Design Tips for Mass Timber:

Understanding the Products, Designing to Meet Code

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WoodWorks

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

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

Photo: StructureCraft

Mass plywood panels (MPP)

Photo: Freres Lumber

Photo: LEVER Architecture

Decking

Photo: Bernard André Photography

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

Photo: DR Johnson

See Mass Timber Manufacturing videos at our [2020 Partner Exhibit Hall]

STRUCTURAL SOLUTIONS | POST, BEAM + PLATE

STRUCTURAL SOLUTIONS | POST + PLATE

STRUCTURAL SOLUTIONS | HONEYCOMB

STRUCTURAL SOLUTIONS | HYBRID LIGHT-FRAME + MASS TIMBER

STRUCTURAL SOLUTIONS | HYBRID STEEL + MASS TIMBER

Concealed Connectors

Self Tapping Screws

Photos: Rothoblaas

OVERVIEW | CONNECTIONS

Beam to Column

Photo: StructureCraft

Photo: Structurlam

Mass Timber Projects In Design and Constructed in the US (June 2020)

Stage	Mass Timber	# of Projects
Construction Started / Built	CLT	163
	DLT	7
	Heavy Timber Decking	82
	NLT	16
	Post & Beam	116
	Total	384
In Design	CLT	312
	DLT	4
	Heavy Timber Decking	54
	NLT	12
	Post & Beam	155
	Total	537
Grand Total		921

State	Stage	
AK	In Design	1
AL	Construction Started / Built	5
	In Design	10
AR	Construction Started / Built	5
	In Design	7
AZ	In Design	2
CA	Construction Started / Built	49
	In Design	68
CO	Construction Started / Built	15
	In Design	18
CT	Construction Started / Built	6
	In Design	3
DC	Construction Started / Built	3
	In Design	5
DE	In Design	2
FL	Construction Started / Built	17
	In Design	28
GA	Construction Started / Built	8
	In Design	17
HI	Construction Started / Built	1
	In Design	2
IA	Construction Started / Built	3
	In Design	4
ID	Construction Started / Built	4
	In Design	5
IL	Construction Started / Built	11
	In Design	12
IN	Construction Started / Built	3
	In Design	1
KS	Construction Started / Built	2
	In Design	3
KY	Construction Started / Built	2
	In Design	4
LA	In Design	4
MA	Construction Started / Built	21
	In Design	22
MD	Construction Started / Built	3
	In Design	6
ME	Construction Started / Built	2
	In Design	14
MI	Construction Started / Built	2
	In Design	8
MN	Construction Started / Built	8
	In Design	3
MO	Construction Started / Built	7
	In Design	8

State	Stage	
MS	In Design	5
MT	Construction Started / Built	7
	In Design	8
NC	Construction Started / Built	18
	In Design	26
ND	In Design	1
NE	Construction Started / Built	3
	In Design	3
NH	Construction Started / Built	1
	In Design	2
NJ	Construction Started / Built	1
	In Design	7
NM	Construction Started / Built	1
	In Design	1
NV	In Design	1
NY	Construction Started / Built	8
	In Design	22
OH	Construction Started / Built	4
	In Design	6
OK	Construction Started / Built	1
	In Design	2
OR	Construction Started / Built	40
	In Design	20
PA	Construction Started / Built	4
	In Design	6
RI	Construction Started / Built	2
	In Design	2
SC	Construction Started / Built	13
	In Design	12
TN	Construction Started / Built	3
	In Design	4
TX	Construction Started / Built	22
	In Design	44
UT	Construction Started / Built	5
	In Design	5
VA	Construction Started / Built	7
	In Design	9
VT	Construction Started / Built	1
	In Design	9
WA	Construction Started / Built	45
	In Design	48
WI	Construction Started / Built	17
	In Design	10
WV	Construction Started / Built	2
WY	Construction Started / Built	2

Considering mass timber for a project? Ask us anything.

