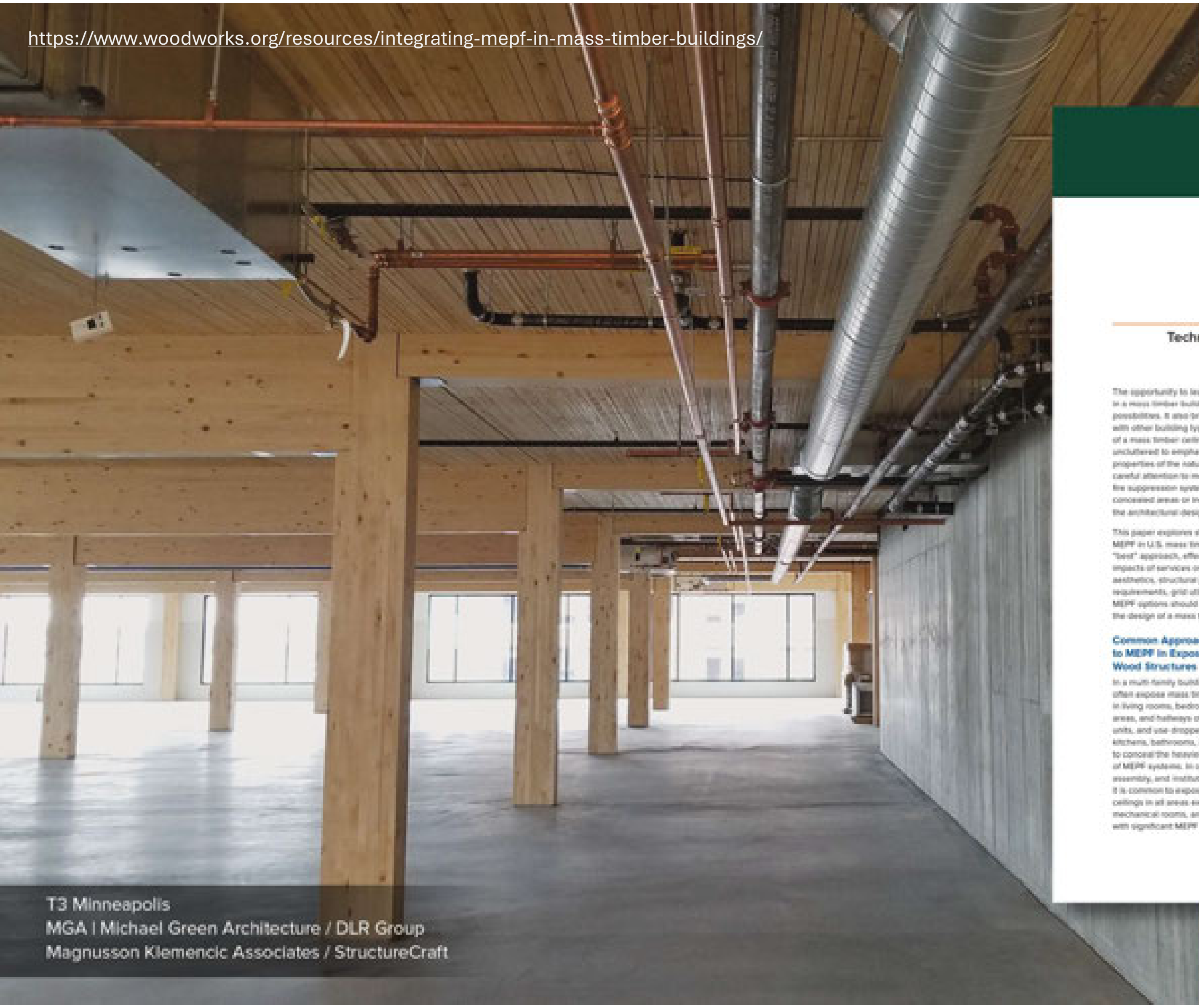
MEP Layout & Integration

Key considerations:

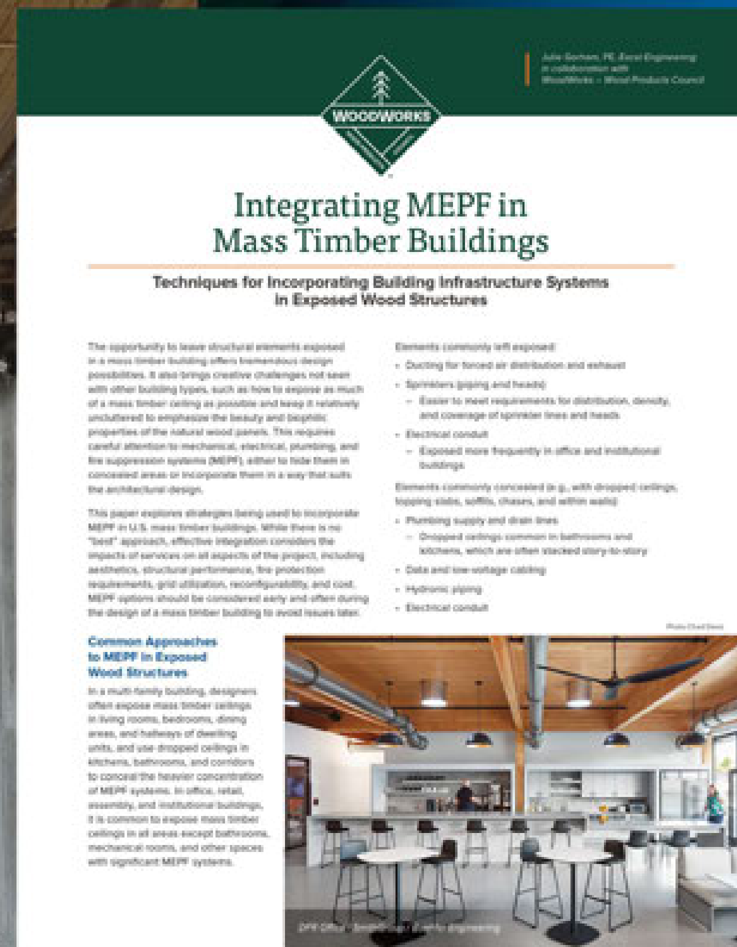
- Level of exposure desired
- Floor to floor, structure depth & desired head height
- Building occupancy and configuration (i.e. central core vs. double loaded corridor)
- Grid layout and beam orientations
- Need for future tenant reconfiguration
- Impact on fire & structural design: concealed spaces, penetrations

Credit: WoodWorks

https://www.woodworks.org/resources/integrating-mepf-in-mass-timber-buildings/



T3 Minneapolis
MGA | Michael Green Architecture / DLR Group
Magnusson Klemencic Associates / StructureCraft



WOODWORKS

Integrating MEPF in Mass Timber Buildings

Techniques for Incorporating Building Infrastructure Systems in Exposed Wood Structures

The opportunity to leave structural elements exposed in a mass timber building offers tremendous design possibilities. It also brings creative challenges not seen with other building types, such as how to expose as much of a mass timber ceiling as possible and keep it relatively uncluttered to emphasize the beauty and biophilic properties of the natural wood panels. This requires careful attention to mechanical, electrical, plumbing, and fire suppression systems (MEPF), either to hide them in concealed areas or incorporate them in a way that suits the architectural design.

This paper explores strategies being used to incorporate MEPF in U.S. mass timber buildings. While there is no "best" approach, effective integration considers the impacts of services on all aspects of the project, including aesthetics, structural performance, fire protection requirements, grid utilization, reconfigurability, and cost. MEPF options should be considered early and often during the design of a mass timber building to avoid issues later.

Elements commonly left exposed:

- Ducting for forced air distribution and exhaust
- Sprinklers (piping and heads)
  - Easier to meet requirements for distribution, density, and coverage of sprinkler lines and heads
- Electrical conduit
  - Exposed more frequently in office and institutional buildings

Elements commonly concealed (e.g., with dropped ceilings, topping slabs, soffits, chases, and within walls):

- Plumbing supply and drain lines
  - Dropped ceilings common in bathrooms and kitchens, which are often stacked story-to-story
- Data and low-voltage cabling
- Hydronic piping
- Electrical conduit

Common Approaches to MEPF in Exposed Wood Structures

In a multi-family building, designers often expose mass timber ceilings in living rooms, bedrooms, dining areas, and hallways of dwelling units, and use dropped ceilings in kitchens, bathrooms, and corridors to conceal the heavier concentration of MEPF systems. In office, retail, assembly, and institutional buildings, it is common to expose mass timber ceilings in all areas except bathrooms, mechanical rooms, and other spaces with significant MEPF systems.

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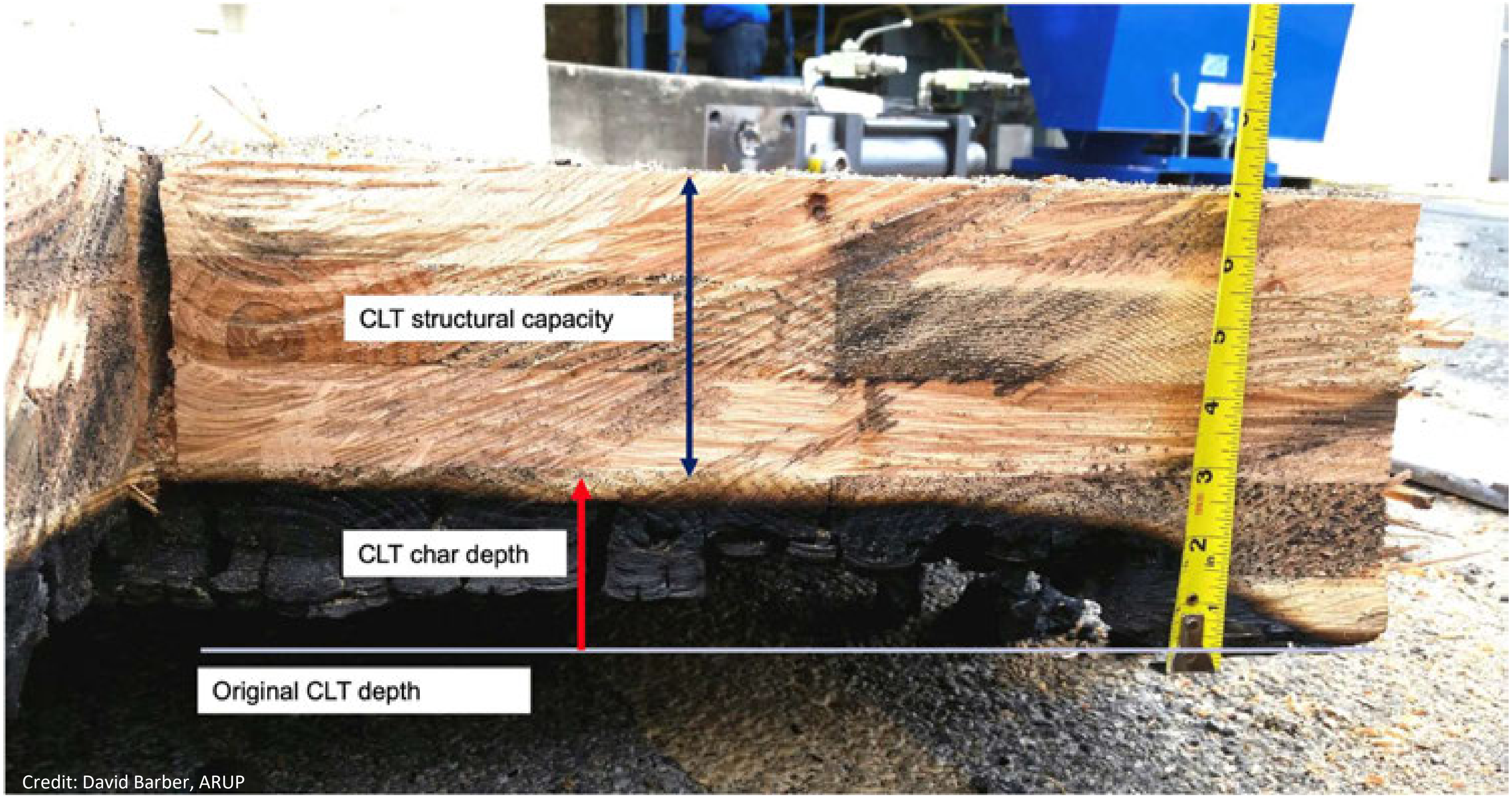
Fire Design of Mass Timber



