Acoustics, Floor Vibration, MEP Integration, Enclosure and Moisture Protection

March 27, 2023

Presented by Jessica Scarlett, Mark Bartlett and Jason Bahr

Adidas East Village Expansion / LEVER Architecture / photo Jeremy Bittermann

Noise **Acoustics** **Sound Pollution**

Whatever you call it, it all comes down to one thing:

Occupant Comfort

Acoustical Design

Types of noise to control: **Exterior to interior**

Acoustical Design

Types of noise to control: **Noise within a space**

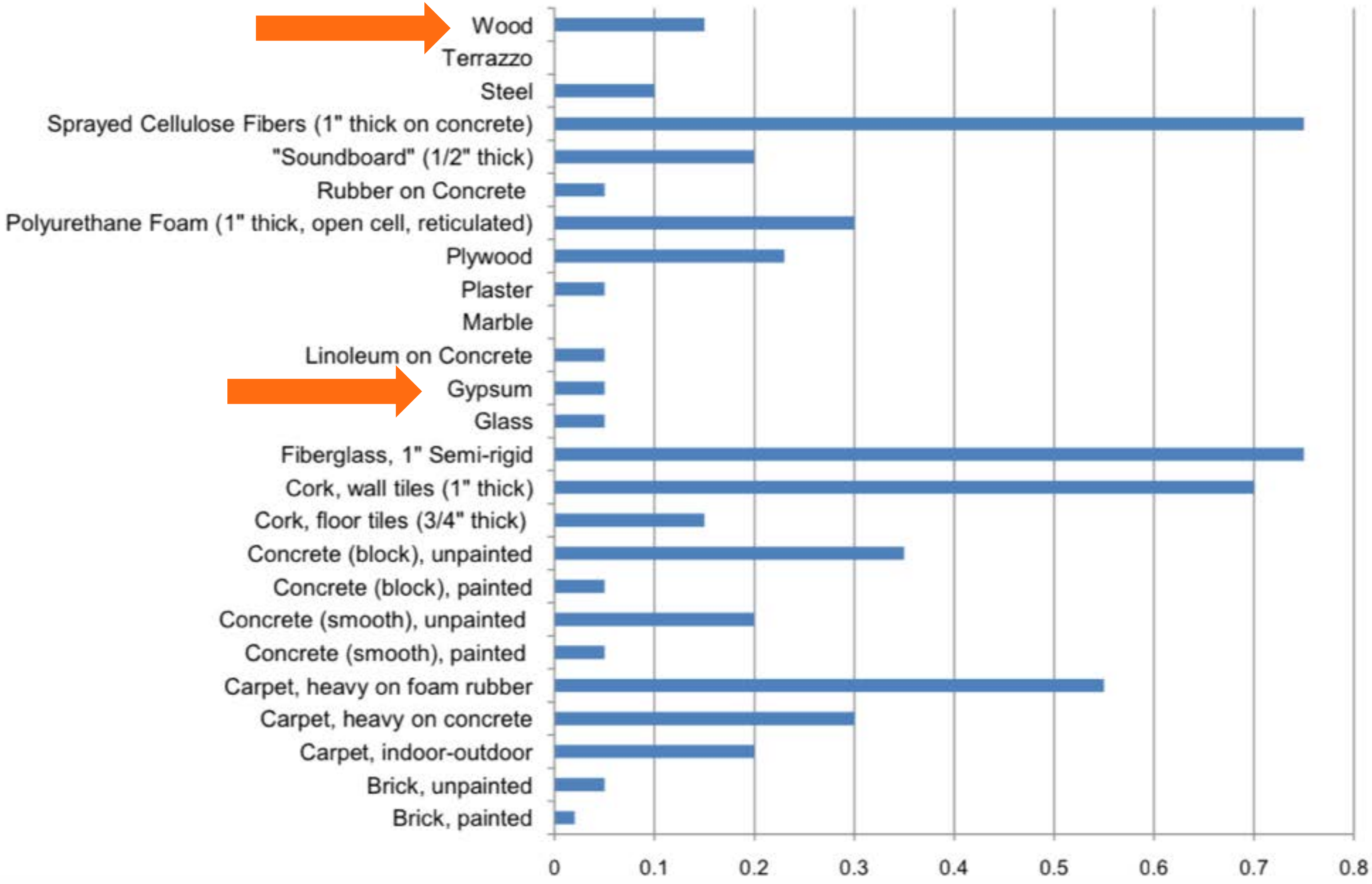
Room Acoustics

What is Sound Absorption?

All materials absorb sound energy to some degree. Whenever sound waves strike a material, part of the acoustical energy in the wave is absorbed and/or transmitted, and the remainder is reflected.

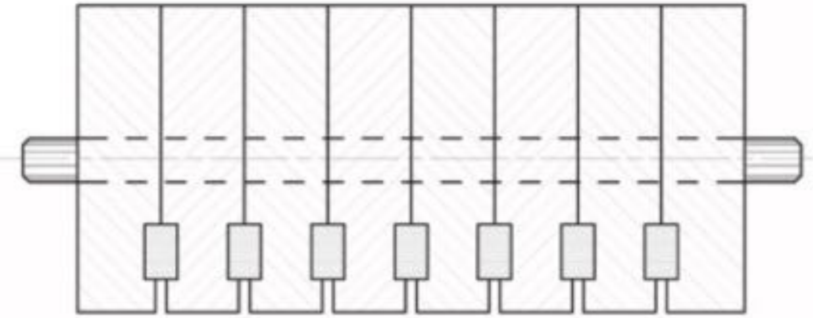
Arena Stage, Washington, DC
Photo: Nic Lehoux, Bing Thom Architects

Noise Reduction Coefficients (NRC) for Common Building Materials:

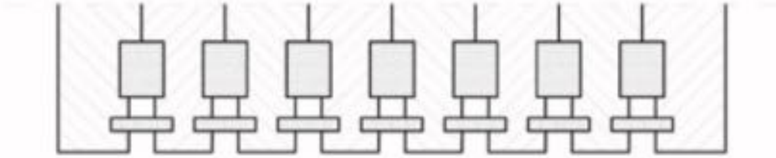


Room Acoustics

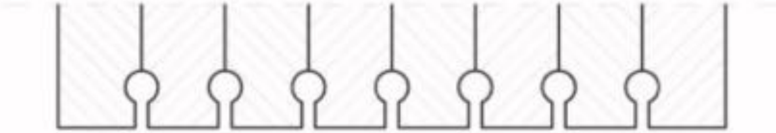
NRC of exposed wood panels like NLT & DLT can be improved with inset absorbing materials



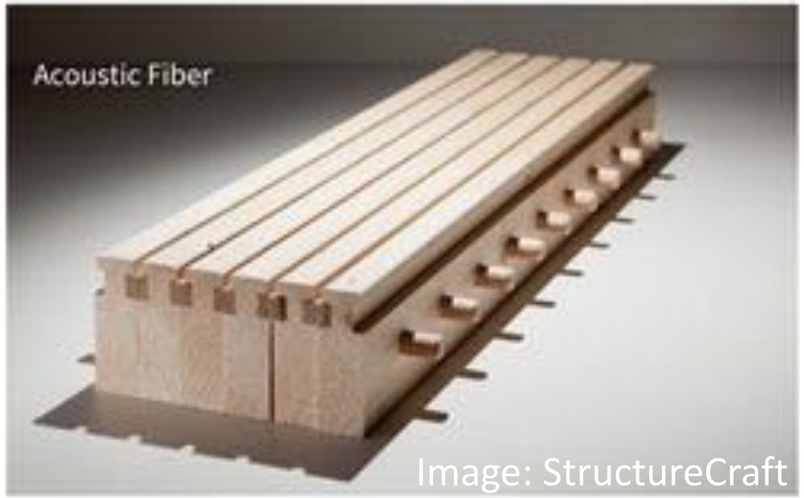
Acoustic Square with Wood Fibre (NRC = 0.55-0.65)



Acoustic Square with Wood Fibre & Felt (NRC = 0.75-0.80)



Acoustic Round (NRC = 0.10-0.25)



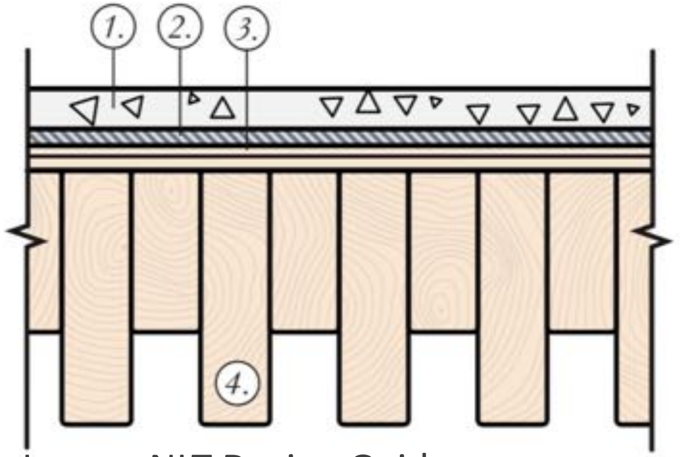


Image: NLT Design Guide

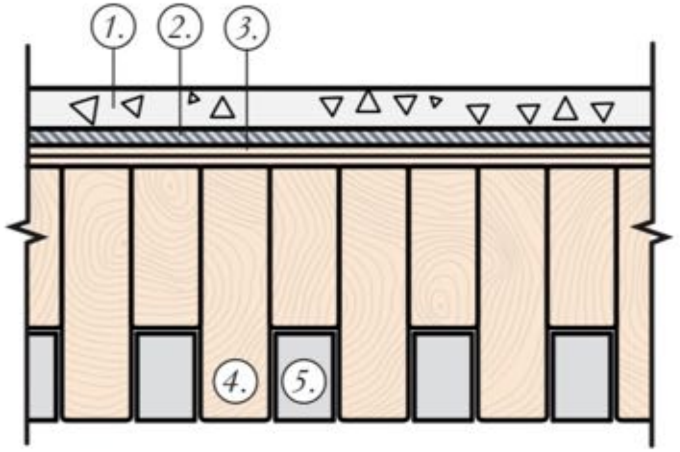


Figure 2.16: *Alternating 2x4 and 2x6 lumber with and without sound absorbing material.*

Key

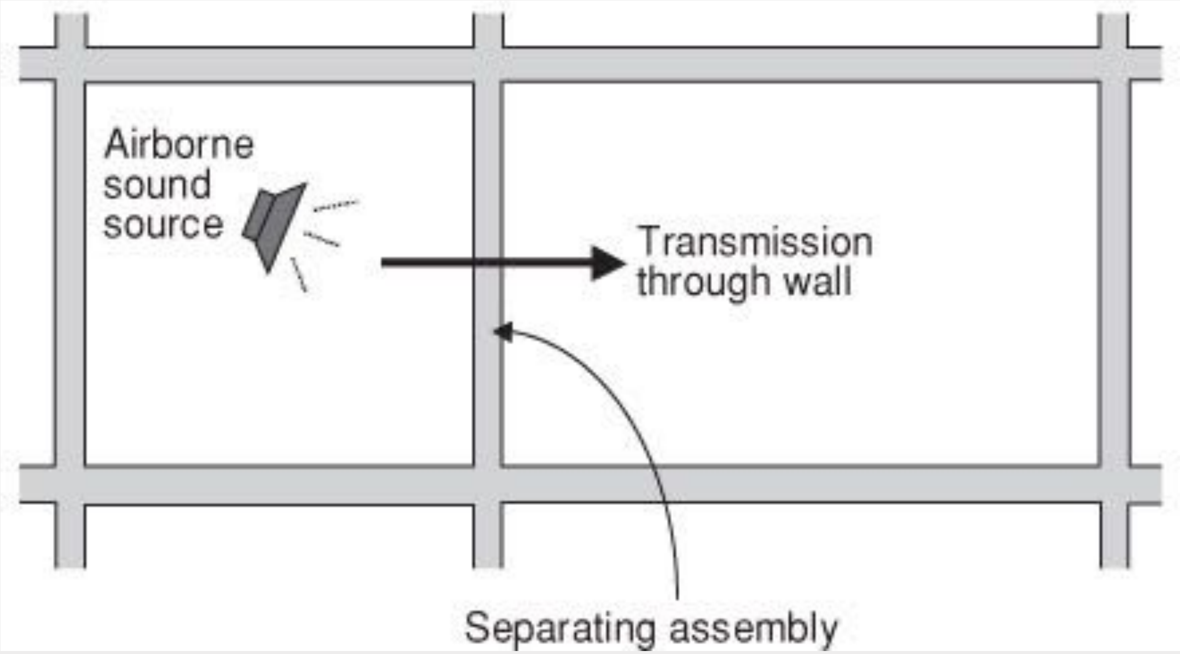
1. *Concrete topping*
2. *Acoustic mat*
3. *Plywood/OSB*
4. *NLT*
5. *Sound absorbing material*

Acoustical Design

Types of noise to control: **Interior to interior**

- **Air-Borne Sound: Sound Transmission Class (STC)**

  Measures how effectively an assembly isolates air-borne sound and reduces the level that passes from one side to the other. Applies to walls and floor/ceiling assemblies

