Credit: Monte French Design Studio, Haycon

Design Considerations for Resilient Mass Timber Structures

October 25, 2023

Jennifer Cover, PE - CEO
Ashley Cagle, PE, SE – Technical Director

"The Wood Products Council" is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

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

AIA Approved Continuing Education

Course Description

Due to their high strength, dimensional stability and positive environmental performance, mass timber building products are quickly becoming materials of choice for sustainably-minded designers. This presentation will provide a detailed look at the variety of mass timber products available, including glue-laminated timber (glulam), cross laminated timber (CLT), nail laminated timber (NLT), heavy timber decking, and other engineered and composite systems. Applications for the use of these products under modern building codes will be discussed, and examples of their use in U.S. projects reviewed. Mass timber's ability to act as both structure and exposed finish will also be highlighted, as will its performance as part of an assembly, considering design objectives related to structural performance, fire resistance, acoustics, and energy efficiency. Other topics will include detailing and construction best practices, lessons learned from completed projects and trends for the increased use of mass timber products in the future.

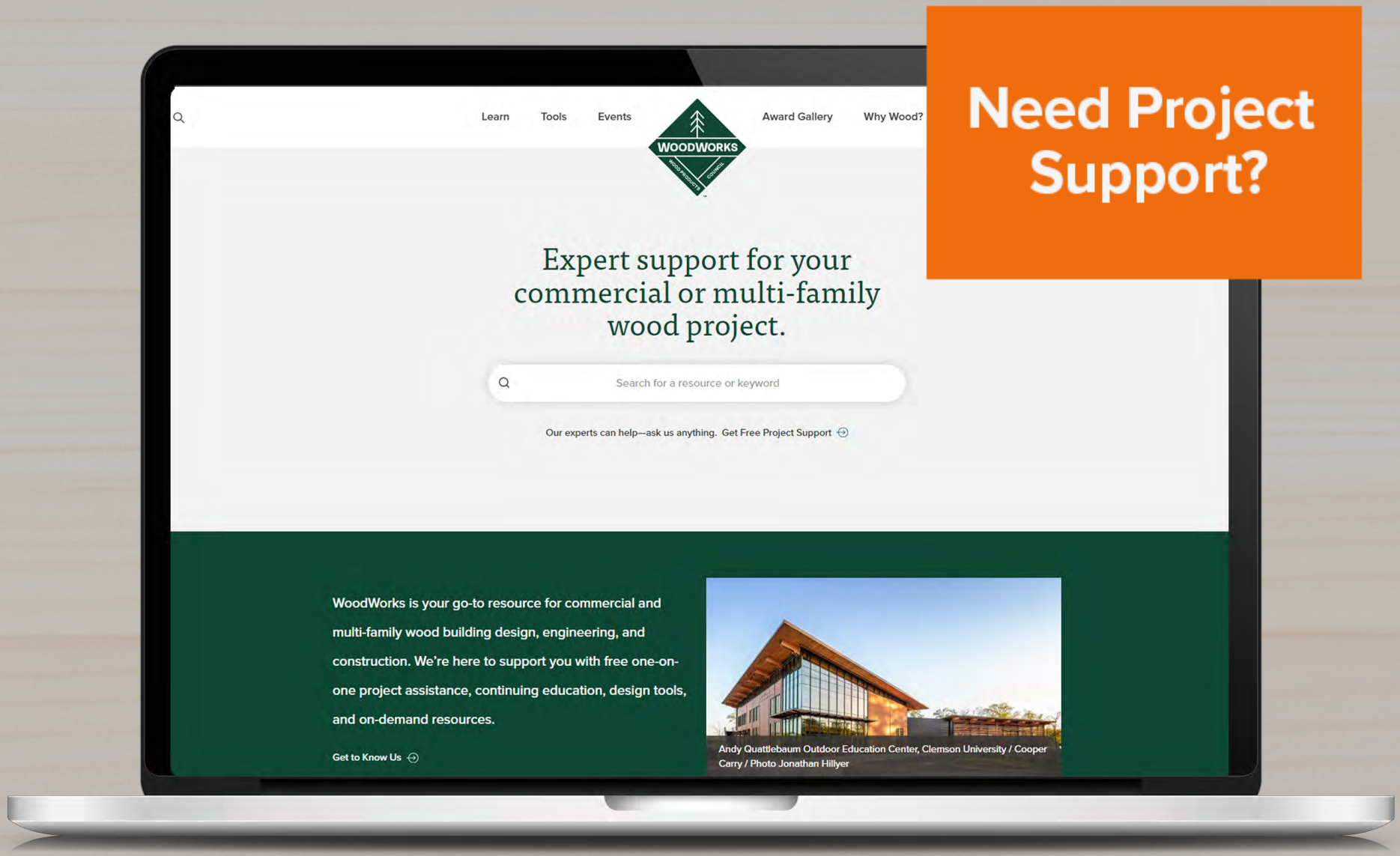
Learning Objectives

1. Identify mass timber products available in North America and consider how they can be used under current building codes and standards.
2. Review completed mass timber projects that demonstrate a range of applications and system configurations.
3. Discuss benefits of using mass timber products, including structural versatility, prefabrication, lighter carbon footprint, and reduced labor costs.
4. Discuss potential construction schedule savings and construction fire safety practices realized through the use of prefabricated mass timber elements.

Regional Directors:
One-on-One Project Support

WOODWORKS
WPC

woodworks.org



Solutions Team

Scott Breneman, PhD, PE, SE

Ashley Cagle, PE, SE

Karen Gesa, PE

Erin Kinder, PE, SE, LEED AP

Melissa Kroskey, AIA, SE

Taylor Landry, PE, MLSE

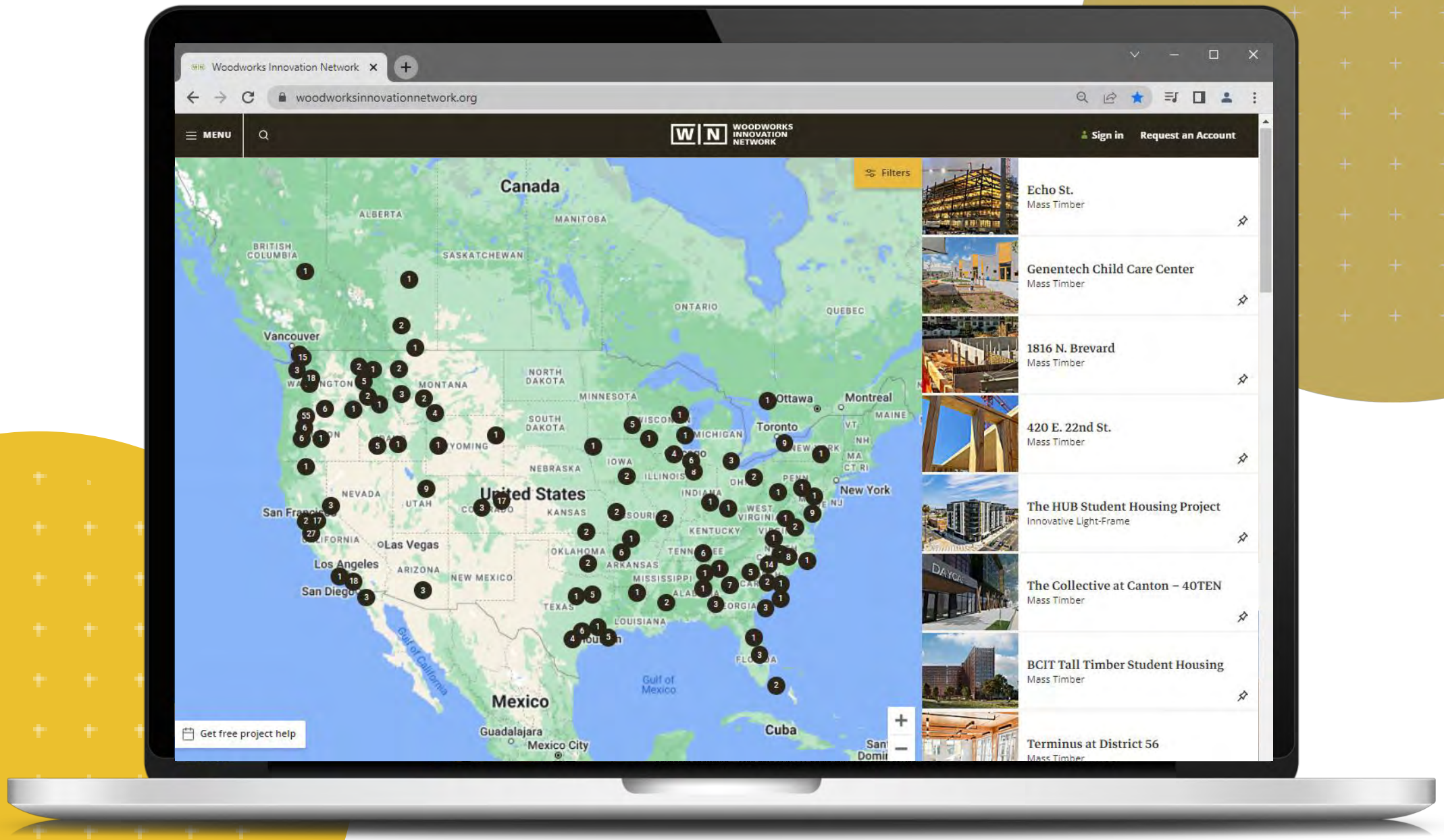
Bruce Lindsey

Terry Malone, PE, SE

Ricky McLain, PE, SE

WOODWORKS
INNOVATION
NETWORK.ORG

111 East Grand / Neumann Monson Architects
photo Mike Sinclair


Woodworks Innovation Network
woodworksinnovationnetwork.org
MENU
WOODWORKS INNOVATION NETWORK
Sign in
Request an Account
Filters
Canada
United States
Mexico
Vancouver
Ottawa
Montreal
Toronto
New York
Las Vegas
Los Angeles
San Diego
Guadalajara
Mexico City
Cuba
Gulf of Mexico
Get free project help
Echo St.
Mass Timber
Genentech Child Care Center
Mass Timber
1816 N. Brevard
Mass Timber
420 E. 22nd St.
Mass Timber
The HUB Student Housing Project
Innovative Light-Frame
The Collective at Canton – 40TEN
Mass Timber
BCIT Tall Timber Student Housing
Mass Timber
Terminus at District 56
Mass Timber

WOODWORKS WPC WOOD PRODUCTS COUNCIL™

Funding Partners

SLB SOFTWOOD LUMBER BOARD

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

Forestry Innovation Investment®

WOODWORKS WPC WOOD PRODUCTS COUNCIL

Sustaining Partners

Boise Cascade
GP Georgia-Pacific
LP BUILDING SOLUTIONS
West Fraser
Weyerhaeuser

Market Development Partners

binderholz
FRERES ENGINEERED WOOD
Global IFS INTEGRATED FLOORING SOLUTIONS
HASSLACHER NORICA TIMBER From wood to wonders.
HUBER ENGINEERED WOODS
MAXXON
MERCER
SANSIN
SIMPSON Strong-Tie
SMARTLAM NORTH AMERICA
STERLING Structural
StructureCraft
VAAGEN TIMBERS

Industry Advantage Partners

ELEMENT5 MODERN TIMBER BUILDINGS
KALESNIKOFF TIMBER INSPIRES
rothoblaas Solutions for Building Technology
RedBUILT

