



Mass Timber Overview: Systems, Products & Codes

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A photograph of a modern building's interior, showcasing a mass timber construction system. The space is characterized by warm, light-brown wood paneling on the walls and ceiling. Large, vertical wooden columns support the structure, and tall windows allow natural light to fill the room. The floor appears to be a smooth, light-colored material, possibly concrete or polished wood. The overall atmosphere is clean, bright, and emphasizes the natural beauty of the wood.

**Mass Timber Construction
Management: Design through Project
Close Out**

Photo: Structurlam

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

Course Description

Innovations in mass timber construction are offering new opportunities for the building industry. Products such as cross-laminated timber (CLT) and glue-laminated timber (glulam) combine multiple laminations of lumber to produce solid timber elements such as floor and wall panels, beams, and columns. These elements have high strength-to-weight ratios, allowing them to replace more traditional construction materials while providing sustainable systems that can meet code criteria for acoustics, fire-resistance, seismic performance, energy efficiency, and more. However, while design and code aspects of mass timber receive a great deal of focus, it is the construction aspects that often decide whether a project goes forward. Mass timber construction has similarities to other systems, but it also has unique attributes—and a complete understanding of the differences is key to efficient project cost estimation and efficient construction. This in-depth, multi-faceted workshop will explore mass timber from design through preconstruction, fabrication, erection, and project close-out. After setting the stage with an overview of mass timber products and sustainability attributes, discussion will focus on construction topics, including risk analysis, cost case studies design team interaction, cost optimization, scheduling, site planning, and other logistics. Intended for construction industry professionals looking to gain a deep understanding of the unique attributes of mass timber construction, this workshop will leave attendees with information they need to successfully bid and construct a mass timber project.

Learning Objectives

1. Understand the preconstruction manager's role in material procurement and coordination of trades for code-compliant mass timber projects.
2. Highlight effective methods of early design-phase cost estimation and building official interaction on code compliance topics that keep mass timber options on the table.
3. Discuss potential construction schedule savings and construction fire safety practices realized through the use of prefabricated mass timber elements.
4. Explore best practices for interaction between manufacturer, design team and preconstruction manager that can lead to cost efficiency and safety on site.

MASS TIMBER OVERVIEW



OVERVIEW | TIMBER METHODOLOGIES



Heavy Timber
Photo: Benjamin Benschneider



Mass Timber
Photo: John Stamets

Glue Laminated Timber (GLT)



Cross-Laminated Timber (CLT)



Nail-Laminated Timber (NLT)



Photo: Think Wood



Photo: StructureCraft



Photo: LendLease



Photo: Ema Peter

Dowel-Laminated Timber (DLT)



Photo: StructureCraft

Mass plywood panels (MPP)



Photo: Freres Lumber

Decking



Photo: StructureCraft



Photo: LEVER Architecture



Photo: Bernard André Photography





**EFFICIENCY FOUND IN UNDERSTANDING SUPPLY CHAIN,
DESIGNING ACCORDING TO ITS CAPABILITIES**

Photo: DR Johnson



Photo: Ema Peter

STRUCTURAL SOLUTIONS | POST, BEAM + PLATE



Photo: Seagate Structures

STRUCTURAL SOLUTIONS | POST + PLATE



Photo: Lendlease

STRUCTURAL SOLUTIONS | HONEYCOMB



Photo: John Klein

STRUCTURAL SOLUTIONS | HYBRID LIGHT-FRAME + MASS TIMBER



Photo: SOM

STRUCTURAL SOLUTIONS | HYBRID STEEL + MASS TIMBER



Photo: Structurlam

STRUCTURAL SOLUTIONS | HYBRID CONCRETE + MASS TIMBER

OVERVIEW | CONNECTIONS



Concealed Connectors



Self Tapping Screws

Photos: Rothoblaas



Beam to Column

Photo: StructureCraft



Photo: Structurlam



Column to Foundation

Photo: Alex Schreyer

OVERVIEW | CONNECTIONS



Panel to Panel & Supports

Photo: Charles Judd



Photo: Alex Schreyer

Mass Timber Projects In Design and Constructed in the US (September 2019)





Photo: Nordic Structures

PRECEDENT PROJECTS | UMASS AMHERST DESIGN BUILDING



Photo: ©Albert Vecerka/Esto



Photos: Baumberger Studio/PATH Architecture



Photo: Hines



Photo: Corey Gaffer courtesy Perkins + Will



Photos: StructureCraft



Photo: Hartshorne Plunkard Architecture



Photos: Flank



Photos: Swinerton | DJC Oregon

PRECEDENT PROJECTS | FIRST TECH CREDIT UNION HILLSBORO, OR



Photos: Michael Elkan | Naturally Wood | UBC

PRECEDENT PROJECTS | BROCK COMMONS



Photos: Daniel Shearin | Waugh Thistleton Architects



Photos: Bygg Mesteren | Voll Arkitekter

MASS TIMBER PRODUCTS



Glue Laminated Timber (GLT)

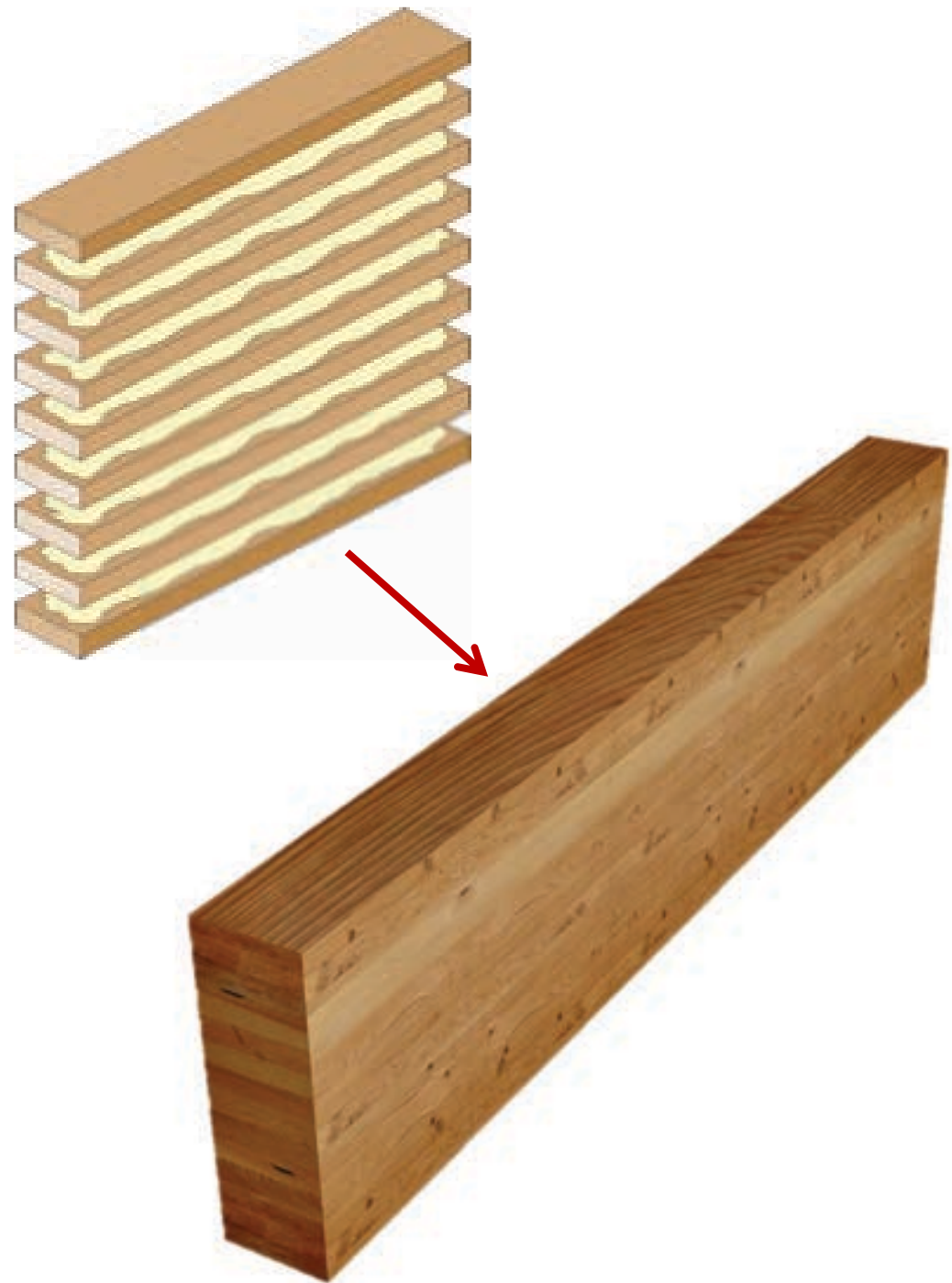


Photo: Alex Schreyer

Glue Laminated Timber (GLT)



