MASS TIMBER

in multi-family Housing, Is it a good fit?

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

PROJECT SUMMARY

TYPE
Urban Infill – Residential

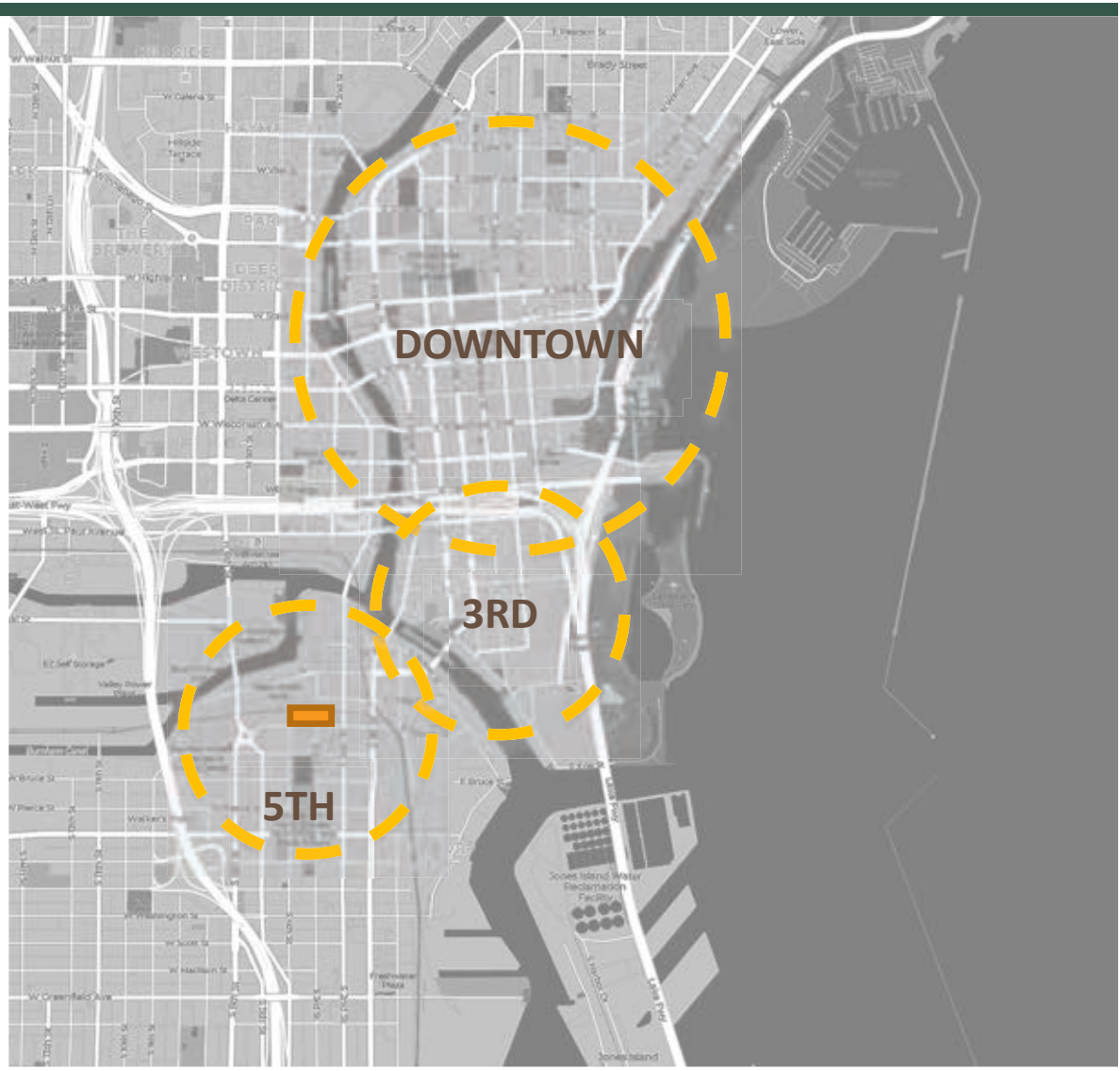
Type III-B

SCALE
5 stories Existing / 4 stories New Construction
60 units (33 units Existing / 27 units New Construction)
68,400 square feet (33,000 sf Existing / 35,400 sf New Construction)

FEATURES
Ground-floor retail space – 4,000 square feet

PROJECT TEAM

Developer:	Pieper Properties LLC
Contractor:	Catalyst Construction
Historical Consultant:	MacRostie Historic Advisors LLC
Structural:	Pierce Engineering
CLT supplier:	KLH
Civil:	The Sigma Group
Lighting Consultant:	Spectrum Lighting & Controls
Envelope Consultant:	Brandt Enclosure Consulting Inc.
Architects:	Engberg Anderson



The Louis Bass Building is Historically significant because it is a contributing member to the **Florida and Third Industrial Historic District as an Industrial Loft type building.** The Industrial Loft is an important building type in Milwaukee's history and is distinguished by its long, narrow, multi-story load bearing brick exterior with heavy timber framing. **Designed by Otto Strack and constructed in 1891**, the building was initially built as a rental for the Pabst Brewing Company but later was occupied, for a short term, by the Lindermann & Hoverson Company, which manufactured stoves, ranges, and other like products. After that, the longest tenant was by Louis Bass, from 1947 until 1982.

Pabst Theatre - WI
Pabst Mansion - WI
Pabst Brewing Campus - WI
Borden's – New York
E.W. Browning Company - Manhattan

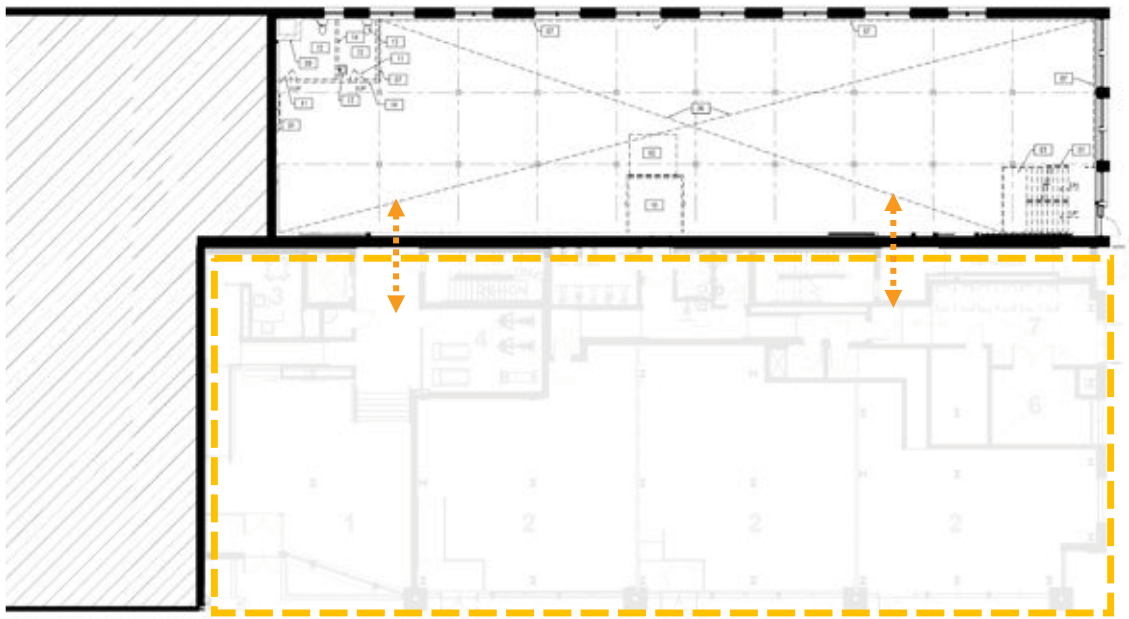
OTTO STRACK.

Louis Bass Building + Architect

EXISTING RE-USE + ADDITION

NPS Historic Tax Project requisite, one of which was the **Louis Bass ghost sign dictated the height of the Addition** as to not cover or obscure it.

EXISTING...



re-use | addition

Lateral Addition + Continuity

EXISTING...

Cream City Brick

Extensively utilized in Milwaukee – made from local clay that yields a distinct texture and yellow/sepia color…

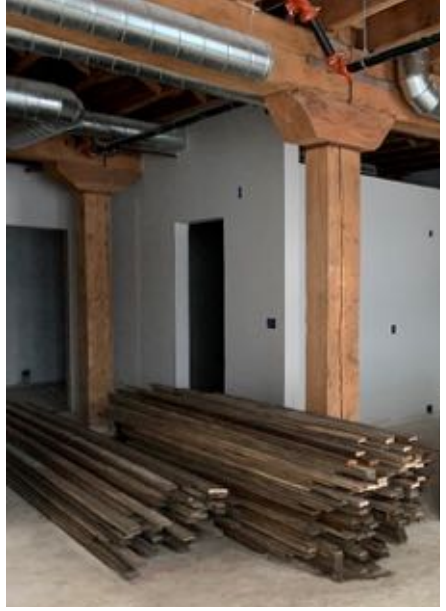
EXISTING…

Stabilize…

Preservation of Original Arched Window

EXISTING...


remove and re-use of existing
wood floors

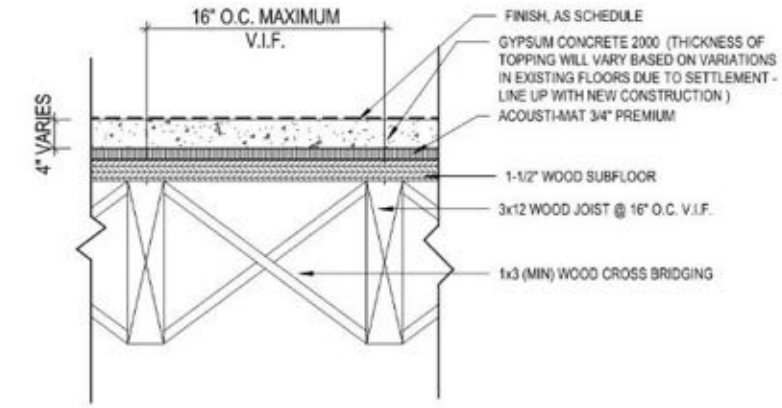



LOUIS BASS
SHPO VISIT - 8/9/2018
SITE MEDIUM GLASS
SHPO APPROVED
CORN COB
SHPO APPROVED
BLACK DIAMON
SHPO NOT APPROVED
COAL SLAG
SHPO NOT APPROVED


implement...