Channel Partners

TIMBERLAB

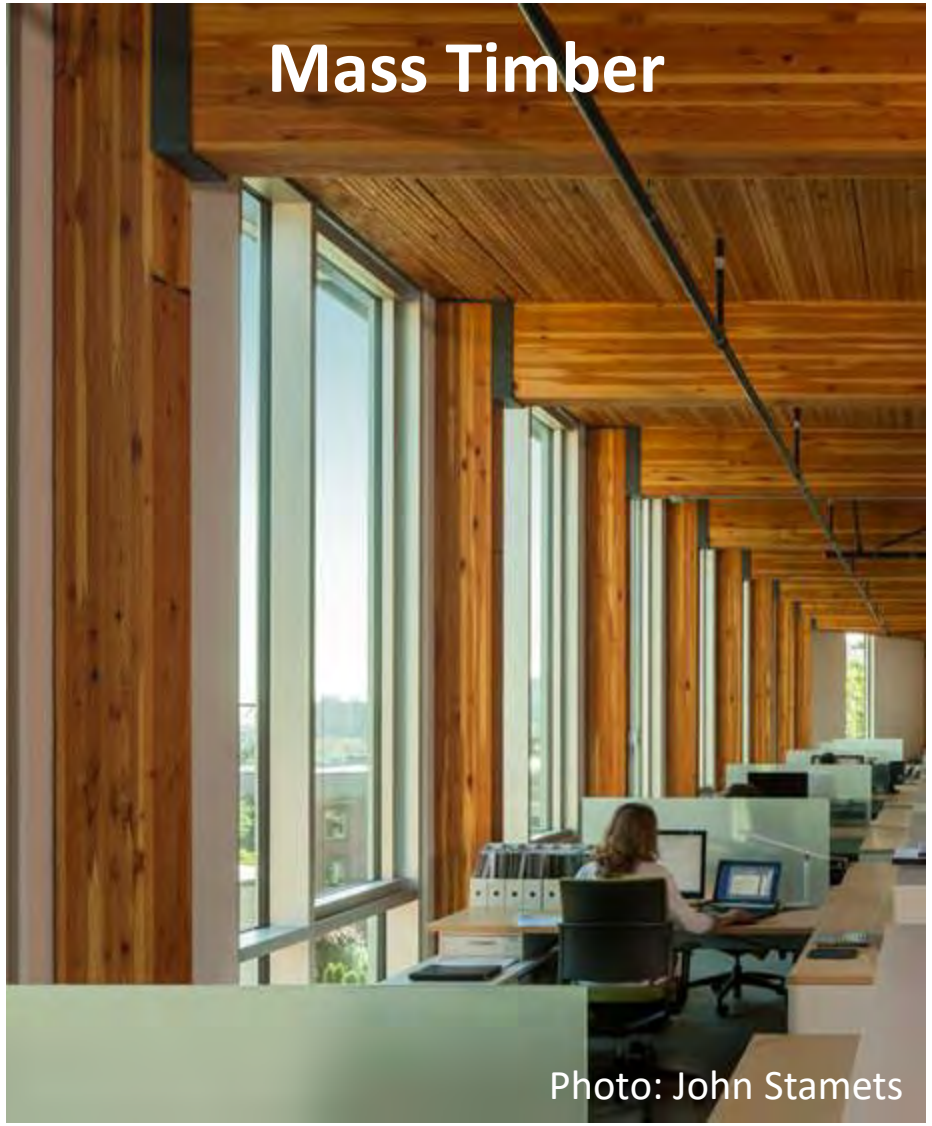
The
What, Why and How
of Mass Timber

Photo: Michael Green Architecture

What is Mass Timber?

Brock Commons, Vancouver, BC | Architect: Acton Ostry| Photo Courtesy: naturally:wood

Timber Methodologies



Glue Laminated Timber (Glulam)

Beams & columns

Cross-Laminated Timber (CLT)

Solid sawn laminations

Cross-Laminated Timber (CLT)

SCL laminations

Photo: Freres Lumber

Photo: StructureCraft

Photo: LendLease

Photo: LEVER Architecture

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Nail-Laminated Timber (NLT)

Photo: Think Wood

Glue Laminated Timber (GLT)

Plank orientation

Photo: StructureCraft

Photo: StructureCraft

Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

Post, Beam + Plate

Photo: Ema Peter

Post + Plate

Photo: Seagate Structures

Honeycomb

Photo: Lendlease

Hybrid: Light-Frame + Mass Timber

Photo: John Klein

Hybrid: Steel + Mass Timber

Photo: Timberlab

Hybrid: Concrete + Mass Timber

Photo: Jeremy Bittermann

Connections

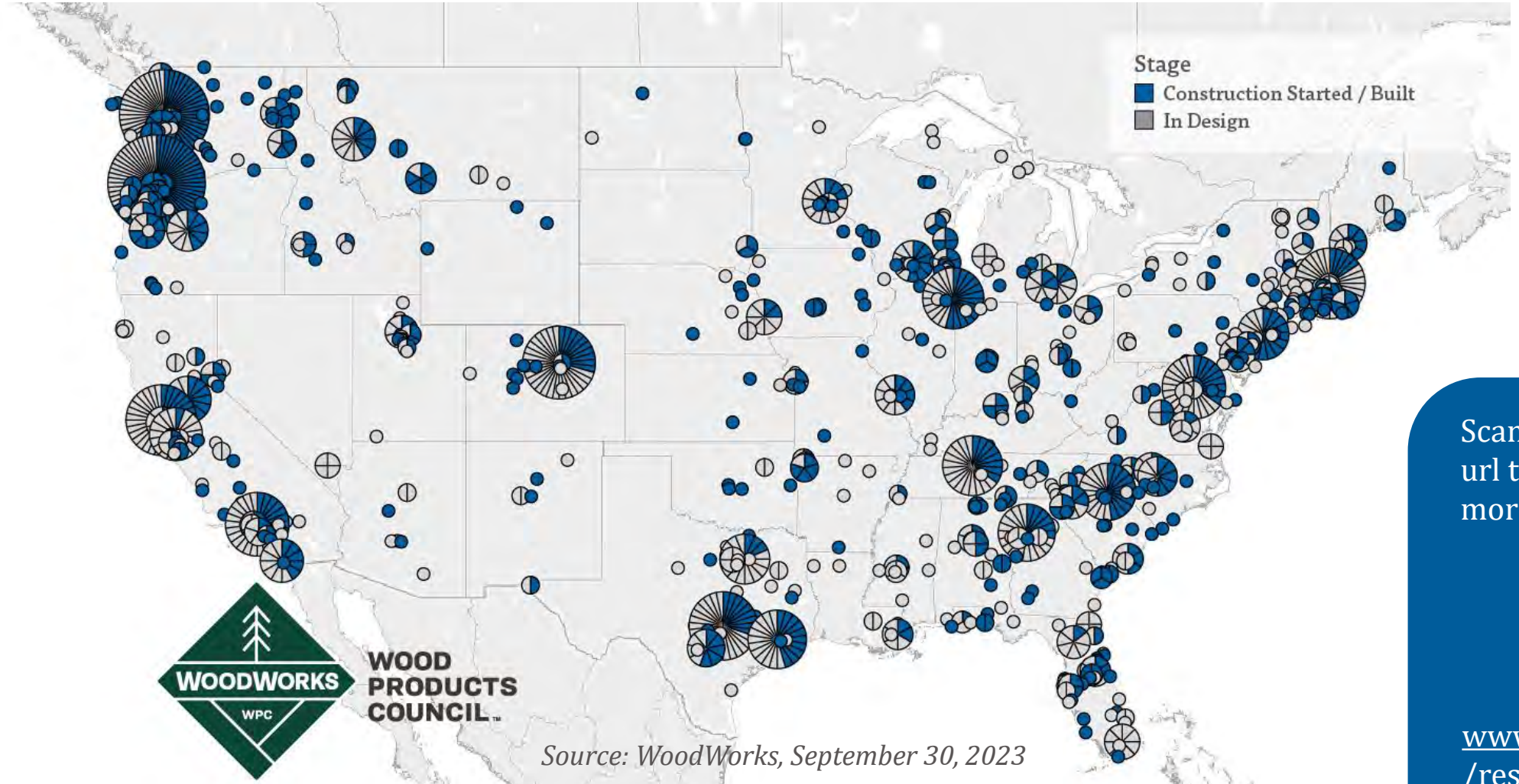
Beam to Column

Photo: StructureCraft

Photo: Structurlam

Current State of Mass Timber Projects

As of September 2023, in the US, **1,934** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.



WOODWORKS WPC
WOOD PRODUCTS COUNCIL

Source: WoodWorks, September 30, 2023

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

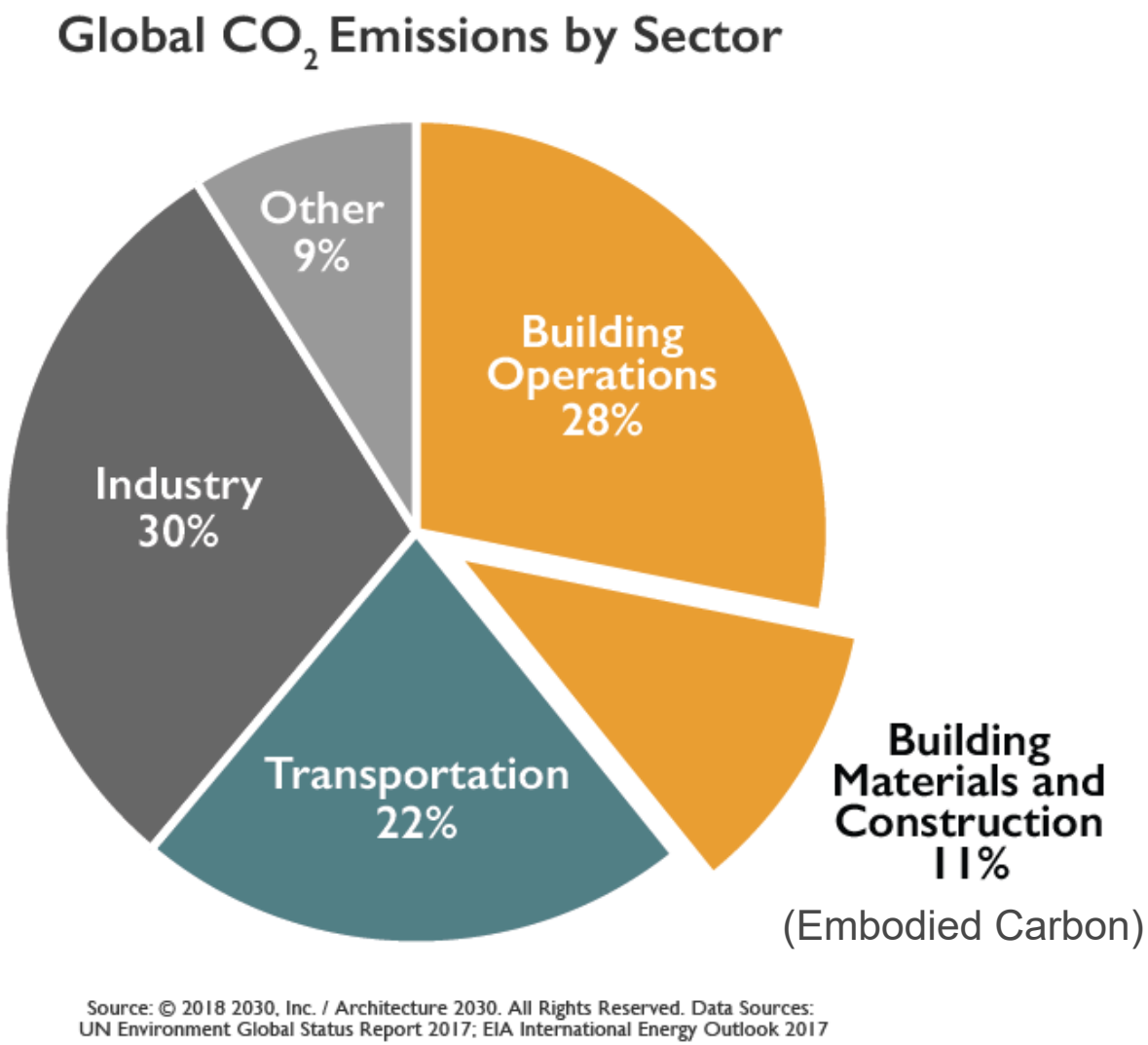
Scan this code or use the url to find the map and more details online.

www.woodworks.org/resources/mapping-mass-timber/

Why Mass Timber?