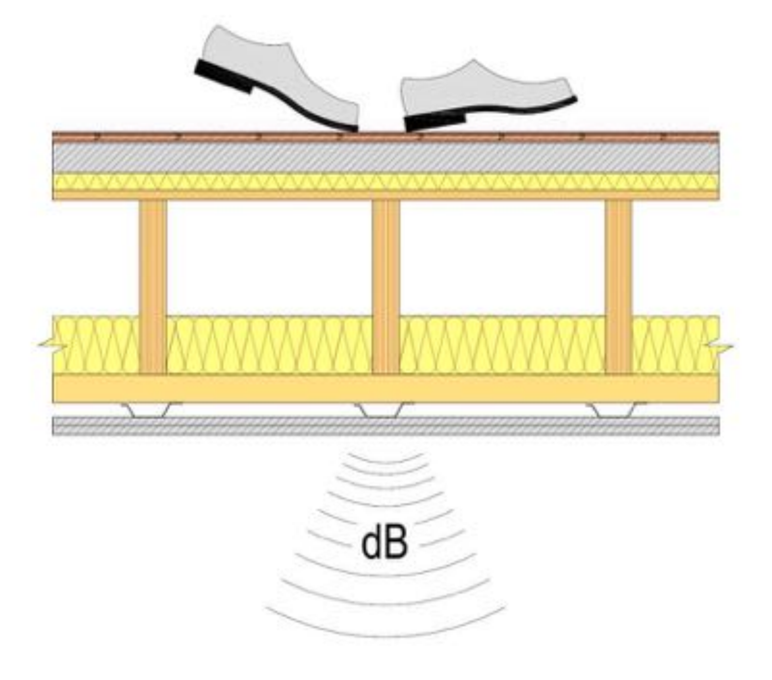


Acoustical Design

Types of noise to control: **Interior to interior**

» **<u>Structure-borne sound</u>: Impact Insulation Class (IIC)**

Evaluates how effectively an assembly blocks impact sound from passing through it. Only applies to floor/ceiling assemblies



Acoustical Criteria

Acoustical Isolation Between Units – Airborne (STC) / Impact (IIC)

Class Designation	Airborne Sound Isolation (STC)	Floor Ceiling Impact Isolation (IIC)
Entry level	50	50
Market rate	55	55
Luxury	60	60

Acoustical Detailing

Mass Timber Wall Acoustics: STC

Photo: Pam Wean, MSES Architects

Photo: Lend Lease & Schaefer

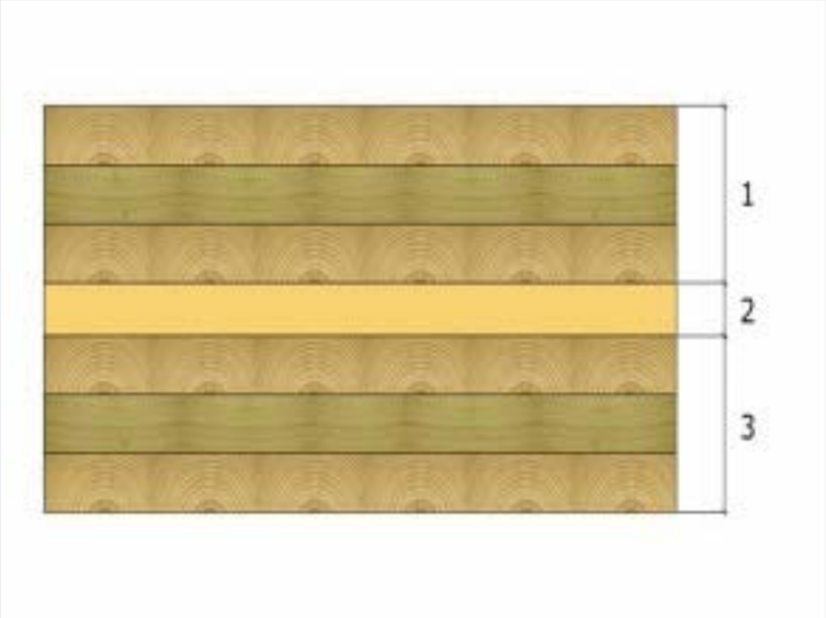
Acoustical Detailing

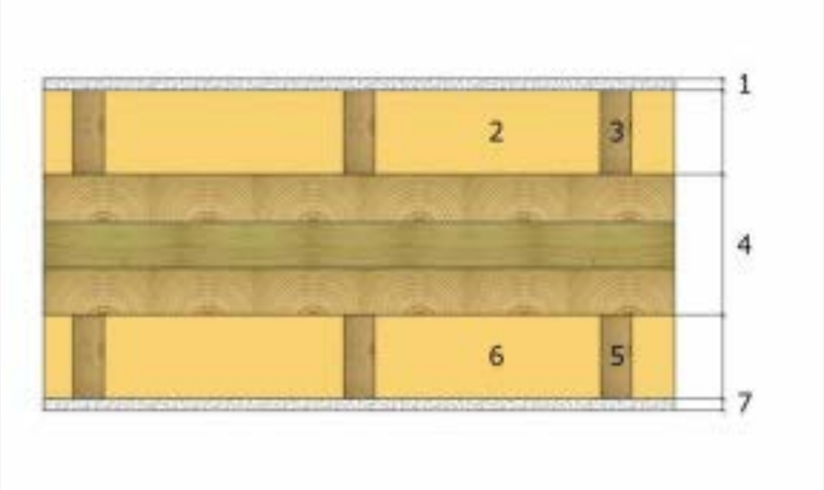
Sound Insulation of Bare CLT Floors and Walls

Number of layers	Thickness (in.)	Wall or Floor	STC	IIC
3	3-3/4 to 4-1/2	Wall	32-34	N.A.
5	5-1/3	Floor	39	23
5	5-3/4	Floor	39	24
Measured on field bare CLT wall and floor				
Number of layers	Thickness in.	Assembly type	FSTC	FIIC
3	4-1/8	Wall	28	N.A.
7	8-1/5	Floor	N.A	25-30

Credit: US CLT Handbook

Acoustical Detailing





Design Examples for >50 STC Walls

STC 50:

1 and 3 = 4-1/2 in. CLT;

2 = 1-1/8 in. Mineral wool in the gap

STC 55:

Add 5/8 in. gypsum board directly to both sides

STC 60:

Gypsum boards plus double the thickness of the gap and mineral wool

STC 58:

1 and 7 = 5/8 in. gypsum boards

3 and 5 = 2 in. by 3 in. wood studs at least 16 in. o.c.

2 and 6 = 2.5 in. mineral wool

4 = 4-1/2 in. CLT

Credit: US CLT Handbook

Acoustical Detailing

Mass Timber Floor Acoustics – STC & IIC

Photo: John Stamets

Acoustical Detailing

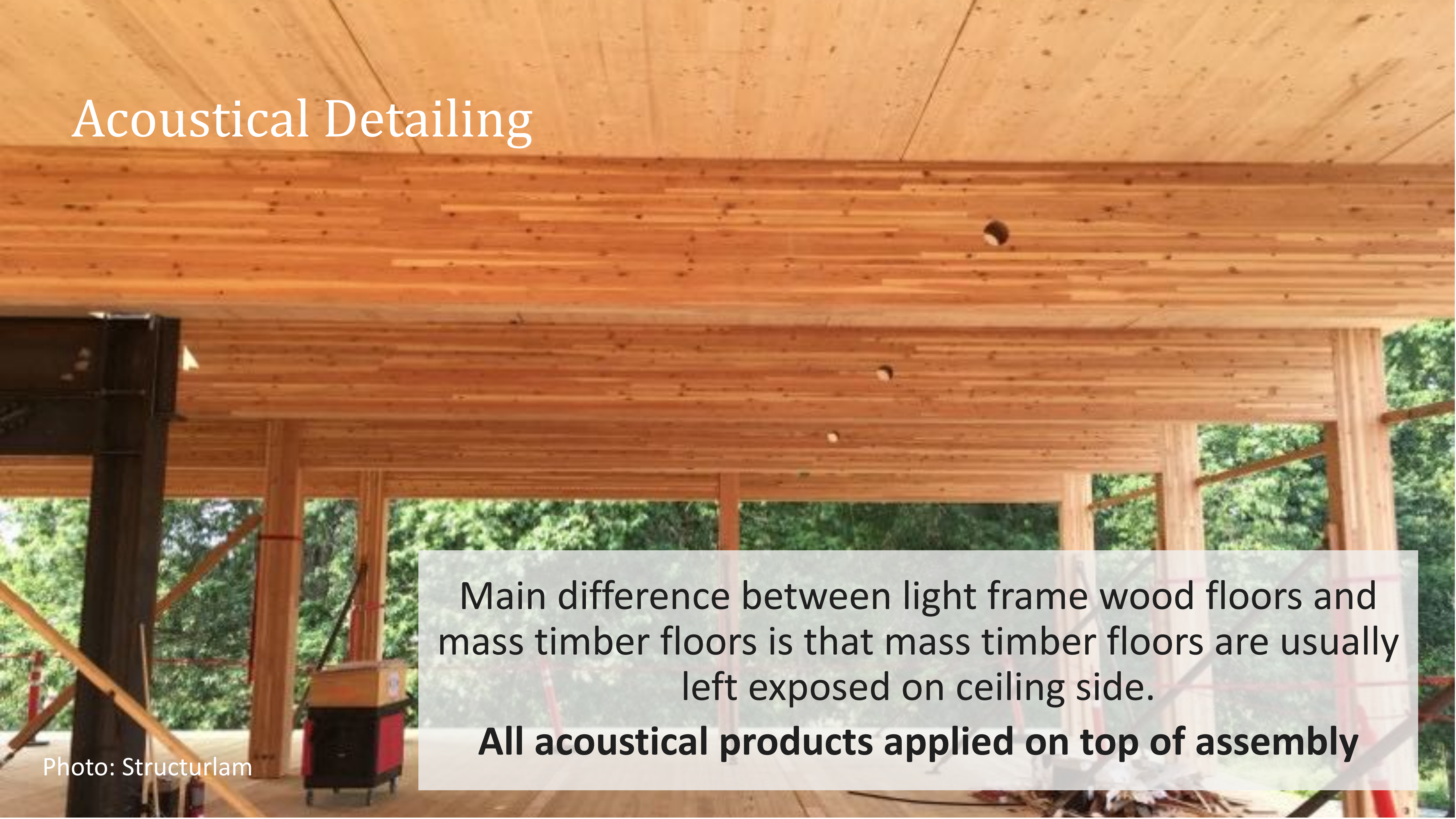


Photo: Structurlam

Main difference between light frame wood floors and mass timber floors is that mass timber floors are usually left exposed on ceiling side.

All acoustical products applied on top of assembly

Acoustical Detailing

Concrete Slab:		CLT Slab:
6” Thick		6-7/8” Thick
80 PSF	⟷	18 PSF
STC 53	⟷	STC 41

Acoustical Detailing

Common mass timber floor assembly:

- » Finish floor (if applicable)
- » Underlayment (if finish floor)
- » 1.5” to 3” thick concrete/gypcrete topping
- » Acoustical mat
- » WSP (if applicable)
- » Mass timber floor panels

Image: AcoustiTECH

Acoustical Detailing

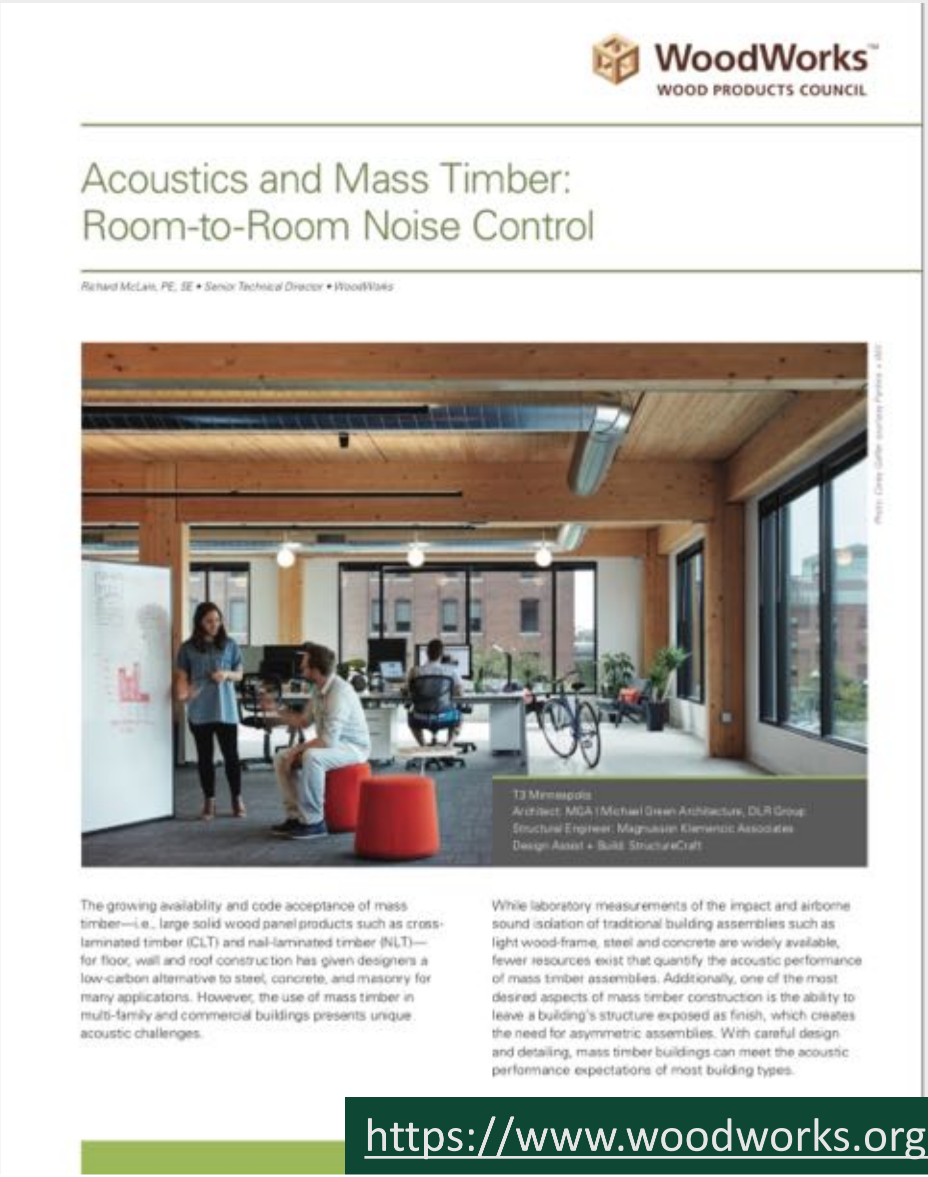
Options without concrete topping:

- Gypsum/cement board (Fermacell, Permabase, etc.)
- Proprietary products

Images: AcoustiTECH

Mass Timber Acoustics

Mass Timber Acoustics



WoodWorks™
WOOD PRODUCTS COUNCIL

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

Richard McLain, PE, SE • Senior Technical Director • WoodWorks

T3 Minneapolis
Architect: MGA | Michael Green Architecture, DLR Group
Structural Engineer: Magnusson Klemencic Associates
Design Assist + Build: StructureCraft

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.