Fire Resistance Ratings (FRR)

- Driven primarily by construction type
- Rating achieved through timber alone or non-combustible protection required?

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[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[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

Fire Resistance Ratings (FRR)

- Thinner panels (i.e. 3-ply) generally difficult to achieve a 1+ hour FRR
- 5-ply CLT / 2x6 NLT & DLT panels can usually achieve a 1- or 2-hour FRR
- Construction Type | FRR | Member Size | Grid (or re-arrange that process but follow

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

Credit: David Barber, ARUP

Construction Type Influences FRR

- Type IV-HT Construction (minimum sizes)
- Other than type IV-HT: Demonstrated fire resistance

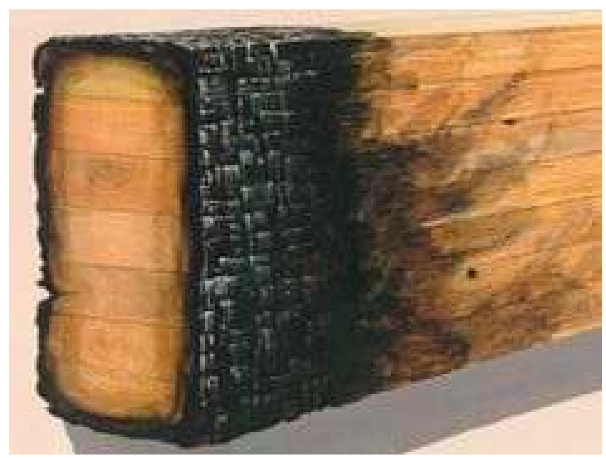
Method of demonstrating FRR (calculations or testing) can impact member sizing


Fire Testing Laboratory

TEST REPORT

American Wood Council

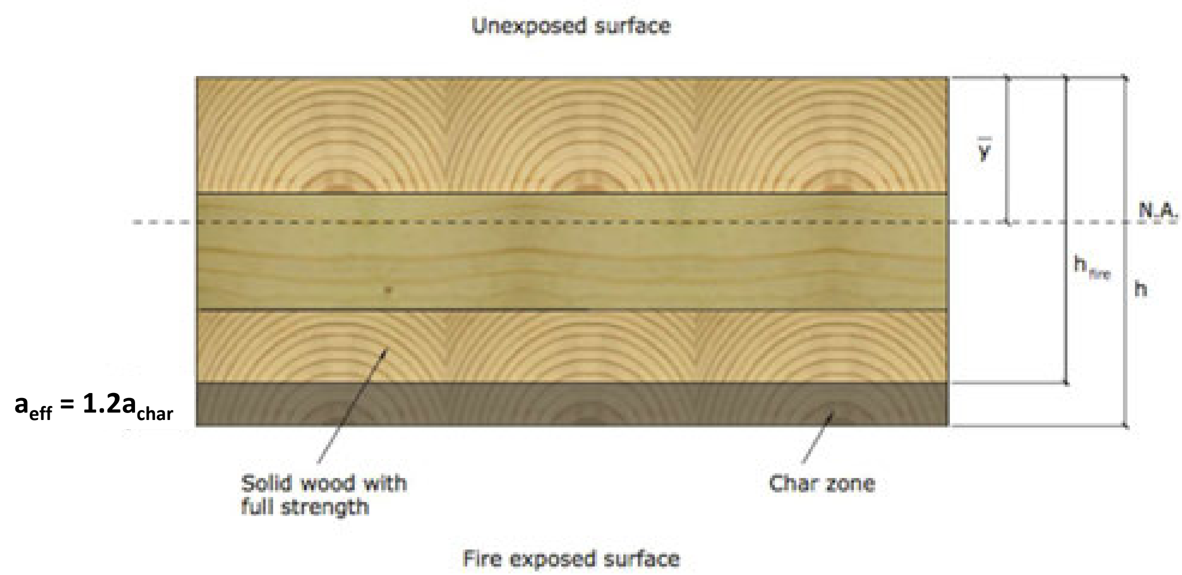
Standard Methods of
Fire Tests of Building Construction and Materials



Which Method of Demonstrating FRR of MT to Use?

1. Calculations in Accordance with IBC 722 ➔ NDS Chapter 16
2. Tests in Accordance with ASTM E119

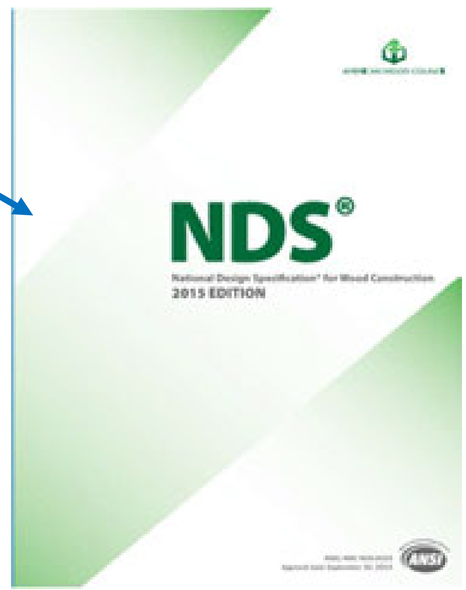
Credit: Urban One



FRR Design of Mass Timber

Calculated FRR of Exposed MT:

IBC 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.

FRR Design of Mass Timber

Nominal char rate of 1.5”/HR is recognized in NDS. Effective char depth calculated to account for duration, structural reduction in heat-affected zone

Credit: ARUP

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

Table 16.2.1B Effective Char Depths (for CLT with β_n=1.5in./hr.)

Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, h_{lam} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

NEW ONLINE TOOL

Mass Timber Fire & Acoustic Database

Search tested and approved assemblies

https://www.woodworks.org/mass-timber-fire-acoustic-database/

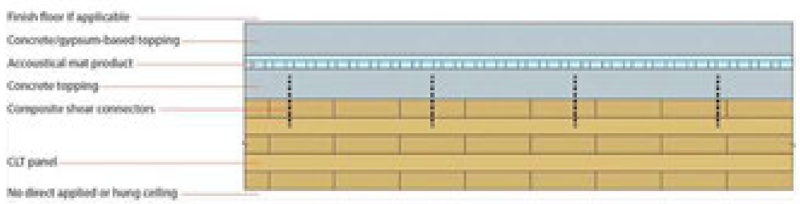
< Back to Mass Timber Fire & Acoustic Database

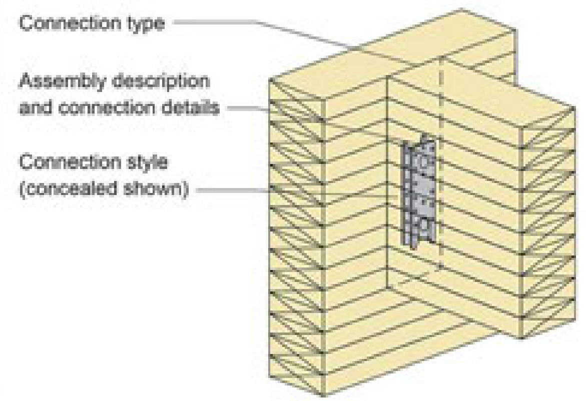
Assembly Type
- ☐ Floor/Roof 532
- ☐ Wall 147

Application Type
- ☐ CLT/Concrete Composite 7
- ☐ Concealed Ceiling 201
- ☐ Concrete/Gypsum Topping 138
- ☐ Other 108
- ☐ Raised Access Floor or Wood Sleepers 78