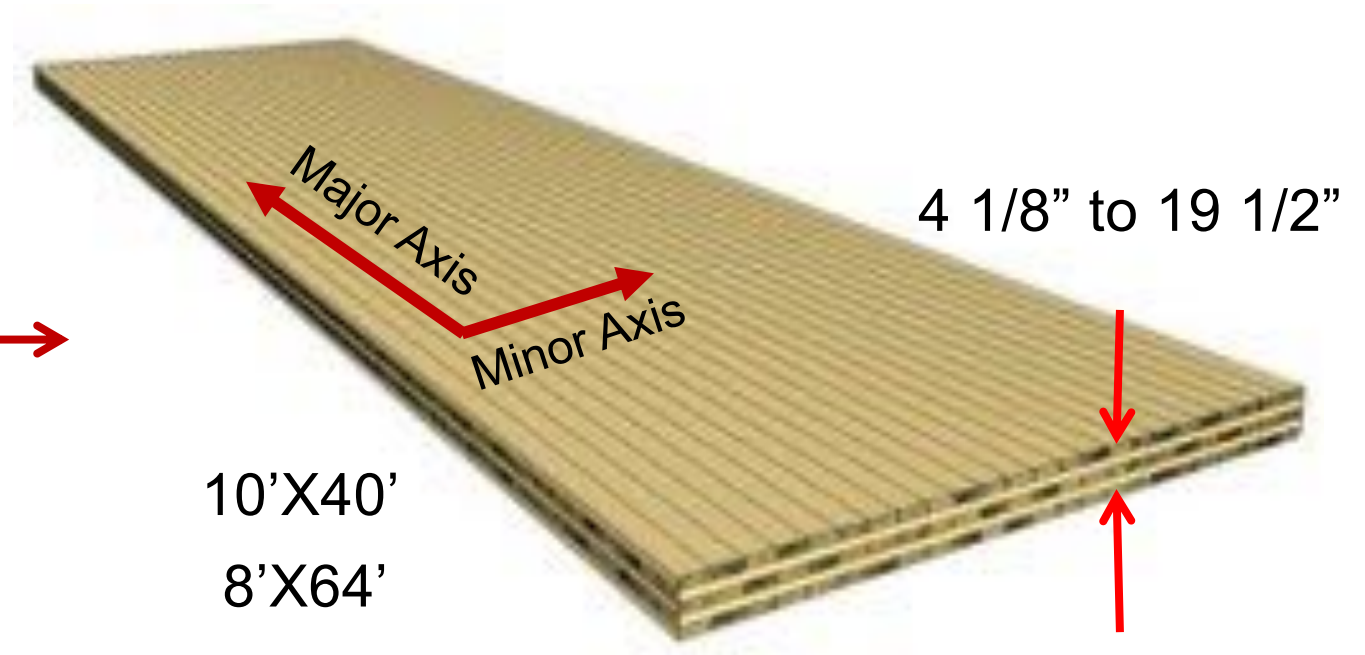
Photo: Manasc Isaac Architects/Fast + Epp



Cross-Laminated Timber (CLT)



Cross-Laminated Timber (CLT)



Nail-Laminated Timber (NLT)



Photo: StructureCraft

Nail-Laminated Timber (NLT)



Photo: StructureCraft



Photo: Think Wood

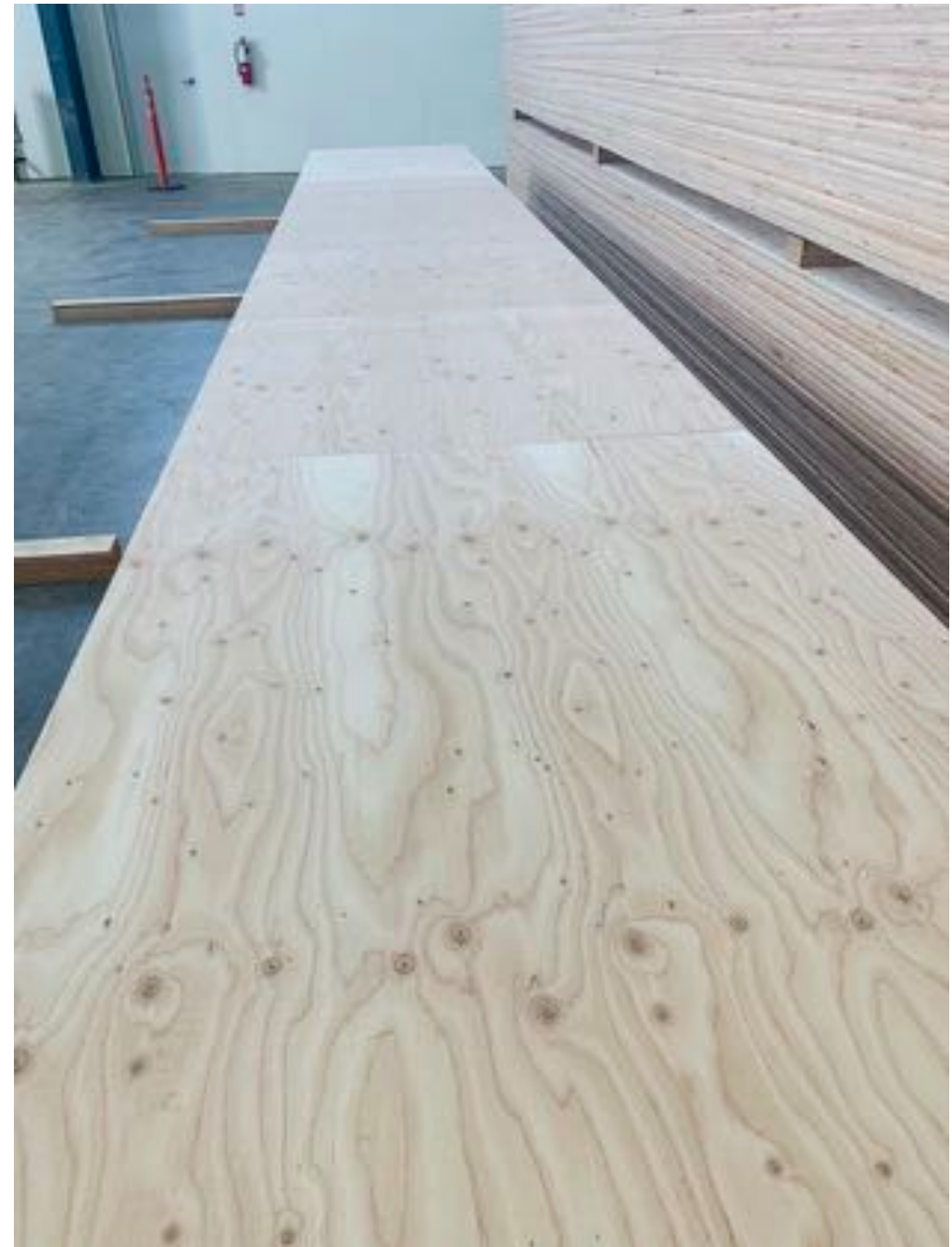


Dowel-Laminated Timber (NLT)



Photo: StructureCraft

Mass Plywood Panels (MPP)