FIGURE 3:
Interior CLT partition wall with chase walls on both sides

Example Mass Timber Wall Assembly, STC 58
Plan View

5/8" Gypsum wallboard
2x3 studs @ 16" o.c. min.
3-ply CLT panel, 4-1/2" thick
2.5" Mineral wool batt insulation

Source: US CLT Handbook

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.[4] 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.

https://www.woodworks.org/resources/acoustics-and-mass-timber-room-to-room-noise-control/

Mass Timber Acoustics

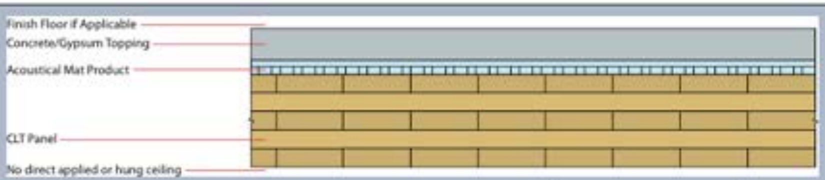
Acoustically-Tested Mass Timber Assemblies

Following is a list of mass timber assemblies that have been acoustically tested as of January 23, 2019. Sources are noted at the end of this document. For free technical assistance on any questions related to the acoustical design of mass timber assemblies, or free technical assistance related to any aspect of the design, engineering or construction of a commercial or multi-family wood building in the U.S., emai help@woodworks.org or contact the WoodWorks Regional Director nearest you: http://www.woodworks.org/project-assistance

Contents:

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® Brand 2500	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
		Soprema® Insonomat	None	45[6]	42[6]	15
			LVT	48[6]	44[6]	16
			LVT Plus	48[6]	47[6]	58
			Eng Wood	47[6]	45[6]	59
			Carpet + Pad	45[6]	71[6]	60
			Ceramic Tile	50[6]	46[6]	61
		USG SAM N75 Ultra	None	45[6]	38[6]	15
			LVT	48[6]	47[6]	16
			LVT Plus	48[6]	49[6]	58
			Eng Wood	47[6]	49[6]	59

https://www.woodworks.org/resources/inventory-of-acoustically-tested-mass-timber-assemblies/

Floor Vibration Design

"One might almost say that **strength is essential** and **otherwise unimportant**"

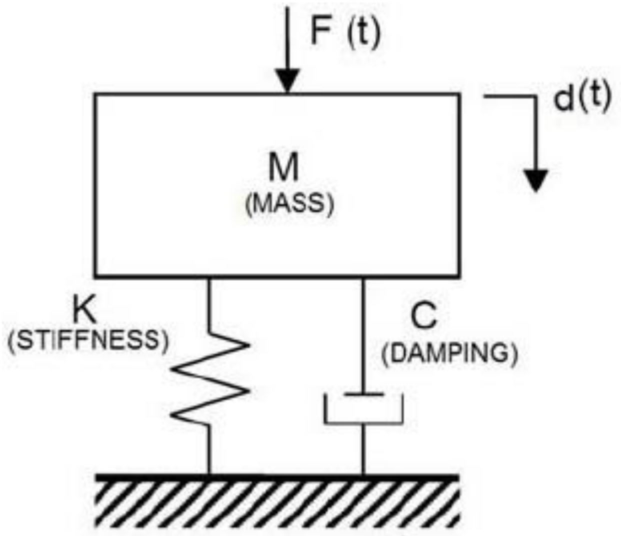
- Hardy Cross

US Building Code Requirements for Vibration

None

- Barely discussed in IBC, NDS, etc.
- ASCE 7 Commentary Appendix C has some discussion, no requirements

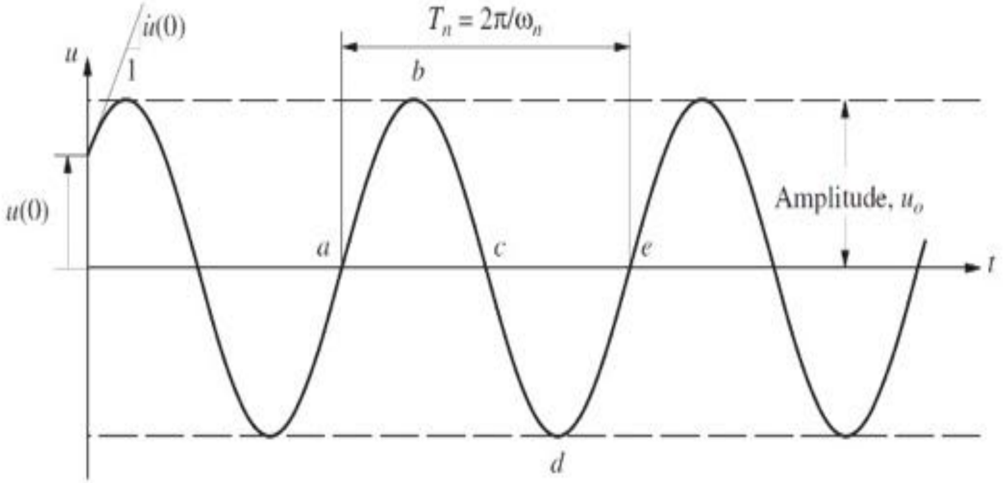
Floor Vibration Dynamics



Natural Frequency

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Undamped Free Response



Period T = 1 / f_n Frequency

Walking Frequency f_w

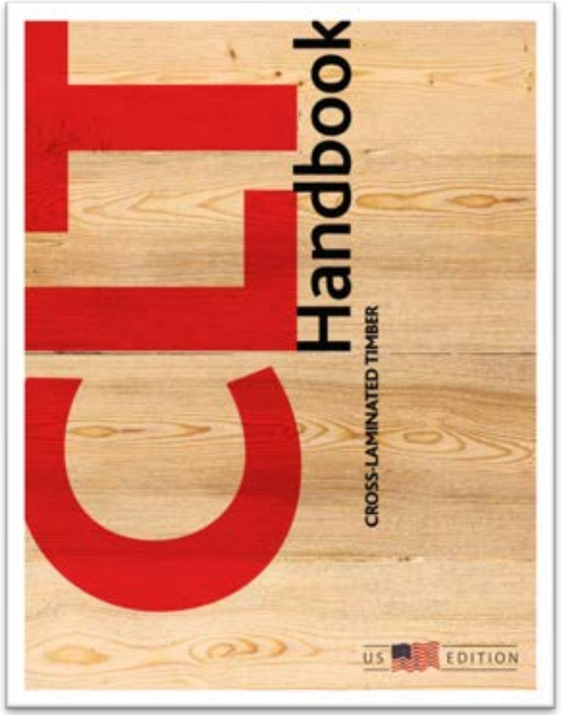
Walking Speed	Walking Frequency	Steps Per Minute
Very Slow	1.25 Hz	75 SPM
Slow	1.6 Hz	95 SPM
Moderate	1.85 Hz	110 SPM
Fast	2.1 Hz	126 SPM
Running	Up to 4.0 Hz	240 SPM
Practical Tip - walk to a metronome too understand the range		

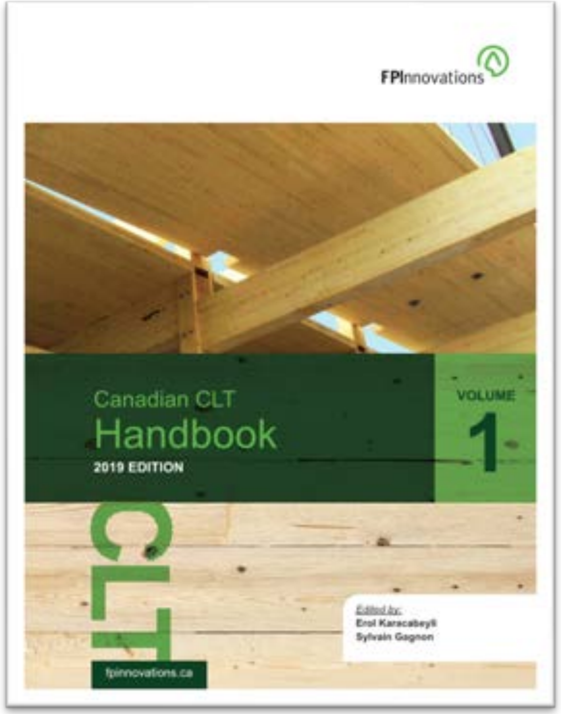
The range of walking frequencies considered is an important consideration of vibration analysis

Vibration Design Methods

Rules of Thumb → Empirical Methods → Simplified Analytical → FEM/Modal Superposition → FEM/Time History

U.S. CLT Handbook, 2013
Canadian CLT Handbook 2nd Ed., 2019
FPInnovations





CLT Handbook Base Span Limit

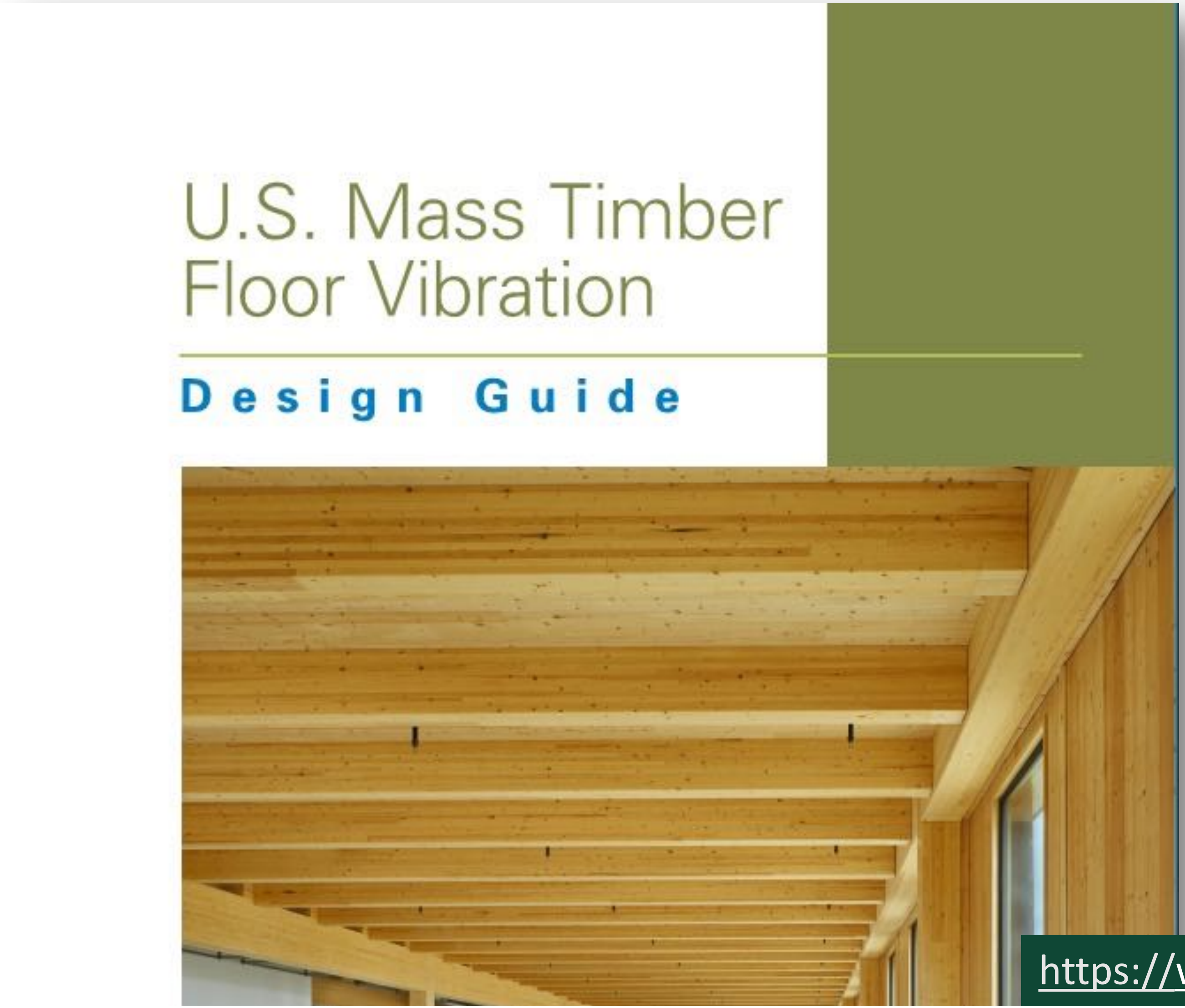
For PRG 320-2019 Basic CLT Grades and Layups from Solid Sawn Lumber