Brock Commons, Vancouver, BC | Architect: Acton Ostry| Photo Courtesy: naturally:wood

New Buildings & Greenhouse Gases



Buildings generate nearly **40%** of annual global greenhouse gas emissions (*building operations + embodied energy*)

Embodied carbon: **11%**

Concrete, iron, steel **~9%**

Image: Architecture 2030

Lower Embodied Carbon + Carbon Storage

Wood ≈ 50% Carbon (dry weight)

Image: Kaiser + Path

Image: Lever Architecture

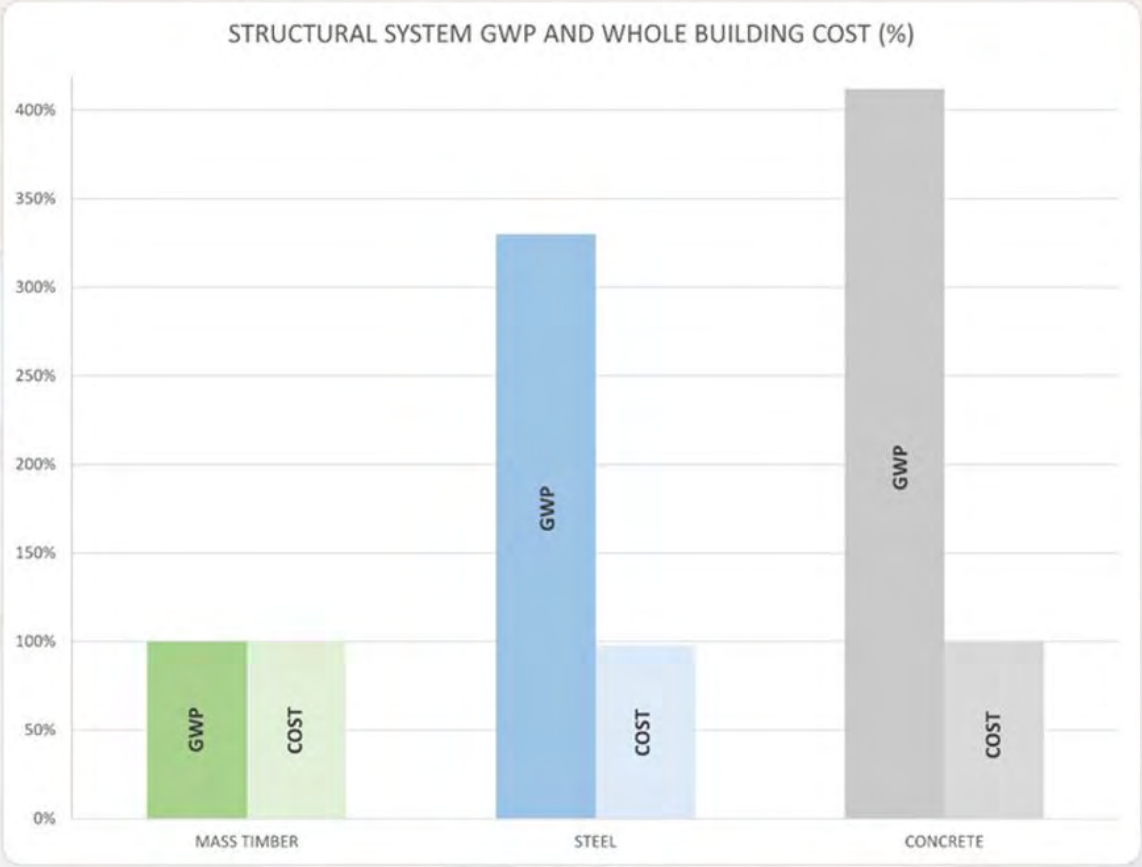
Platte Fifteen

Denver's First CLT Commercial Office Building Puts Sustainability to Work

PROJECT DETAILS

LOCATION:
Denver, Colorado

SIZE:
Five stories; 150,418 square feet



Source: Platte Fifteen Life Cycle Assessment https://www.woodworks.org/resources/platte-fifteen-life-cycle-assessment/

Rendering: Hickok Cole Architect

WoodWorks Resources

Whole Building Life Cycle Assessment (WBLCA)

- Introduction to Whole Building Life Cycle Assessment: The Basics
- Worksheet for Structural WBLCA of Mass Timber Buildings
- WBLCAs of Built Projects

Expert articles on topics such as:

- Biogenic Carbon in LCA Tools
- Long-Term Biogenic Carbon Storage
- What Net Zero Means in Building Construction
- Environmental Product Declarations (EPDs)

Scan for a complete list of sustainability resources at woodworks.org

Photo: DPR Office, SmithGroup, photo Chad Davies

WoodWorks Carbon Calculator

- Available at **woodworks.org**
- Estimates total wood mass in a building
- Provides **estimated** carbon impacts:
  - Amount of **carbon stored** in wood
  - Amount of **greenhouse gas emissions avoided** by choosing wood over a non-wood material

WOODWORKS WPC WOOD PRODUCTS COUNCIL™

http://www.woodworks.org/carbon-calculator-download-form/

Franklin Elementary School

Franklin, WV

Photo: MSES Architects

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:

Source: US EPA

605 cars off the road for a year

Energy to operate a home for 269 years

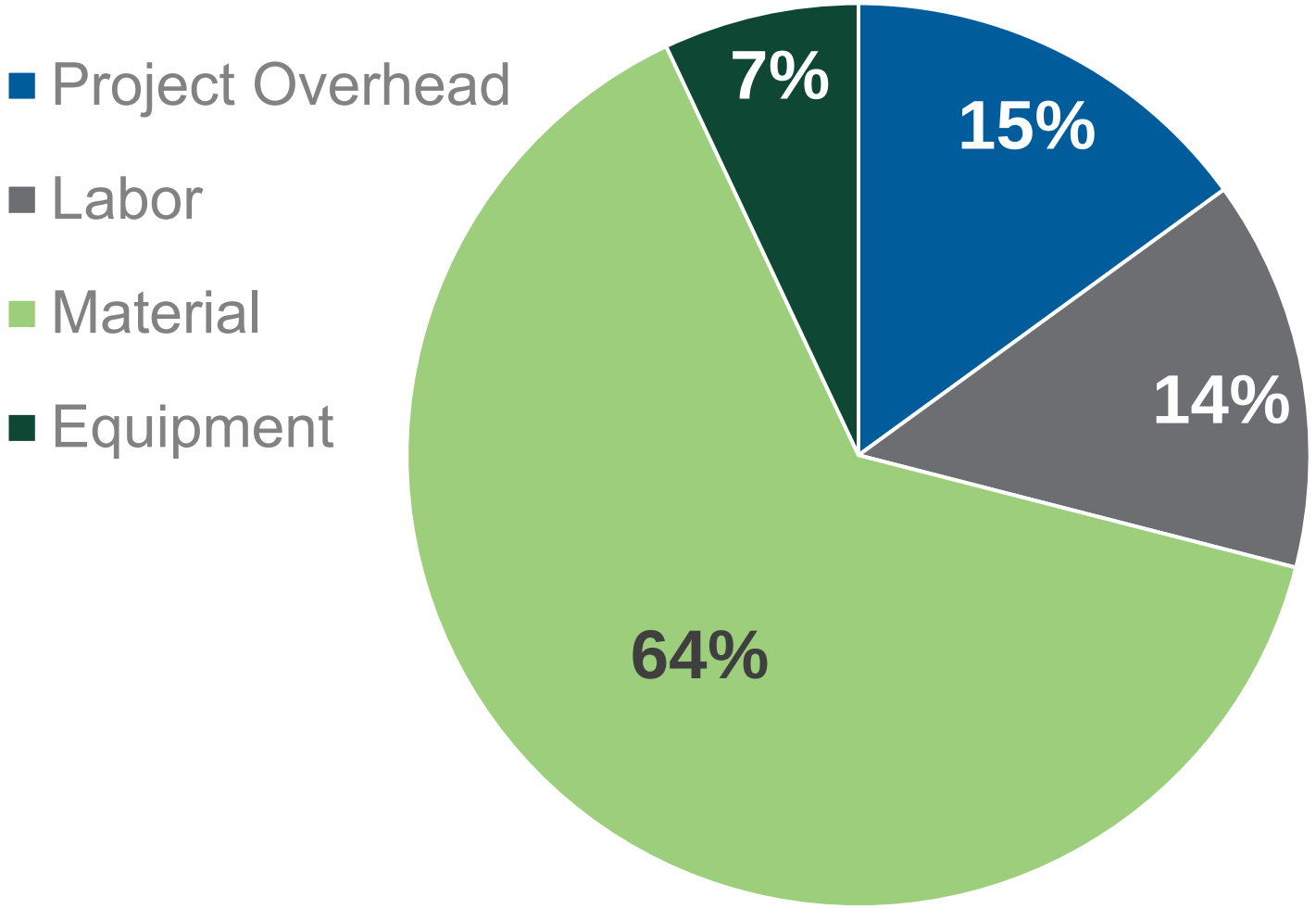
Estimated by the Wood Carbon Calculator for Buildings, based on research by Sarthre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations. Note: CO_2 on this chart refers to CO_2 equivalent.

Biophilic Design

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

Key Early Design Decisions

Typical MT Package Costs



Source: Swinerton

Material Mass

75% lighter weight than concrete

Source: Structurlam

Pre-Drilled and Precise

Mass timber elements fabricated to tight tolerances

Computer Numerically Controlled (CNC) connections

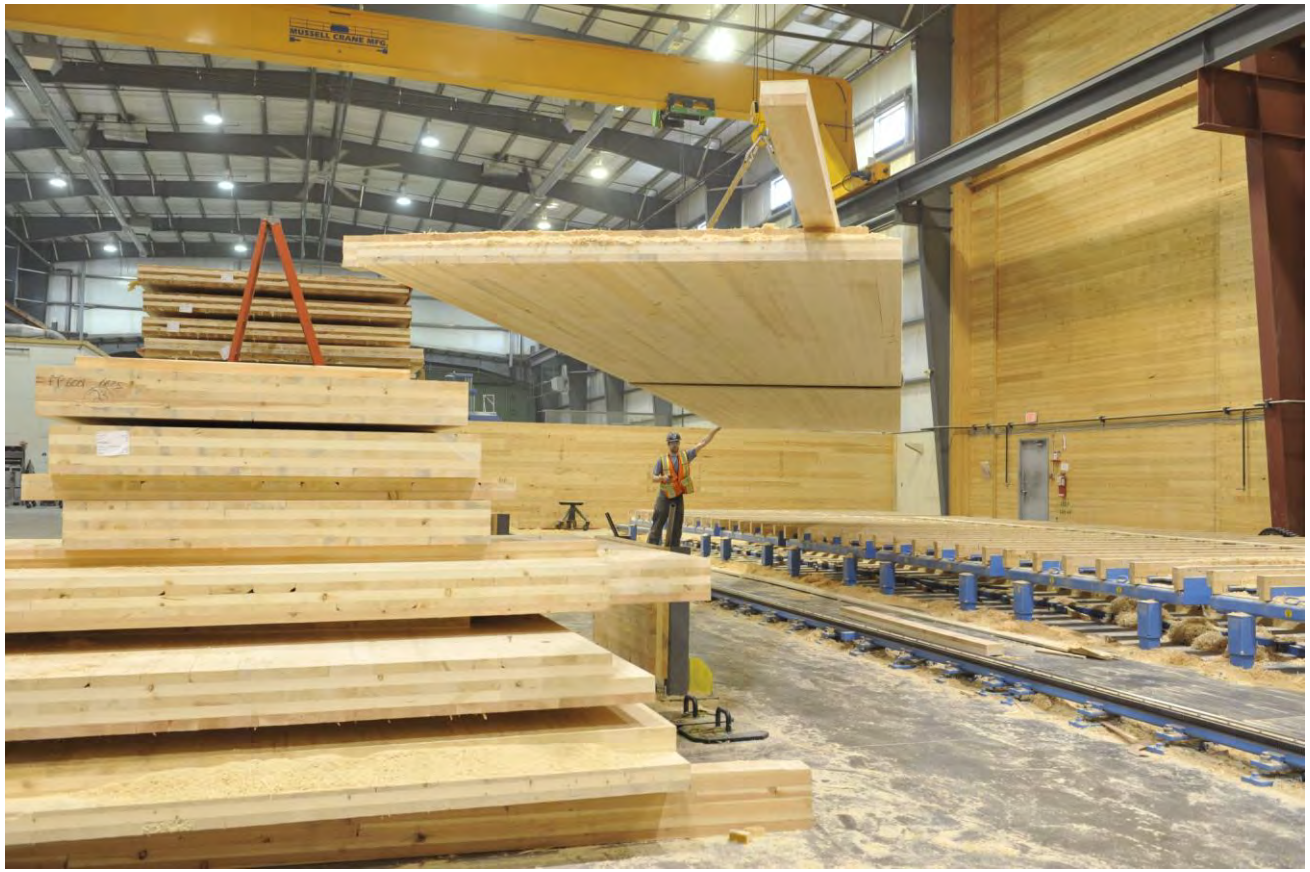
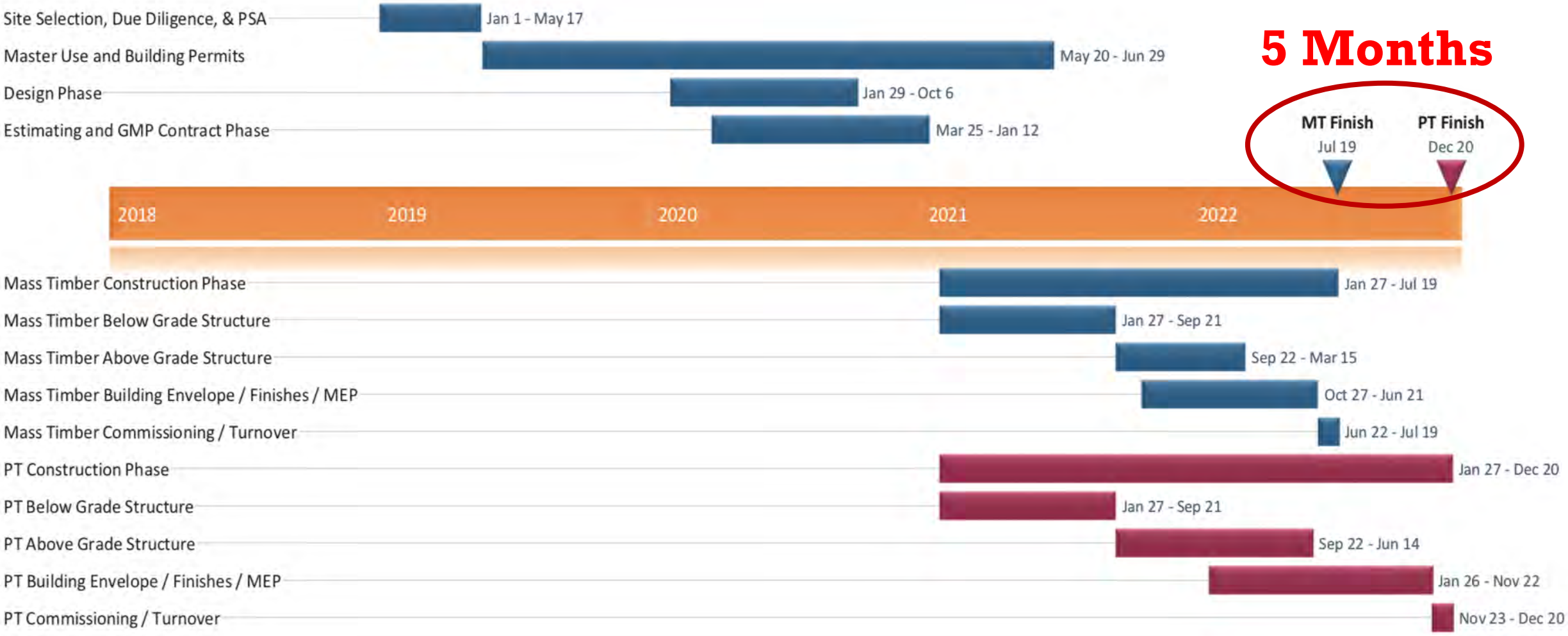