Mass Timber Panel
- ☐ CLT 507
- ☐ CLT (SCL) 56
- ☐ NLT 72
- ☐ DLT 22

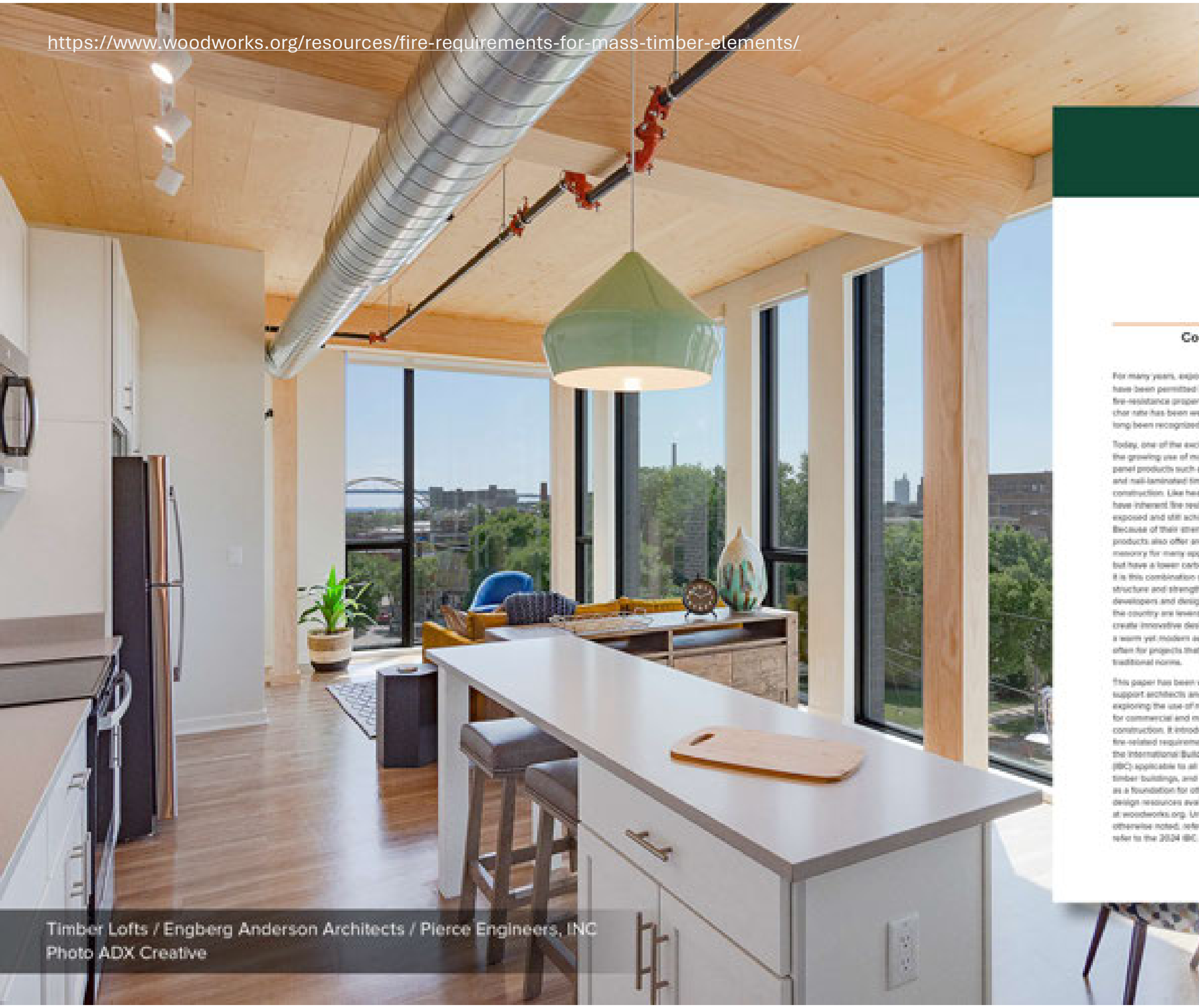
CLT-Concrete Composite Floor Assemblies, Ceiling Side Exposed





Mass Timber Panel	Topping	Acoustical Mat Products Between Concrete Composite and Upper Topping	Upper Topping	Finish Floor	Sound Rating	Impact Rating	Method of Compliance
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® 3/8	1" Gyp-Crete®	52	STC	50 IIC	Maxxon / Intertek Report # K3094.97-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® 3/8	1" Gyp-Crete®	53	STC	52 IIC	Maxxon / Intertek Report # K3094.69-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® SBR over Maxxon Acousti-Mat® 3/4 Premium	1.5" Gyp-Crete®	56	STC	57 IIC	Maxxon / Intertek Report # K3094.98-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® SBR over Maxxon Acousti-Mat® 3/4 Premium	1.5" Gyp-Crete®	57	STC	61 IIC	Maxxon / Intertek Report # K4507.06-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® SBR over Maxxon Acousti-Mat® 3/4 Premium	2" Gyp-Crete®	60	STC	61 IIC	Maxxon / Intertek Report # K3094.86-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® SBR over Maxxon Acousti-Mat® 3/4 Premium	2" Gyp-Crete®	58	STC	63 IIC	Maxxon / Intertek Report # K3094.86-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	5/8" OSB on 5/8" Georgia Pacific Dens Deck® on Kinetics® Ultra Quiet SR	None	60	STC	62 IIC	Veneklasen Associates / Intertek Report # K3094.19-113-11-R0 Contact Product Manufacturer for More Information

https://www.woodworks.org/resources/fire-requirements-for-mass-timber-elements/



Timber Lofts / Engberg Anderson Architects / Pierce Engineers, INC
Photo ADX Creative

Scott Breneman, PhD, PE, SE
WoodWorks – Wood Products Council

WOODWORKS

Fire Requirements for Mass Timber Elements

Code Applications, Construction Types, and Fire Ratings

For many years, exposed heavy timber framing elements have been permitted in U.S. buildings due to their inherent fire-resistance properties. The predictability of wood's char rate has been well-established for decades and has long been recognized in building codes and standards.

Today, one of the exciting trends in building design is the growing use of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall, and roof construction. Like heavy timber, mass timber products have inherent fire resistance that allows them to be left exposed and still achieve a fire-resistance rating (FRR). Because of their strength and dimensional stability, these products also offer an alternative to steel, concrete, and masonry for many applications, but have a lower carbon impact. It is this combination of exposed structure and strength that developers and designers across the country are leveraging to create innovative designs with a warm yet modern aesthetic, often for projects that go beyond traditional norms.

This paper has been written to support architects and engineers exploring the use of mass timber for commercial and multi-family construction. It introduces fire-related requirements in the International Building Code (IBC) applicable to all mass timber buildings, and serves as a foundation for other fire design resources available at woodworks.org. Unless otherwise noted, references refer to the 2024 IBC.

Mass Timber & Construction Type

Before demonstrating FRRs of exposed mass timber elements, it is important to understand under what circumstances the IBC currently allows the use of mass timber in commercial and multi-family construction.

A building's assigned construction type is the main indicator of where and when all wood systems can be used. IBC Section 602 defines five main options (Type I through V). Types I, II, III, and V have subcategories A and B, while Type IV has subcategories IV-HT, IV-A, IV-B, and IV-C. Types III, IV, and V permit the use of wood framing throughout much of the structure and are used extensively for modern mass timber buildings.

T3 RiNo | Denver, CO

https://www.woodworks.org/resources/fire-design-of-mass-timber-structural-members/

Scott Breneman, PhD, PE, SE
WoodWorks – Wood Products Council

WOODWORKS

Fire Design of Mass Timber Structural Members

Demonstrating Fire-Resistance Ratings of Mass Timber Products

Traditionally, the role of the structural engineer on building projects has focused on structure-related tasks—member sizing, connection detailing, general notes, and specifications for structural components. Design criteria such as fire-resistance ratings (FRRs), acoustics, and aesthetics have primarily been the architect's domain. However, when it comes to mass timber, the structure often contributes to the building's passive fire resistance. This can happen when the structure is functioning as an exposed finish or when partial fire resistance is provided by a covering over the timber and the rest is provided by the timber itself. This combination of structure, finish, and fire resistance makes the mass timber design process a necessarily collaborative effort between architect and engineer.

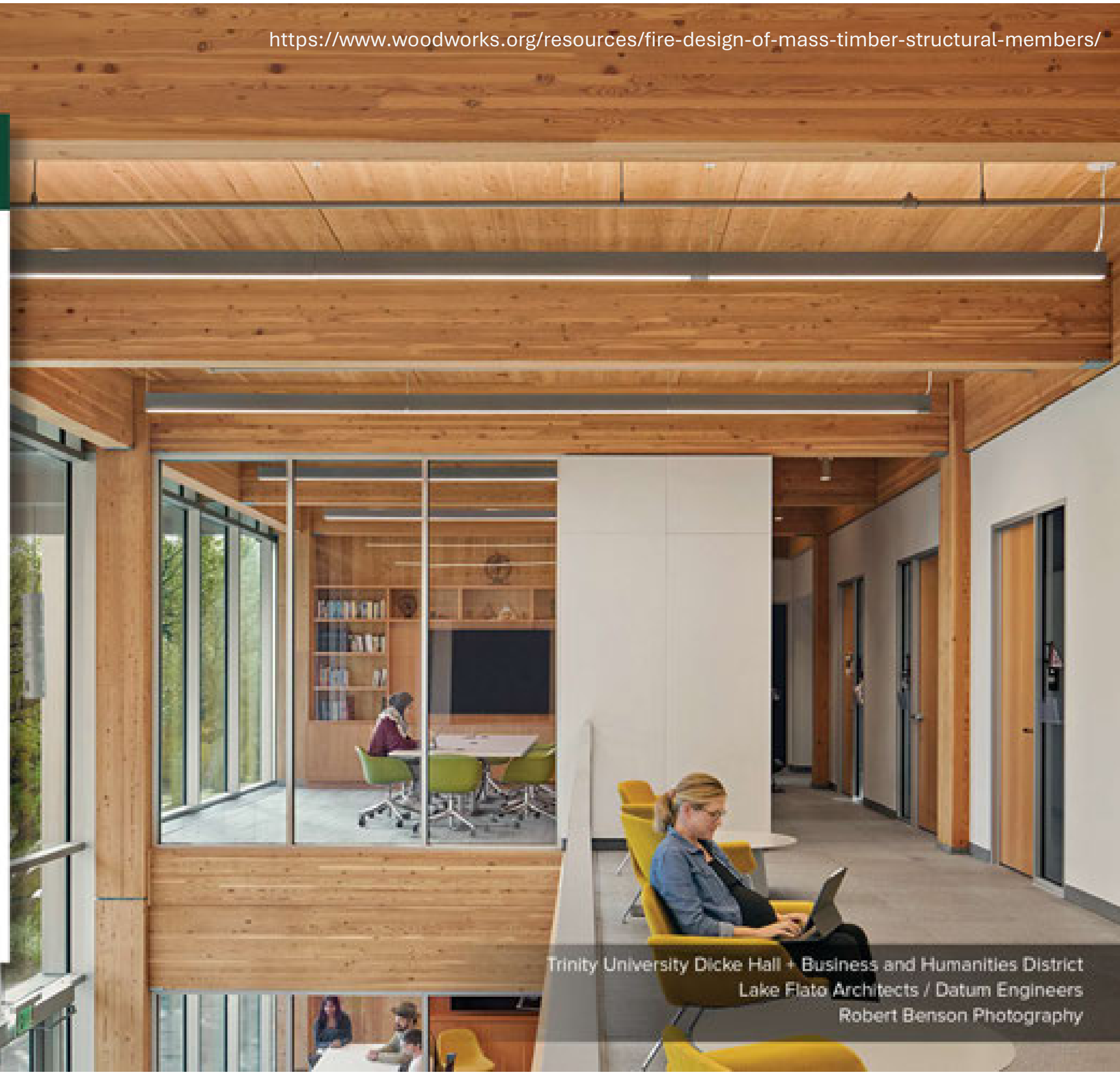
This paper presents several methods for demonstrating the FRR of a mass timber element, particularly when the mass timber structural members are required to be fire-resistance-rated. These elements include horizontal assemblies (floors, roofs) and walls, which serve both structural and fire containment purposes, and structural members such as beams and columns where the purpose is mainly structural. While much of the information is introductory, it covers how to evaluate the suitability of tested horizontal cross-laminated timber (CLT) assemblies with reduced load ratings for different spans and loading conditions and the different models for calculating structural FRRs of nail-laminated timber (NLT).

