

# Mass Timber Construction: Making the Case

April 10, 2024

Presented by  
Tino Kalayil, PE, WoodWorks



Image: INTRO Cleveland / photo Nick Johnson, Tour D Space

T E K R A M E S I D E S

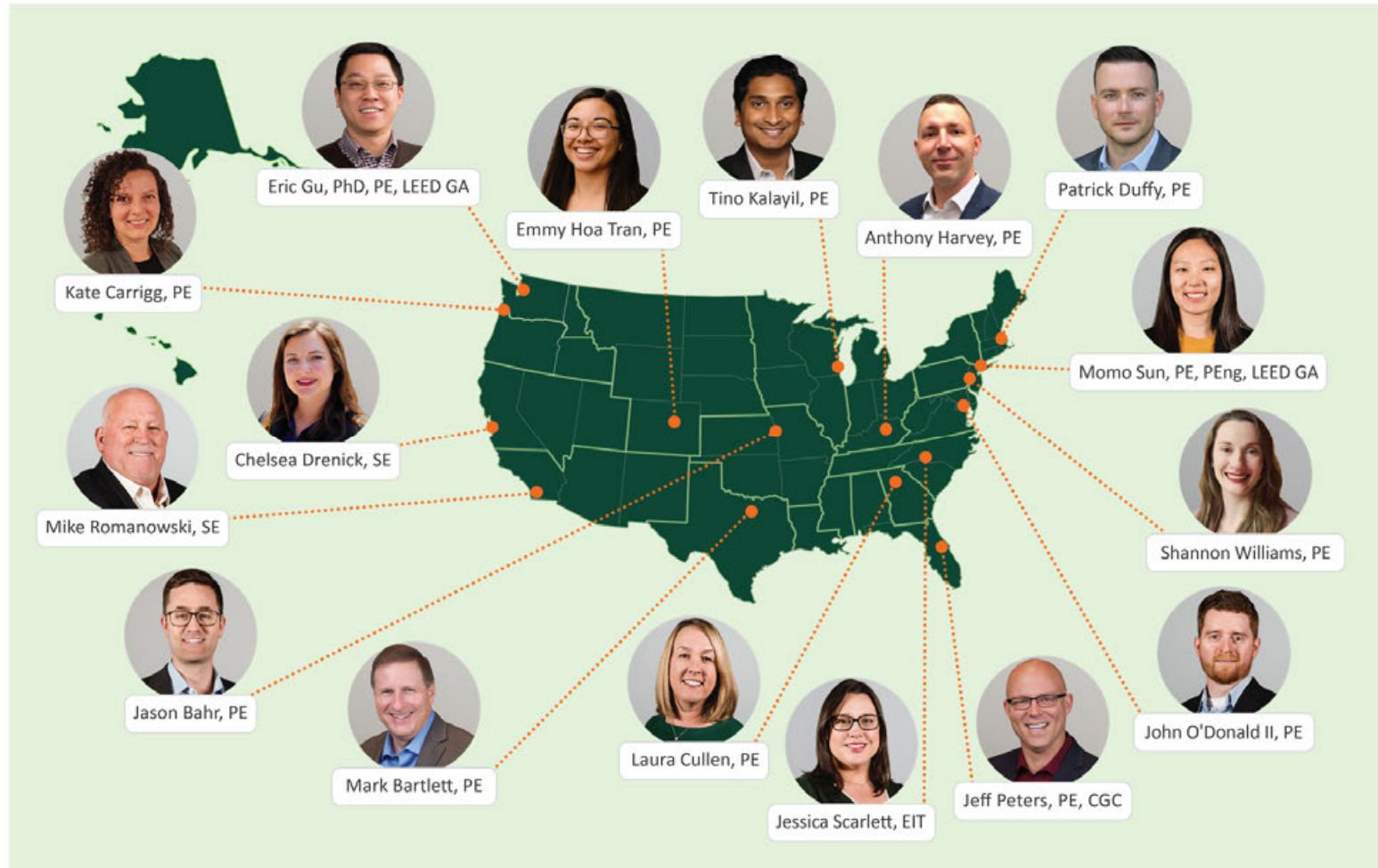
# Agenda



## Mass Timber Construction: Making the Case

<b>10:00 am – 11:00 am</b>	Mass Timber Construction Management: Economics, Logistics & Risk Analysis
<b>11:00 am - 11:15 am</b>	Break
<b>11:15 pm – 12:15 pm</b>	Mass Timber: Making the Case to Developers and Owners
<b>12:15 pm – 1:00 pm</b>	Lunch

# Regional Directors: One-on-One Project Support



# Solutions Team



Scott Breneman, PhD, PE, SE



Ashley Cagle, PE, SE



Matt Cloninger, PE, SE



Karen Gesa, PE



Erin Kinder, PE, SE, LEED AP



Melissa Kroskey, AIA, SE



Taylor Landry, PE, MLSE



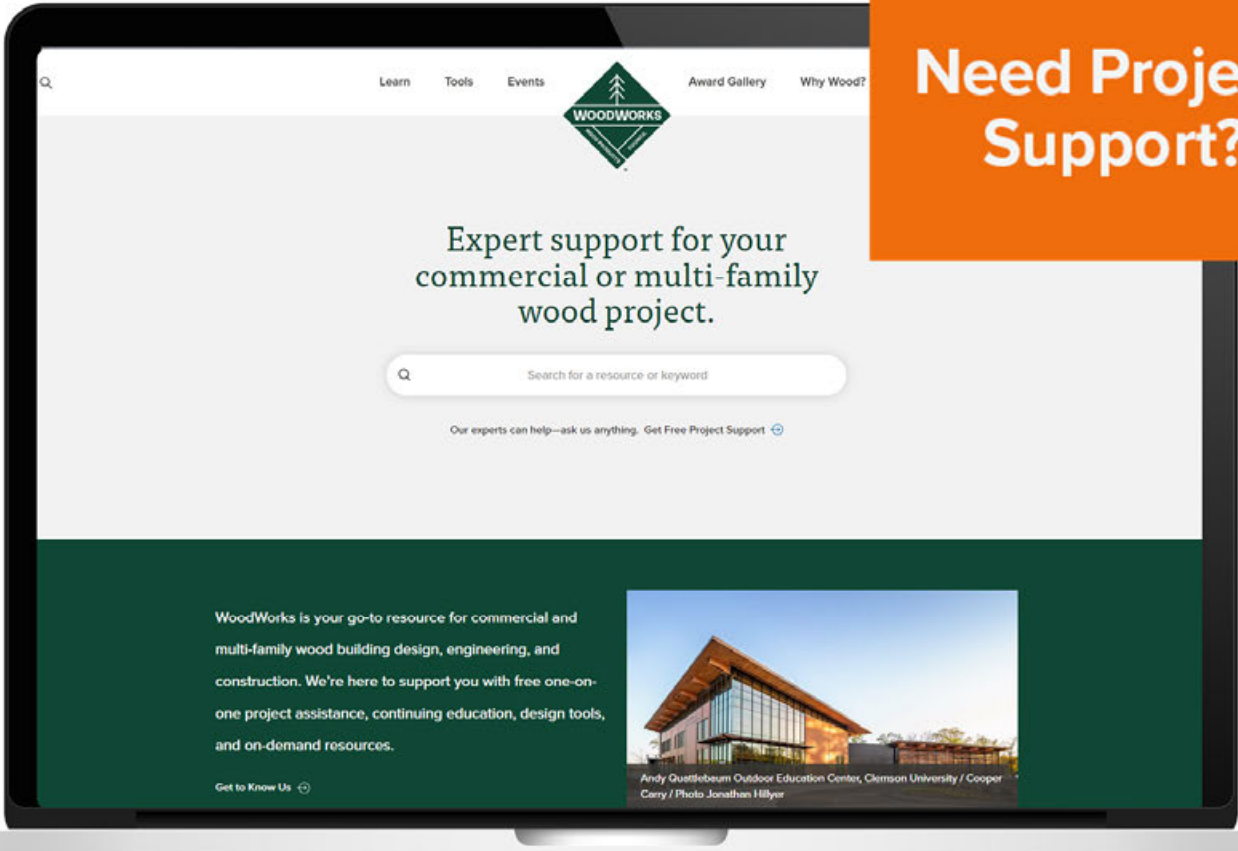
Bruce Lindsey



Ricky McLain, PE, SE



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Tools

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Why Wood?

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Building Systems

Light-Frame

Mass Timber / CLT

Off-Site / Panelized Construction

Hybrid

Building Types

Multi-Family / Mixed Use

Education

Office

Commercial Low-Rise

Industrial

Civic / Recreational

Institutional / Healthcare

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Discover mass timber projects across the US and connect with their teams.

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WoodWorks is your go-to resource for commercial and multi-family wood building design, engineering, and construction. We're here to support you with free one-on-





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Why Wood?

About

Need Project Support?

### Building Systems

- Mass Timber / CLT 24
- Light-Frame 9
- Panelized Construction 7
- Hybrid 5

### Building Types

- Multi-Family / Mixed-Use 16
- Education 10
- Office 10
- Commercial Low-Rise 9
- Civic / Recreational 6
- Industrial 6
- Institutional / Healthcare 6

### Project Roles

- Architect 14
- Developer/Owner 11
- Structural Engineer 10
- Contractor/Installer 6

### Resource Types

- Expert Tips 10
- Solution Papers 2
- Calculators 1
- Guides, Manuals & Inventories 1

### Regions

- National 20
- Midwest 5
- South 4
- West 4



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

This paper covers key aspects of mass timber acoustical design, including rules of thumb for optimal design, common assemblies, detailing strategies, and flanking paths. Companion to the Inventory of Mass Timber Acoustic

Assemblies.

Solution Papers



#### Designing Mass Timber Floor Assemblies for Acoustics

The growing availability and code acceptance of mass timber for construction has given designers a low-carbon alternative.

Expert Tips



#### Impact of Wall Stud Size and Spacing on Fire and Acoustic Performance

Interior wall partitions in a wood-frame building—such as unit demising and corridor walls in a multi-family project—must meet several design objectives simultaneously. Two primary functions are fire resistance and acoustical separation. Having to cite two tested wall assemblies, one for fire-resistance endurance results and another for acoustic results, is common.

Expert Tips

#### Firehouse 12

The continuous plywood shell that creates varying acoustic conditions within the performance space forms the exterior of the auditorium.

Award Winner



#### Acoustical Considerations for Mixed-Use Wood-Frame Buildings

This paper will help you understand the effects of acoustics in the context of other performance areas, enabling you to more easily navigate the decisions and trade-offs required when evaluating assembly options.

Solution Papers



#### Holes and Penetrations in Mass Timber Floor and Roof Panels

Guidance for the design of mass timber floor and roof panels with openings, including structural, fire resistance, and acoustic impacts, and tips for reinforcement.

Expert Tips

## Who are you looking for?

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Verified by Project Experience **196**

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Verified by Education **24**

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WoodWorks Partners **22**

### Industry

- Architect **0**
- Contractor **0**
- Developer **0**
- Engineer **0**
- Installer **0**
- Insurance Broker **0**
- Other **1**

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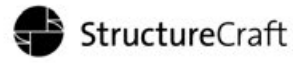
Sustaining Partners

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Industry Advantage Partner

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Channel Partner

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



# Course Description

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## **Mass Timber Construction Management: Economics, Logistics & Risk Analysis**

How do contractors answer the increasing demand for mass timber buildings from architects and ownership groups? Growing this budding industry requires an understanding from both designers and seasoned construction professionals of how to construct efficiently, navigate jurisdictions new to mass timber, and manage the procurement risks to deliver the dream of a new and optimized building system. This session will introduce mass timber products and building systems then consider why some mass timber projects never pass the concept stage, what can mitigate risk and improve financial feasibility, and how the development, architectural, engineering, and construction community can achieve success with mass timber projects of various scales and typologies. Particular emphasis will be given to preconstruction coordination, holistic approaches to costing and scheduling studies, project delivery methods, and how to achieve the highest level of cost efficiency

# Learning Objectives

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## **Mass Timber Construction Management: Economics, Logistics & Risk Analysis**

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

# Course Description

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## **Mass Timber: Making the Case to Developers and Owners**

Would you like to pitch sustainable mass timber to a client? Are you wondering how mass timber might pencil in a project pro forma? If so, this presentation will provide insight on completing the value proposition for developers and owners. The aesthetic differentiation and biophilic benefits of mass timber have broad appeal to a wide range of stakeholders, from end users to ESG-investors. Professionals hoping to influence decisions to use mass timber will learn how this appeal can translate to return on investment in an overview of initial findings from WoodWorks' Mass Timber Business Case Study series, written for the developer/owner/investor audience. This presentation will provide an overview of the case study series highlighting key takeaways. Developers/owners, architects, engineers and builders will all learn how mass timber can create value.

# Learning Objectives

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## **Mass Timber: Making the Case to Developers and Owners**

1. Discuss the environmental benefits of mass timber and how they resonate with a wide range of stakeholders from occupants to project teams, investors and communities.
2. Understand how the biophilic benefits of wood can contribute to occupant health, tenant appeal and the financial value of a real estate development.
3. Through case study examples, explore code-compliant design of mass timber structures.
4. Learn talking points to translate the biophilic and ESG-related benefits of mass timber into potential value creation for developers, owners, and investors; helping to convince these decision makers to invest in a more sustainable and healthier built environment.

# Learning Objectives

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## **Mass Timber: Making the Case to Developers and Owners**

1. Discuss the environmental benefits of mass timber and how they resonate with a wide range of stakeholders from occupants to project teams, investors and communities.
2. Understand how the biophilic benefits of wood can contribute to occupant health, tenant appeal and the financial value of a real estate development.
3. Through case study examples, explore code-compliant design of mass timber structures.
4. Learn talking points to translate the biophilic and ESG-related benefits of mass timber into potential value creation for developers, owners, and investors; helping to convince these decision makers to invest in a more sustainable and healthier built environment.



# Mass Timber Construction: Making the Case

Part 1: Mass Timber Construction Management: Economics,  
Logistics & Risk Analysis

April 10, 2024

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# Presentation Outline

1. Mass Timber Overview
  - » Structural Solutions
  - » Connections
  - » Projects
  - » Products
2. Construction Management
  - » Risk Analysis (Risks & Solutions)
  - » Economics (What does it cost?)
  - » Logistics (Schedule & Coordination)