Photo credit: naturally:wood

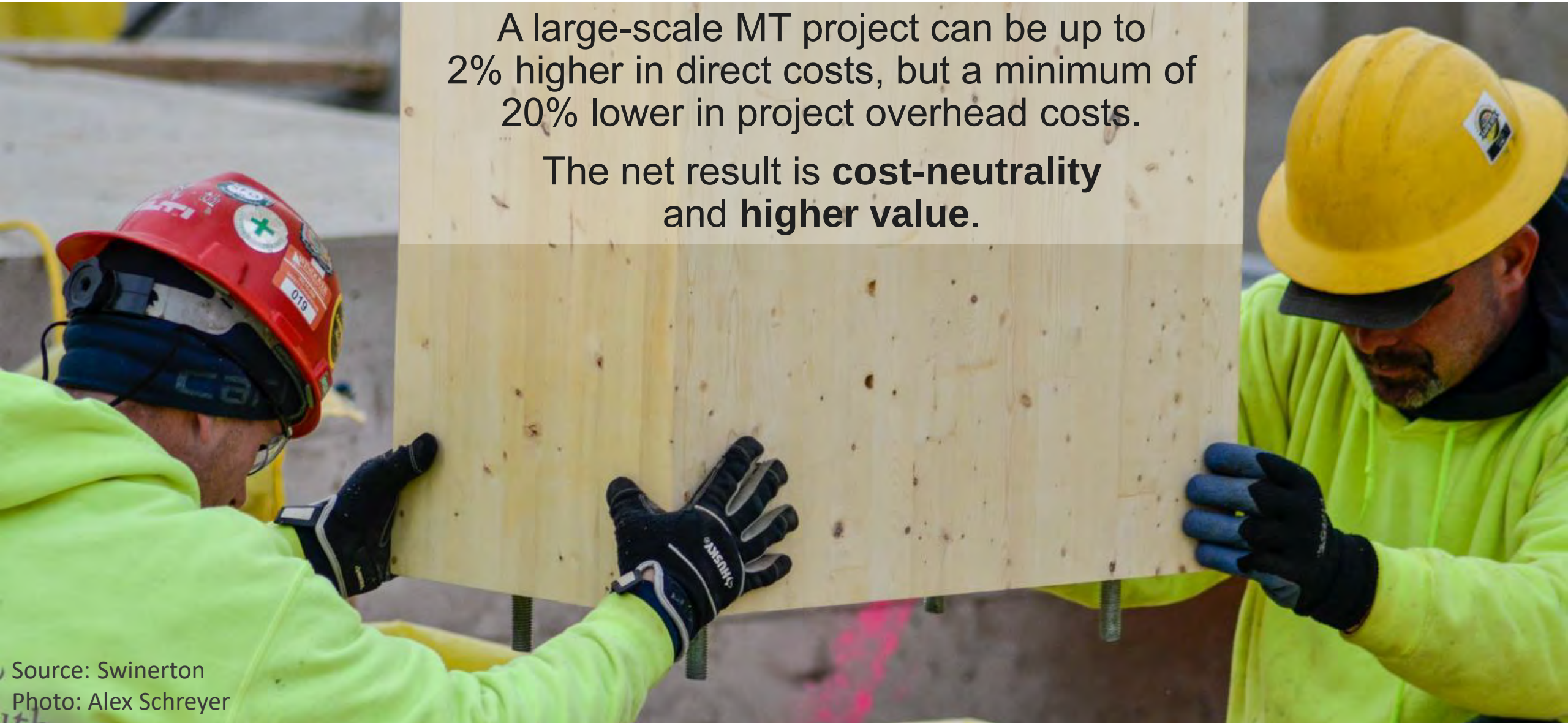
Mass Timber Installer Training

Construction Impacts: Schedule



Seattle Mass Timber Tower Study, Source: DLR Group | Fast + Epp | Swinerton Builders

Schedule Impact on Cost: Value of Time



Source: Swinerton
Photo: Alex Schreyer

Tall Mass Timber: Structural Warmth is a Value-Add

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

Optimization Checklists

- Design considerations
- Cost considerations
- Coordination between designers and builders

Free Resource: www.woodworks.org

WOODWORKS

Mass Timber Cost and Design Optimization Checklists

WoodWorks has developed the following checklists to assist in the design and cost optimization of mass timber projects.

The *design optimization* checklists are intended for building designers (architects and engineers), but many of the topics should also be discussed with the fabricators and builders. The *cost optimization* checklists will help guide coordination between designers and builders (general contractors, construction managers, estimators, fabricators, installers, etc.) as they are estimating and making cost-related decisions on a mass timber project. The *pre-design* checklist should be reviewed by the developer/owner, designers and builders.

1 De Haro
San Francisco, CA
ARCHITECT:
Perkins&Will
ENGINEERS:
DCI Engineers
CONTRACTOR:
Hathaway Dinwiddie

WoodWorks offers a wide range of resources at woodworks.org, many of which are referenced in this document. We also recommend that designers and builders download the following:

Mass Timber Design Manual[1] – Includes technical papers, continuing education articles, expert Q&As and more. Published in partnership with Think Wood.

U.S. Mass Timber Construction Manual[2] – Provides a framework for the planning, procurement and management of mass timber projects.

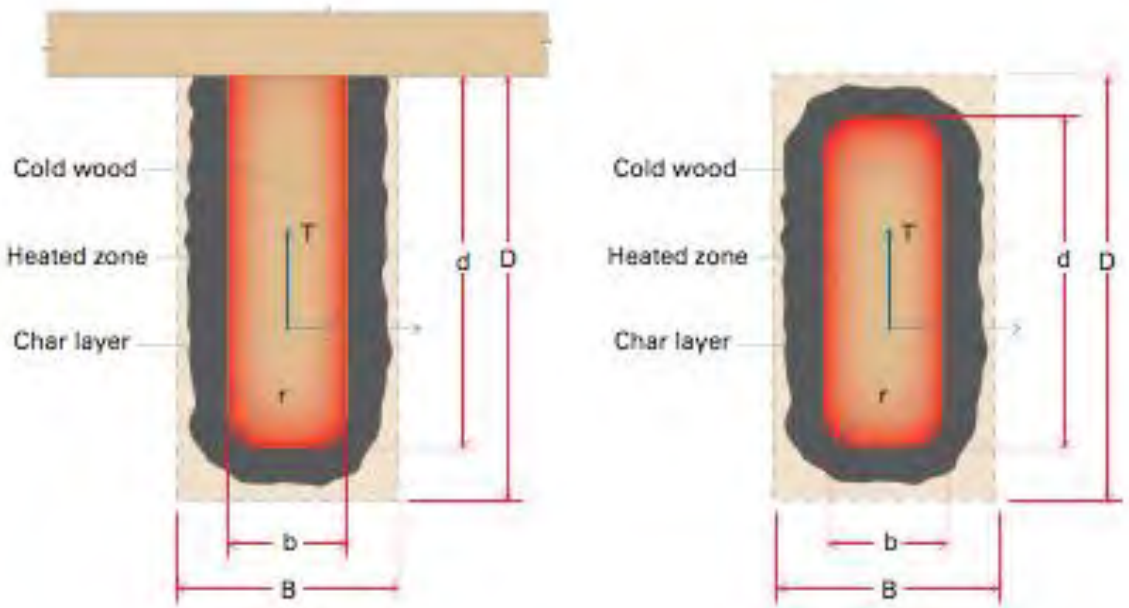
https://www.woodworks.org/resources/mass-timber-cost-and-design-optimization-checklists/

How? Design Considerations and Applications

Brock Commons, Vancouver, BC | Architect: Acton Ostry| Photo Courtesy: naturally:wood

Fire Resistance

Mass Timber's fire-resistive performance is well-tested, documented and recognized via code acceptance



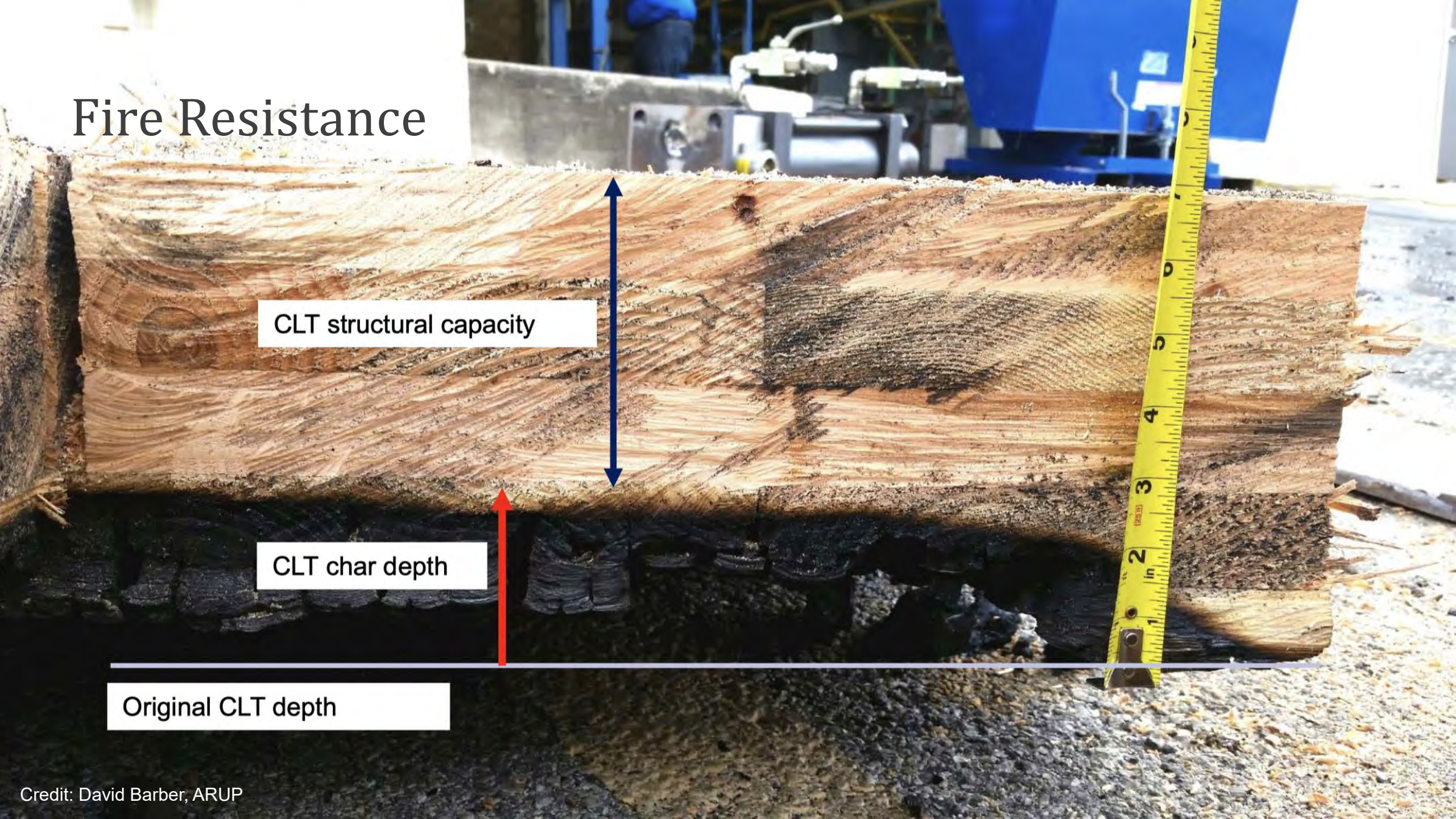
Source: AWC's TR 10

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

Source: AWC's NDS

Fire Resistance



Credit: David Barber, ARUP

Fire Design

Discusses:

- Code compliance options
- Structural fire calculations
- Inventory of fire-tested assemblies

Free Resource: www.woodworks.org

Richard McLain, PE, SE
Senior Technical Director
Scott Breneman, PhD, PE, SE
Senior Technical Director
WoodWorks – Wood Products Council

Fire Design of Mass Timber Members

Code Applications, Construction Types and Fire Ratings

For many years, exposed heavy timber framing elements have been permitted in U.S. buildings due to their inherent fire-resistance properties. The predictability of wood's char rate has been well-established for decades and has long been recognized in building codes and standards.

