Code Meets Classroom: Tall Wood Code and Mass Timber Schools

November 19, 2025

Presented by
Jessica Scarlett
WoodWorks

Image: Franklin Road Academy/ Courtesy of Anecdote

What is Mass Timber?

Mass timber is a category of framing styles often using small wood members formed into large panelized solid wood construction including CLT, NLT or glulam panels for floor, roof and wall framing

Glue Laminated Timber

(Glulam) Beams & columns

Photo: StructureCraft

Cross-Laminated Timber

(CLT) Solid sawn laminations

Photo: LendLease

Cross-Laminated Timber

(CLT) SCL laminations

Photo: Freres Lumber

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

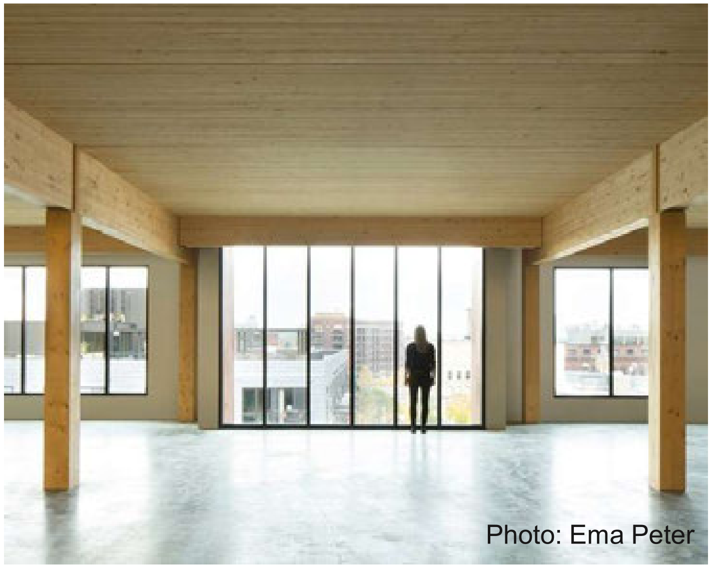


Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

What is Tall Mass Timber?

Photo: WoodWorks
Architect/Developer: oWOW


Ascent
Milwaukee, WI
Korb + Associates Architects
Thronton Tomasetti
Photo: C.D. Smith Construction

Ascent

Milwaukee, WI

493,000 sf, 25 stories total (19 mass timber)

Type IV-HT with code modifications

Multi-Family

Completed 2022

W|N PROFILE

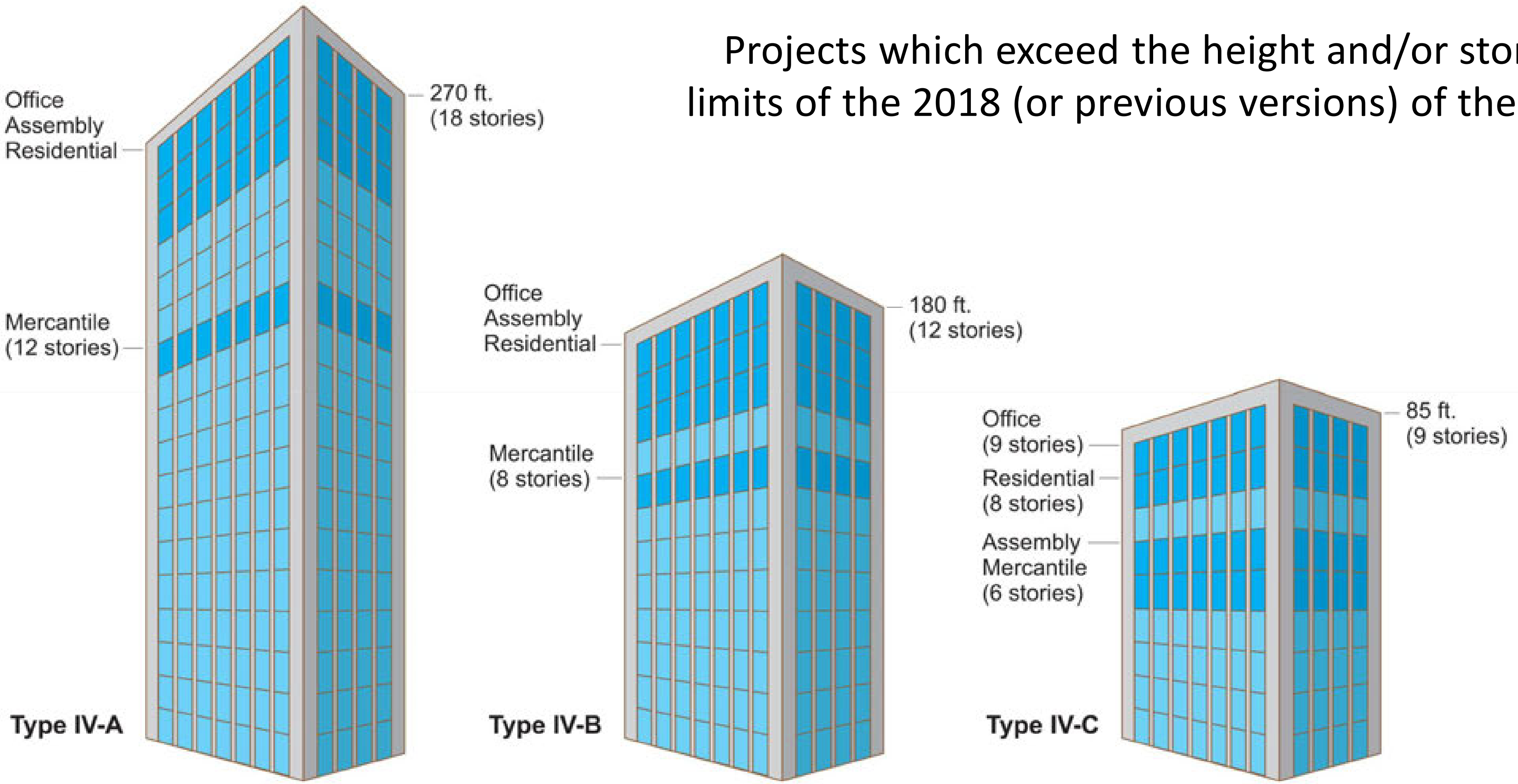
BUSINESS CASE STUDY

WOOD DESIGN AWARD WINNER

Korb + Associates Architects
Thronton Tomasetti
Photo: VRX Media Group

Tall Mass Timber

Projects which exceed the height and/or story limits of the 2018 (or previous versions) of the IBC



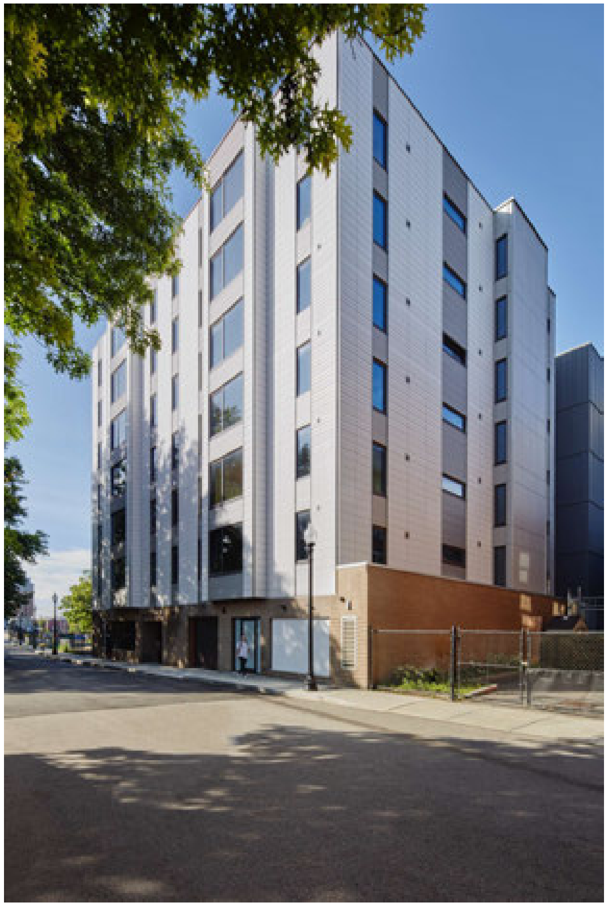
Tall Mass Timber

2021 IBC Introduces 3 new tall wood construction types:

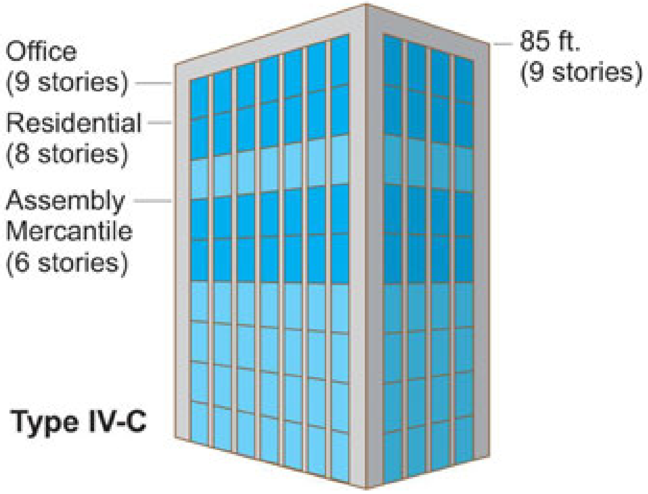
- » IV-A
- » IV-B
- » IV-C
- » Previous type IV renamed type IV-HT

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B

Type IV-C



Monte French Design Studio
Photos: Jane Messinger

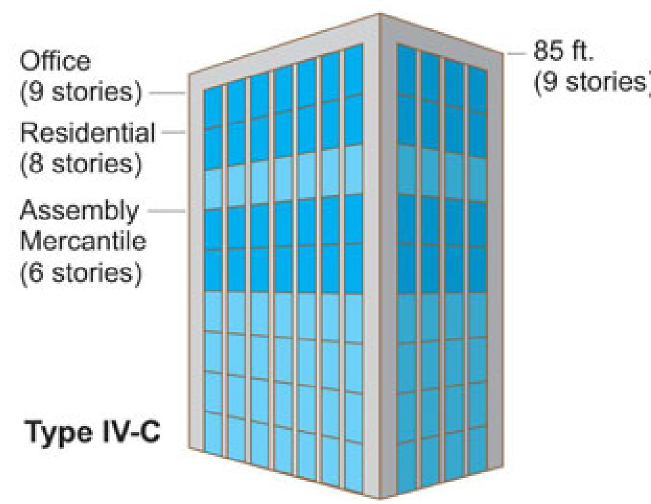


Type IV-C Exposure Limits

All Mass Timber surfaces may be exposed

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

Monte French Design Studio
Photo: Jane Messinger



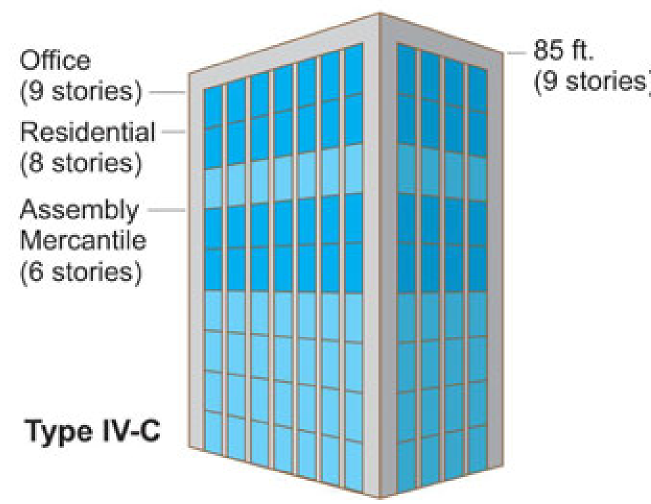
Type IV-C Building Size Limits

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

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

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	6	85 ft	56,250 SF	168,750 SF
B	9	85 ft	135,000 SF	405,000 SF
M	6	85 ft	76,875 SF	230,625 SF
R-2	8	85 ft	76,875 SF	230,625 SF

Areas exclude potential frontage increase



Heartwood

Seattle, WA

atelierjones LLC
DCI Engineers
Image: atelierjones LLC

Heartwood

Seattle, WA

atelierjones LLC
DCI Engineers
Image: atelierjones LLC

66,000 sf, 8 stories

Type IV-C

Workforce Housing

MT / CLT

Wood construction: 1 day per floor

Completed 2023

WN PROFILE

Type IV-B

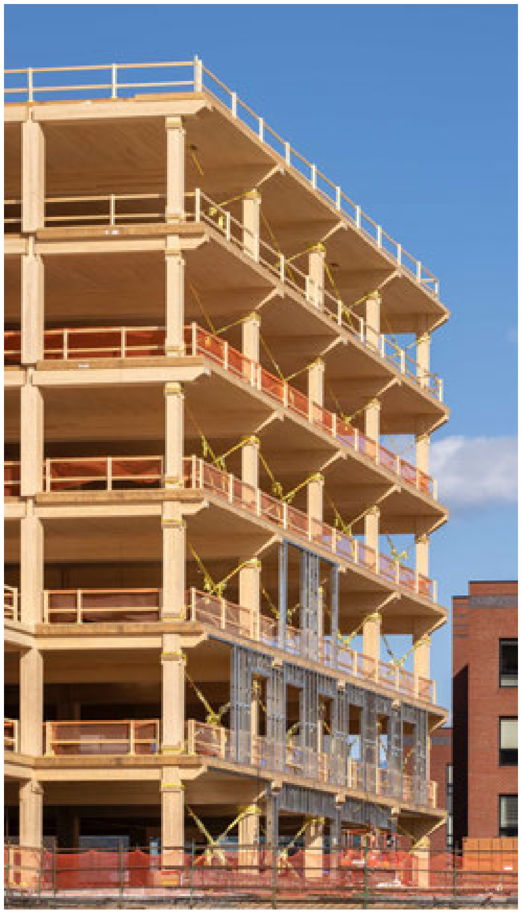
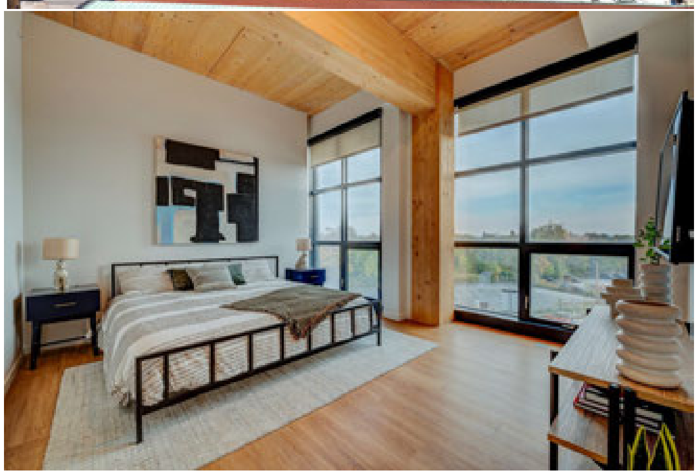
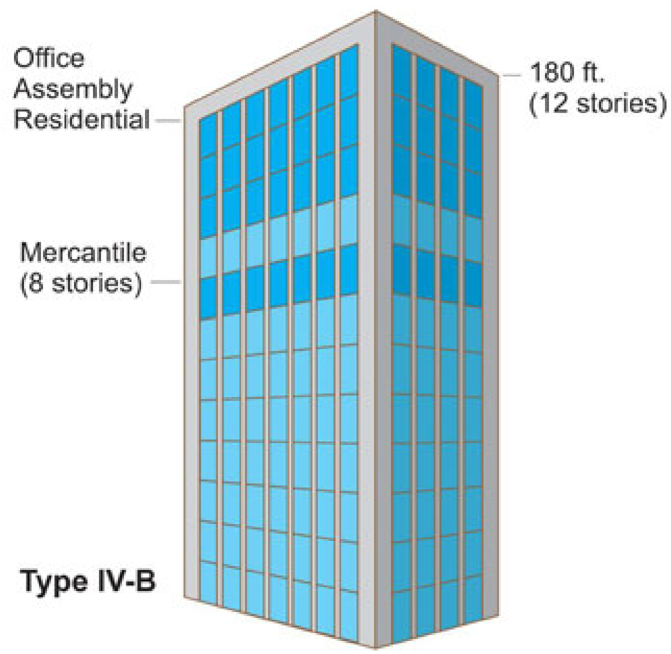


Photo: ©Prakash Patel



Photos: Nick Johnson, Tour D Space



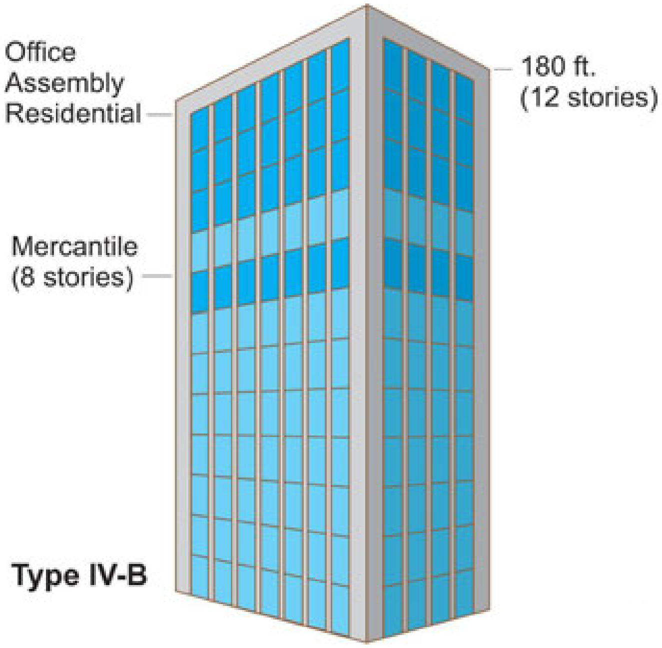
Type IV-B Exposure Limits

NC protection on some surfaces of Mass Timber

2021 IBC: 20% of ceilings or 40% of walls can be exposed

2024 IBC: 100% of ceilings or 40% of walls can be exposed

Photo: Nick Johnson, Tour D Space



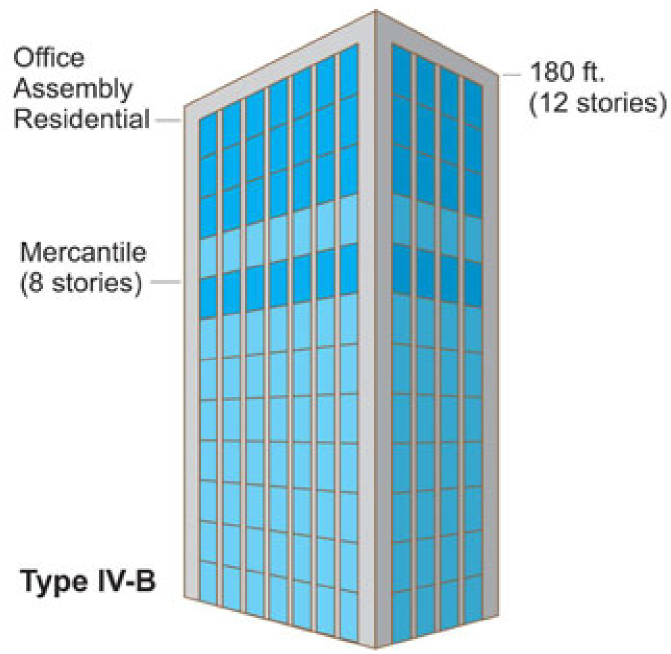
Type IV-B Building Size Limits

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

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

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	12	180 ft	90,000 SF	270,000 SF
B	12	180 ft	216,000 SF	648,000 SF
M	8	180 ft	123,000 SF	369,000 SF
R-2	12	180 ft	123,000 SF	369,000 SF

Areas exclude potential frontage increase



BAKER'S PLACE

MADISON, WI

Baker’s Place

Madison, WI

304,800 sf,

14 stories total (11 mass timber)

Type IV-B

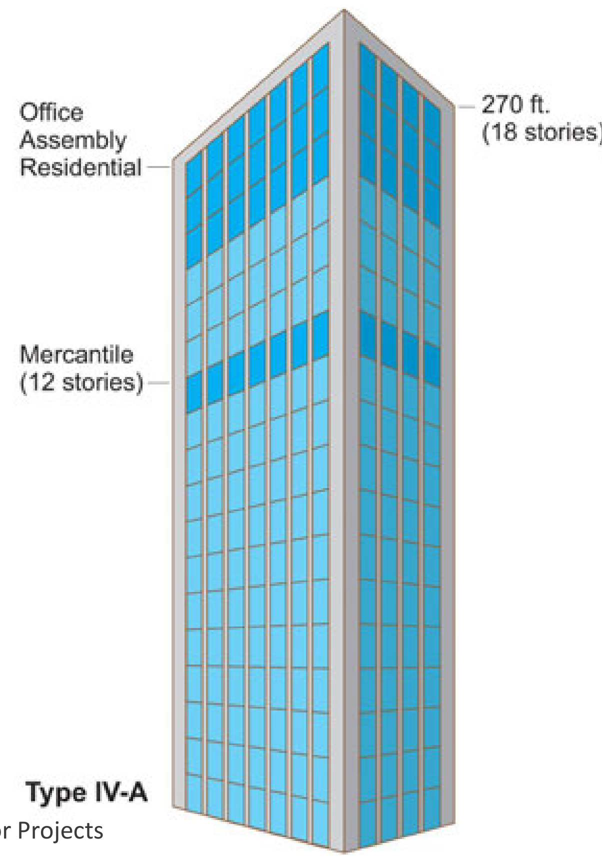
Multi-Family

Passive House

W|N PROFILE

Angus-Young
Michael Green Architecture
Equilibrium Consulting
Photo Michael Green
Architecture

Type IV-A

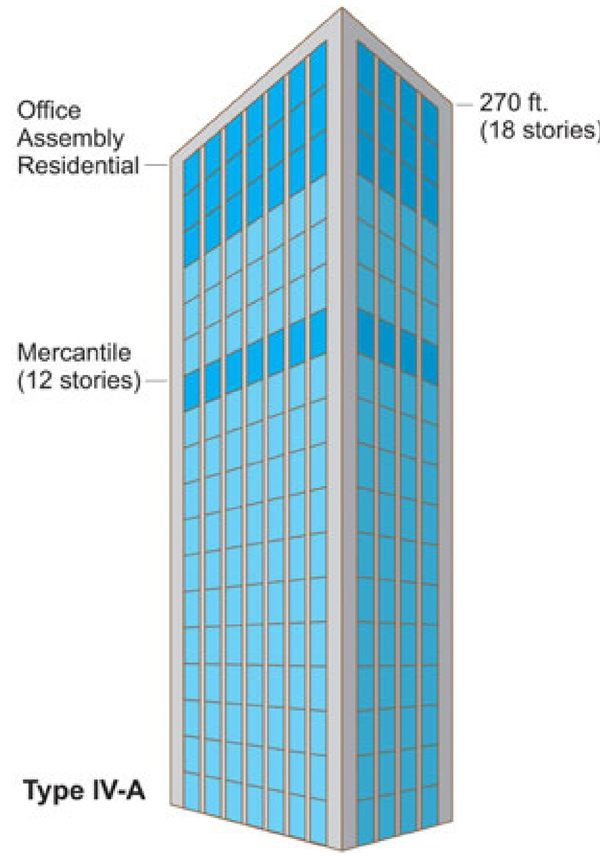


Photos: Flor Projects

Type IV-A Exposure Limits

100% NC protection on all surfaces of Mass Timber

Photo: Flor Projects



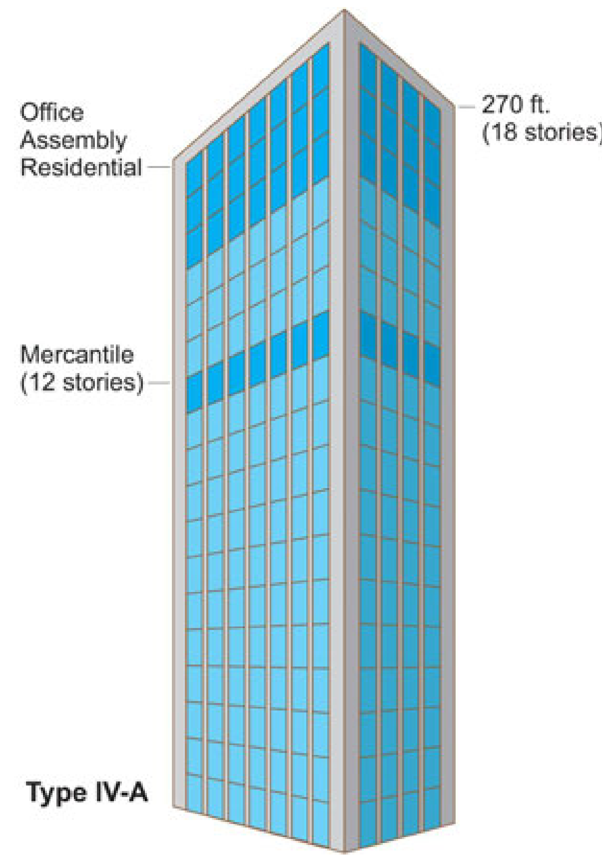
Type IV-A Building Size Limits

In most cases, Type IV-A height & story allowances = 1.5 * Type I-B height & story allowances

Type IV-A area = 3 * Type IV-HT area

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

Areas exclude potential frontage increase

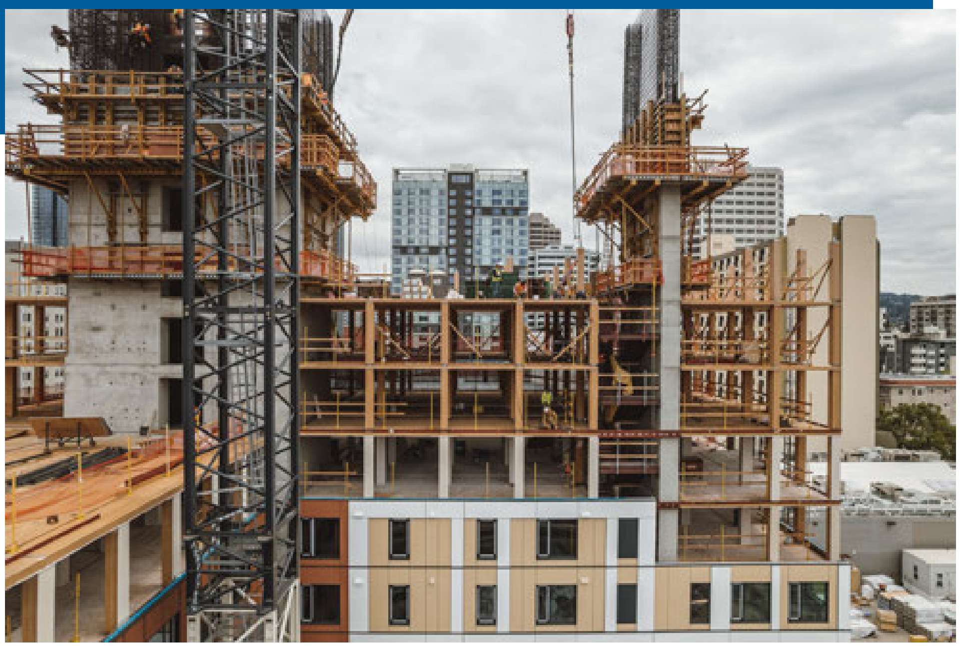



1510 Webster
Oakland, CA
oWow
DCI Engineers
Photo: Flor Projects

1510 Webster

Oakland, CA

- 16 stories mass timber, 1 level steel over two-level concrete
- Designed with Tall Wood code provisions in the 2021 CBC
- Mass timber with concrete cores and staircases



Photos: Flor Projects

oWow
DCI Engineers

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	A	B	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a, b]	2[a, b, c]	1[b, c]	0[c]	1[b, c]	0	3[a]	2[a]	2[a]	HT	1[b, c]	0
Bearing walls												
Exterior[e, f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT[g]	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	1 1/2[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	1 1/2	1	1	HT	1[b,c]	0

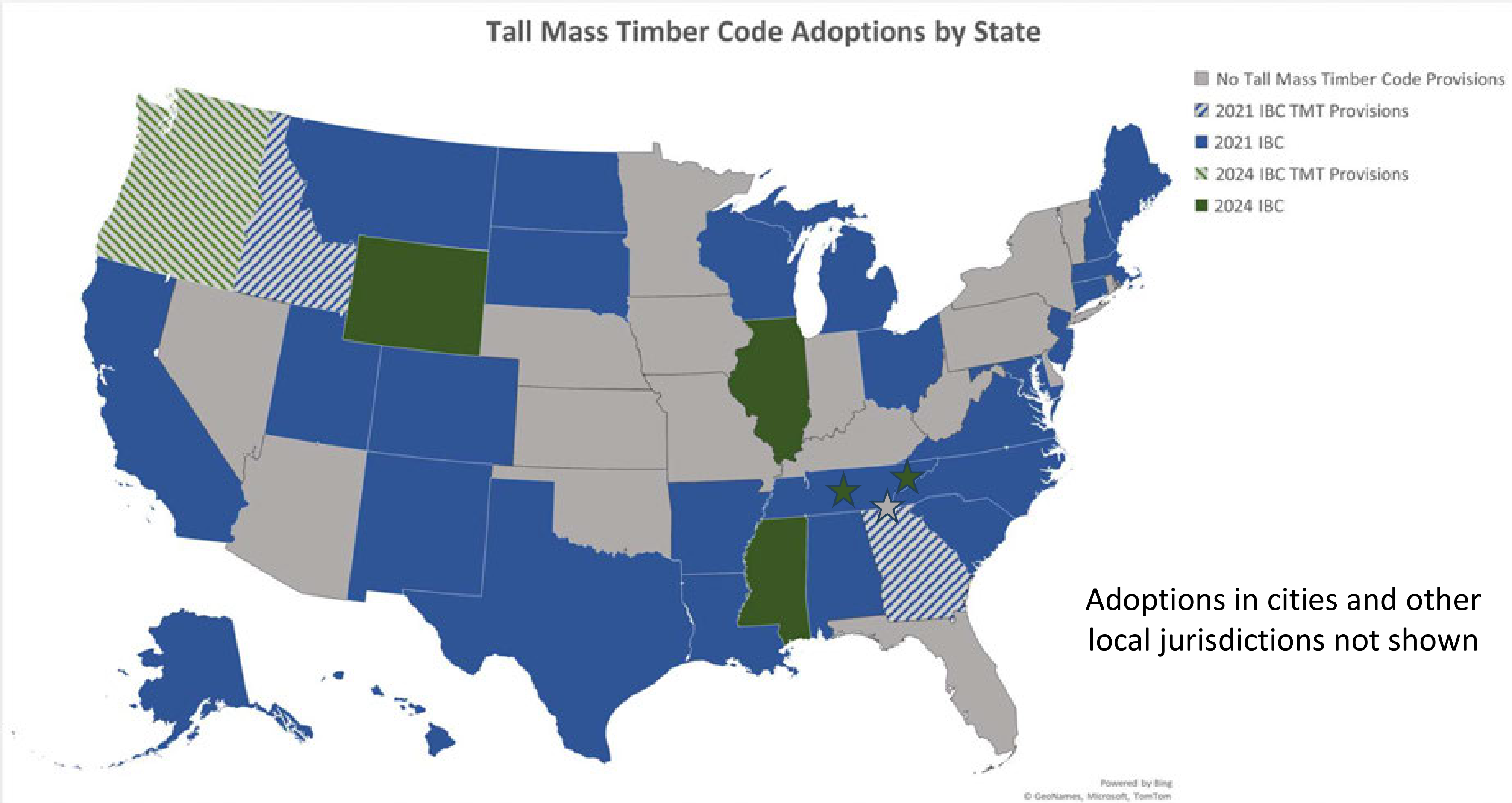
Source: 2021 IBC

Tall Mass Timber in the U.S.