# MASS TIMBER OVERVIEW



OVERVIEW | TIMBER METHODOLOGIES



Light Wood-Frame  
Photo: WoodWorks



Heavy Timber  
Photo: Benjamin Benschneider



Mass Timber  
Photo: John Stamets

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



Photo: Ema Peter

**STRUCTURAL SOLUTIONS | POST, BEAM + PLATE**



Photo: Seagate Structures

**STRUCTURAL SOLUTIONS | POST + PLATE**





Photo: Lendlease

**STRUCTURAL SOLUTIONS | HONEYCOMB**



Photo: John Klein

**STRUCTURAL SOLUTIONS | HYBRID LIGHT-FRAME + MASS TIMBER**



Photo: SOM

**STRUCTURAL SOLUTIONS | HYBRID STEEL + MASS TIMBER**

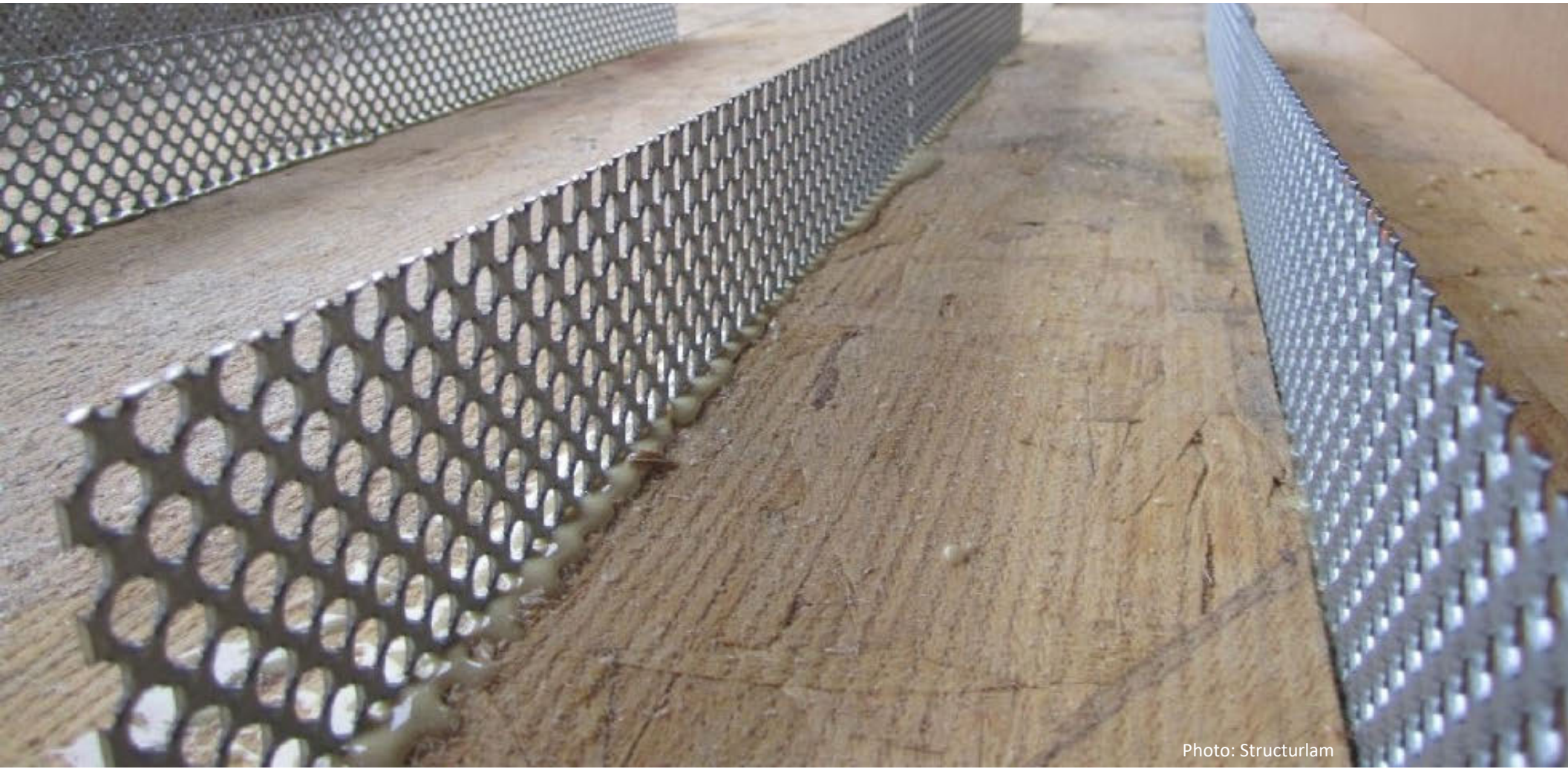


Photo: Structurlam

**STRUCTURAL SOLUTIONS | HYBRID CONCRETE + MASS TIMBER**

## OVERVIEW | CONNECTIONS



Concealed Connectors



Self Tapping Screws

Photos: Rothoblaas

OVERVIEW | CONNECTIONS



Beam to Column

Photo: StructureCraft



Photo: Structurlam

OVERVIEW | CONNECTIONS



Column to Foundation

Photo: Alex Schreyer

OVERVIEW | CONNECTIONS



Panel to Panel & Supports

Photo: Charles Judd



Photo: Alex Schreyer



# MASS TIMBER PRODUCTS



## Glue Laminated Timber (GLT)

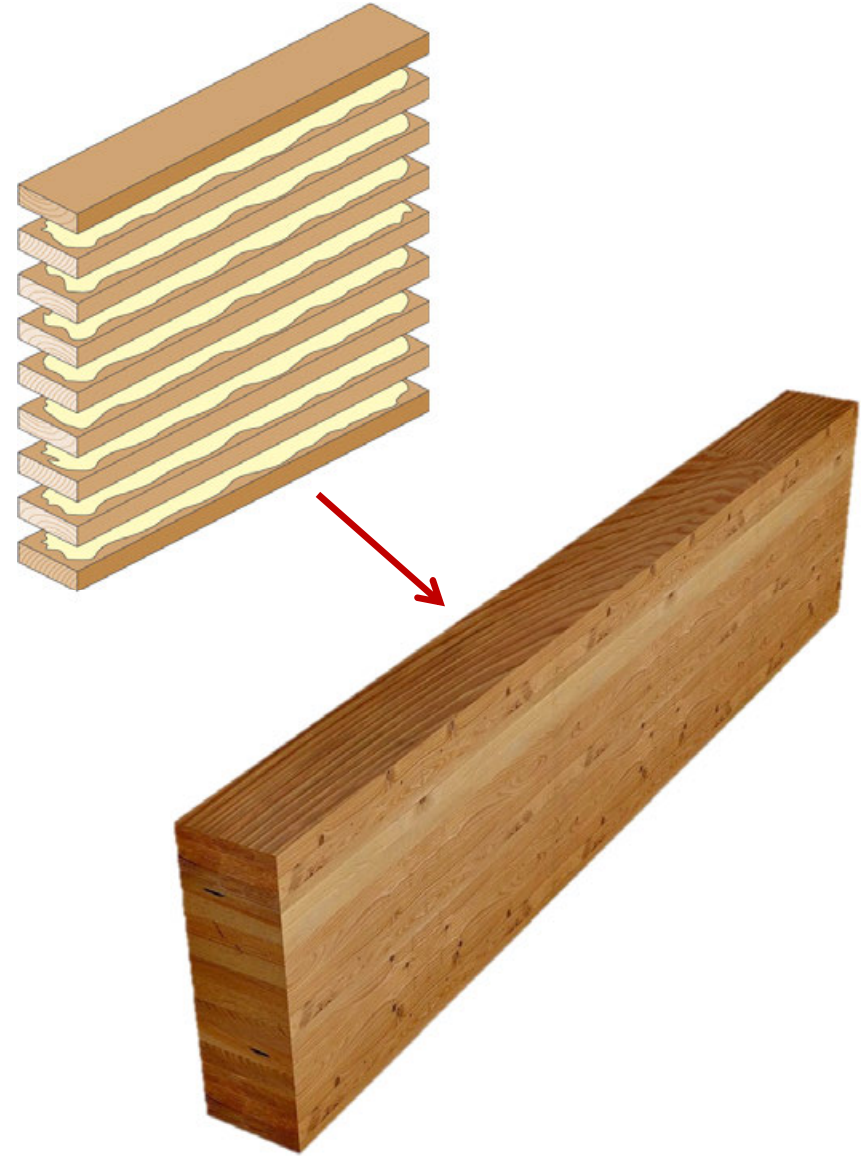


Photo: Alex Schreyer

## Glue Laminated Timber (GLT)



Photo: Manasc Isaac Architects/Fast + Epp

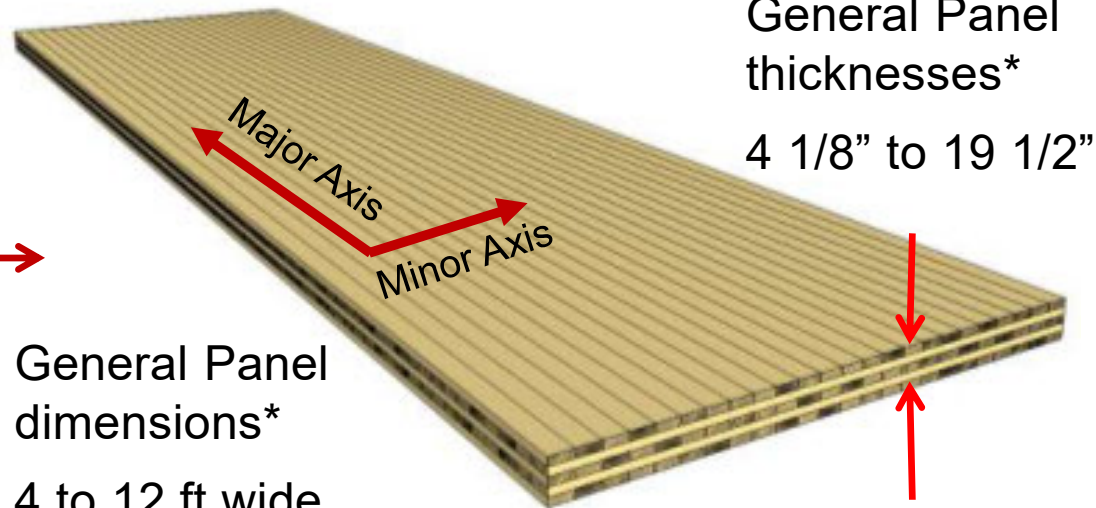
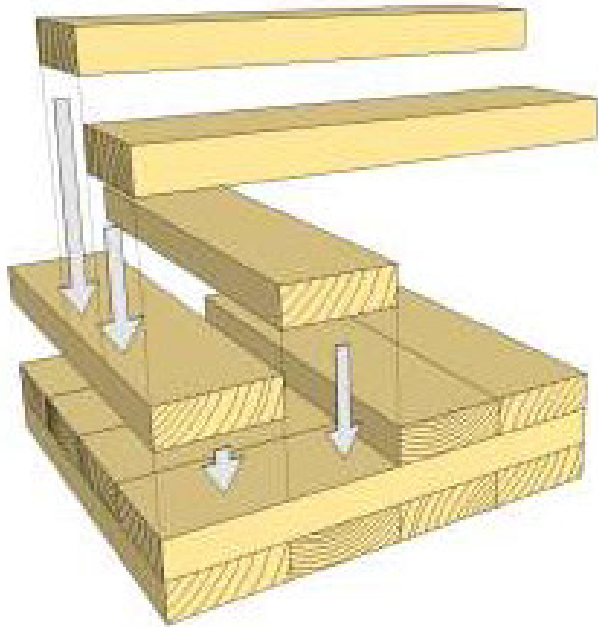


Cross-Laminated Timber (CLT)



## Cross-Laminated Timber (CLT)

With solid sawn laminations



General Panel  
thicknesses\*  
4 1/8" to 19 1/2"

General Panel  
dimensions\*  
4 to 12 ft wide  
24 to 64 ft long

\*Consult with manufacturers for  
available panel sizes

Cross-Laminated Timber (CLT)

With SCL laminations



Photos: Freres Lumber

## Nail-Laminated Timber (NLT)

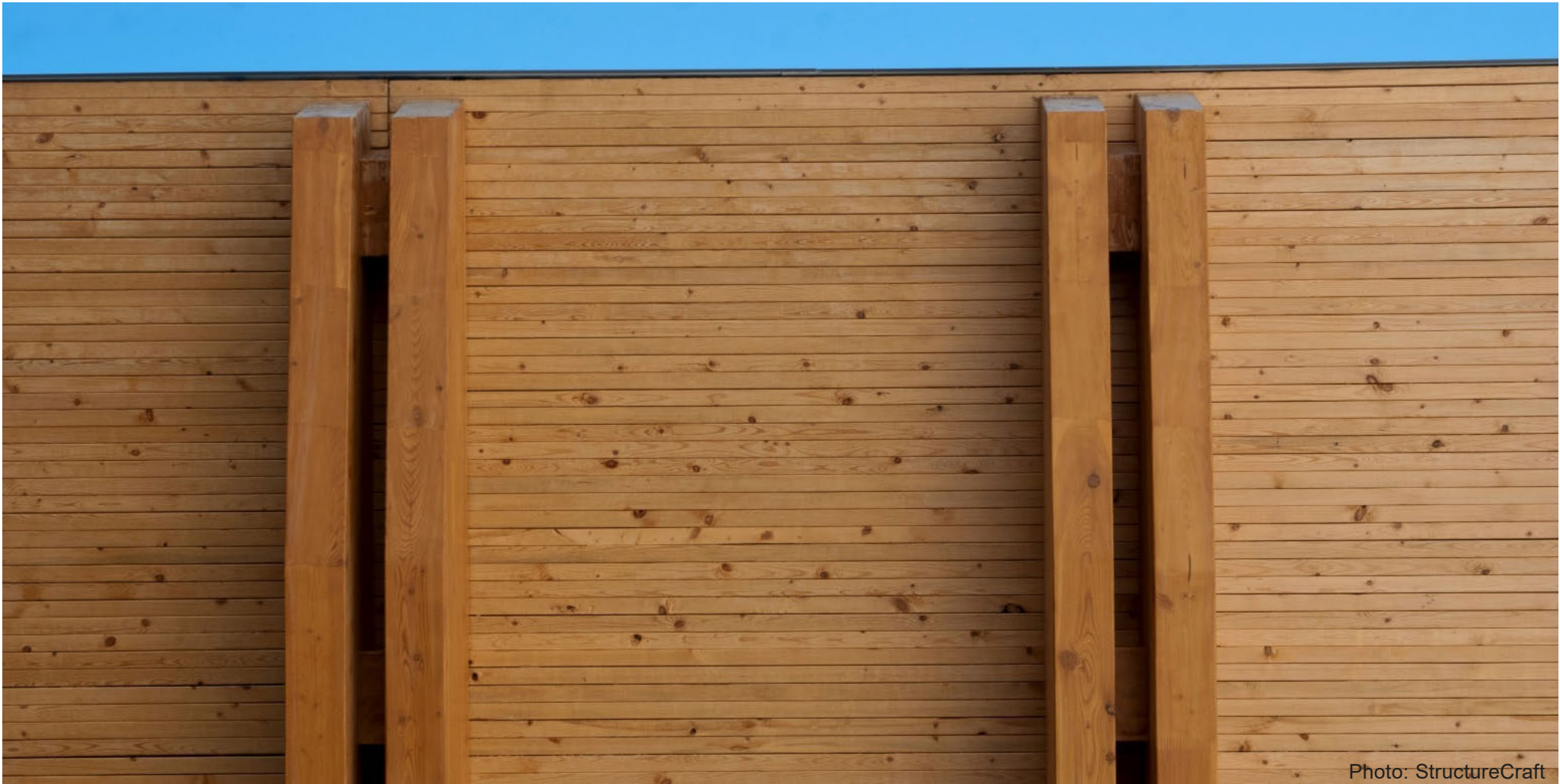


Photo: StructureCraft

## Nail-Laminated Timber (NLT)





Dowel-Laminated Timber (NLT)



Photo: StructureCraft

# Other Mass Timber Product Options



Glue Laminated Timber  
GLT



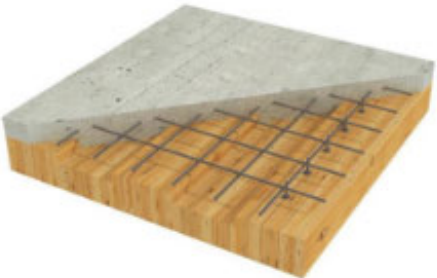
Laminated Veneer Lumber  
LVL



Parallel Strand Lumber  
PSL



Laminated Strand Lumber  
LSL



Timber-Concrete Composite  
TCC



Decking

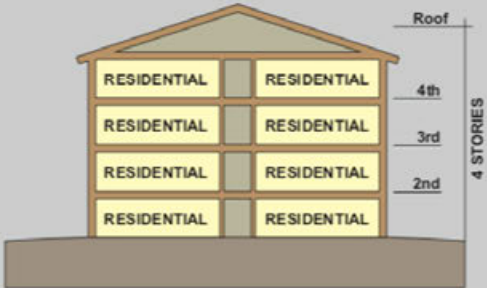
# MASS TIMBER IN THE CODE



# BUILDING CODE APPLICATIONS | CONSTRUCTION TYPE

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

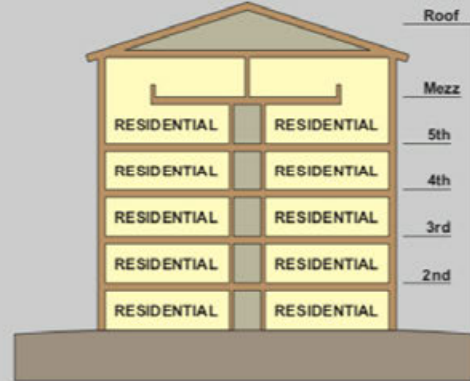
IBC Table 503: Base Height



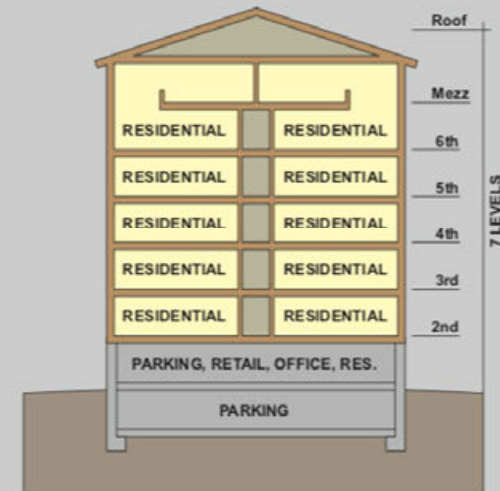
IBC Section 504: NFPA 13-Compliant Sprinkler System



IBC Section 505: Mezzanine

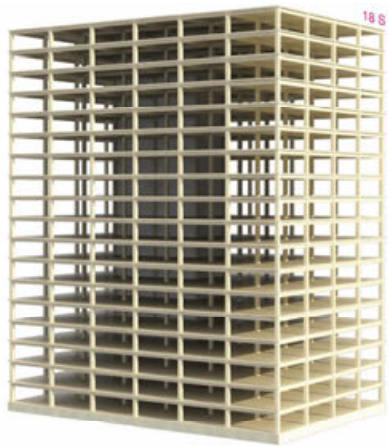


IBC Section 510.2: Podium



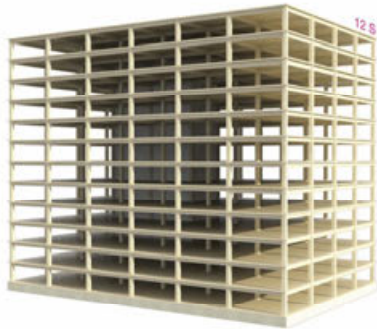
**BUILDING CODE APPLICATIONS | CONSTRUCTION TYPE**

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



18 STORIES  
 BUILDING HEIGHT 270'  
 ALLOWABLE BUILDING AREA 972,000 SF  
 AVERAGE AREA PER STORY 54,000SF

**TYPE IV-A**



12 STORIES  
 BUILDING HEIGHT 180 FT  
 ALLOWABLE BUILDING AREA 648,000 SF  
 AVERAGE AREA PER STORY 54,000SF

**TYPE IV-B**



9 STORIES  
 BUILDING HEIGHT 85'  
 ALLOWABLE BUILDING AREA 405,000 SF  
 AVERAGE AREA PER STORY 45,000 SF

**TYPE IV-C**

**IBC 2021**

324,000 SF  
ALLOWABLE BUILDING AREA

54,000 SF  
AVERAGE AREA PER STORY

6 STORIES MAXIMUM  
 85'-0" MAXIMUM BUILDING HEIGHT  
 324,00 SF MAXIMUM AREA

**TYPE IV- HT**

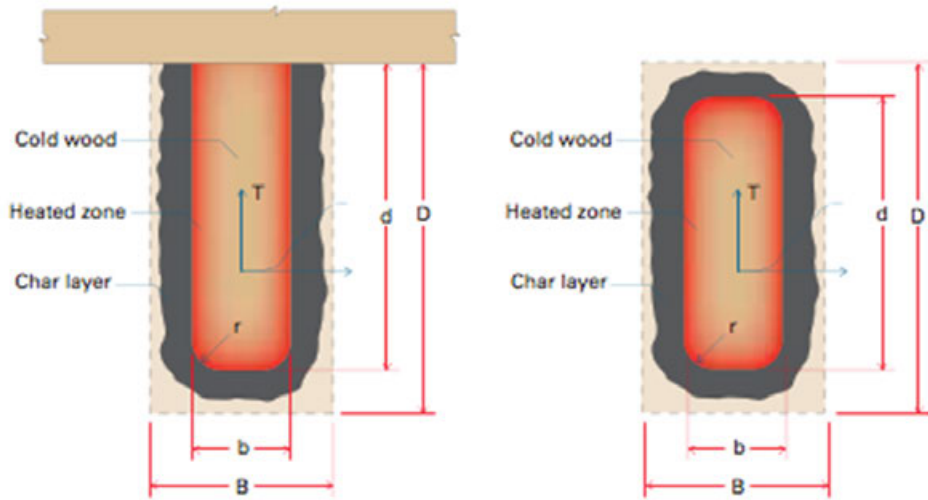
**IBC 2015**

**BUSINESS OCCUPANCY [GROUP B]**

\*BUILDING FLOOR-TO-FLOOR HEIGHTS ARE SHOWN AT 12'-0" FOR ALL EXAMPLES FOR CLARITY IN COMPARISON BETWEEN 2015 TO 2021 IBC CODES.

BUILDING CODE APPLICATIONS | 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  $\beta_n = 1.5$  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




Credit: David Barber, ARUP

# Fire Design Resource

Discusses:

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

Free Resource: [www.woodworks.org](http://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/>

# MASS TIMBER CONSTRUCTION MANAGEMENT





## MASS TIMBER CONSTRUCTION MANAGEMENT

### **RISK ANALYSIS**

Threats to mass timber projects  
Strategic project delivery

### **ECONOMICS**

Holistic project estimating  
Anatomy of a mass timber  
package

### **LOGISTICS**

Design Engagement  
Schedule  
Site Planning

## Mass Timber Construction Management

**RISK  
ANALYSIS**

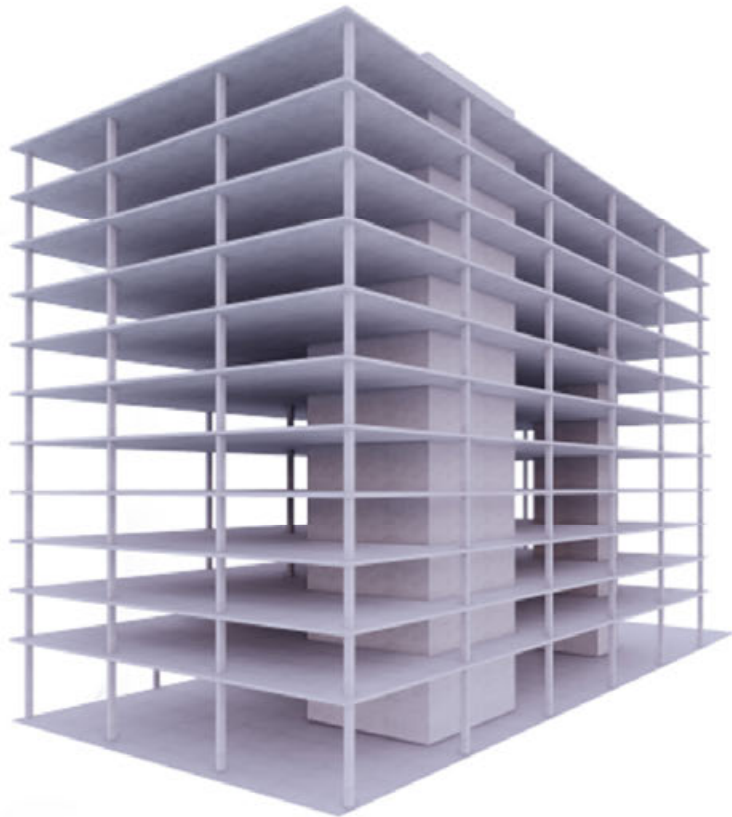
**ECONOMICS**

**LOGISTICS**

### THREE KEY POINTS:

1. Mass timber is a custom building system, not a commodity.
2. Select the right partners for your project.
3. Assess projects holistically when estimating costs.