Today, one of the exciting trends in building design is the growing use 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. Like heavy timber, mass timber products have inherent fire resistance that allows them to be left exposed and still achieve a fire-resistance rating (FRR). Because of their strength and dimensional stability, these products also offer an alternative to steel, concrete, and masonry for many applications, but have a much lighter carbon footprint. It is this combination of exposed structure and strength that developers and designers across the country are leveraging to create innovative designs with a warm yet modern aesthetic, often for projects that go beyond traditional norms.

This paper has been written to support architects and engineers exploring the use of mass timber for commercial and multi-family construction. It focuses on how to meet fire-resistance requirements in the International Building Code (IBC), including calculation and testing-based methods. Unless otherwise noted, references refer to the 2021 IBC.

Mass Timber & Construction Type

Before demonstrating FRRs of exposed mass timber

framing throughout much of the structure and are used extensively for modern mass timber buildings.

Type III (IBC 602.3) – Timber elements can be used in floors, roofs and interior walls. Fire-retardant-treated wood (FRTW) framing is permitted in exterior walls required to have an FRR of 2 hours or less.

Type V (IBC 602.5) – Timber elements can be used throughout the structure, including floors, roofs and both interior and exterior walls.


University of Washington Founders Hall
LMN Architects / Magnusson Klemencic Associates

https://www.woodworks.org/resources/wood-frame-schools-durability-techniques-for-interior-high-traffic-and-moisture-areas/

Photo: LendLease

Tall Wood Fire Tests

Commissioned series of 5 full-scale tests on 2-story mass timber structure at ATF lab in MD, May-June 2017

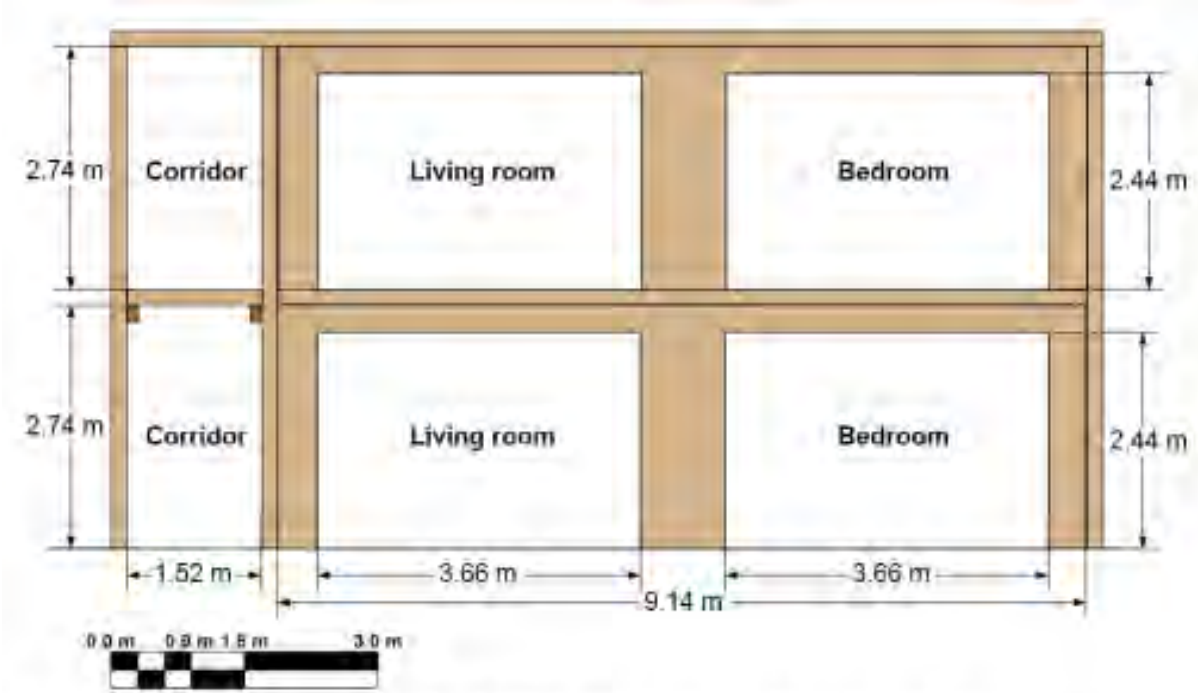


Figure 2. Elevation view of the front of the cross-laminated timber test structure.

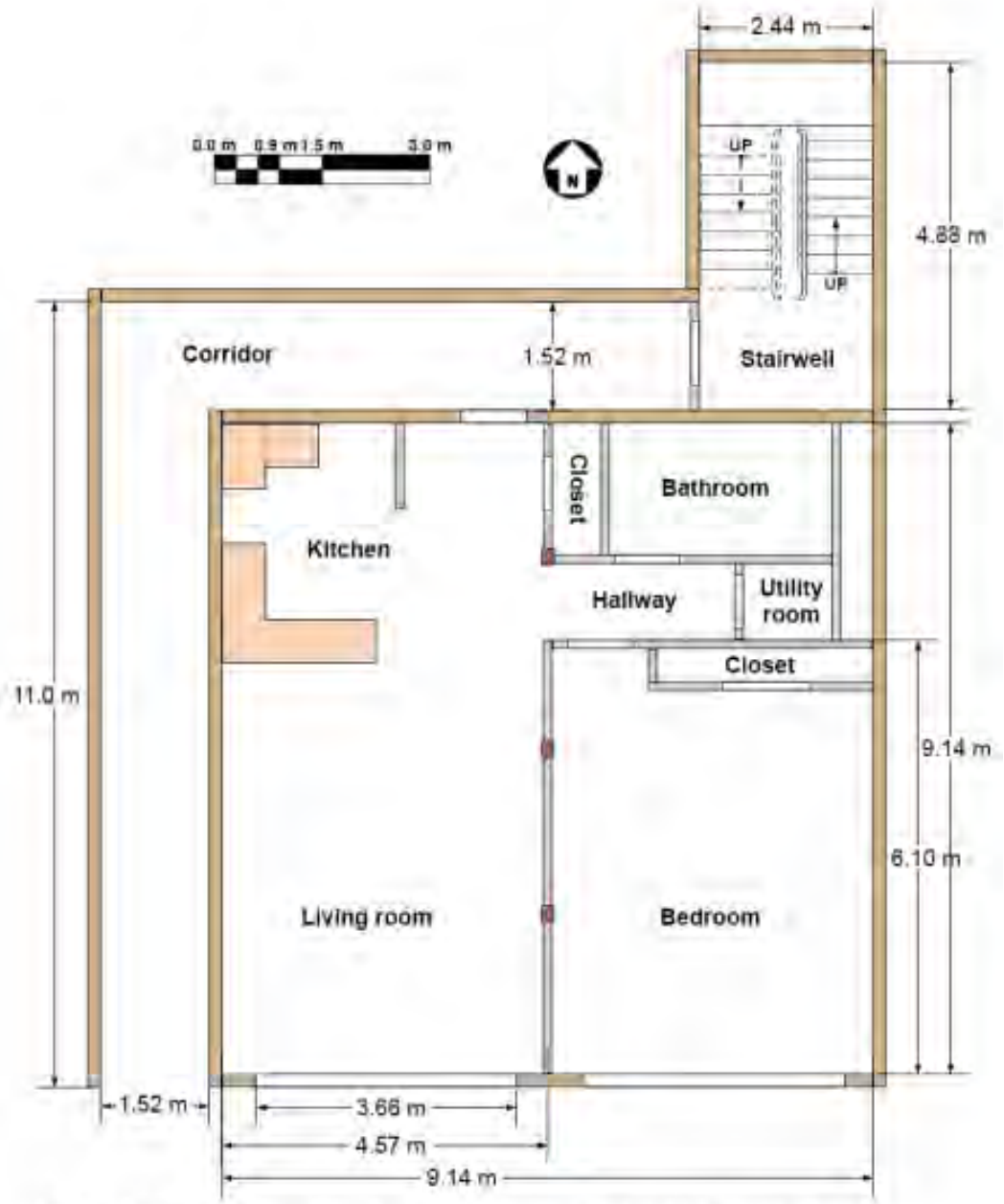


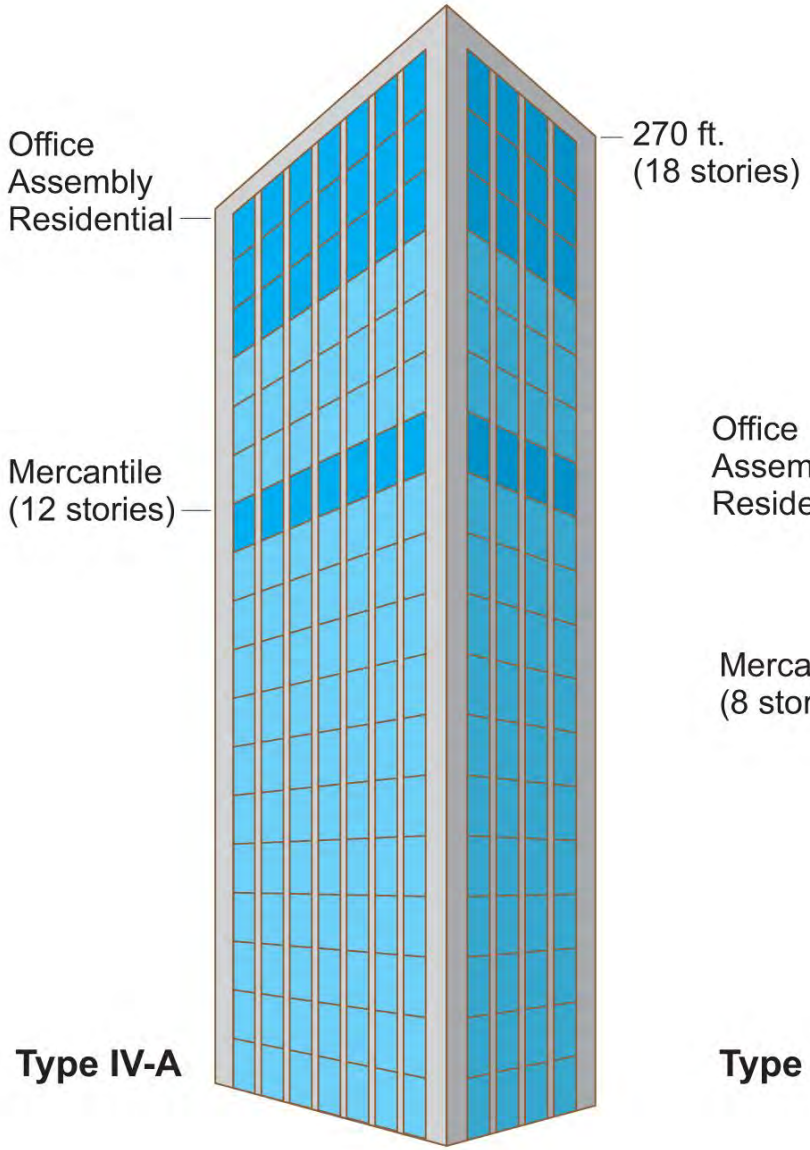
Figure 1. General plan view of cross-laminated timber test structure.