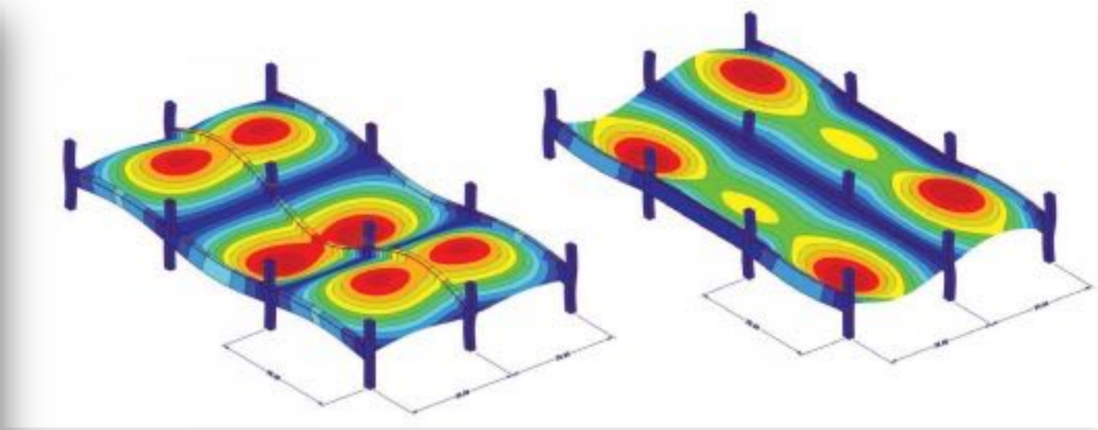
Grade	Layup	Thickness	Base Span Limit
E1	3ply	4 1/8”	13.1
	5ply	6 7/8”	18.2
	7ply	9 5/8”	22.7
E2	3ply	4 1/8”	12.4
	5ply	6 7/8”	17.2
	7ply	9 5/8”	21.6
E3	3ply	4 1/8”	12.0
	5ply	6 7/8”	16.7
	7ply	9 5/8”	20.9
E4	3ply	4 1/8”	12.7
	5ply	6 7/8”	17.6
	7ply	9 5/8”	22.1
E5	3ply	4 1/8”	12.6
	5ply	6 7/8”	17.5
	7ply	9 5/8”	21.9

Grade	Layup	Thickness	FPI Span Limit
V1	3ply	4 1/8”	12.6
	5ply	6 7/8”	17.6
	7ply	9 5/8”	22.0
V1(N)	3ply	4 1/8”	12.6
	5ply	6 7/8”	17.6
	7ply	9 5/8”	22.0
V2	3ply	4 1/8”	12.4
	5ply	6 7/8”	17.2
	7ply	9 5/8”	21.5
V3	3ply	4 1/8”	12.0
	5ply	6 7/8”	16.7
	7ply	9 5/8”	20.9
V4	3ply	4 1/8”	11.7
	5ply	6 7/8”	16.3
	7ply	9 5/8”	20.4
V5	3ply	4 1/8”	12.1
	5ply	6 7/8”	16.8
	7ply	9 5/8”	21.0

Reference: US Mass Timber Floor Vibration Design Guide, assuming 12% M.C.

New Mass Timber Floor Vibration Design Guide





Worked office, lab and residential Examples

Covers simple and complex methods for bearing wall and frame supported floor systems

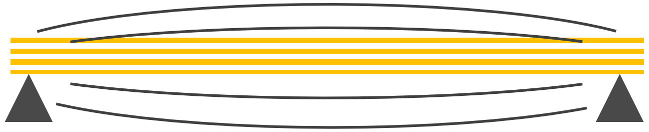
https://www.woodworks.org/publications-media/solution-papers/

Parameters of Modal Superposition Methods

Excitation Force(s)

Structure

Vibration Response



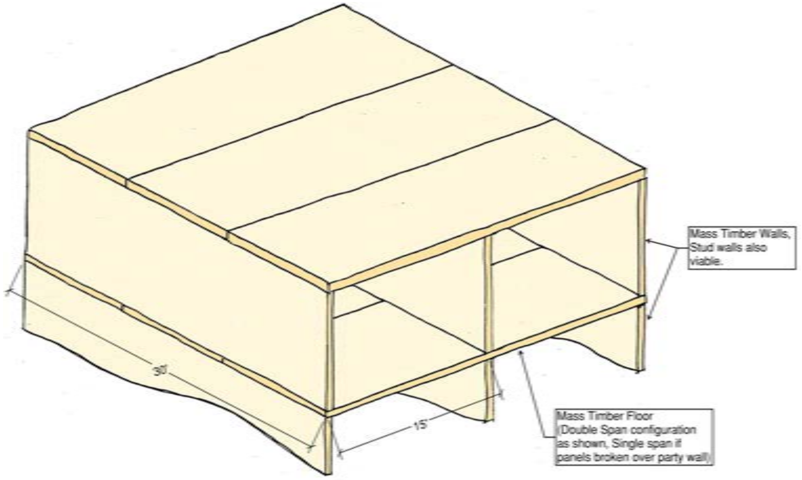
Walking Frequency, f_w
…
Walking Location
Walking Path