Sources of FRR Requirements

For buildings designed under the International Building Code (IBC), construction type is one of the major determinants of which timber products can be used, whether the timber products can be left exposed to view, and the FRR requirements for building elements, including those constructed with mass timber products. For information on selecting construction type and determining the FRR of building elements, see the IBC and the WoodWorks publication, *Fire Requirements for Mass Timber Elements – Code Applications, Construction Types, and Fire Ratings*. The latter provides a detailed review of the sources and types of fire requirements applicable to mass timber buildings.

Generally, the IBC requires lower FRRs for smaller buildings and higher FRRs for larger buildings. Using business occupancies (B) as an example, unrated construction is allowed in some buildings up to four stories (Type III-B), and 1-hour-rated construction is permitted in some buildings up to six stories (Type III-A). For the newer Type IV-C and IV-B construction types, which can be a

Robert Benson Photography



Trinity University Dicke Hall + Business and Humanities District
Lake Flato Architects / Datum Engineers
Robert Benson Photography

David Barber, MS, PEng
CHM Fire
Scott Breneman, PhD, PE, SE
WoodWorks – Wood Products Council

WOODWORKS

Fire Design of Mass Timber Connections

Requirements and Compliance Strategies

Introduction

This paper introduces the design of mass timber connections for fire resistance. It is intended for architects and engineers with limited experience in this type of connection design and describes pathways for compliance under the International Building Code (IBC), connection types, and methods for determining a fire-resistance rating (FRR). References are to the 2024 IBC and may be applicable to other editions.

For a more comprehensive look at the fire design of mass timber buildings, see the WoodWorks publications, *Fire Requirements for Mass Timber Elements: Code Applications, Construction Types, and Fire Ratings* and *Fire Design of Mass Timber Structural Members: Demonstrating Fire-Resistance Ratings of Mass Timber Products*.

Fire-Resistance Ratings and Connections

A fire-resistance rating is a quantified measure of how long a building component or assembly—such as a wall, floor, beam, or column—can continue to function when subjected to a controlled fire exposure. Established through laboratory tests following standards like ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials and UL 263 Standard for Fire Tests of Building Construction and Material, FRRs reflect the component or assembly's ability to resist heat, prevent flame and hot gas passage, and, when applicable, support applied loads for a defined period, typically expressed in hours. The tests simulate fire conditions using a standard time-temperature curve, and tested assemblies are required to meet performance thresholds for structural stability and thermal protection. These ratings are essential standardized benchmarks in building codes, guiding design decisions to improve occupant safety and limit fire damage.

IBC Section 704 provides FRR requirements specific to structural members. This section does not explicitly mention connections; however, it states that the FRR of a structural member "shall not be less than the ratings required for the fire-resistance-rated assemblies supported by the structural members." For connections between fire-resistance-rated structural members, the connection needs fire protection that achieves at least the same FRR as the supported member(s).

Other sections of the IBC have FRR requirements that apply to structural members based on aspects of the project such as construction type (Table 601), occupancy separations (Section 508), dwelling unit separations (Section 420.1), and support of horizontal assemblies (Section 711).

If a connection has a fire protection requirement, the two main paths for demonstrating fire resistance of the connection assembly are the same as for structural members: testing and approved analytical methods.

T(De-Horn / SKS Partners / Perkins&Will / DCI Engineers

Outline

- » Introduction
- » Multi-Family Typologies
- » Construction Types
- » Building Codes
- Key Design Considerations
  - » MEP
  - » Fire Design
  - Acoustics and Sound Control
  - » Early Design Decisions Example
- » Final Considerations

Acoustics & Sound Control

Consider Impacts of:

» Timber & Topping Thickness

» Panel Layout

» Gapped Panels

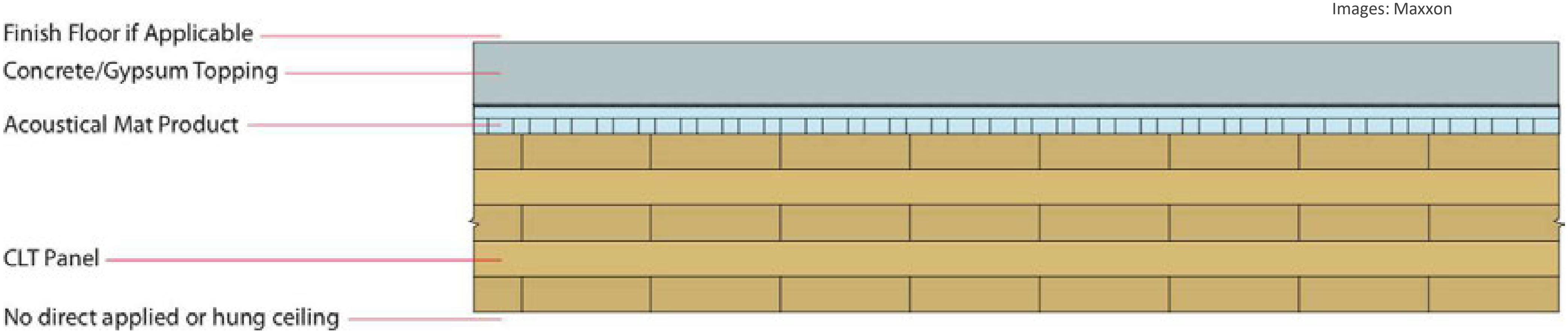
» Connections & Penetrations

» MEP Layout & Type

Credit: Rothoblaas

Acoustics & Sound Control

Images: Maxxon



Code requirements only address residential occupancies:

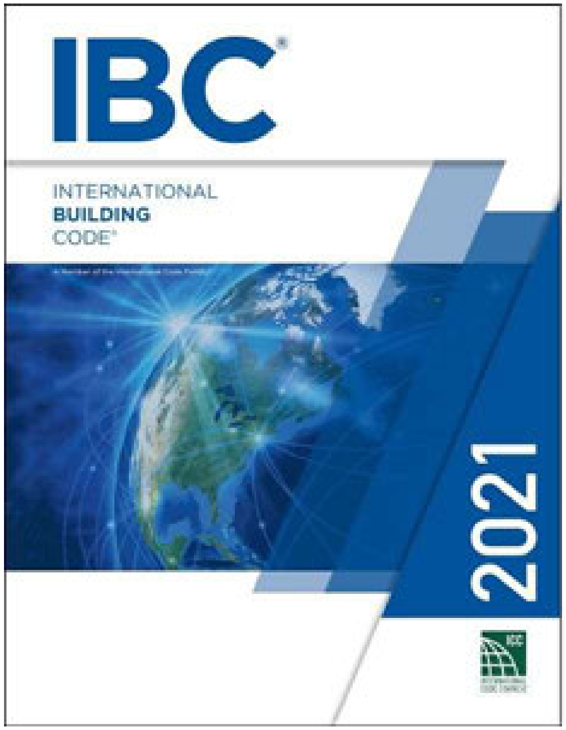
For unit to unit or unit to public or service areas:

Min. STC of 50 (45 if field tested):

Walls, Partitions, and Floor/Ceiling Assemblies

Min. IIC of 50 (45 if field tested) for:

Floor/Ceiling Assemblies



Acoustics and Sound Control

TABLE 1:

Examples of Acoustically-Tested Mass Timber Panels

Mass Timber Panel	Thickness	STC Rating	IIC Rating
3-ply CLT wall[4]	3.07"	33	N/A
5-ply CLT wall[4]	6.875"	38	N/A
5-ply CLT floor[5]	5.1875"	39	22
5-ply CLT floor[4]	6.875"	41	25
7-ply CLT floor[4]	9.65"	44	30
2x4 NLT wall[6]	3-1/2" bare NLT 4-1/4" with 3/4" plywood	24 bare NLT 29 with 3/4" plywood	N/A
2x6 NLT wall[6]	5-1/2" bare NLT 6-1/4" with 3/4" plywood	22 bare NLT 31 with 3/4" plywood	N/A
2x6 NLT floor + 1/2" plywood[2]	6" with 1/2" plywood	34	33

Source: Inventory of Acoustically-Tested Mass Timber Assemblies, WoodWorks[7]

Acoustics and Sound Control

Regardless of the structural materials used in a wall or floor ceiling assembly, there are 3 effective methods of improving acoustical performance:

1. Add mass
2. Add noise barriers
3. Add decouplers

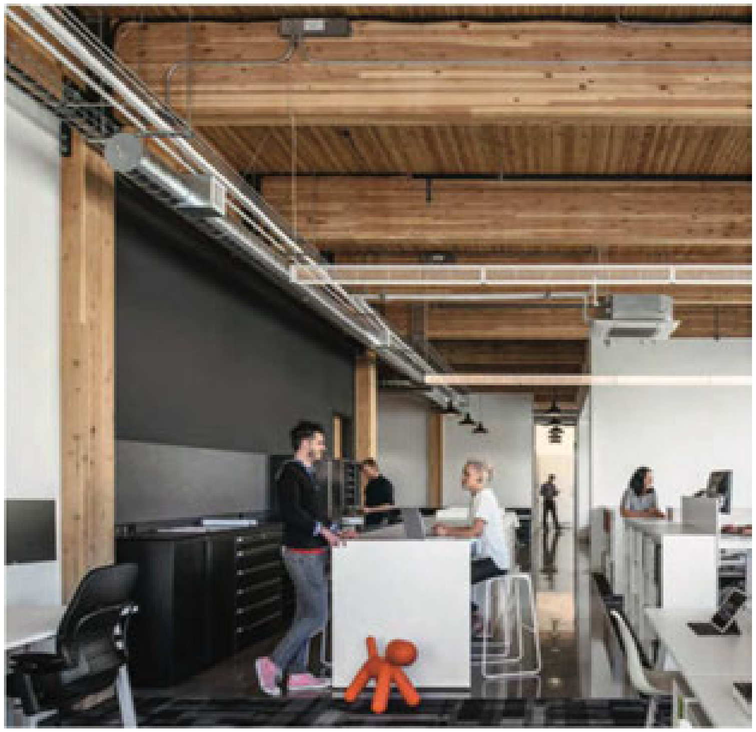


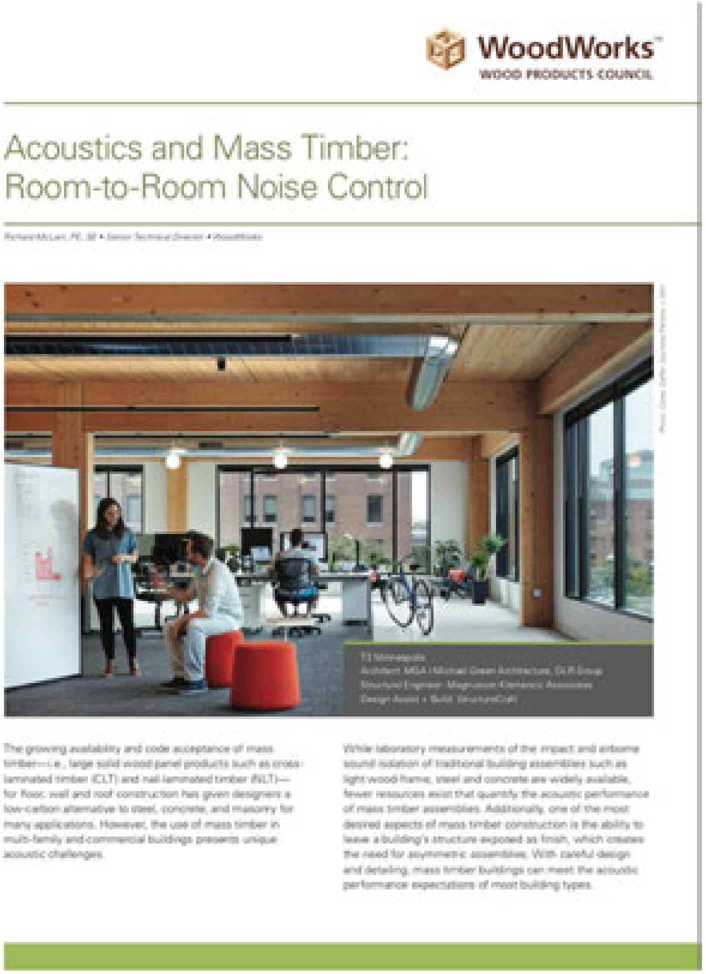
Image credit: Christian Columbres

Common Mass Timber Floor Assembly

» Finish floor (if applicable)
» Underlayment (if finish floor)
» 1.5” to 4” thick concrete/gypcrete topping
» Acoustical mat
» WSP (if applicable)
» Mass timber floor panels