How Did We Arrive Here?

INTRO, Cleveland, OH | Architect: Hartshorne Plunkard Architecture | Image Courtesy Harbor Bay Real Estate Advisors, Image Fiction

TALL MASS TIMBER CODE ADOPTIONS



Adoptions in cities and other local jurisdictions not shown

https://www.woodworks.org/resources/status-of-building-code-allowances-for-tall-mass-timber-in-the-ibc/

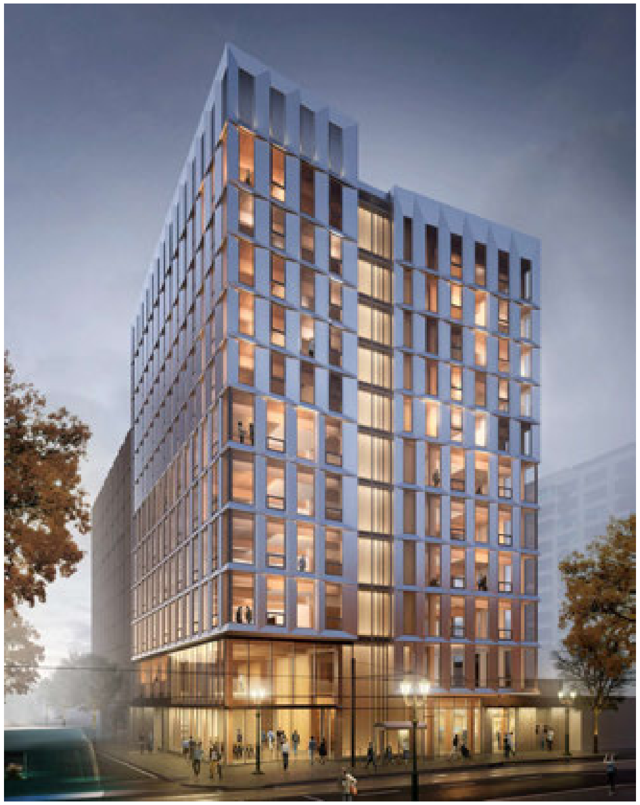
2008 – 2015: International Inspiration

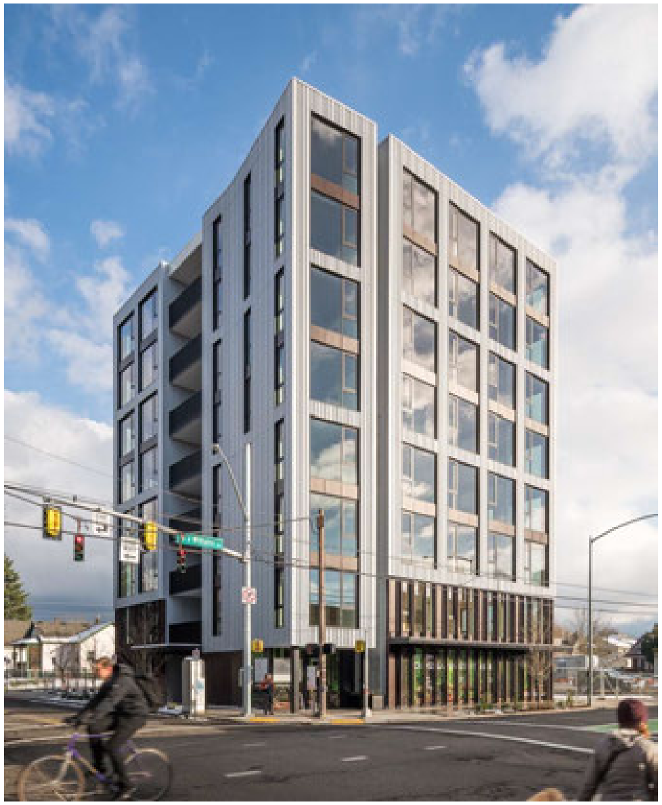
8-18-Story Projects in Europe, Canada, Australia

Photos: Waugh Thisleton Architects | Bygg Mesteren | Voll Arkitekter | Michael Elkan | Naturally Wood | UBC

2015-2018: Domestic Innovation

Tall Wood Building Competition, 8-Story Carbon 12 in Portland, OR





Photos: SHoP Architects | LEVER Architecture | Baumberger Studio/PATH Architecture

2015-2018: Building a Code Roadmap

Photos: ICC

2015-2018: Building a Code Roadmap

Photo: Lendlease

2015-2018: Building a Code Roadmap

Photo: Lendlease

2015-2018: Building a Code Roadmap

Photo: Lendlease

2015-2018: Building a Code Roadmap

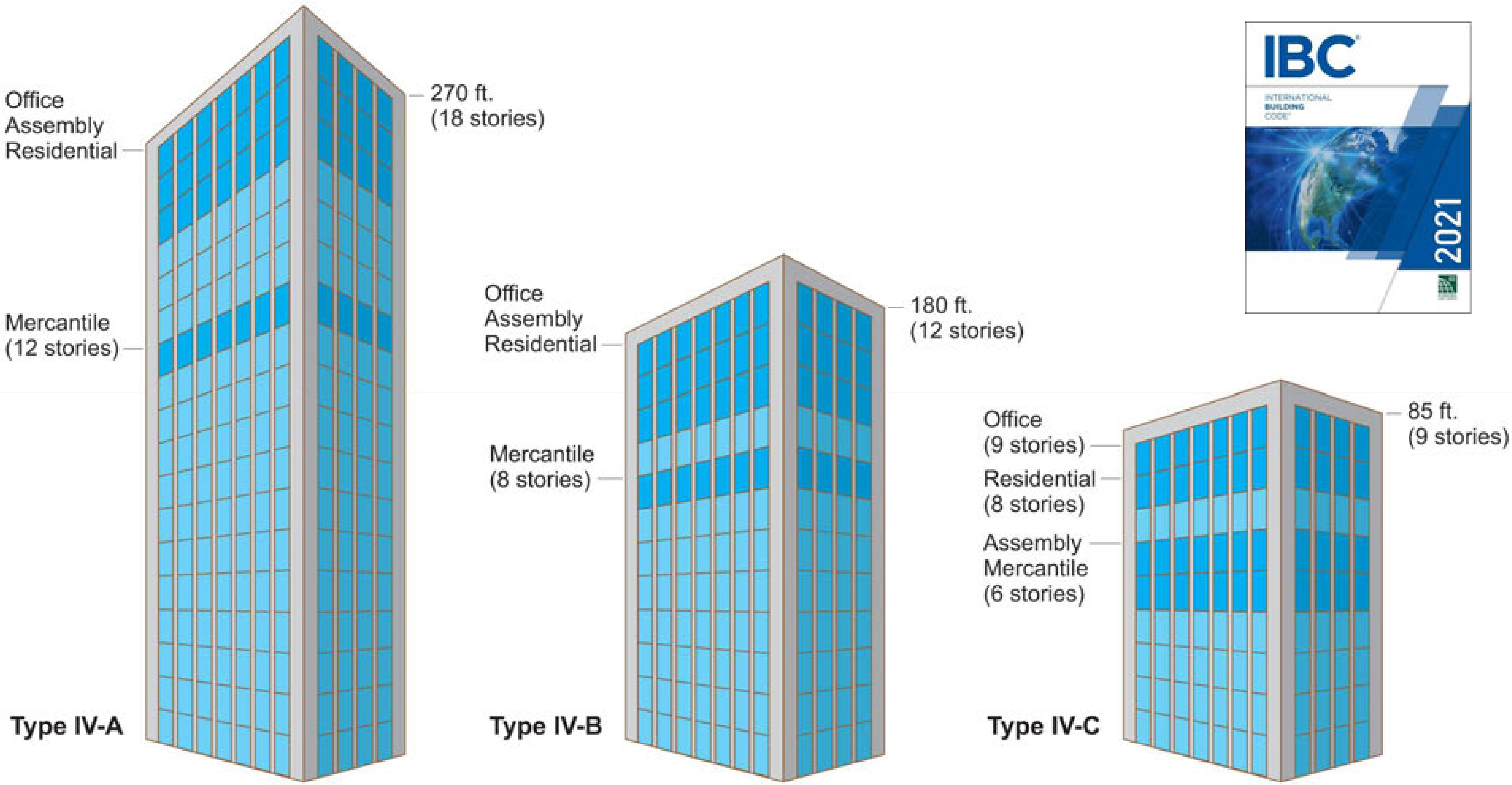
Photo: Lendlease

2015-2018: Building a Code Roadmap

Photo: Lendlease

2018-2021: Rollout of a New Code Path

2021 IBC



2019-2022: REFINING THE CODE ROADMAP

Fire Safe Implementation of Mass Timber In Tall Buildings

Research of the fire performance of CLT and Glued Laminated Timber buildings, with visible wood surfaces.

The main aim of this research project was to identify safe limits of exposed mass timber surface areas that correspond with performance criteria used for previous U.S. Building Code Changes.

Source: RISE

2019-2022: REFINING THE CODE ROADMAP

USDA
United States Department of Agriculture

Compartment Fire Testing of a Two-Story Mass Timber Building

Samuel L. Zelinka
Laura E. Hasburgh
Keith J. Bourne
David R. Tucholski
Jason P. Ouellette

Forest Service | Forest Products Laboratory | General Technical Report FPL–GTR–247 | May 2018

Conservatism: ATF lab tests based on older generation CLT adhesives

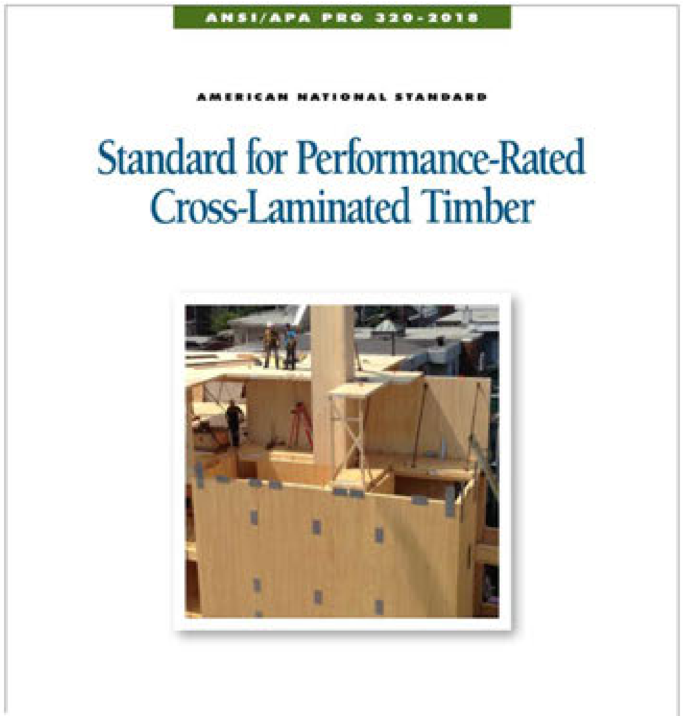
2018 ATF tests were initiated before the 2018 version of ANSI/APA PRG 320 was published and the tested CLT was not compliant with the new product standard.

Source: RISE, USDA FS FPL & AWC

2019-2022: REFINING THE CODE ROADMAP

PRG 320 is manufacturing & performance standard for CLT

2019 edition (referenced in 2021 IBC) added new elevated temperature adhesive performance requirements validated by full-scale and medium-scale qualification testing to ensure CLT does not exhibit fire re-growth



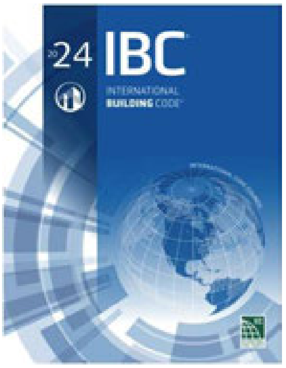
ANNEX B. PRACTICE FOR EVALUATING ELEVATED TEMPERATURE PERFORMANCE OF ADHESIVES USED IN CROSS-LAMINATED TIMBER (MANDATORY)

2019-2022: REFINING THE CODE ROADMAP

Photo: RISE

2019-2022: REFINING THE CODE ROADMAP

Change to 2024 IBC: IV-B Ceiling Exposure



602.4.2.2.2 Protected area.

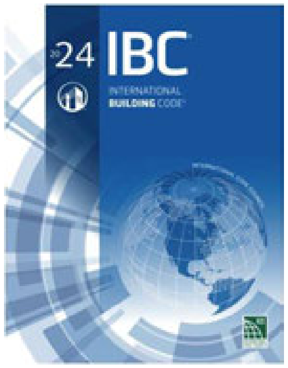
Interior faces of *mass timber* elements, including the inside face of exterior *mass timber walls* and *mass timber roofs*, shall be protected in accordance with Section 602.4.2.2.1.

Exceptions: Unprotected portions of *mass timber* ceilings and walls complying with Section 602.4.2.2.4 and the following:

1. Unprotected portions of *mass timber* ceilings and walls complying with one of the following:
   - 1.1. Unprotected portions of *mass timber* ceilings, including attached beams, limited to an area less than or equal to 100 percent of the floor area in any *dwelling unit*within a *story* or fire area within a *story*.
   - 1.2. Unprotected portions of *mass timber* walls, including attached columns, limited to an area less than or equal to 40 percent of the floor area in any *dwelling unit*within a *story* or fire area within a *story*.
   - 1.3. Unprotected portions of both walls and ceilings of *mass timber*, including attached columns and beams, in any *dwelling unit* or fire area and in compliance with Section 602.4.2.2.3.
2. *Mass timber* columns and beams that are not an integral portion of walls or ceilings, respectively, without restriction of either aggregate area or separation from one another.

2019-2022: REFINING THE CODE ROADMAP

Change to 2024 IBC: IV-B Exposure Separation



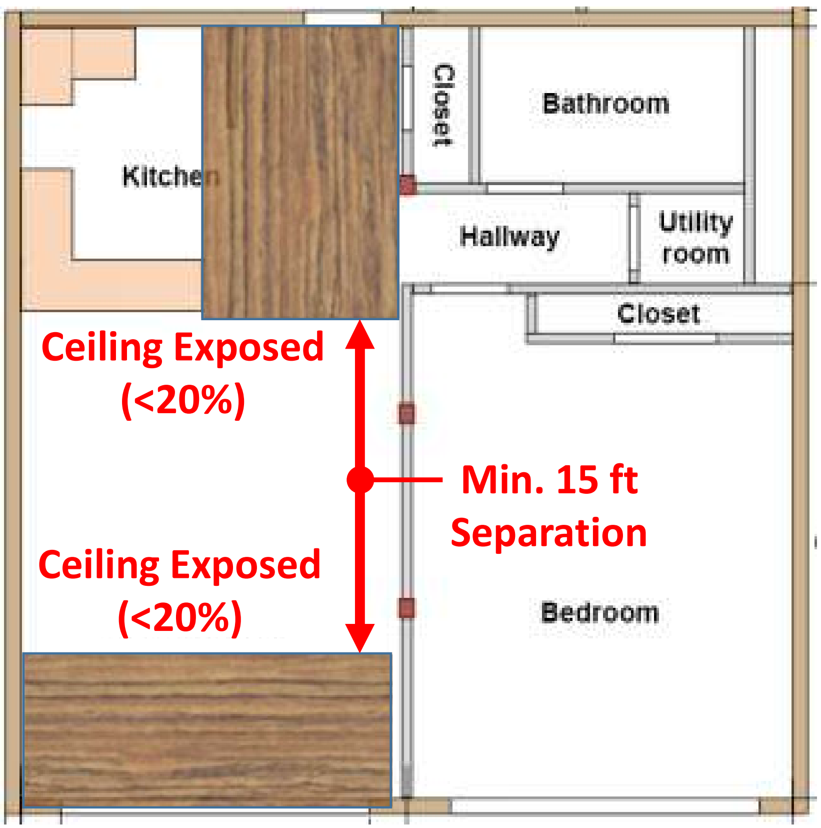
602.4.2.2.4 Separation distance between unprotected *mass timber* elements.

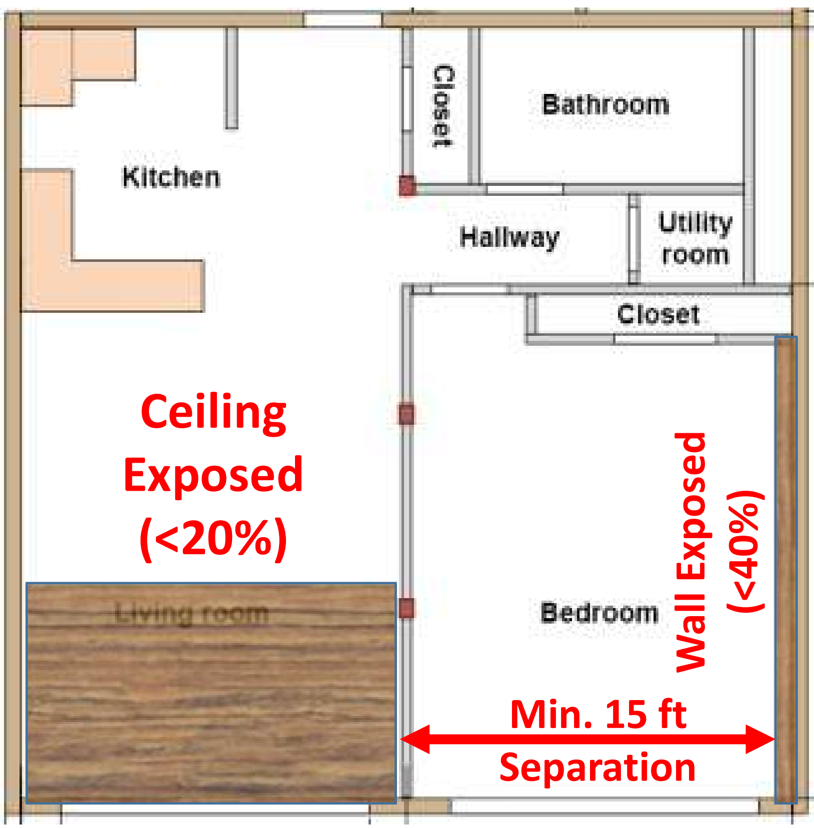
In each *dwelling unit* or *fire area*, unprotected portions of *mass timber* walls shall be not less than 15 feet (4572 mm) from unprotected portions of other walls measured horizontally along the floor.

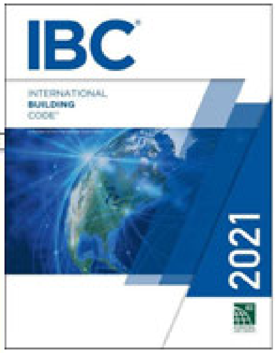
2024 IBC eliminates need for 15 ft separation between exposed walls and ceilings, and between portions of exposed ceilings

2019-2022: REFINING THE CODE ROADMAP

2021 IBC Allowances



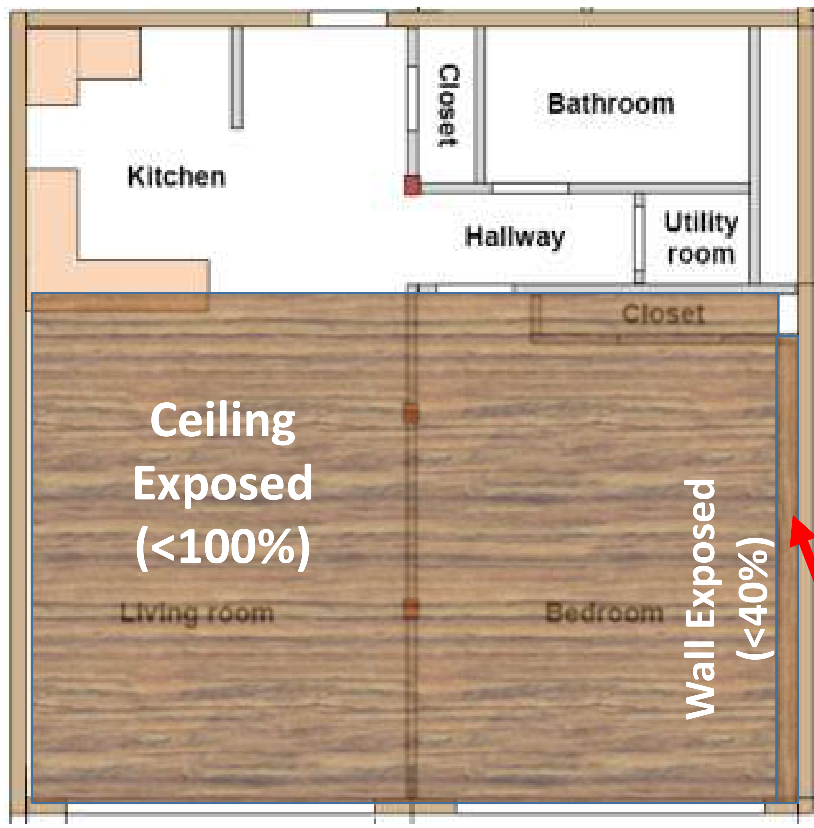




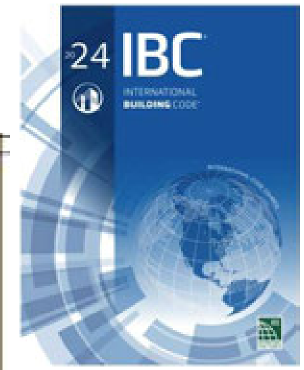
Credit: AWC

2019-2022: REFINING THE CODE ROADMAP

2024 IBC Allowances



No separation req'd between wall & ceiling, only wall to wall

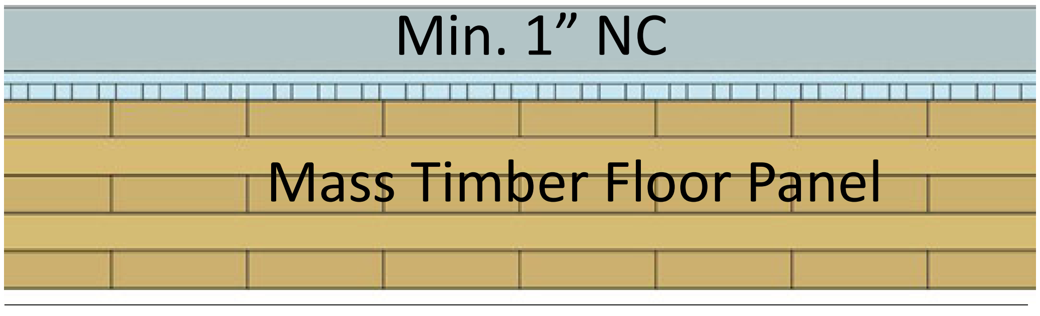


Credit: AWC

2019-2022: REFINING THE CODE ROADMAP

100% Timber Ceiling Exposure Up to 12 Stories

2019-2022: REFINING THE CODE ROADMAP



Min. 1” thick NC protection required on mass timber floors in IV-A and IV-B. Not required in IV-C

2019-2022: REFINING THE CODE ROADMAP

Change to 2024 IBC: Sequencing of NC topping install

F174-21
IFC: 3303.5

Proponents: David Tyree, representing AWC (dtyree@awc.org); Raymond O'Brocki, AWC, representing AWC (robrocki@awc.org)

2021 International Fire Code

Revise as follows:

3303.5 Fire safety requirements for buildings of Types IV-A, IV-B and IV-C construction. Buildings of Types IV-A, IV-B and IV-C construction designed to be greater than six stories above*grade plane* shall comply with the following requirements during construction unless otherwise *approved* by the *fire code official*.

1. Standpipes shall be provided in accordance with Section 3313.
2. A water supply for fire department operations, as *approved* by the *fire code official* and the *fire chief*.
3. Where building construction exceeds six stories above *grade plane* and noncombustible protection is required by Section 602.4 of the *International Building Code*, at least one layer of noncombustible protection shall be installed on all building elements on floor levels, including mezzanines, more than four levels below active mass timber construction before additional floor levels can be erected.

   ~~Exception~~ Exceptions:

   1. Shafts and vertical exit enclosures shall not be considered part of the active mass timber construction.
   2. Noncombustible material on the top of mass timber floor assemblies shall not be required before erecting additional floor levels.

4. Where building construction exceeds six stories above *grade plane*, required exterior wall coverings shall be installed on floor levels, including mezzanines, more than four levels below active mass timber construction before additional floor levels can be erected.

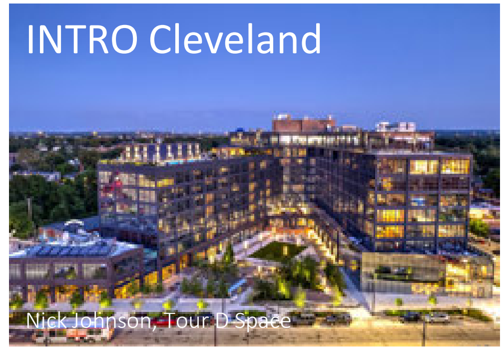
   Exception: Shafts and vertical exit enclosures shall not be considered part of the active mass timber construction.

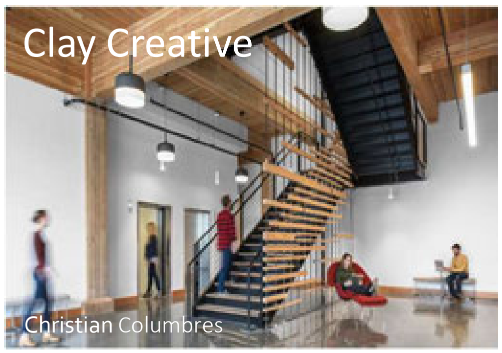
Credit: ICC

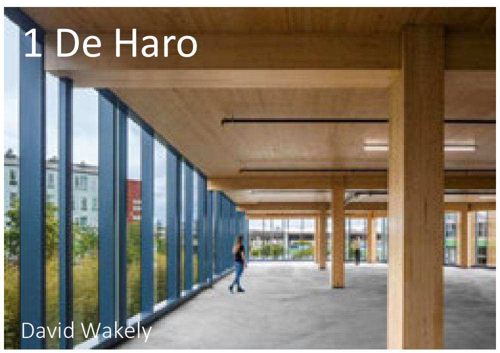
WHY ALL OF THE INTEREST?