# Risk: Cost Analysis of Structure Only



**\$/SF**



**\$/SF**

*Image: GBD Architects*

# Risk Mitigation: Total Project Cost Analysis

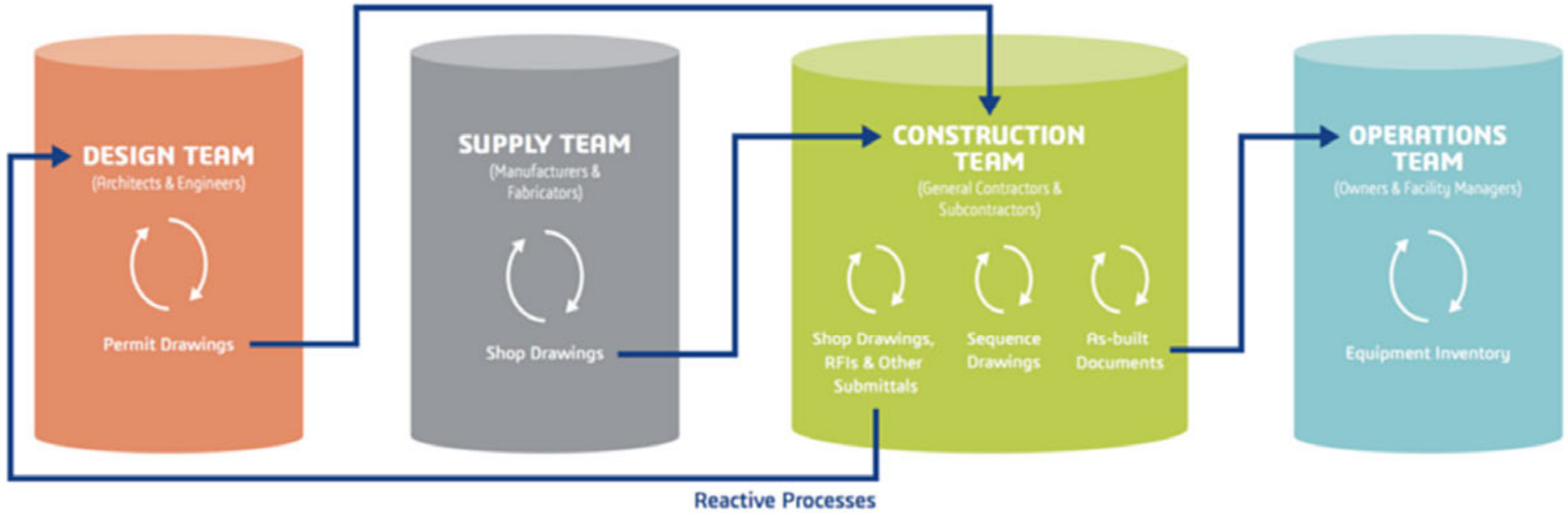
## CONSIDERATIONS:

- Ceiling Treatment
- Floor Topping
- HVAC System & Route
- Foundation Size
- Soil Improvements
- Exterior Skin Coordination
- Value of Time



Credit: Hacker Architects

# Risk: Design-Bid-Build Procurement



# Risk Mitigation: Trade Partner/Master Builder Approach



# Procurement Strategy is Key to Success



5% Savings

Neutrality

10% Premium

# Risk: Perception of a Commoditized Material





# Risk Mitigation: Embrace the Prefab Advantage



Photo: Swinerton

# Risk: Lack of Supply Chain Understanding

I don't have any historic cost data for this structural system.

Who makes this stuff?  
How do you procure it?

Photo: Swinerton

# Risk Mitigation: Complementary Procurement

GC Hires  
Turnkey Mass Timber  
Subcontractor

GC Buys Material  
GC Self-Performs Install  
GC Coordinates

GC Buys Material  
GC Subcontracts Labor  
GC Coordinates

**RISK SPECTRUM**

**+** Hiring Experience  
Single Point of Responsibility

**-** Prequal Capacity of Sub  
Potential Added Mark-Up

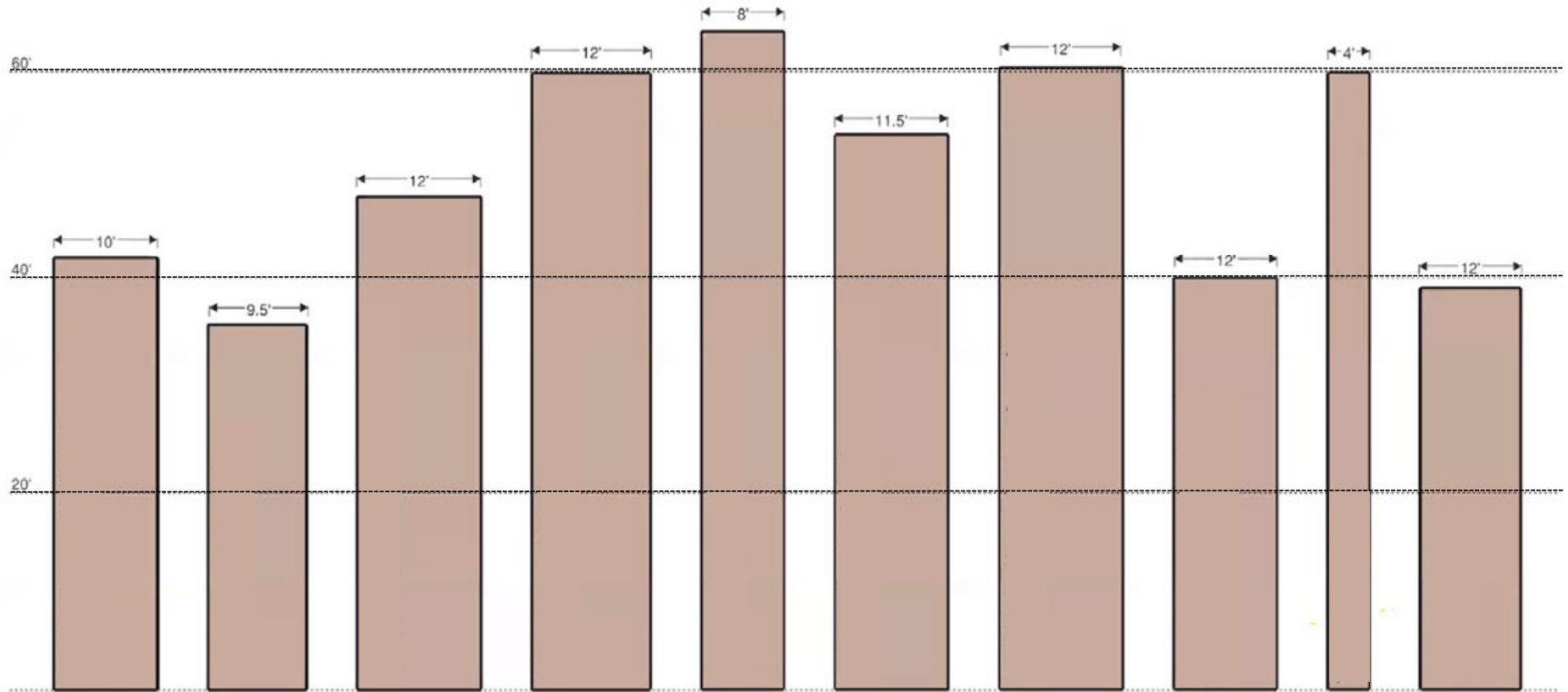
**+** Hiring Experience  
Single Point of Responsibility  
Financial Security of strong GC

**-** Lack of familiarity with supply chain  
Steep learning curve for coordination

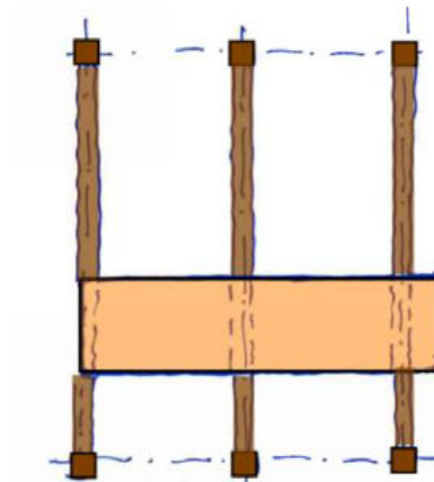
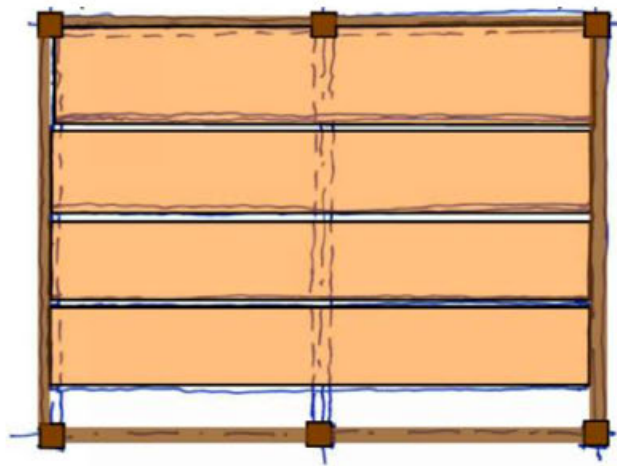
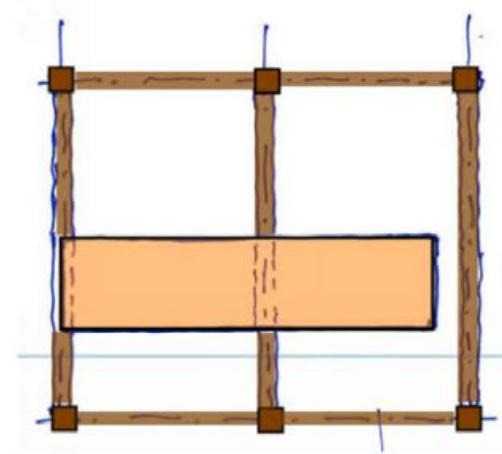
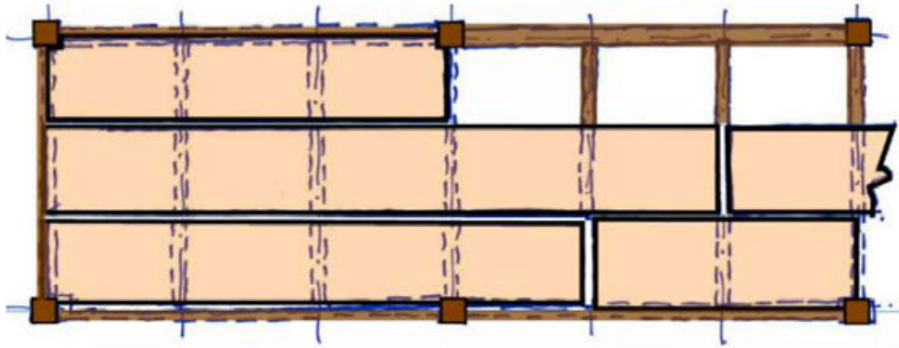
**+** Potential Added Mark-Up

**-** Multiple layers of coordination  
Prequal Capacity of Sub

# Understand Manufacturer's Capabilities



Credit: TimberLab



Credit: Tanya Luthi, Entuitive

## Understand Manufacturer's Capabilities

# Schedule Savings for Rough-In Trades

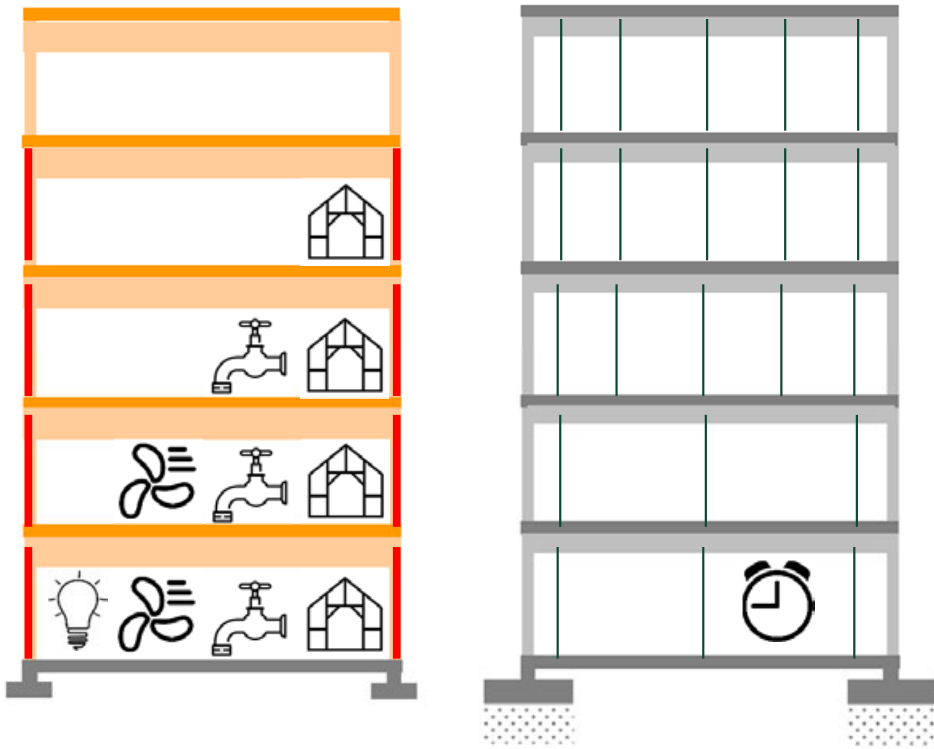
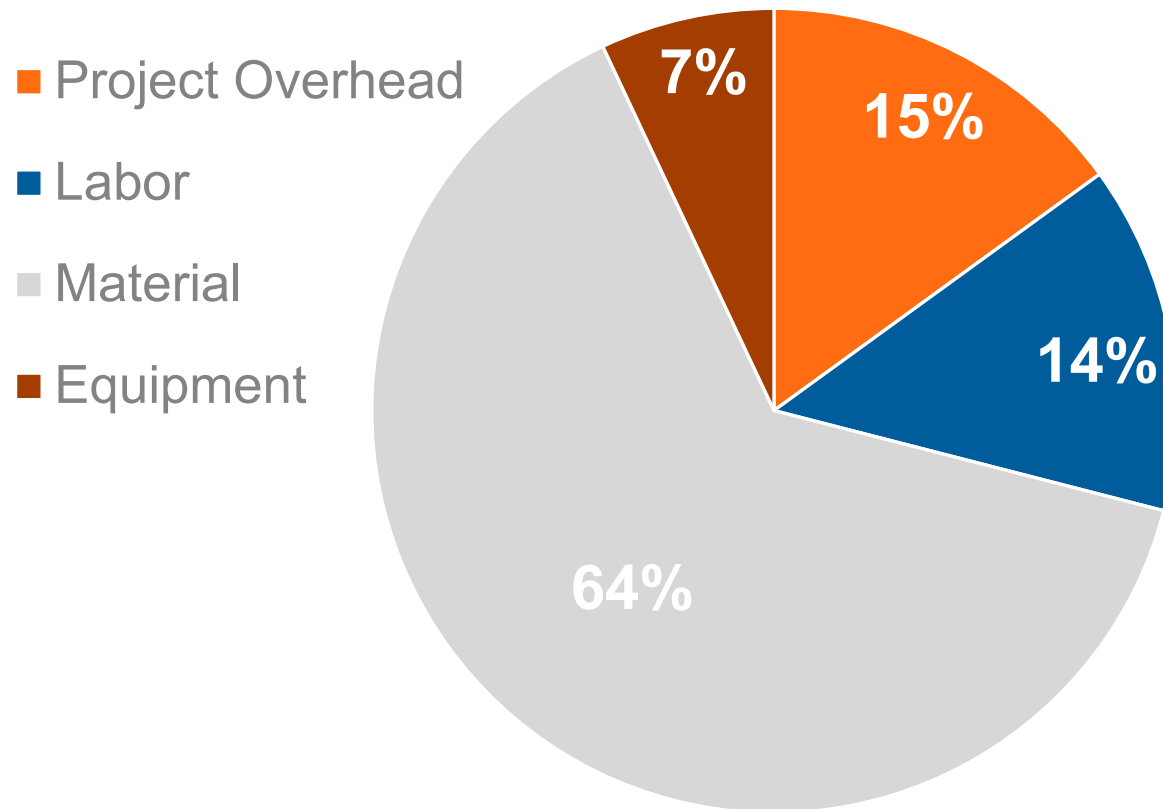


Image: Swinerton



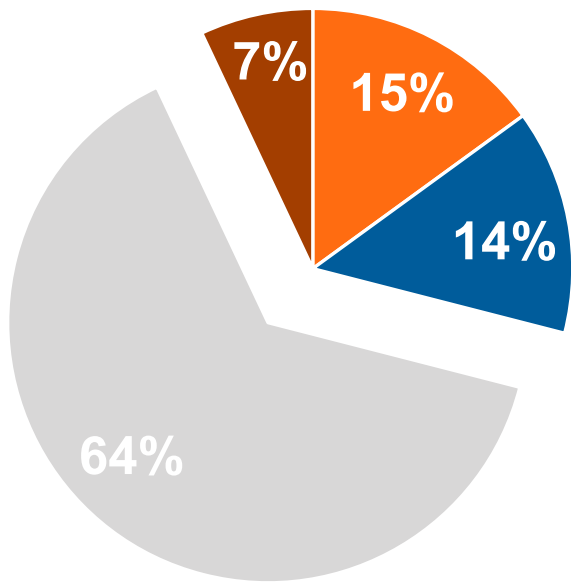
Photo: WoodWorks

# Anatomy of a Turnkey Mass Timber Package



Source: Swinerton

# Material (Direct Cost)



Turnkey Mass Timber Package

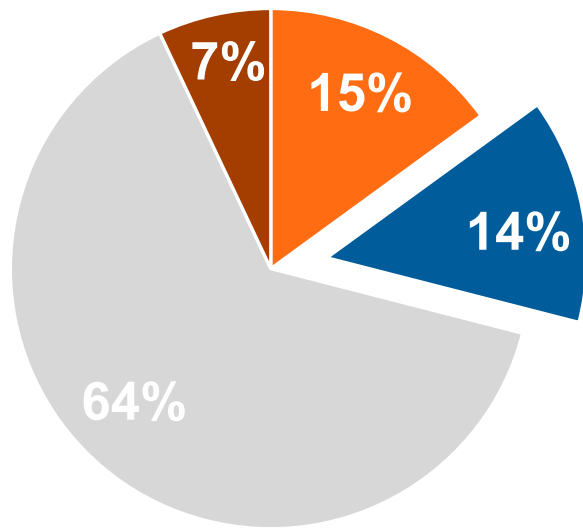


or





# Labor (Direct Cost)

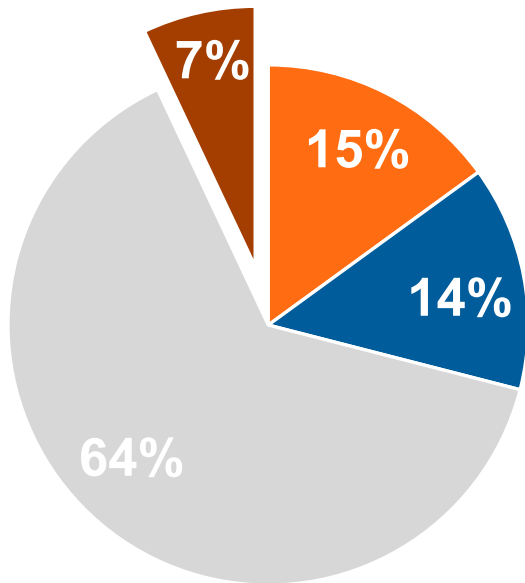


Turnkey Mass Timber Package



Photo: Swinerton

# Equipment (Direct Cost)



Turnkey Mass Timber Package

Source: Swinerton

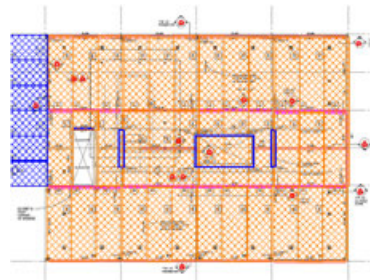
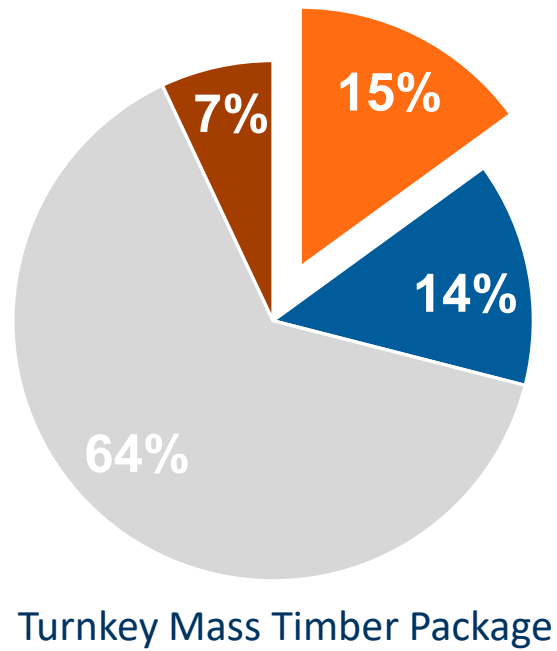