Credit: AcoustiTECH

Solutions Paper



WoodWorks
WOOD PRODUCTS COUNCIL

Acoustics and Mass Timber: Room-to-Room Noise Control

The growing availability and code acceptance of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction has given designers a low-carbon alternative to steel, concrete, and masonry for many applications. However, the use of mass timber in multi-family and commercial buildings presents unique acoustic challenges.

While laboratory measurements of the impact and airborne sound isolation of traditional building assemblies such as light wood-frame, steel and concrete are widely available, fewer resources exist that quantify the acoustic performance of mass timber assemblies. Additionally, one of the most desired aspects of mass timber construction is the ability to leave a building's structure exposed as finish, which creates the need for asymmetric assemblies. With careful design and detailing, mass timber buildings can meet the acoustic performance expectations of most building types.

Mass Timber Assembly Options: Walls

Mass timber panels can also be used for interior and exterior walls—both bearing and non-bearing. For interior walls, the need to conceal services such as electrical and plumbing is an added consideration. Common approaches include building a chase wall in front of the mass timber wall or installing gypsum wallboard on resilient channels that are attached to the mass timber wall. As with bare mass timber floor panels, bare mass timber walls don't typically provide adequate noise control, and chase walls also function as acoustical improvements. For example, a 3-ply CLT wall panel with a thickness of 3.07" has an STC rating of 33. In contrast, Figure 3 shows an interior CLT partition wall with chase walls on both sides. This assembly achieves an STC rating of 58, exceeding the IBC's acoustical requirements for multi-family construction. Other examples are included in the inventory of tested assemblies noted above.

Acoustical Differences between Mass Timber Panel Options

The majority of acoustically-tested mass timber assemblies include CLT. However, tests have also been done on other mass timber panel options such as NLT and dowel-laminated timber (DLT), as well as traditional heavy timber options such as tongue and groove decking. Most tests have concluded that CLT acoustical performance is slightly better than that of other mass timber options, largely because the cross-orientation of laminations in a CLT panel limits sound flanking.

For those interested in comparing similar assemblies and mass timber panel types and thicknesses, the inventory noted above contains tested assemblies using CLT, NLT, glued-laminated timber panels (GLT), and tongue and groove decking.

Improving Performance by Minimizing Flanking

Even when the assemblies in a building are carefully designed and installed for high acoustical performance, consideration of flanking paths—in areas such as assembly intersections, beam-to-column/wall connections, and MEP penetrations—is necessary for a building to meet overall acoustical performance objectives.

One way to minimize flanking paths at these connections and interfaces is to use resilient connection isolation and sealant strips. These products are capable of resisting structural loads in compression between structural members and connections while providing isolation and breaking hard, direct connections between members. In the context of the three methods for improving acoustical performance noted above, these strips act as decouplers. With airtight connections, interfaces and penetrations, there is a much greater chance that the acoustic performance of a mass timber building will meet expectations.

Acoustical isolation strips

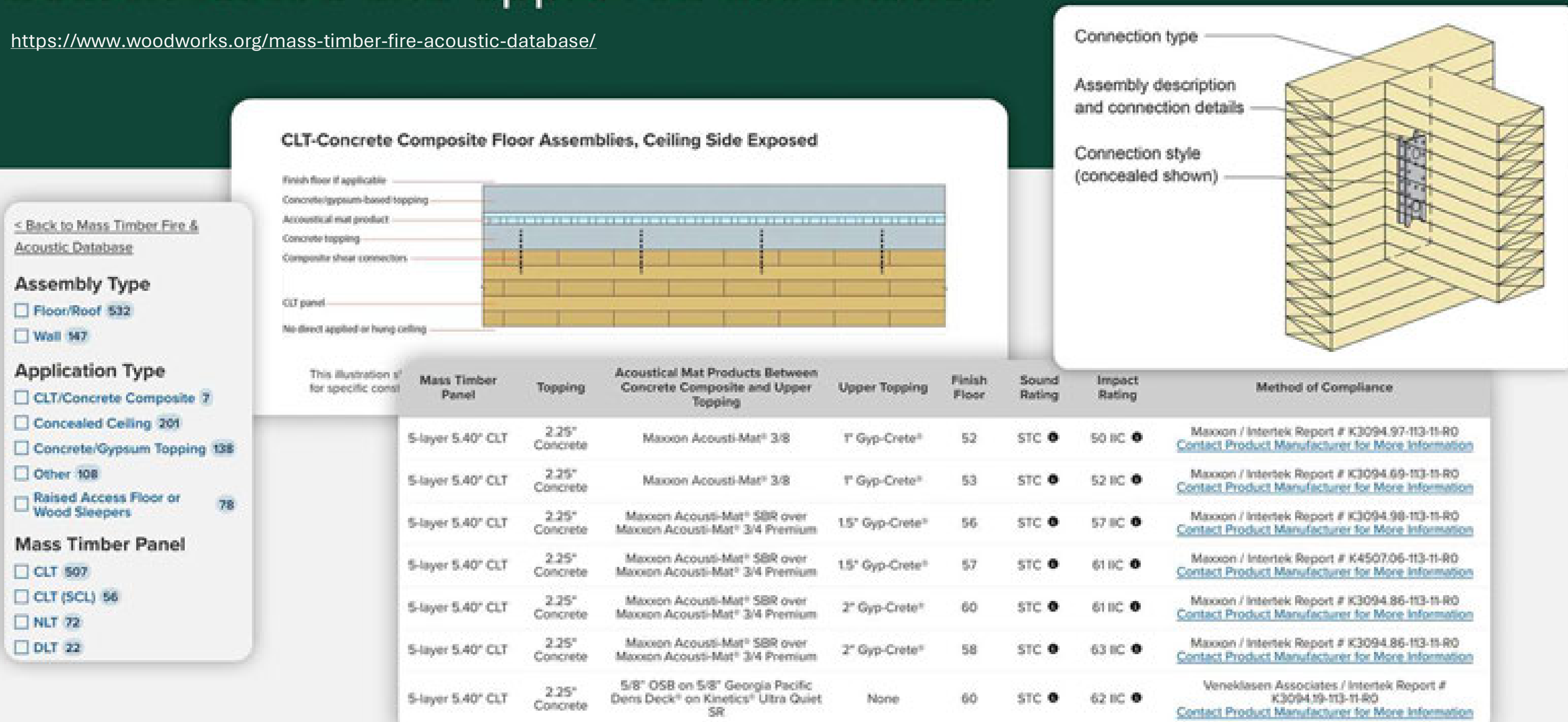
http://www.woodworks.org/wp-content/uploads/wood_solution_paper-MASS-TIMBER-ACOUSTICS.pdf

NEW ONLINE TOOL

Mass Timber Fire & Acoustic Database

Search tested and approved assemblies

https://www.woodworks.org/mass-timber-fire-acoustic-database/



Mass Timber Panel	Topping	Acoustical Mat Products Between Concrete Composite and Upper Topping	Upper Topping	Finish Floor	Sound Rating	Impact Rating	Method of Compliance
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® 3/8	1" Gyp-Crete®	52	STC	50 IIC	Maxxon / Intertek Report # K3094.97-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® 3/8	1" Gyp-Crete®	53	STC	52 IIC	Maxxon / Intertek Report # K3094.69-113-11-R0 Contact Product Manufacturer for More Information
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5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® SBR over Maxxon Acousti-Mat® 3/4 Premium	2" Gyp-Crete®	60	STC	61 IIC	Maxxon / Intertek Report # K3094.86-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	Maxxon Acousti-Mat® SBR over Maxxon Acousti-Mat® 3/4 Premium	2" Gyp-Crete®	58	STC	63 IIC	Maxxon / Intertek Report # K3094.86-113-11-R0 Contact Product Manufacturer for More Information
5-layer 5.40" CLT	2.25" Concrete	5/8" OSB on 5/8" Georgia Pacific Dens Deck® on Kinetics® Ultra Quiet SR	None	60	STC	62 IIC	Veneklasen Associates / Intertek Report # K3094.19-113-11-R0 Contact Product Manufacturer for More Information

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7-story, 84 ft tall multi-family