Install...

EXISTING...



EXISTING FLOOR/CEILING ASSEMBLY

The existing Louis Bass building consisted of **load bearing brick exterior walls** and wood framing on the interior. The framing employed here was **12x12 heavy timber columns** and mostly typically **3"x12" floor joists** with the exception of one floor that used 2"x12" framing. The floor system is 3/4" t&g over a 2"x t&g sub-floor. Not meeting the dimensional requisites of HT and considering the existing with the new construction, **construction type III-B** was the best selection to code the project as a whole.

Due **the historic nature of the building**, we were allowed to keep the wood structure exposed because the historic finishes and the use of sprinklers.

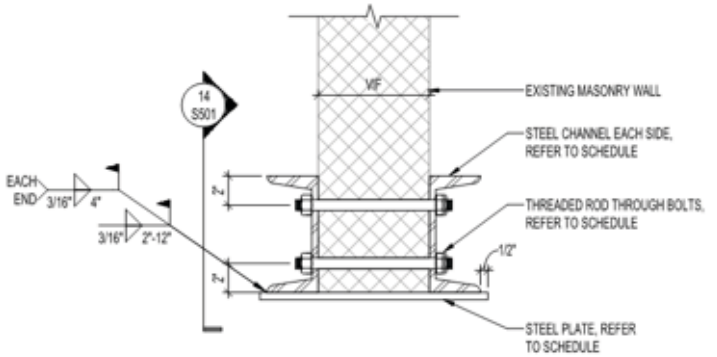
IEBC 2015 - 1203.5 Interior Finishes

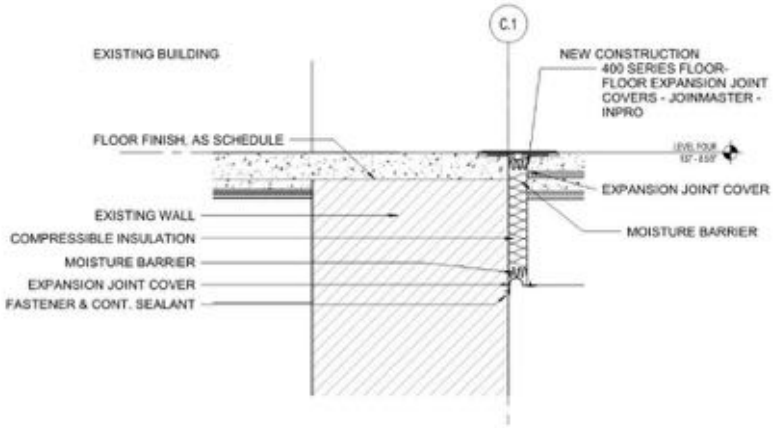
The existing finishes of walls and ceilings shall be accepted when it is demonstrated that they are the historic finishes.

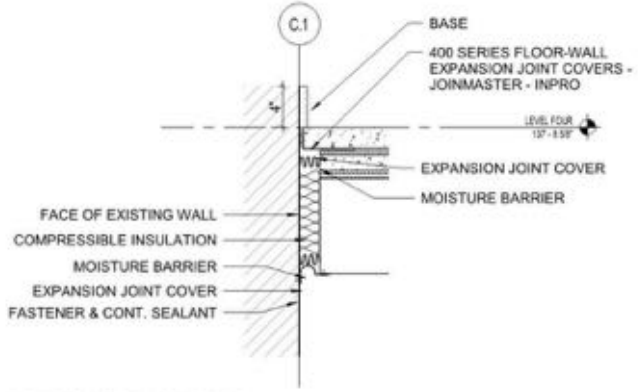
IEBC 2015 - 1203.12 Automatic Fire-Extinguishing Systems

Every historical building that cannot be made to conform to the construction requirements specified in the International Building Code for the occupancy or use and that constitutes a distinct fire hazard shall be deemed to be in compliance if provided with an approved automatic fire-extinguishing system.

EXISTING... FLOOR ASSEMBLY







EXISTING – Lateral Addition + Continuity

EXISTING RE-USE **+ ADDITION**

LEVEL THREE

LEVEL ONE

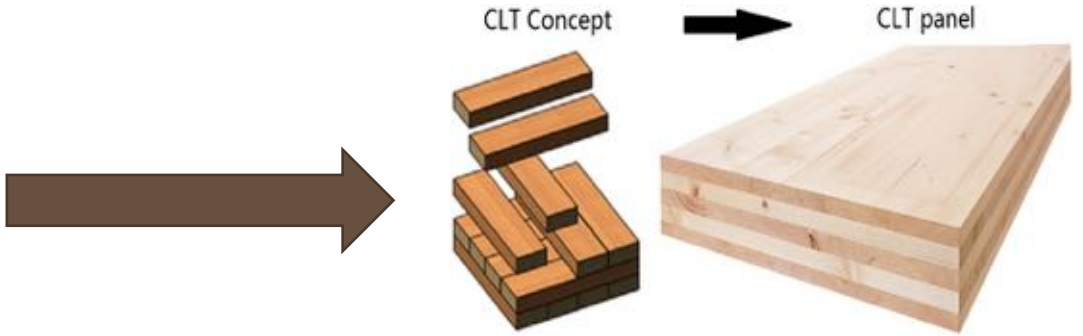
EXISTING – Lateral Addition + Continuity