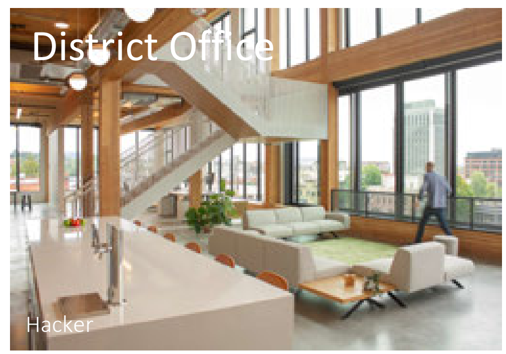
Photo: WoodWorks
Architect/Developer: oWOW

Mass Timber Business Case Studies









WOODWORKS
WOOD PRODUCTS COUNCIL

$ Costs + $ Returns
Challenges,
Lessons Learned, Successes

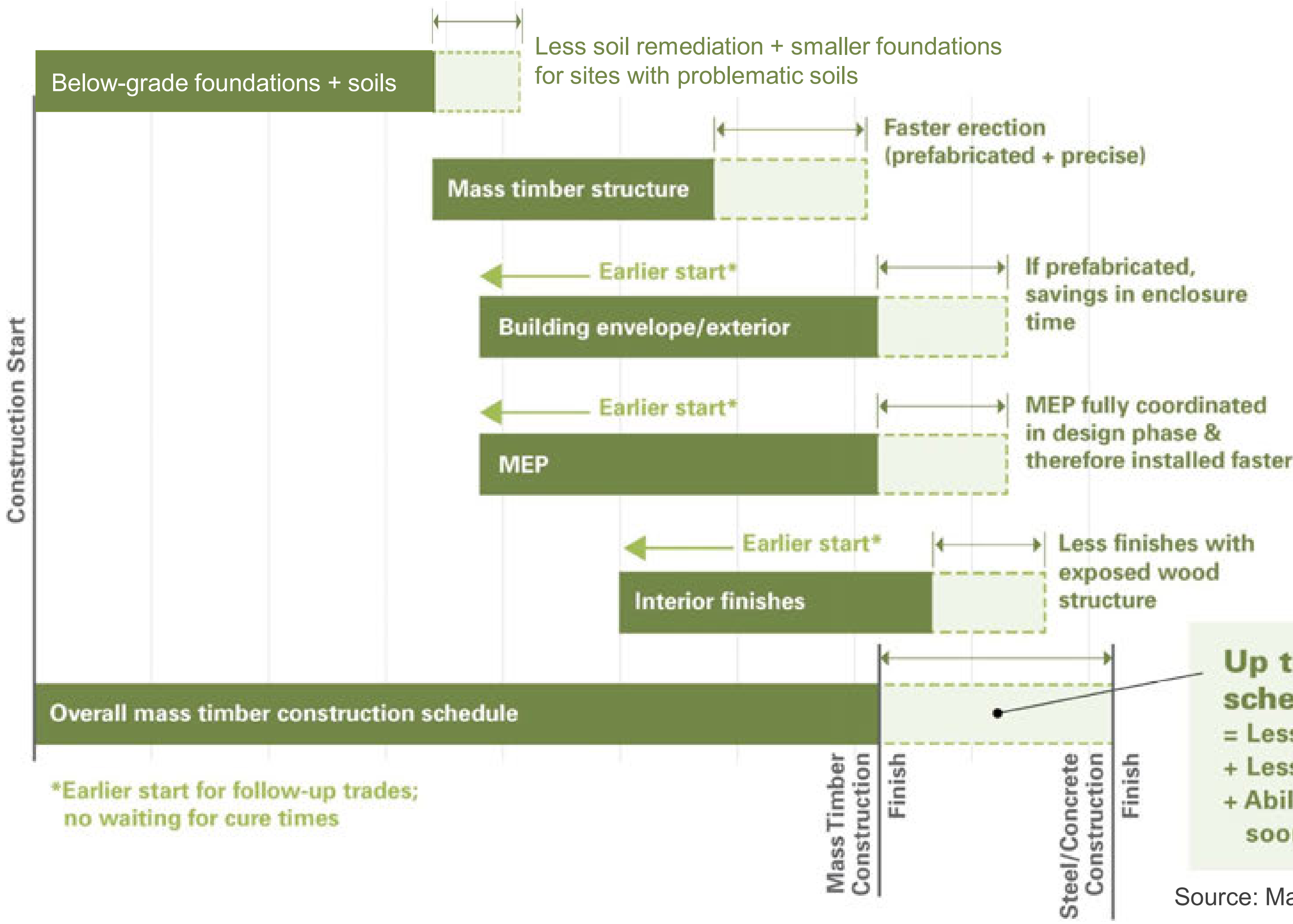
Scan code here
to download the
current package

Mass Timber: Structural Warmth is a Value-Add

TMBR (unbuilt) Minneapolis, MN | Images: D/O Architects

Compressing the Typical Schedule

Fast Construction



Up to 25% schedule savings
= Less carrying costs
+ Less GC overhead
+ Ability to lease/occupy sooner

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

Source: Mass Timber Cost & Design Optimization, WoodWorks[2]

Schedule Savings for Rough-In Trades

Fast Construction

NO curing
(mass timber)

Curing & maze of
shores (concrete)

Photo: WoodWorks

Construction Impacts: Labor Availability

Photo: Lendlease

But is it cost competitive?

Need to Consider Holistic Costs, Not Structure Only

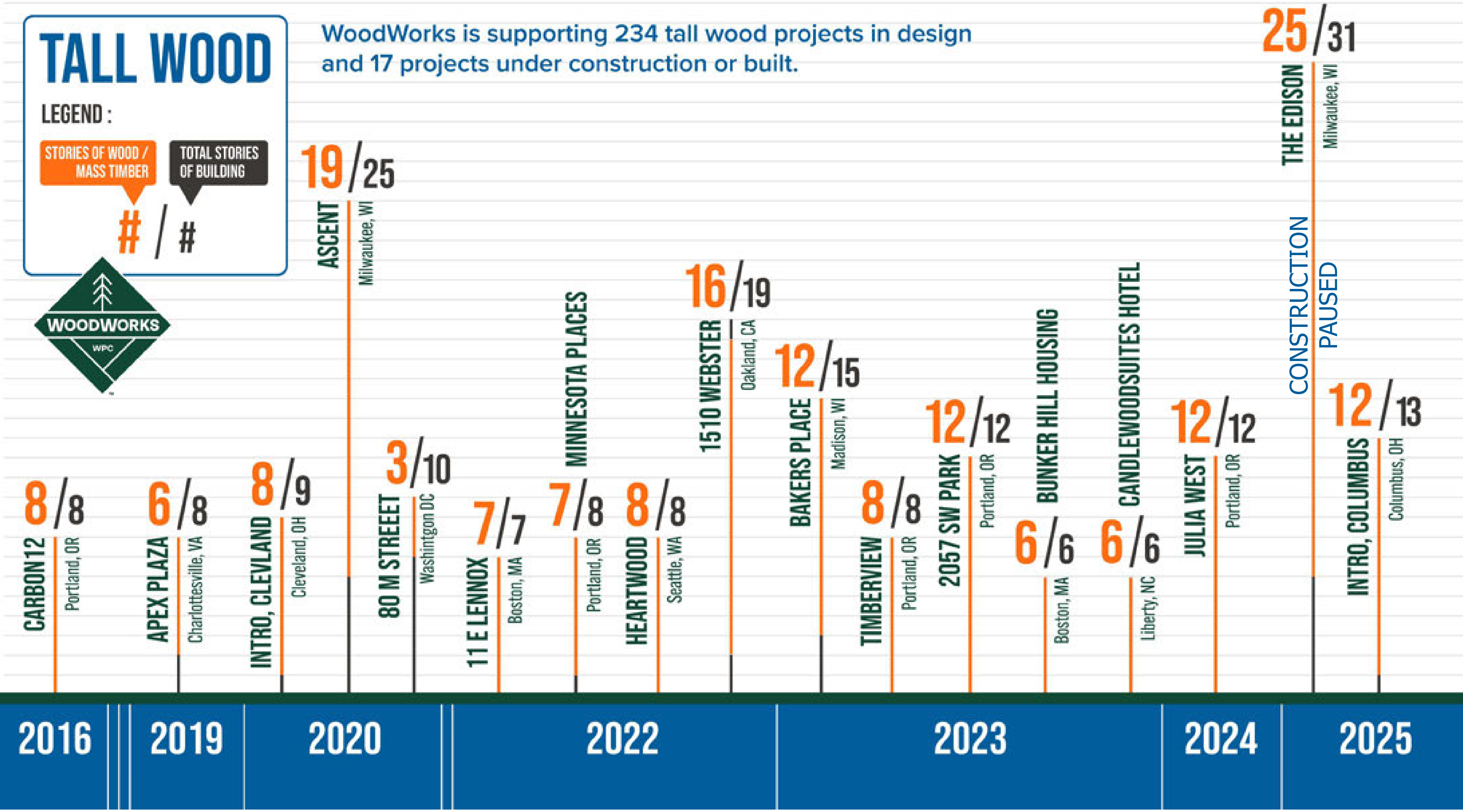
$/SF

$/SF

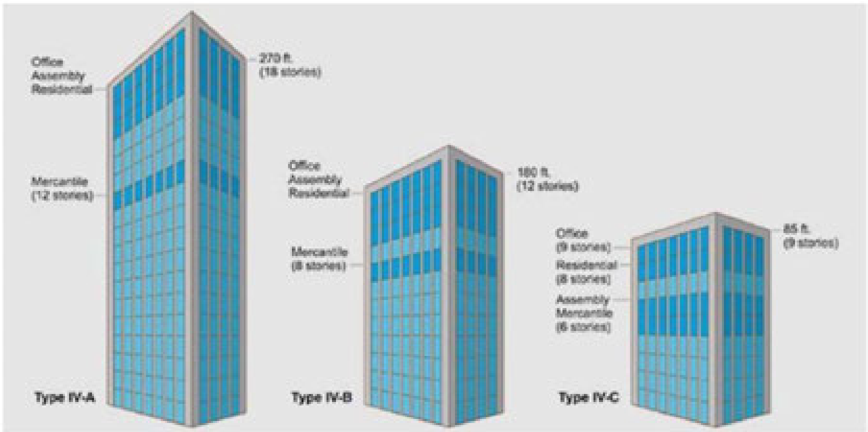
Image: GBD Architects

2022 AND BEYOND: PROJECTS RISING

Photo: Harbor Bay Real Estate Advisors, Image Fiction | Architect: Hartshorne Plunkard Architecture


TALL WOOD
LEGEND :
STORIES OF WOOD / MASS TIMBER
TOTAL STORIES OF BUILDING
/
WOODWORKS
WPC
WoodWorks is supporting 234 tall wood projects in design and 17 projects under construction or built.
8/8 CARBON12 Portland, OR
6/8 APEX PLAZA Charlottesville, VA
8/9 INTRO, CLEVLAND Cleveland, OH
19/25 ASCENT Milwaukee, WI
3/10 80 M STREET Washingtgon DC
7/7 11 E LENNOX Boston, MA
7/8 MINNESOTA PLACES Portland, OR
8/8 HEARTWOOD Seattle, WA
16/19 1510 WEBSTER Oakland, CA
12/15 BAKERS PLACE Madison, WI
8/8 TIMBERVIEW Portland, OR
12/12 2057 SW PARK Portland, OR
6/6 BUNKER HILL HOUSING Boston, MA
6/6 CANDLEWOODSUITES HOTEL Liberty, NC
12/12 JULIA WEST Portland, OR
25/31 THE EDISON Milwaukee, WI
CONSTRUCTION PAUSED
12/13 INTRO, COLUMBUS Columbus, OH
2016
2019
2020
2022
2023
2024
2025

TALL MASS TIMBER RESOURCES



Tall Mass Timber

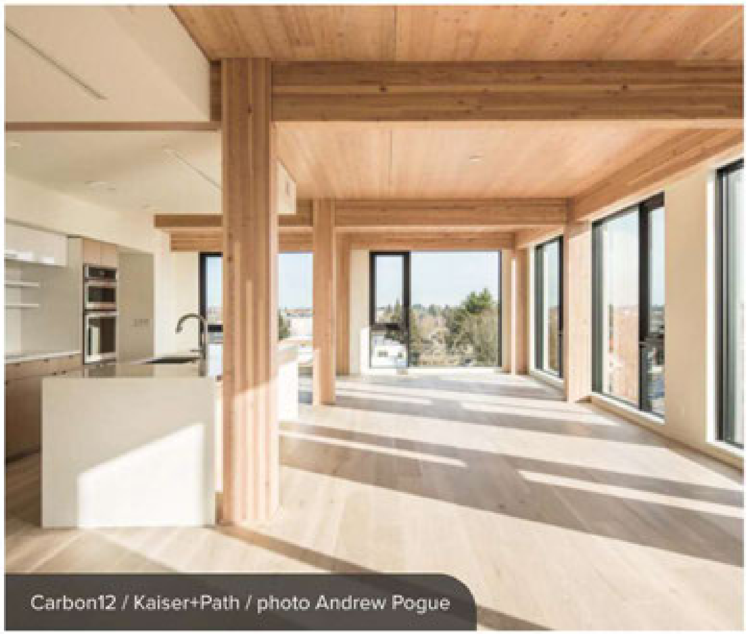
Code opportunities and requirements, FAQs, project examples and resources for teams interested in tall timber projects.

Learn More

www.woodworks.org/learn/mass-timber-clt/tall-mass-timber/

TALL MASS TIMBER RESOURCES

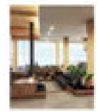
Technical Design Guidance from WoodWorks


Carbon12 / Kaiser+Path / photo Andrew Pogue

Solution Papers

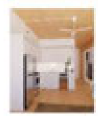
Tall Wood Buildings in the 2021 IBC – Up to 18 Stories of Mass Timber

Looking for information on the tall wood provisions in the 2021 International Building Code? This paper summarizes the provisions as well as the background and research that supported their adoption.

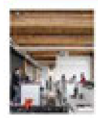


Demonstrating Fire-Resistance Ratings for Mass Timber Elements in Tall Wood Structures
Solution Papers

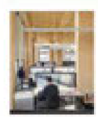
Shaft Wall Requirements in Tall Mass Timber Buildings
Solution Papers



Concealed Spaces in Mass Timber and Heavy Timber Structures
Solution Papers



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



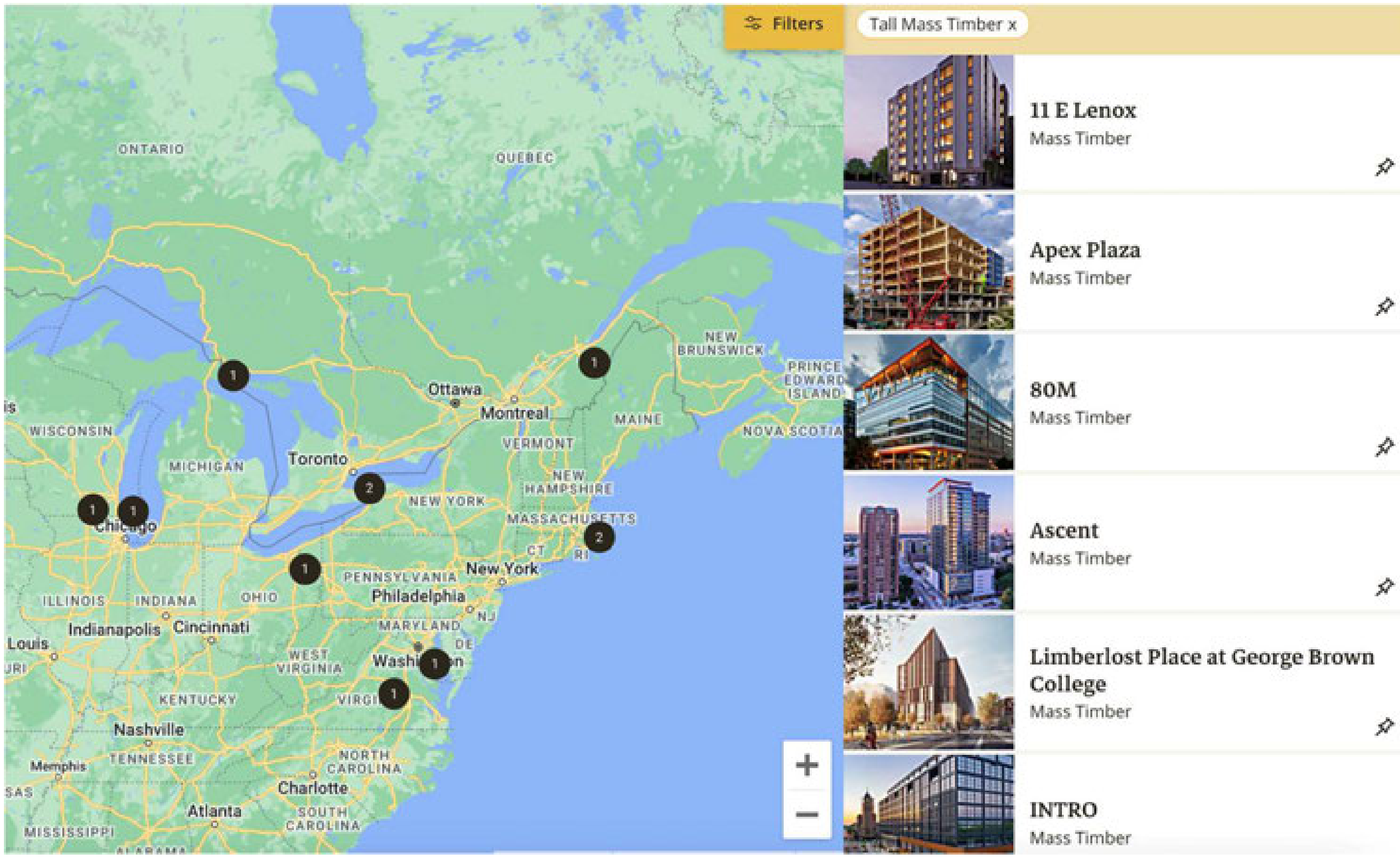
Fire Design of Mass Timber Members: Code Applications, Construction Types and Fire Ratings
Solution Papers

TALL MASS TIMBER RESOURCES

Articles and Expert Tips

TALL MASS TIMBER RESOURCES

Interactive Tall Mass Timber Project Map



Construction of Schools in the U.S.

Construction of Schools in the U.S.

Total U.S. Educational Facility Construction costs in 2023:

$120.23 Billion

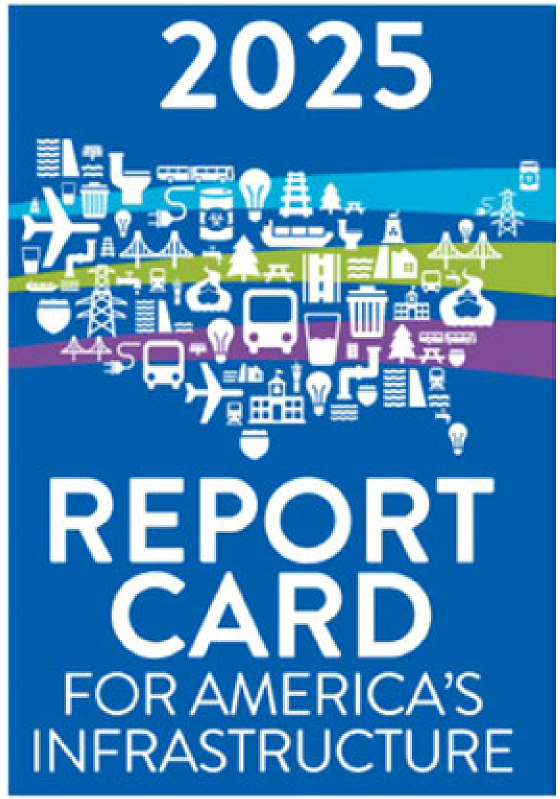
*Includes New Construction, Renovations, and Site Work

Source: spaces4learning 2024
Facilities Construction Brief

Nationwide Projections

American Society of Civil Engineers school infrastructure grade:

D+



Source: 2025 ASCE Infrastructure Report Card
https://infrastructurereportcard.org/

National Averages

National averages for 2023 K-12 education facilities construction costs range from:

$413/SF

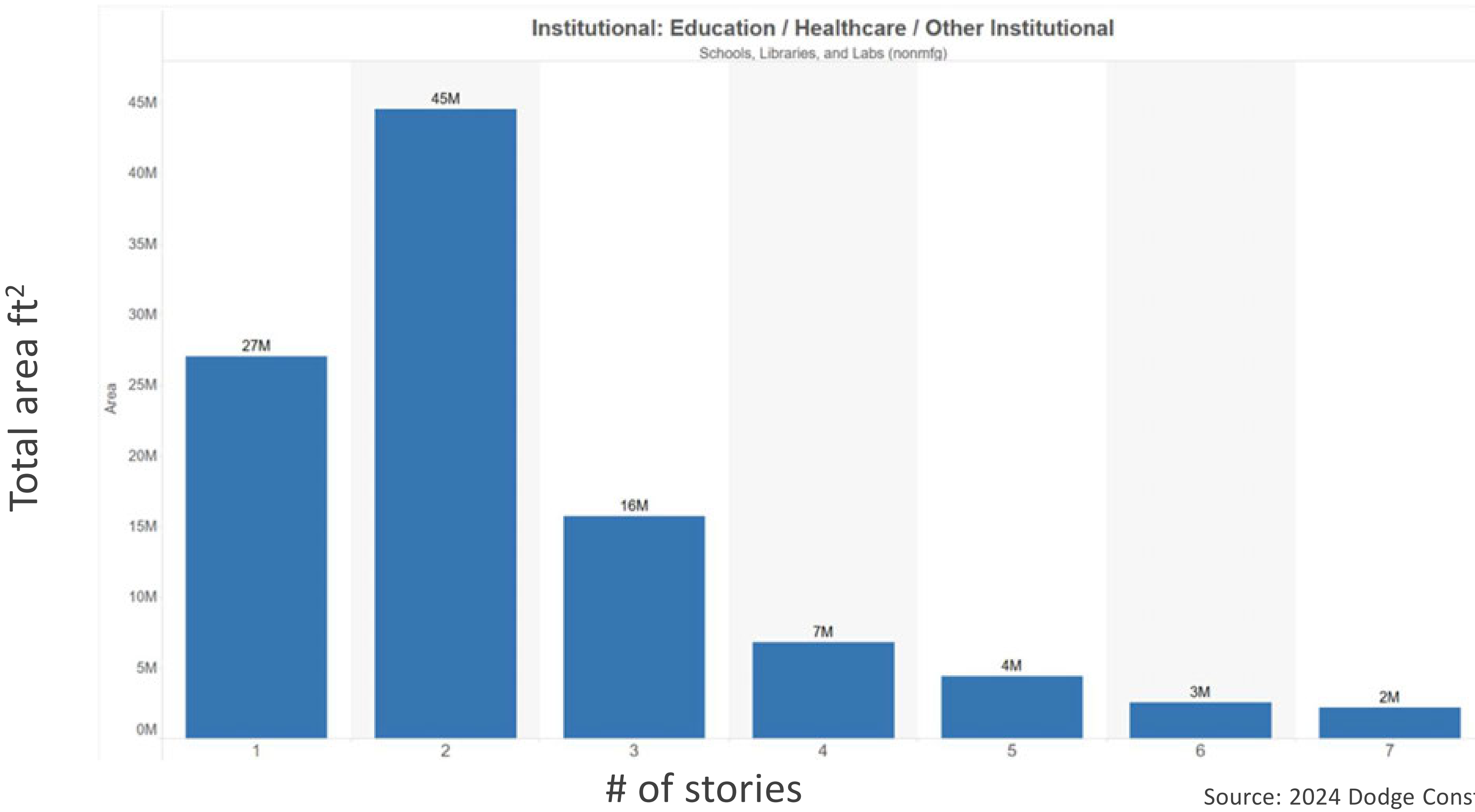
in the Southcentral (low)

$520/SF

in the Northeast (high)

Source: Cumming US Costs

School Market Size by Story per Year



Source: 2024 Dodge Construction Data

Market Drivers

Why Choose Mass Timber?

- Aesthetic Value and Biophilia
- Speed of Construction
- Lightweight Structure
- Lower Carbon Impact


Wisner-Pilger Public Schools Addition / BVH Architecture / R.O. Youker Structural Engineering / Photo A.J. Brown

Aesthetic Value & Biophilia

George Fox University – Canyon Commons | Hacker | Photo: Jeremy Bitterman

Speed of Construction: Sacred Heart School

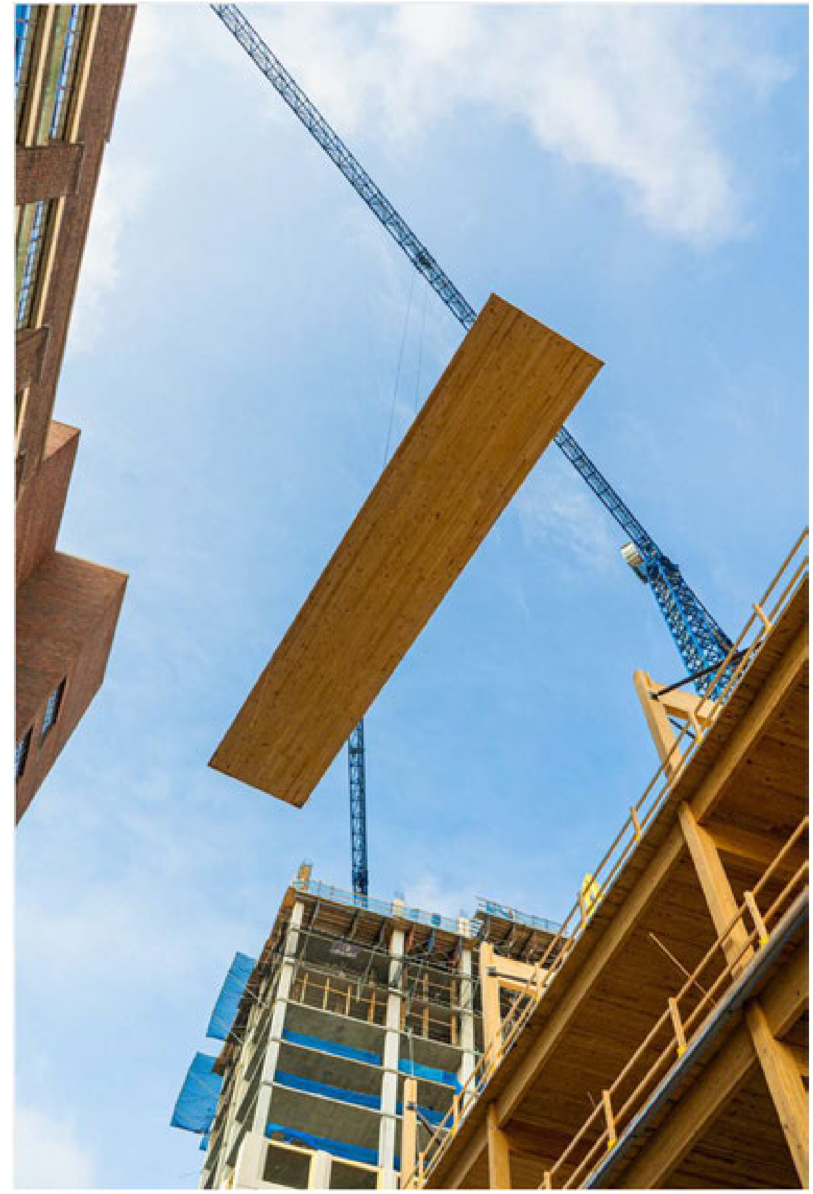
- Four 1,000 sf classrooms
- 11 weeks fast-track for construction
- Installed over summer break
- Similar modular CLT projects saw 13 months design to completion

Sacred Heart School, Atherton / Aedis Architects / Daedalus Structural Engineering / Photo Marco Zecchin

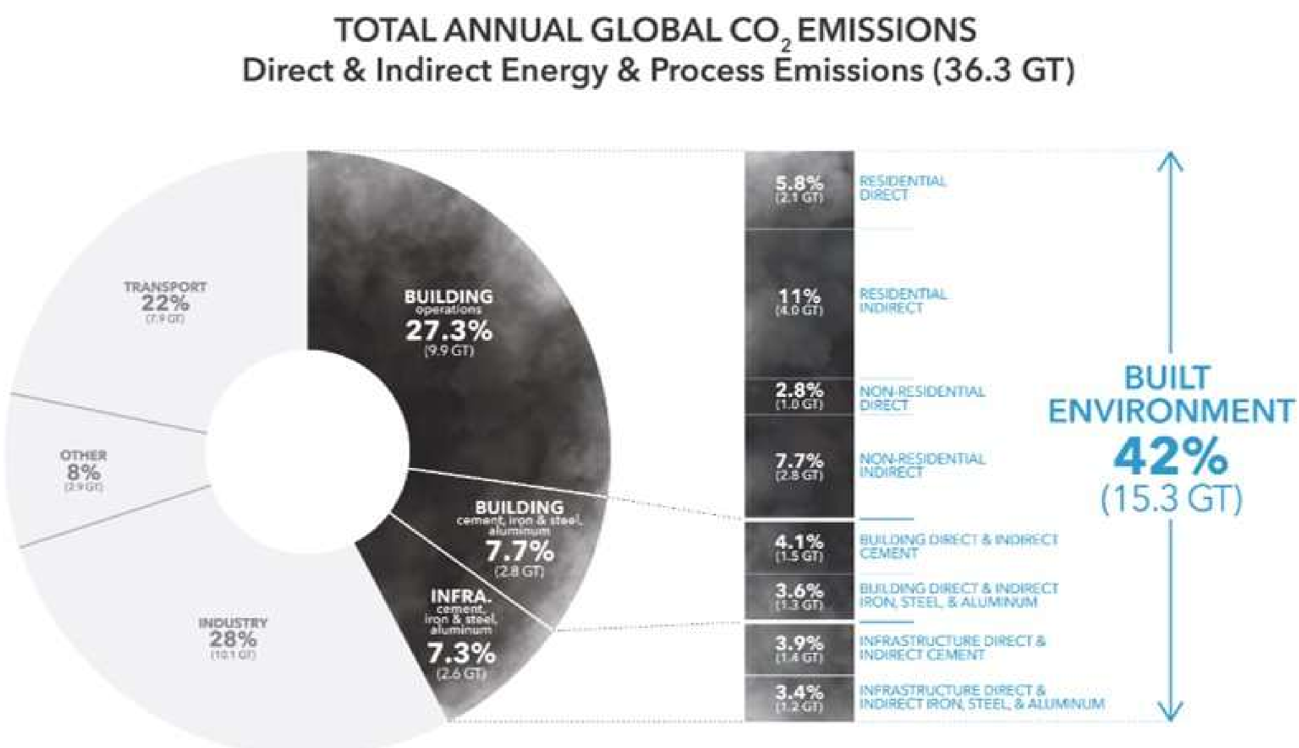
Lightweight Structure

75% LIGHTER WEIGHT THAN CONCRETE

619 Ponce / Jamestown / Handel Architects / StructureCraft / Raftermen Photography, courtesy of GFA



Lower Carbon Impact:
The Built Environment & Carbon Dioxide Emissions



Analysis & Aggregation by Architecture 2030 using data sources from IEA & Statista.