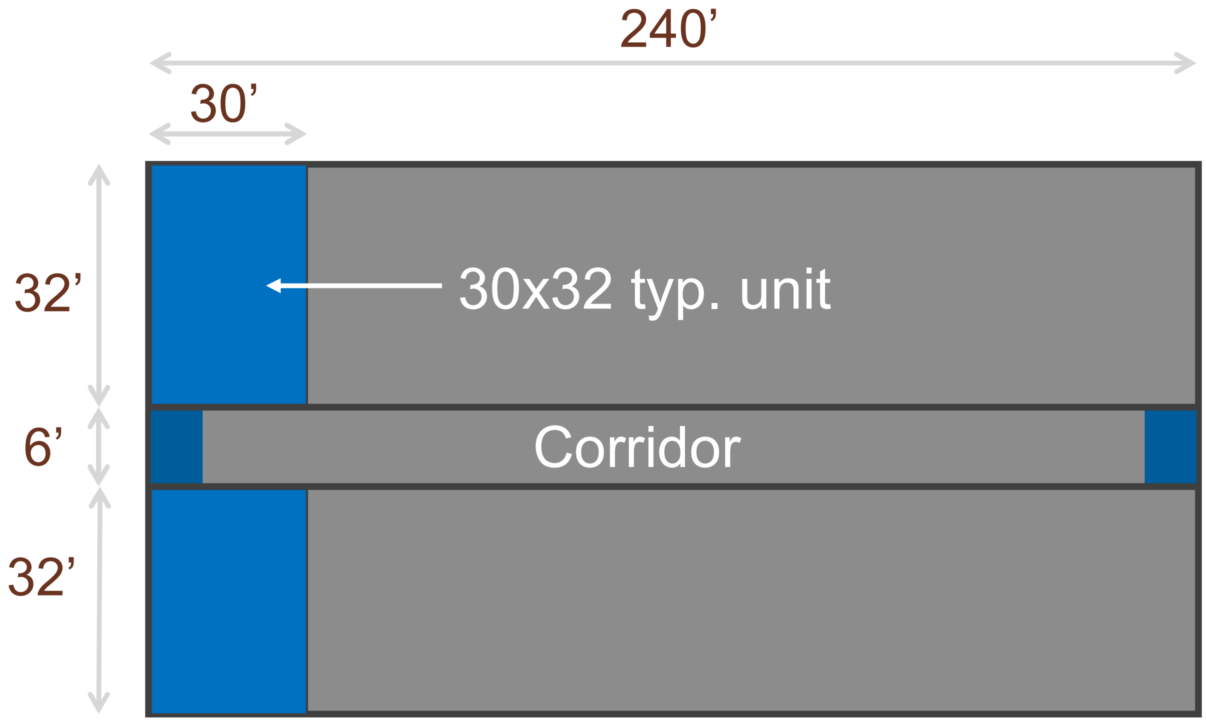
- » Parking & Retail on 1st floor, residential units on floors 2-7
- » NFPA 13 sprinklers throughout
- » Floor plate = 18,000 SF
- » Total Building Area = 126,000 SF

Credit: Monte French Design Studio

Credit: Monte French Design Studio

7-story Building typical floor plan:

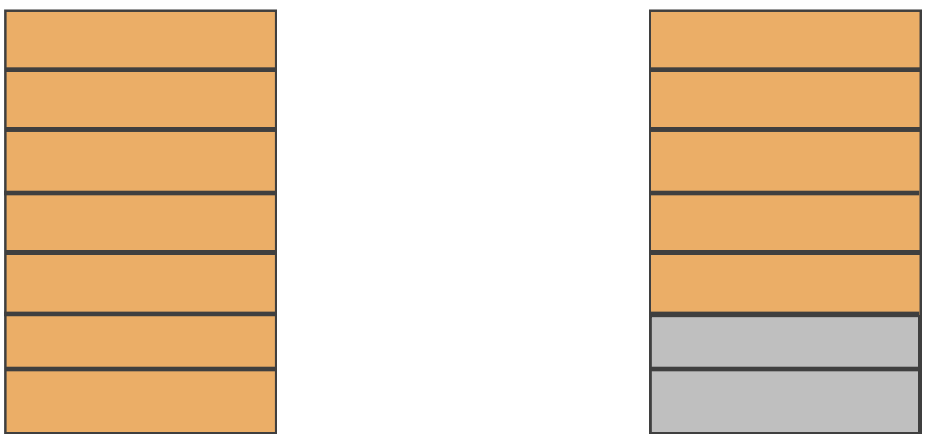
Credit: Monte French Design Studio



MT Construction Type Options:

- 7 stories of IV-C
- 5 stories of III-A over 2 stories of I-A podium
- 5 stories of IV-HT over 2 stories of I-A podium

Credit: Monte French Design Studio



7 stories of IV-C

Credit: Monte French Design Studio

Implications of Type IV-C:

» 2 hr FRR, all exposed floor panels, beams, and columns

» Likely will need at least 5-ply CLT / 2x6 NLT/DLT

» Efficient spans in the 14-17 ft range

» Efficient grids of that or multiples of that (i.e. 30x25, etc)