Photo: Swinerton

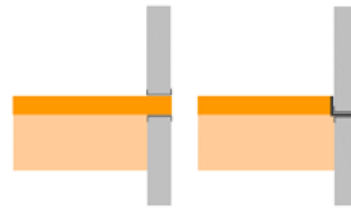


Photo: Alex Schreyer

# Project Overhead



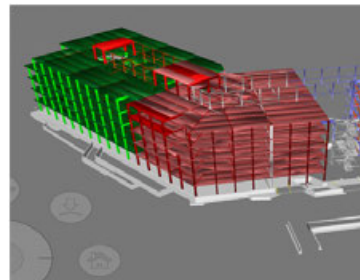
Cost Analysis



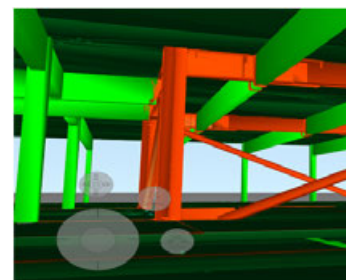
Design Refinement



System Integration



VD&C



Detail Optimization



Logistics Planning

Photos: Swinerton

# Value Analysis

$$\textit{Value} = \frac{\textit{Function} + \textit{Aesthetics}}{\textit{Cost}}$$

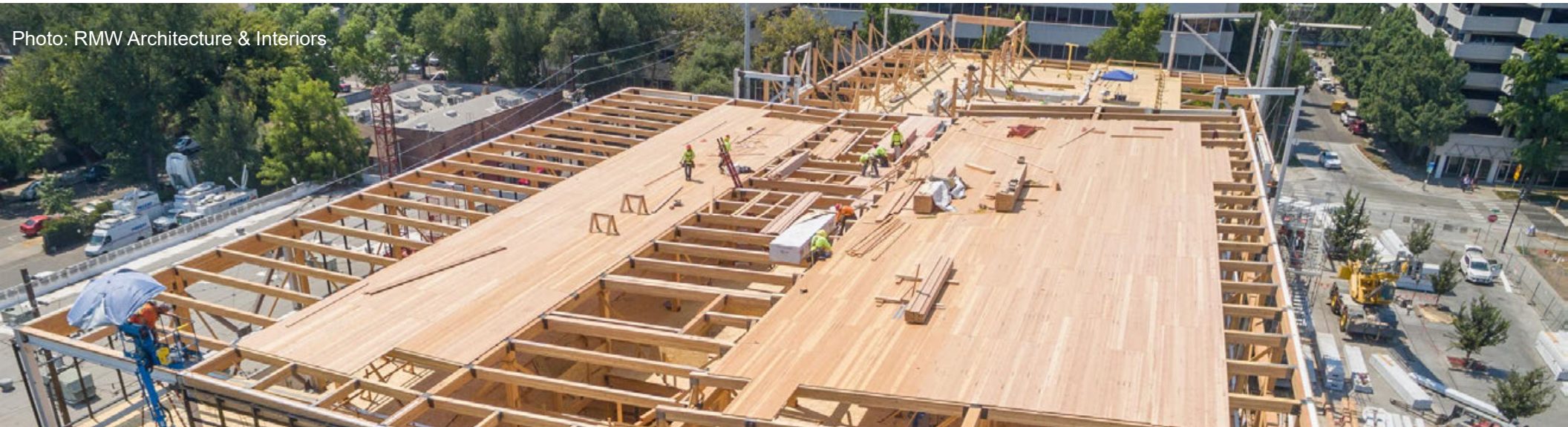


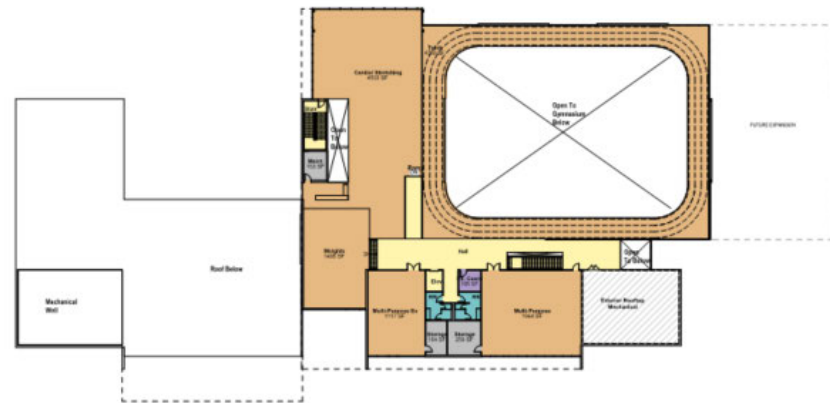
Photo: RMW Architecture & Interiors

# Value: Program

Level 1



Level 2



## Concept Plan



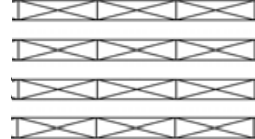
Hillsboro Community Center at 53rd Ave.

May 03, 2018

**opsis**

# Cost: Construction Type

**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 1hr & maybe 2hr		+\$12-15/SF 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.



Expert Tips

## Key Design Considerations for Mass Timber Projects

Important considerations related to construction type, fire ratings, panel thickness, member size and occupancy.

Share 

### Selecting a Construction Type

For mass timber projects, selection of construction type is one of the more significant design decisions. While it's common to choose construction type based on structural material—i.e., to assume that steel and concrete structures should be Type II, light-frame wood should be Type V, and exposed heavy/mass timber should be Type IV—this approach can lead to additional costs. While Type IV construction can be used for exposed mass timber projects, a full understanding of the allowable use of materials in all five construction types, as well as the unique allowances and limitations associated with each, will help to inform the most efficient design.

To optimize a building design from a construction type and level of fire resistance perspective, it is best to start from the lowest end of the spectrum, Type V-B construction, and work up. This avoids unnecessary defaults or assumptions—and unnecessary costs. The fact that certain materials are being used doesn't mean there is only one option for construction type. Similarly, a mix of occupancy groups doesn't dictate that certain materials, construction types or building configurations are required. For example, a mass timber building may have isolated steel, concrete or masonry structural elements, but this doesn't mean that Type I or II construction is necessary, nor does it mean that some or all of the building can't be framed with mass timber. Likewise, a building with mass timber elements has options other than Type IV construction. Note IBC Section 602.1.1:

**602.1.1 Minimum requirements.** *A building or portion thereof shall not be required to conform to the details of a type of construction higher than that type which meets the minimum requirements based on occupancy even though certain features of such a building actually conform to a higher type of construction.*

This section permits the use of elements commonly used in a higher construction type without requiring that the entire building meet all of the provisions of that construction type. For example, if a building's size permitted the use of Type V-B construction, it could still be completely framed with noncombustible materials while being classified as V-B. Similarly, a Type III or V building could be framed with a combination of combustible and noncombustible materials.

As noted, from flexibility in ter

<https://www.woodworks.org/resources/key-design-considerations-for-mass-timber-projects/>

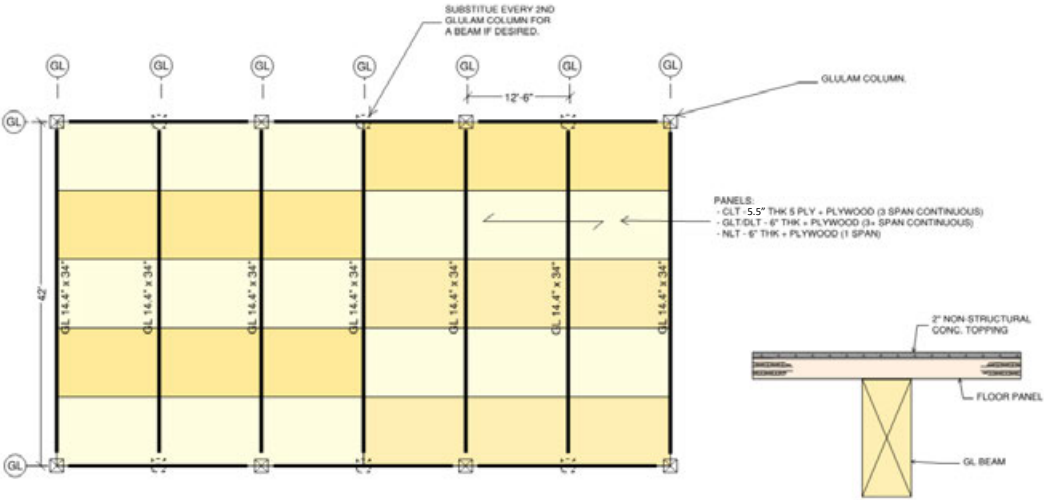
# Value: Open Floor Plan



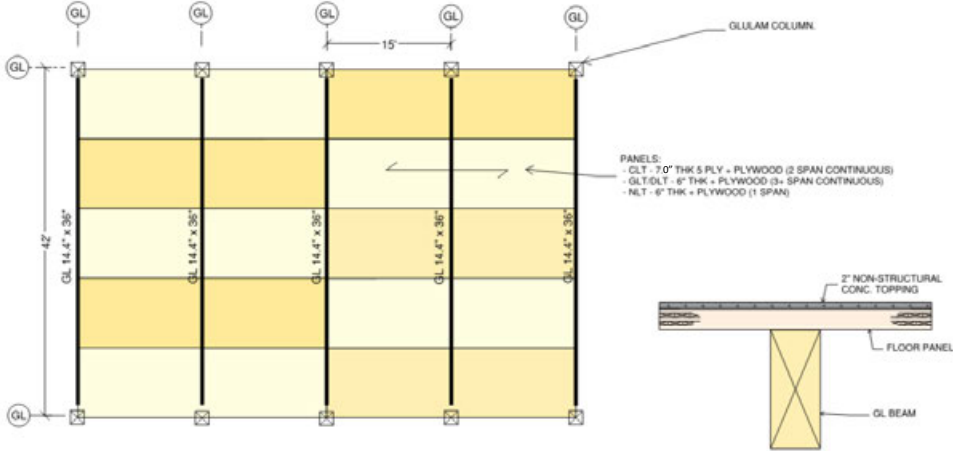
Photo: Swinerton



# Cost: Structural System & Grid



**Baseline**  
 12'-6" Glulam Spacing  
 5.5" CLT



**\$ +5%**  
 15' Glulam Spacing  
 7" CLT


Source: Seattle Mass Timber Tower Book



### Expert Tips

## Creating Efficient Structural Grids in Mass Timber Buildings

Although a mass timber solution may work economically on grids created for other materials, a few modifications can increase efficiencies related to member sizing and manufacturer capabilities.

Share 

Mass timber products such as cross-laminated timber (CLT), nail-laminated timber (NLT) and glue-laminated timber (glulam) are at the core of a revolution that is shifting how designers think about construction. At no time has materials selection been such an integral aspect of the building designer's daily responsibilities. In addition to its sustainability and light carbon footprint, mass timber has benefits that include enhanced aesthetics, speed of construction and light weight, all of which can positively impact costs. However, to convince building owners and developers that a mass timber solution is viable, the structural design must also be cost competitive. This requires a full understanding of both material properties and manufacturer capabilities.

Mass timber is commonly seen in projects such as offices, schools and tall mixed-use buildings, which often have assumed structural grids. Intended to meet the need for tenant flexibility, these "default" grids align with the capabilities of materials historically used—i.e., steel and concrete. When it comes to laying out a structural grid for mass timber, the square peg/round hole analogy is pertinent. Although a mass timber solution may work economically on many grids conducive to steel/concrete framing, some grid modification may be valuable. Trying to force a mass timber solution on a grid laid out for steel and concrete can result in member size inefficiencies while negating opportunities related to manufacturer capabilities. As such, it is critically important to design a mass timber building *as a mass timber building* from the start. This requires a thorough understanding of how to best lay out the structural grid, without sacrificing space functionality, to optimize member sizes—but there's more to cost efficiency than column spacing.

The following considerations are based on a post-and-beam frame for occupancies such as offices; however, many also apply to bearing wall-supported systems in other occupancy types.

### Grid Selection

Simplistically, there are two main grid options for mass timber buildings: square and rectangular. In deciding which to use, there are a number of factors to consider.

To determine efficient grid spacing, it is important to understand possible span ranges for mass timber floor panels. Due to their relative light weight, allowable spans for these panels are often governed by vibration and deflection rather than bending or shear capacity. In addition to panel vibration

<https://www.woodworks.org/resources/creating-efficient-structural-grids-in-mass-timber-buildings/>

# Value: Perimeter Glazing



Photos: Mark Bitterman

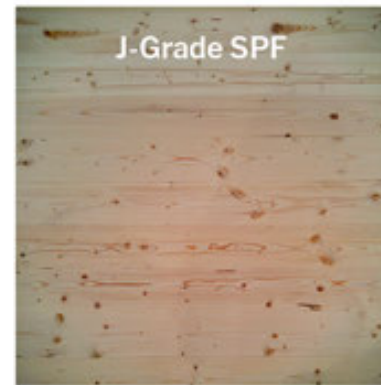


# Cost Impacts of Finish/ Appearance Grade

## Appearance vs. Industrial Grades

### Aesthetic Expectations

- Appearance grade more \$
- Industrial grade can save \$
- Specification of appearance grade varies by product
- CLT, DLT, NLT: aesthetic expectations are agreed upon by building designer and manufacturer/ fabricator (ask for samples & outline in specs)
- Glulam: grades are standardized



Structurlam

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Expert Tips

## Specifying Appearance Grades for CLT, NLT and Glulam

Information for designers seeking to specify appearance grade for cross-laminated timber (CLT), nail-laminated timber (NLT), or glue-laminated timber (glulam).

Share

For mass timber, specification of appearance grade varies by product. Aesthetic expectations for cross-laminated timber (CLT) and nail-laminated timber (NLT) are agreed upon between the building designer and manufacturer/fabricator and described in the product specifications, whereas grades for glued-laminated timber (glulam) are standardized.

### CLT Appearance Grades

Starting with the 2015 version of the International Building Code (IBC), CLT has been prescriptively



# SCHEDULE



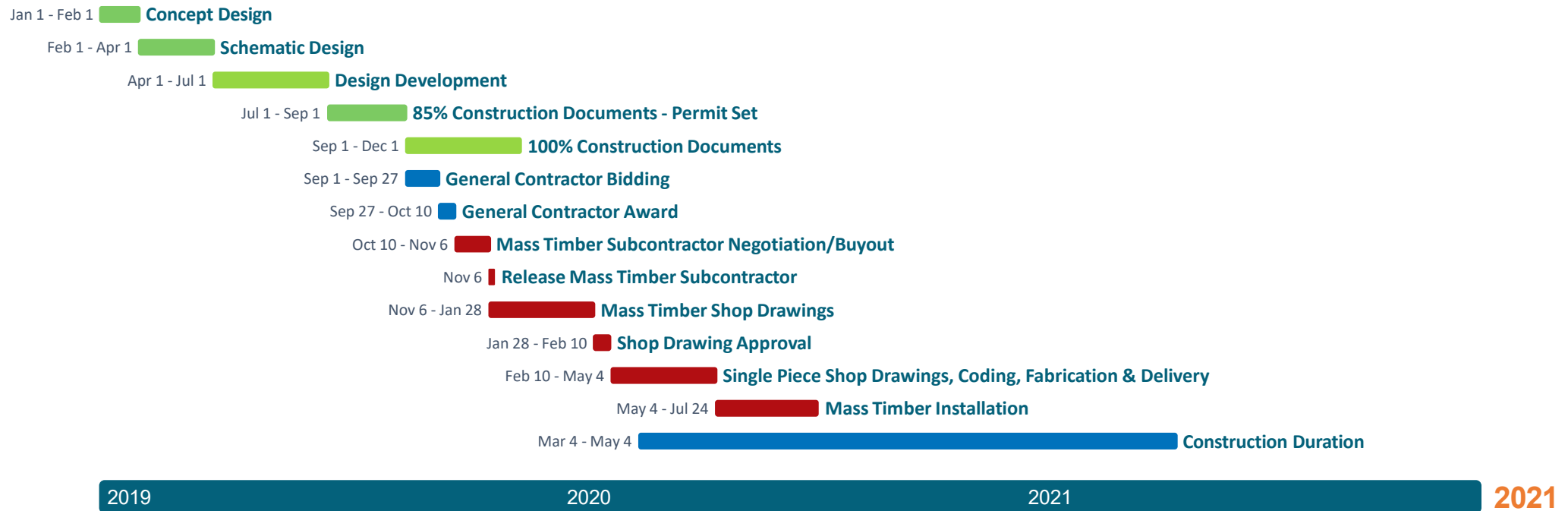
Photo: Swinerton

# Procurement Approach Determines Schedule



# Procurement Approach Determines Schedule

## Example 6 Story Type IIIA Project



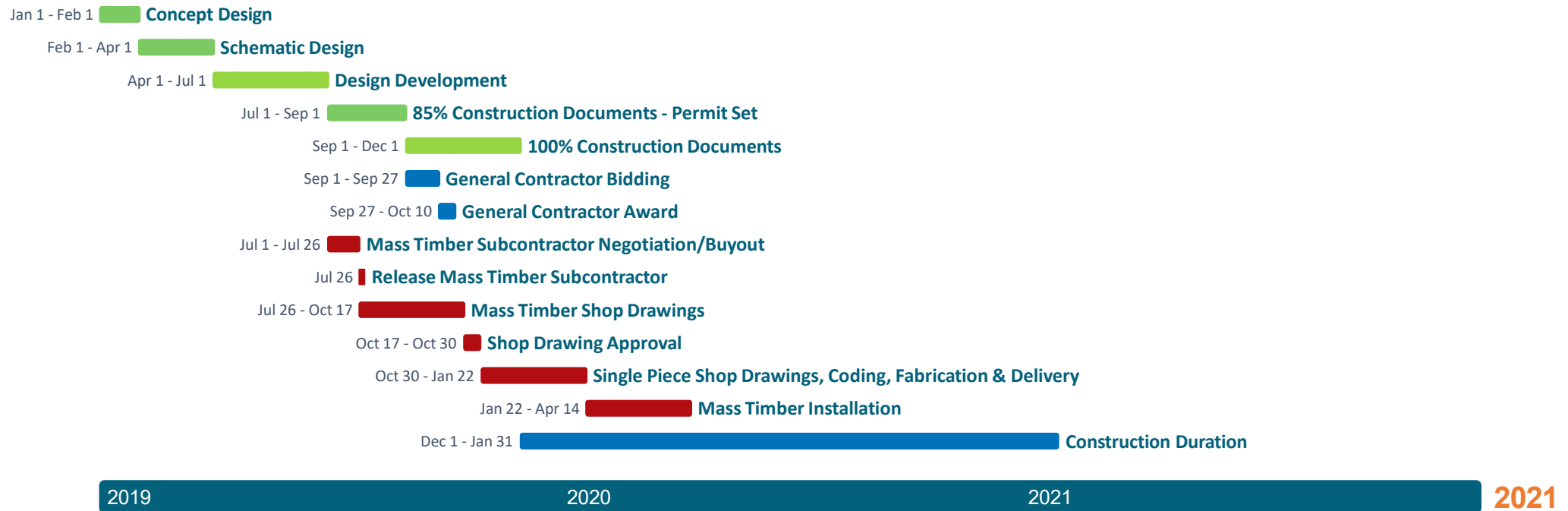
Source: Swinerton

# Design-Bid-Build Procurement



# Procurement Approach Determines Schedule

## Example 6 Story Type IIIA Project



Source: Swinerton

# Design-Build/Design-Assist Procurement

# Procurement Logic for Scheduling

**Shop drawings, Planning, Fabrication, Delivery**

**Mass  
Timber  
Installation**

Nov    Dec    Jan    Feb    Mar    Apr    May    Jun    Jul    Aug    Sep

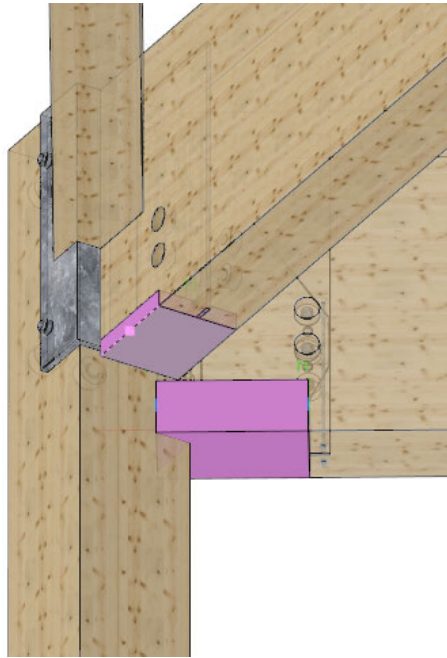
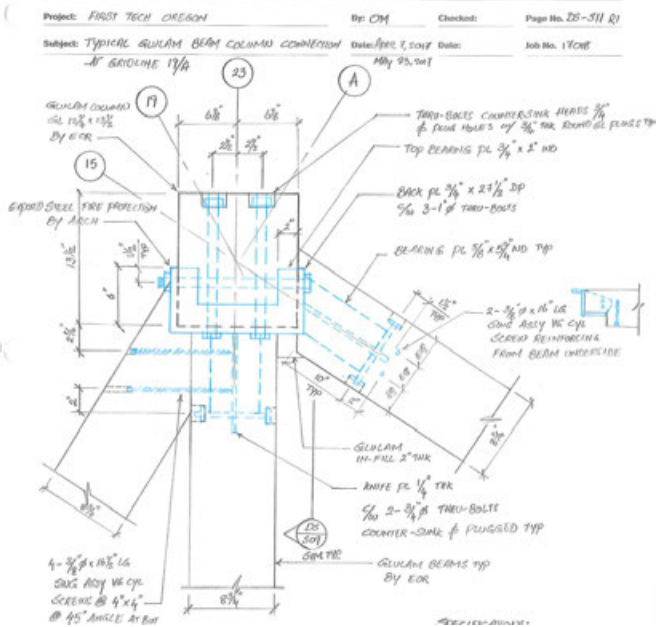
Source: Swinerton

Example 6 Story Type IIIA Project

What are the schedule drivers on a mass timber project?