Other Mass Timber Product Options



Glue Laminated Timber
GLT



Laminated Veneer Lumber
LVL



Parallel Strand Lumber
PSL



Laminated Strand Lumber
LSL



Timber-Concrete Composite
TCC



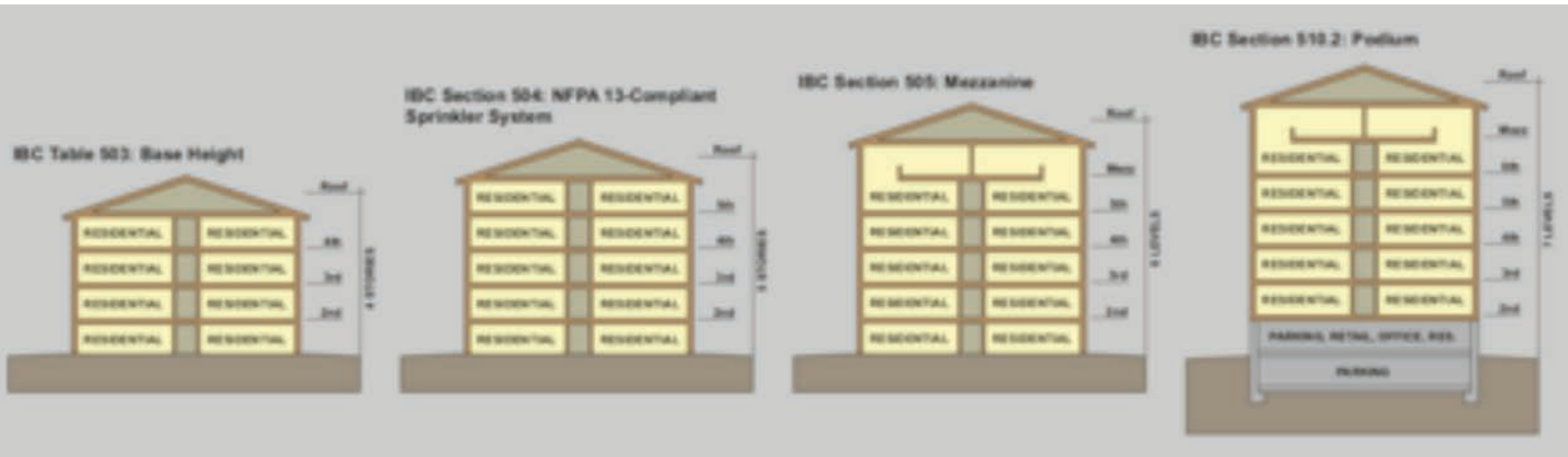
Decking

MASS TIMBER IN THE CODE



BUILDING CODE APPLICATIONS | CONSTRUCTION TYPE

Mass Timber in Low- to Mid-Rise: 1-6 Stories in Construction Types III, IV or V



Credit: WoodWorks

Tall Mass Timber: Up to 18 Stories in Construction Types IV-A, IV-B or IV-C



WoodWorks Tall Wood Design Resource

- 2021 IBC provisions
- Design Steps
- Free download at woodworks.org



MASS TIMBER FIRE-RESISTANCE



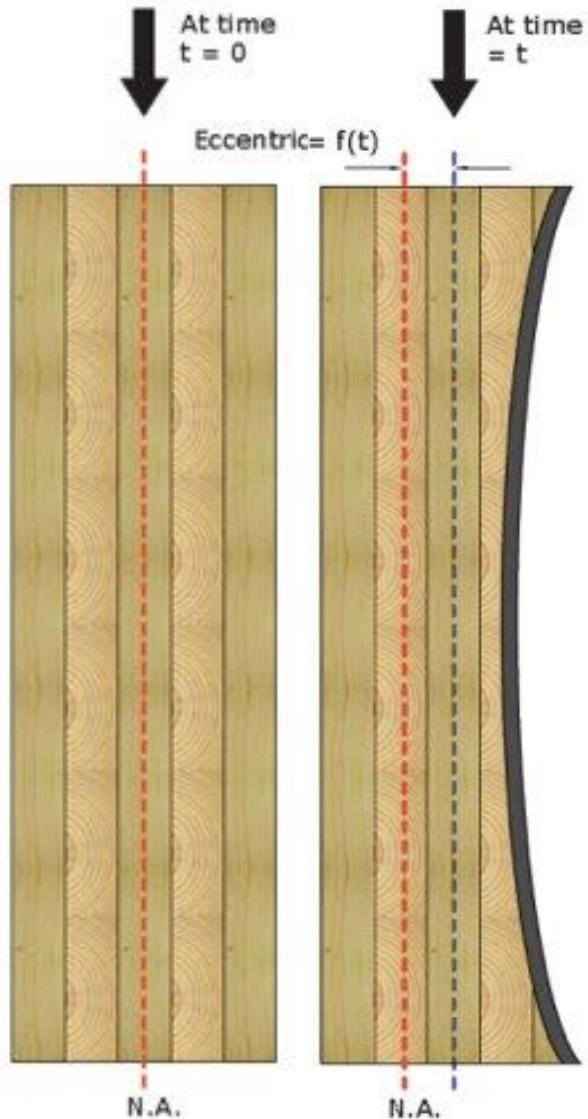
TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame ^d (see Section 202)	3 ^a	2 ^a	1	0	1	0	HT	1	0
Bearing walls									
Exterior ^{a,1}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions									
Exterior	See Table 602								
Nonbearing walls and partitions									
Interior ^d	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1½ ^b	1½ ^c	1½ ^c	0 ^e	1½ ^c	0	HT	1½ ^c	0

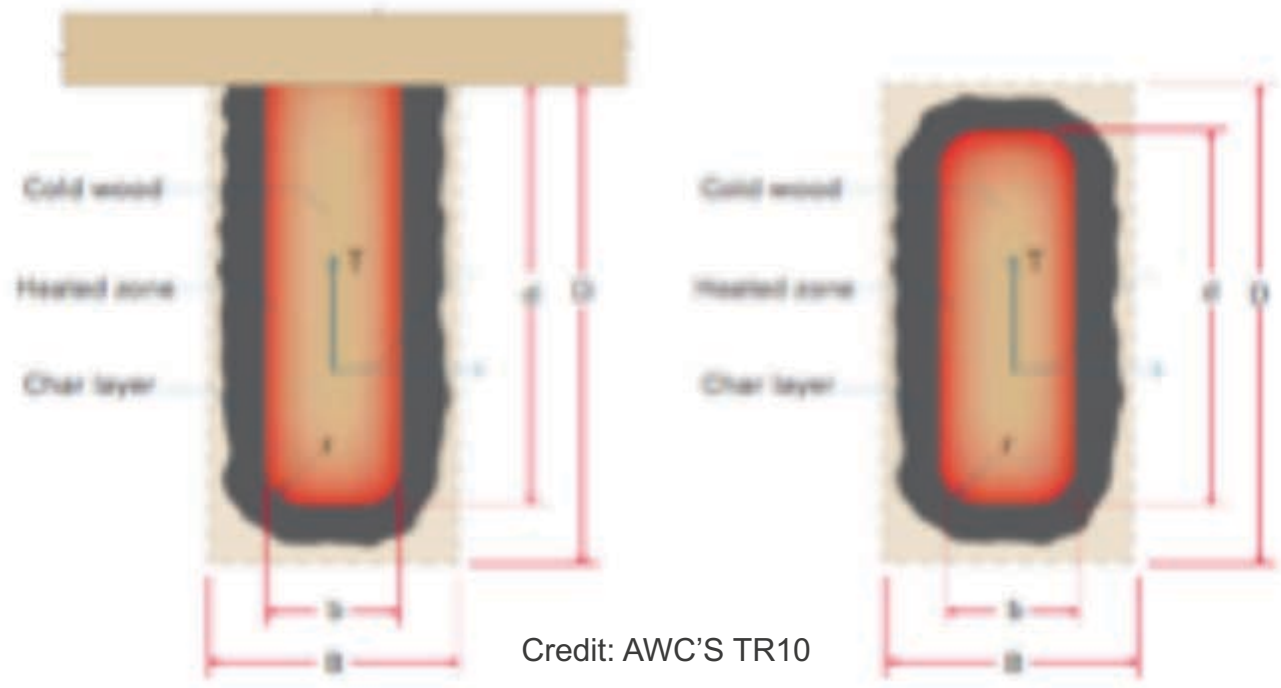
For SI: 1 foot = 304.8 mm.

- Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.
- Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.
- In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.
- Not less than the fire-resistance rating required by other sections of this code.
- Not less than the fire-resistance rating based on fire separation distance (see Table 602).
- Not less than the fire-resistance rating as referenced in Section 704.10.

Mass Timber's Fire-Resistive Performance is Well-Tested, Documented and Recognized via Code Acceptance



Credit: CLT Handbook

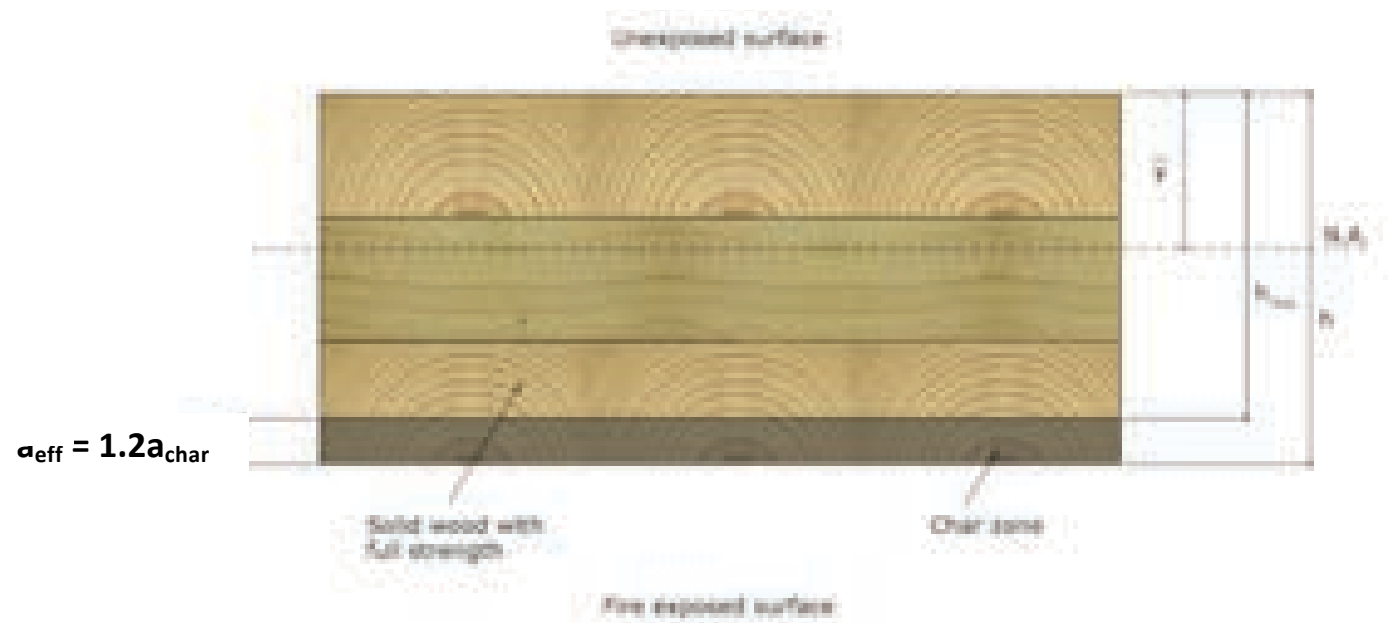


Credit: AWC'S TR10

How do you determine Fire Resistance Rating of Mass Timber?