Built environment generates about **40%** of annual carbon dioxide emissions

- » Building Operations
- » Embodied Carbon

Embodied carbon: **15%**

- » Cement
- » Iron
- » Steel
- » Aluminum

Carbon Benefits of Wood

- **Lower embodied carbon** compared to other common building materials
- **Less fossil fuel consumed** during manufacture
- **Avoid process emissions**
- **Extended carbon storage in products**
- **Carbon sequestration in forests**
- Promotes **forest health**

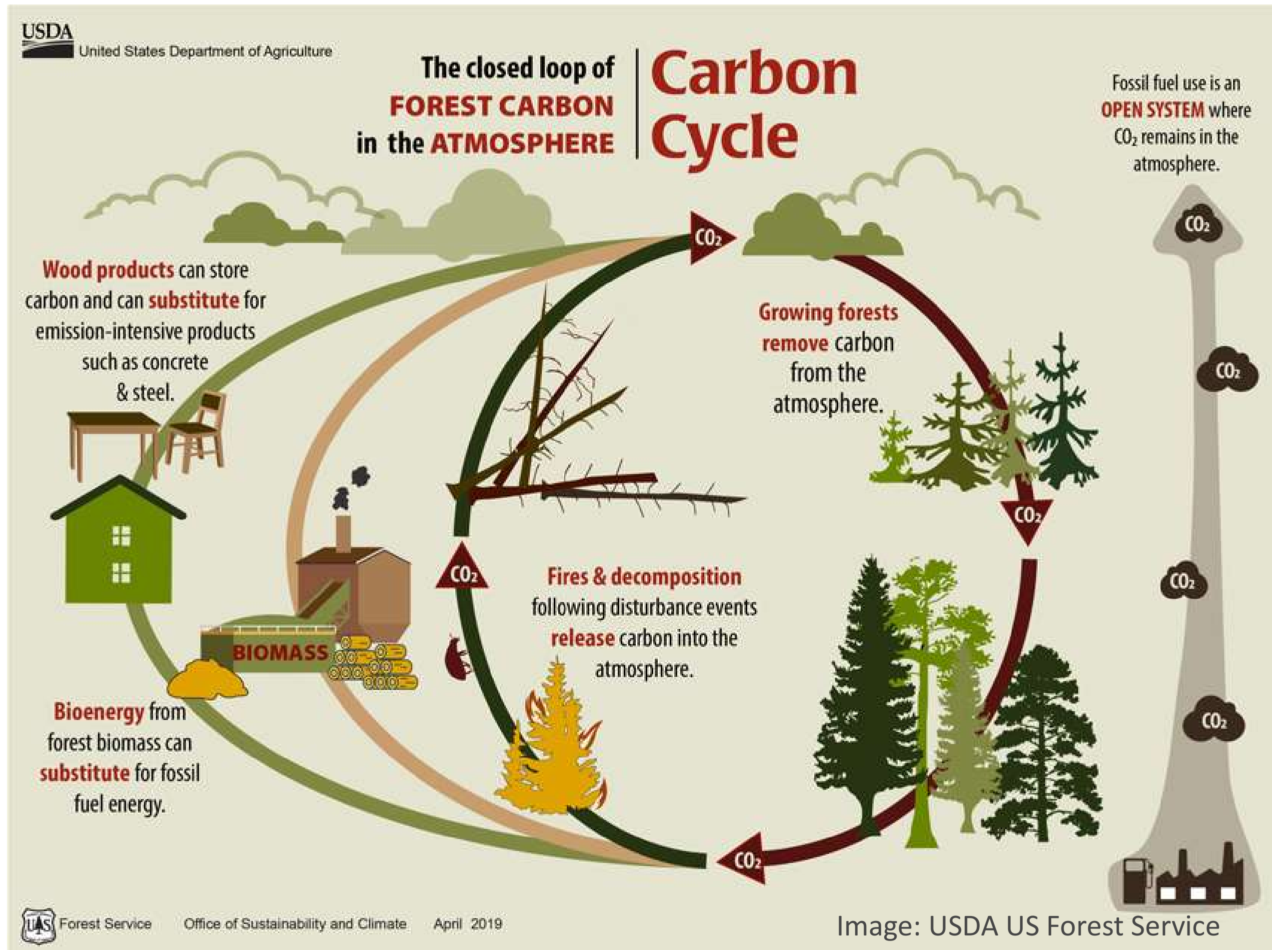


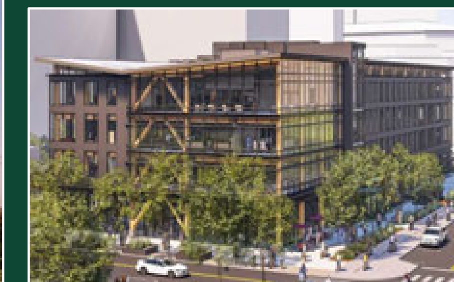
Image: USDA US Forest Service

Mass Timber Comparative Life Cycle Assessment Series

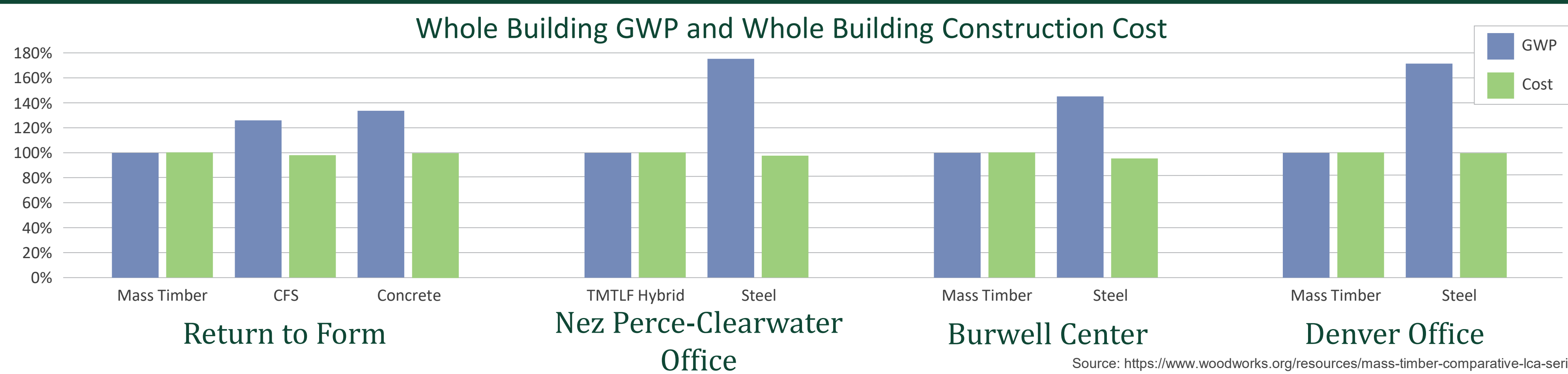
Rendering tres birds

Mosaic Architecture / Morrison-Maierle / Photo Heidi Long, Longview Studios

University of Denver Burwell Center for Career Achievement / Lake|Flato Architects / Shears Adkins Rockmore / KL&A Engineers and Builders / Photo © Frank Ooms



Rendering Shears Adkins Rockmore



Source: https://www.woodworks.org/resources/mass-timber-comparative-lca-series/

Franklin Elementary School

Franklin, WV

MSES Architects
MSES Consultants, Inc.
Photo: Pam Wean, MSES Architects

Franklin Elementary School

Franklin, WV

- First school in the U.S. built with CLT
- CLT selected to fit tight construction schedule
- CLT roof, above-grade floor, and bearing walls. Panels precut for openings and utility chases

Volume of wood products used:
818,736 board feet (equivalent)

U.S. and Canadian forests grow this much wood in:
4 minutes

Carbon stored in the wood:
1,014 metric tons of CO_2

Avoided greenhouse gas emissions:
2,155 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
3,169 metric tons of CO_2

EQUIVALENT TO:

605 cars off the road for a year

Energy to operate a home for 269 years

Source: US EPA

Estimated by the Wood Carbon Calculator for Buildings, based on research by Sarthre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations. Note: CO_2 on this chart refers to CO_2 equivalent.

Photos: Pam Wean, MSES Architects

MSES Architects
MSES Consultants, Inc.

Frequently Asked Questions:

1. Do building types III, IV, and V allow the height and area that I need for a school?
2. How would I meet fire-resistance requirements with a wood building?
3. How would I ensure that the building has good durability?
4. Can wood members span 50+ ft over the gym or cafeteria?

Allowed Building Size
Building Types III, IV & V

Construction Types

2018 & 2021 IBC 602

Type III

Exterior walls non-combustible or FRTW

Interior elements any allowed by code

Type IV-HT (Heavy Timber)

Exterior walls non-combustible or FRTW

Interior elements qualify as Heavy Timber (min. sizes)

No concealed spaces (except in 2021 IBC with certain conditions)

Type IV-C (Mass Timber: 2021 IBC)

Building elements qualify as non-combustible or mass timber construction

Fire rating requirements for structural frame, bearing walls, and floor/roof construction

Limits on concealed spaces

Type V

All building elements are any allowed by code

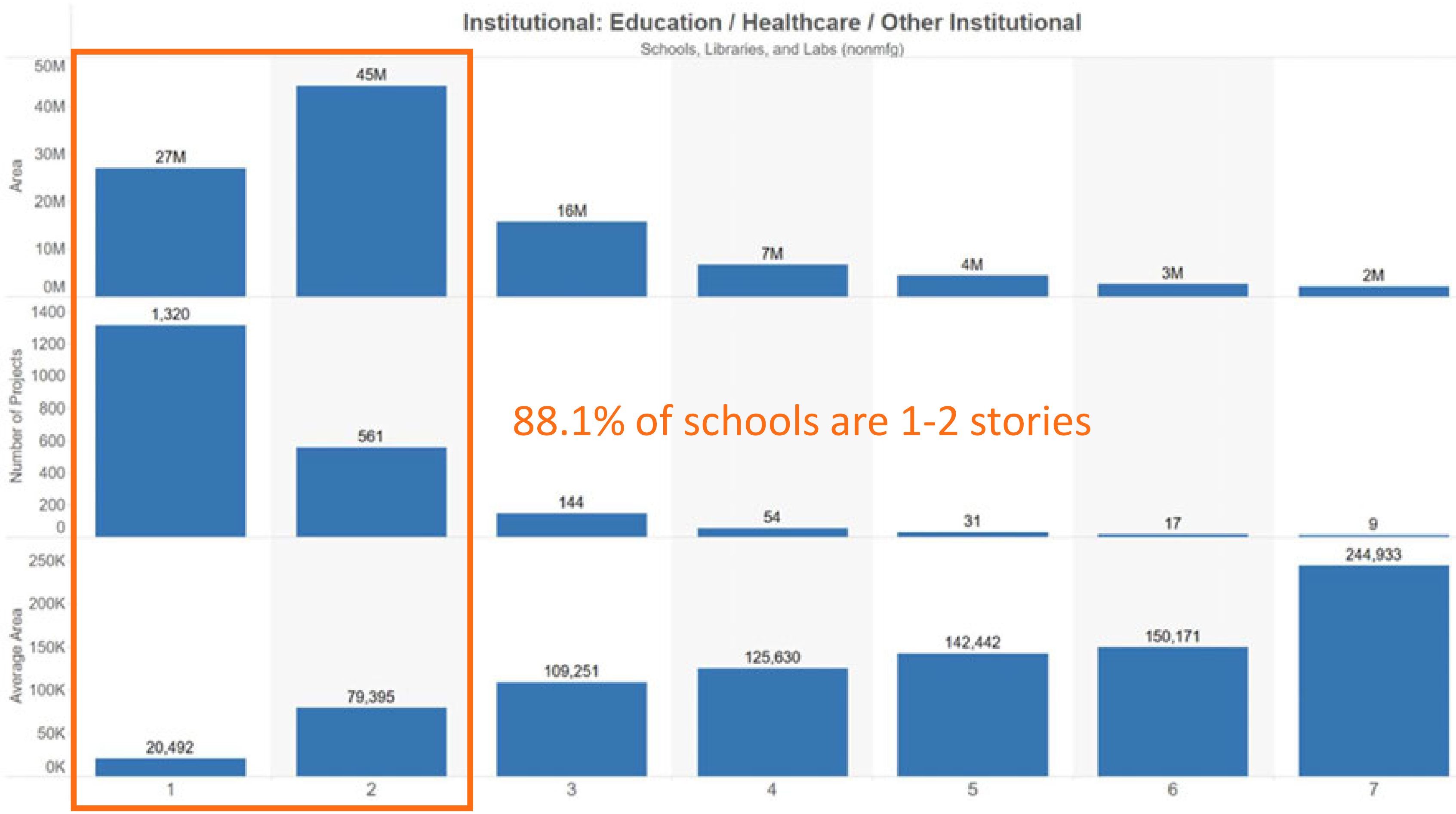
ICC Building Valuation Data, **E occupancy**, February 2025

Cost per SF

$282	$272	$264	$253	$236	$224	$244	$207	$200
IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB

Construction Type

School Market Size by Story



Source: 2024 Dodge Construction Data

Common Ground High School

New Haven, CT

Gray Organschi Architecture
Edward Stanley Engineers
Photo: Gary Sundberg

Common Ground High School

New Haven, CT

- LEED Gold Certified
- Designed to blend into local landscape and farms
- Built with a mission of ecology and sustainability
- Type V-B, 2 story, 15,000 sf

Photos: Gary Sundberg

Gray Organschi Architecture
Edward Stanley Engineers

Evergreen Charter School

Hempstead, NY

Martin Hopp Architect
ODEH Engineers
Rendering: Martin Hopp Architect

Evergreen Charter School

Hempstead, NY

- Type III-A, 85,000 sf, 5 stories
- 2022 SLB MT Design Competition Winner
- LEED Gold Certified, Net-Zero Ready

Martin Hopp Architect
ODEH Engineers
Rendering: Martin Hopp Architect

Construction Types

Allowable Building Area

IBC 2021 Table 506.2

TABLE 506.2
ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET[a, b]

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	45,000	30,000	18,750	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	180,000	120,000	75,000	60,000	46,000	22,000
	SM	UL	UL	46,500	25,500	42,000	25,500	135,000	90,000	56,250	45,000	34,500	16,500
E	NS	UL	UL	26,500	14,500	23,500	14,500	76,500	51,000	31,875	25,500	18,500	9,500
	S1	UL	UL	106,000	58,000	94,000	58,000	306,000	204,000	127,500	102,000	74,000	38,000
	SM	UL	UL	79,500	43,500	70,500	43,500	229,500	153,000	95,625	76,500	55,500	28,500

Allowable Building Size

IBC Chapter 5

Credit: iStock/urfinguss

How do we go bigger?

Allowable Building Size

2018 & 2021 IBC 507

Unlimited Area Buildings:

IBC Section 507 gives unlimited area building routes in Type III and IV Construction for:

- Assembly
- Education

Lakeridge Middle School / Mahlum Architects / KPFF / Photo Arthur Ross

Allowable Building Size
IBC 2018 & 2021 Section 507

Unlimited Area Buildings

Provisions for unlimited area buildings rely on open space surrounding building (IBC 507)

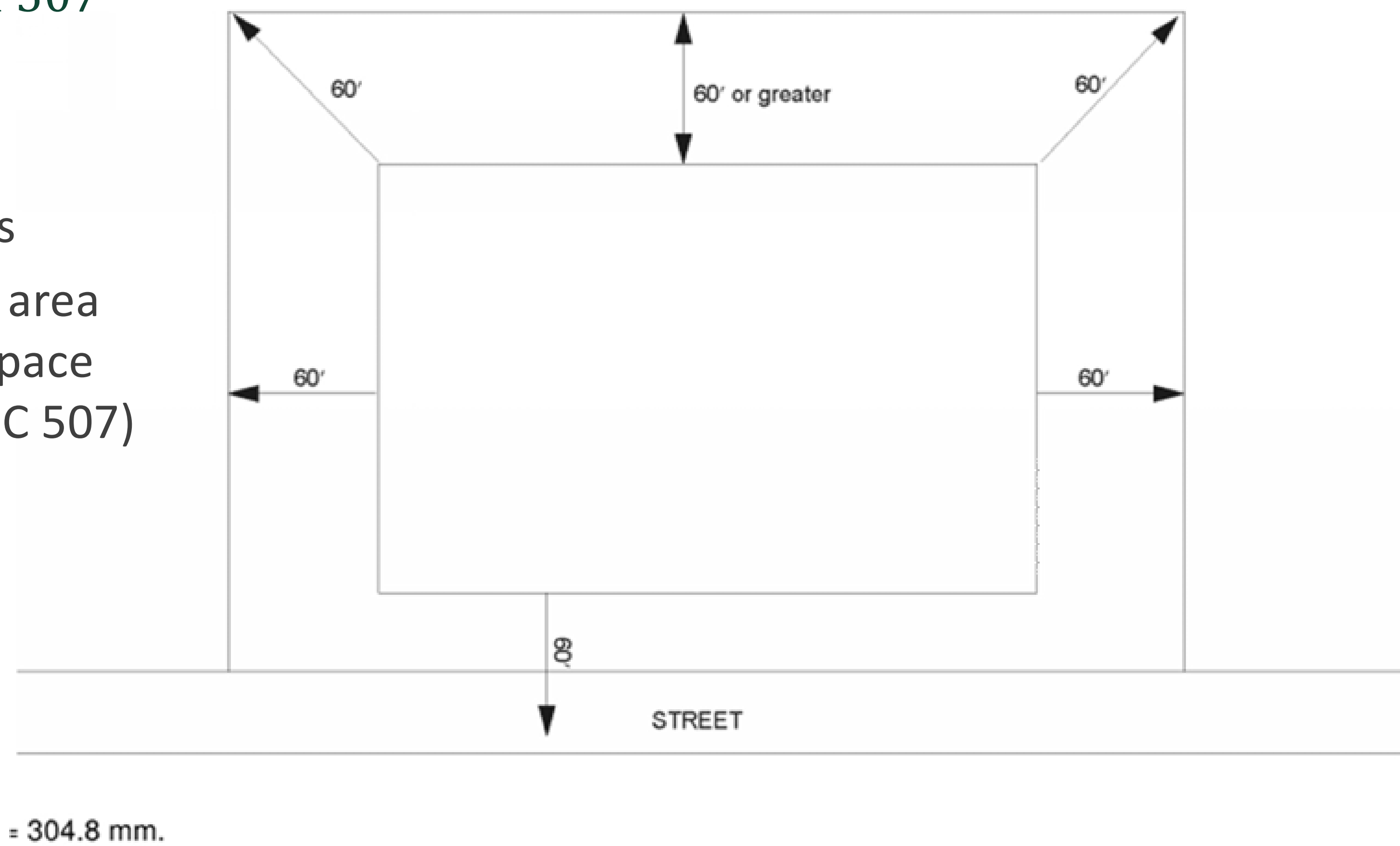


Figure 507.2
REQUIRED SEPARATION FOR UNLIMITED AREA BUILDINGS

Assembly Spaces in Educational Facilities

2018 & 2021 IBC 303.1.3

Educational facilities:

» A room or space used for assembly purposes that is associated with a Group E occupancy is not considered a separate occupancy.

Examples:

» *Gymnasium used for school sports*

» *Cafeteria used for school meals*

El Dorado High School / CADM Architecture / Engineering Consultants / Photo Dennis Ivy

Separated Occupancies

2018 & 2021
IBC Table 508.4

OCCUPANCY	A, E		I-1[a], I-3, I-4		I-2		R[a]		F-2, S-2[b], U		B[e], F-1, M, S-1	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2
I-1[a], I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP
R[a]	—	—	—	—	—	—	N	N	1[c]	2[c]	1	2
F-2, S-2[b], U	—	—	—	—	—	—	—	—	N	N	1	2
B[c], F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N
H-1	—	—	—	—	—	—	—	—	—	—	—	—
H-2	—	—	—	—	—	—	—	—	—	—	—	—
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—
H-5	—	—	—	—	—	—	—	—	—	—	—	—

S = Sprinklered
NS = No Sprinkler
NP = Not Permitted
N = No Separation Required

» For A & E occupancies: no separation required

Multiple Functions

2018 & 2021 IBC 302.1

Buildings used for multiple functions:

» A room or space that is intended to be occupied at different times for different purposes shall comply with all of the requirements that are applicable to each of the purposes for which the room or space will be occupied.

Example: church hall also used as a daycare center and for wedding receptions

El Dorado High School / CADM Architecture / Engineering Consultants / Photo Dennis Ivy

Cottonwood Valley Charter School E-Pod

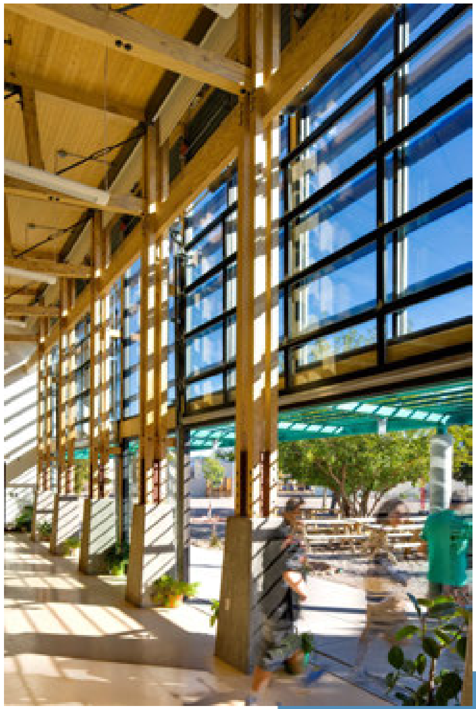
Socorro, NM

Environmental Dynamics, Inc.
Walla Engineering, Ltd.
Photo: Patrick Coulie Photography

Cottonwood Valley Charter School E-Pod

Socorro, NM

» Operable wall extends multipurpose space outdoors
» Design echoes the simple shed structures of industrial and agricultural buildings in the area



Photos: Patrick Coulie Photography

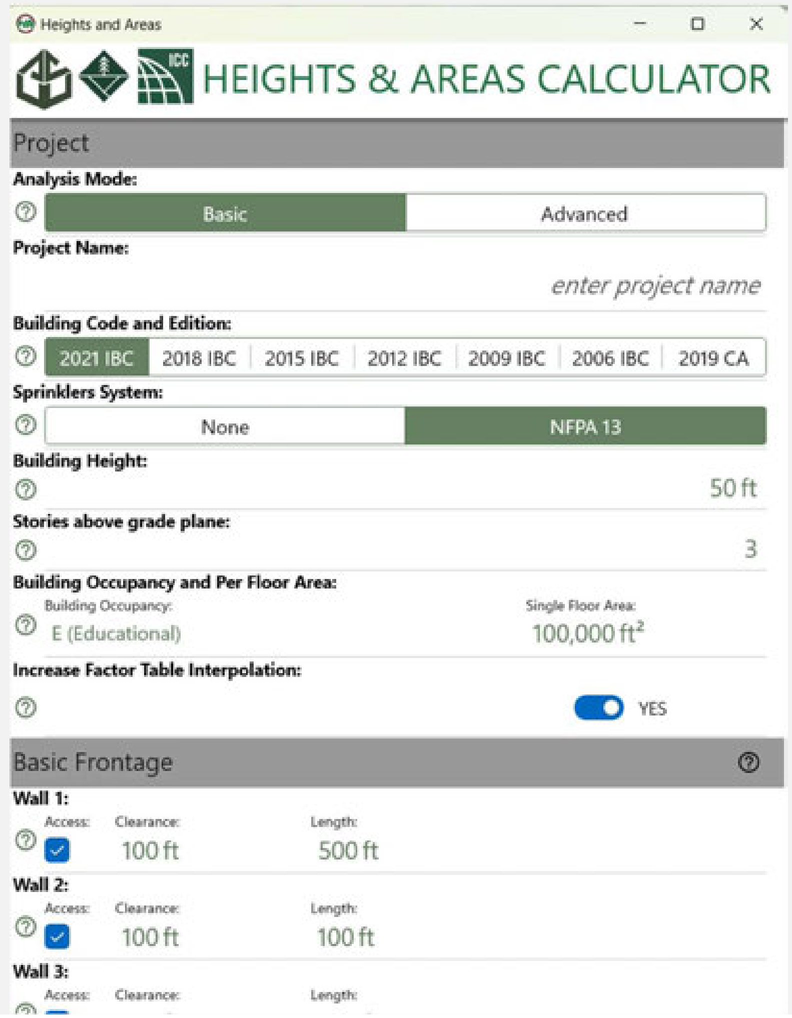
Environmental Dynamics, Inc.
Walla Engineering, Ltd.

Allowable Building Size

Heights and areas calculator – free tool

http://www.woodworks.org/design-and-tools/design-tools/online-calculators/

Handles Separated & Nonseparated Occupancies (Check "both")



Credit: AWC & WoodWorks Heights and Areas Calculator App

Fire Resistance

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	A	B	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a, b]	2[a, b, c]	1[b, c]	0[c]	1[b, c]	0	3[a]	2[a]	2[a]	HT	1[b, c]	0
Bearing walls												
Exterior[e, f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT[g]	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	$1^1/_2$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	$1^1/_2$	1	1	HT	1[b,c]	0

Source: 2021 IBC

Fire Resistance Detailing

NDS Chapter 16

Exposed wood fire resistance

Assumptions:

Nominal assumed char rate = 1.5”/hr.

Structurally spanning members: reduced section checked for capacity vs. demand.

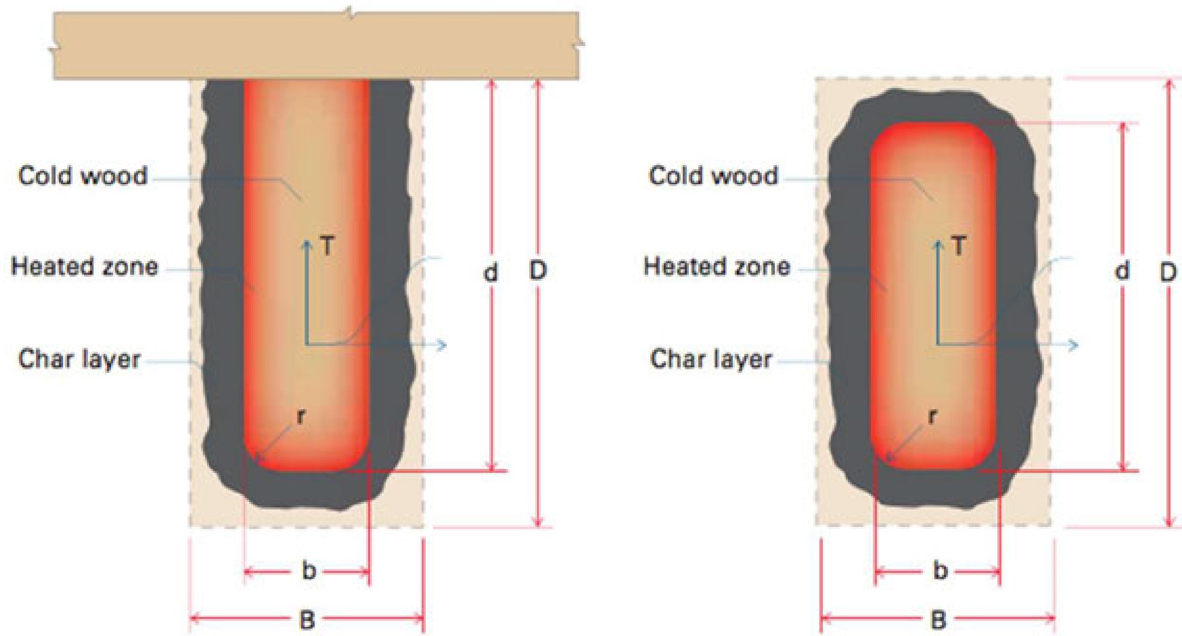


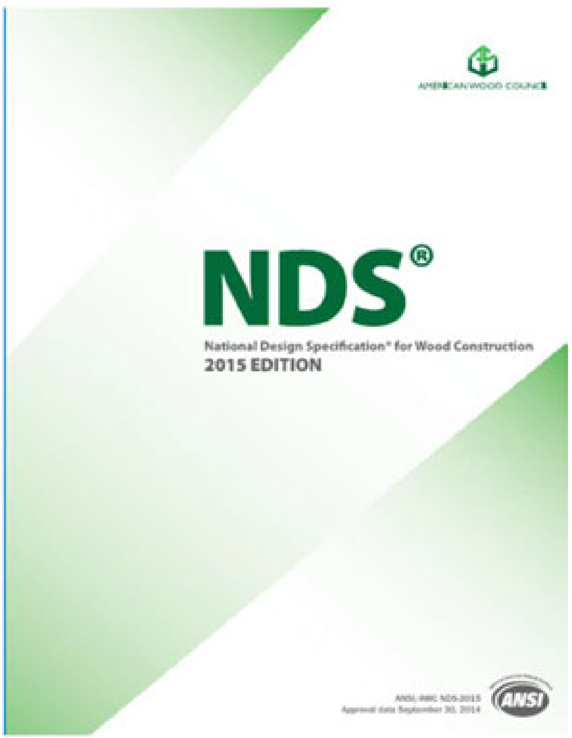
Figure 1-1 Reduction in member breadth and depth over time, t

Source: AWC’s TR 10

Fire Resistance Detailing

2018 & 2021 IBC 722

For Exposed Wood Members: IBC 722.1 References AWC's NDS Chapter 16
(AWC's TR 10 is a design aid to NDS Chapter 16.)