CLT

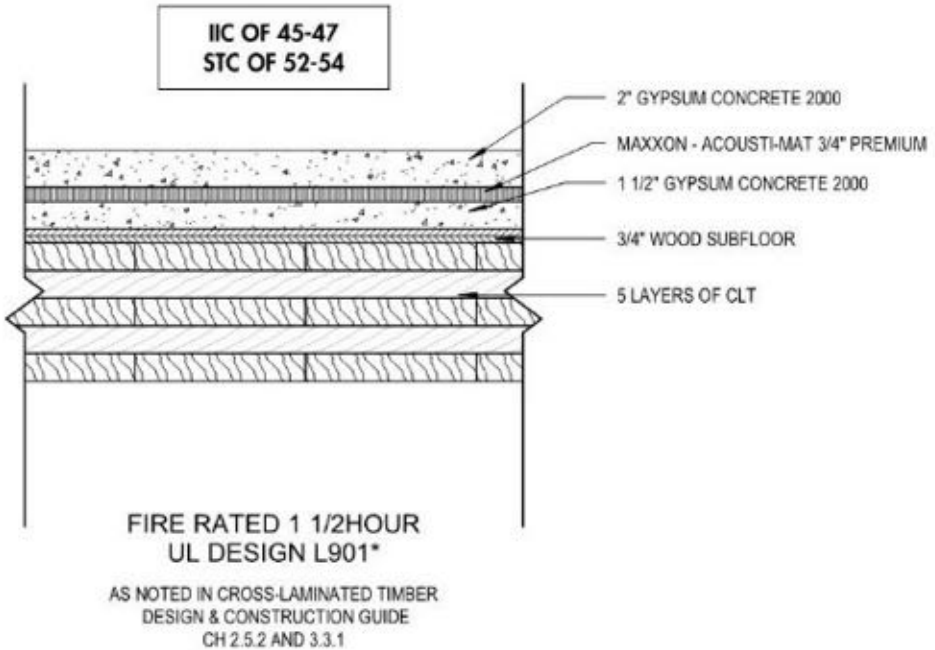
GLT

NLT

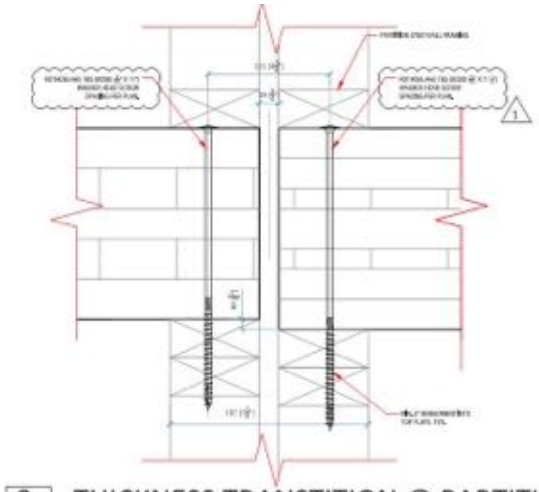
DLT



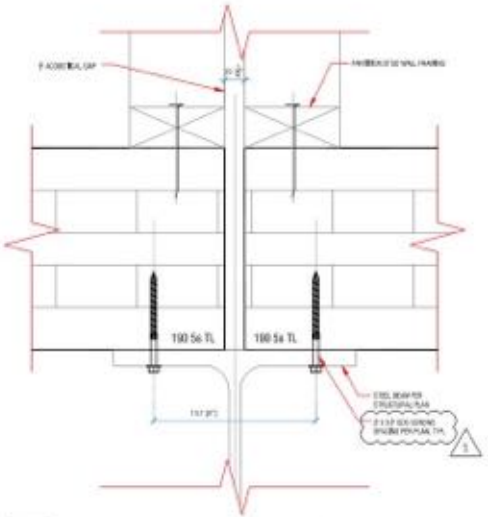
D L T + N L T + C L T



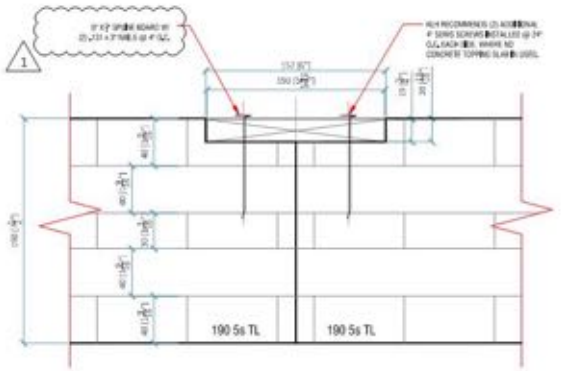
NEW CONSTRUCTION FLOOR/CEILING ASSEMBLY



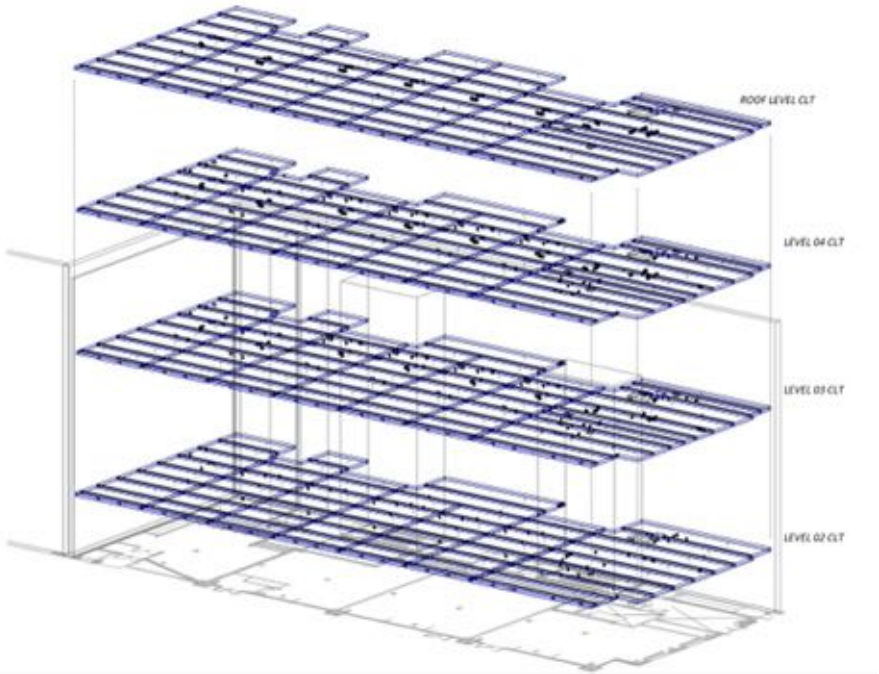
8 THICKNESS TRANSTITION @ PARTITION WALL
CLT-002 SCALE: 3" = 1'-0"



2 PARTITION GAP @ STEEL
CLT-002 SCALE: 3" = 1'-0"



1 TYP. 190 5s SPLINE JOINT
CLT-002 SCALE: 3" = 1'-0"



ADDITION... structure+module

Mass Timber - CLT

ADDITION...


timber
LOFTS
HIGH-TECH & HIGH-STYLE
COMING SPRING 2020
timber

ADDITION...

Proportion + Rhythm + Texture/Motif + Tone

NEW | EXISTING

Massing + Aesthetic NPS Coordinated & Approved…

Historic Tax Credits: Historic tax credits are available for Historically designated buildings that are rehabilitated according to the Secretary of Interior's Standards for Rehabilitation. The Historic Tax Credit process is a three-part application process to garner the subsidy/income tax credit.

- Part I : Presents information about the significance and appearance of the building.
- Part II: Describes the condition of the building and the planned rehabilitation work.
- Part III: Submitted after the project is completed and documents that the work was completed as proposed.

ADDITION + EXISTING

Vision of Ownership. Sustainability was a key consideration and it started with the **recycling/adaptive re-use** of the Louis Bass building. Continuing that theme, the Owner was well versed in the **advantages of CLT/Mass Timber** and selected this as a system early on, not only for sustainability, but also because it offered **aesthetic continuity** of the interior structure from existing to new.

Aesthetic Continuity

ADDITION + EXISTING

ADDITION...

ADDITION...

ADDITION...

EXISTING...

ADDITION + EXISTING

ADDITION + EXISTING

ADDITION + EXISTING

- Questions?
- This concludes the American Institute of Architects Continuing Education System Course
- Contact Information:

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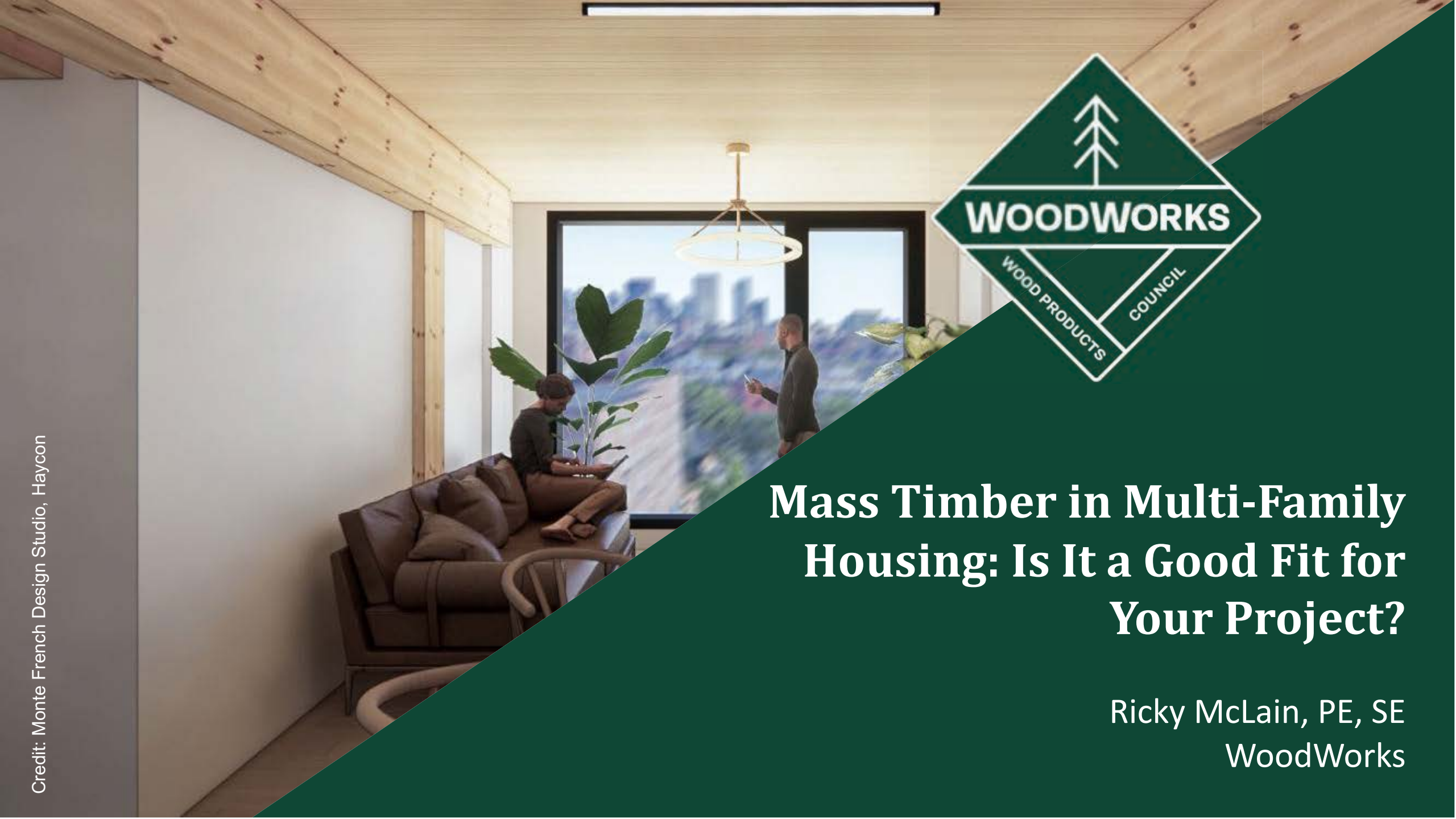

Credit: Monte French Design Studio, Haycon

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

Ricky McLain, PE, SE
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 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.

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

Ascent, Milwaukee, WI
Source: Korb & Associates Architects

Glue Laminated Timber (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo: Freres Lumber

Photo: StructureCraft

Photo: LendLease

Photo: LEVER Architecture

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Nail-Laminated Timber (NLT)

Photo: Think Wood

Glue-Laminated Timber (GLT)