Stiffness
Mass/Weight
Damping
Boundary Conditions

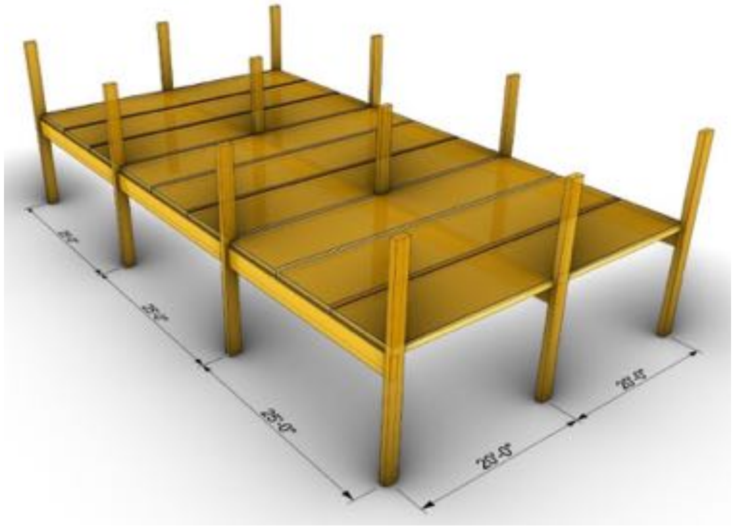
Performance Targets

Details of U.S. Mass Timber Floor Vibration Design Guide

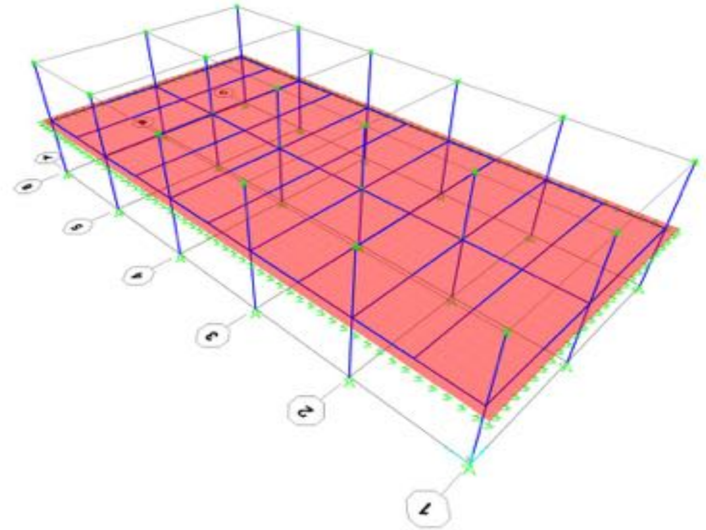
Vibration Design Examples



Residential Bearing Wall Building with CLT



Open Office with NLT on Glulam Frame

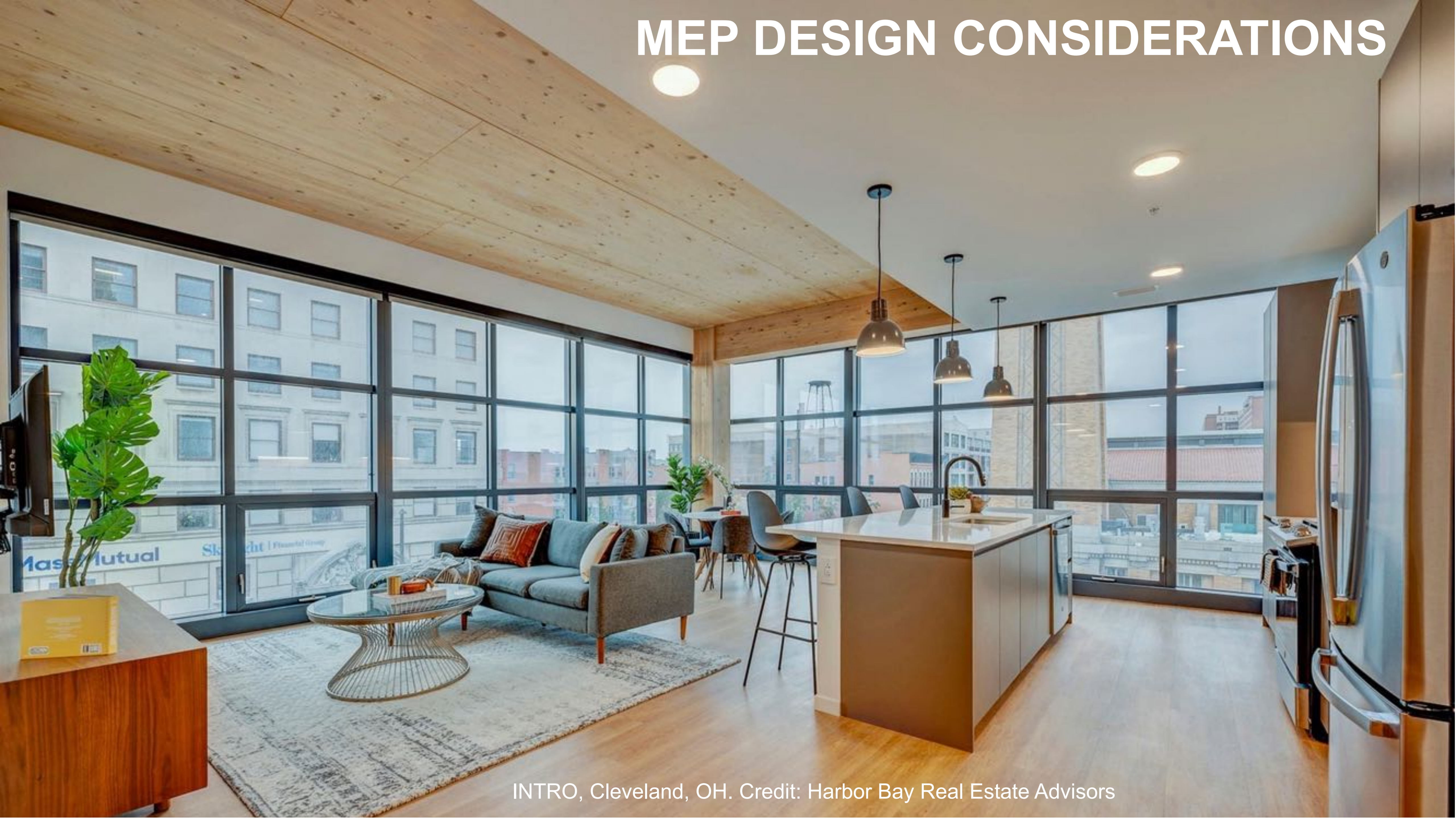


High Performance Lab Space with CLT on Glulam Frame

SB

https://www.woodworks.org/publications-media/solution-papers/

MEP DESIGN CONSIDERATIONS



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

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

MEP Layout & Integration


Photo credit: WoodWorks

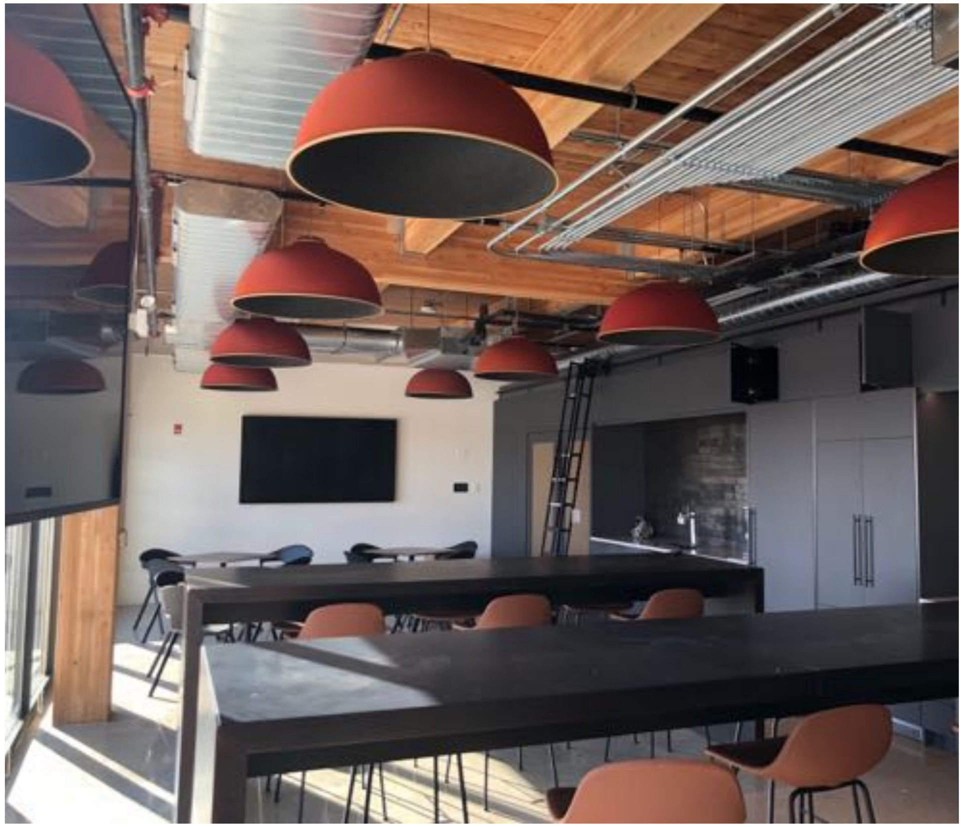
Exposed MEP

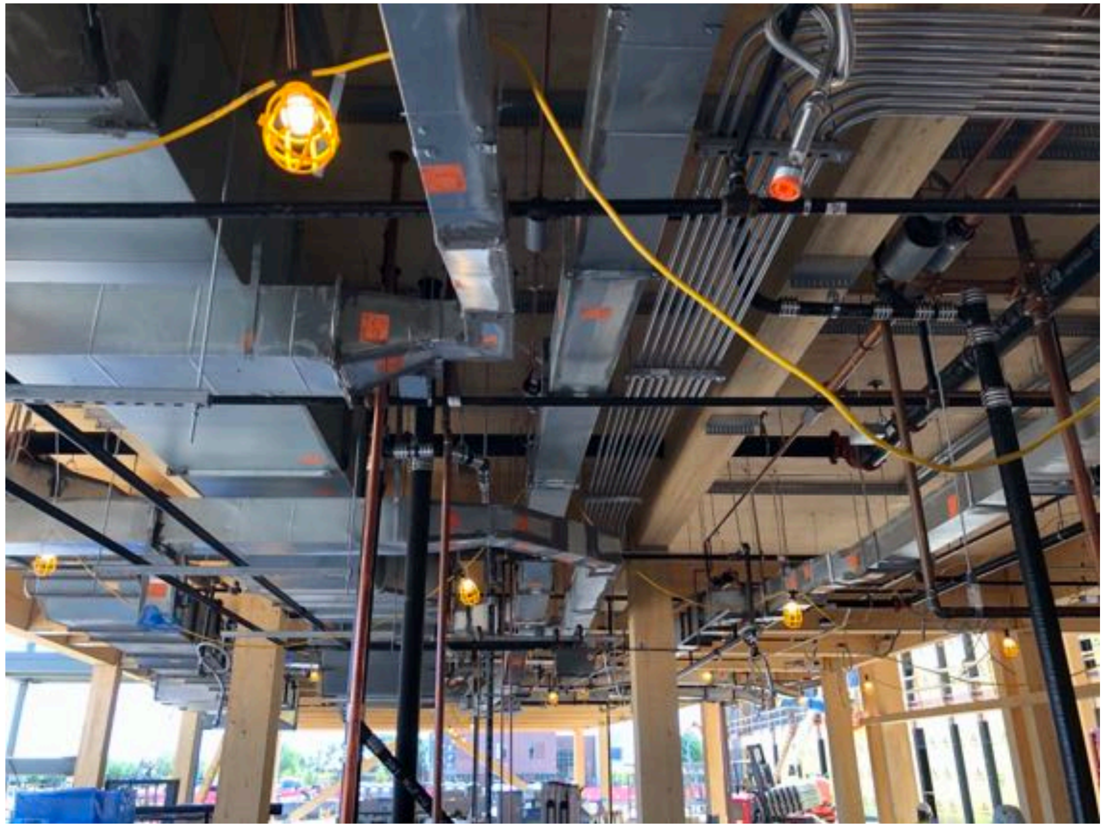
MEP items often left exposed on the ceiling side of floor assembly

MEP Layout & Integration

Set Realistic Owner Expectations About Aesthetics

- MEP fully exposed with MT structure, or limited exposure?



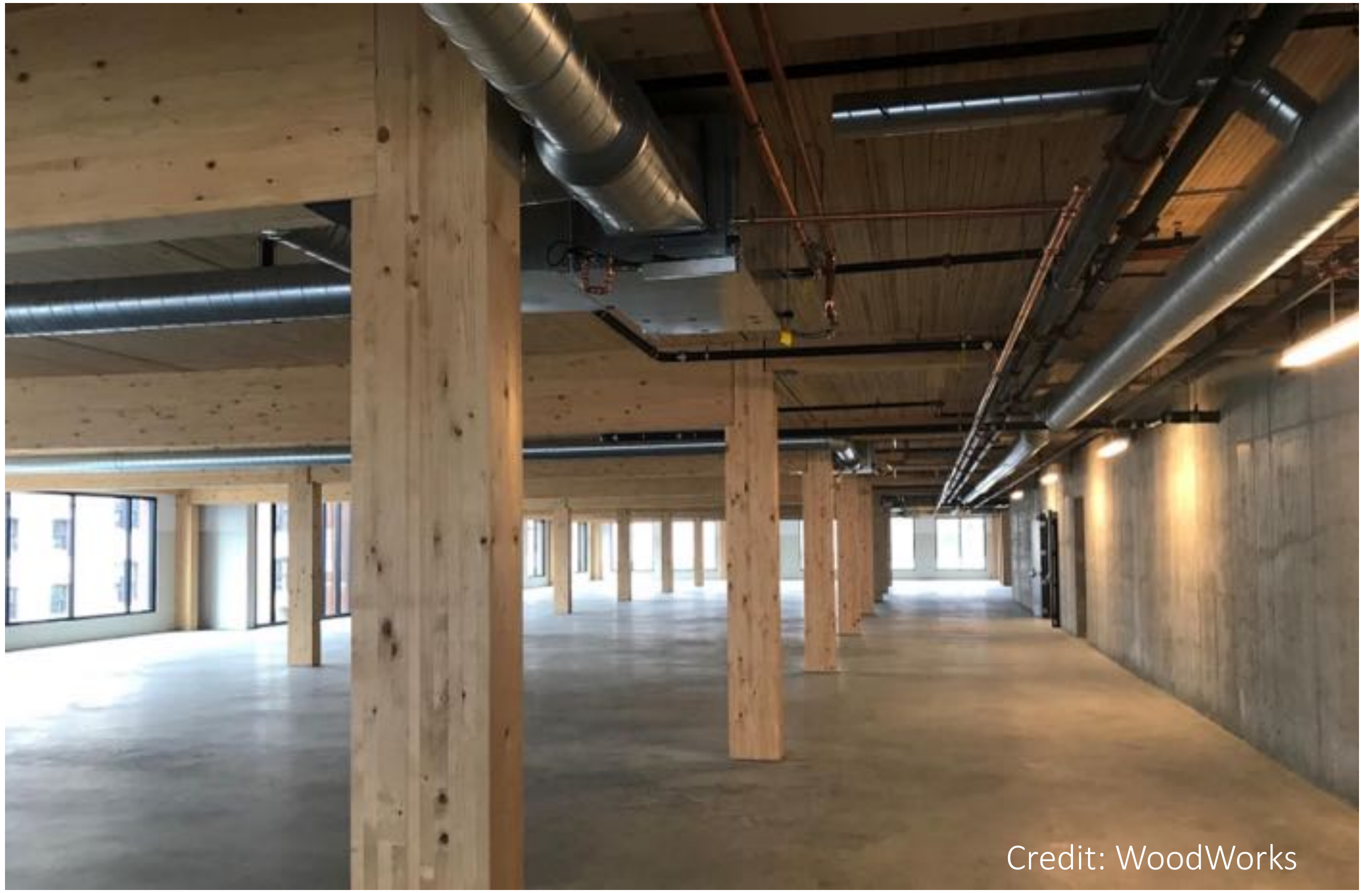


MEP Layout & Integration

Smaller grid bays at central core (more head height)

- Main MEP trunk lines around core, smaller branches in exterior bays


Credit: Blaine Brownell


Credit: WoodWorks

MEP Layout & Integration

Grid impact: one-way beam layout.

Columns/beams spaced at panel span limits in one direction.

Beam penetrations are minimized/eliminated

Recall typical panel span limits:

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

MEP Layout & Integration

Dropped below MT framing

- Can simplify coordination (fewer penetrations)
- Bigger impact on head height


Credit: Alex Schreyer


Credit: WoodWorks

MEP Layout & Integration

In penetrations through MT framing

- Requires more coordination (penetrations)
- Bigger impact on structural capacity of penetrated members
- Minimal impact on head height


Credit: WoodWorks


Credit: WoodWorks

MEP Layout & Integration

In chases above beams and below panels

- Fewer penetrations
- Bigger impact on head height (overall structure depth is greater)
- FRR impacts: top of beam exposure

Credit: JC Buck

Credit: KL&A Engineers & Builders

MEP Layout & Integration

In raised access floor (RAF) above MT
- Aesthetics (minimal exposed MEP)