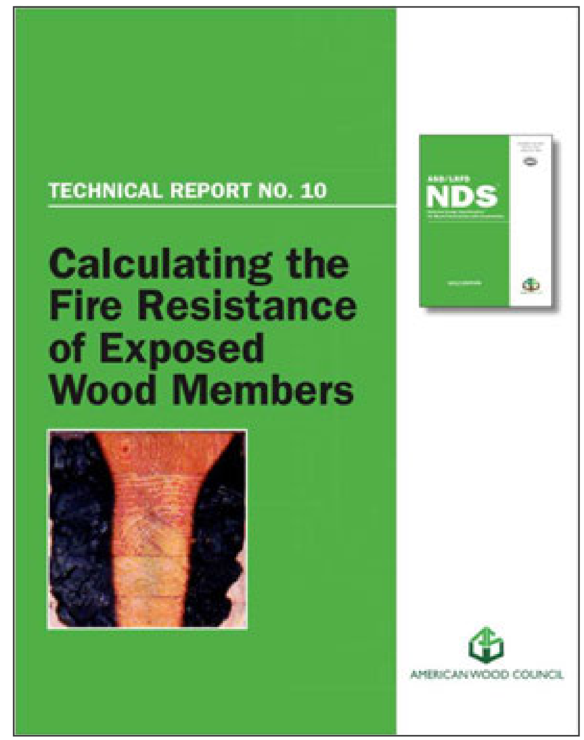



NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 149

FIRE DESIGN OF WOOD MEMBERS

16.1	General	150
16.2	Design Procedures for Exposed Wood Members	150
16.3	Wood Connections	151
Table 16.2.1	Effective Char Rates and Char Layer Thicknesses (for β_n = 1.5 in./hr.)	150
Table 16.2.2	Adjustment Factors for Fire Design	151

16



Acoustics

Acoustical Detailing

IBC 1207

Air-borne sound:

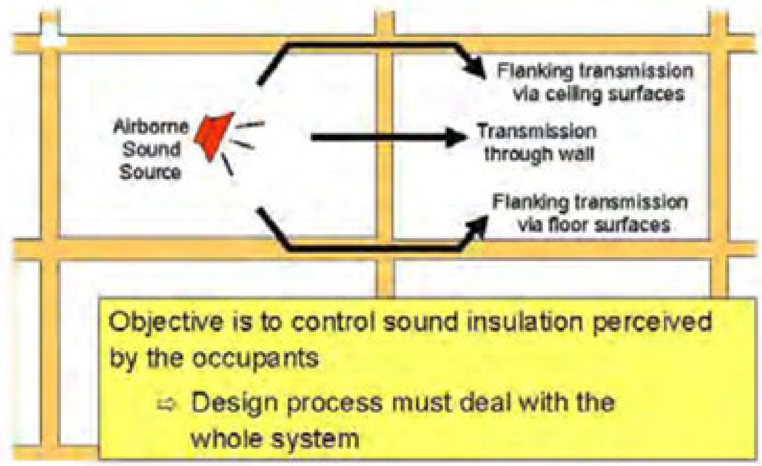
» Sound Transmission Class (STC)

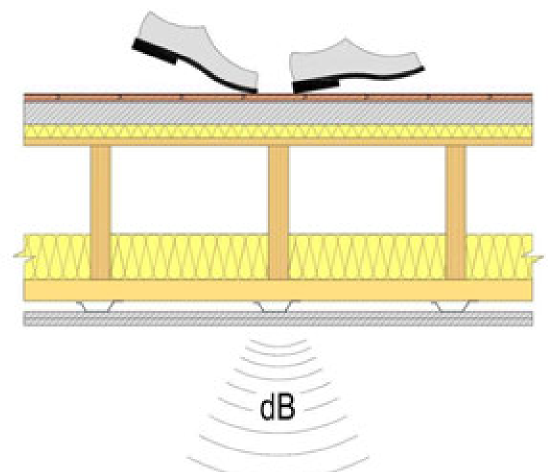
Measures how effectively an assembly isolates air-borne sound and reduces the level that passes from one side to the other.

Structure-borne sound:

» Impact Insulation Class (IIC)

Evaluates how effectively an assembly blocks impact sound from passing through it.





Source: ICC G2 Guideline for Acoustics

Acoustical Detailing
2021 IBC 1207

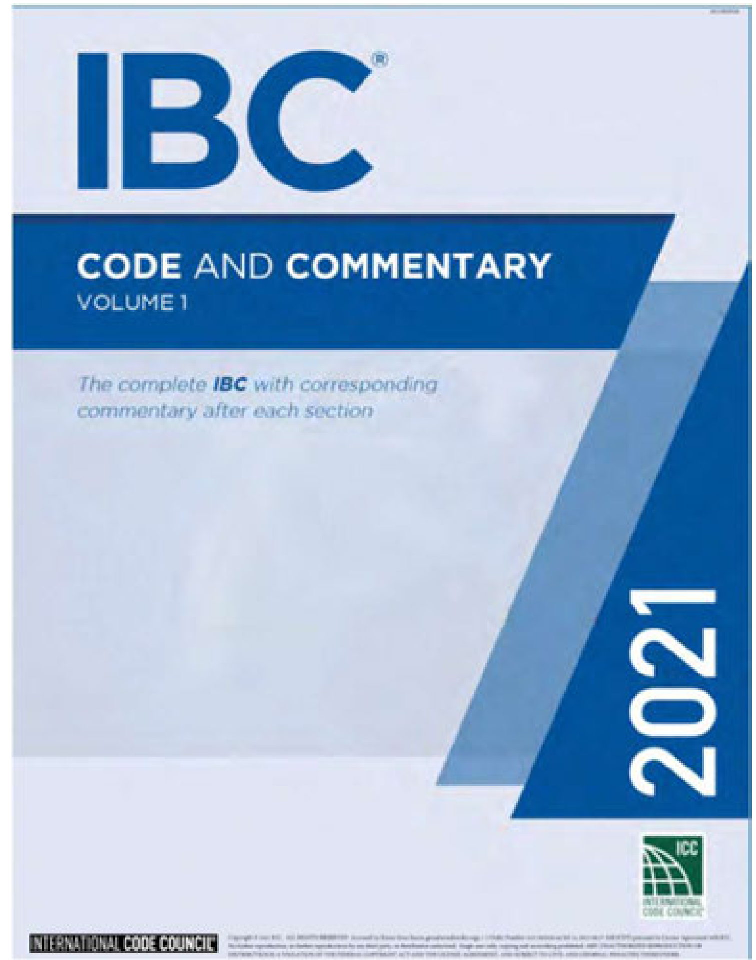
2021 IBC:

1207.2 requires “enhanced classroom acoustics in all classrooms with a volume of 20,000 cu ft or less.”

1207.1 states that enhanced classroom acoustics shall comply with Section 808 of ICC A117.1

Typical classroom = 30’ x 30’ x 10’ = 9,000 cu ft

So this requirement will be for most standard classrooms.



Acoustical Detailing
2021 IBC 1207

ICC A117.1 = Accessible and Usable Buildings and Facilities

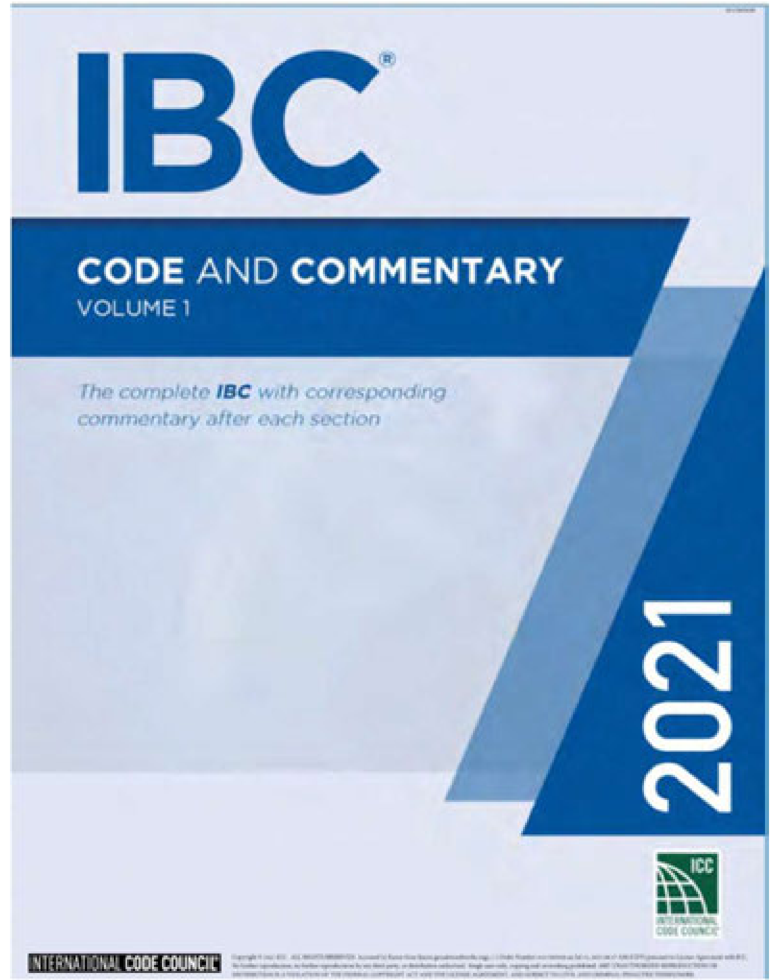
Section 808 = Enhanced Acoustics for Classrooms

Reverberation requirements

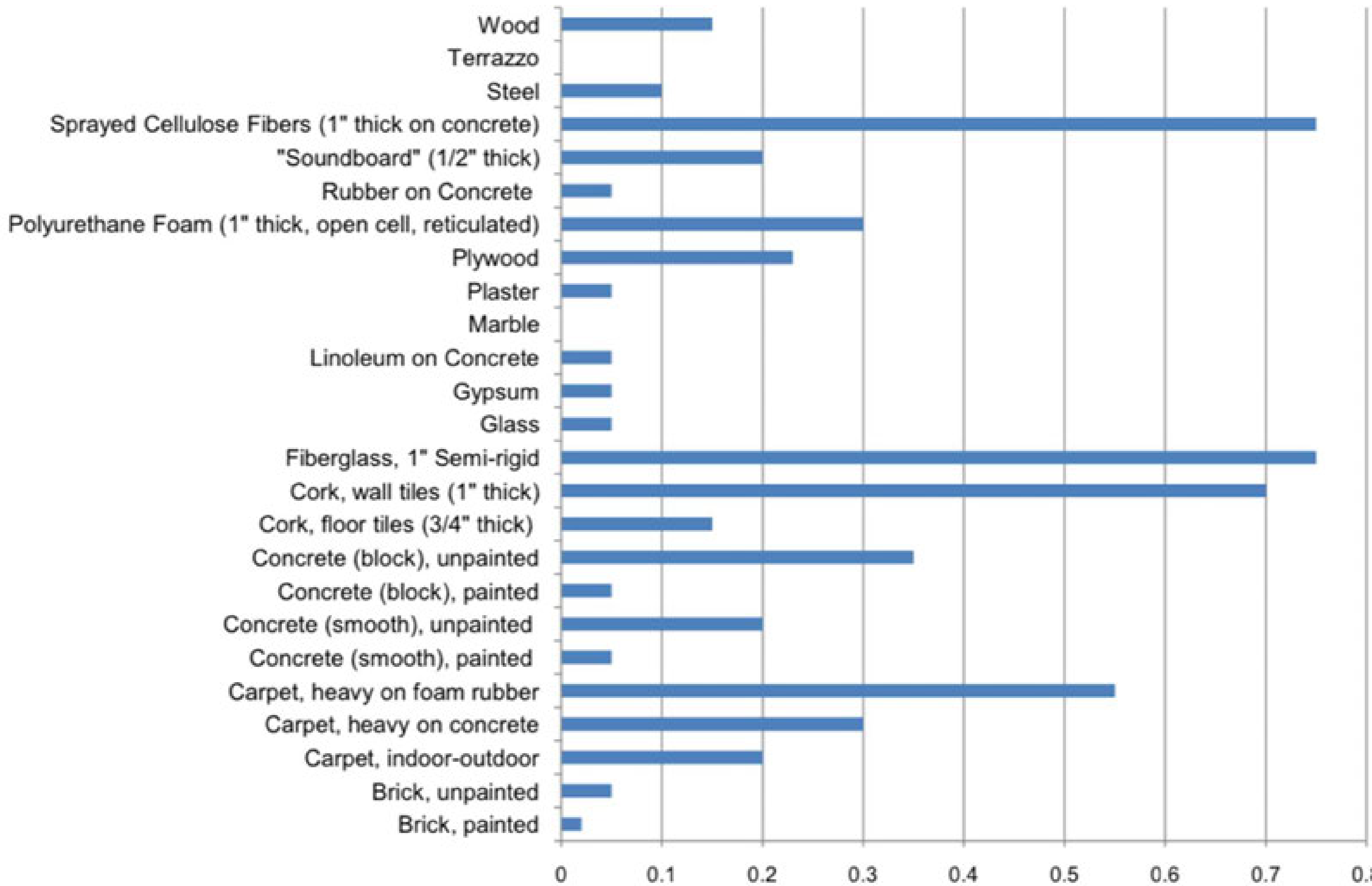
Noise reduction requirements

Ambient sound limitations

No STC or IIC requirements



Noise Reduction Coefficients (NRC) for Common Building Materials:



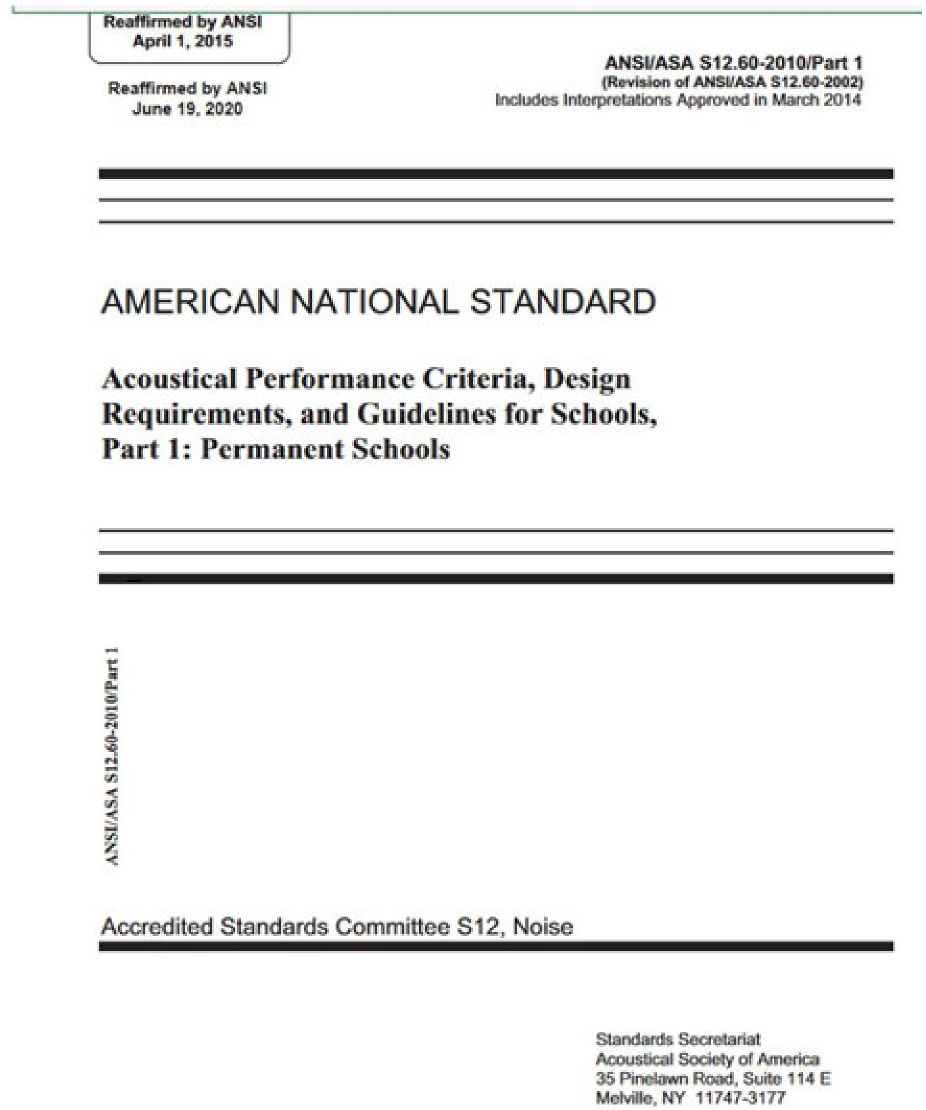
Acoustical Detailing

ANSI S12.60:

Optional acoustics criteria for schools.

Examples:

- Floor/wall separating learning space from corridor: STC 45
- Floor/wall separating learning space from music room: STC 60



Reaffirmed by ANSI
April 1, 2015

Reaffirmed by ANSI
June 19, 2020

ANSI/ASA S12.60-2010/Part 1
(Revision of ANSI/ASA S12.60-2002)
Includes Interpretations Approved in March 2014

AMERICAN NATIONAL STANDARD

Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools

ANSI/ASA S12.60-2010/Part 1

Accredited Standards Committee S12, Noise

Standards Secretariat
Acoustical Society of America
35 Pinelawn Road, Suite 114 E
Melville, NY 11747-3177

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
- Mass timber floor panels

Image credit: AcoustiTECH

Acoustical Detailing
Sound Insulation of Bare CLT Floors and Walls

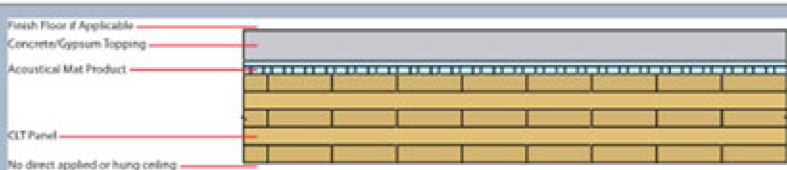
Examples of Acoustically-Tested Mass Timber Panels

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]

Acoustical Detailing

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



CLT Panel	Concrete/Gypsum Topping	Acoustical Mat Product Between CLT and Topping	Finish Floor	STC[1]	IIC[1]	Source
CLT 3-ply (3.5")	3" concrete	Maxxon Acousti-Mat® 3/4	None	53[2] ASTC	45[2] FIIC	72
CLT 3-ply (4.125")	2" concrete	Pliteq GenieMat™ FF25	None	54	44	89
CLT 3-ply (4.125")	2" concrete	Pliteq GenieMat™ FF25	LVT on GenieMat RST05	53	48	90
CLT 3-ply (4.125")	2" concrete	Pliteq GenieMat™ FF25	Eng Wood on GenieMat RST05	53	46	91
CLT 3-ply (4.125")	2" concrete	Pliteq GenieMat™ FF25	Carpet Tile	52	50	92
CLT 3-ply (4.125")	3" concrete	Kinetics® RIM-33L-2-24 System with ¾" Plywood	None	57	45	103
CLT 3-ply (4.125")	3" concrete	Kinetics® RIM-33L-2-24 System with ¾" Plywood	LVT	-	58	104
CLT 3-ply (4.125")	3" concrete	Kinetics® RIM-33L-2-24 System with ¾" Plywood	2 layers of ¾" USG Fiberock® on Kinetics® Soundmatt	55	55	105
CLT 3-ply (4.125")	3" concrete	Kinetics® RIM-33L-2-24 System with ¾" Plywood	LVT on 2 layers of ¾" USG Fiberock® on Kinetics® Soundmatt	-	59	106
CLT 3-ply (4.125")	3" concrete	Kinetics® Ultra Quiet SR with synthetic roofing felt	None	57	46	107
CLT 3-ply (4.125")	3" concrete	Kinetics® Ultra Quiet SR with synthetic roofing felt	LVT	-	55	108
CLT 3-ply (4.125")	3" concrete	Kinetics® Ultra Quiet SR with synthetic roofing felt	2 layers of ¾" USG Fiberock® on Kinetics® Soundmatt	57	53	109
CLT 3-ply (4.125")	3" concrete	Kinetics® Ultra Quiet SR with synthetic roofing felt	LVT on 2 layers of ¾" USG Fiberock® on Kinetics® Soundmatt	-	50	110
CLT 3-ply (4.125")	4" concrete	Kinetics® RIM-33L-2-24 System with ¾" Plywood	None	60	53	111

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

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


Photo: Josh Partee

Lakeridge Middle School

Lake Oswego, OR

Building Facts	141,000 sf, 2 stories Type V-B Educational Completed 2020
Developer	Lake Oswego School District
Architect	Mahlum
Engineer	KPFF Consulting Engineers
General Contractor	Skanska

Durability

High Traffic Areas

Durability Detailing

Durability design goals include minimal maintenance and repairs while maintaining safety. Consider high-traffic areas and areas of high moisture. Plan finishes, details accordingly.

- Corridors
- Bathrooms
- Entries
- Labs
- Kitchen
- Building envelope

Sacred Heart School, Atherton / Aedis Architects / Daedalus Structural Engineering / Photo Marco Zecchin

Durability Detailing

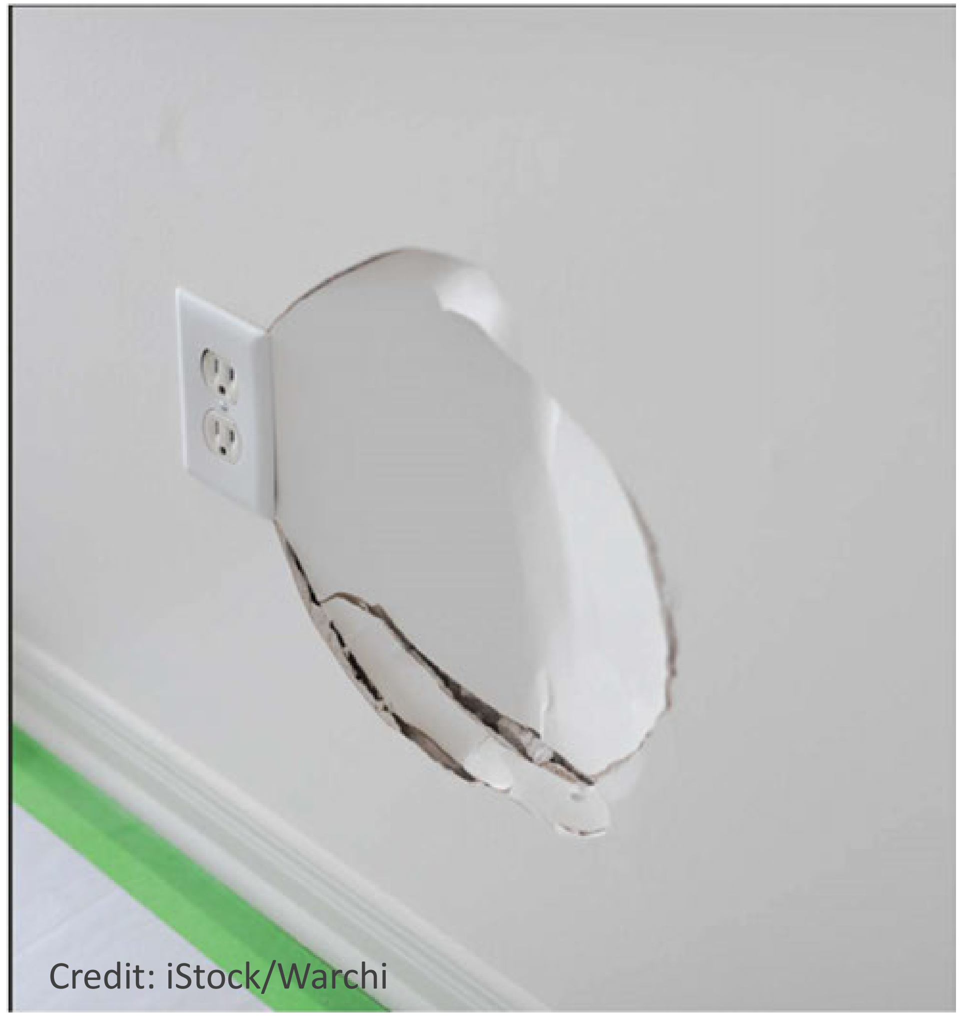
Higher durability finishes in high traffic areas.

Photos: Jim Hansen

Photo: CADM architecture

Durability Detailing

Impact resistant finishes on walls.



Credit: iStock/Warchi

Duke Lower and Middle Schools

Durham, NC

DTW Architects and Planners
GKC Associates
Photo: Jerry Markatos

Duke Lower and Middle Schools

Durham, NC

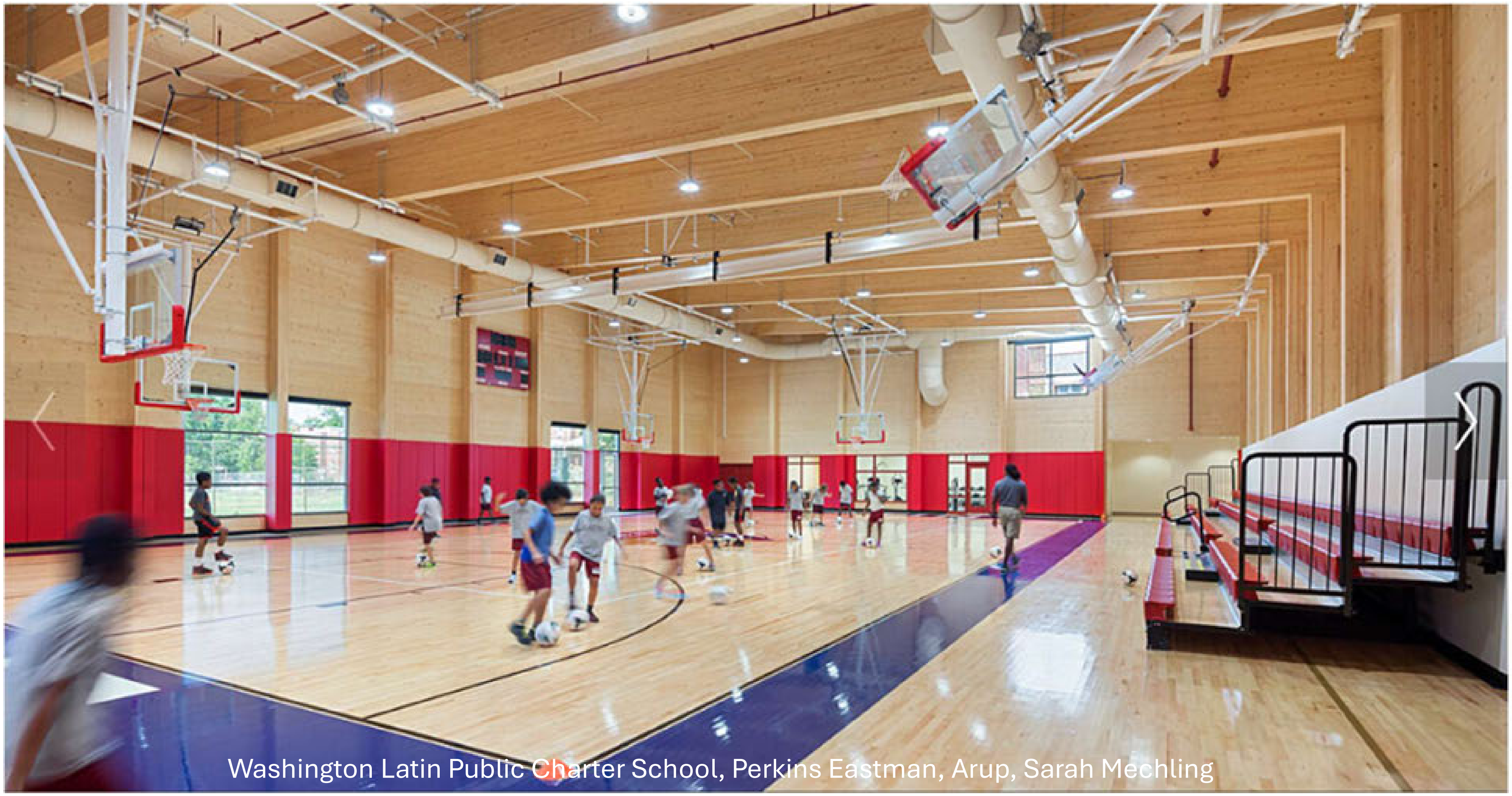
» Duke school is located next to the Duke Forest

» Wood selected for how the warmth and beauty could influence students

Photos: Jerry Markatos

DTW Architects and Planners
GKC Associates

Durability Detailing



Washington Latin Public Charter School, Perkins Eastman, Arup, Sarah Mechling

Wood-Framed Schools: Durability, Paper

This paper examines two important durability challenges: areas of high traffic and high moisture.