# Schedule Impacts: Translating 2D to 3D



Photos: Swinerton

# Schedule Impacts: Hybrid Structures



Is there a schedule savings with a mass timber structure compared to other structural systems?



Photo: StructureCraft Builders

# Overall Project Cost Analysis: 12 Story Type IV-B

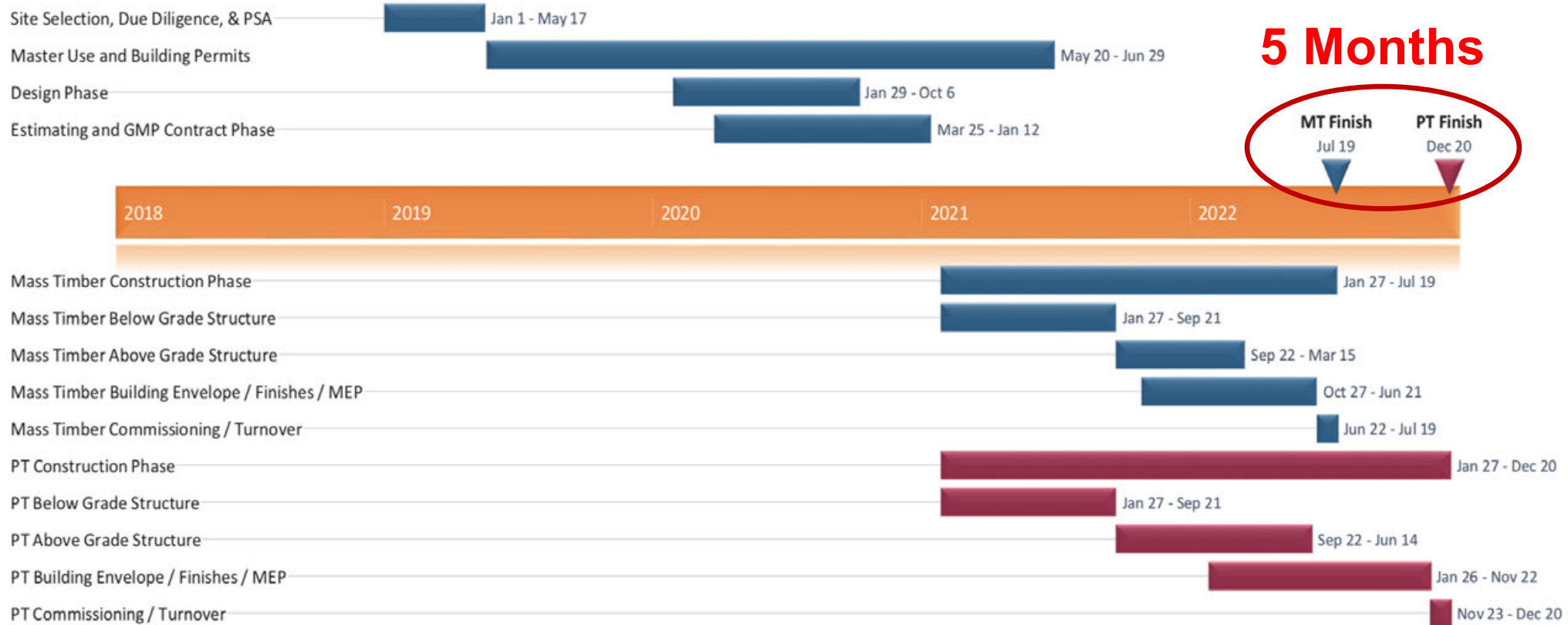
	MASS TIMBER	PT CONCRETE	* MASS TIMBER SAVINGS VS. PT CONCRETE (%)
DIRECT COST OF WORK	86,997,136	85,105,091	2.2%
PROJECT OVERHEAD	9,393,750	11,768,750	-20.2%
ADD-ONS	8,387,345	8,429,368	-0.5%
<b>Total</b>	<b>104,778,231</b>	<b>105,303,209</b>	<b>-0.5%</b>

Source: Swinerton

\* Includes 2 layers of gyp on 80% of interior surfaces



# Overall Project Schedule Analysis: 12 Story Type IV-B



Source: Swinerton



## Schedule Impact on Cost | Value of Time

A large scale MT project can be up to 2% higher in direct costs, but a minimum of 20% lower in project overhead costs. The net result is cost-neutrality and higher value.

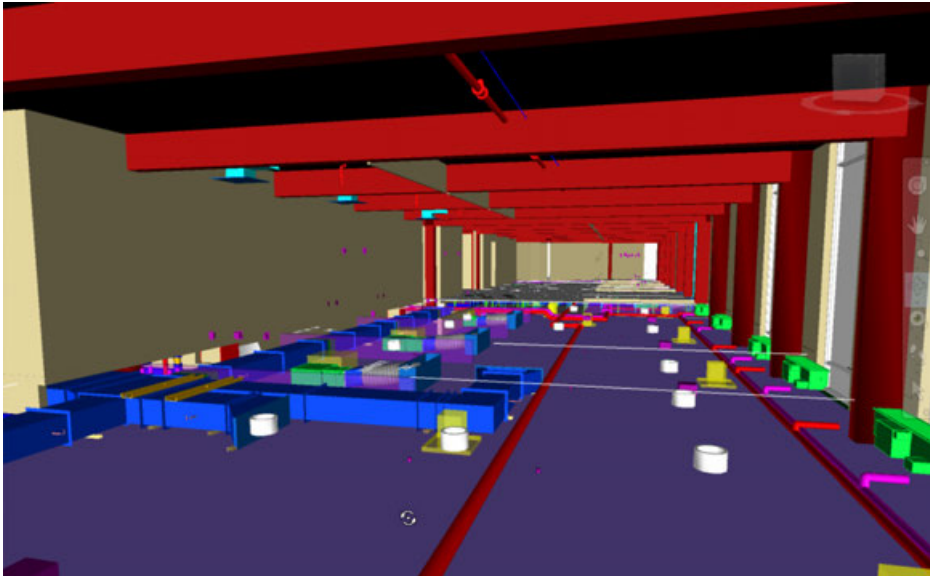


Source: Swinerton  
Photo: Alex Schreyer

# Early Move-In for Rough-In Trades.



# Embracing BIM for Fabrication



Photos: Swinerton

# Holistic Schedule Analysis

Shorter Schedule = Lower General Conditions Costs



Photo: Swinerton

# SITE PLANNING



Photo: Swinerton

QA/QC



Photo: Swinerton

# LOGISTICS PLANNING



Photo: Swinerton

# MATERIAL DELIVERY



Photo: Swinerton



# SITE ORGANIZATION & STAGING



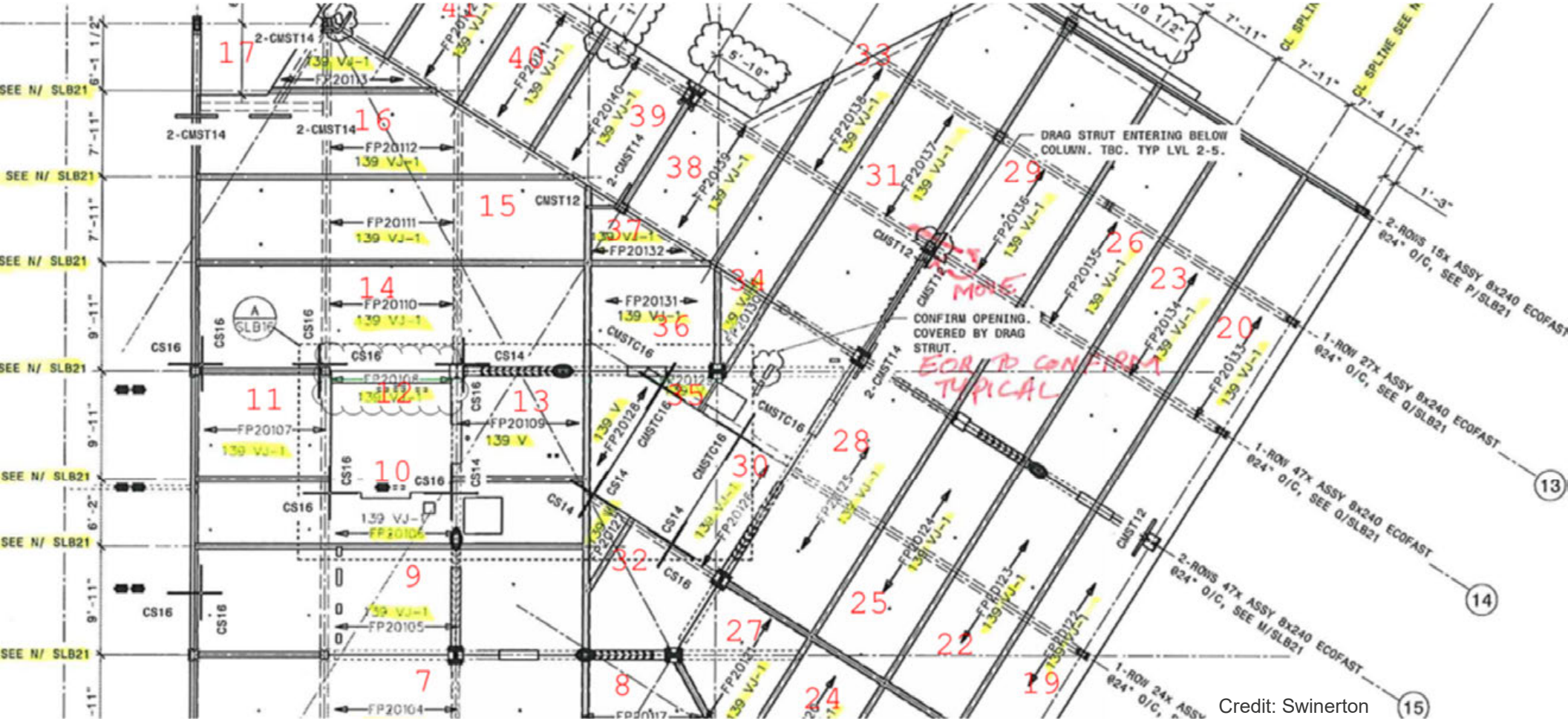
Photo: Swinerton

# PICK PLAN



Photo: Swinerton

# Sequencing



Credit: Swinerton

13  
14  
15



Photo: Swinerton

# Material Protection

Painting steel  
Taping joints

Protect end cuts of timber



Photo: Alex Schreyer



## Workforce Development

Training is the key to efficiency  
Training takes time and money

## Training versus Education

## Resources available to all

MT Construction Manual  
Installer Curriculum  
Other WW Resources  
CM Workshops  
Previous recorded versions  
Learning Management System

# Mass Timber Construction Management Program



MASS TIMBER CONSTRUCTION  
MANUAL



8- & 16-HOUR INSTALLER  
TRAINING PACKAGE AND  
TRAINING CENTERS



COMMUNITY COLLEGE  
AND UNIVERSITY CM  
PROGRAMS



VIRTUAL AND/OR IN-PERSON  
WORKSHOPS



PARTNER WITH  
CONSTRUCTION ASSOCIATIONS



PROJECT TOURS



ENGAGE WITH GENERAL  
CONTRACTORS ACROSS THE US

# Agenda



## Mass Timber Construction: Making the Case

<b>10:00 am – 11:00 am</b>	Mass Timber Construction Management: Economics, Logistics & Risk Analysis
<b>11:00 am - 11:15 am</b>	Break
<b>11:15 pm – 12:15 pm</b>	Mass Timber: Making the Case to Developers and Owners
<b>12:15 pm – 1:00 pm</b>	Lunch

# Mass Timber Construction: Making the Case

Part 2: Mass Timber: Making the Case to Developers and Owners

April 10, 2024

Presented by  
Tino Kalayil, PE, WoodWorks



Image: INTRO Cleveland / photo Nick Johnson, Tour D Space



# Topics

- » Resources for Developers/ Owners
- » Forest to City, A Mass Timber Introduction
- » Sustainability & Forestry
- » Tall Wood
- » Construction Management
- » Insurance
- » Mass Timber Buildings Sold
- » Business Case Studies

# Topics

- Resources for Developers/ Owners
  - » Forest to City, A Mass Timber Introduction
  - » Sustainability & Forestry
  - » Tall Wood
  - » Construction Management
  - » Insurance
  - » Mass Timber Buildings Sold
  - » Business Case Studies

# Resources for Developers/Owners

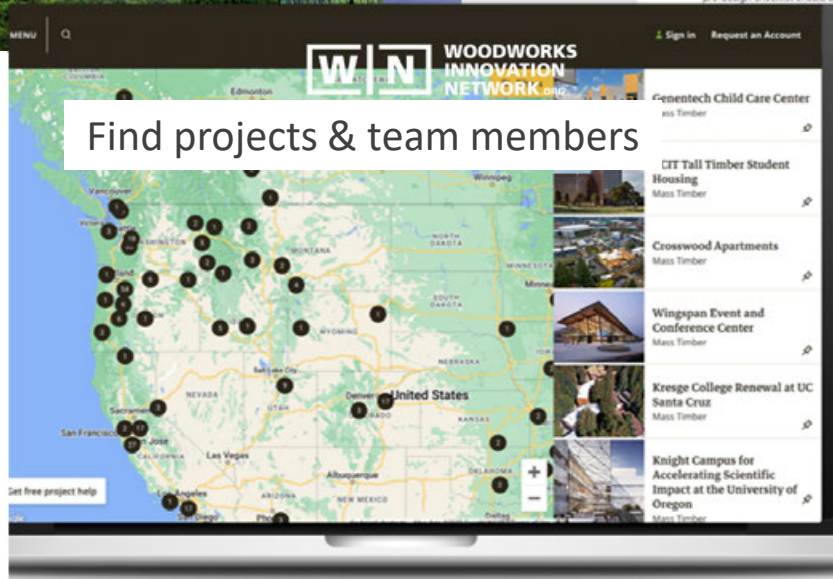
Scan for website



## 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.

The Hon. San Francisco, CA  
 Assembly  
 Performance  
 Director  
 DCI Engineers  
 Construction  
 Harmony Committee



## Mass Timber: The Optimal Solution for Multi-Family High-Rise Construction

As urbanization and rising land costs drive greater density, the need for efficient and sustainable construction methods becomes increasingly crucial. Mass timber is an innovative solution that can meet housing needs while addressing environmental concerns, and was the preferred technology for the way we build in urban centers.

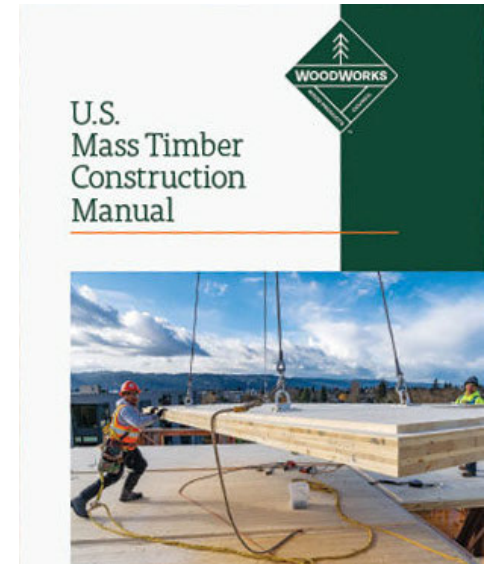
**The Urban Densification Imperative**  
 According to the United Nations, 68% of the world's population is expected to live in urban centers by 2050. These areas are constrained by limited available land, while increased demand has resulted in soaring land costs. Both add pressure to maximize building space, which requires efficient construction methods that minimize a building's footprint and allow vertical expansion. None of this is possible in mass timber. These constraints apply to high-rise projects across the United States, and of course many successful mass timber high-rises continue to be completed. Which begs the question: Why more timber, why now?

**Mass Timber's Value Proposition**  
 As multi-family development is accelerated, forward-thinking developers are not only the ones to provide sustainable, cost-effective projects, but to hedge against future development caused by economic recession, job losses, an over-saturated housing market, or other factors. What then is the value proposition of mass timber?

Optimization was also top of mind for the developer of Ascent, a 25-story mass timber housing project and currently the world's tallest mass timber building.

**The primary driver for its use architecturally**, we used looking for a difference, and in 2017 I saw the rendering for Blue Beach Tower (a study in a potential 80-story mass timber tower in Chicago). It was a revelation to see that not only is it possible to build a high-rise out of wood, but you can also expose that structure inside, and the aesthetics are incomparable. It was this idea moment of, "How can we do this?"