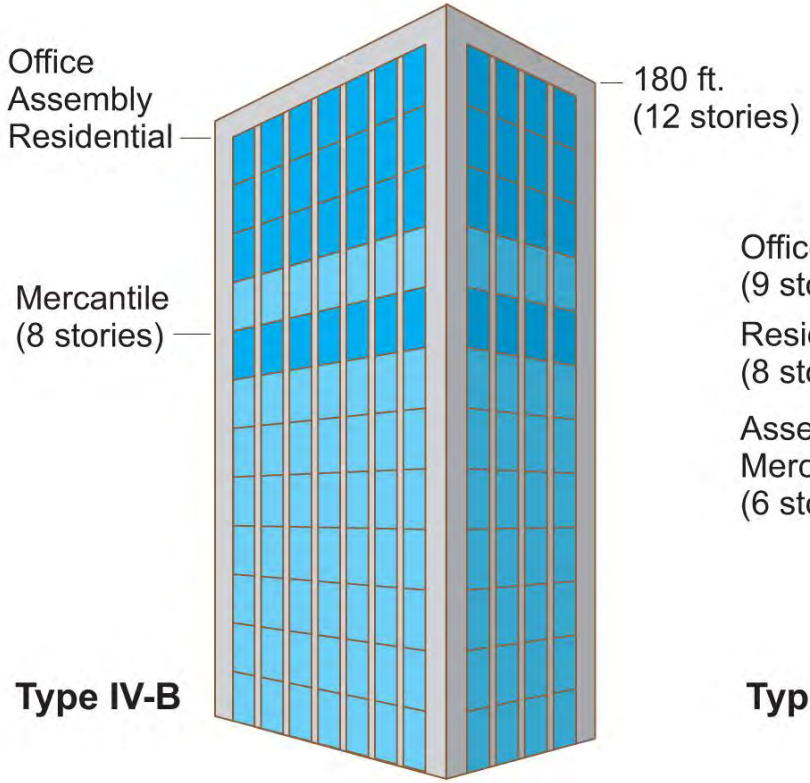
Images: AWC

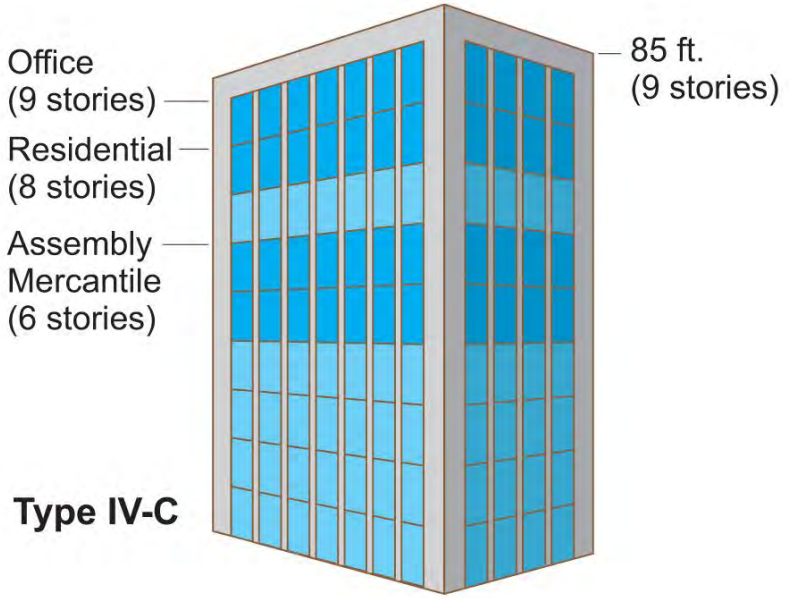
Photo: LendLease

Construction Types

New Tall Wood Construction Types in 2021 IBC

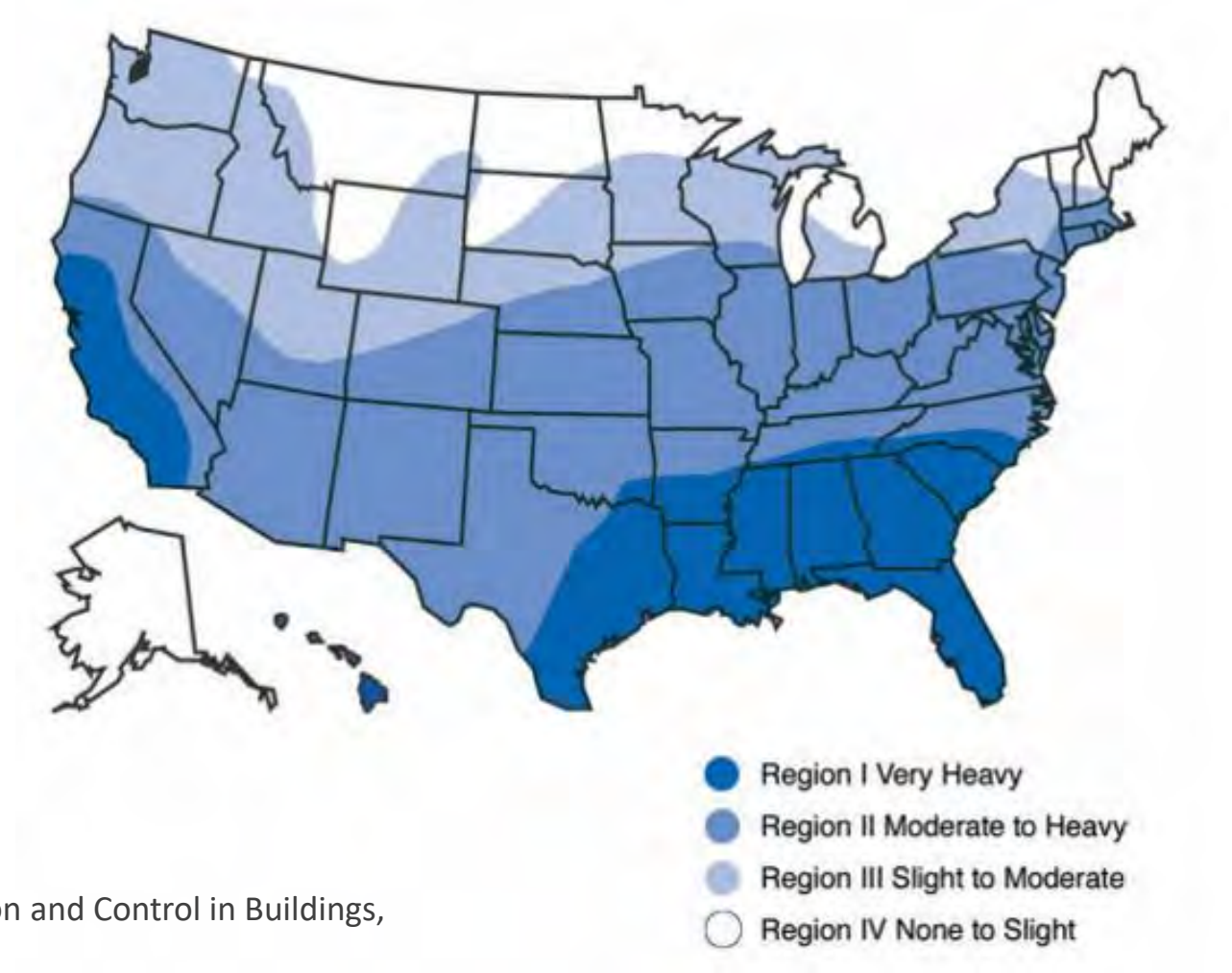






Controlling Termites

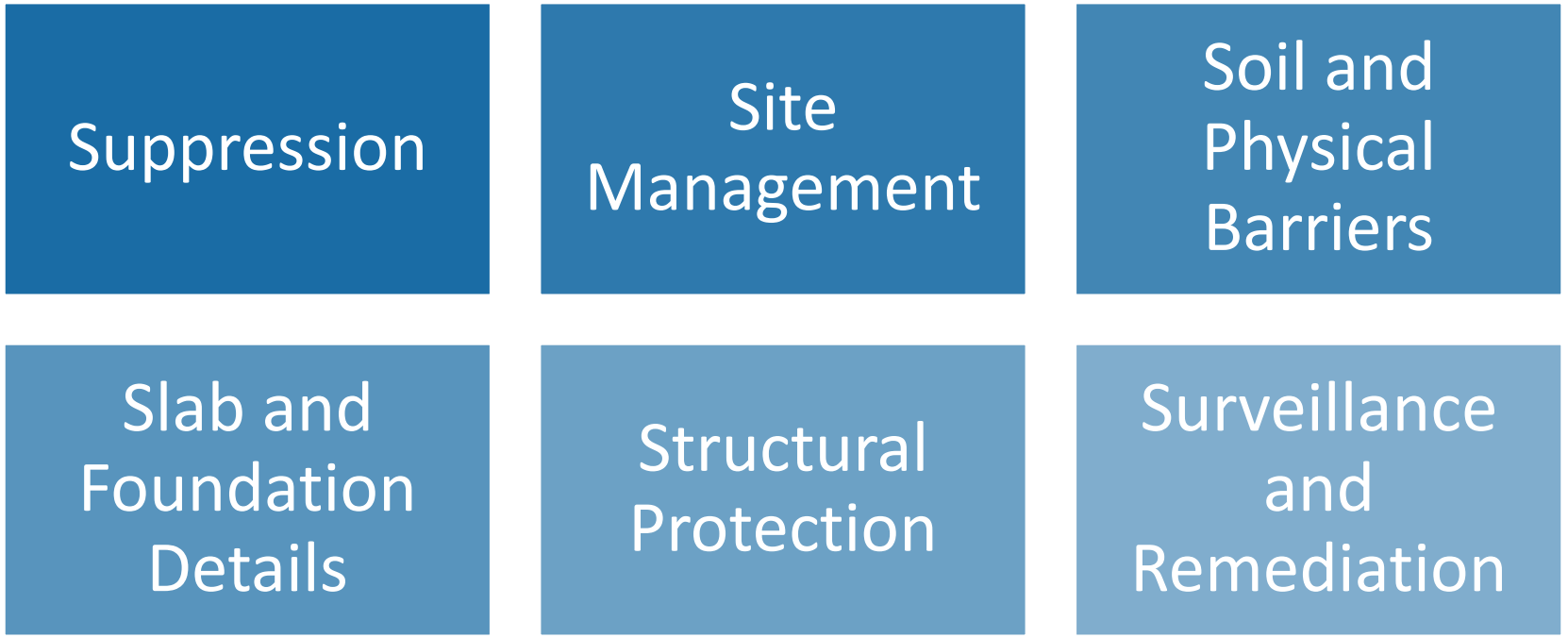
2006 Map Subterranean Termite Hazard Severity



Subterranean Termites—Their Prevention and Control in Buildings, US Forest Service 2006

Durability Detailing

The 6S Approach to Subterranean Termite Control



Durability Detailing

- Approaches to designing for termite protection

Free Resource: www.woodworks.org

WoodWorks™
WOOD PRODUCTS COUNCIL

Effective Termite Protection for Multi-Family & Commercial Wood Buildings

Techniques for Keeping Wood-Frame Buildings Pest-Free

Wood-frame construction is a good choice for commercial and multi-family buildings, even in states where termites pose a higher risk. Wood buildings are safe, economical and sustainable. With the right precautions, they're also durable and insect resistant. That includes proper design and detailing, good construction practices, and a pest management strategy that involves pesticides and/or physical barriers. Where termites pose a risk, it is good practice for the general contractor to engage a pest control specialist during pre-construction to map out an appropriate plan.

According to Faith Oi, PhD, Director of the University of Florida's Pest Management University, the key to effective termite prevention is making the building inhospitable to termites. "Subterranean termites, which are the most damaging and economically important species in the U.S., follow pheromones and physical guidelines such as the outside of foundation walls. They can use any gap as a pathway—so it's important to minimize hidden access and treat critical areas."

This paper focuses on how to design and construct wood-frame buildings for termite prevention, and how to keep buildings insect-free over the long term. Intended for developers and design/construction teams, it covers building code requirements, best practices, control methods, costs, and ongoing maintenance. It emphasizes subterranean termites (including Formosans), and briefly covers drywood termites and other insects with the potential to cause damage.