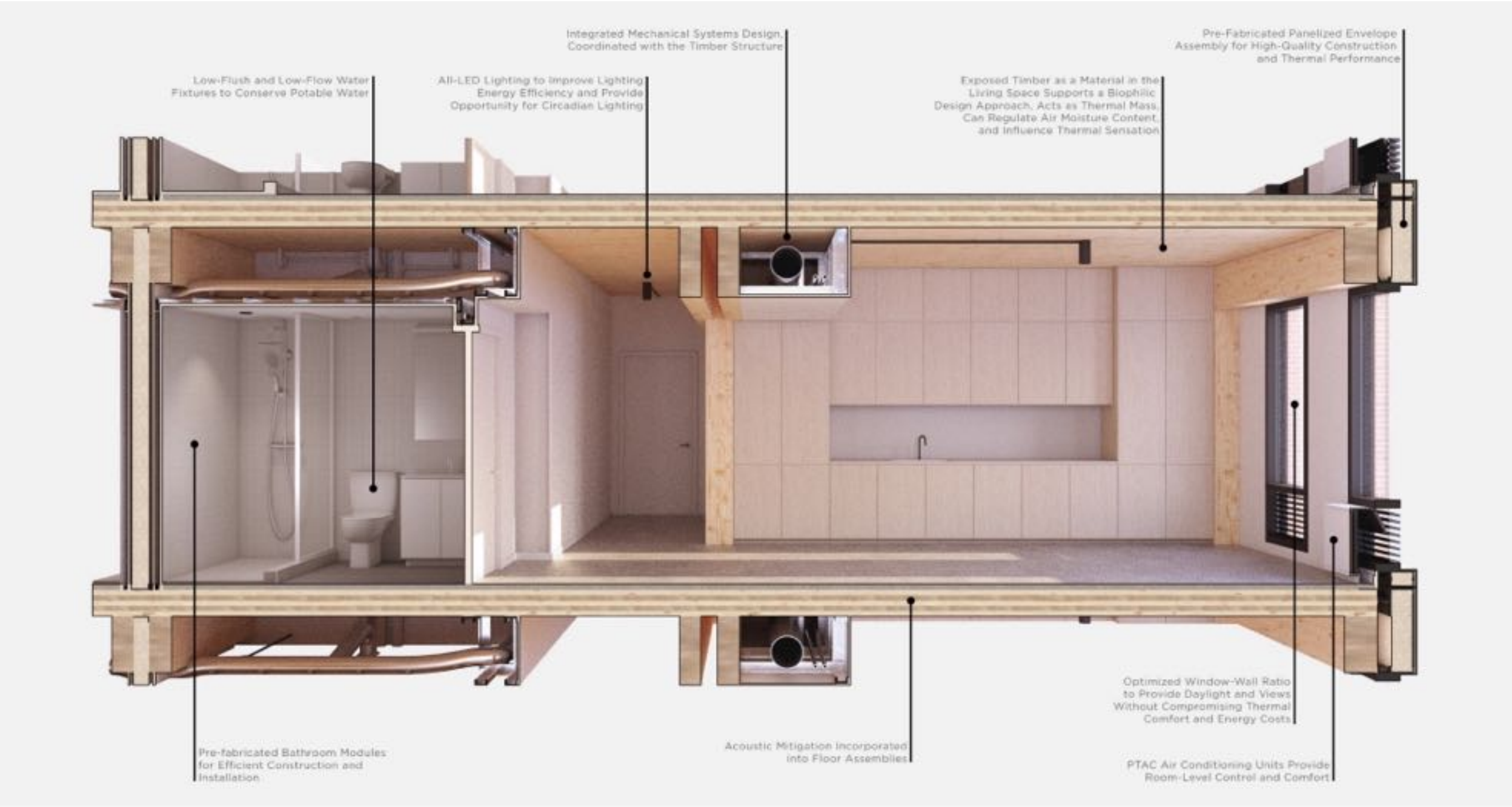
MEP Layout & Integration

In raised access floor (RAF) above MT

- Impact on head height
- Concealed space code provisions


Credit: Global IFS

MEP Layout & 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

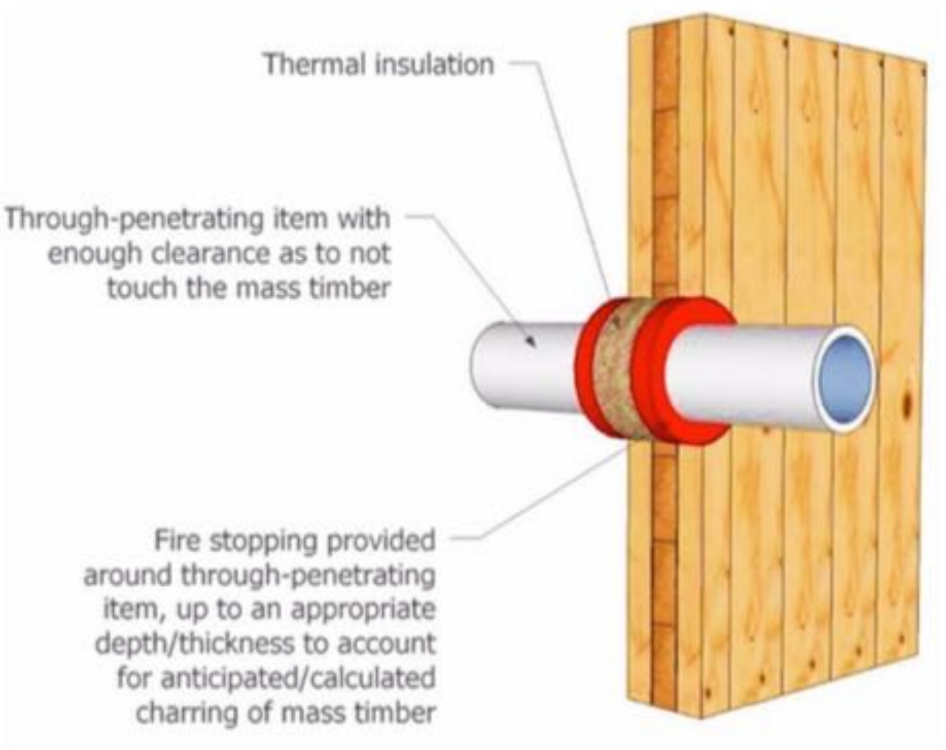
Penetration Fire Protection

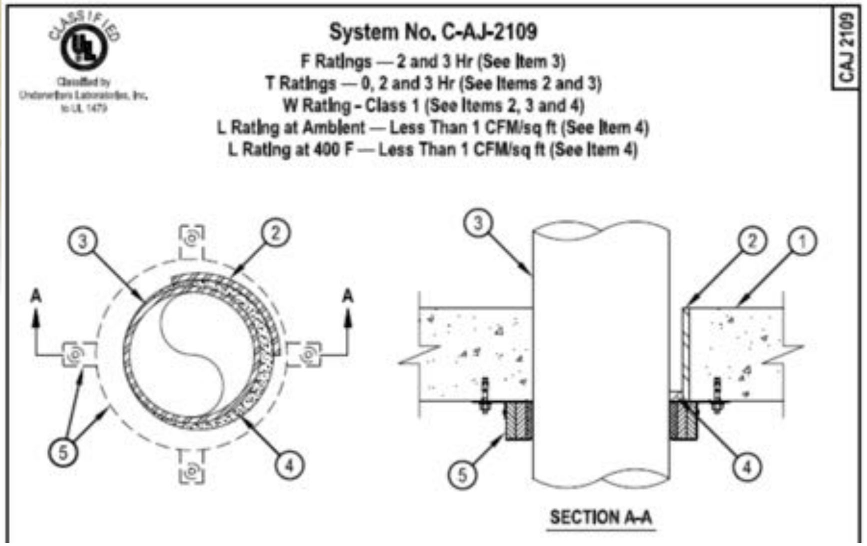
Although not a new code requirement or specific to tall wood, more testing & information is becoming available on firestopping of penetrations through MT assemblies

Photos: AWC/FPInnovations

Penetration Fire Protection

Most firestopping systems include combination of fire safing (eg. noncombustible materials such as mineral wool insulation) plus fire caulk





Photos: AWC/FPInnovations/Hilti

Penetration Fire Protection

Firestop systems tests on Mass Timber
Contact WoodWorks for information

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FIRE RESISTANCE PERFORMANCE EVALUATION OF A PENETRATION FIRESTOP SYSTEM TESTED IN ACCORDANCE WITH ASTM E814-13A, *STANDARD TEST METHOD FOR FIRE TESTS OF PENETRATION FIRESTOP SYSTEMS*

FINAL REPORT
Consisting of 18 Pages

SwRI® Project No. 01.21428.01.001a
Test Date: September 30, 2015
Report Date: October 22, 2015

Prepared for:

American Wood Council
222 Catoctin Circle SE
Leesburg, VA 20175

WCTE 2018
2018 World Conference on Timber Engineering
August 20 - 23, 2018 | Seoul, Republic of Korea

FIRE PERFORMANCE OF FIRESTOPS, PENETRATIONS, AND FIRE DOORS IN MASS TIMBER ASSEMBLIES

Lindsay Ranger [1], Christian Dagenais [1], Conroy Lum[1], Tony Thomas[1]

ABSTRACT: Integrity and continuity must be maintained for fire separations required to provide fi prevent passage of hot gases or increased temperature on the unexposed side. Vulnerable locations, whe are introduced into mass timber systems, are susceptible to fire spread. Service and closure penetrat timber fire separation have been investigated. Many of the fire stop systems were able to achieve 1-½ accordance with CAN/ULC-S115, which would be required for 2-hr fire resistance rated assemblies, su tall wood buildings. Construction details are outlined which ensure adequate fire performance of these p

KEYWORDS: Firestop, through-penetrations, fire rated door, mass timber, cross-laminated tim buildings, fire resistance

1 INTRODUCTION

Many tall wood buildings using mass timber are planned or are currently being designed for construction around the world. A few have been built in Canada, including an 18 storey cross-laminated timber (CLT) and glulam building in British Columbia. The prescriptive requirements in the National Building Code of Canada (NBCC) [1] do not (yet) permit the construction of wood buildings taller than six stories, however an alternative

construction, as well as in several alter building designs.

Although the general fire performance well documented, there are still sever warrant further investigation to ensure safety levels are met and a number available for designers to use. Generating generic assemblies will reduce the need f completed on an individual construction

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FIRESTOPPING TEST WITNESS REPORT

for

NORDIC STRUCTURES

Penetration Fire Protection

Inventory of Fire Tested Penetrations in MT Assemblies

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Table 3: North American Fire Tests of Penetrations and Fire Stops in CLT Assemblies

CLT Panel	Exposed Side Protection	Penetrating Item	Penetrant Centered or Offset in Hole	Firestopping System Description	F Rating	T Rating	Stated Test Protocal	Source	Testing Lab
3-ply (78mm 3.07")	None	1.5" diameter data cable bunch	Centered	3.5 in diameter hole. Mineral wool was installed in the 1in. annular space around the data cables to a total depth of approximately 2 – 5/64 in. The remaining 1in. annular space from the top of the mineral wool to the top of the floor assembly was filled with Hilti FS-One Max caulking.	1 hour	0.5 hour	CANULC S115	26	Intertek March 30, 2016
3-ply (78mm 3.07")	None	2" copper pipe	Centered	4.375 in diameter hole. Pipe wrap was installed around the copper pipe to a total depth of approximately 2 – 5/64in. The remaining 1in. annular space starting at the top of the mineral wool to the top of the floor assembly was filled with Hilti FS-One Max caulking.	1 hour	N.A.	CANULC S115	26	Intertek March 30, 2016
3-ply (78mm 3.07")	None	2.5" sched. 40 pipe	Centered	4.92 in diameter hole. Pipe wrap was installed around the schedule 40 pipe to a total depth of approximately 2 – 5/64in. The remaining 1in. annular space starting at the top of the pipe wrap to the top of the floor assembly was filled with Hilti FS-One Max caulking.	1 hour	N.A.	CANULC S115	26	Intertek March 30, 2016
3-ply (78mm 3.07")	None	6" cast iron pipe	Centered	8.35 in diameter hole. Mineral wool was installed in the 1in. annular space around the cast iron pipe to a total depth of approximately 2 – 5/64in. The remaining 1in. annular space starting at the top of the pipe wrap to the top of the floor assembly was filled with Hilti FS-One Max caulking.	1 hour	N.A.	CANULC S115	26	Intertek March 30, 2016
3-ply (78mm 3.07")	None	Hilti 6 in drop in device. System No.: F-B-2049	Centered	9.01" diameter hole. Mineral wool was installed in the 1 – 1/4in. annular space around the drop-in device to a total depth of approximately 1 – 7/64in and the remaining 1in. annular space from the top of the mineral wool to the top edge of the 9 – 1/64in. hole in the CLT was filled with Hilti FS-One Max caulking.	1 hour	0.75 hour	CANULC S115	26	Intertek March 30, 2016
5-ply CLT (131mm 5.16")	None	1.5" diameter data cable bunch	Centered	3.5" diameter hole. Mineral wool was installed in the 1in. annular space around the data cables to a total depth of approximately 4 – 5/32 in. The remaining 1in. annular space from the top of the mineral wool to the top of the floor assembly was filled with Hilti FS-One Max caulking.	2 hours	1.5 hours	CANULC S115	26	Intertek March 30, 2016
5-ply CLT (131mm 5.16")	None	2" copper pipe	Centered	4.375 in diameter hole. Pipe wrap was installed around the copper pipe to a total depth of approximately 4 – 5/32 in. The remaining 1in. annular space starting at the top of the mineral wool to the top of the floor assembly was filled with Hilti FS-One Max caulking.	2 hours	N.A.	CANULC S115	26	Intertek March 30, 2016
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5-ply (175mm 6.875")	None	1" nominal PVC pipe	Centered	4.21 in diameter with a 3/4 in plywood reducer flush with the top of the slab reducing the opening to 2.28 in. Two wraps of Hilti CP 648-E W45/1-3/4" Firestop wrap strip at two locations with a 30 gauge steel sleeve which extended from the top of the slab to 1 in below the slab. The first location was with the bottom of the wrap strip flush with the bottom of the steel sleeve and the second was with the bottom of the wrap strip 3 in. from the bottom of the slab. The void between the steel sleeve and the CLT and between the steel sleeve and pipe at the top was filled with Roxul Safe mineral wool leaving a 3/4 in deep void at the top of the assembly. Hilti FS-One Max Intumescent Firestop Sealant was applied to a depth of 3/4 in on the top of the assembly between the plywood and steel sleeve as well as the steel sleeve and pipe.	2 hours	2 hours	ASTM E814	24	QAI Laboratories March 3, 2017

New for GCs and installers:

U.S. Mass Timber Construction Manual

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20. OSHA. *Other OSHA Requirements That May Apply to Your Jobsite.* https://www.osha.gov/complianceassistance/quickstarts/construction#step2
21. OSHA. *Survey Your Workplace for Additional Hazards.* https://www.osha.gov/complianceassistance/quickstarts/construction#step3
22. OSHA. *Develop a Jobsite Safety and Health Program.* https://www.osha.gov/complianceassistance/quickstarts/construction#step4