The Gorkham  
 Mass Land Education  
 Developer of Ascent  
 25 stories - Milwaukee, WI

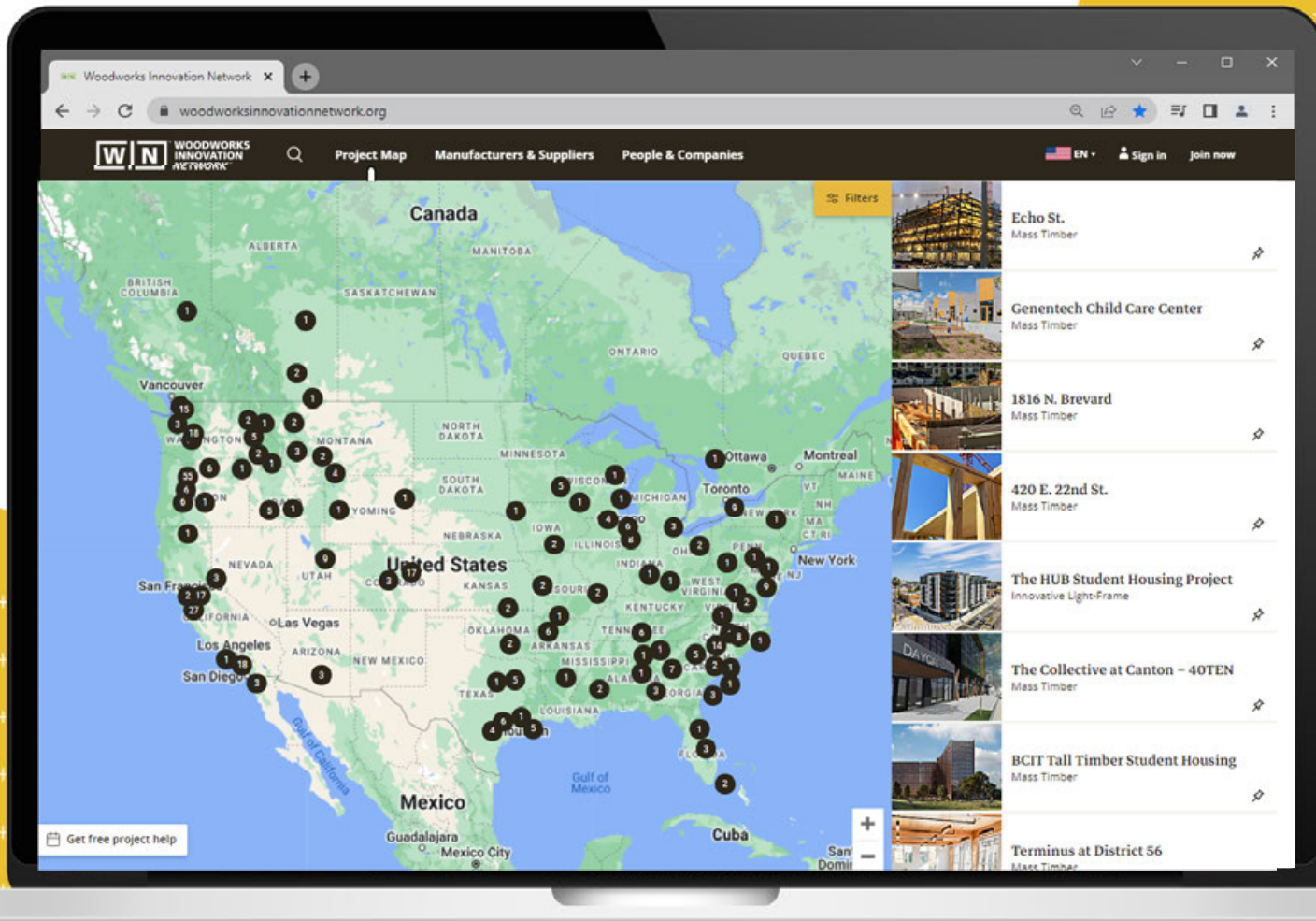




**WOODWORKS  
INNOVATION  
NETWORK.ORG**



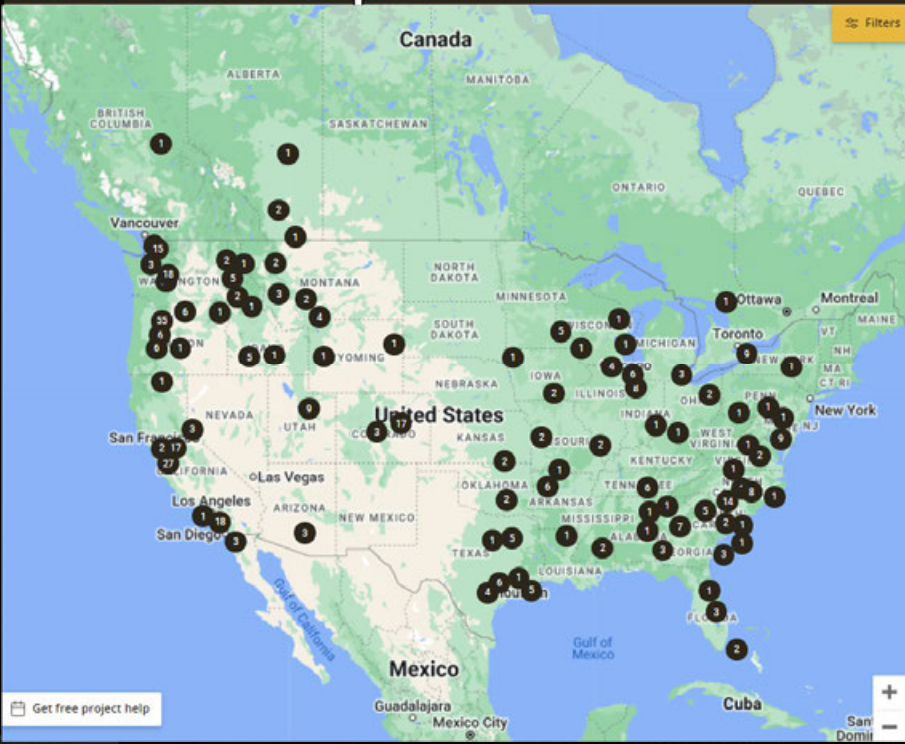
111 East Grand / Neumann Monson Architects  
photo Mike Sinclair



Woodworks Innovation Network x +  
woodworksinnovationnetwork.org

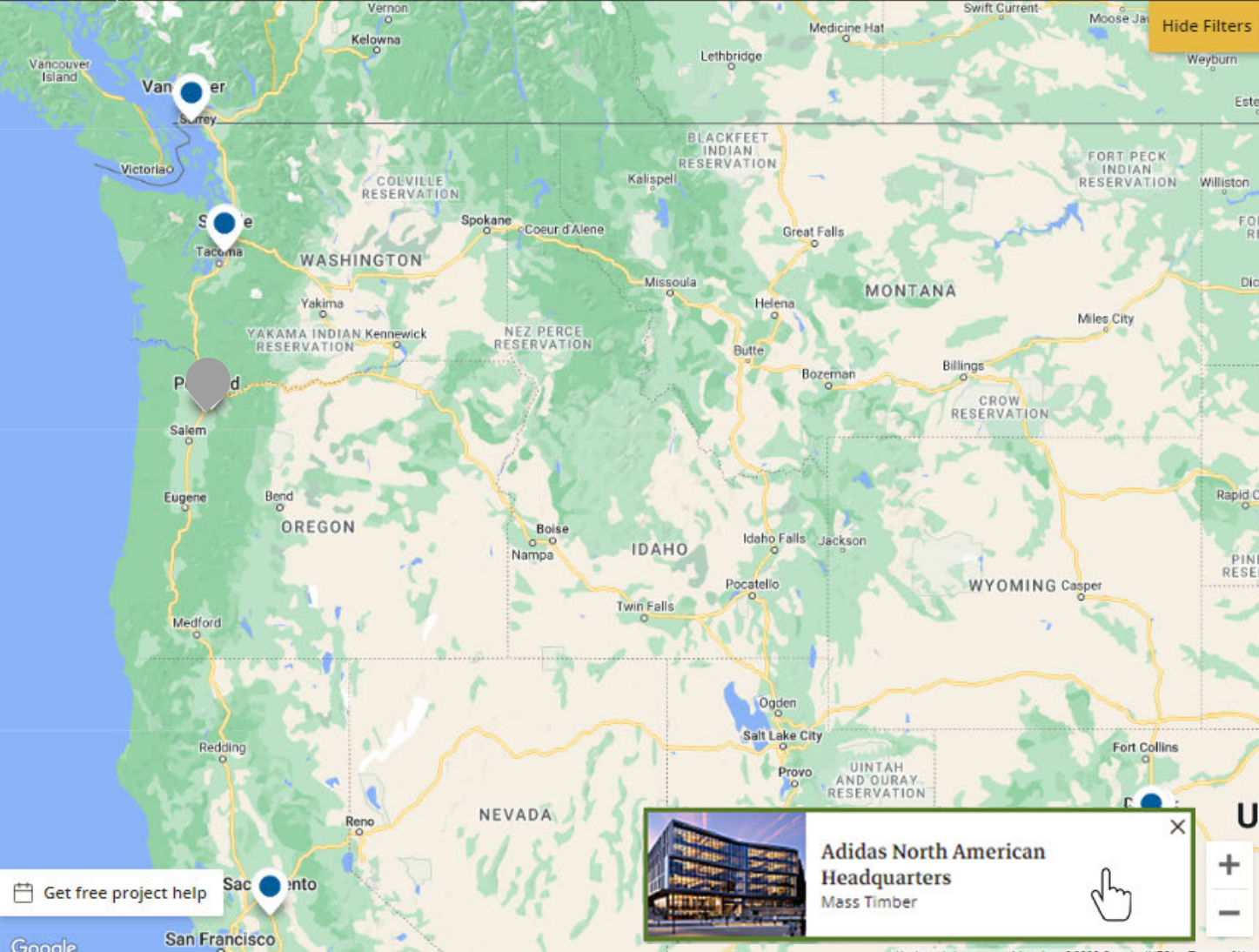
WOODWORKS INNOVATION NETWORK  
Project Map Manufacturers & Suppliers People & Companies

EN Sign in Join now



- 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

Get free project help



- Structural Composite Lumber (e.g. LVL and LSL) 0
- Timber-Frame / Post and Beam 2
- Wood structural panels 0
- Wood-Concrete Composite Systems 0

**Other Properties**

- Wood Design Award Winner 2
- Affordable Housing 1
- Business Case Study Available 0
- Spec Office 1
- Technical Case Study Available 1

**Number of Stories**

1 — 12

**Year Built**

Select...

**Construction Types**

- |                                  |                                    |
|----------------------------------|------------------------------------|
| <input type="checkbox"/> I-A 0   | <input type="checkbox"/> IV-B 1    |
| <input type="checkbox"/> I-B 0   | <input type="checkbox"/> IV-C 0    |
| <input type="checkbox"/> II-A 0  | <input type="checkbox"/> IV-HT 2   |
| <input type="checkbox"/> II-B 0  | <input type="checkbox"/> Unknown 0 |
| <input type="checkbox"/> III-A 3 | <input type="checkbox"/> V-A 0     |
| <input type="checkbox"/> III-B 1 | <input type="checkbox"/> V-B 1     |
| <input type="checkbox"/> IV-A 0  |                                    |

**Square Footage**

- < 10,000 18
- 10,000 - 50,000 72
- 50,000 - 200,000 74
- 200,000 + 8

Get free project help

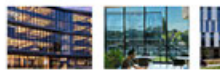
Free Project Support from WoodWorks

# Adidas North American Headquarters

Portland, OR



Photo Credit Jeremy Bittermann



Innovation, performance, and sustainability were top priorities for Adidas when they expanded their North American headquarters. The building faced unique design challenges, including tight schedules, budget constraints, and the need for a sustainable structure.



Photo Credit

Innovation, performance, and sustainability were top priorities for Adidas when they expanded their North American headquarters. The building faced unique design challenges, including tight schedules, budget constraints, and the need for a sustainable structure.

View

COMMENTS

LEVIS

Turkey

General

INDUSTRY

The

Adidas



**Thomas Robi**  
Founding Principal, LEVIS  
Portland, OR

INDUSTRY  
Architect

SERVICES OFFERED  
Architect, Design

HAS EXPERIENCE WITH THESE BUSINESS TYPES  
Business (Office)

HAS EXPERIENCE WITH THESE MATERIALS  
Mass Timber

HAS EXPERIENCE WITH THESE CONSTRUCTION TYPES  
I/A

BADGES EARNED



**SEND A MESSAGE**

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PROJECTS:



Albina Yard  
Portland, OR



Redfox Commons  
Portland, OR

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# Topics

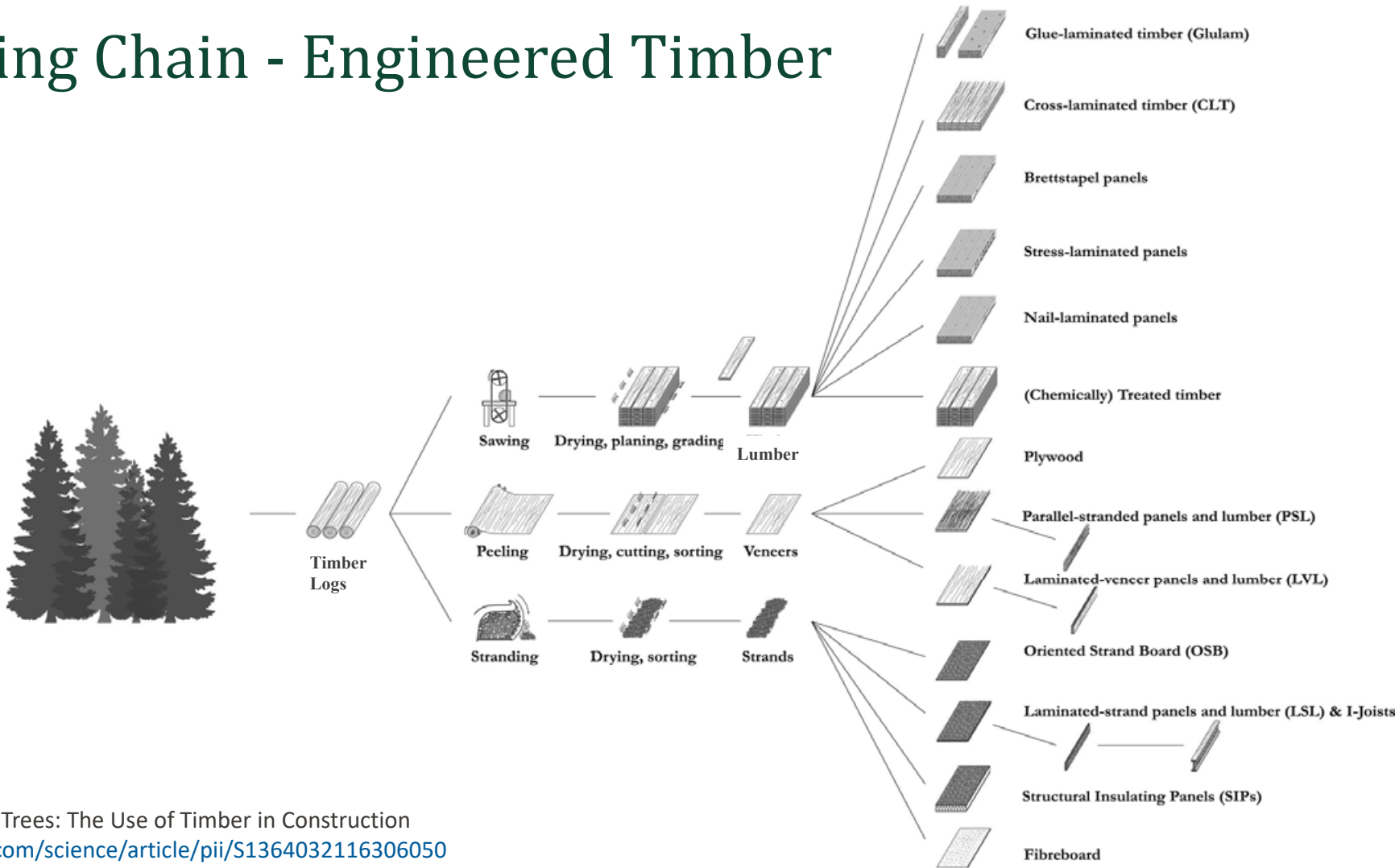
- » Resources for Developers/ Owners
- Forest to City, A Mass Timber Introduction
- » Sustainability & Forestry
- » Tall Wood
- » Construction Management
- » Insurance
- » Mass Timber Buildings Sold
- » Business Case Studies

# Forests – Timber – Building Materials



Logs at Manufacturing Facility, Oregon | Photo: WoodWorks

# Processing Chain - Engineered Timber



Source: The Wood from the Trees: The Use of Timber in Construction  
<https://www.sciencedirect.com/science/article/pii/S1364032116306050>

# Small Diameter Trees



Photos: WoodWorks

# Mass Timber Products

Nail-Laminated Timber (NLT)



Cross-Laminated Timber (CLT)



Glue-Laminated Timber (GLT)



Structural Composite Lumber (SCL)



Image source: StructureCraft

# Large Pre-fabricated Mass Timber Panels



Candlewood Suites, Redstone Arsenal, AL | Lendlease



Image: MyTiCon

# Mass Timber Buildings

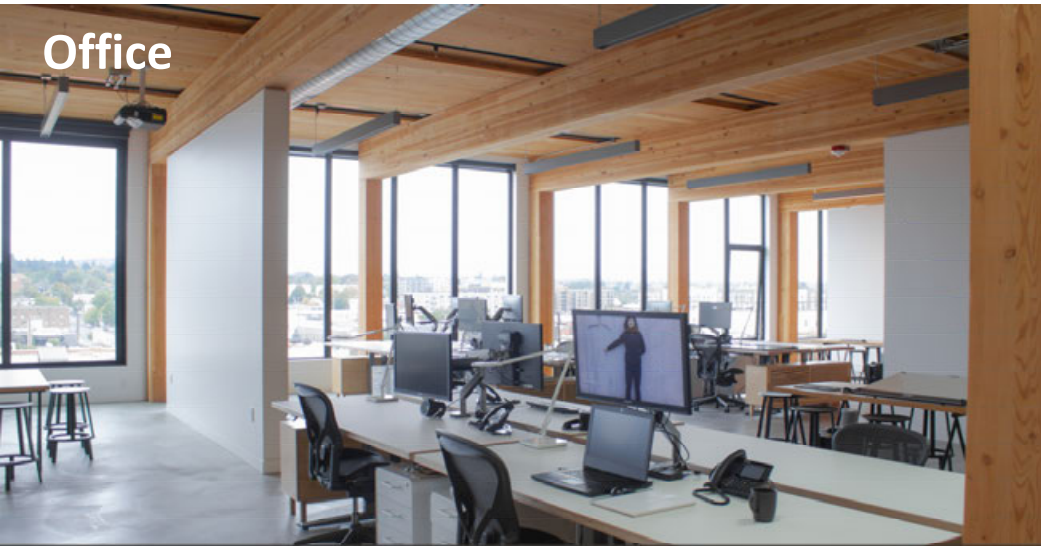


# Forest-to-Cities Climate Challenge A Systemic Solution in Action



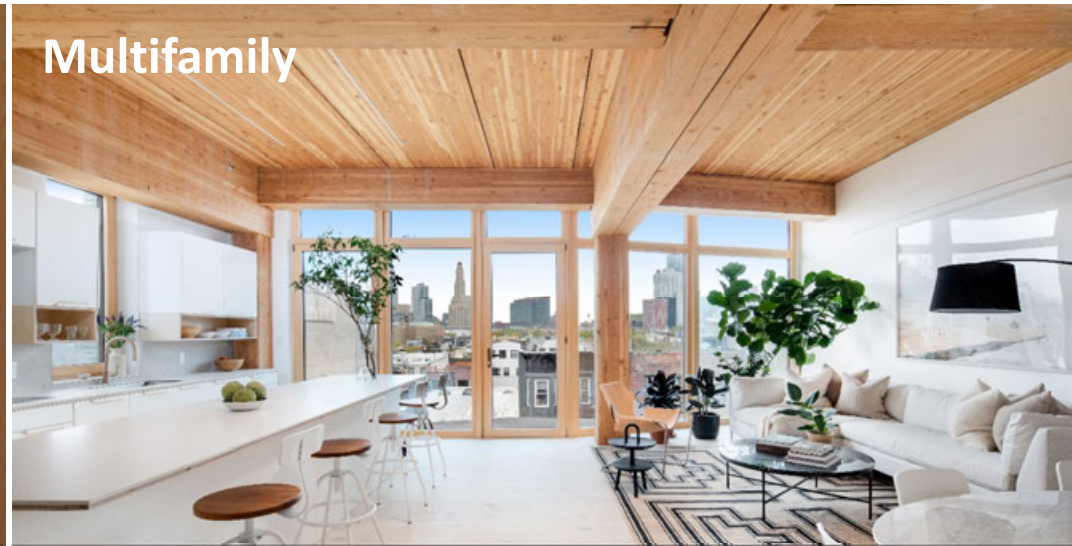
[www.ForesttoCities.org](http://www.ForesttoCities.org)