2 Options:

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



MT FRR Calculations Method:

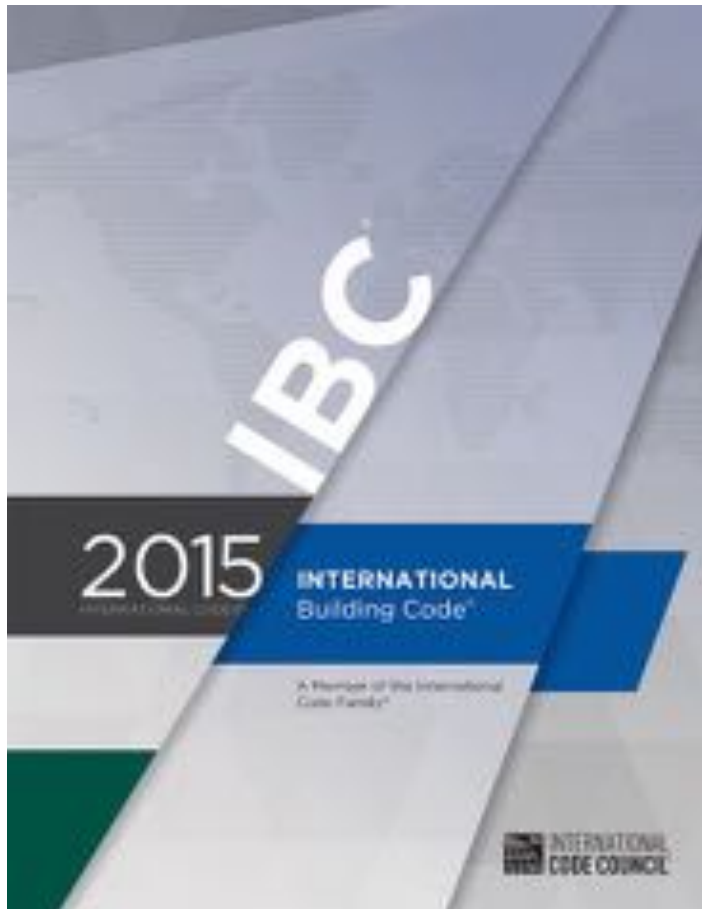
- IBC 703.3 allows several methods of determining FRR. One is calculations per 722.
- 722.1 refers to NDS Chpt 16 for exposed wood FRR

703.3 Methods for determining fire resistance. The application of any of the methods listed in this section shall be based on the fire exposure and acceptance criteria specified in ASTM E119 or UL 263. The required *fire resistance* of a building element, component or assembly shall be permitted to be established by any of the following methods or procedures:

3. Calculations in accordance with Section 722.

722.1 General. The provisions of this section contain procedures by which the *fire resistance* of specific materials or combinations of materials is established by calculations. These procedures apply only to the information contained in this section and shall not be otherwise used. The calculated *fire resistance* of concrete, concrete masonry and clay masonry assemblies shall be permitted in accordance with ACI 216.1/TMS 0216. The calculated *fire resistance* of steel assemblies shall be permitted in accordance with Chapter 5 of ASCE 29. The calculated *fire resistance* of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANS/AF&PA *National Design Specification for Wood Construction (NDS)*.

Code Path for Calculated FRR of Exposed MT



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

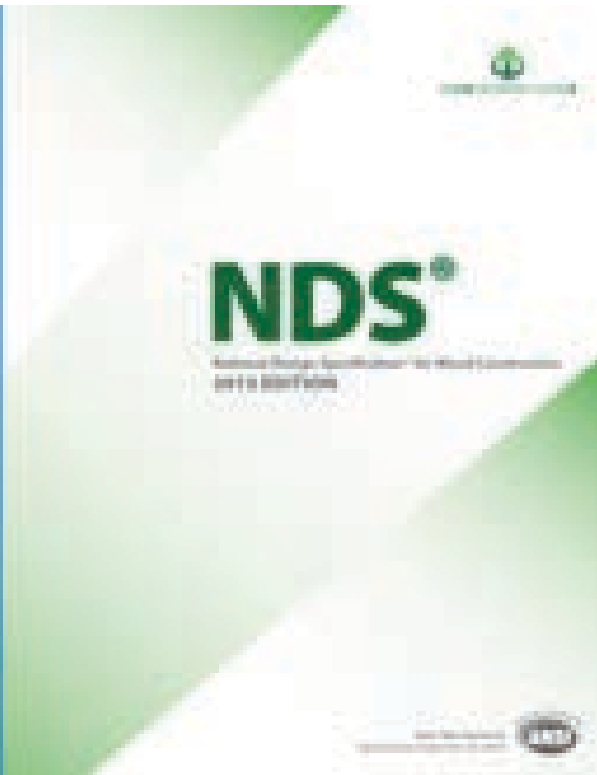
"The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with **Chapter 16 of ANSI/APC National Design Specification for Wood Construction (NDS)**"



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.



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

Credit: AWC'S NDS

Table 16.2.1B Effective Char Depths (for CLT with $\beta_s=1.5\text{in./hr.}$)

Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, b_{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



Credit: FPInnovations

**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: AWC'S NDS



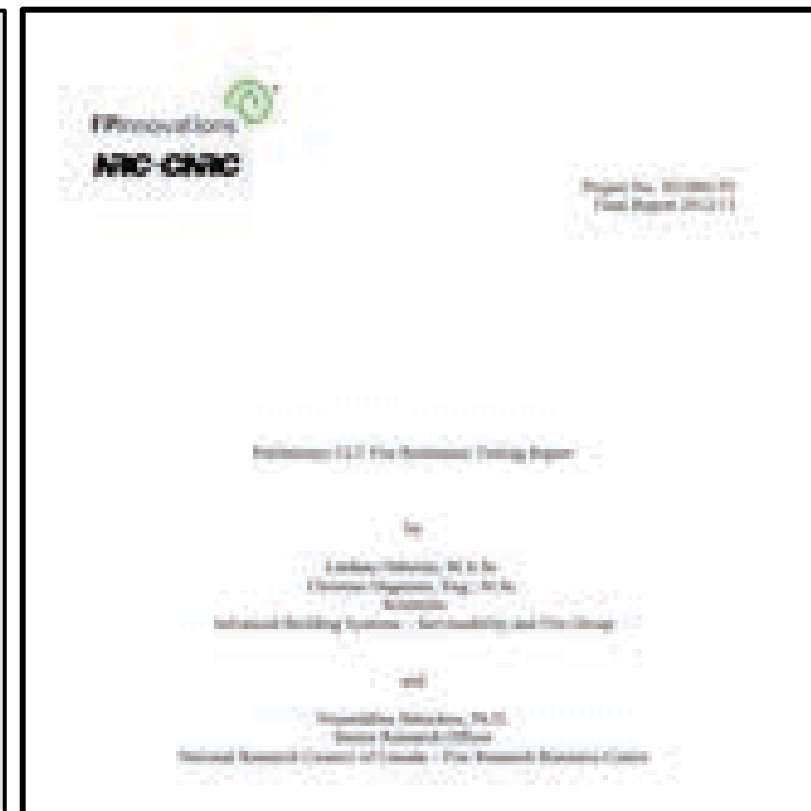
Credit: David Barber, ARUP

Table 16.2.1A Char Depth and Effective Char Depth (for $\beta_{10} = 1.5 \text{ in./hr.}$)

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

Tested Assemblies Method:

- **Many successful Mass Timber ASTM E119 fire tests have been completed by industry & manufacturers**



WOODWORKS INVENTORY OF FIRE TESTED MT ASSEMBLIES

Table 2: North American Fire Resistance Tests of Mass Timber Floor / Roof Assemblies



Test Report	Manufacturer	U.S. Code or Metric Code	Testing Protocol	Fire Resistance Rating	Fire Rating	Test Results	Fire Resistance Rating	Notes	Testing Lab
Report 1001 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1002 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1003 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1004 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1005 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1006 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1007 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1008 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1009 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1010 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1011 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1012 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1013 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1014 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1015 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1016 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1017 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1018 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1019 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1
Report 1020 (2010)	Timber	ICC 400 (2010) 400.1.1	1 hour 15 min Fire Resistance	Pass	Pass	Timber	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1	ICC 400 (2010) 400.1.1

Free download at woodworks.org



Mass Timber Fire Design Resource

- Code compliance options for demonstrating FRR
- Updated as new tests are completed
- Free download at woodworks.org

FIRE PROTECTION OF CONNECTIONS



Connections between building elements must be able to maintain FRR no less than that required of the connected members.

16.3 Wood Connections

Wood connections, including connectors, fasteners, and portions of wood members included in the connection design, shall be protected from fire exposure for the required fire resistance time. Protection shall be provided by wood, fire-rated gypsum board, other approved materials, or a combination thereof.