Photo: Charlan Brock Architects

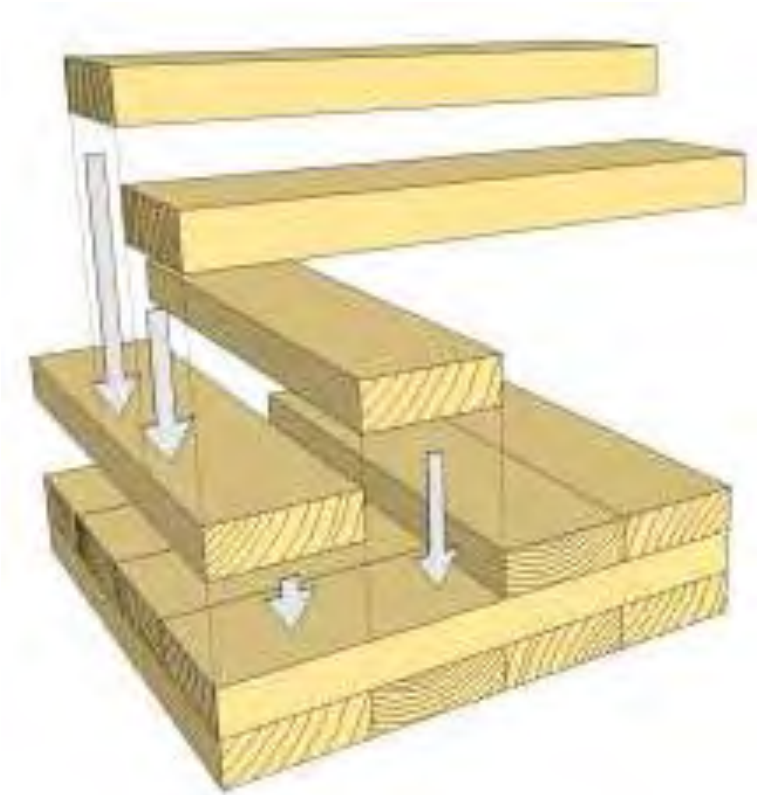
https://www.woodworks.org/resources/effective-termite-protection-for-multi-family-commercial-wood-buildings/

Mass Timber Products: Glulam

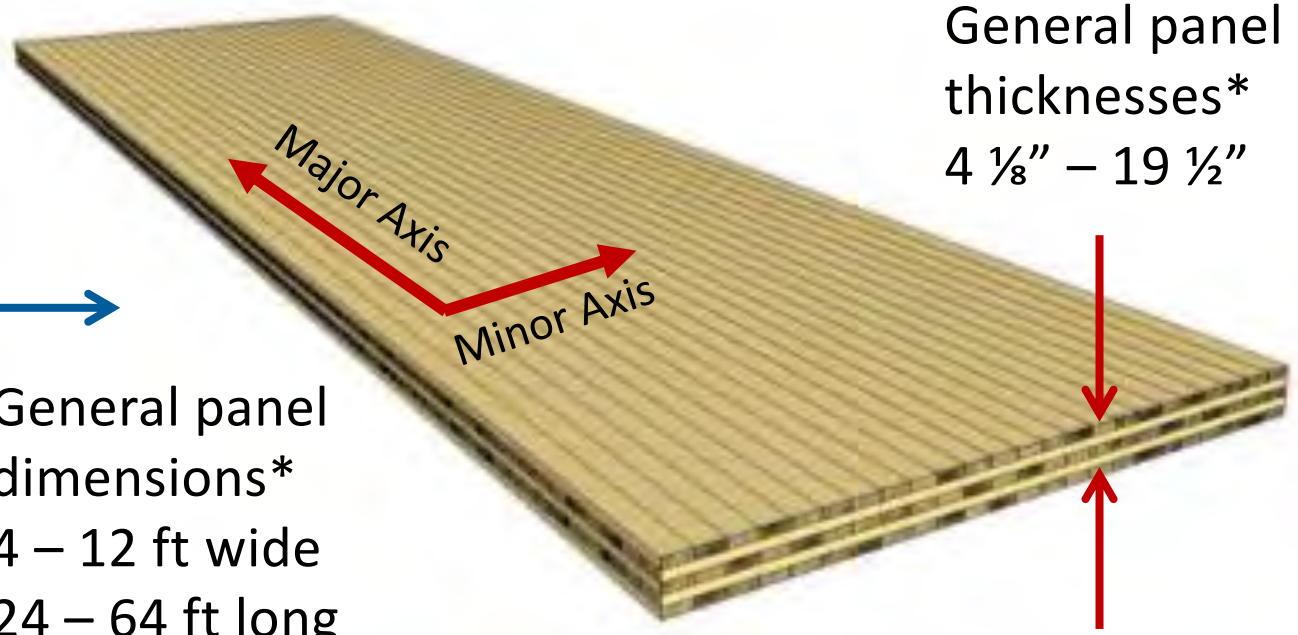
- PT readily available
- FRT may be available, varies by manufacturer & treater
- Can be cambered, curved & tapered
- Different Appearance Grades available

Cross-Laminated Timber (CLT)

With solid sawn laminations



General panel dimensions*
4 – 12 ft wide
24 – 64 ft long



General panel thicknesses*
4 ⅛” – 19 ½”

*Consult with manufacturers for available panel sizes

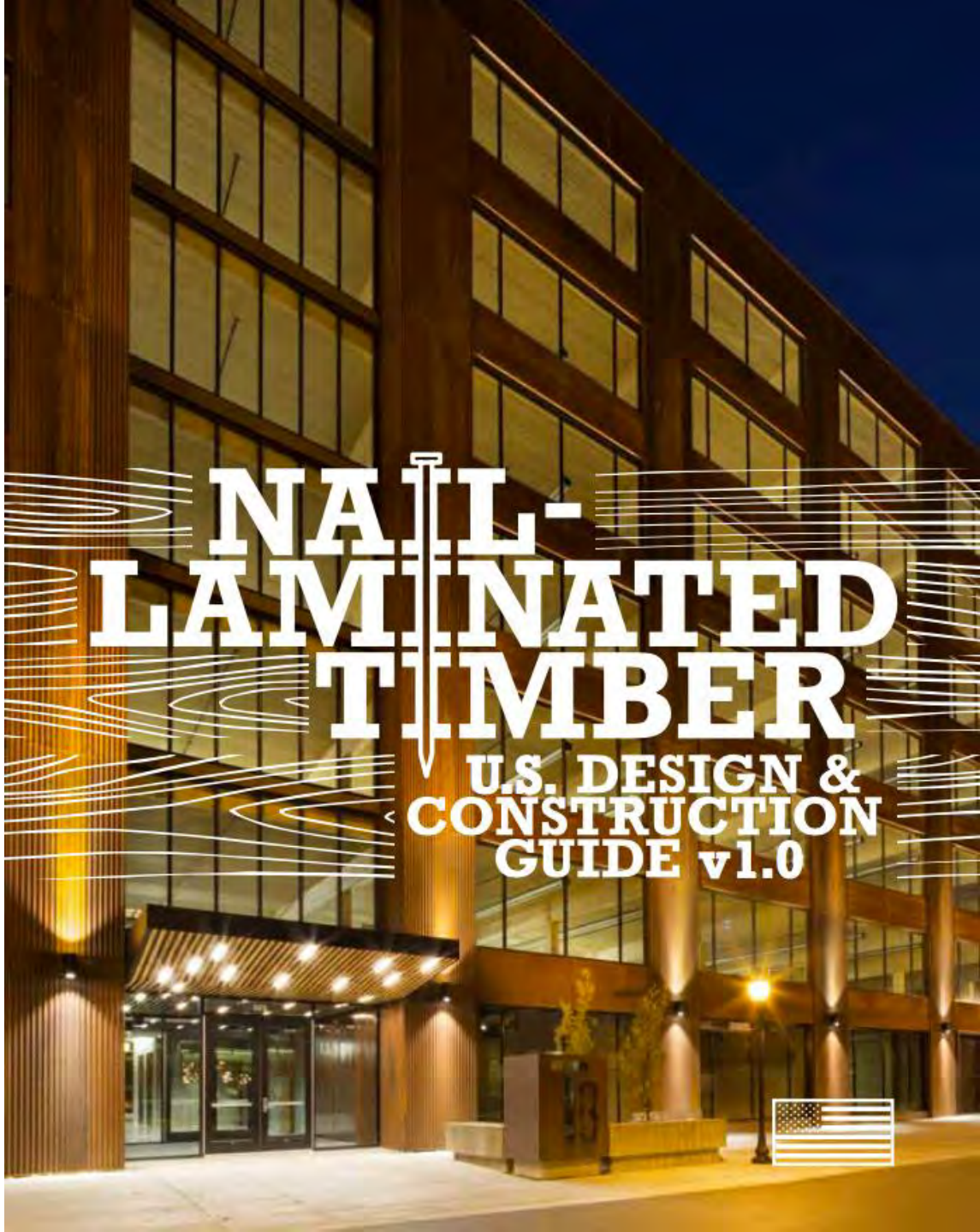
Nail-Laminated Timber

- Can use preservative treated or naturally decay resistant wood for exterior applications
- NLT does not have an accepted standard for production
- Some requirements for assembly (lam to lam nailing) are in IBC
- Quality control a key factor in overall project success

NLT Design Guide

Content includes:

- Architecture
- Fire
- Structure
- Enclosure
- Supply and Fabrication
- Construction and Installation
- Erection engineering
- Free download at www.thinkwood.com/nltguide



Application - Mass Timber in Schools

Allowable Building Size

2018 IBC Chapter 5

Educational (E) Occupancy with NFPA 13 Sprinkler System

Construction Type / Allowable Limit	IIIA	IIIB	IV (HT)	VA	VB
Stories	4	3	4	2	2
Height (ft)	85	75	85	70	60
1 story: Total Bldg Area (ft^2)	111.6k	68.9k	121.1k	87.9k	45.1k
2 story: Total Bldg Area (ft^2)	176.3k	108.8k	191.3k	138.8k	71.3k
3+ story: Total Bldg Area (ft^2)	264.4k	163.1k	286.9k	NP	NP

Assumes full frontage increase

ICC Building Valuation Data, **E occupancy**, February 2023

Cost per SF

Construction Type

Allowable Building Size

2018 IBC Chapter 5

Assembly (A-2, 3, 4) Occupancies with NFPA 13 Sprinkler System

Construction Type / Allowable Limit	IIIA	IIIB	IV (HT)	VA	VB
Stories	4	3	4	3	2
Height (ft)	85	75	85	70	60
1 story: Total Bldg Area (ft^2)	66.5k	45.1k	71.3k	54.6k	28.5k
2 story: Total Bldg Area (ft^2)	105k	71.3k	112.5k	86.3k	45k
3+ story: Total Bldg Area (ft^2)	157.5k	106.9k	168.8k	129.4k	NP