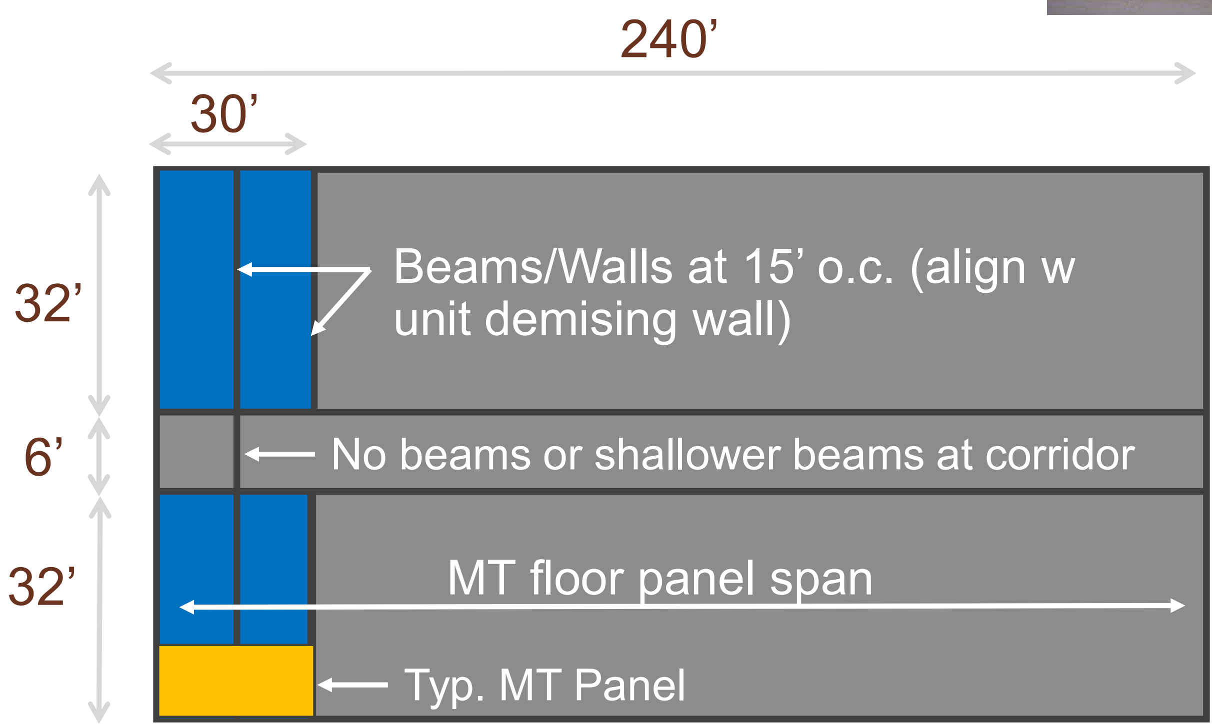
» No podium required

» CLT exterior walls permitted

Type IV-C Grid Options

Option 1

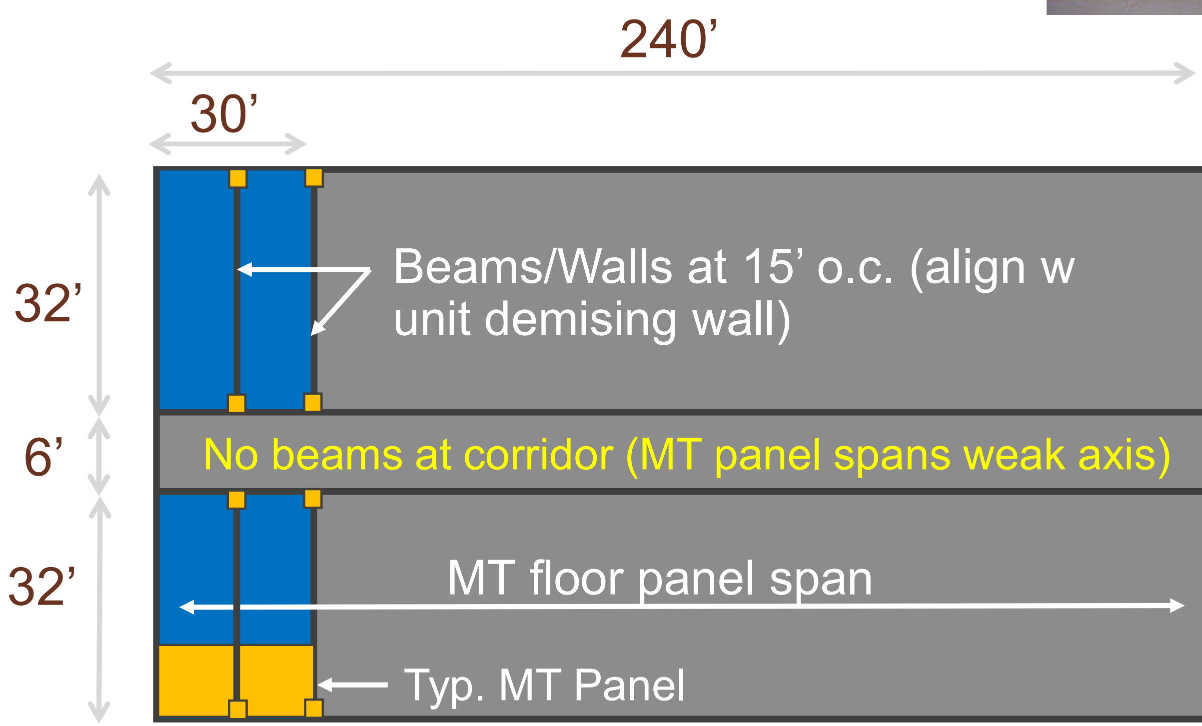
Credit: Monte French Design Studio



Type IV-C Grid Options

Option 1

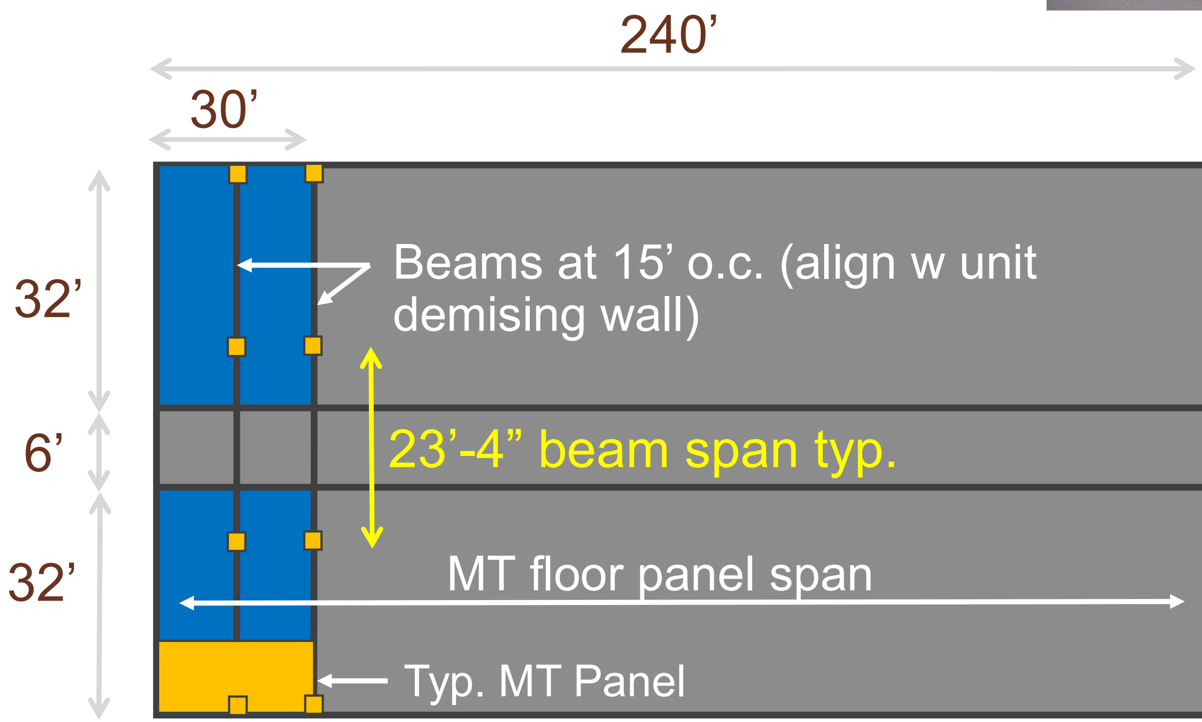
Credit: Monte French Design Studio



Type IV-C Grid Options

Option 1

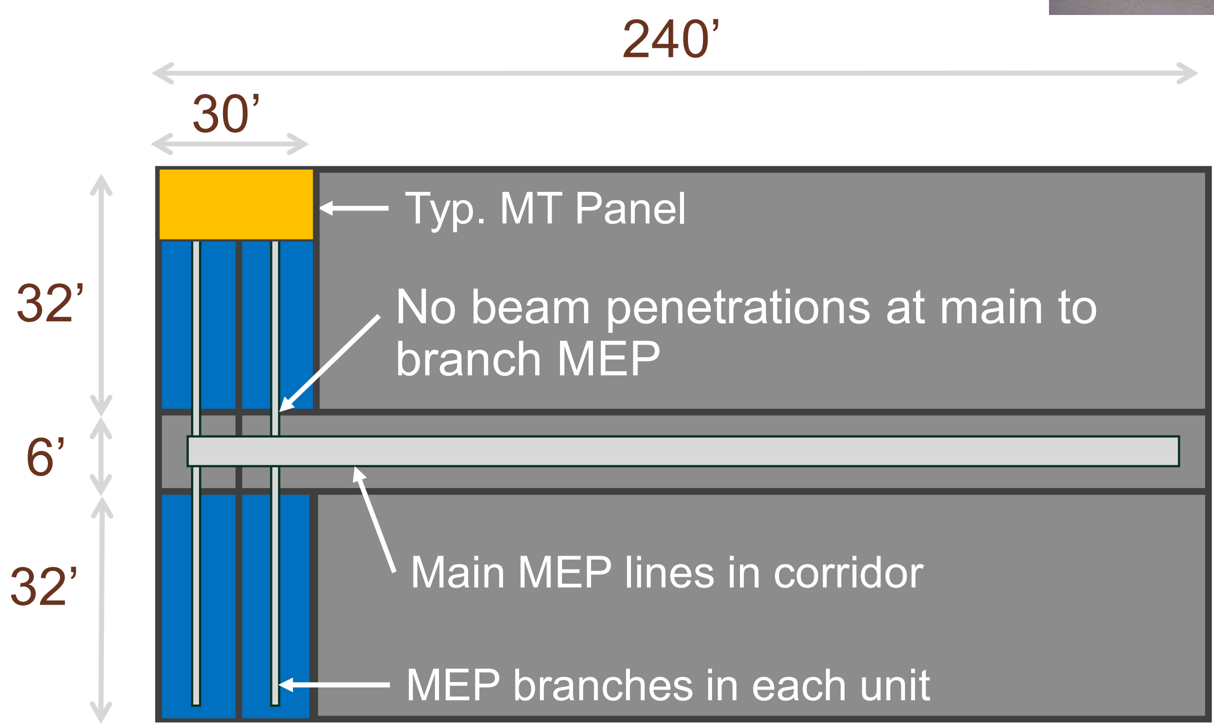

Credit: Monte French Design Studio



Type IV-C Grid Options

Option 1

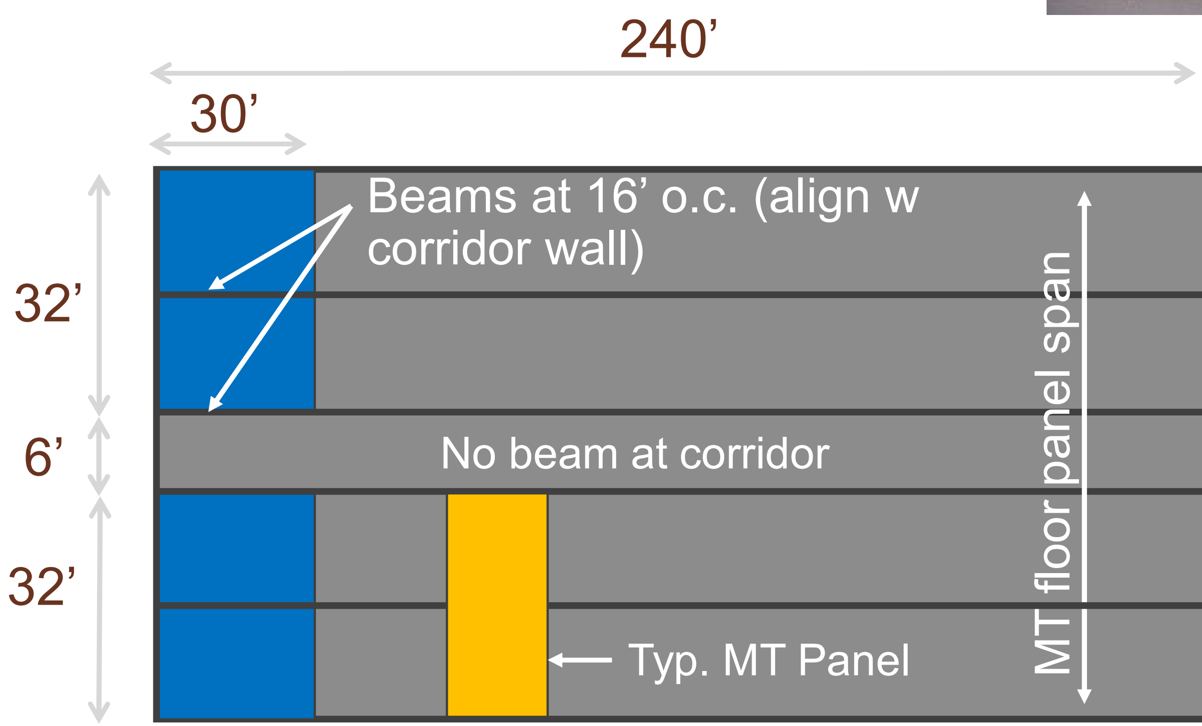
Credit: Monte French Design Studio



Type IV-C Grid Options

Credit: Monte French Design Studio

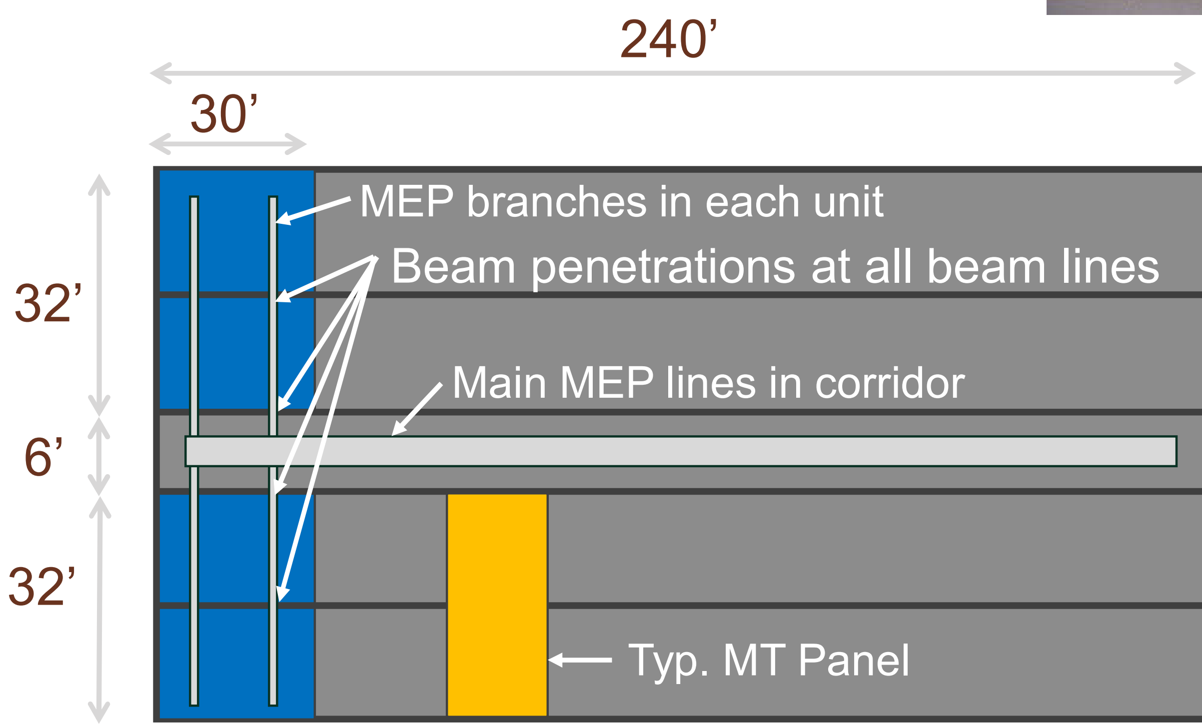
Option 2



Type IV-C Grid Options

Option 2

Credit: Monte French Design Studio



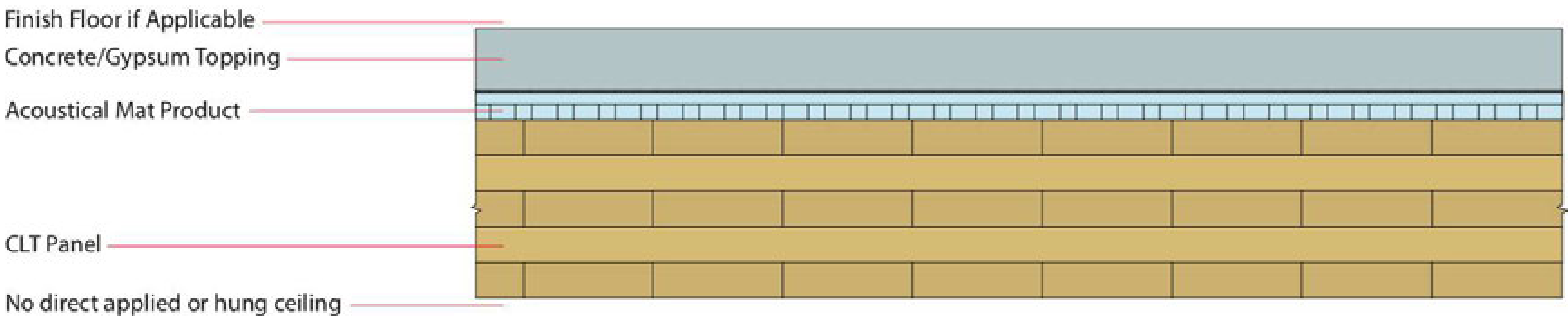
Type IV-C Floor Assembly Options

Credit: Monte French Design Studio

- 2-hr FRR: 5-ply CLT (tested assembly) or 7-ply CLT (char calculations)
- STC & IIC 50 min: 2” topping (5-ply CLT) or 1.5” topping (7-ply CLT)