Plank orientation

Photo: StructureCraft

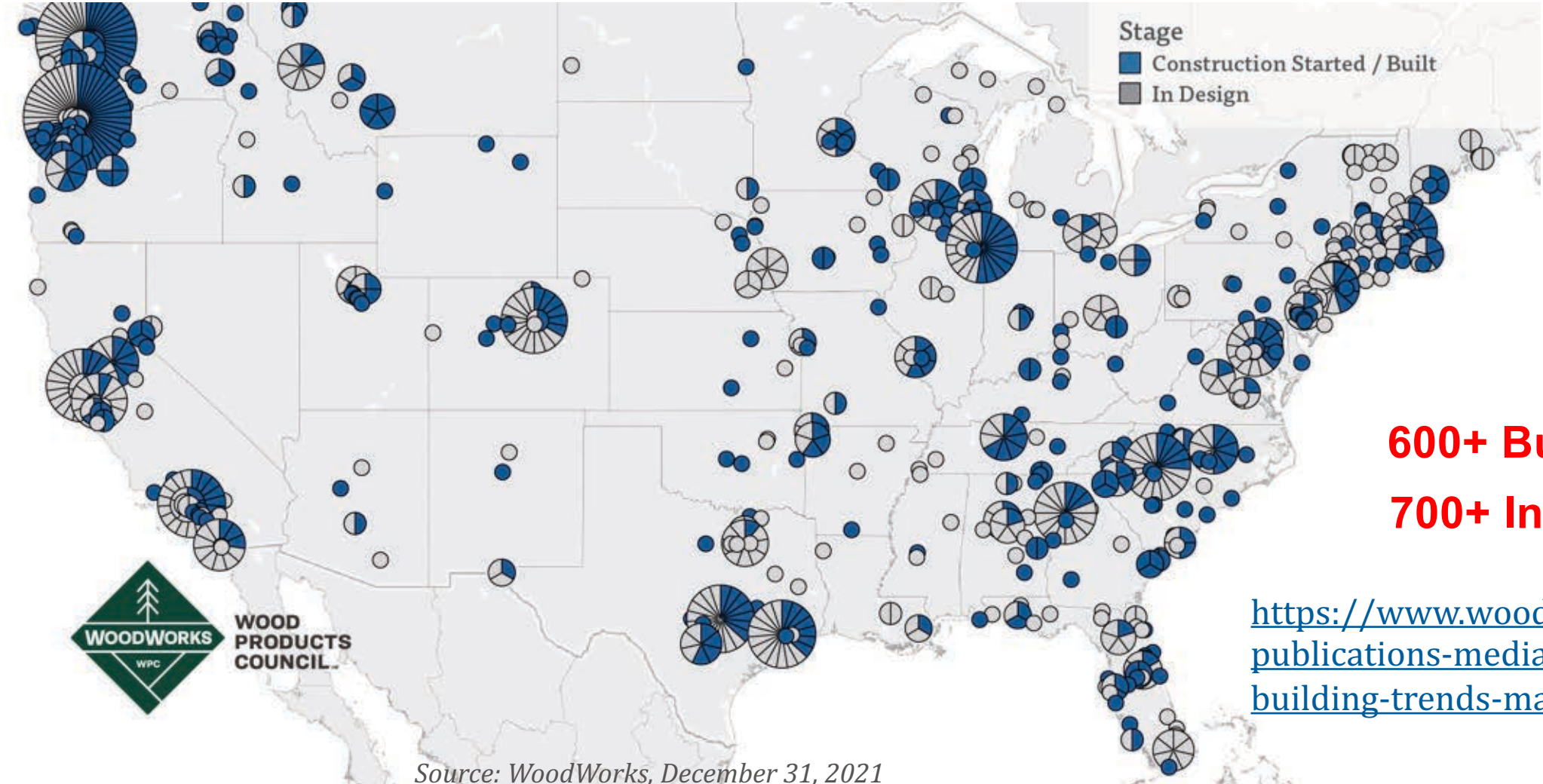
Photo: StructureCraft

Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

Current State of Mass Timber Projects

As of March 2022, in the US, **1,384** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.



600+ Built

700+ In Design

https://www.woodworks.org/publications-media/building-trends-mass-timber/

Source: WoodWorks, December 31, 2021

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

Multi-Housing 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

Low- and Mid-Rise Multi-Family

Credit: A & X Creative and Engberg Anderson

HYBRID LIGHT-FRAME + MASS TIMBER

THE KIND PROJECT, SACRAMENTO, CA

Credit: Kalesnikoff Mass Timber

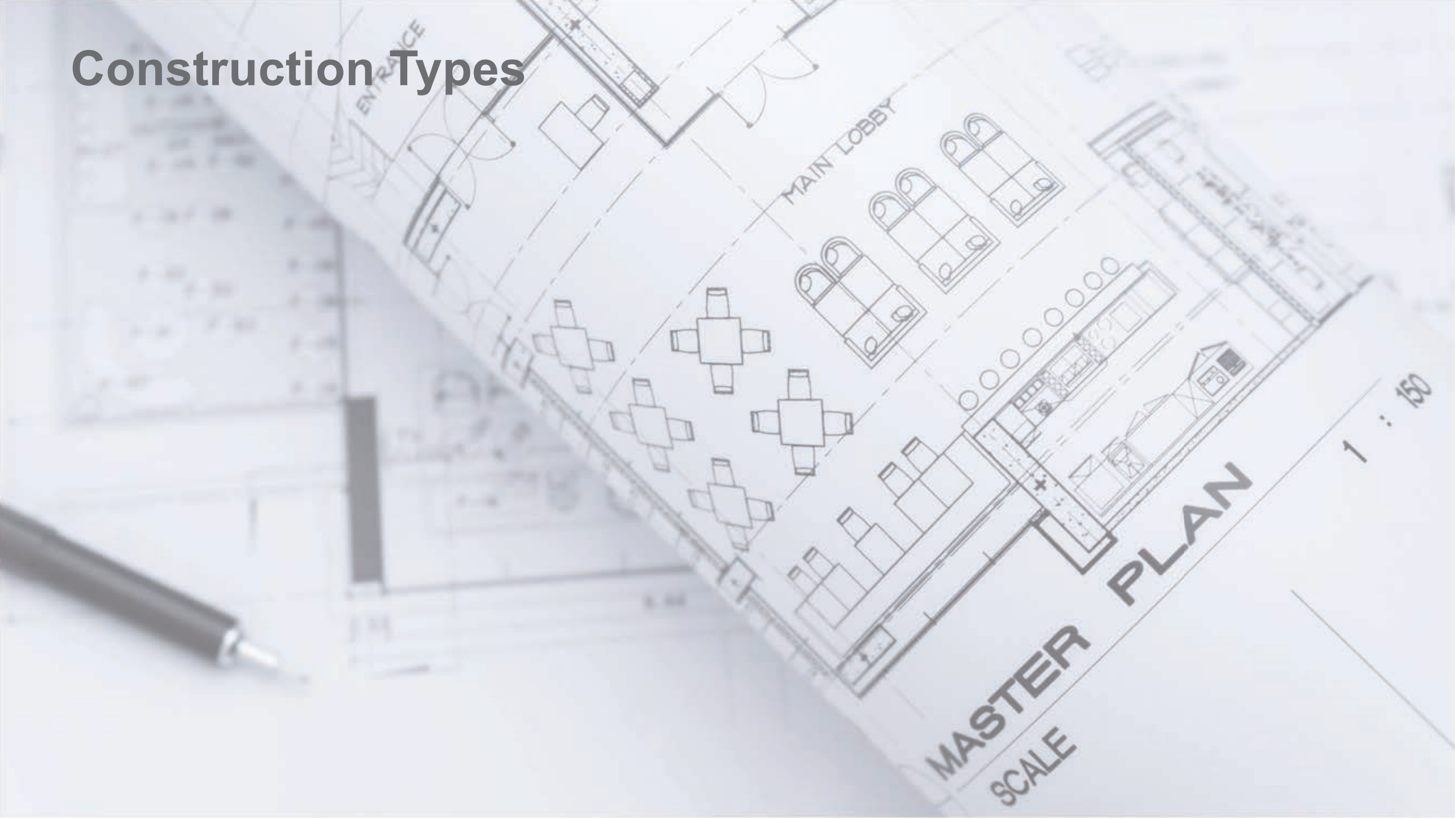
CIRRUS, DENVER, CO

Credit: KL&A Engineers & Builders

THE DUKE, AUSTIN, TX

Credit: WGI

Construction Types

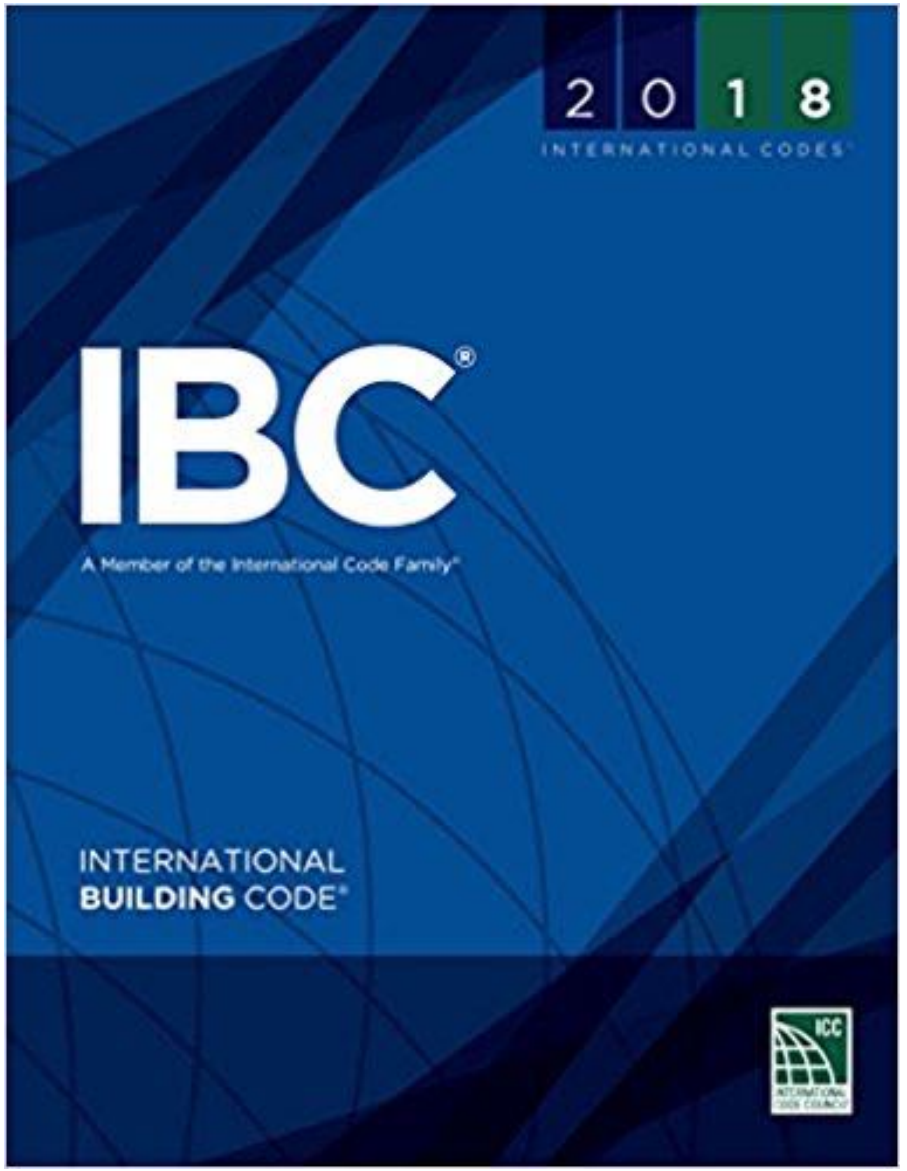


Construction Types

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

All wood framed building options:

Type III
Exterior walls non-combustible (may be FRTW)
Interior elements any allowed by code, including mass timber

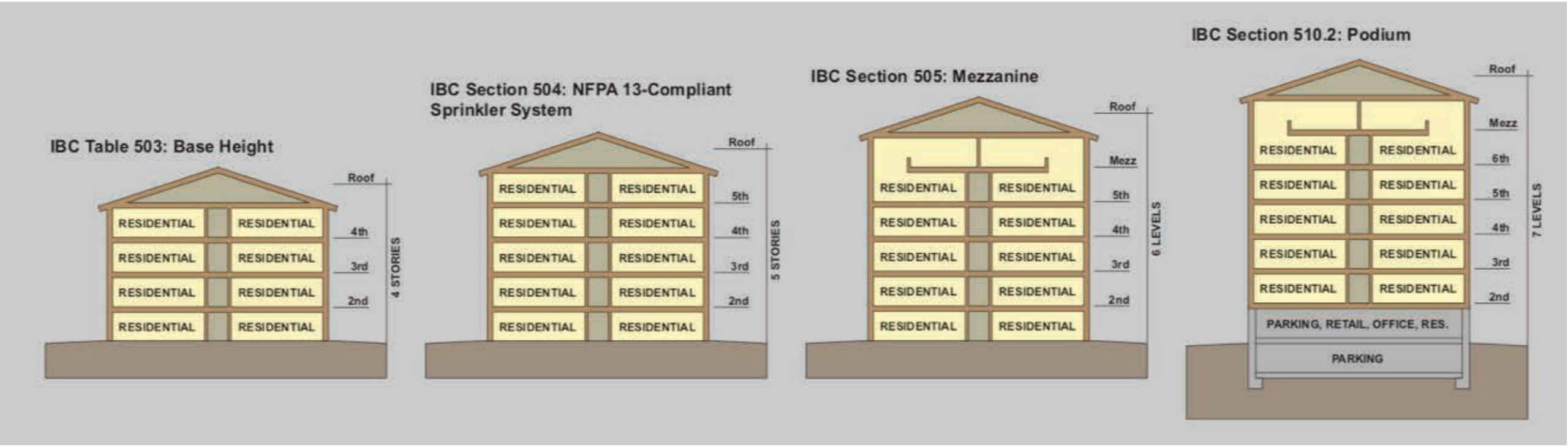
Type V
All building elements are any allowed by code, including mass timber

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)

Photo Credit: Hacker Architects, Jeremy Bittermann

PRESCRIPTIVE BUILDING CODES



Tall Mass Timber Multi-Family

Credit: Harbor Bay Real Estate Advisors, Purple Film, INTRO, Cleveland, OH

11 E LENOX, BOSTON, MA

7 STORIES

70 FT

Passive House

Multi-Family

Credit: H + O Structural Engineering

Credit: Monte French Design Studio

INTRO, CLEVELAND

9 Stories | 115 ft

8 Timber Over 1 Podium

512,000 SF

297 Apartments, Mixed-Use

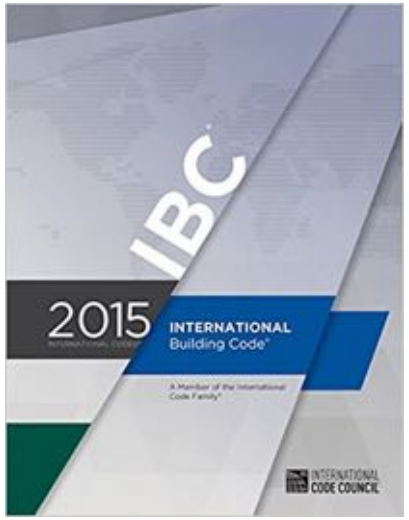
Photo: Harbor Bay Real Estate Advisors, Purple Film | Architect: Hartshorne Plunkard Architecture

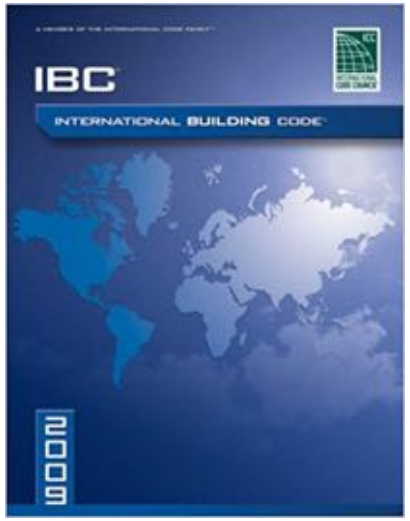
ASCENT, MILWAUKEE

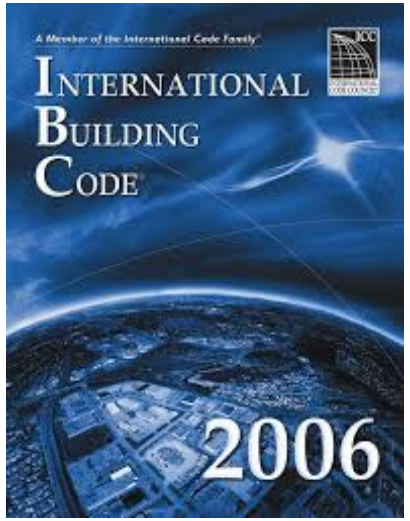
Tallest Mass Timber Building in the World

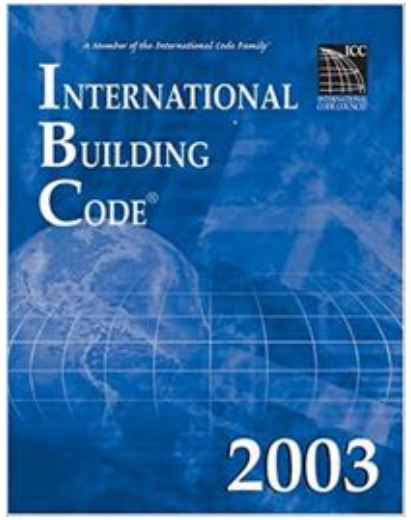
Photo: CD Smith Construction |
Architect: Korb & Associates Architects