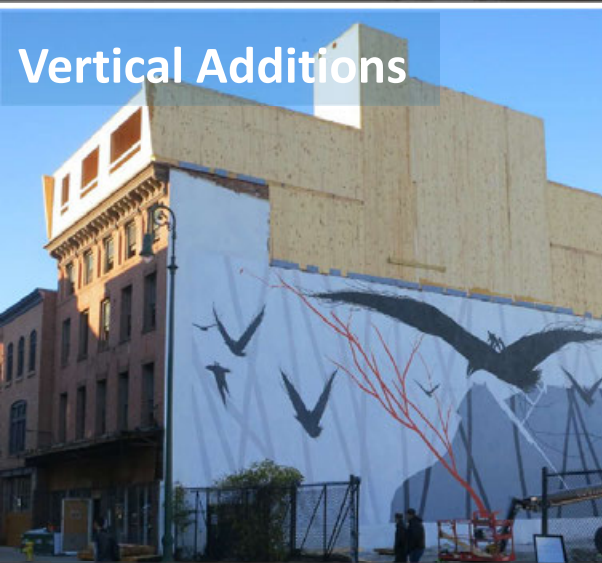
## Office

District Office, Portland | Urban Development + Partners | Hacker Architects



## Multifamily

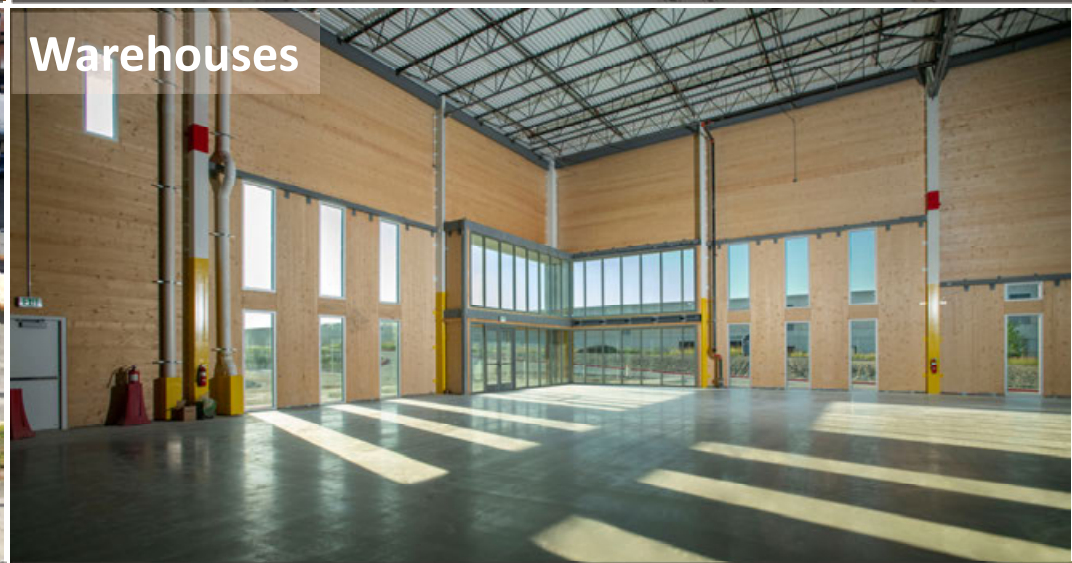
Timber House, Brooklyn | Brooklyn Home Company | Mesh Architectures | Photo: Travis Mark



## Vertical Additions



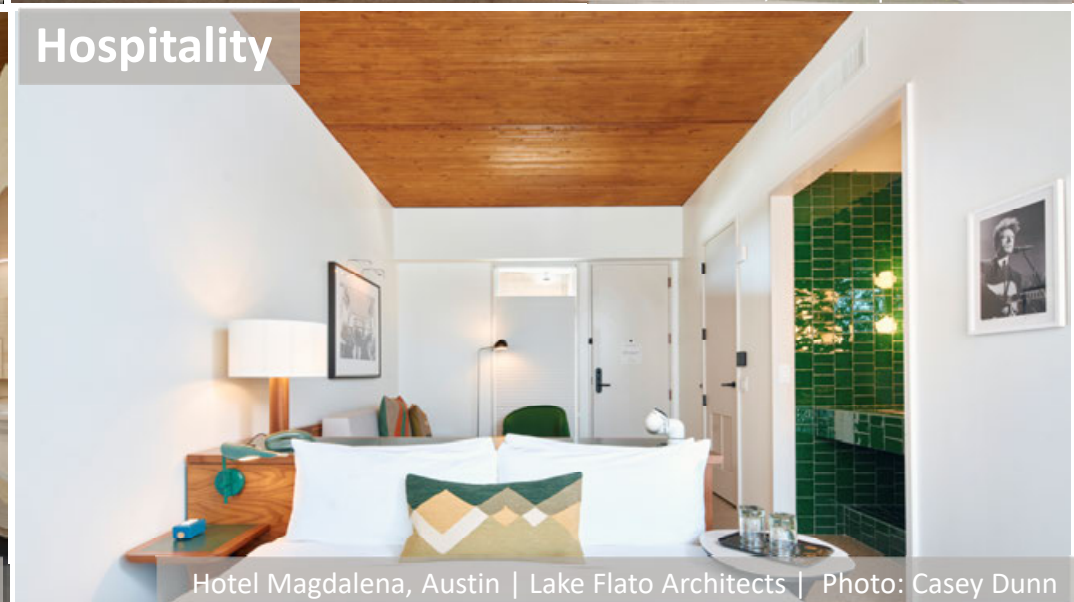
Gray Organschi Architecture



## Warehouses

Southfield Park 35 Warehouse, Dallas | Affinius Capital | Image: Mark Humphries Photography

ACME Timber Lofts, New Haven | Spiritos Properties



# Topics

- » Resources for Developers/ Owners
- » Forest to City, A Mass Timber Introduction
- **Sustainability & Forestry**
- » Tall Wood
- » Construction Management
- » Insurance
- » Mass Timber Buildings Sold
- » Business Case Studies

# Sustainability Brief

- » High level overview of sustainability benefits of mass timber
  - » Carbon benefits
  - » Forest health & wildfire resilience
  - » Healthy buildings & biophilia
  - » Energy efficiency & insulation
  - » Circular economy
- » Short read - great for developers, their capital partners, and anyone who just needs a brief intro to topic

<https://www.woodworks.org/resources/meeting-sustainability-objectives-with-wood-buildings/>

## Meeting Sustainability Objectives with Wood Buildings

Healthy Buildings, Carbon Impact, Resilience, Circularity



Mass timber structural systems help meet several development objectives that fall under the broad sustainability umbrella, including healthy buildings, reduced carbon impact, resilience, and circularity. Developers and owners can take advantage of wood's benefits to create buildings that contribute value by attracting tenants, align with evolving policy requirements, and appeal to investors who are increasingly seeking sustainable investments.

### Carbon Benefits of Wood Buildings

Less Embodied Carbon + Stored Carbon = Lower Carbon Impact

**Low embodied carbon:** Wood products have low embodied carbon compared to steel and concrete.<sup>1,2</sup> Embodied carbon is a measure of the greenhouse gas (GHG) emissions associated with materials and construction processes throughout the lifetime of a structure. Embodied carbon, especially upfront emissions associated with producing materials and constructing a building, can be significant.<sup>3</sup>

**Biogenic carbon:** As trees grow, they absorb carbon dioxide (CO<sub>2</sub>) from the atmosphere, release the oxygen (O<sub>2</sub>), and store the carbon in their wood, leaves or needles, and roots. Wood elements used in a building continue to store this carbon for the building's lifetime—longer if the wood is reclaimed and reused or recycled.

Developer Crescent Real Estate chose mass timber for Platte Fifteen, a speculative office development in Denver, for aesthetic differentiation and alignment of sustainability goals. They found that the authentic aesthetic of timber appeals to both technology companies as well as more traditional tenants.<sup>4</sup>

*"Mass timber is great environmentally and creates warm, natural, biophilic spaces that enrich human experiences. It is a viable, sustainable structural option that drove leasing and the ultimate economic success of Platte Fifteen. The differentiated authentic timber interiors proved to be exceptionally attractive to quality, sustainability-minded tenants and investors. It is fundamentally what makes this building special."*

— Conrad Suszynski, Co-CEO  
Crescent Real Estate



Platte Fifteen – Denver, CO  
Crescent Real Estate

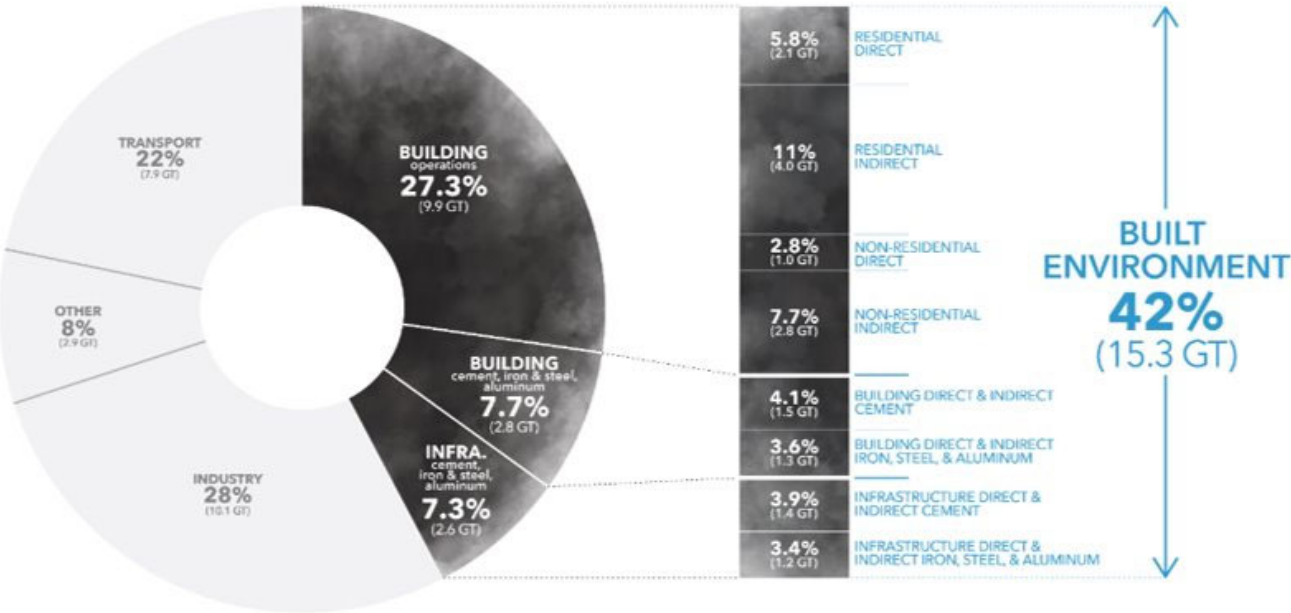
# Healthy Buildings & Biophilia



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

# The Built Environment & Carbon Dioxide Emissions

TOTAL ANNUAL GLOBAL CO<sub>2</sub> EMISSIONS  
Direct & Indirect Energy & Process Emissions (36.3 GT)



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

- » Building Operations
- » Embodied Carbon

Embodied carbon: **15%**

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

© Architecture 2030. All Rights Reserved.  
Analysis & Aggregation by Architecture 2030 using data sources from IEA & Statista.

# Carbon Terms

- » **Embodied Carbon:** Carbon emissions associated with the entire life cycle of the building including harvesting, mining, manufacturing, transporting, installing, maintaining, decommissioning, and disposing/reuse of a material or product
- » **Operational Carbon:** Carbon emissions associated with operating a building including power, heat, and cooling



Image: Boston Society for Architecture

# Embodied Carbon

- Primarily related to **manufacturing of materials**
- More significant than many people realize, has been **historically overlooked**
- Big upfront GHG “cost” - which makes it a **good near-term target** for climate change mitigation

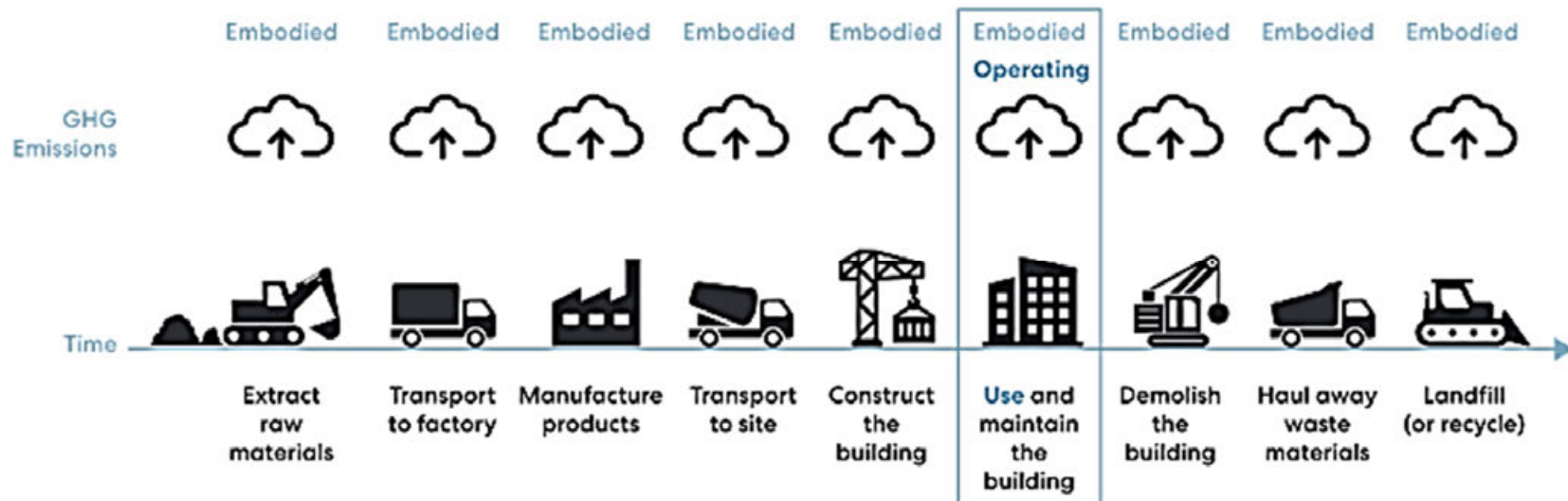
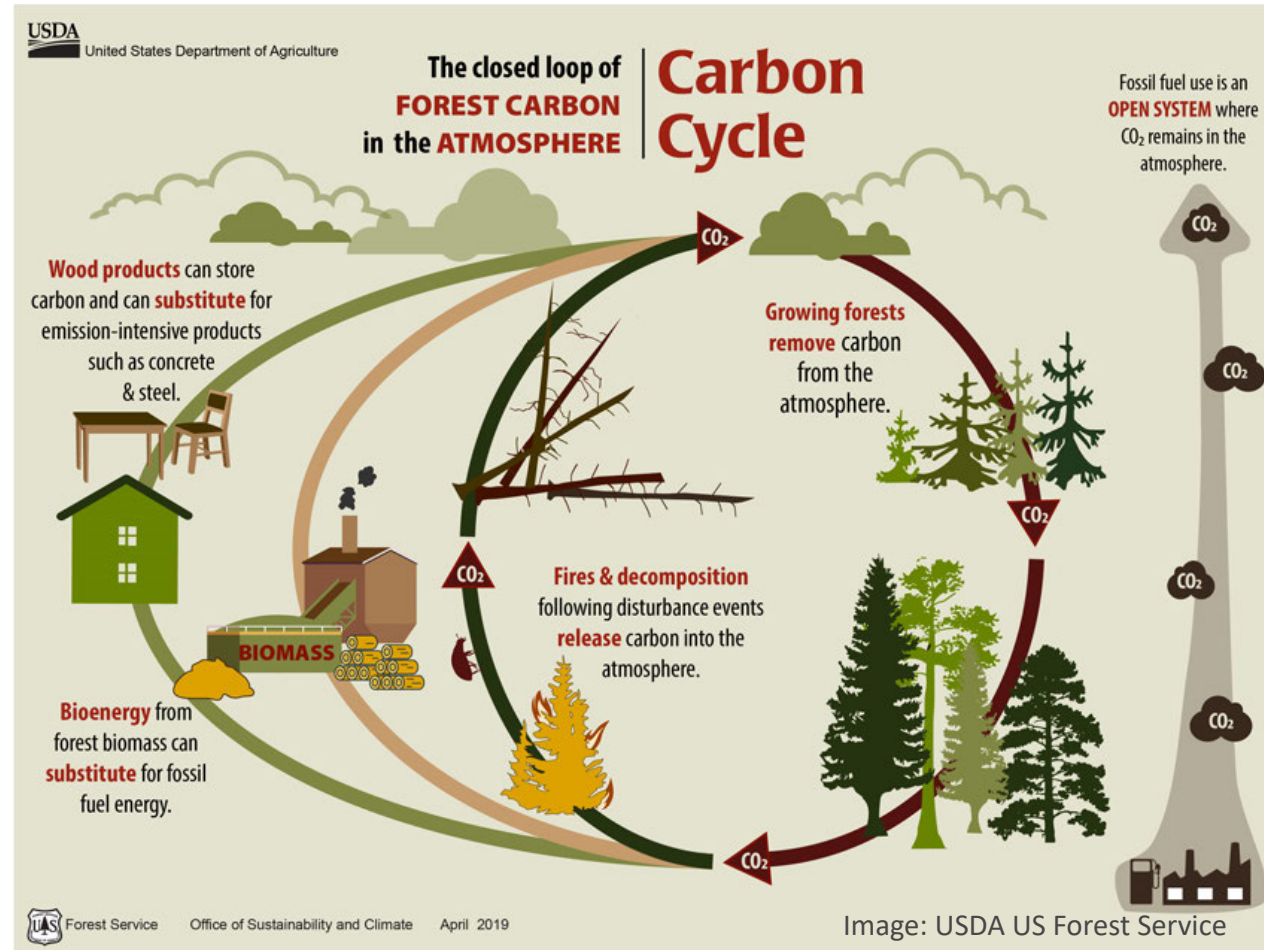


Image: ThinkWood



# 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**



## Carbon Storage: Wood $\approx$ 50% Carbon (dry weight)



Image: Kaiser + Path

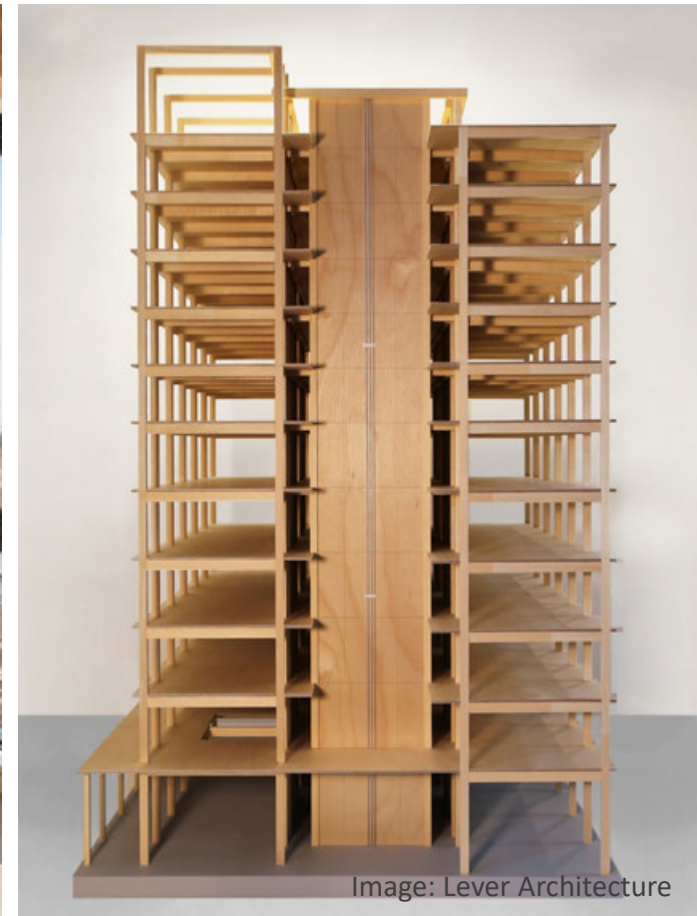
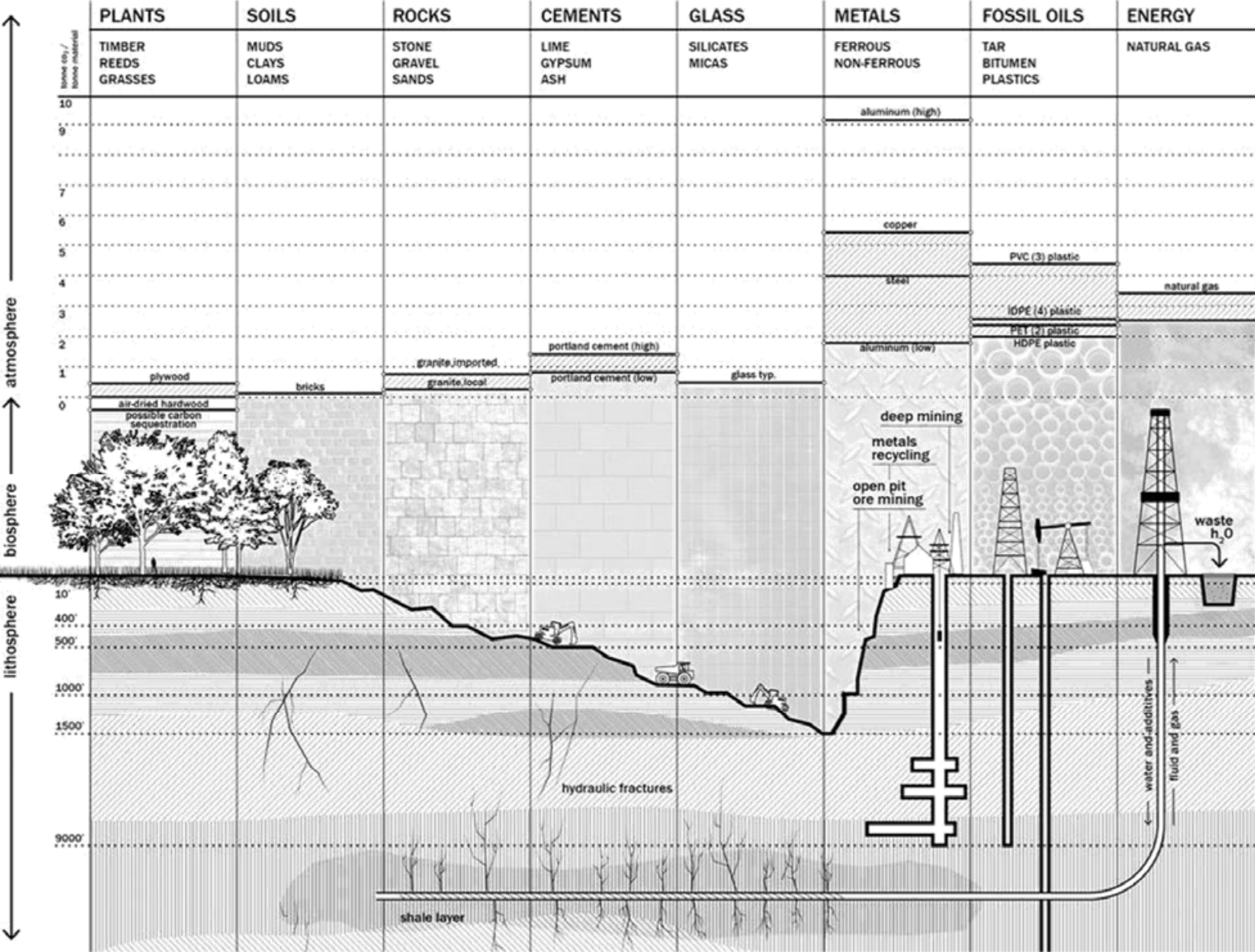