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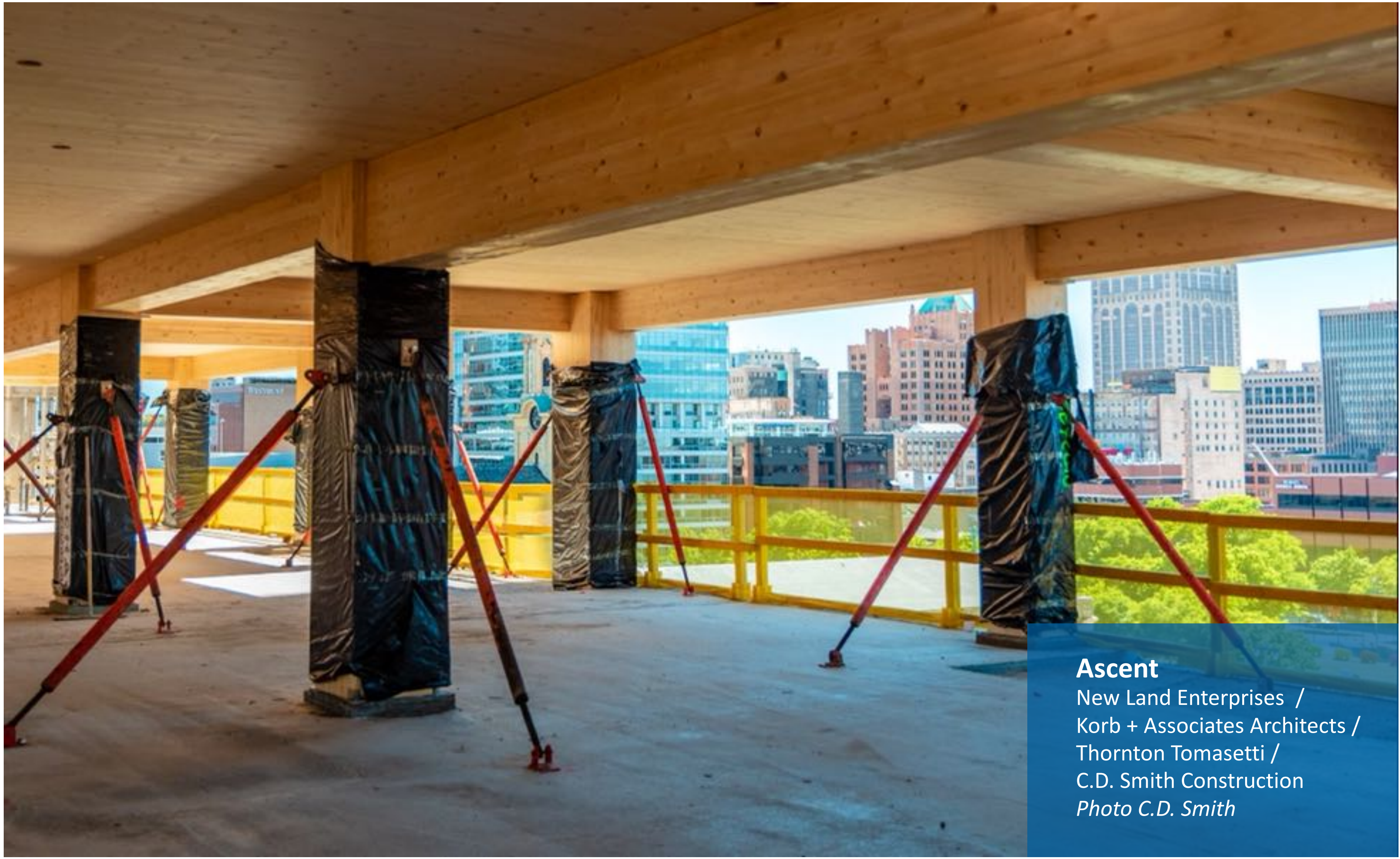
PHOTO: MARCUS KAUFFMAN

Material Protection

- Moisture
- UV rays
- Damage



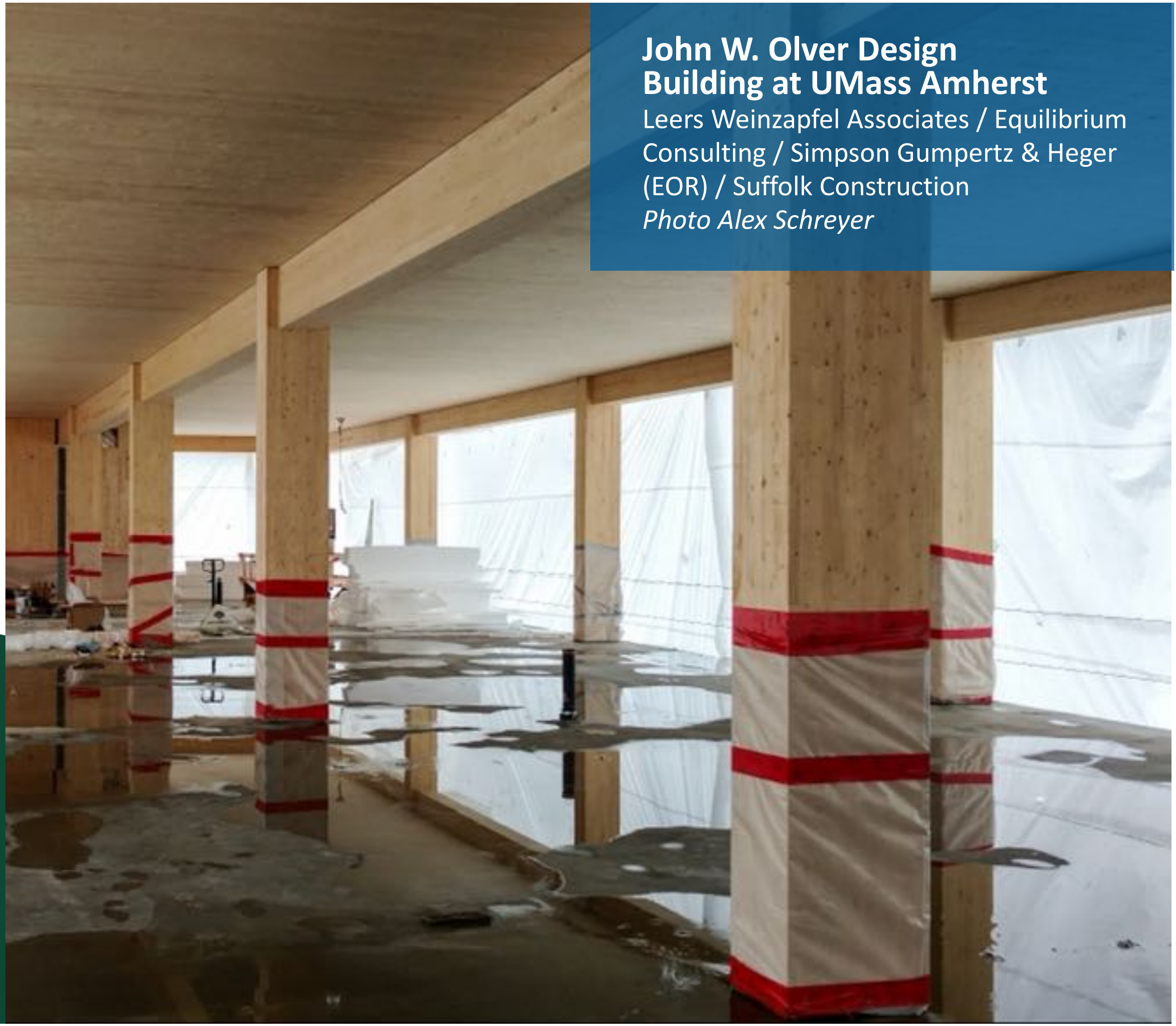
Ascent
New Land Enterprises /
Korb + Associates Architects /
Thornton Tomasetti /
C.D. Smith Construction
Photo C.D. Smith

Moisture Management

Keep wood as dry as possible to avoid:

- Stains and dirt
- Shrinkage and swelling
- Damage from prolonged moisture exposure

Mass timber can get wet—and *will* get wet on most projects. That is not a problem, provided an effective moisture management plan is in place.



John W. Olver Design Building at UMass Amherst
Leers Weinzapfel Associates / Equilibrium Consulting / Simpson Gumpertz & Heger (EOR) / Suffolk Construction
Photo Alex Schreyer

Moisture Management Plan

Planning starts at the earliest stage and is collaborative.

Construction team responsibilities include:

- » Construction phase plan; on-site strategies based on risk evaluation
  - » Coverings
  - » Deflection/diversion
  - » Ventilation/drying
- » Anticipating and troubleshoots issues
- » Monitoring

Type and Extent of Protection

- Decision by architect/contractor
- Appearance requirements
- Extent and cost of protection methods
- Protection in fabrication plant and/or on jobsite
- Capability of fabricator
- Capability of installer/moisture protection subcontractor
- Schedule protection plan
- Protection prior to installation
- Protection during installation
- Protection after installation

Moisture Management Responsibility and Risk

- Responsibility for managing and cost of the plan
- Contractor and/or fabricator
- Conditions to be considered
- Schedule delays and revisions
- Construction weather conditions (worst case)

Monitoring Moisture Before, During and After Construction

- Coordination with concrete topping activities
- Roofing material
- Columns, beams and floor/wall panels

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Factory-Applied Sealants & Coatings

Adidas Headquarters
LEVER Architecture / KPFF / Turner Construction Company
Photo Jeremy Bittermann

Membranes can be spray-applied, sheet product (adhesive or non), or board/sheathing product.

Vaproshield

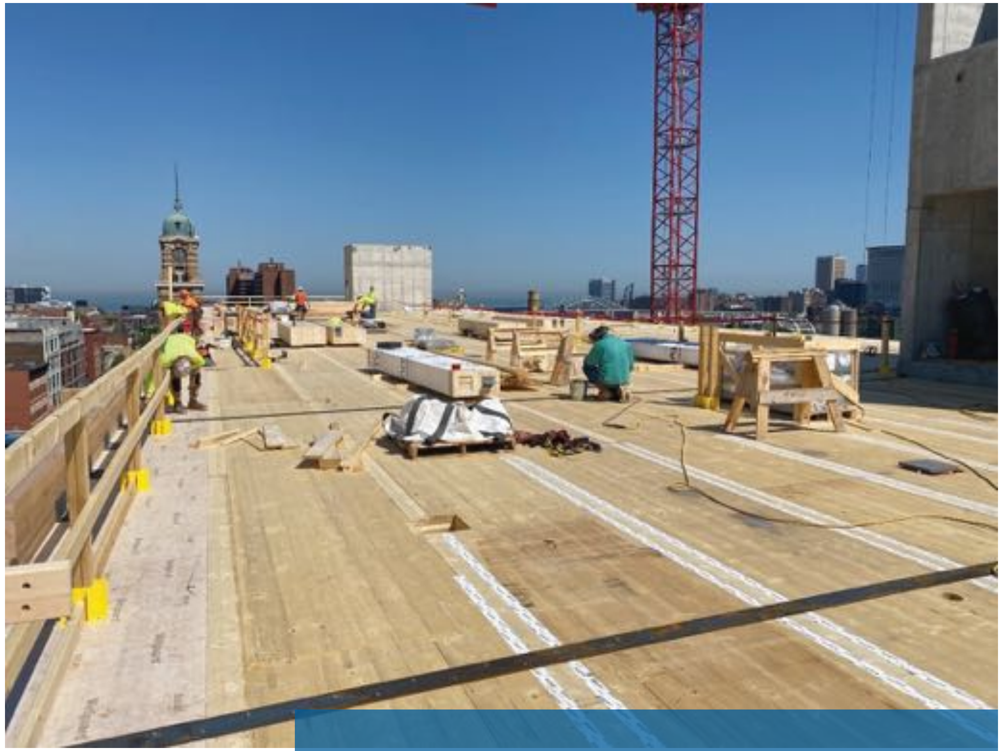
Transportation & Storage

Photos Paul Alberts / Ardor Media / naturallywood.com

MATERIAL DELIVERY

Photo: Swinerton

Panel Joint Treatment



INTRO
Harbor Bay Ventures / Hartshorne Plunkard Architecture / Forefront Structural Engineers / Fast + Epp / Panzica Construction
Photos WoodWorks