For free project support, contact:
help@woodworks.org
woodworks.org/project-assistance

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

Photo: ©Albert Vecerka/Esto

PRECEDENT PROJECTS | UMASS AMHERST DESIGN BUILDING

Photos: Baumberger Studio/PATH Architecture

PRECEDENT PROJECTS | CARBON 12 | PORTLAND, OR

Photo: Corey Gaffer courtesy Perkins + Will

PRECEDENT PROJECTS | T3 MINNEAPOLIS

Photos: StructureCraft

Photo: Hartshorne Plunkard Architecture

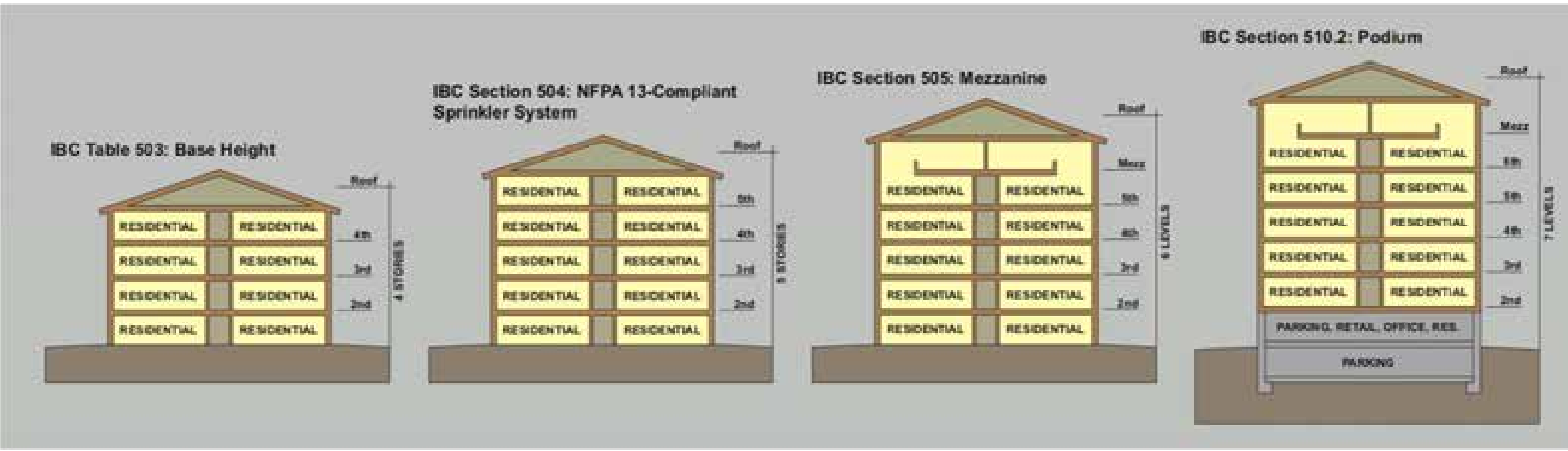
PRECEDENT PROJECTS | T3 ATLANTA

Photos: Michael Elkan | Naturally Wood | UBC

PRECEDENT PROJECTS | BROCK COMMONS

MASS TIMBER IN THE CODE

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



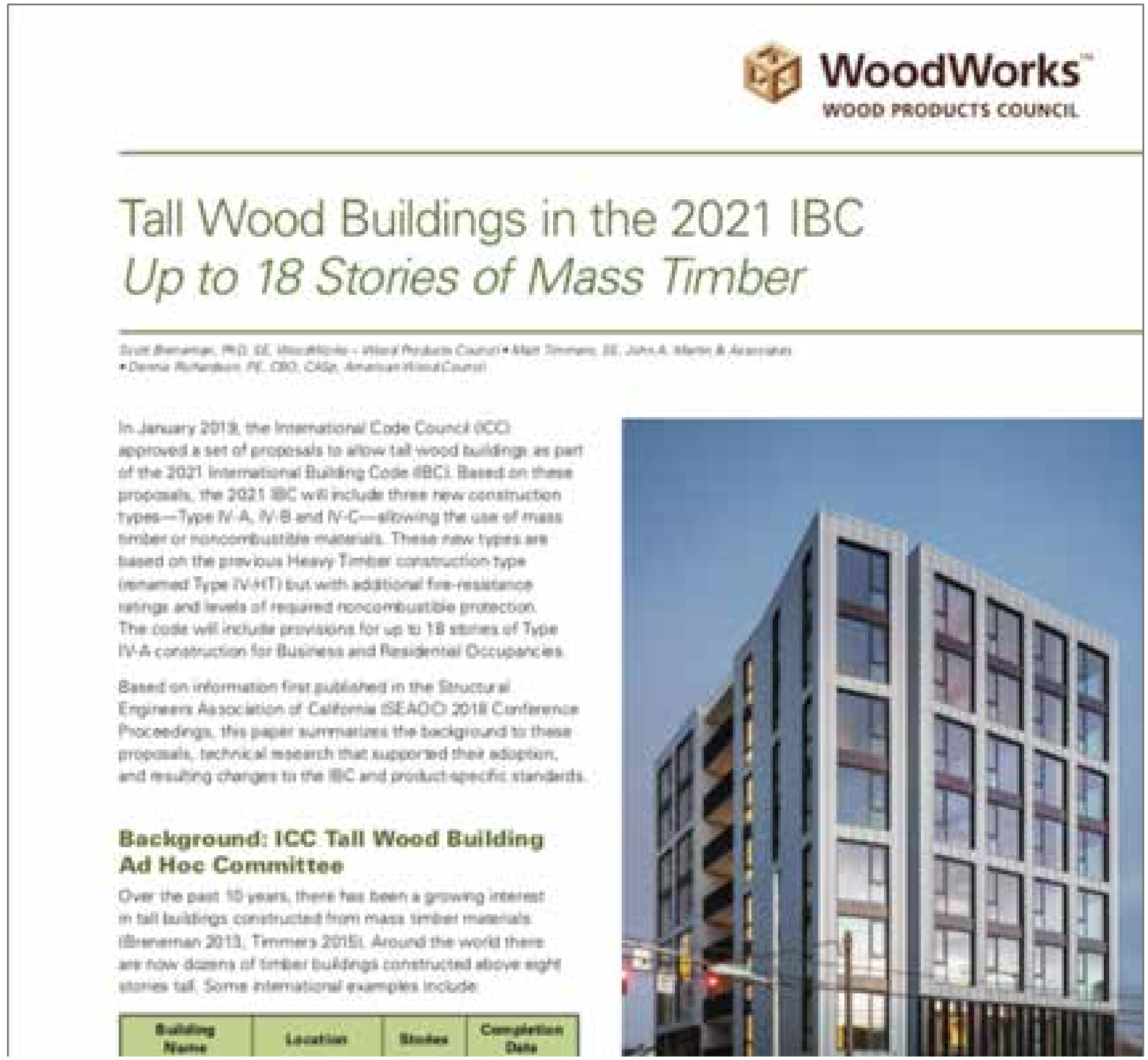
Credit: WoodWorks

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

Credit: Susan Jones, atelierjones

WoodWorks Tall Wood Design Resource

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



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Tall Wood Buildings in the 2021 IBC
Up to 18 Stories of Mass Timber

Scott Breneman, PhD, SE, WoodWorks – Wood Products Council • Matt Timmers, SE, John A. Martin & Associates • Dennis Richardson, PE, CBO, CASp, American Wood Council

In January 2019, the International Code Council (ICC) approved a set of proposals to allow tall wood buildings as part of the 2021 International Building Code (IBC). Based on these proposals, the 2021 IBC will include three new construction types—Type IV-A, IV-B and IV-C—allowing the use of mass timber or noncombustible materials. These new types are based on the previous Heavy Timber construction type (renamed Type IV-HT) but with additional fire-resistance ratings and levels of required noncombustible protection. The code will include provisions for up to 18 stories of Type IV-A construction for Business and Residential Occupancies.

Based on information first published in the Structural Engineers Association of California (SEAOC) 2018 Conference Proceedings, this paper summarizes the background to these proposals, technical research that supported their adoption, and resulting changes to the IBC and product-specific standards.

Background: ICC Tall Wood Building Ad Hoc Committee

Over the past 10 years, there has been a growing interest in tall buildings constructed from mass timber materials (Breneman 2013, Timmers 2015). Around the world there are now dozens of timber buildings constructed above eight stories tall. Some international examples include:

Building Name	Location	Stories	Completion Date

MASS TIMBER FIRE-RESISTANCE

Photo Credit: FPInnovations

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[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	 3 3[a]	 2 2[a]	 1 1	 0 0	 2 1	 2 0	 2 1/HT	 1 1	 0 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)	$1^1/_2$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. 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.

b. 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.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating required by other sections of this code.