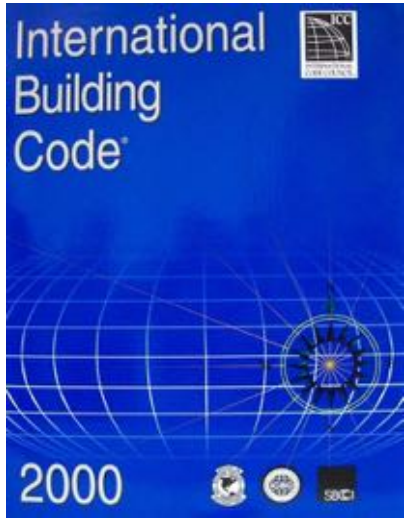
3 YEAR CODE CYCLE





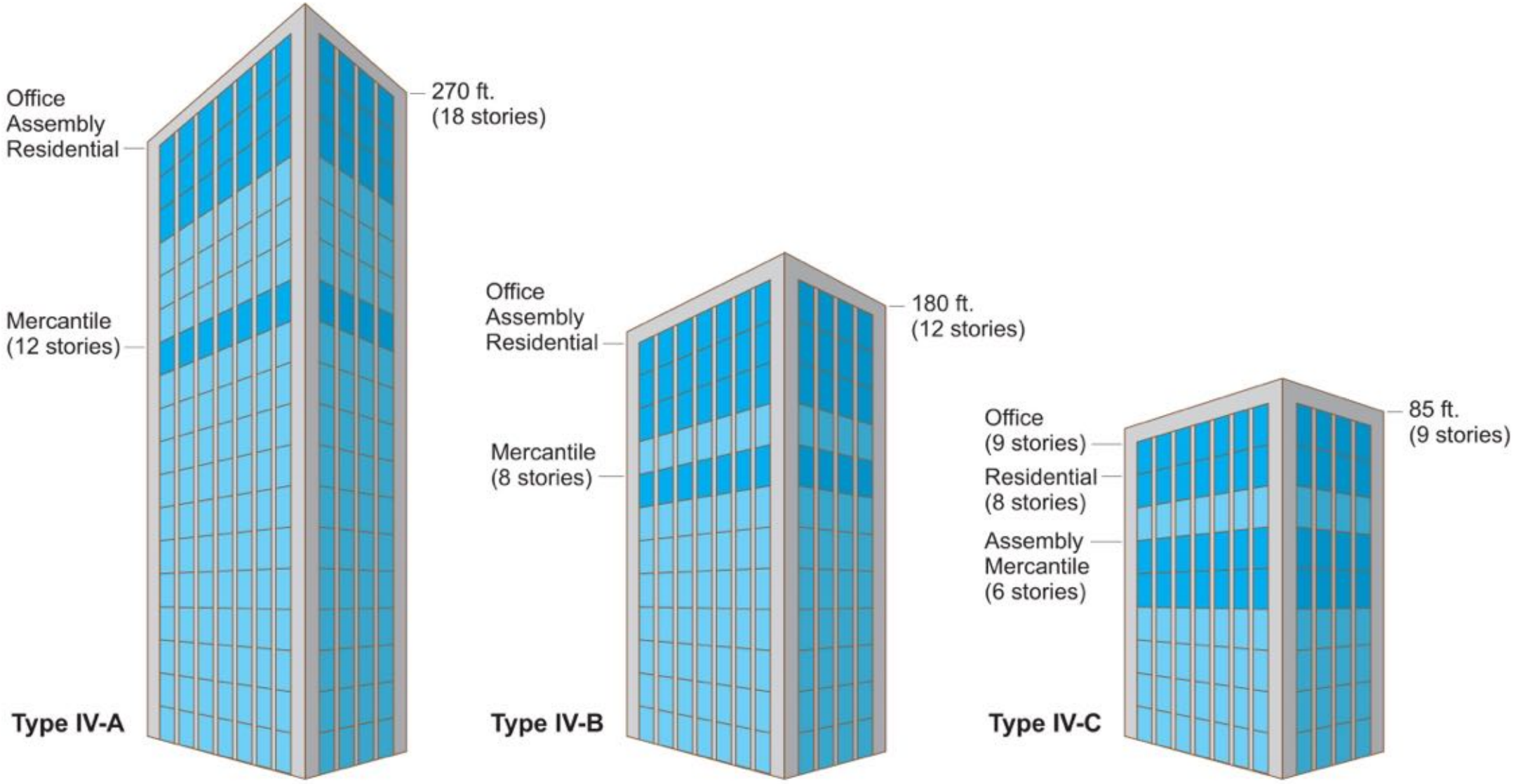






Source: ICC

PRESCRIPTIVE BUILDING CODES



Type IV-C

9 STORIES	
BUILDING HEIGHT	85'
ALLOWABLE BUILDING AREA	405,000 SF
AVERAGE AREA PER STORY	45,000 SF

TYPE IV-C

Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

Type IV-C Protection vs. Exposed

IV-C

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path, Ema Peter

All Mass Timber surfaces may be exposed

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

Type IV-B

12 STORIES
BUILDING HEIGHT 180 FT
ALLOWABLE BUILDING AREA 648,000 SF
AVERAGE AREA PER STORY 54,000SF

TYPE IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

Type IV-B Protection vs. Exposed

IV-B

12 STORIES
BUILDING HEIGHT 180 FT
ALLOWABLE BUILDING AREA 648,000 SF
AVERAGE AREA PER STORY 54,000SF

TYPE IV-B

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path

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

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

Type IV-A

18 STORIES
BUILDING HEIGHT 270'
ALLOWABLE BUILDING AREA 972,000 SF
AVERAGE AREA PER STORY 54,000SF

TYPE IV-A

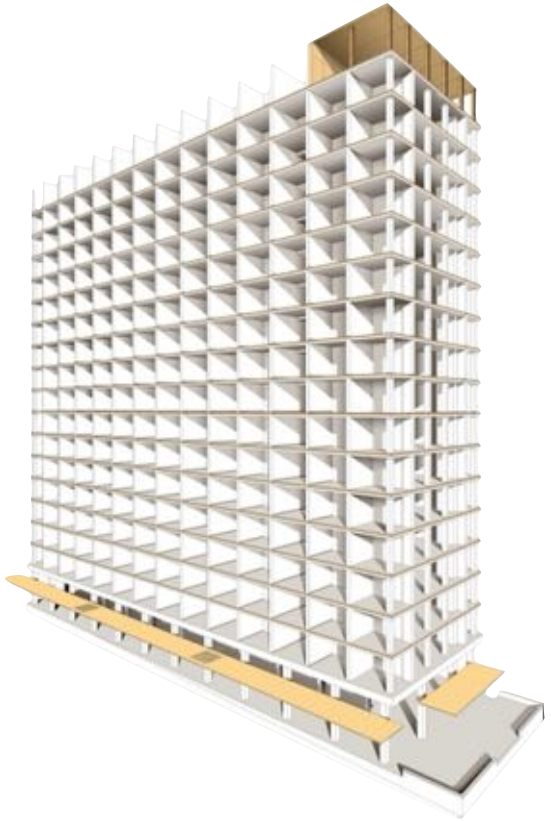
Credit: Susan Jones, atelierjones

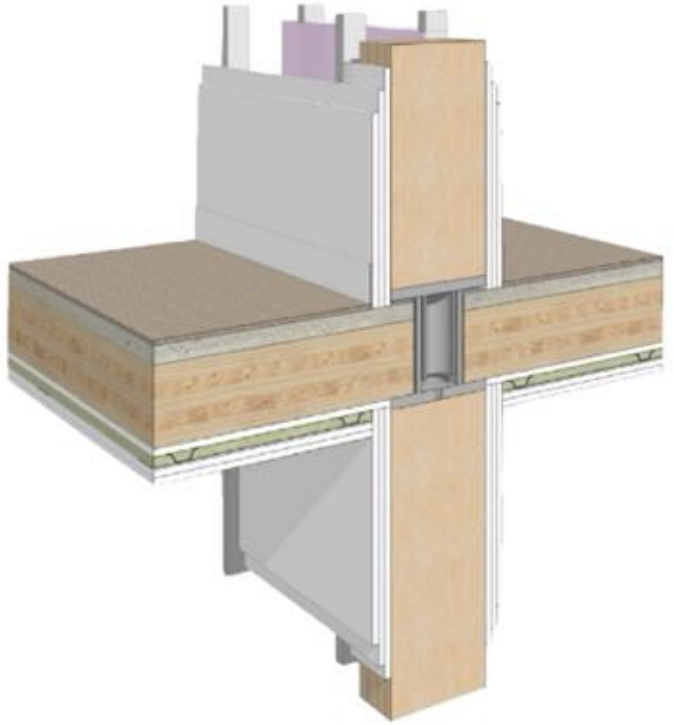
Photos: Structurlam, naturally:wood, Fast + Epp