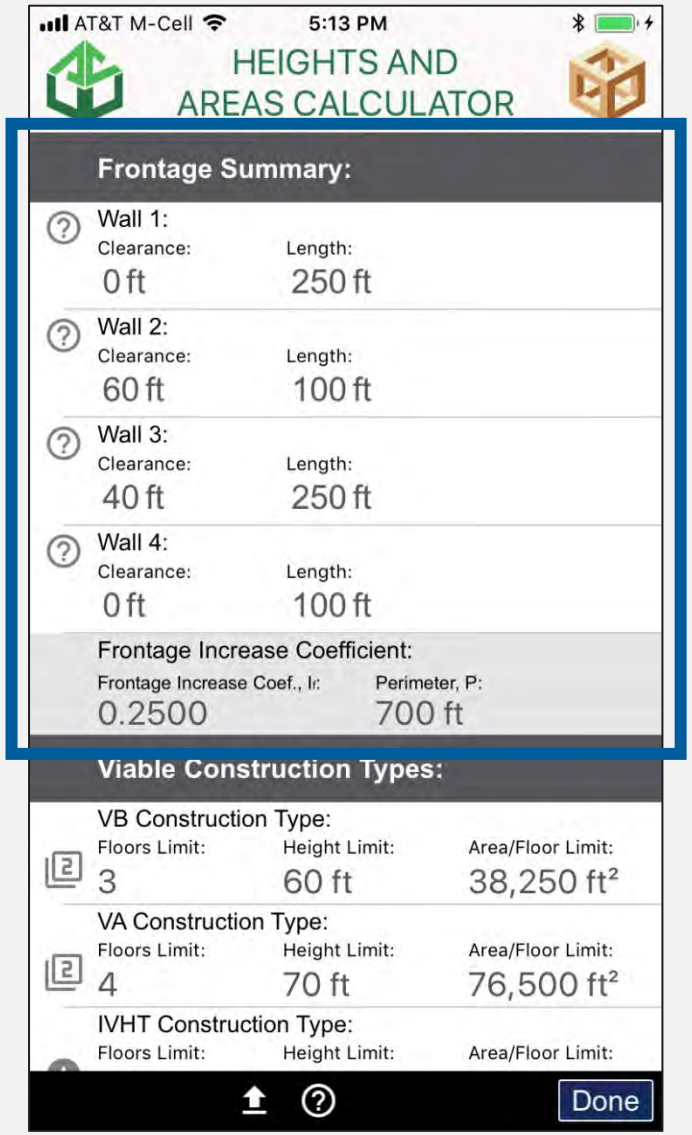
Assumes full frontage increase

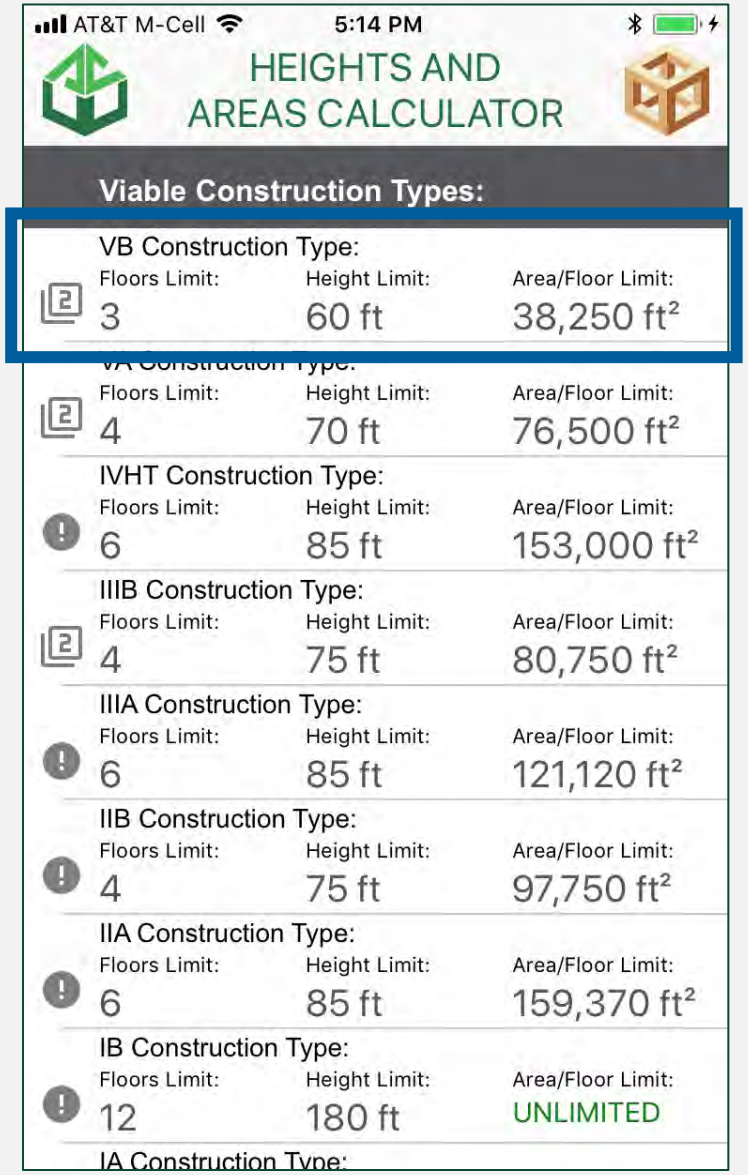
Allowable Building Size

Heights and areas calculator – free tool

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

Handles Separated & Nonseparated Occupancies (Check “both”)





Franklin Elementary School Gym

Franklin, WV

Photo: Pam Wean, MSES Architects

Duke Lower & Middle School Library

Durham, NC

Photo: DTW Architects & Planners

Return to map

Save

CLT Classrooms

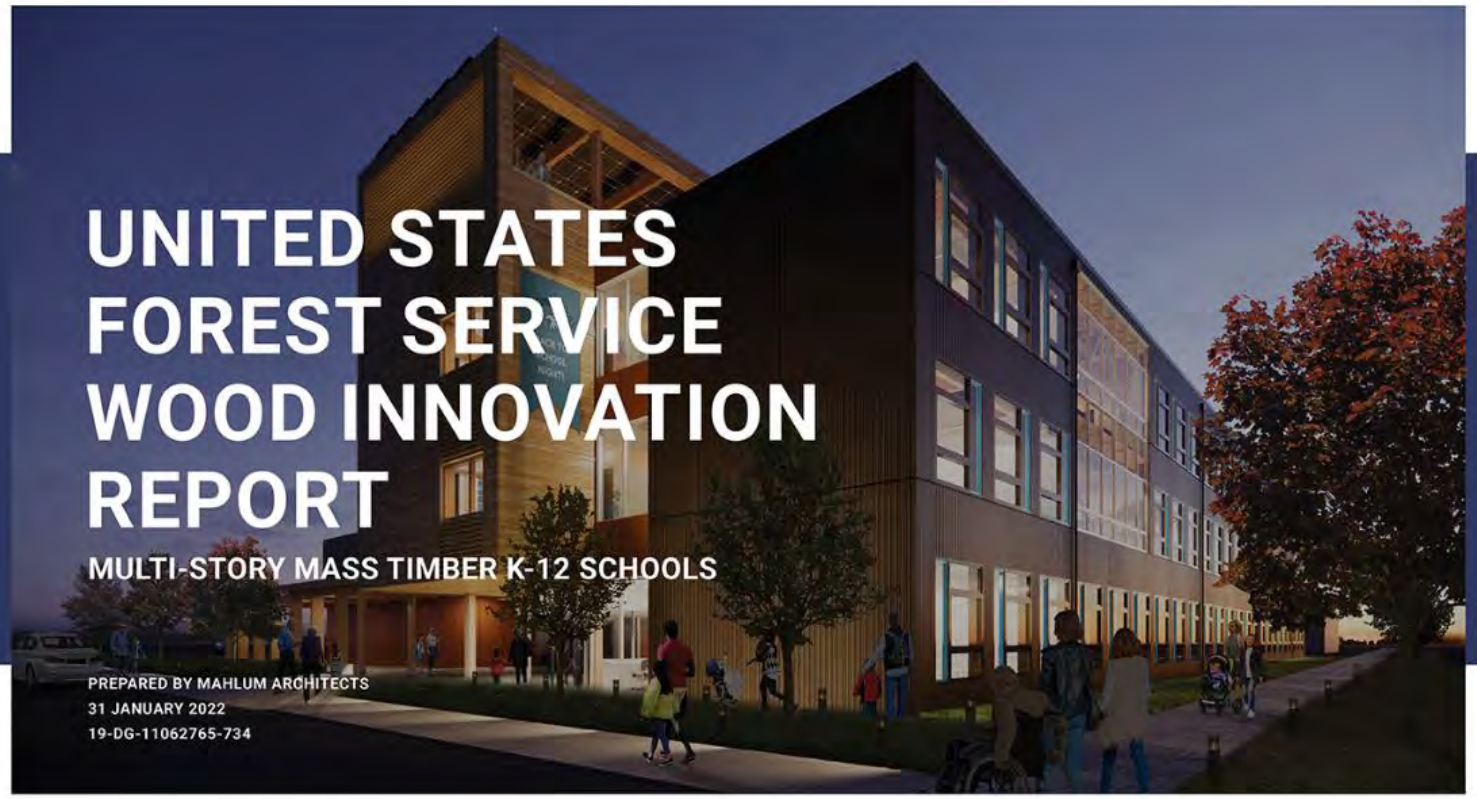
Mount Vernon, WA

BLDG SYSTEM	NO. OF STORIES	SQ. FOOTAGE
Mass Timber	1	4,000

Photo Courtesy of Mahlum

Feasibility of Mass Timber K-12 Schools

Washington | Mahlum Architects



This report explores the use of mass timber to deliver exceptional K-12 educational spaces in Washington State that are cost-effective, resource efficient, and low carbon.

mahlum

https://www.mahlum.com/growing-schools-the-feasibility-of-mass-timber-k-12-schools-in-washington-state/

Return to map

Save

Sacred Heart Schools

Atherton, CA

BLDG SYSTEM	NO. OF STORIES	SQ. FOOTAGE
Mass Timber	1	4,000









Prefabricated Mass Timber Classroom Buildings

Northern California | TimberQuest

TIMBERQUEST

PREFABRICATED MASS TIMBER CLASSROOM BUILDINGS DESIGNED TO LAST

TimberQuest™ offers sustainable solutions for high-quality, cost-competitive education facilities that are California Division of State Architect pre-approved for rapid installation at K-12 public and private schools and community colleges.

We offer solutions for one- and two-story classroom buildings and multi-purpose / gym facilities, each customizable to suit your needs.

SINGLE-STORY SOLUTIONS

Single-story building with 3-9 classrooms

LEARN MORE

TWO-STORY SOLUTIONS

Two-story building with 6-20+ classrooms

LEARN MORE

MULTI-PURPOSE / GYM SOLUTIONS

Customizable multi-purpose space or gym facility

LEARN MORE

https://timber-quest.com/

Application - Mass Timber in Multifamily

Ascent, Milwaukee, WI
Source: Korb & Associates Architects

Allowable Building Size

2018 IBC Chapter 5

Residential (R-1, 2, 4) Occupancies with NFPA 13 Sprinkler System

Construction Type / Allowable Limit	IIIA	IIIB	IV (HT)	VA	VB
Stories	5	5	5	4	3
Height (ft)	85	75	85	70	60
1 story: Total Bldg Area (ft^2)	114k	76k	97.4k	57k	33.3k
2 story: Total Bldg Area (ft^2)	180k	120k	153.8k	90k	52.5k
3+ story: Total Bldg Area (ft^2)	270k	180k	230.6k	135k	78.8k

Assumes full frontage increase

Multi-Housing Typologies

MT Floors & Roofs on LF Bearing Walls

Credit: KL&A Engineers & Builders

MT Floors & Roofs on Post & Beam Framing

Credit: ADX Creative and Engberg Anderson

MT Floors & Roofs on MT Bearing Walls

Credit: Grey Organschi Architecture and Spiritos Properties

Project One

Oakland, CA

Credit: Gurnet Point

Save

Sonrisa Studio Apartments

Sacramento, CA

BLDG SYSTEM	NO. OF STORIES	SQ. FOOTAGE
Mass Timber	5	23,600






Heartwood

Seattle, WA

Photo: Atelier Jones |
Architect: Atelier Jones

Candlewood Suites at Redstone Arsenal

Huntsville, AL

Photo: Lend Lease

Fire-Hardened Mass Timber Homes

Sierra Institute & atelierjones

Sierra Institute for Community and Environment

atelierjones llc

https://sierrainstitute.us/mass-timber-housing/

Prefabricated Mass Timber Homes

Green Canopy NODE

Workforce Housing

The Mass Timber Model Home is a complete test of our **Integrated Kit** including prefabrication, installation, and logistics. Components were manufactured off-site and the two-story + rooftop deck home was assembled in Spokane, WA.

Learn more >

https://www.greencanopynode.com/mass-timber-model-home

Modular Mass Timber Homes

PathHouse

Our mission is to convert climate change challenges into housing solutions.

PathHouse

The PathHouse process* for mass timber volumetric modular housing units:

- Sequesters carbon
- Replaces energy-intensive materials
- Contributes to wildfire risk reduction
- Stimulates rural and urban workforce economy
- Utilizes the benefits of industrialized construction to address our housing challenges, at scale

*patents pending

https://www.pathhouse.com/

Application – Building Codes: Fire and Life Safety
IBC

The building code:

- Controls building size
- Regulates materials used
- Stipulates fire resistance

Construction Types

IBC defines 5 construction types: I, II, III, IV, V

A building must be classified as one of these

Construction Types I & II:

All elements required to be non-combustible materials

However, there are exceptions including several for mass timber

Construction Types

All wood framed building options:

- **Type III**
  Exterior walls non-combustible (may be FRTW)
  Interior elements any allowed by code

- **Type V**
  All building elements are any allowed by code

Types III and V are subdivided into **A** (protected) and **B** (unprotected)

- **Type IV (Heavy/Mass Timber)**
  Exterior walls non-combustible (may be FRTW)
  Interior elements qualify as Heavy Timber (min. sizes, no concealed spaces)

Image: Hacker Architects, Jeremy Bittermann

Occupancy Groups

2018 IBC Chapter 3

A: *Assembly*: restaurant, theater, arena, lecture hall
B: *Business*: office building, college, bank
E: *Educational*: K-12 school, children's daycare
M: *Mercantile*: retail store, sales room
R: *Residential*: apartment, dormitory, hotel
S: *Storage*: parking, bulk material storage

Construction Types

Allowable Building Height

IBC 2018 Tables 504.3 & 504.4

TABLE 504.3
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE[a]

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60

TABLE 504.4
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE[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	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	2	1
	S	UL	6	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
E	NS	UL	5	3	2	3	2	3	1	1
	S	UL	6	4	3	4	3	4	2	2

Construction Types

Allowable Building Area

IBC 2018 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	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	22,000
	SM	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500
B	NS	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	108,000	54,000	27,000
E	NS	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500
	S1	UL	UL	106,000	58,000	94,000	58,000	102,000	74,000	38,000
	SM	UL	UL	79,500	43,500	70,500	43,500	76,500	55,500	28,500

Questions?

Jennifer Cover

CEO | WoodWorks

jennifer@woodworks.org

Ashley Cagle

Technical Director

ashley.cagle@woodworks.org

This concludes The American Institute of Architects Continuing Education Systems Course

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

Copyright Materials

Funding provided in part by the Softwood Lumber Board