Deflection & Diversion

From Moisture Risk Management Strategies for Mass Timber Buildings,
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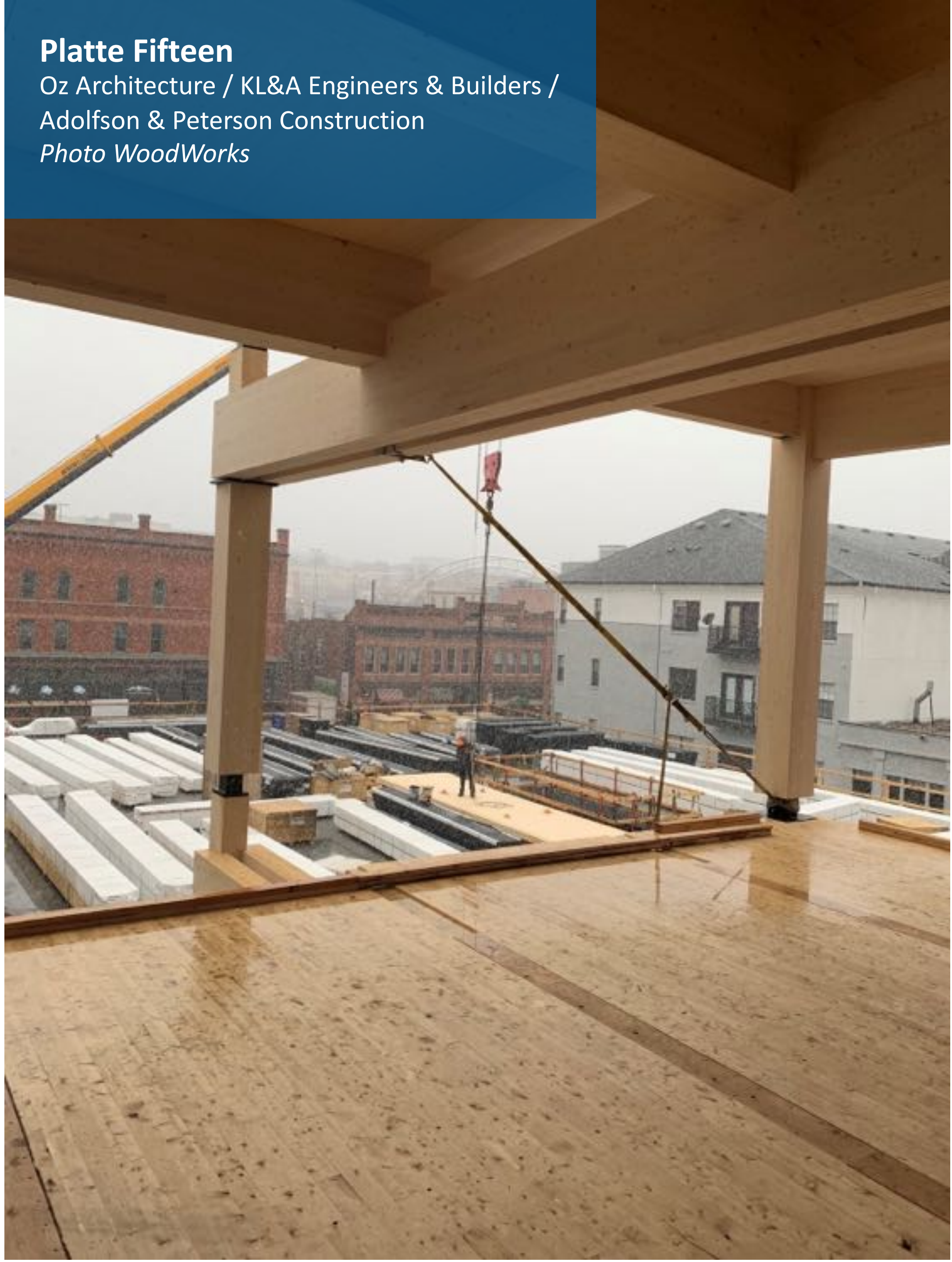
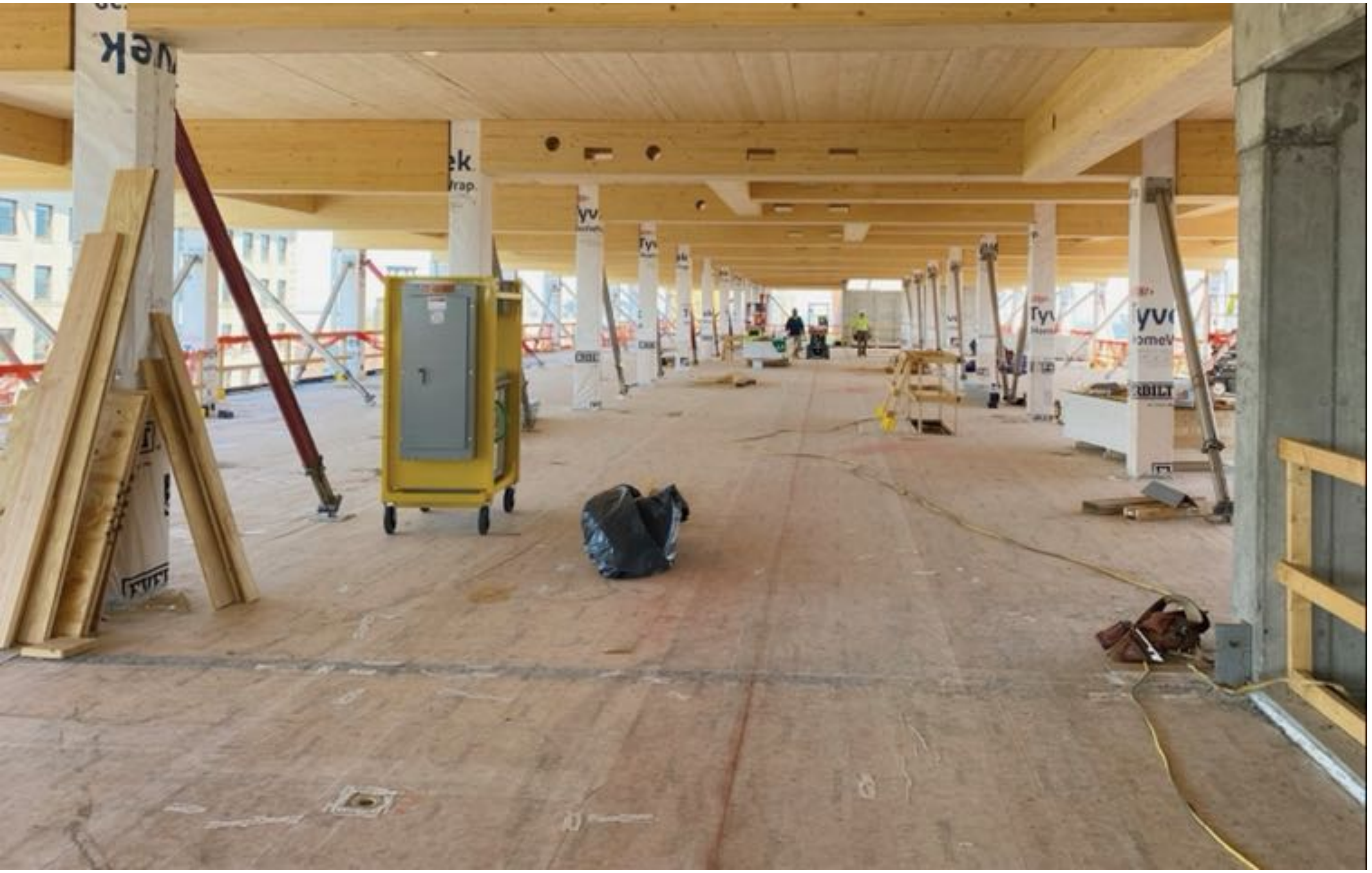


Platte Fifteen
Oz Architecture / KL&A Engineers & Builders /
Adolfson & Peterson Construction
Photo WoodWorks

Coverings



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Moisture Monitoring

Monitor the moisture content (MC) of wood materials throughout construction.

- When materials are received
- Regular intervals
- After rainfall
- Before drying in

Product	MC at Manufacture	Desired MC at Project Close-in with Direct-Applied Concrete Toppings
CLT	12% +/- 3%[a]	<16%
GLT	12-16%[b]	<16%
NLT	<19%[c]	<16%
DLT	15-19%[d]	<16%

Sources: [a]PRG-320 standard, [b]ANSI A190.1, [c]Nail-Laminated Timber Design Guide – U.S. Edition, and [d]DLT Design and Profile Guide

The best way to minimize exposure to moisture is to close in the project quickly.

INTRO / Photo Harbor Bay Ventures

MASS TIMBER APPEAL

Reduced construction time

1 Floor = 3 Days

17 Floors Erected in 9.5 Weeks

Brock Commons, Vancouver, BC
Source: naturally:wood[5]

Cleaning Mass Timber

Sanding and cleaning solutions are the most common ways to remove stains.

Photos WoodWorks

Planning for Environmental Exposures

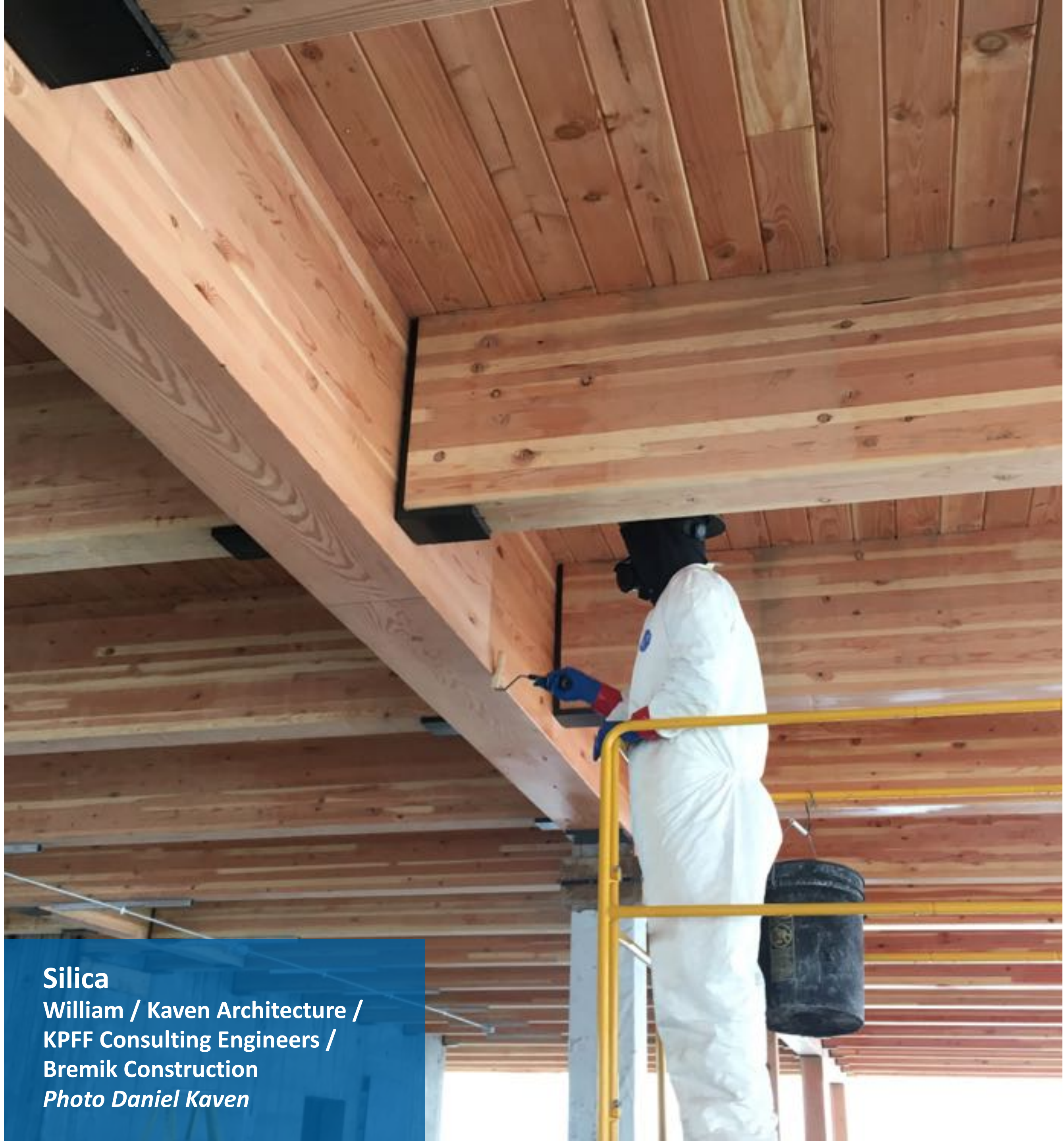
- Plan Early
- Risk Evaluation
- Develop Construction Phase Plan
- Execute the Design and Moisture Management Plan
- Monitor

RDH Moisture Management Guide 1st Ed

Applying Finishes

Below, glulam panels are coated in the controlled environment of a fabrication facility. On the right, a coating is being applied on the jobsite.

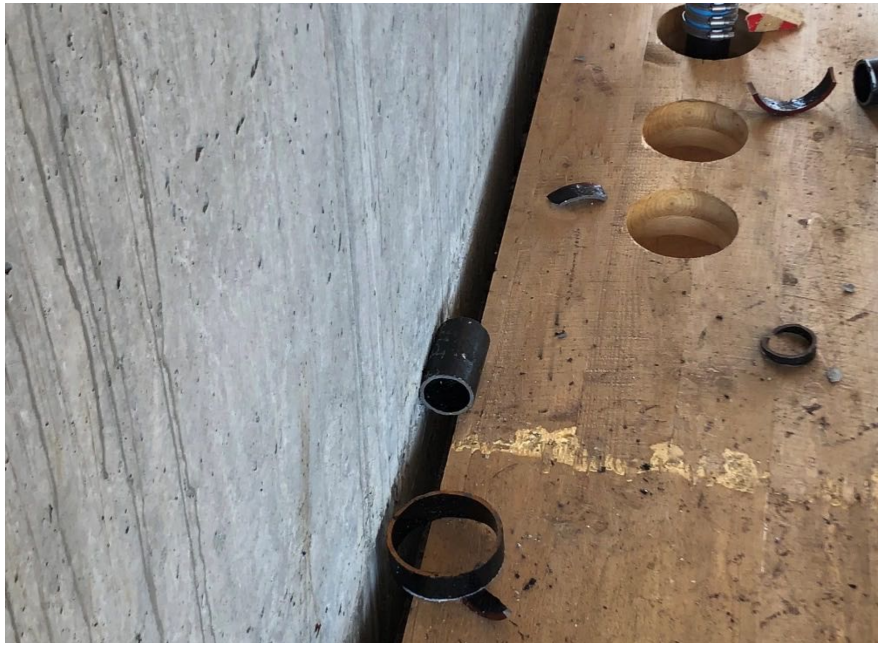
Photo Sansin Corporation, Western Archrib



Silica
William / Kaven Architecture / KPFF Consulting Engineers / Bremik Construction
Photo Daniel Kaven

On Site Considerations

Onsite Considerations



Other Materials

Questions? Ask us anything.

Jessica Scarlett, EIT
Regional Director | NC, SC, TN

(803) 616-621

jessica.scarlett@woodworks.org

Mark Bartlett, PE
Regional Director | TX

(214) 679-1874

mark.bartlett@woodworks.org

Jason Bahr, PE
Regional Director | KS, AR, MO, OK

(913) 732-0075

jason.bahr@woodworks.org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