IV-A

Type IV-A Protection vs. Exposed

Credit: Susan Jones, atelierjones





Credit: Acton Ostry Architects, Fast + Epp

100% NC protection on all surfaces of Mass Timber

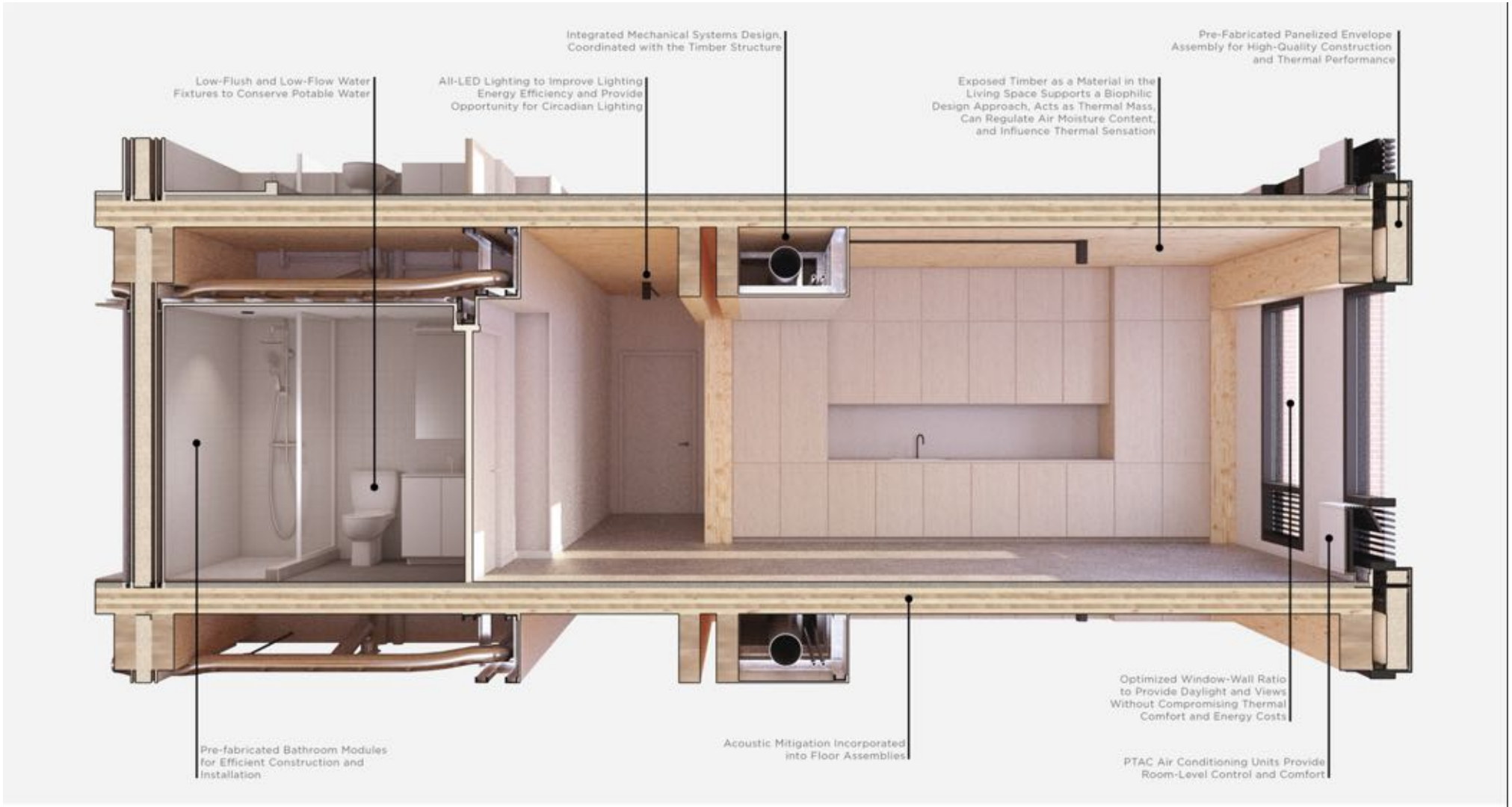
2024 IBC Changes

RISE Tests, 2020
Photo: RISE

KEY DESIGN CONSIDERATIONS

INTRO, Cleveland, OH. Credit: Harbor Bay Real Estate Advisors

MEP SYSTEMS, ROUTING, INTEGRATION



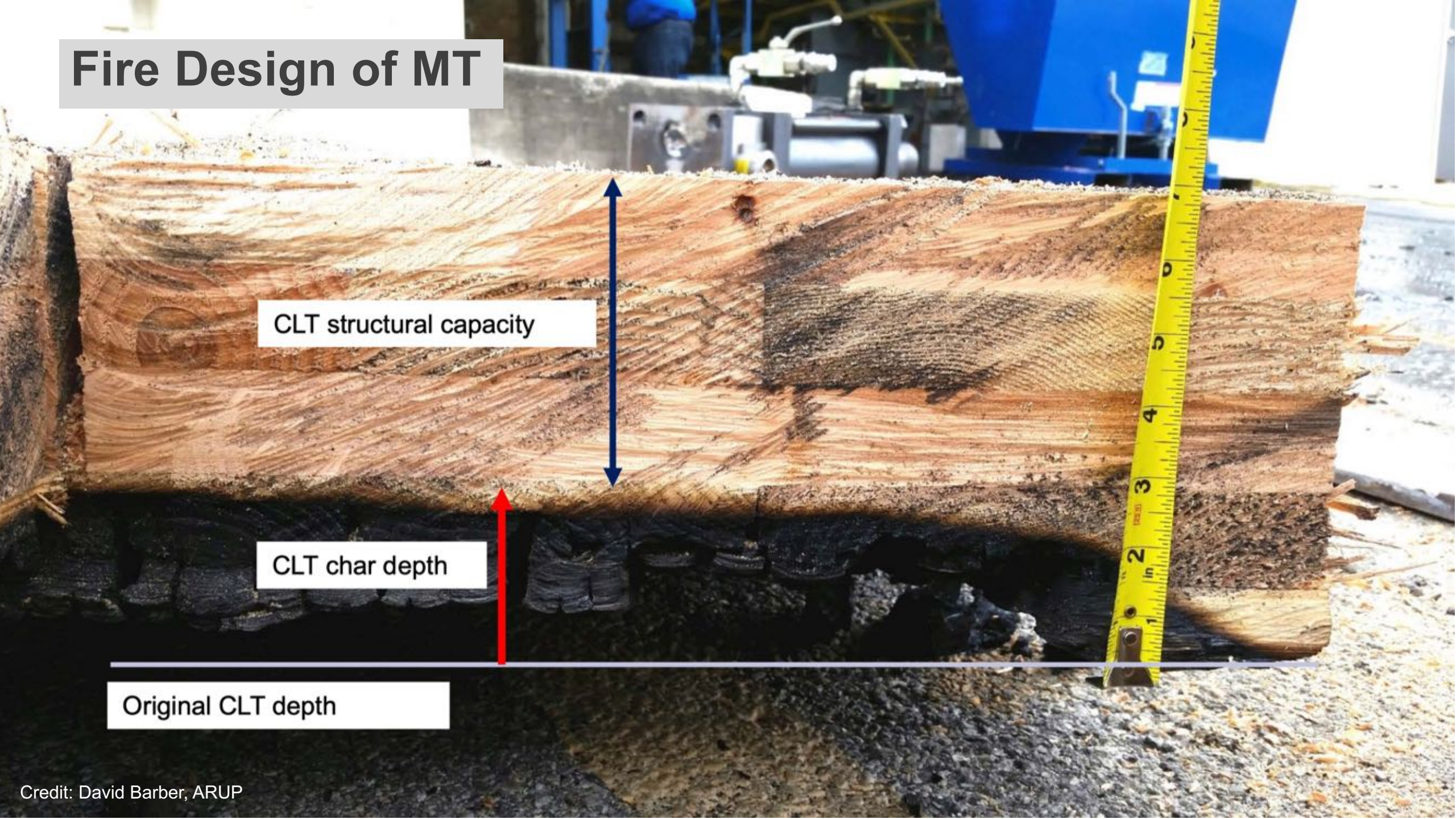
INTEGRATED SYSTEMS

The Tallhouse building system prioritizes the integration of design, engineering, and construction. This results in a high performance building finely tuned to meet energy, comfort, acoustic, and design criteria that has been vetted by constructability experts to ensure fast, efficient production.

Utilizing Pre-Fabricated Facade Panels and Bathroom Modules that are manufactured off-site in factories allows for reducing construction time on-site, higher quality control practices, and safer labor conditions for construction workers. Efficient routing of duct-work conserves material, and associated embodied carbon, allowing more exposed timber all while providing the air quality needed for healthy living. Water conserving fixtures reduce potable water use as a precious resource, while maintaining reliable performance.

Credit: John Klein, Generate Architecture

Fire Design of MT



Credit: David Barber, ARUP

Key Early Design Decisions

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 how one impacts the others)

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

FRR Design of MT

WoodWorks Inventory of Fire Tested MT Assemblies

Table 1: North American Fire Resistance Tests of Mass Timber Floor / Roof Assemblies

WoodWorks™ WOOD PRODUCTS COUNCIL

CLT Panel	Manufacturer	CLT Grade or Major x Minor Grade	Ceiling Protection	Panel Connection in Test	Floor Topping	Load Rating	Fire Resistance Achieved (Hours)	Source	Testing Lab
3-ply CLT (114mm 4.488 in)	Nordic	SPF 1650 Fb 1.5E MSR x SPF #3	2 layers 1/2" Type X gypsum	Half-Lap	None	Reduced 36% Moment Capacity	1	1 (Test 1)	NRC Fire Laboratory
3-ply CLT (105mm 4.133 in)	Structurlam	SPF #1/#2 x SPF #1/#2	1 layer 5/8" Type X gypsum	Half-Lap	None	Reduced 75% Moment Capacity	1	1 (Test 5)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	2	NRC Fire Laboratory March 2016
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer of 5/8" Type X gypsum under Z-channels and furring strips with 3 5/8" fiberglass batts	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	5	NRC Fire Laboratory Nov 2014
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	3/4 in. proprietary gypcrete over Maxxon acoustical mat	Reduced 50% Moment Capactiy	1.5	3	UL
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer 5/8" normal gypsum	Topside Spline	3/4 in. proprietary gypcrete over Maxxon acoustical mat or proprietary sound board	Reduced 50% Moment Capactiy	2	4	UL
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer 5/8" Type X Gyp under Resilient Channel under 7 7/8" I-Joists with 3 1/2" Mineral Wool beween Joists	Half-Lap	None	Loaded, See Manufacturer	2	21	Intertek 8/24/2012
5-ply CLT (175mm 6.875")	Structurlam	E1 M5 MSR 2100 x SPF #2	None	Topside Spline	1-1/2" Maxxon Cyp-Grete 2000 over Maxxon Reinforcing Mesh	Loaded, See Manufacturer	2.5	6	Intertek, 2/22/2016
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap & Topside Spline	2" gypsum topping	Loaded, See Manufacturer	2	7	SwRI (May 2016)
5-ply CLT (175mm 6.875")	Nordic	SPF 1950 Fb MSR x SPF #3	None	Half-Lap	None	Reduced 59% Moment Capacity	1.5	1 (Test 3)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	Structurlam	SPF #1/#2 x SPF #1/#2	1 layer 5/8" Type X gypsum	Half-Lap	None	Unreduced 101% Moment Capacity	2	1 (Test 6)	NRC Fire Laboratory
7-ply CLT (245mm 9.65")	Structurlam	SPF #1/#2 x SPF #1/#2	None	Half-Lap	None	Unreduced 101% Moment Capacity	2.5	1 (Test 7)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	SmartLam	SL-V4	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 4)	Western Fire Center 10/26/2016
5-ply CLT (175mm 6.875")	SmartLam	V1	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 5)	Western Fire Center 10/28/2016
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 6)	Western Fire Center 11/01/2016
5-ply CLT (160mm 6.3")	KLH	CV3M1	None	Half-Lap & Topside spline	None	Loaded, See Manufacturer	1	18	SwRI