Source: NDS



Photo: MyTiCon

Multiple ways to demonstrate connection fire protection: calculations, prescriptive NC, test results, others as approved by AHJ



Photo: John Stamets



Photo: Josh Partee



Photo: Christian Columbres



Photo: Blaine Brownell

2017 Glulam Beam to Column Connection Fire Tests under standard ASTM E119 time-temperature exposure



Softwood Lumber Board Glulam Connection Fire Test Summary Report

Issue | June 5, 2017

Full Report Available:

<https://www.thinkwood.com/wp-content/uploads/2018/01/reThink-Wood-Arup-SLB-Connection-Fire-Testing-Summary-web.pdf>



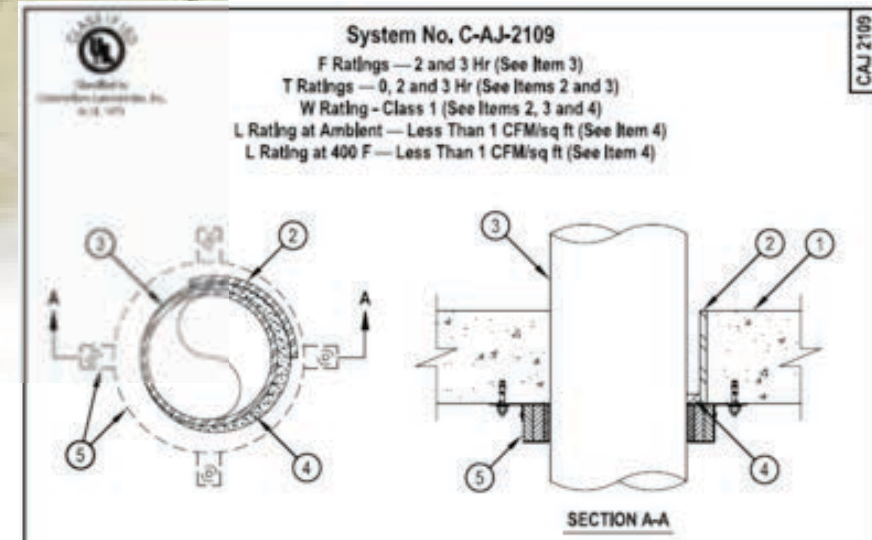
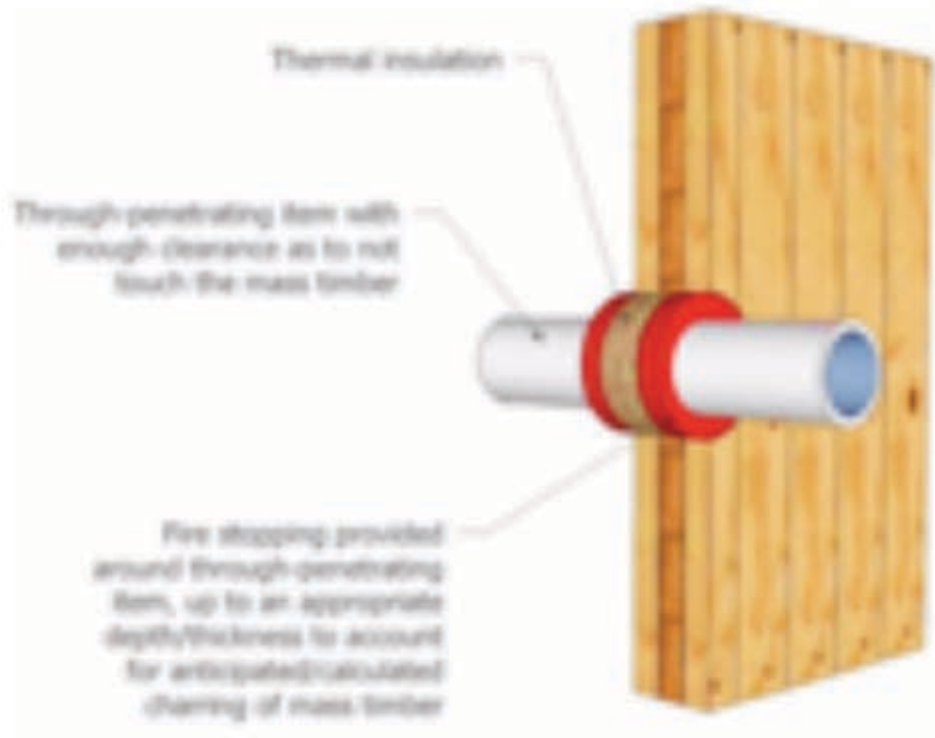
FIRE PROTECTION OF PENETRATIONS



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



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



Inventory of Fire Tested Penetrations in MT Assemblies



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

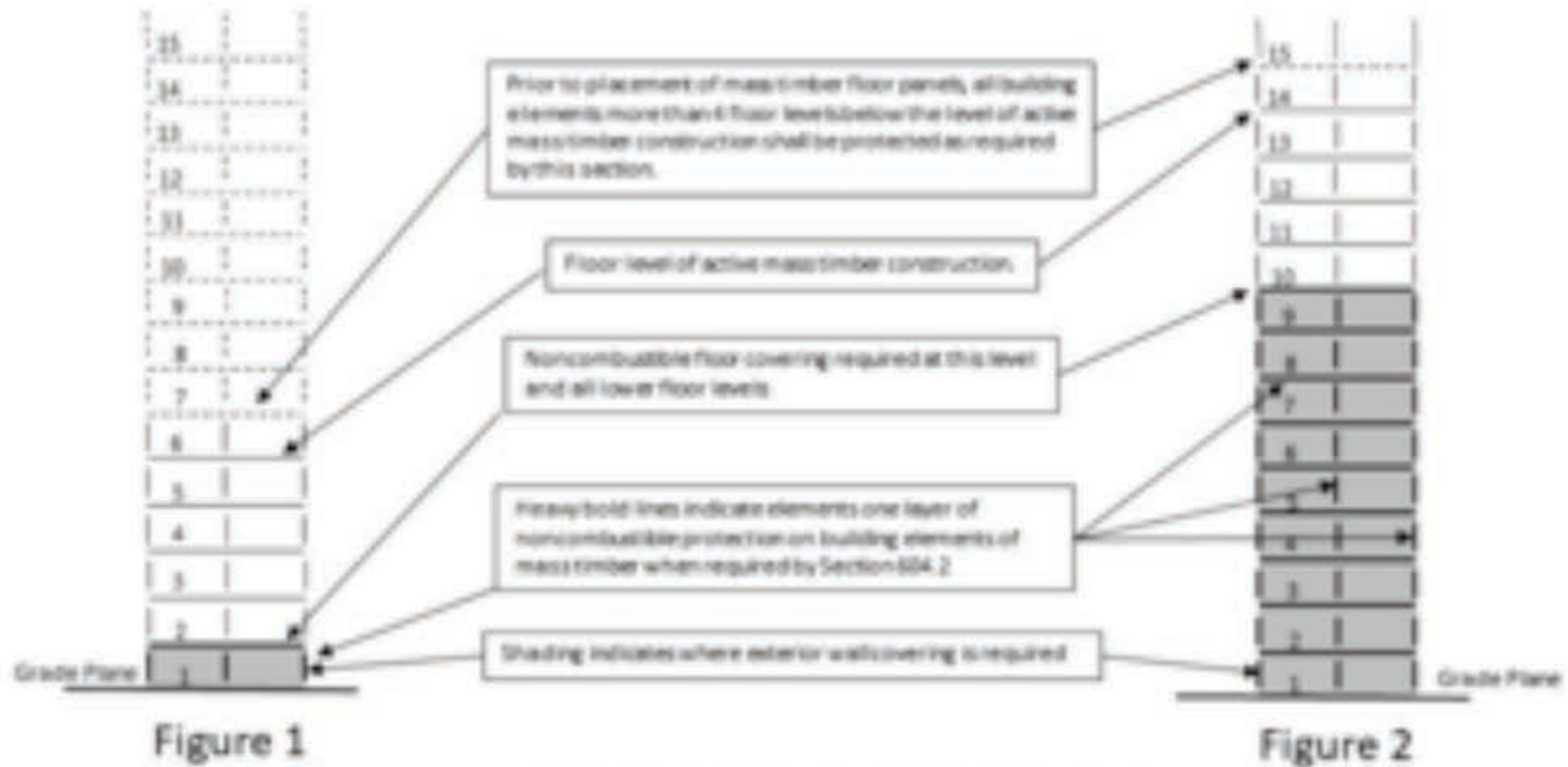
UL Test	Approved Fire Protection	Penetrating Item	Firestop System	Penetrating Item Description	1 Rating	2 Rating	Approved Test Standard	Success	Testing Lab
UL 190A (UL 190A-1)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-1	100%	UL
UL 190A (UL 190A-2)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-2	100%	UL
UL 190A (UL 190A-3)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-3	100%	UL
UL 190A (UL 190A-4)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-4	100%	UL
UL 190A (UL 190A-5)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-5	100%	UL
UL 190A (UL 190A-6)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-6	100%	UL
UL 190A (UL 190A-7)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-7	100%	UL
UL 190A (UL 190A-8)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-8	100%	UL
UL 190A (UL 190A-9)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-9	100%	UL
UL 190A (UL 190A-10)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-10	100%	UL
UL 190A (UL 190A-11)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-11	100%	UL
UL 190A (UL 190A-12)	None	1/2" diameter steel rod	None	1/2" diameter steel rod inserted in the fire assembly and secured by the fire assembly to a depth of approximately 2' - 10". The fire assembly was tested to the top of the fire assembly and the fire assembly was tested to the top of the fire assembly.	1 Pass	1 Pass	UL 190A-12	100%	UL

Free download at woodworks.org

ConstructionFireSafetyPractices.com



2021 IBC Construction Fire Safety for Tall Mass Timber



Examples of Protection During Construction
For Mass Timber Buildings Greater Than
6 Stories Above Grade Plane