Free resource at **woodworks.org**

Wood-Frame Schools: Durability Techniques for Interior High Traffic and Moisture Areas

Richard McLain, PE, SE, WoodWorks

Wilkes Elementary School
Bainbridge Island, WA
Mahlum Architects

Photo
Benjamin Benschneider

Ask any group of design professionals, school facility planners or maintenance personnel to discuss the primary design objectives for school construction, and the topic of durability will arise. Specifically, they point to the challenge of creating structures that last (a common goal is 50 years or more[1]), while minimizing the time and cost associated with maintenance and repairs, and allowing the school to remain open and safe at all times.

Wood-frame schools can be highly durable; around the world, many wood buildings 50 to 100 years old (and much older) are still in service, including school facilities. For example, Lincoln High School in Tacoma, Washington, a wood-frame building with masonry veneer, was built in 1914 and renovated in 2007. Hanover Street Elementary School in Lebanon, New Hampshire, a wood and masonry-frame

Durability of any structural material comes down to the surrounding environment (e.g., moisture, temperature, and relative humidity), ability to dry if it becomes wet, and quality of details and control layers. Designing for a long service life means anticipating potential durability issues and implementing strategies to avoid them.

This paper will examine two of the most significant durability challenges when designing wood-frame schools: areas of high traffic and high moisture. It also includes a discussion related to the durability of exposed heavy and mass timber elements, which are often used as a design feature to bring wood's natural warmth into the learning environment.

Durability

Effective Enclosure

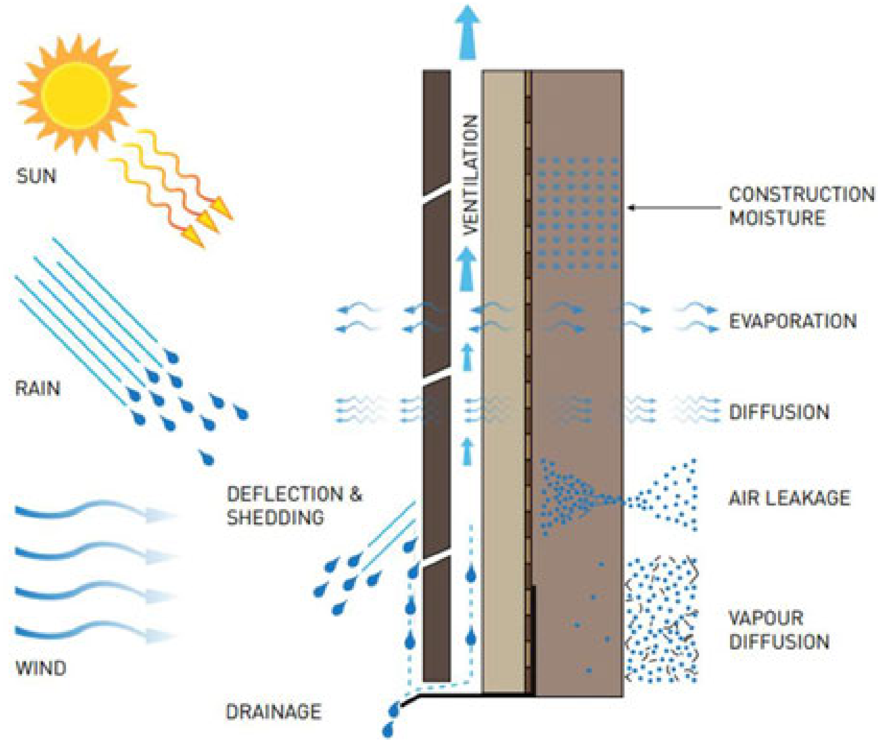
Building Enclosure: 4 D's of Durable Construction

Deflection: use overhangs, flashings, & cladding profiles to deflect precipitation and shed water away from the building.

Drainage: provide an adequate airspace to drain the water that may penetrate cladding to the outside.

Drying: properly vent the drainage cavity select and arrange control layer materials to minimize wetting and promote drying by diffusion and evaporation.

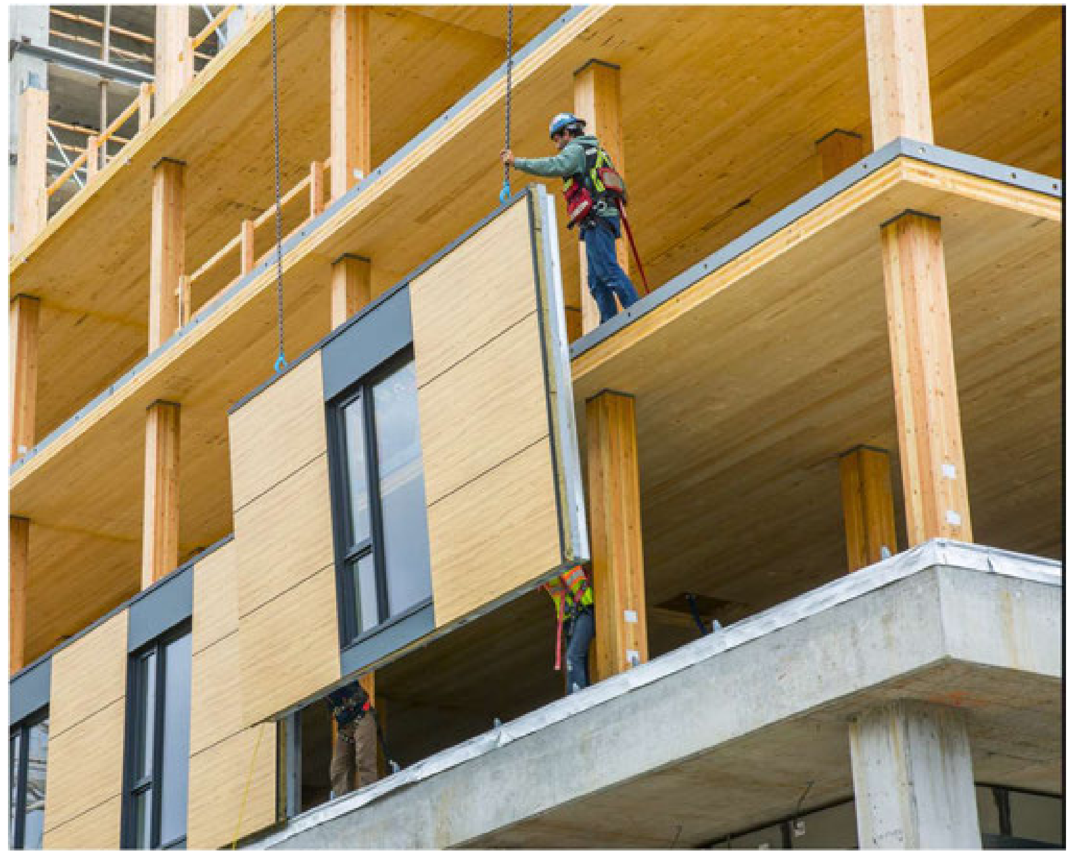
Durability – use durable materials that can tolerate periodic wetting.



The "Perfect Wall"
Source: Mass Timber Building Science Primer
By Mass Timber Institute & RDH

Building Envelope Design – Mass Timber Tips

- Enclosing the building quickly is a goal with mass timber
- Prefabricated enclosures work well with fast pace of mass timber
- Tall wood building requirements may necessitate lower floors of the building being enclosed prior to construction of upper floors.



Credit: KK Law, courtesy naturallywood.com

Expert Tips: MT Coatings

- Factors impacting coating decisions
  - Wood species, expected exposure, color options, performance, maintenance, etc.
- Protective treatments vs. finishes
  - Protective undercoat typically applied in shop
  - Additional coats for protection and beauty
- Best Practices for protecting wood in situ
  - Construction teams need to develop a moisture management plan
- Maintenance cycles
  - Develop an inspection & maintenance plan for wood exposed to exterior elements

Expert Tips

Architectural Finishes and Mass Timber: A Primer

Covers coatings and how to choose them, protective treatments vs. finishes, best practices for protecting wood in situ, and maintenance cycles

Adidas North American Headquarters / LEVER Architecture / photo Jeremy Bittermann

Finish Quality: Exposed Structure Mass Timber Appearance

Panel appearance (CLT, NLT, DLT, etc.)

» Negotiated by owner/ manufacturer

» No industry standard

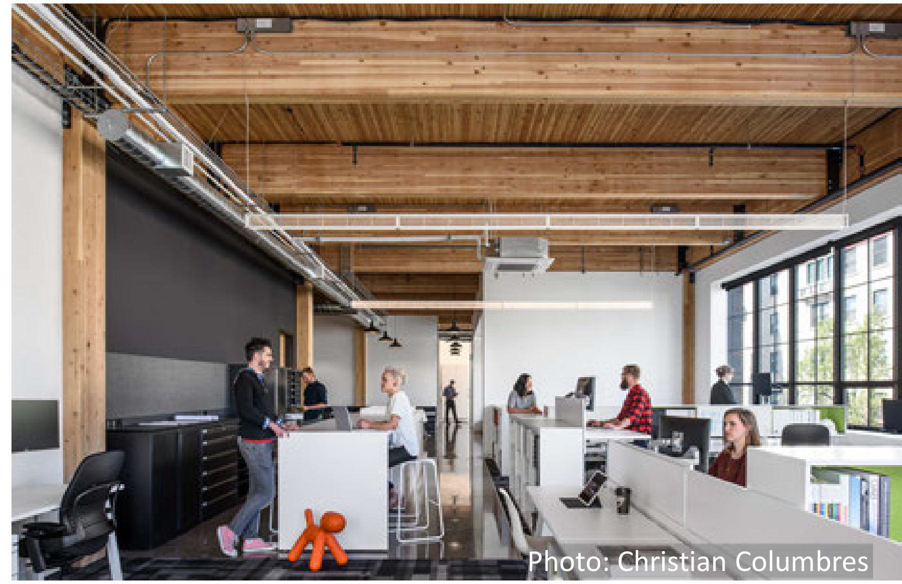
» Request large samples

» Industrial appearance, save $

Glulam beam & column appearance

» Industry standards

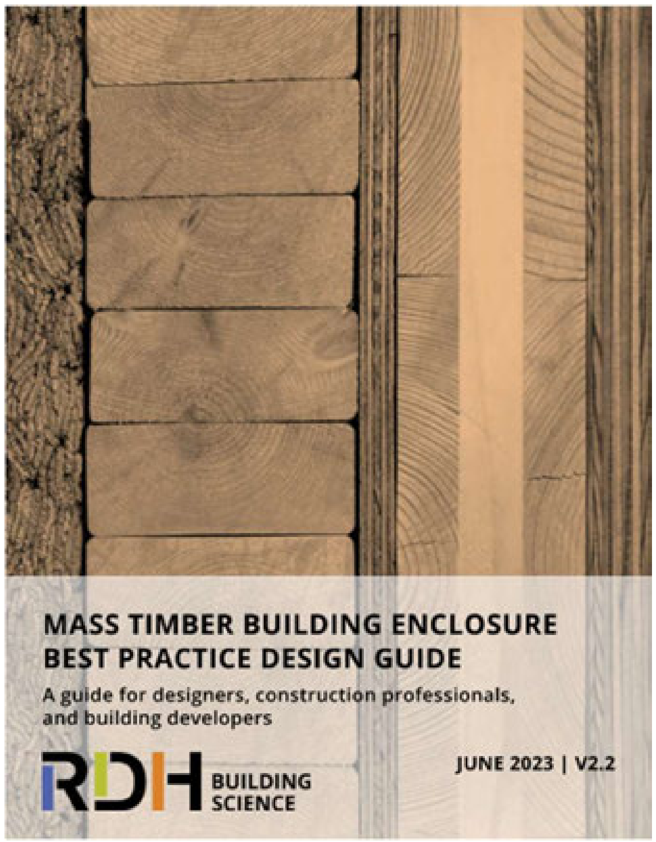
Expert Tip: Specifying Appearance for CLT, NLT and Glulam
https://www.woodworks.org/resources/specifying-appearance-grades-for-clt-nlt-and-glulam/

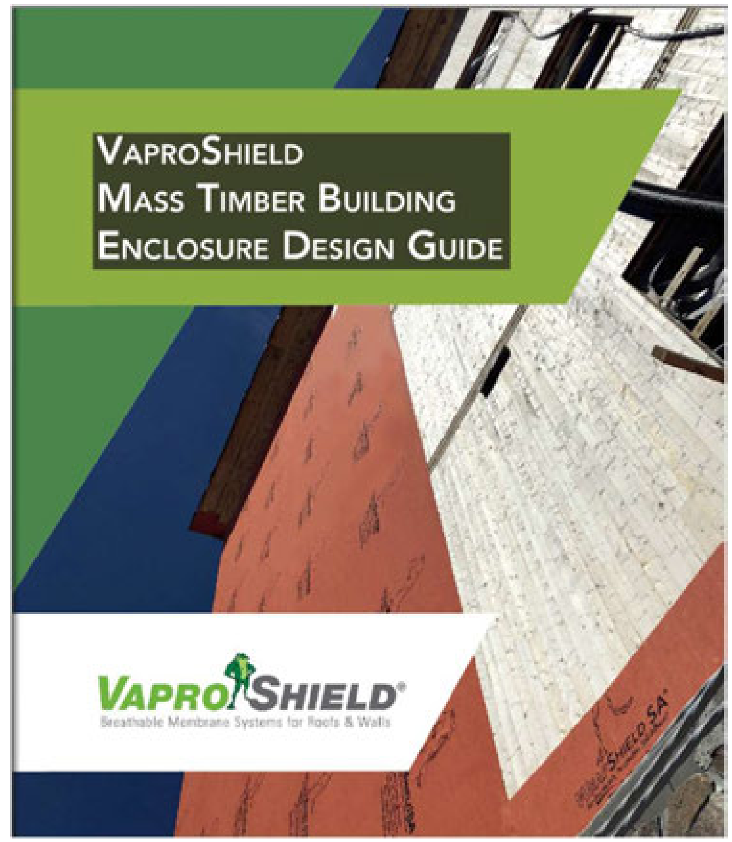


Building Envelope: Mass Timber Detailing Guides

WoodWorks provides structural details on our website. However, those don't consider control layers of the building envelope.

These are two great guides with example building envelope details for mass timber.

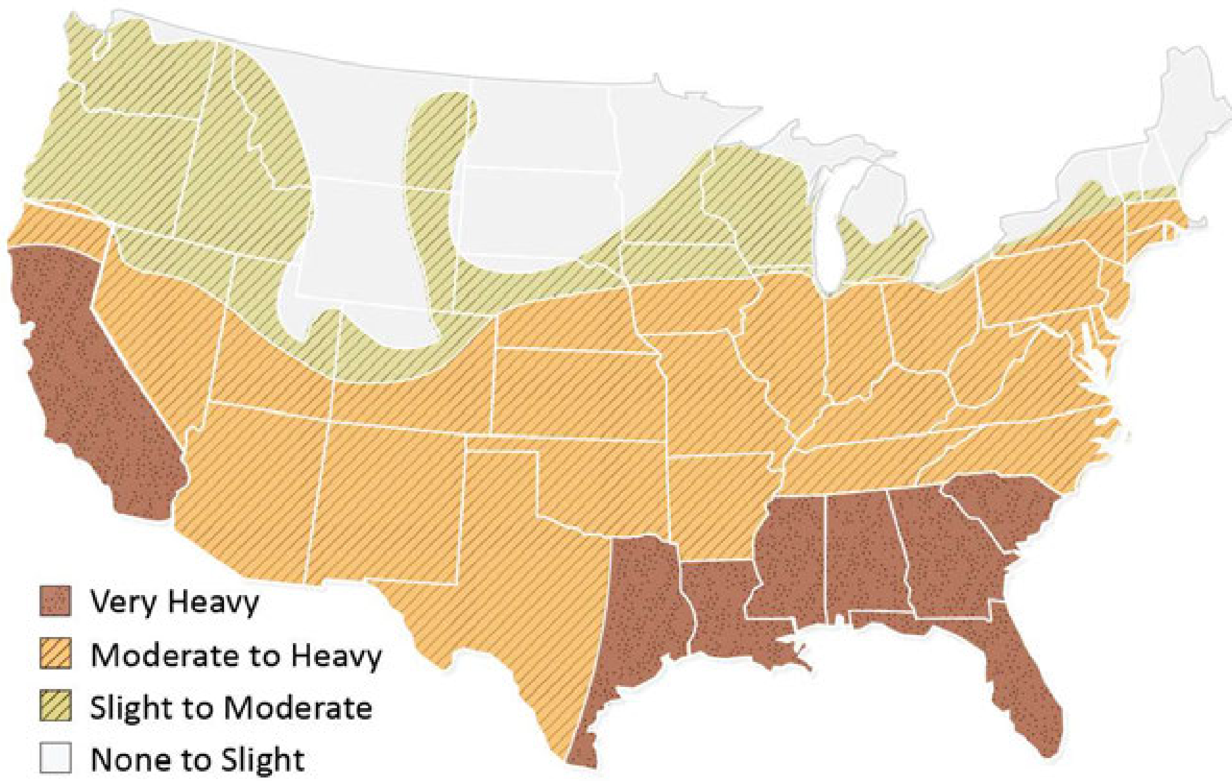




Durability

Termite Protection

Termite Probability Map



2021 IBC Commentary Figure 2304.12.2.7 (2021 IRC Figure R318.4)

Site Management

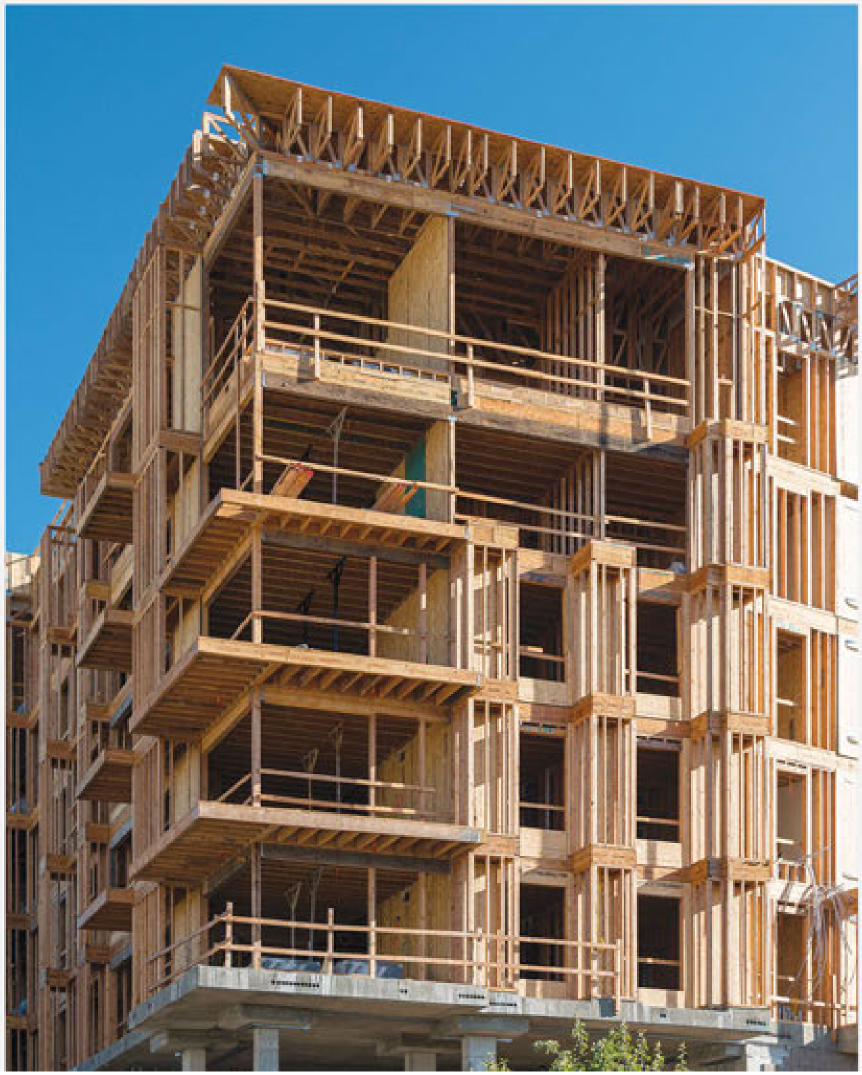
Remove:

- » Stumps, roots & any buried untreated wood
- » Concrete formwork (don’t leave embedded)
- » Wood offcuts & other debris (incl. in CMU block cells)

Other:

- » Cover & wrap construction materials that are stored on site, keeping non-treated wood a min of 6-8” from soil.
- » Drain water away from building at slope of 5% per 10’
- » Don’t use excavation spoil under wood-frame elements or store cellulose based materials like cardboard in crawlspaces.

SOLUTION PAPER



Effective Termite Protection for Multi-Family & Commercial Wood Buildings

Techniques for Keeping Wood-Frame Buildings Pest-Free

https://www.woodworks.org/resources/effective-termite-protection-for-multi-family-commercial-wood-buildings/

Photo Brett Drury

Space Planning

Space Planning

What's in a School?

"Small Spaces"
- Classrooms
- Bathrooms
- Offices

"Medium Spaces"
- Labs
- Music Room
- Kitchen

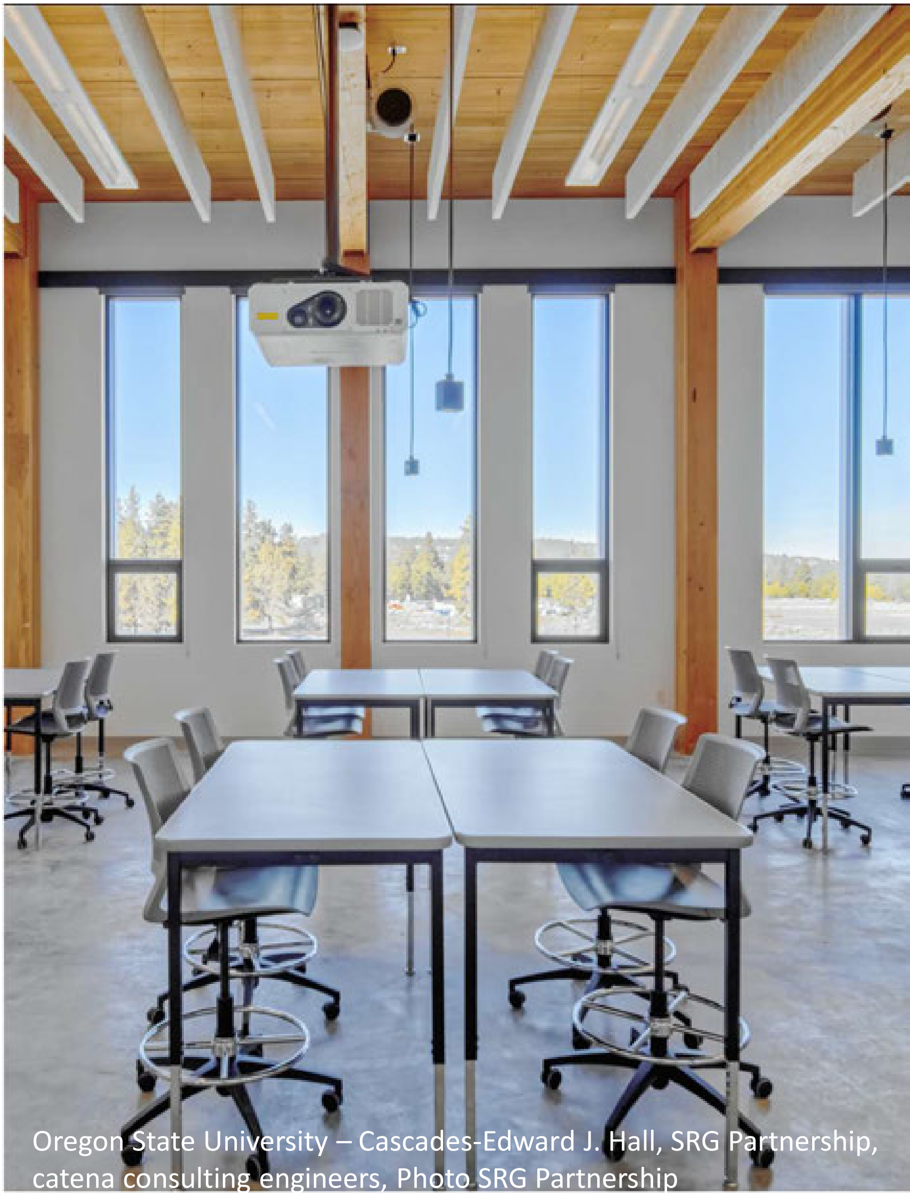
"Large Spaces"
- Cafeteria
- Gymnasiums
- Library

El Dorado High School / CADM Architecture / Engineering Consultants / Photo Dennis Ivy

Space Planning

Classroom Wings

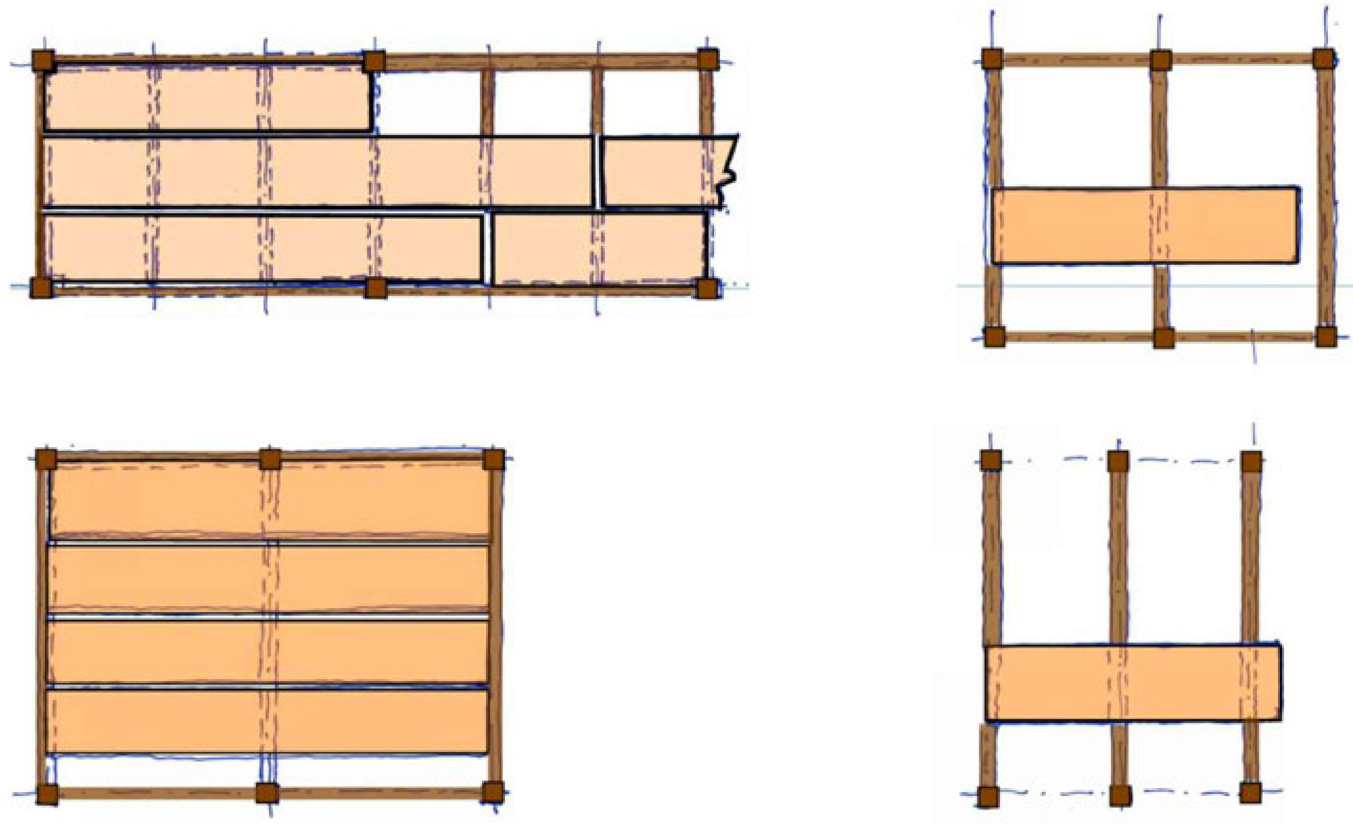
- Double-loaded corridor
- Classrooms: 800 sf min; 28-36 sf/student
- Usually square to slightly rect. – length no more than 1.5x width
- Common sizes: 28’x30’, 30’x30’, 30’x32’
- Corridor width: 6-18 ft wide, lockers?
- Min ceiling height: 9 ft. typ flr to flr ~ 13ft



Oregon State University – Cascades-Edward J. Hall, SRG Partnership, catena consulting engineers, Photo SRG Partnership

Structural Grid

- Consider Efficient Layouts
- Repetition & Scale
- Manufacturer Panel Sizing
- Transportation