e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

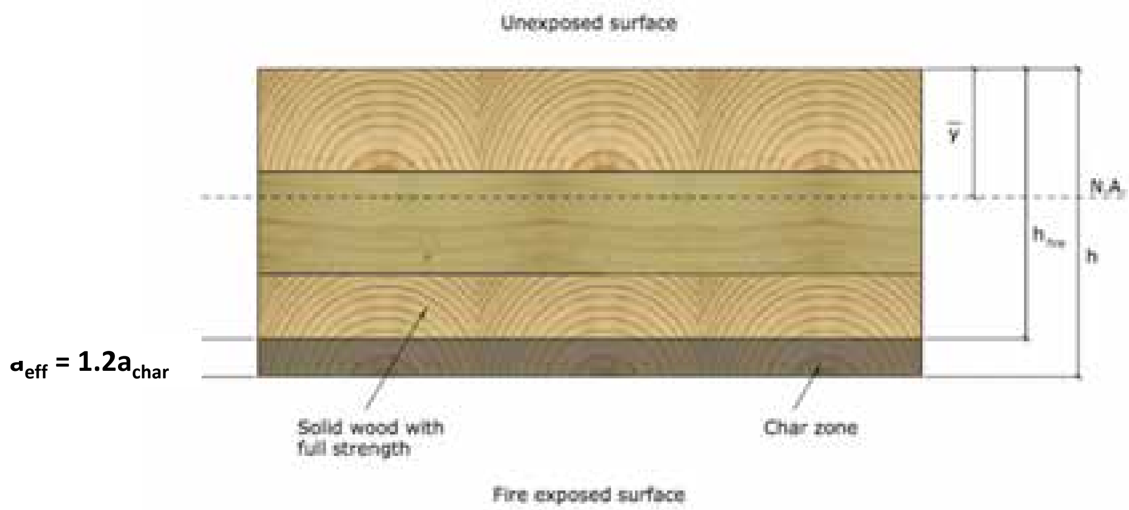
f. Not less than the fire-resistance rating as referenced in Section 704.10.

Credit: IBC Table 601

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



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: David Barber, ARUP

Credit: AWC'S NDS

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

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

WOODWORKS INVENTORY OF FIRE TESTED MT ASSEMBLIES

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

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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 1.5 EMSR x SPF #3	2 layers 1/2" Type X gypsum	Half-Lap	None	Reduced 50% 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	3	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 Capacity	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 Capacity	2	4	UL
5-ply CLT (175mm 6.875")	Nordic	E1	[illegible]	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 Gyp-Crete 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 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap	nominal [illegible]	[illegible] See Manufacturer	[illegible]	[illegible]	[illegible] 11/01/2016
5-ply CLT [illegible]	KLH	CV3M1	None	Half-Lap & Topside spline	None	Loaded, See Manufacturer	1	18	SwRI [illegible]


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Fire-Resistive Design of Mass Timber Members

Code Applications, Construction Types and Fire Ratings

Mass Timber & Construction Type

Mass Timber Fire Design Resource

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

MASS TIMBER ACOUSTICS DESIGN

BY ITSELF, NOT ADEQUATE FOR ACOUSTICS

WoodWorks Inventory of Acoustically Tested MT Assemblies

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

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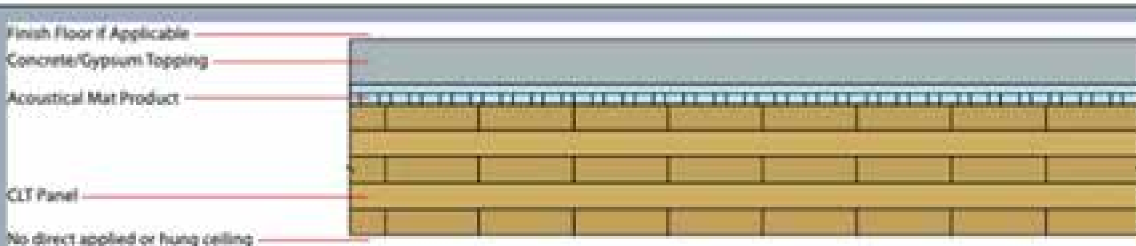

CLT Panel	Concrete/Gypsum Topping	Acoustical Mat Product Between CLT and Topping	Finish Floor	STC[1]	IIC[1]	Source
CLT 5-ply (6.875")	1-1/2" Gyp-Crete®	Maxxon Acousti-Mat® 3/4	None	47[2] ASTC	47[3] AIIC	1
			LVT	-	49[2] AIIC	
			Carpet + Pad	-	75[2] AIIC	
			LVT on Acousti-Top®	-	52[2] AIIC	
			Eng Wood on Acousti-Top®	-	51[2] AIIC	
			None	49[2] ASTC	45[2] AIIC	
		USG SAM N25 Ultra	LVT	48[6]	47[6]	16
			LVT Plus	48[6]	49[6]	58
			Eng Wood	47[6]	47[6]	59
	1-1/2" Levelrock® Brand 2500		LVT	48[6]	44[6]	16

More than 400 Tested Assemblies

Free download at woodworks.org

MASS TIMBER ACOUSTICS DESIGN RESOURCE

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

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

Mass Timber Assembly Options: Walls

Acoustical Differences between Mass Timber Panel Options

Improving Performance by Minimizing Flanking

WoodWorks can help connect you with:

Manufacturers

Suppliers

Distributors

Experienced Designers, Contractors, Installers

And Much More

Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

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