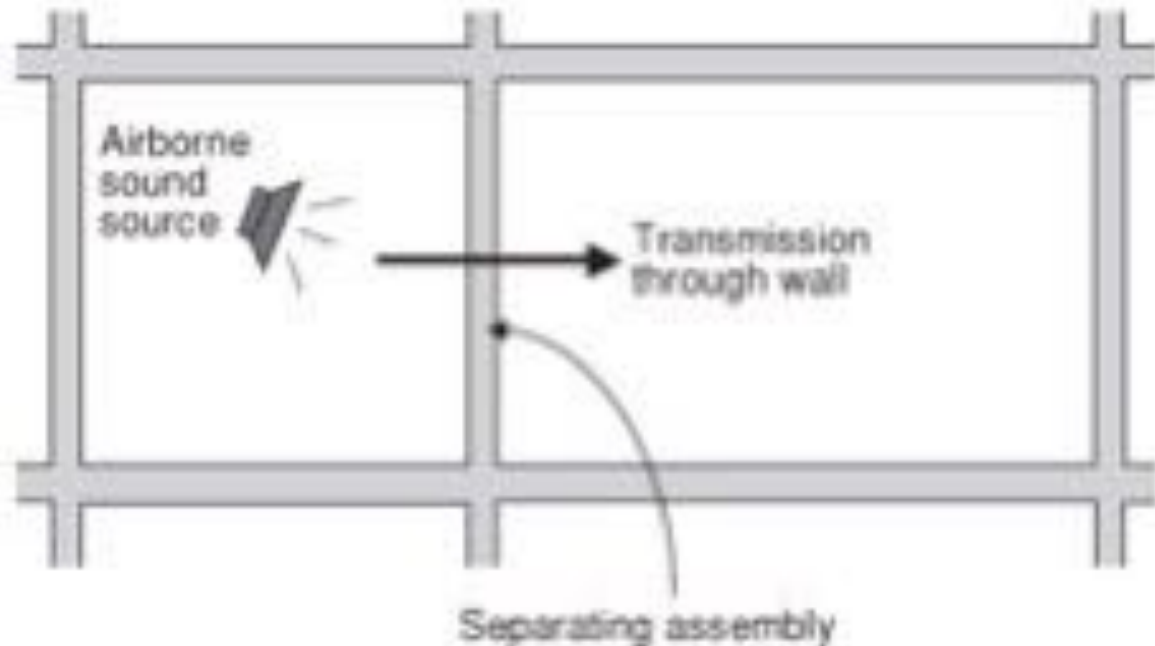
MASS TIMBER ACOUSTICS DESIGN



Air-Borne Sound:

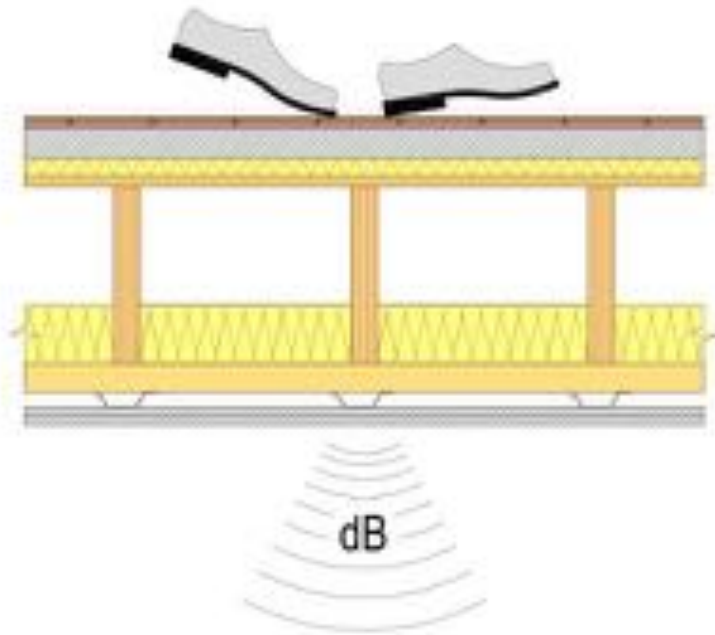
Sound Transmission Class (STC)

- 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



Structure-borne sound: **Impact Insulation Class (IIC)**

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



Code requirements only address residential occupancies:

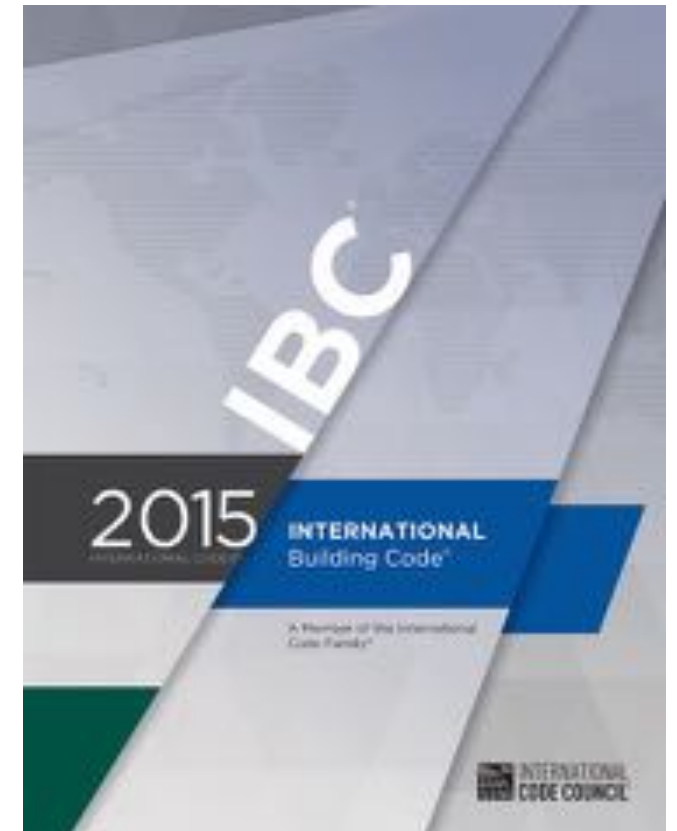
For unit to unit or unit to public or service areas:

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



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

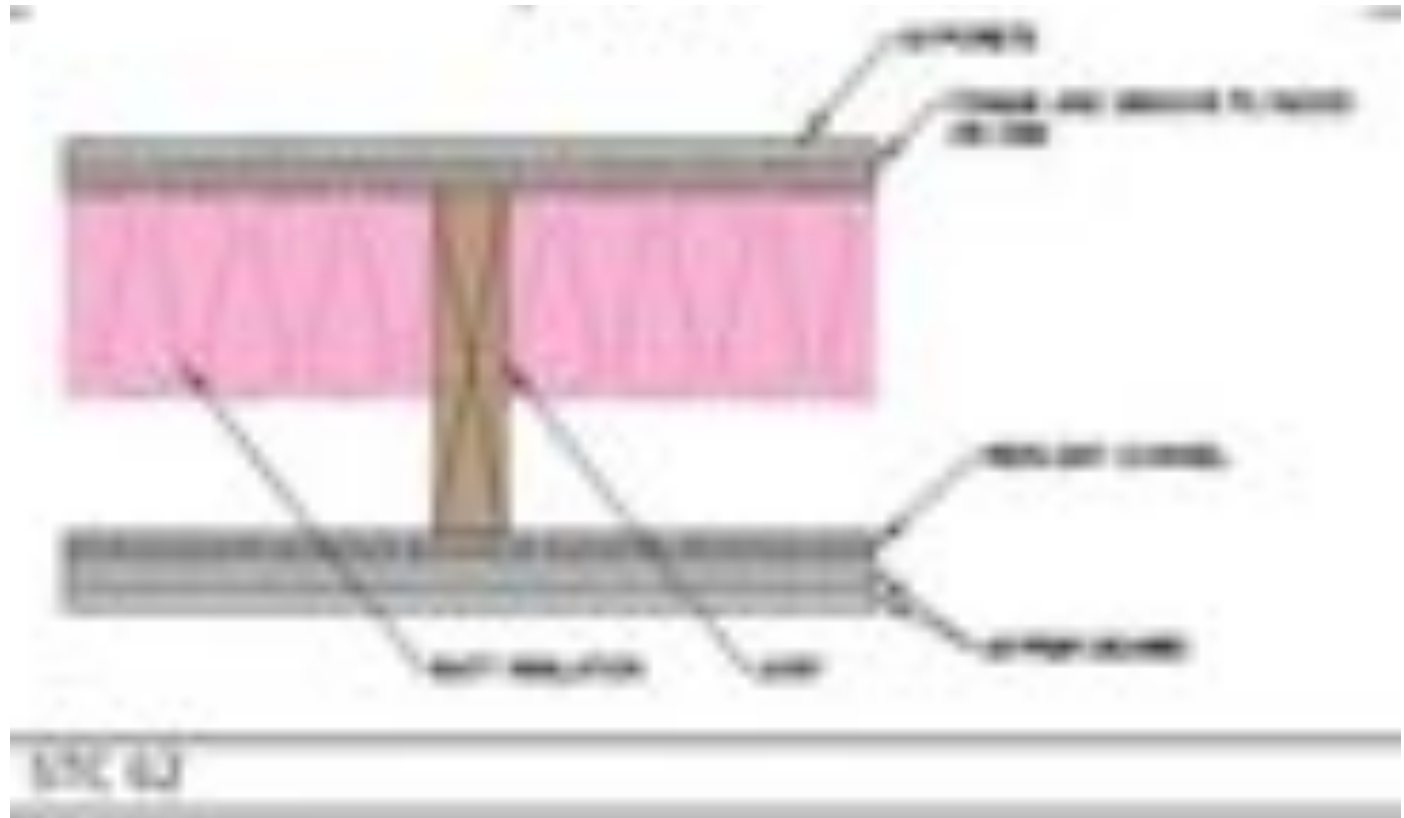
1. Add Mass
2. Add noise barriers
3. Add decouplers