Credit: Tanya Luthi, Entuitive

Floor to Ceiling Glazing Possibilities

Photos: Mark Bitterman

Structural Design

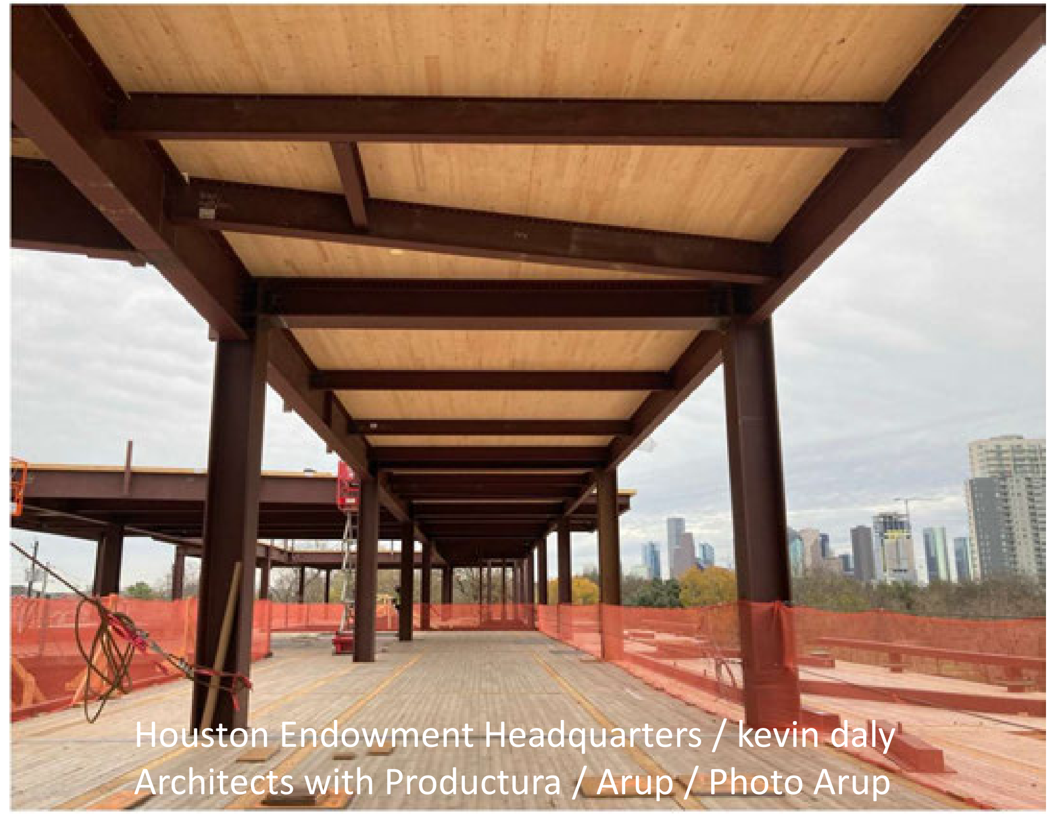
Mass Timber Building Options

Post and Beam

Flat Plate

Honeycomb

Mass Timber Building Options



Hybrid: Light-frame

Hybrid: Steel framing

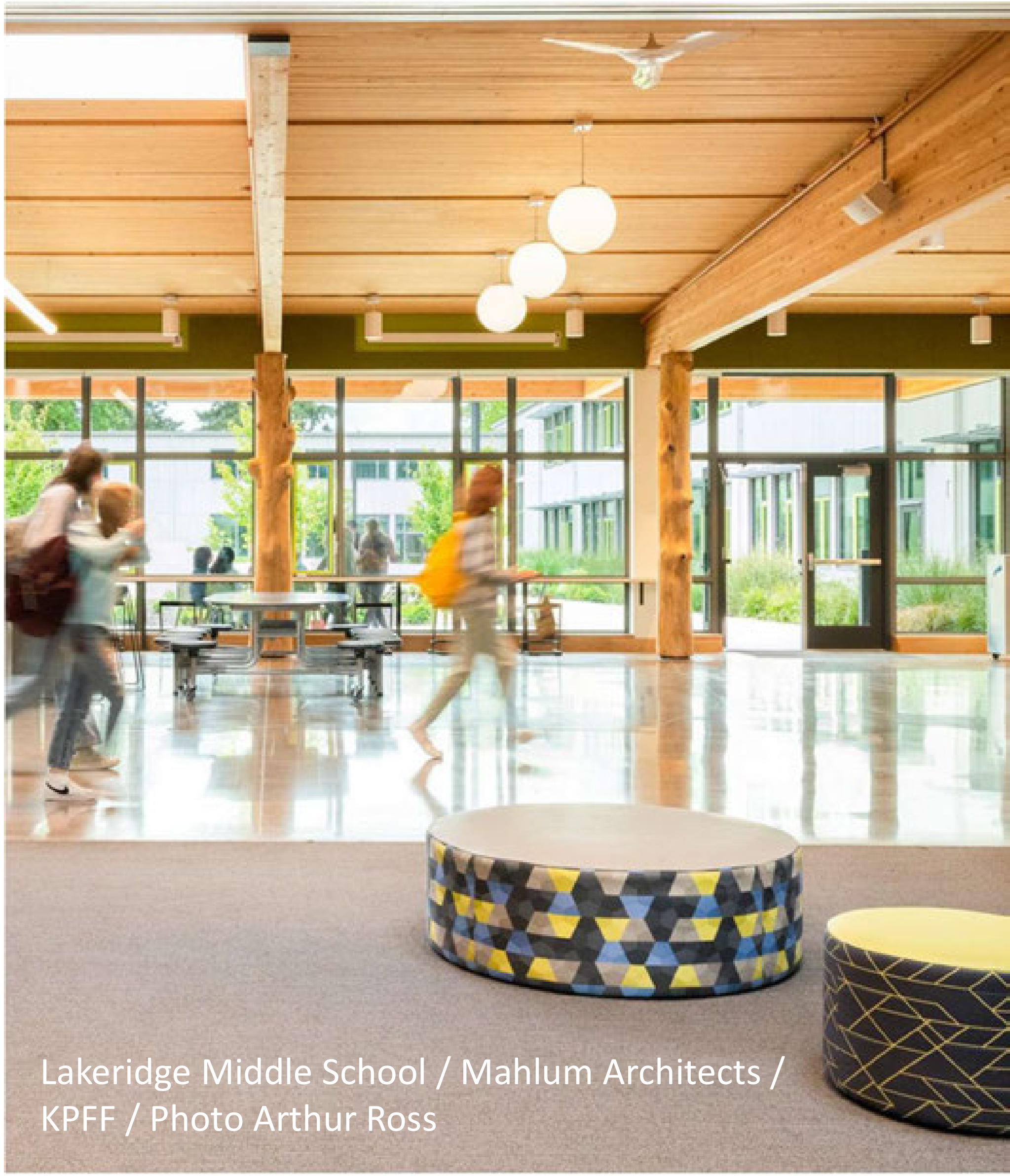
Structural Grid

Member Sizes

- Impact of FRR on Sizing
- Impact of Sizing on Efficient Spans
- Consider connections – can drive member sizing

0 HR FRR: Consider 3-ply Panel

- Efficient Spans of 10-12 ft
- Grids of 20x20 (1 purlin) to 30x30 (2 purlins) may be efficient



Lakeridge Middle School / Mahlum Architects / KPFF / Photo Arthur Ross

Structural Grid

Member Sizes

» Impact of FRR on Sizing
» Impact of Sizing on Efficient Spans
» Consider connections – can drive member sizing

1 or 2 HR FRR: Likely 5-ply Panel

» Efficient spans of 14-17 ft
» Grids of 15x30 (no purlins) to 30x30 (1 purlin) may be efficient


Barry Mills Hall and the John and Lile Gibbons Center for Arctic Studies, Bowdoin College / HGA / Photo Michael Moran

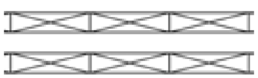
Structural Grid - Panels

» Cost and Construction Type – Panel selection

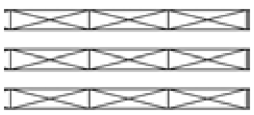
TABLE 601: Fire Resistance Rating Requirements for Building Elements (Hours)

Building Element	I-A	I-B	III-A	III-B	IV-A	IV-B	IV-C	IV-HT	V-A	V-B
Primary Structural Frame	3*	2*	1	0	3*	2	2	HT	1	0
Ext. Bearing Walls	3*	2*	2	2	3*	2	2	2	1	0
Int. Bearing Walls	3*	2*	1	0	3*	2	2	1/HT	1	0
Floor Construction	2	2*	1	0	2	2	2	HT	1	0
Roof Construction	1.5*	1*	1	0	1.5	1	1	HT	1	0
Exposed Mass Timber Elements					None	20-40%	Most	All		

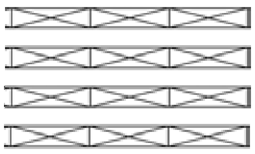
Baseline
0hr & HT



+$10/SF over 3-ply
1hr & maybe 2hr



+$12-15/SF over 5-ply
2hr FRR



Cost Source: Swinerton

*These values can be reduced based on certain conditions in IBC 403.2.1, which do not apply to Type IV buildings.

MEPF
Integration

MEP Layout Integration

Dropped below MT framing

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

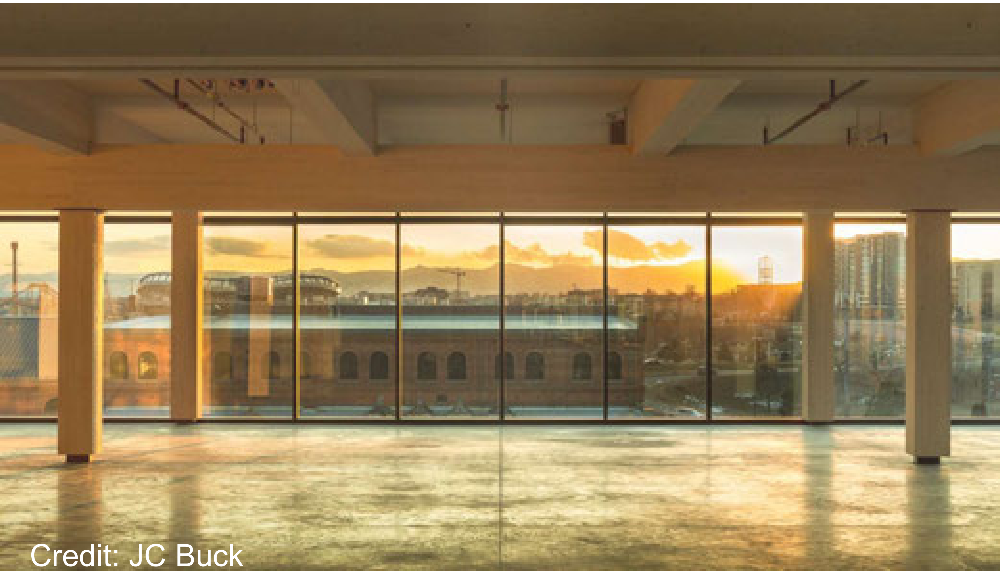
Credit: Alex Schreyer

Credit: WoodWorks

MEP Layout Integration

In chases above beams and below panels

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



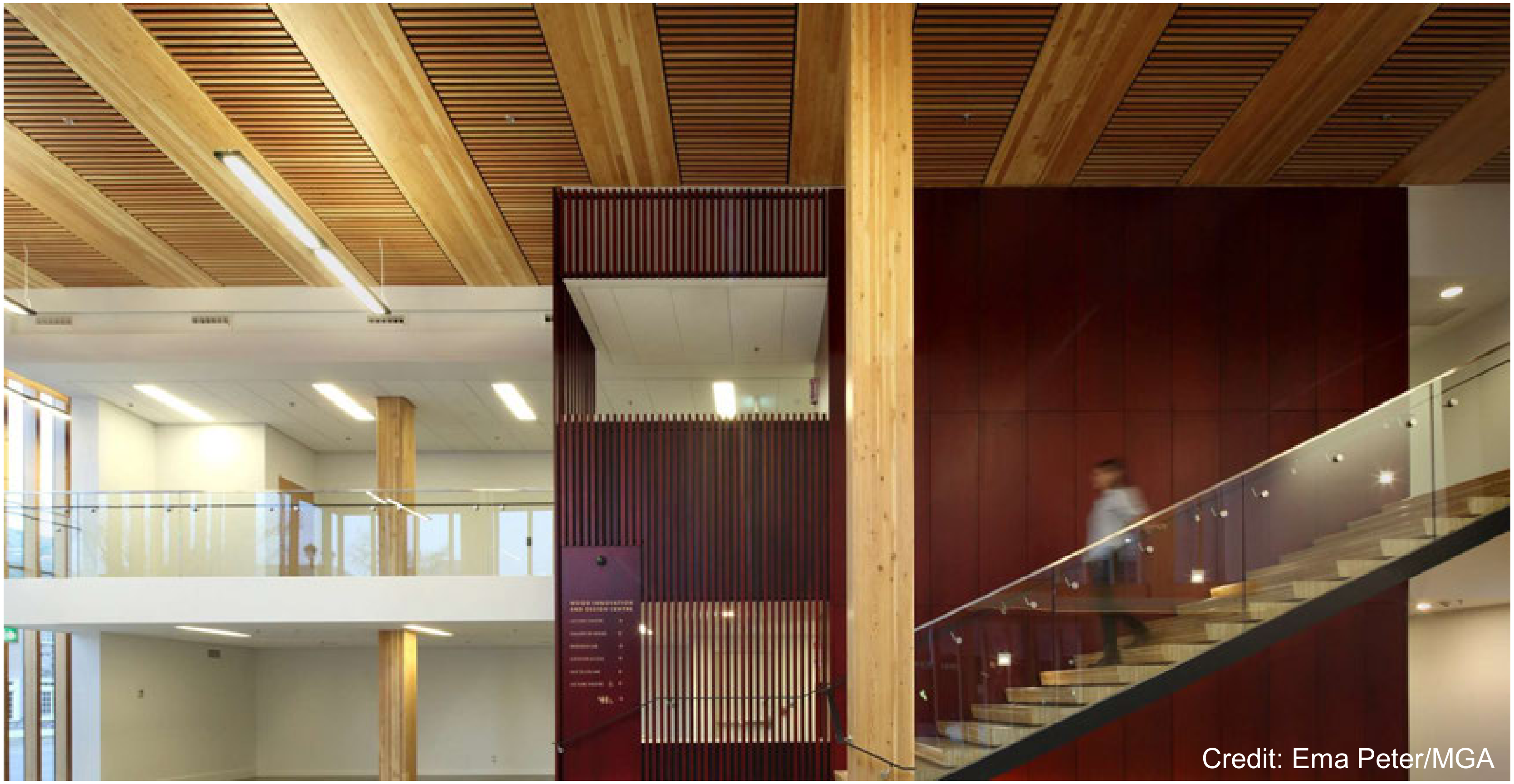
MEP Layout Integration

In penetrations through MT framing

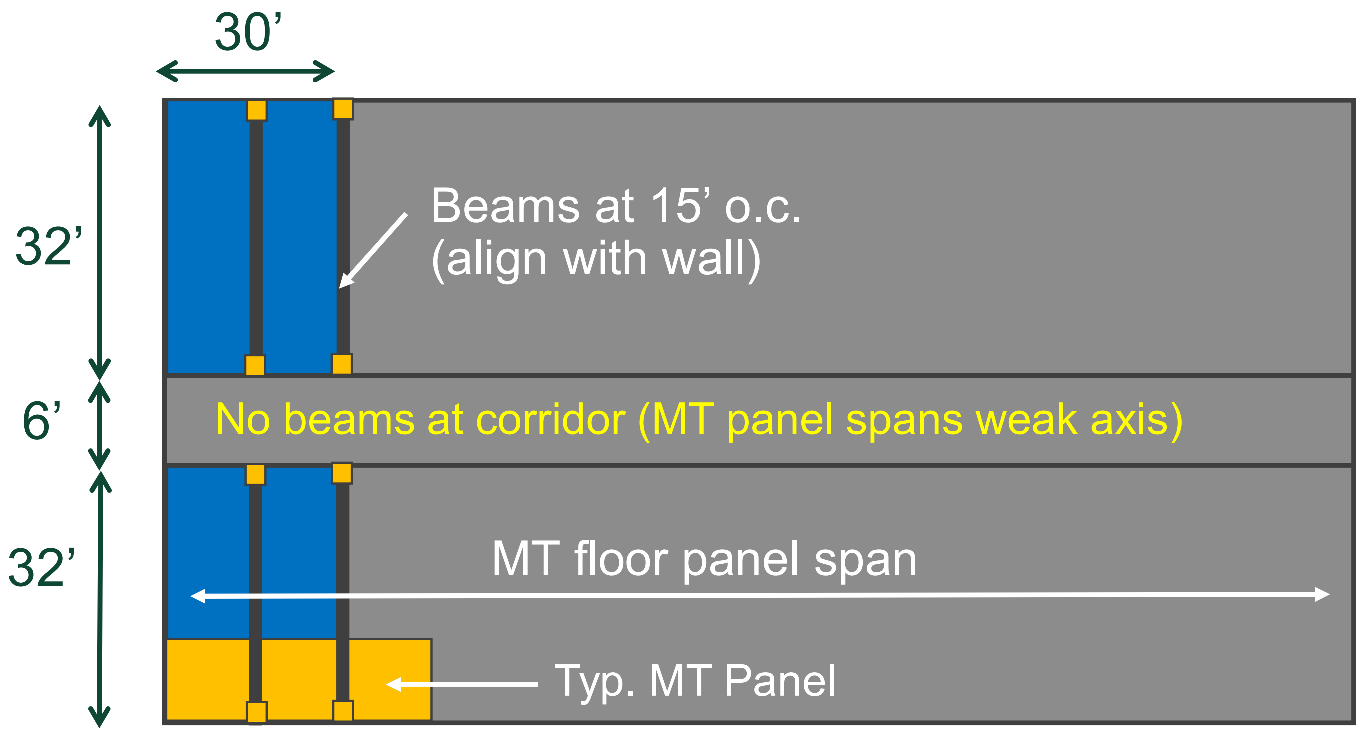
- Requires more coordination (penetrations)
- Bigger impact on structural capacity of penetrated members
- Minimal impact on head height

MEP Layout Integration

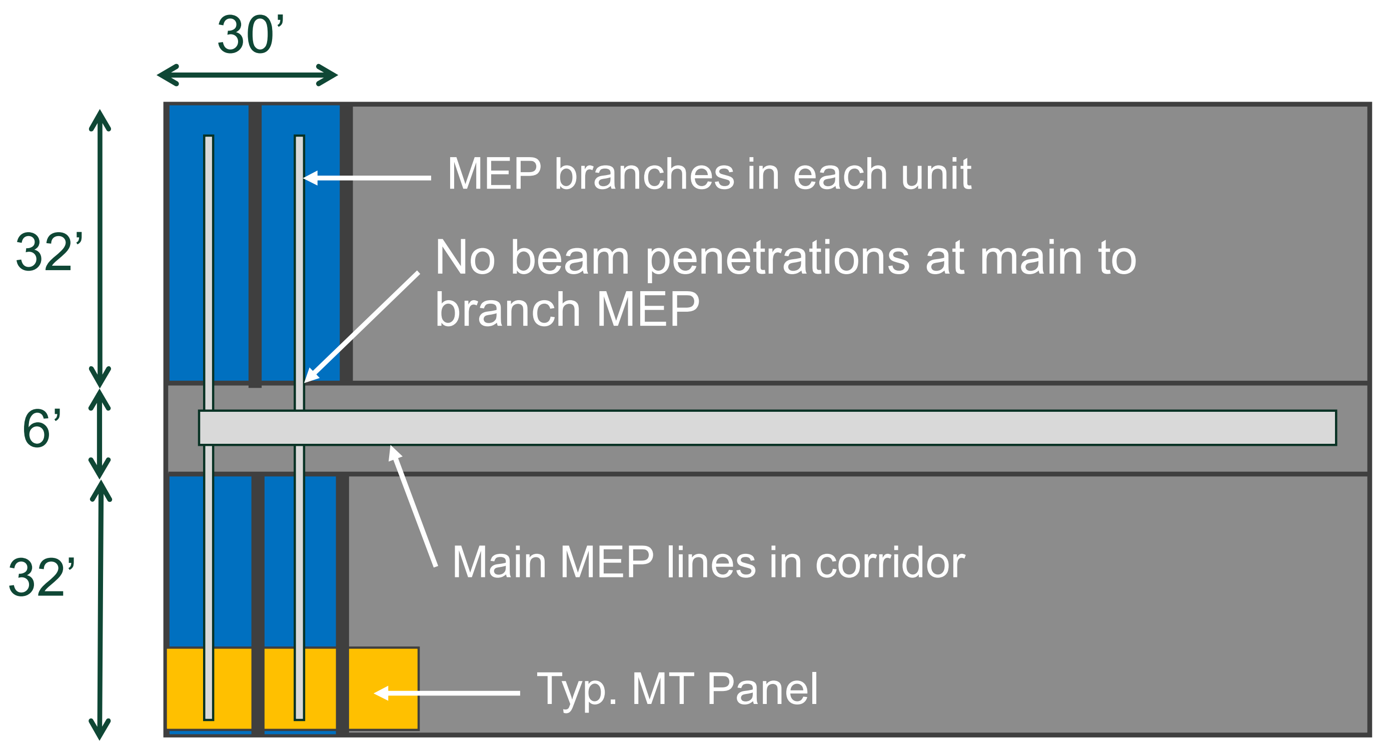
In gaps between MT panels


Credit: Ema Peter/MGA

Early Design Decisions Example – Grid Option



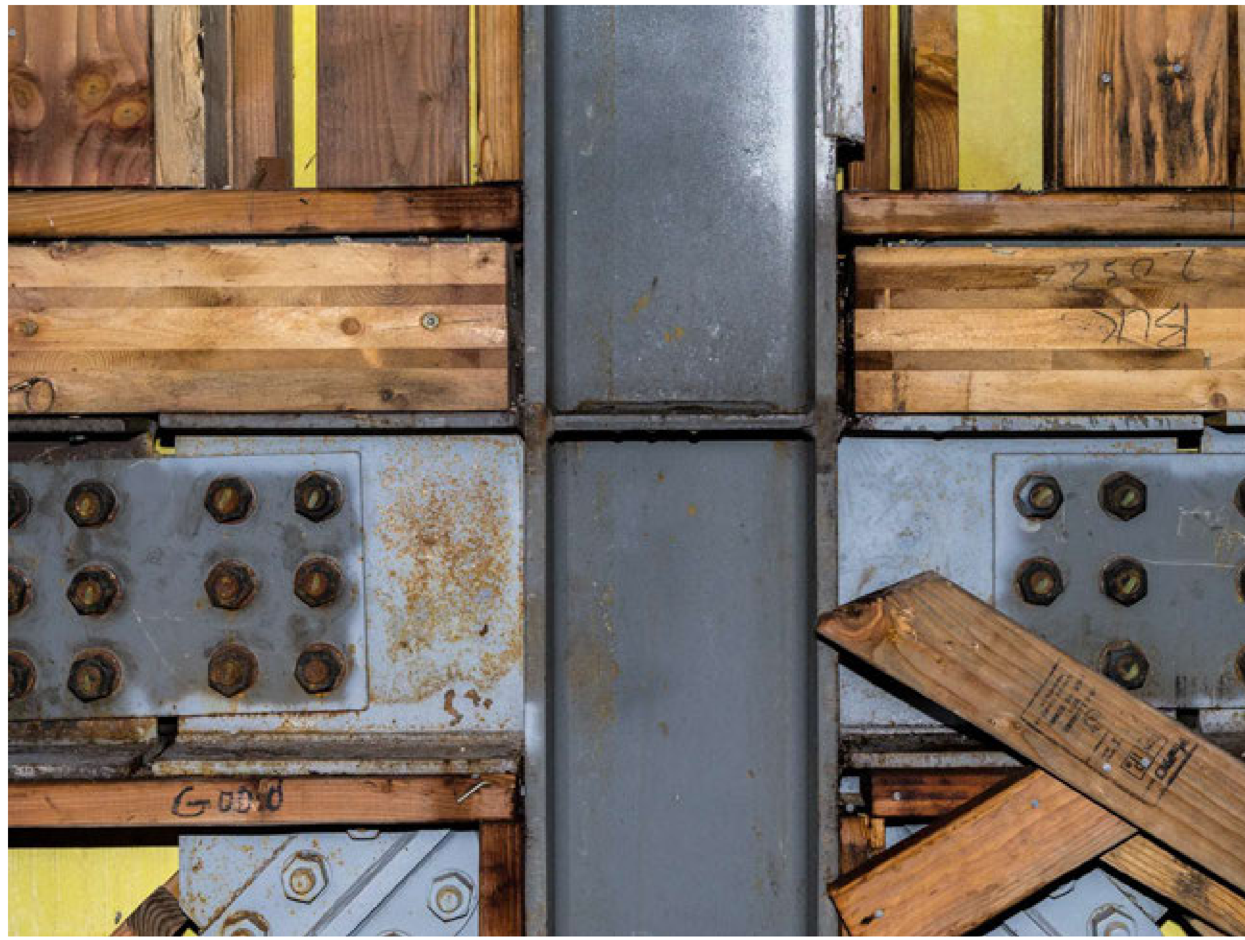
Early Design Decisions Example – Grid Option



Lateral Systems

Mass Timber Lateral Systems

Mass Timber Lateral Systems



Mass Timber Lateral Systems

Mass Timber Lateral Systems

Mass Timber Shear Walls

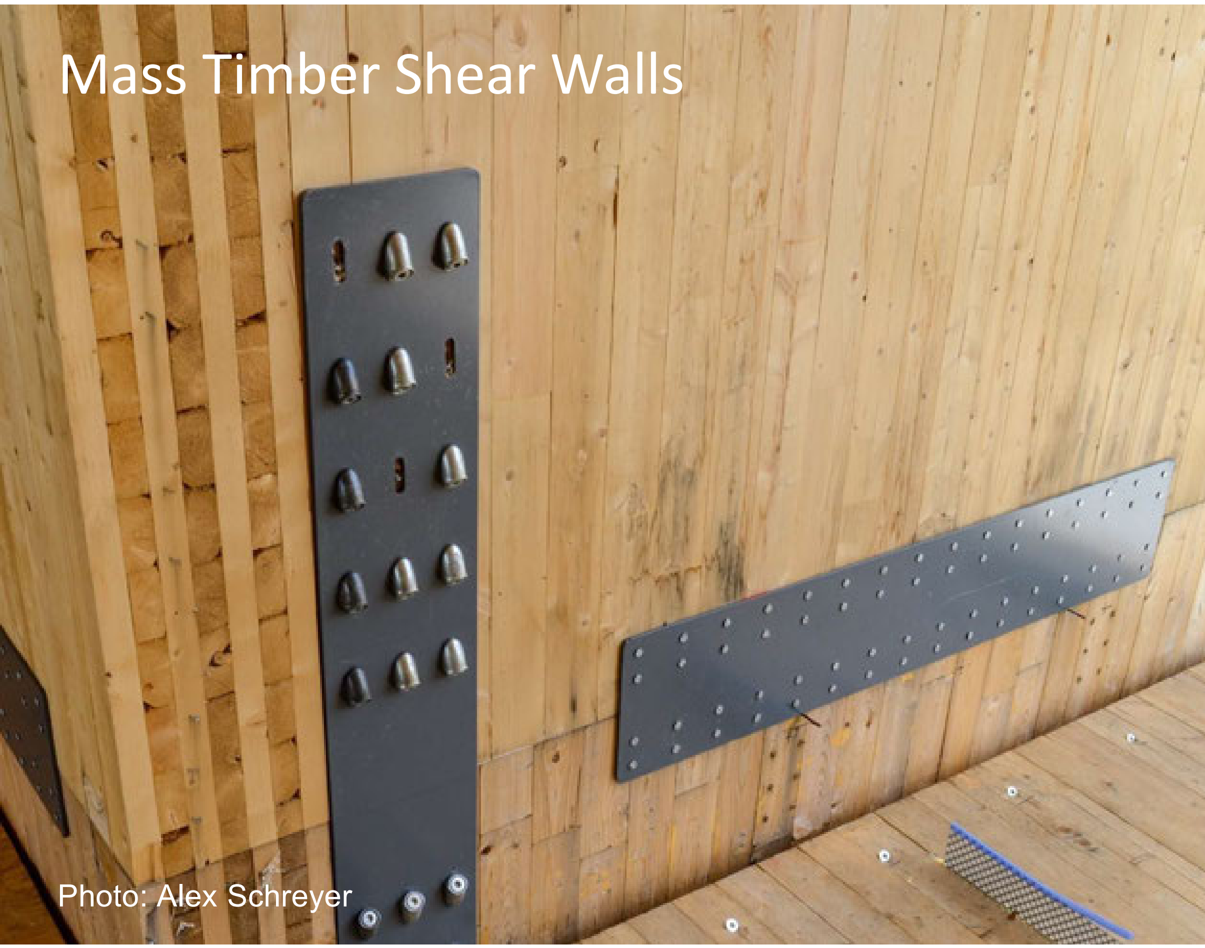


Photo: Alex Schreyer

Mass Timber Lateral Systems – Code Permitted Options

	Max Height	Lateral Systems Permitted by Construction Type			
		Type IV-C	Type IV-HT	Type III (A & B)	Type V (A & B)
Concrete Shear Wall	> 85’	✓	✓	✓	✓
Steel Braced Frame	> 85’	✓	✓	✓	✓
Light Frame Wood Shear Wall	≤ 65’ (SDC D,E,F) 85’ (SDC B,C)	✗	✓ (FRTW at exterior, ≥1-hr FRR at interior)	✓ (FRTW at exterior)	✓
Mass Timber (CLT) Shear Wall	≤ 65’ (SDPWS 2021, ASCE 7-22, IBC 2024)	✓ (shafts require noncombustible covering)	✓	✓ (interior only)	✓