Note: many other acoustic mat and topping options exist, one example shown here

Note: 5-ply is most efficient for the 15-16 ft panel spans shown



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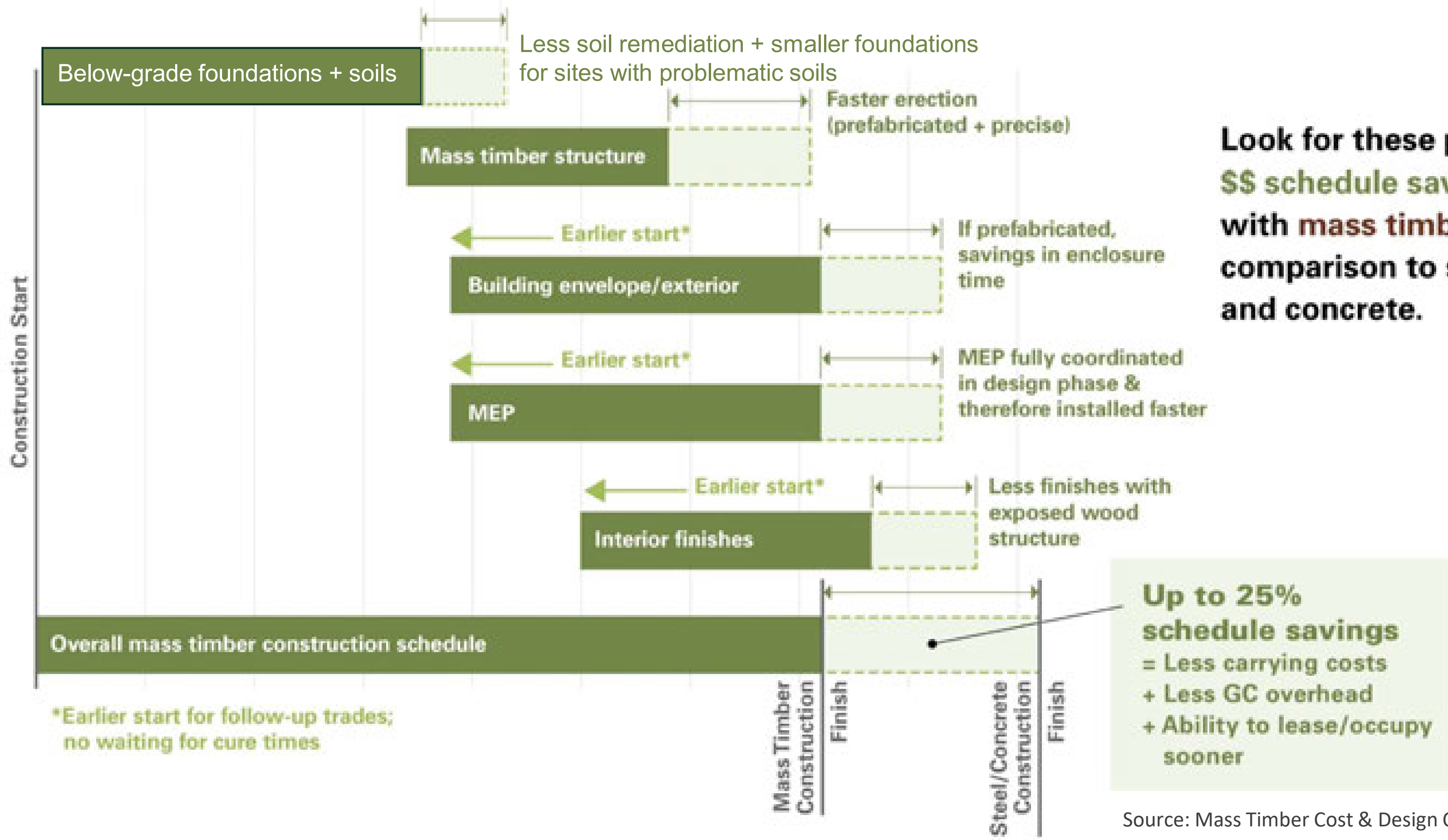
Final Considerations - Know Your Why

- Speed of Construction
- Market Distinction
- Sustainability
- Lightweight
- Leasing Velocity
- Cost
- Urban Density

Compressing the Typical Schedule



Look for these potential $$ schedule savings with mass timber in comparison to steel and concrete.

Source: Mass Timber Cost & Design Optimization, WoodWorks[2] https://www.woodworks.org/resources/mass-timber-cost-and-design-optimization-checklists/

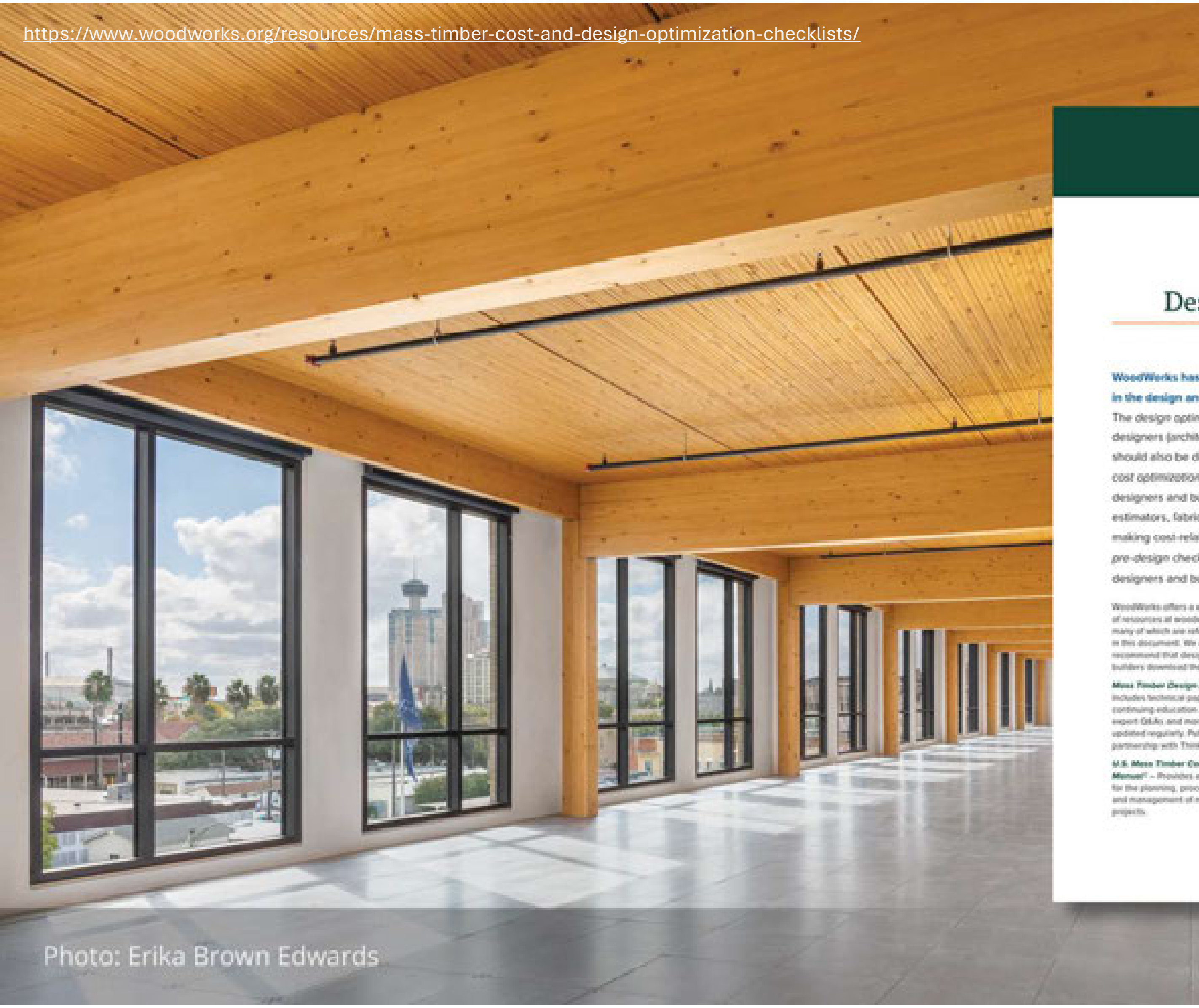


Photo: Erika Brown Edwards

WOODWORKS

Mass Timber Cost and Design Optimization Checklists

WoodWorks has developed the following checklists to assist in the design and cost optimization of mass timber projects. The design optimization checklists are intended for building designers (architects and engineers), but many of the topics should also be discussed with the fabricators and builders. The cost optimization checklists will help guide coordination between designers and builders (general contractors, construction managers, estimators, fabricators, installers, etc.) as they are estimating and making cost-related decisions on a mass timber project. The *pre-design* checklist should be reviewed by the developer/owner, designers and builders.

WoodWorks offers a wide range of resources at woodworks.org, many of which are referenced in this document. We also recommend that designers and builders download the following:

Mass Timber Design Manual – Includes technical papers, continuing education articles, expert Q&As and more, and is updated regularly. Published in partnership with Think Wood.

U.S. Mass Timber Construction Manual – Provides a framework for the planning, procurement and management of mass timber projects.

1 De Haro
San Francisco, CA
ARCHITECT
Perkins&Will
ENGINEERS
DCI Engineers
CONTRACTOR
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Mass Timber in Multi-Family Housing: Is it a Good Fit for Your Project?

There's a good chance it is…Let's talk about it!

Questions? Ask me anything.

Emmy Hoa Tran, PE
Regional Director | CO, MT, NE, ND, SD, WY
(303) 242-1239

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901 East Sixth, Thoughtbarn-Delineate Studio, Leap!Structures, photo Casey Dunn

Funding provided in part by the Softwood Lumber Board