Image credit: Christian Columbres

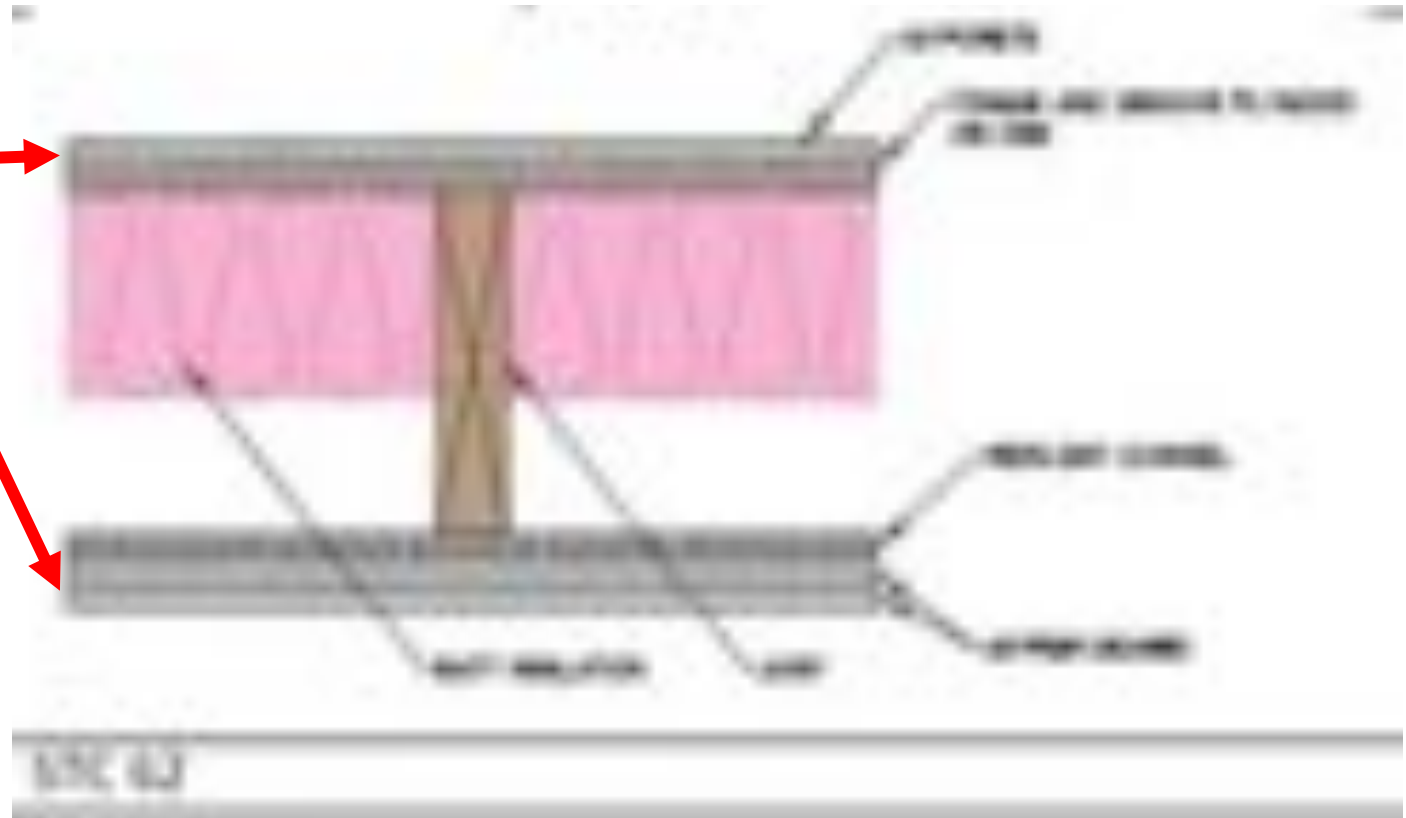
What does this look like in typical wood-frame construction:

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



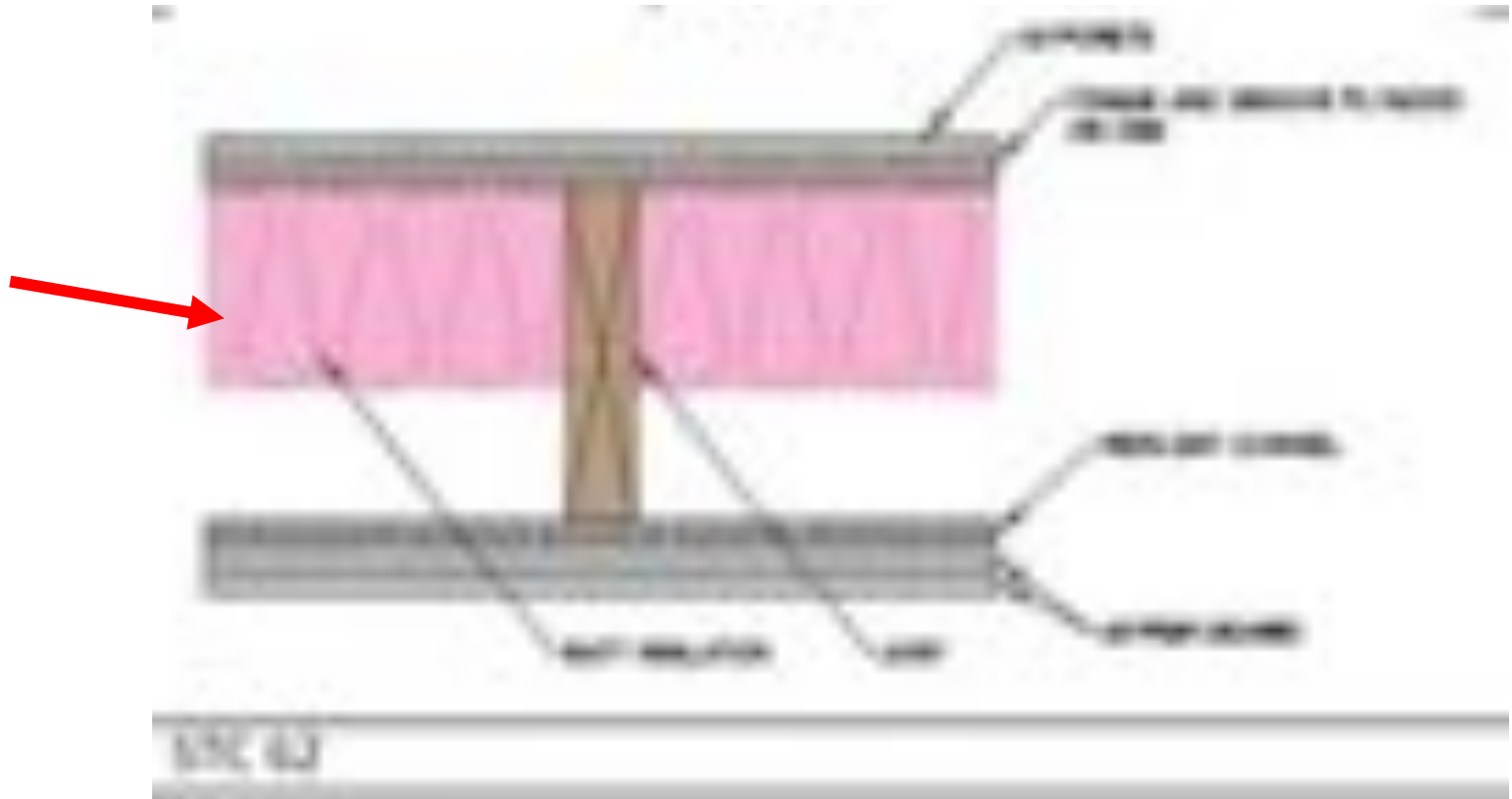
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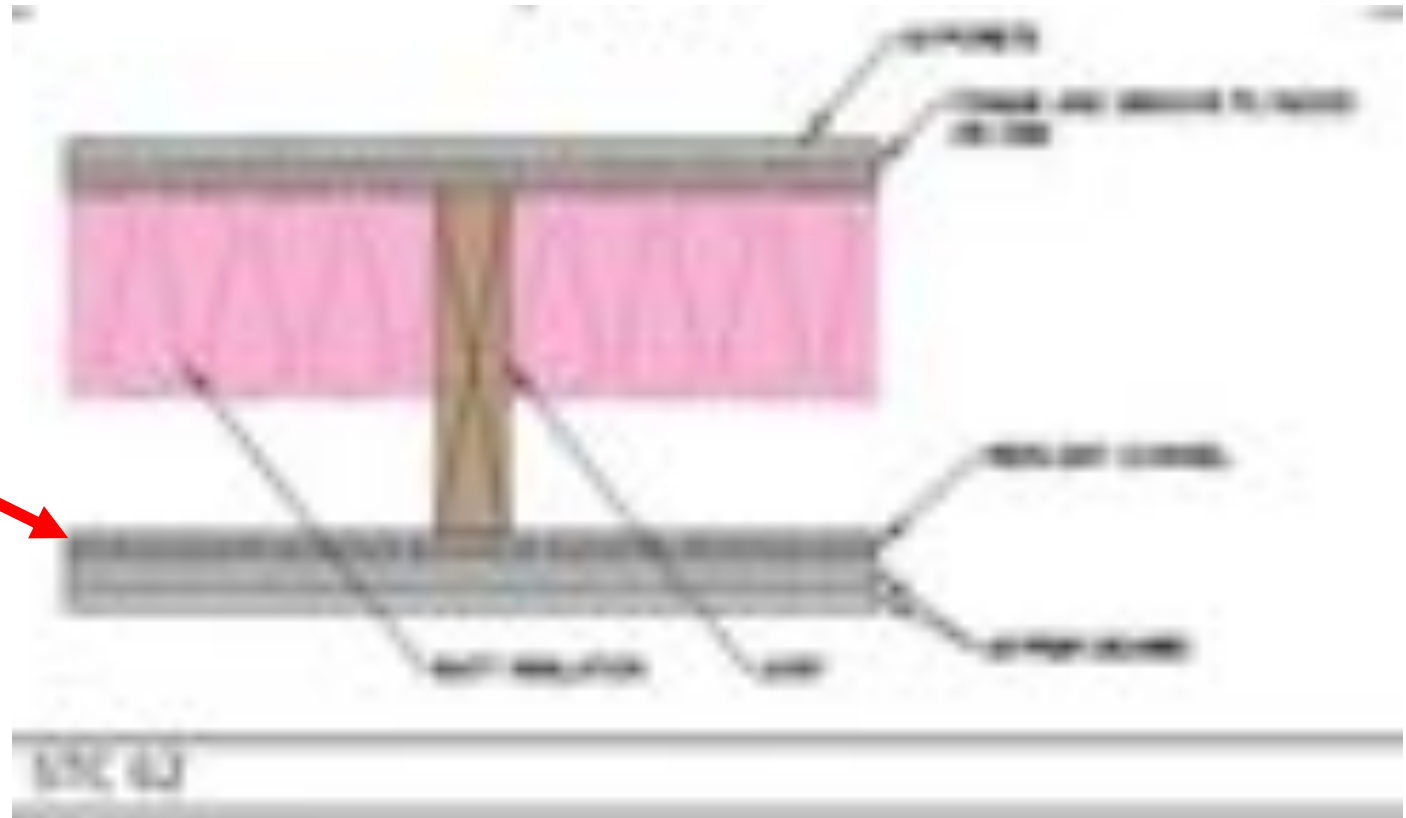
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What does this look like in typical wood-frame construction:

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2. Add noise barriers
3. Add decouplers



MASS TIMBER: STRUCTURE IS FINISH



BY ITSELF, NOT ADEQUATE FOR ACOUSTICS



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

TABLE 1:
Examples of Acoustically-Tested Mass Timber Panels

Mass Timber Panel	Thickness	STC Rating	IIC Rating
3-ply CLT wall ^a	3.07"	33	N/A
5-ply CLT wall ^a	6.875"	38	N/A
5-ply CLT floor ^b	5.1875"	39	22
5-ply CLT floor ^c	6.875"	41	25
7-ply CLT floor ^d	9.65"	44	30
2x4 NLT wall ^e	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 ^e	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 ^f	6" with 1/2" plywood	34	33

Source: Inventory of Acoustically-Tested Mass Timber Assemblies, WoodWorks⁷



Concrete Slab:

6" Thick

80 PSF

STC 53



CLT Slab:

6-7/8" Thick

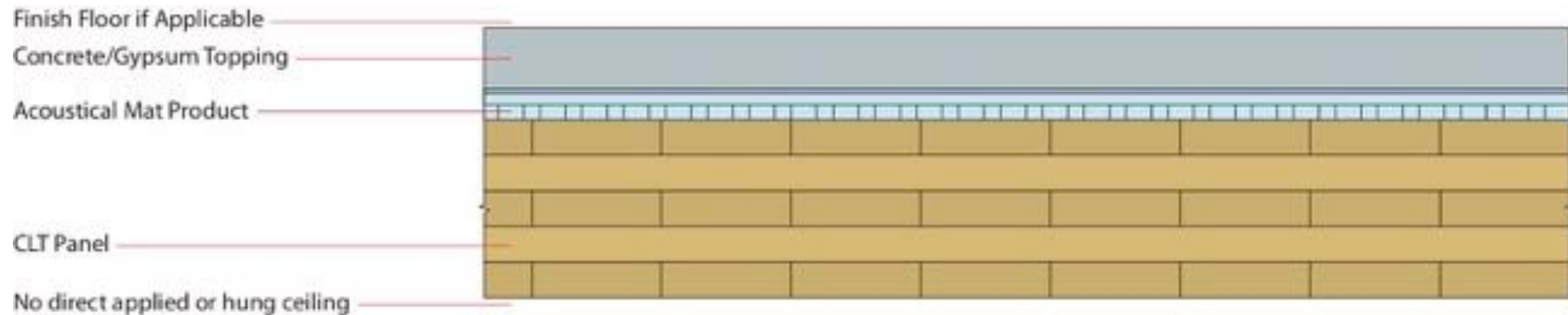
18 PSF

STC 41



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

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




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 panel exposed on ceiling side




MASS TIMBER ACOUSTICS DESIGN RESOURCE



WoodWorks
WOOD PRODUCTS COUNCIL

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

Author: Michael, Ph.D. | WoodWorks Technical Design Principles



TO: Architects
Subject: Mass Timber Assembly Construction, STC & Sound Transmission Class (STC) Performance, Acoustic Design Principles, Design from a Sound Perspective

The growing availability and wider 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 residential 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 acoustical treatments. With careful design and detailing, mass timber buildings can meet the acoustic performance expectations of most building types.

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

FIGURE 2:
Example CLT partition wall with staggered joints at 180° offset



Mass Timber Assembly Options: Walls

Mass timber walls provide superior structural and acoustic performance. The mass walls, the specific construction details and conditions of construction, and other considerations. Common assembly types include building a mass wall in front of the mass timber wall, creating a double wall, or creating a mass timber wall with staggered joints. The mass timber wall with staggered joints provides the best acoustic performance. The staggered joints are created by offsetting the joints of the CLT panels at 180° offset. Figure 2 shows an example CLT partition wall with staggered joints. This assembly achieves an STC rating of 50, exceeding the STC 45 acoustic requirements for a party wall assembly. Other examples are included in the sections of design considerations below.

Acoustical Differences Between Mass Timber Panel Options

The majority of acoustically rated mass timber assemblies include CLT. However, there have also been studies on other mass timber panel options such as NLT and cross-laminated timber (CLT) as well as hybrid assemblies. Other options such as hybrid assemblies include mass timber walls with staggered joints. While there have been studies on CLT and hybrid assemblies, building codes that treat all other mass timber options equally have not been the same. The majority of assemblies include CLT panel types for sound testing.

Improving Performance by Minimizing Flanking

Even when the perimeter of a building is carefully designed and detailed for high acoustic performance, consideration of flanking paths—in other words, air-borne transmission, such as structural connections, and other paths—is necessary for a building's total sound acoustic performance to be optimal.

One way to minimize flanking paths of these connections and interfaces is to use modern connection systems and details. These products are capable of handling structural loads, a connection between structural members and connections with existing concrete and existing walls, which connections between members in the context of the mass timber building. The use of these methods for improving acoustic performance is shown below. These options are for connections with single connections, interfaces and connections. There are many other options that can improve the acoustic performance of a mass timber building with mass timber details.



Acoustic connection detail
Flanking connection

WoodWorks Inventory of Acoustically Tested MT Assemblies



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



<div> <div> <div>CLT Floor Assembly</div> <div>Concrete/Gypsum Topping</div> <div>Acoustical Wall Product</div> <div>Finish Floor</div> <div>STC</div> <div>WT</div> <div>Source</div> </div> <div> <div>CLT Floor Assembly</div> <div>Concrete/Gypsum Topping</div> <div>Acoustical Wall Product</div> <div>Finish Floor</div> <div>STC</div> <div>WT</div> <div>Source</div> </div> </div>						
CLT Panel	Concrete/Gypsum Topping	Acoustical Wall Product Between CLT and Topping	Finish Floor	STC	WT	Source
CLT Panel (4.0/10)	1-1/2" Top-Guide	Wooden Acoustical Wall (1/4")	None	47-49	47-49	1
			CLT	-	48-50	
			Carpet + Pad	-	50-52	
			CLT on Acoustical Wall	-	52-54	
			CLT on Acoustical Wall	-	52-54	
			CLT on Acoustical Wall	-	52-54	
CLT Panel (4.0/10)	1-1/2" Top-Guide	Wooden Acoustical Wall (1/4")	None	47-49	47-49	1
			CLT	-	48-50	
			Carpet + Pad	-	50-52	
			CLT on Acoustical Wall	-	52-54	
			CLT on Acoustical Wall	-	52-54	
			CLT on Acoustical Wall	-	52-54	
CLT Panel (4.0/10)	1-1/2" Top-Guide	Wooden Acoustical Wall (1/4")	None	47-49	47-49	1
			CLT	-	48-50	
			Carpet + Pad	-	50-52	
			CLT on Acoustical Wall	-	52-54	
			CLT on Acoustical Wall	-	52-54	
			CLT on Acoustical Wall	-	52-54	

More than 400 Tested Assemblies

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- Experienced Designers, Contractors, Installers**
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Questions?

**This concludes The American
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Continuing Education
Systems Course**

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