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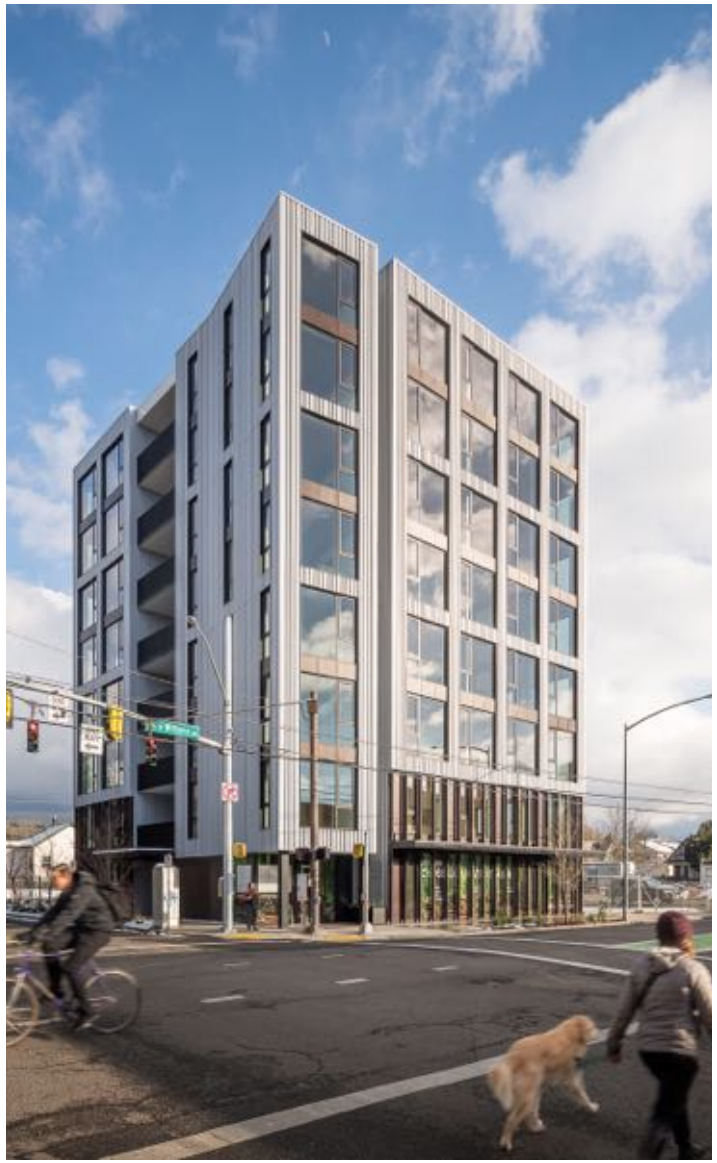
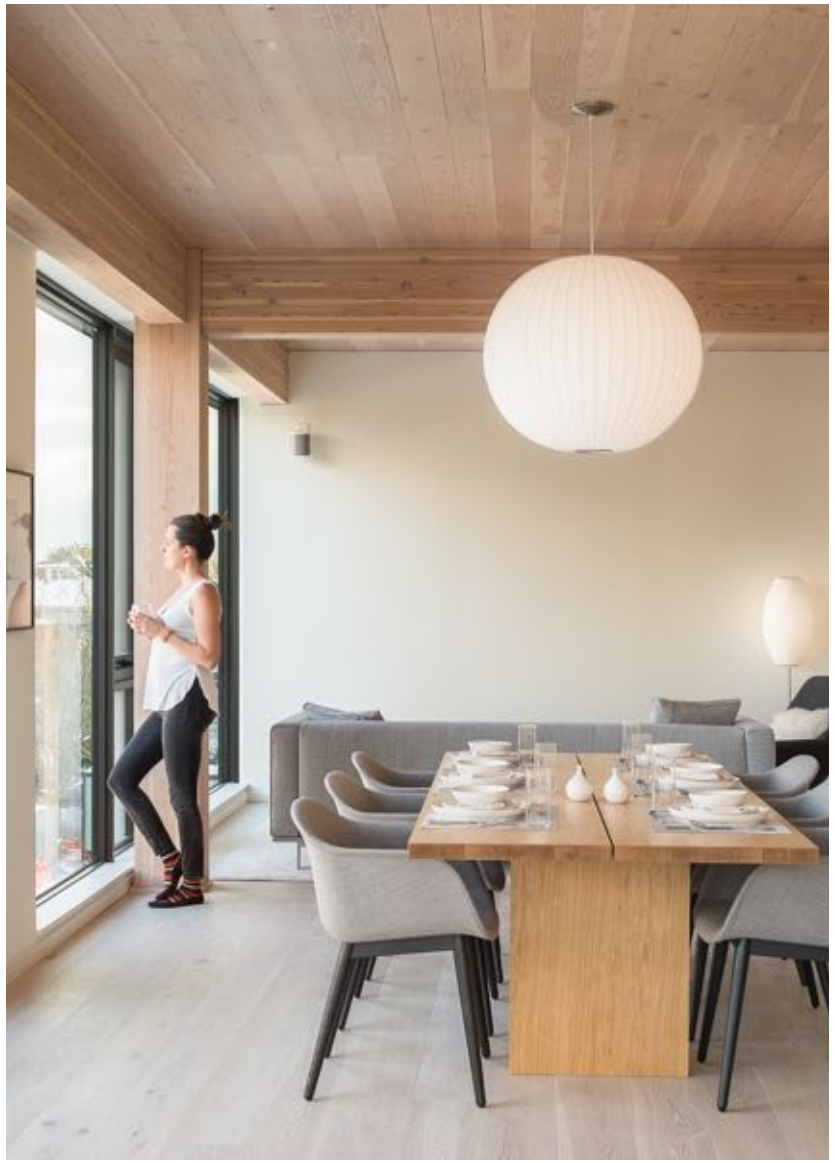
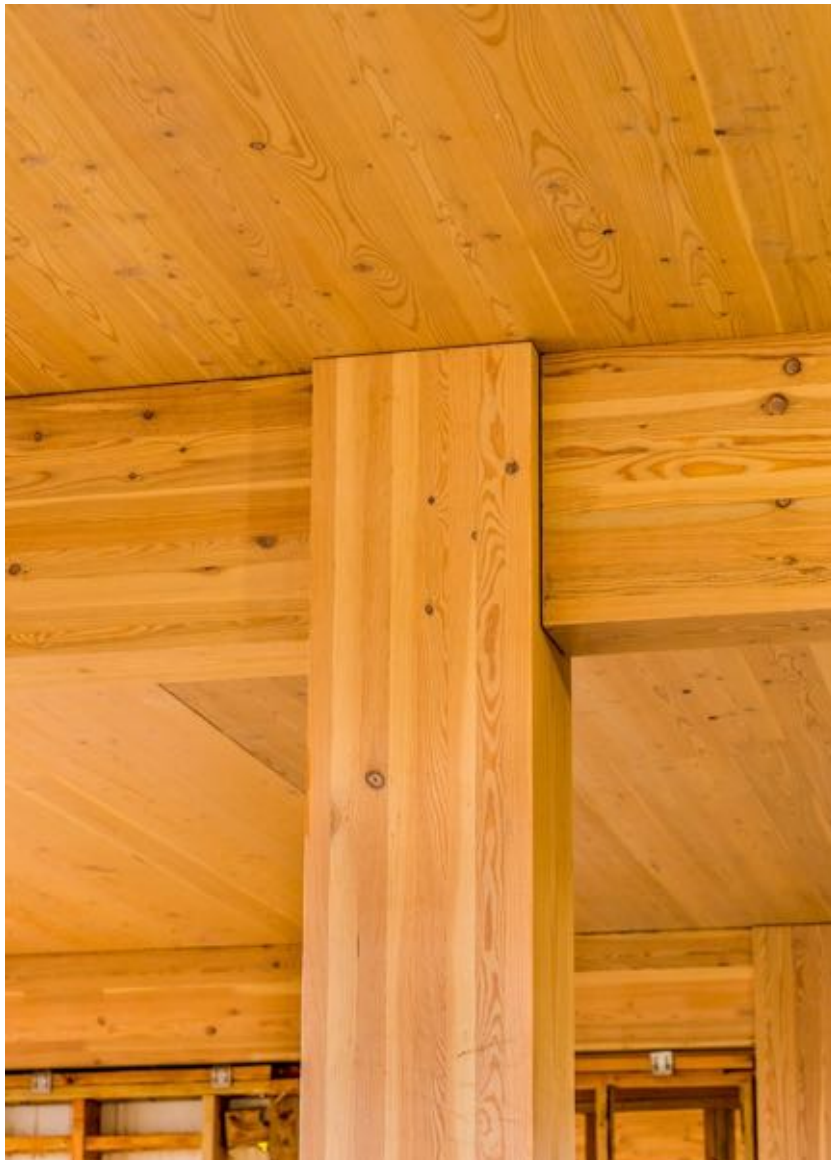
MT: Structure Often is Finish







Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman | Architect: Kaiser + PATH

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But by Itself, Not Adequate for Acoustics

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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]

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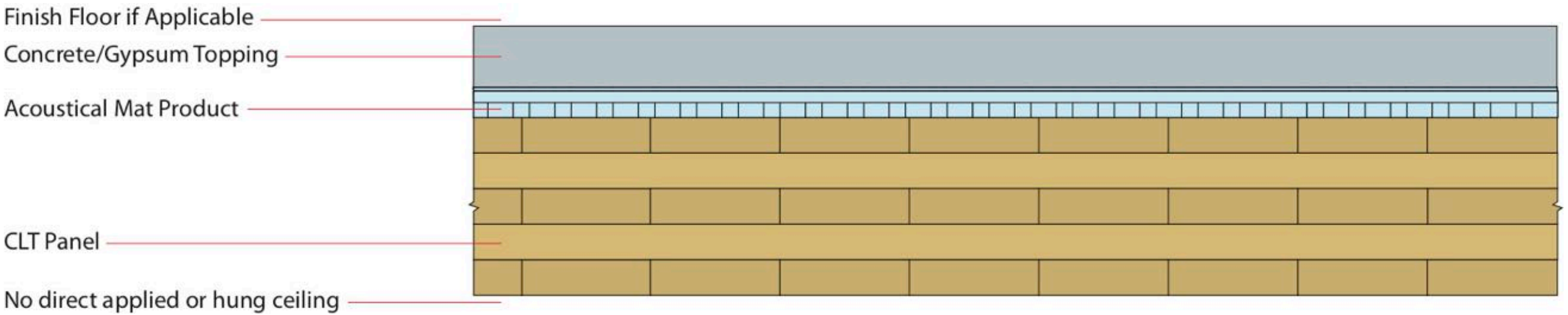
There are three main ways to improve an assembly's acoustical performance:

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



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Inventory of Tested Assemblies

Table 1: CLT Floor Assemblies with Concrete/Gypsum Topping, Ceiling Side Exposed

WoodWorks™ WOOD PRODUCTS COUNCIL

CLT Panel	Concrete/Gypsum Topping	Acoustical Mat Product Between CLT and Topping	Finish Floor	STC[1]	IIC[1]	Source
CLT 5-ply (6.875")	1-1/2" Gyp-Crete®	Maxxon Acousti-Mat® 3/4	None	47[2] ASTC	47[2] AIIC	1
			LVT	-	49[2] AIIC	
			Carpet + Pad	-	75[2] AIIC	
			LVT on Acousti-Top®	-	52[2] AIIC	
			Eng Wood on Acousti-Top®	-	51[2] AIIC	
		Maxxon Acousti-Mat® ¾ Premium	None	49[2] ASTC	45[2] AIIC	
			LVT	-	47[2] AIIC	
			LVT on Acousti-Top®	-	49[2] AIIC	
	1-1/2" Levelrock®	USG SAM N25 Ultra	None	45[6]	39[6]	15
			LVT	48[6]	47[6]	16
			LVT Plus	48[6]	49[6]	58
			Eng Wood	47[6]	47[6]	59
			Carpet + Pad	45[6]	67[6]	60
			Ceramic Tile	50[6]	46[6]	61
			None	45[6]	42[6]	15
			LVT	48[6]	44[6]	16

Questions?

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

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