WoodWorks CLT Diaphragm Design Guide

https://www.woodworks.org/resources/clt-diaphragm-design-guide/

WOODWORKS
WOOD PRODUCTS COUNCIL

CLT DIAPHRAGM DESIGN GUIDE

BASED ON THE 2021 SDPWS

WOODWORKS
WOOD PRODUCTS COUNCIL

Holmes Structures

kpff

SWINERTON
MASS TIMBER

Funded By:

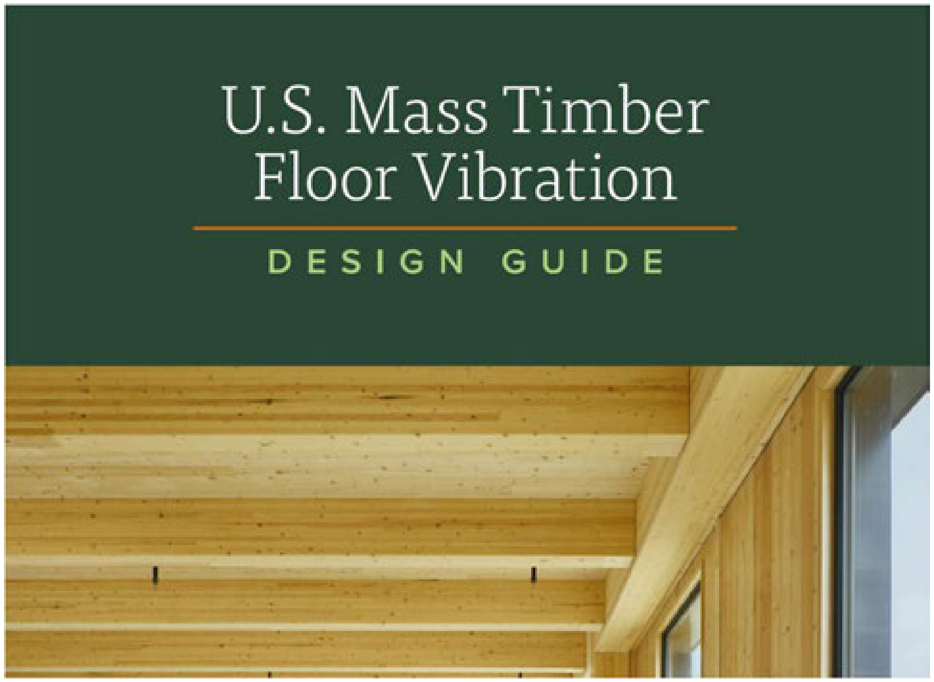
U.S. Endowment
for Forestry and Communities

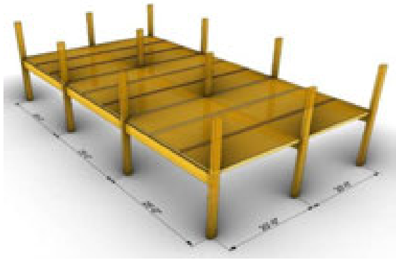
USDA

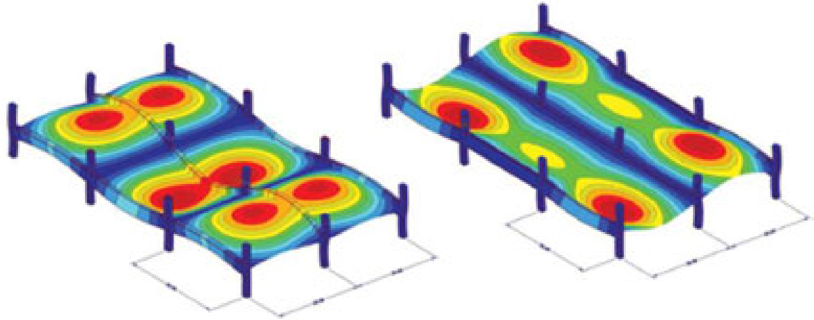
Mass Timber Floor Vibration Guide

Worked office, lab and residential Examples

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

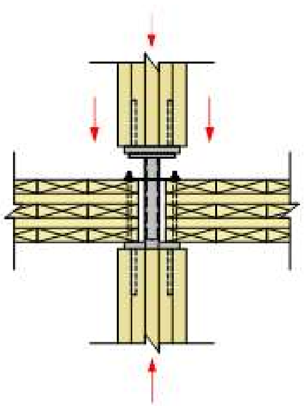


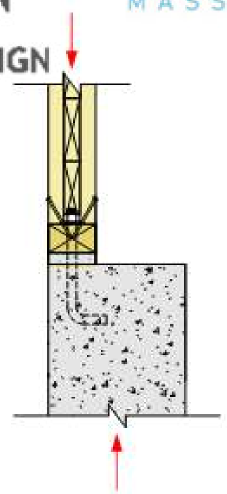


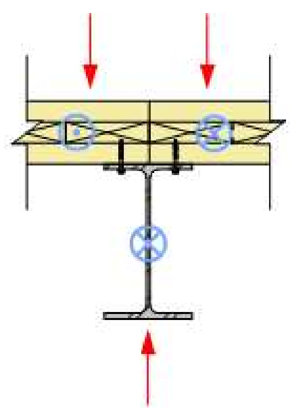


Mass Timber Connections Index

A library of commonly used mass timber connections with designer notes and information on fire resistance, relative cost and load-carrying capacity.





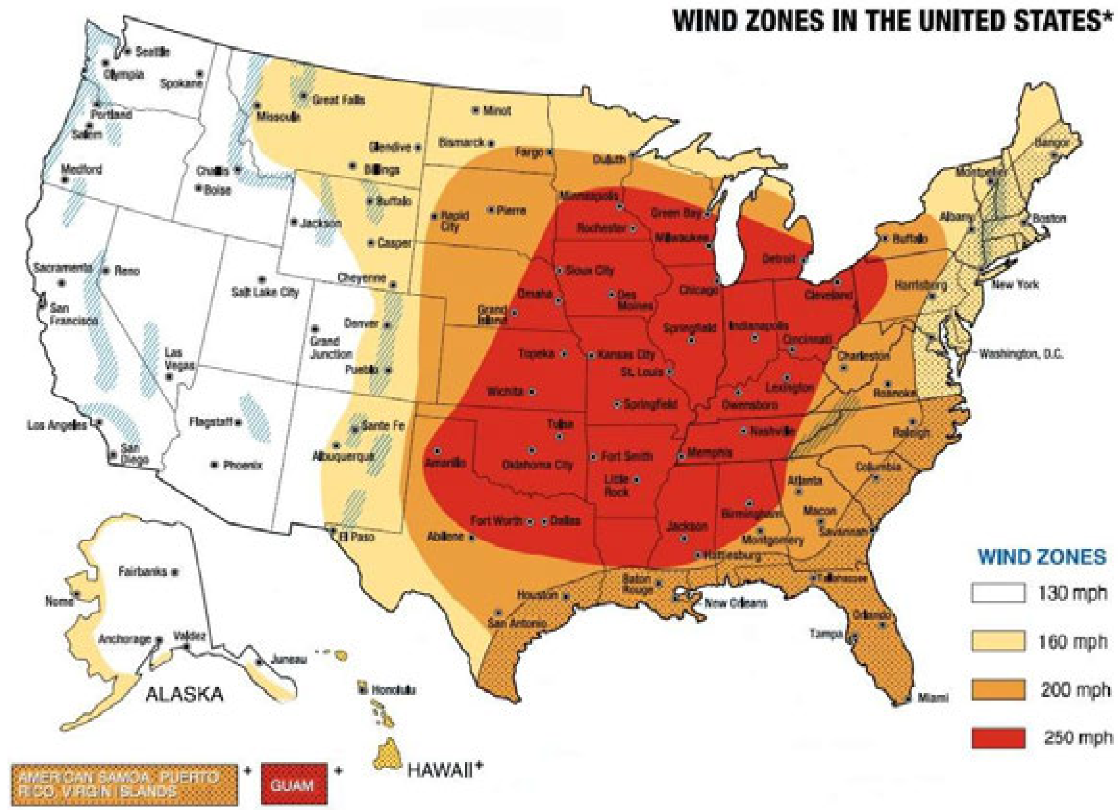


Storm Shelters

Storm Shelters
2018 & 2021 IBC 423

‘Tornado Alley’

IBC 423 requires ICC 500 compliant storm shelters – typically constructed as safe rooms in a larger facility – for group E buildings with tornado wind speed of 250 mph.



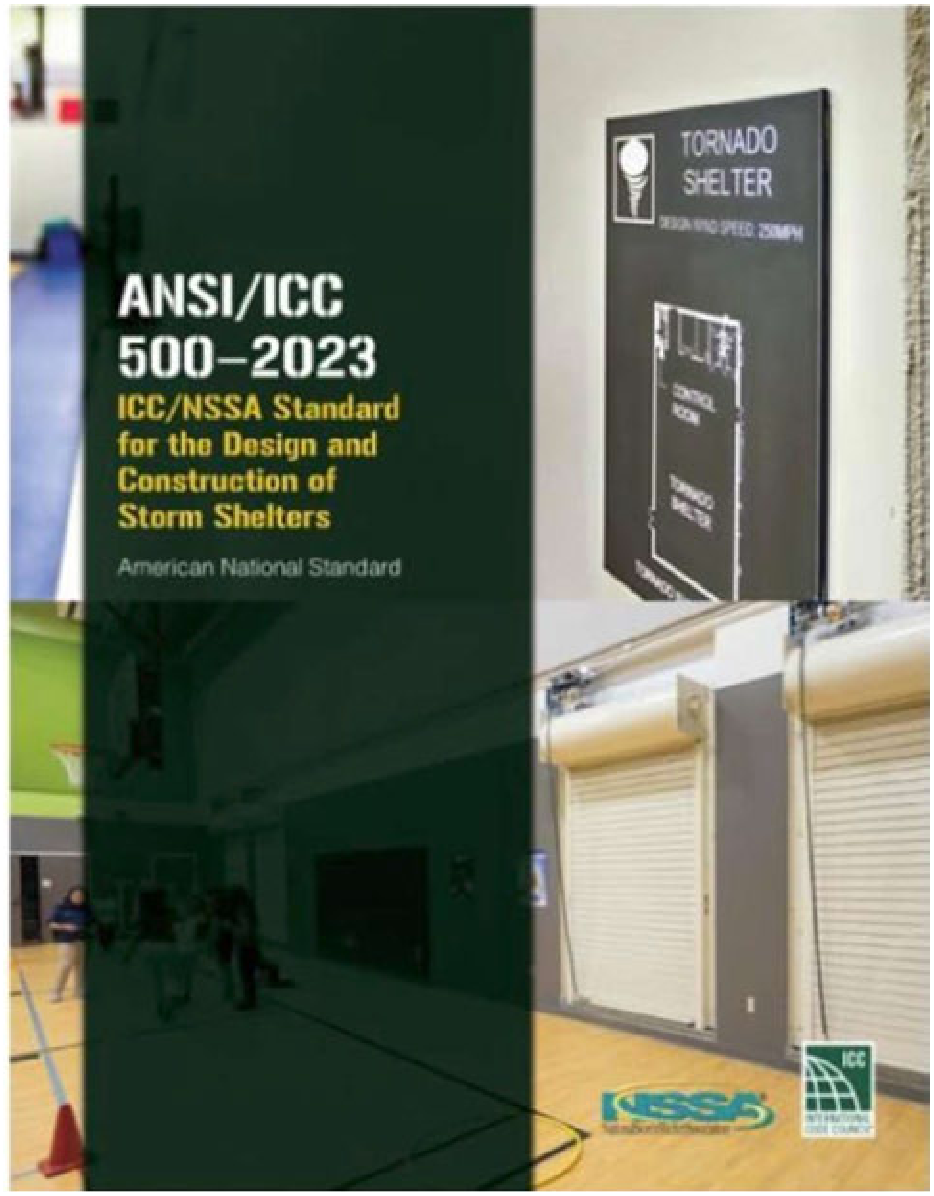
Commentary Figure 423.4
SHELTER DESIGN WIND SPEEDS FOR TORNADOES

Source: International Code Council[1]

Storm Shelters
ICC 500

Includes requirements for:

- Wind, rain, live, flood and hydrostatic loading
- Shielding from host and adjacent buildings
- Resistance to wind-borne and falling debris



Source: International Code Council, ICC 500-2023

Storm Shelters
2018 & 2021 IBC 423 & ICC 500

An entire building can be designated as a Storm shelter, or more commonly, the shelter is a room/portion of the building that can accommodate the occupant load.

Source: CADM Architects

Storm Shelters
2018 & 2021 IBC 423

Development of a Ready-to-Assemble Tornado Safe Room from Cross Laminated Timber

Robert H. Falk, Research Engineer
James J. Bridwell, General Engineer
USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin

Tom Williamson, Timber Engineering Consultant
Timber Engineering, LLC
Tacoma, Washington

Todd Black, Operations Manager
DR Johnson
Tualatin, Oregon

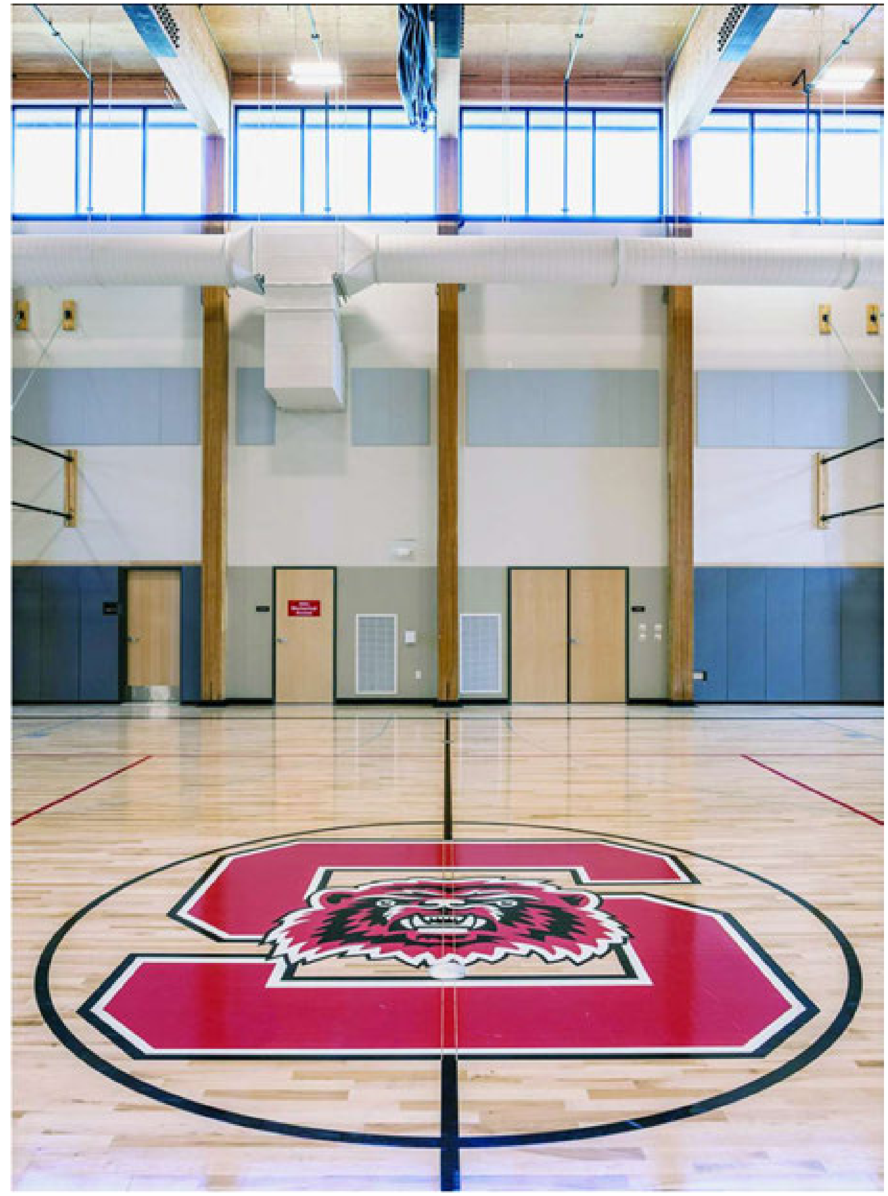
Fig 19
Safe room tied down to strong floor

Source: USDA FS FPL CLT tornado shelter[3]

Long-Span Open Areas

Gyms/Arenas:

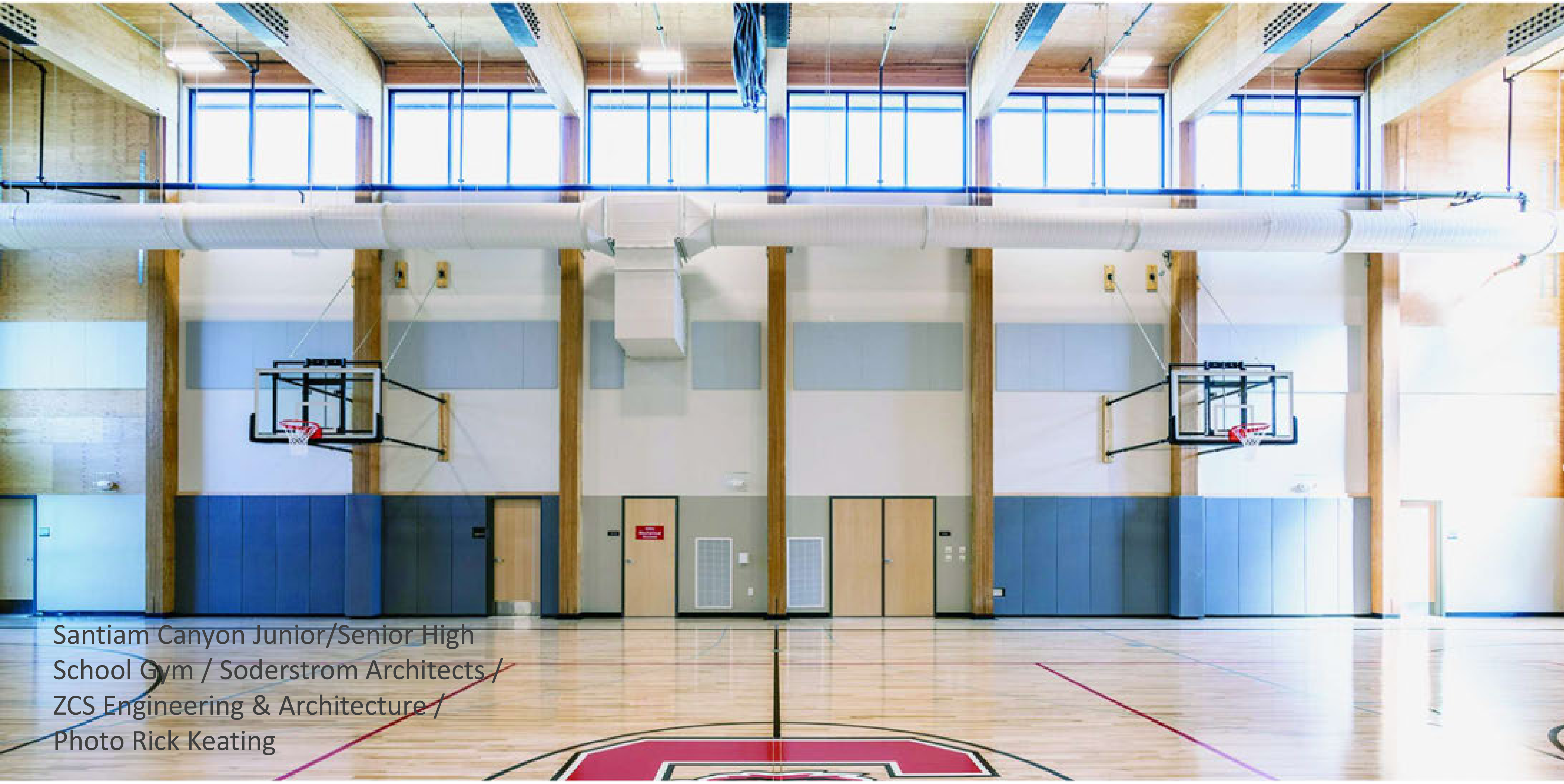
- **Area:** 7,000 sf+
- **Ceiling heights:** 20 ft+
- **Spans:** 60 ft - 300 ft+



Santiam Canyon Junior/Senior High School Gym / Soderstrom Architects / ZCS Engineering & Architecture / Photo Rick Keating

Santiam Canyon High School

Glulam Beams: 72 ft span

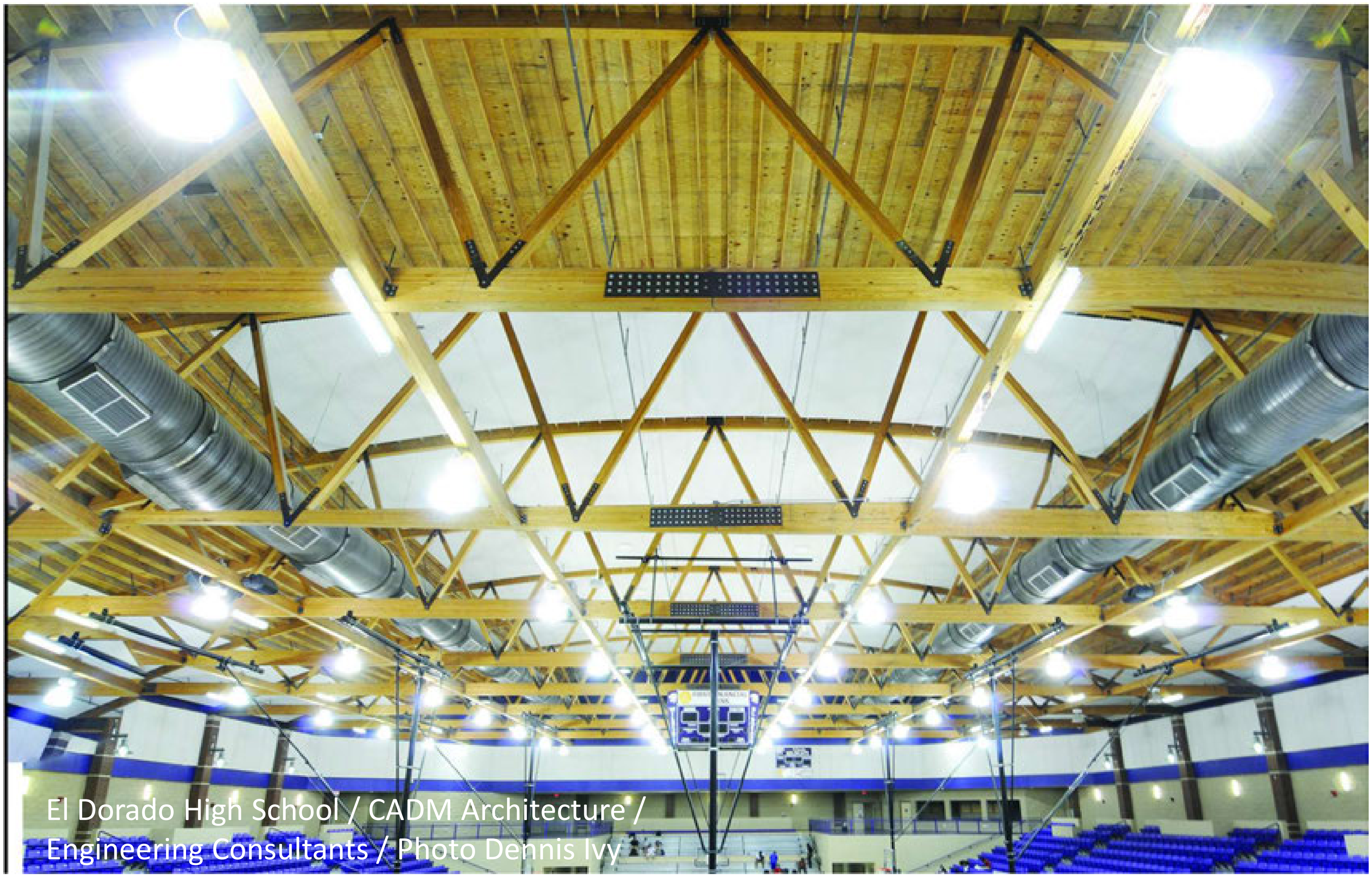


Santiam Canyon Junior/Senior High School Gym / Soderstrom Architects / ZCS Engineering & Architecture / Photo Rick Keating

Evergreen Charter School Glulam Trusses: 48 ft span

El Dorado High School

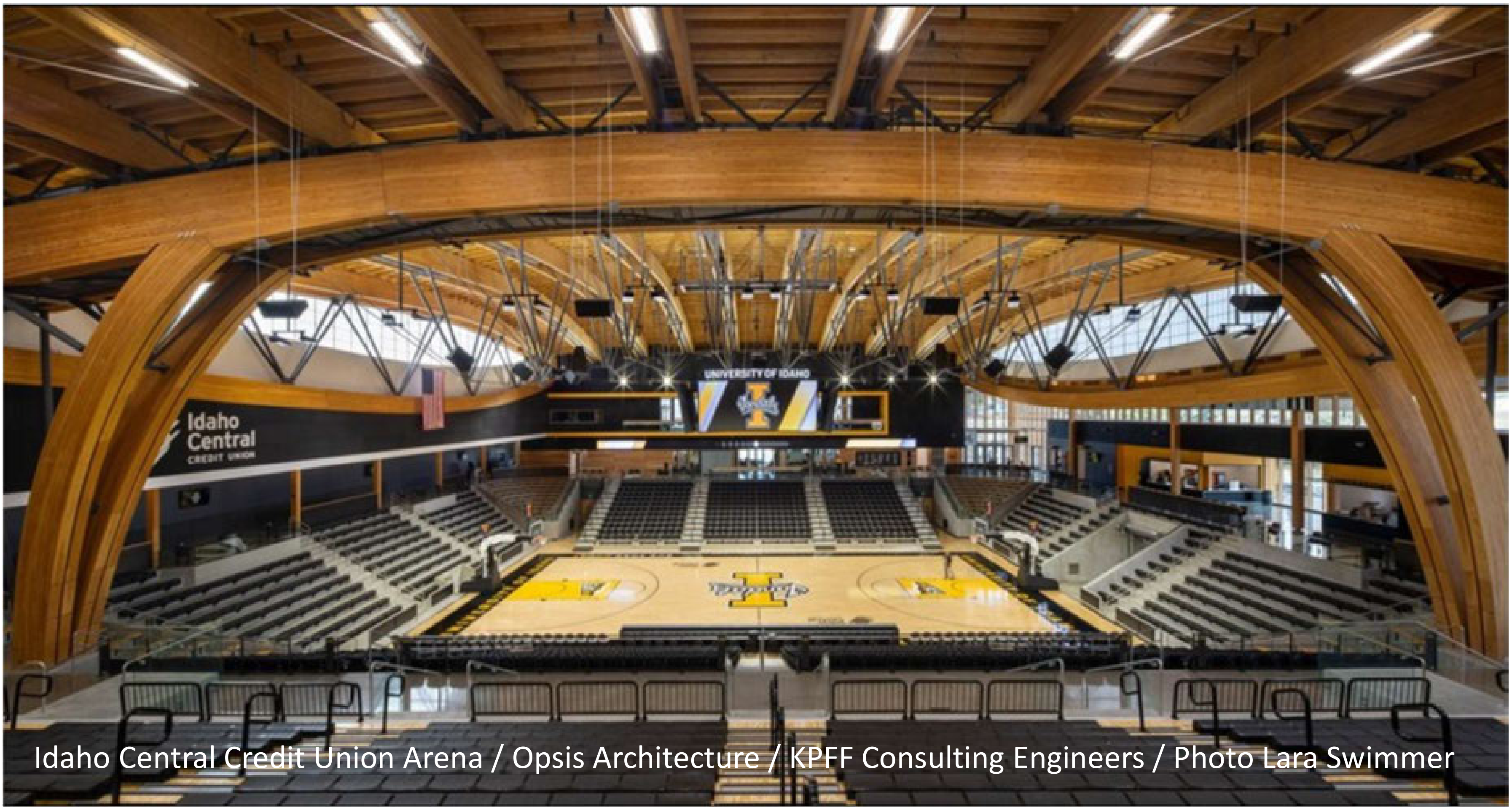
Glulam Trusses: 165 ft span



El Dorado High School / CADM Architecture / Engineering Consultants / Photo Dennis Ivy

University of Idaho Credit Union Arena

Glulam Trusses : 140 ft span



Idaho Central Credit Union Arena / Opsis Architecture / KPFF Consulting Engineers / Photo Lara Swimmer

YMCA Camp Thunderbird Duke Energy Pavilion,
Lake Wylie, SC

70-foot clear span

Engineer: Bulla Smith
Design Engineering
Photos: Stanley Capps

Questions? Ask us anything.

Jessica Scarlett, EIT, LEED AP
Regional Director – NC, SC, TN
(803) 616-6231
jessica.scarlett@woodworks.org

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

Funding provided in part by the Softwood Lumber Board