Image: Lever Architecture

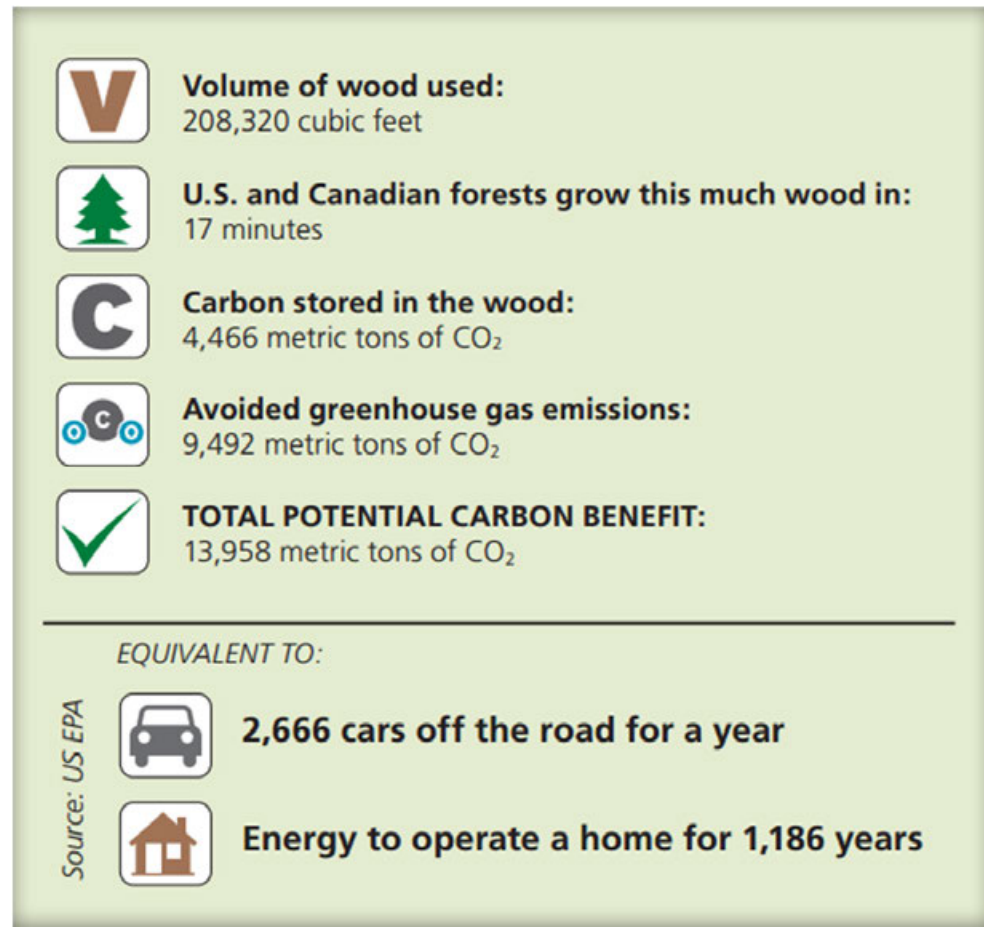
# Extractivism and its Impacts



Source: Timber City Research Initiative, Gray Organschi Architecture

# WoodWorks Carbon Calculator

- Available at [woodworks.org](http://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



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

# Platte Fifteen

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

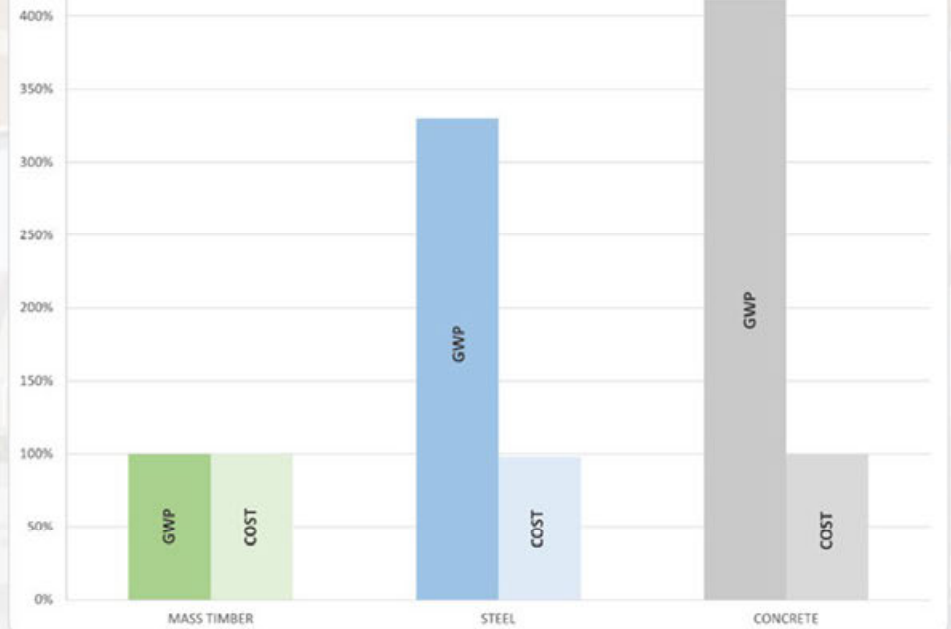


## PROJECT DETAILS

**LOCATION:**  
Denver, Colorado

**SIZE:**  
Five stories; 150,418 square feet

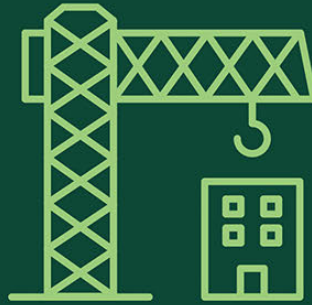
STRUCTURAL SYSTEM GWP AND WHOLE BUILDING COST (%)



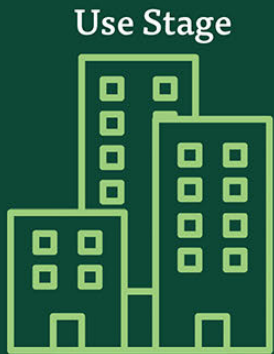
Source: Platte Fifteen Life Cycle Assessment  
<https://www.woodworks.org/resources/platte-fifteen-life-cycle-assessment/>



Production Stage



Construction Stage



Use Stage



End-of-Life Stage



## Mass Timber Comparative Life Cycle Assessment Series

Comparing the embodied carbon impacts and cost of mass timber buildings to functionally equivalent buildings

### Introduction



Author

KL&A Engineers & Builders / KL&A Team Carbon

# Credits for Sustainable/ Well Certifications



## LEED v4.1 BD+C Indoor Environmental Air Quality

- Low-Emitting Materials
- Thermal Comfort

## Materials & Resources

- Environmental Product Declarations
- Responsible Sourcing of Raw Materials
- Building Life-Cycle Impact Reduction
- Construction & Demolition Waste Management



## Passive House 3rd Edition Core Principles

- Thermal Insulation
- Thermal Bridge Reduced Design
- Airtightness



## WELL v2 Materials

- Materials Transparency

## Mind

- Nature & Place
- Restorative Spaces

## Thermal Comfort

- Thermal Performance
- Verified Thermal Comfort



## Living Building Challenge 4.0

### Energy Petal

- Energy + Carbon Reduction
- Net Positive Carbon

### Materials Petal

- Responsible Materials
- Responsible Sourcing
- Living Economy Sourcing
- Red List
- Net Positive Waste

### Beauty Petal

- Beauty + Biophilia

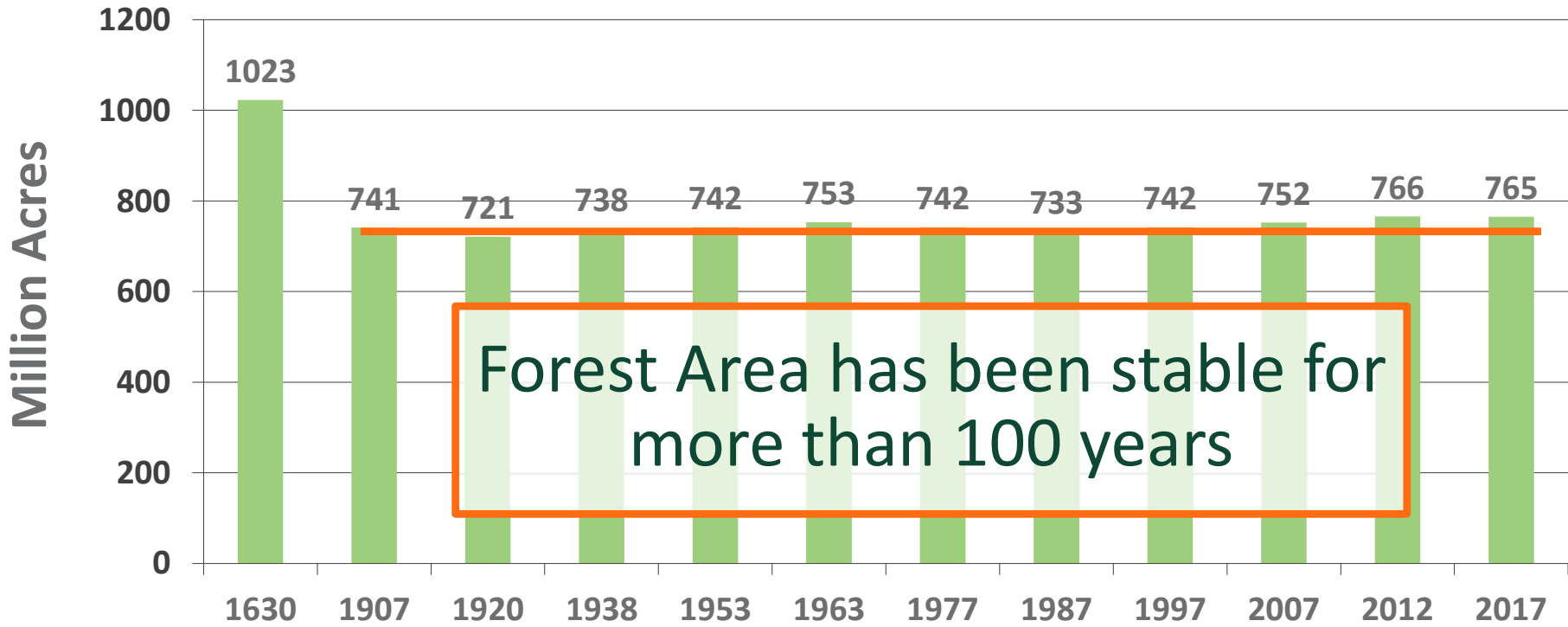
Source: [Mercer Mass Timber and The Environment](#)

# State of Our Forests



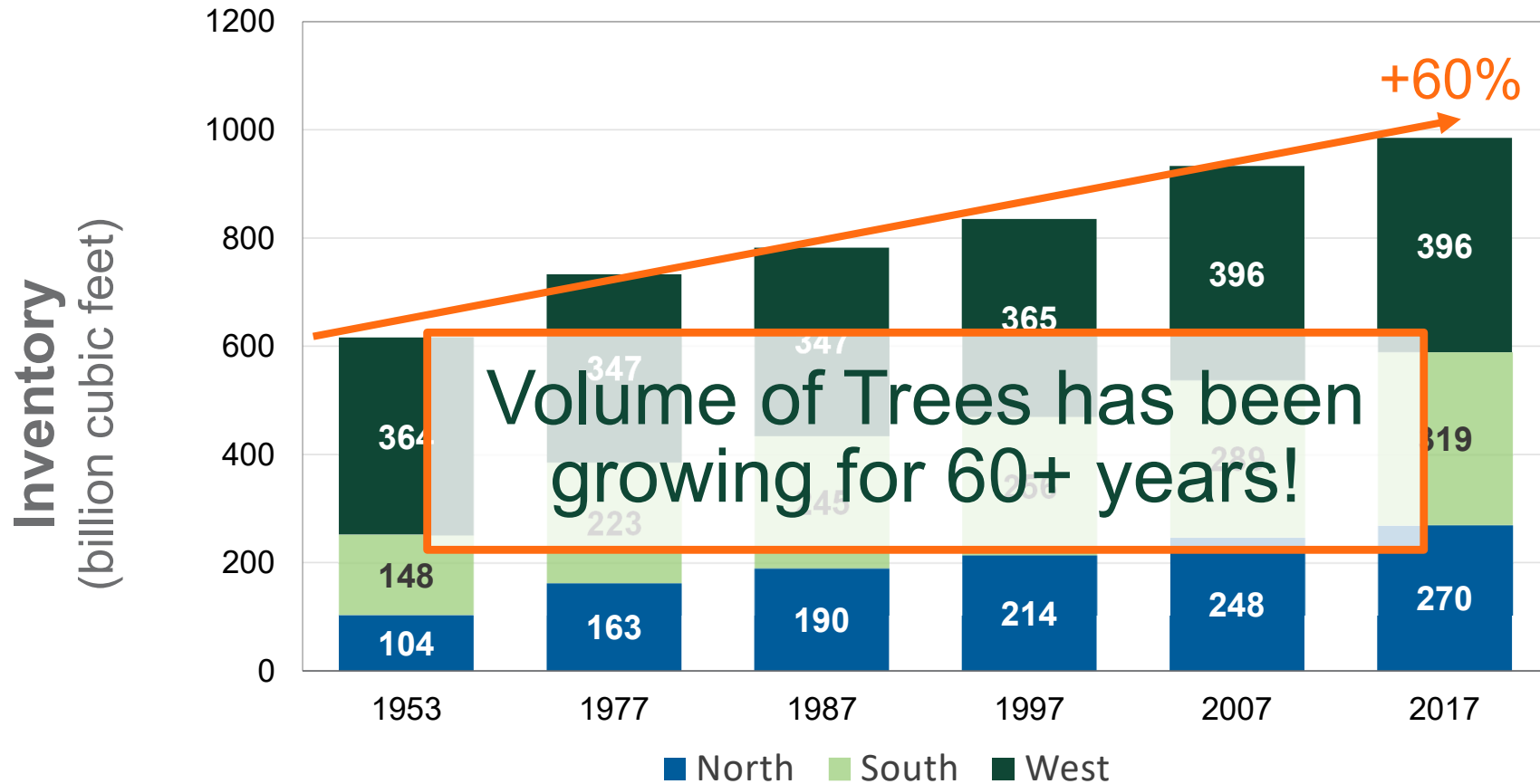


# U.S. Forest Land: Forest Area in the United States 1630 – 2017



Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

# State of our Forests: US Timber Volume on Timberland

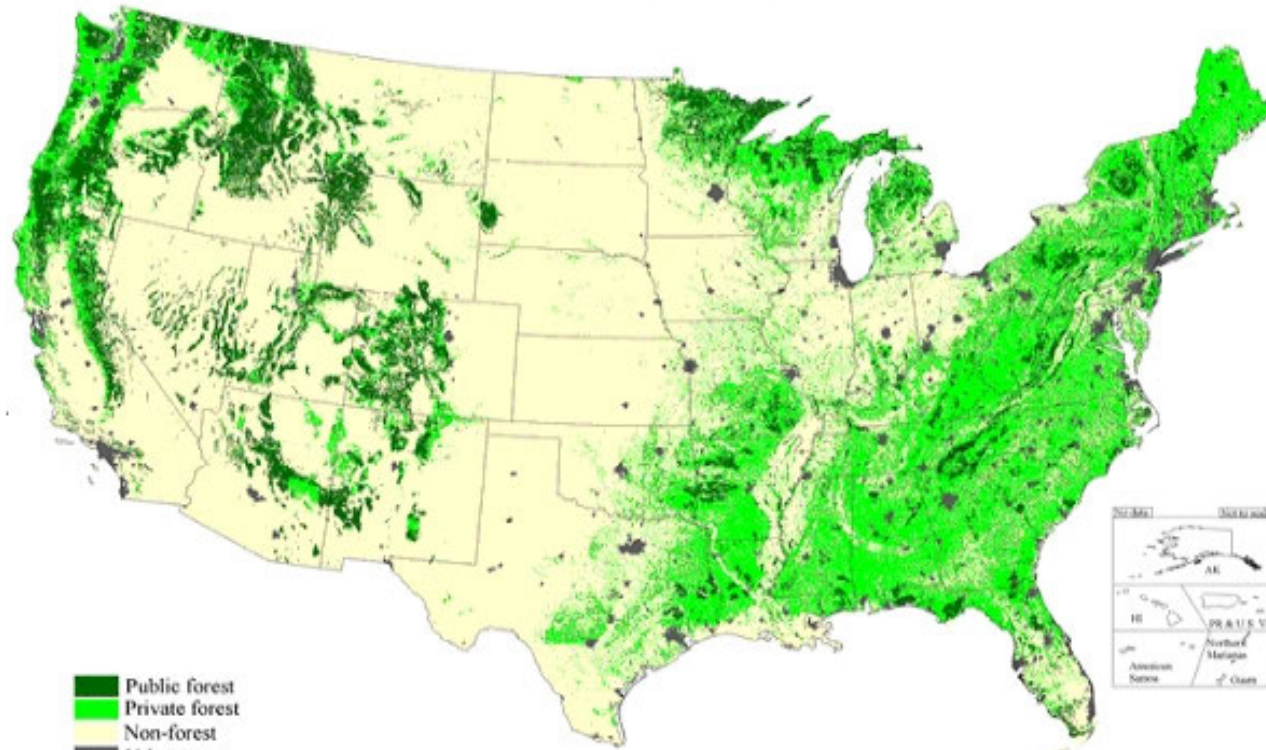


Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

# US Forest Lands

## Forest Land Ownership

This map displays the basic vegetation (forest vs. non-forest) of the conterminous United States as well as ownership (private vs. public). The lands displayed as "public" include Federal and State lands but do not generally include lands owned by local governments and municipalities.



- Public forest
- Private forest
- Non-forest
- Urban areas

USDA Forest Service, State and Private Forestry,  
Cooperative Forestry Staff, Washington Office.



100 0 100 200 300 400 500 Miles

Data sources:  
Forest: NLCD (1992)  
Ownership: PAD (2001)  
States: ESRI Data & Maps 2002  
Urban areas: DCW (1998)

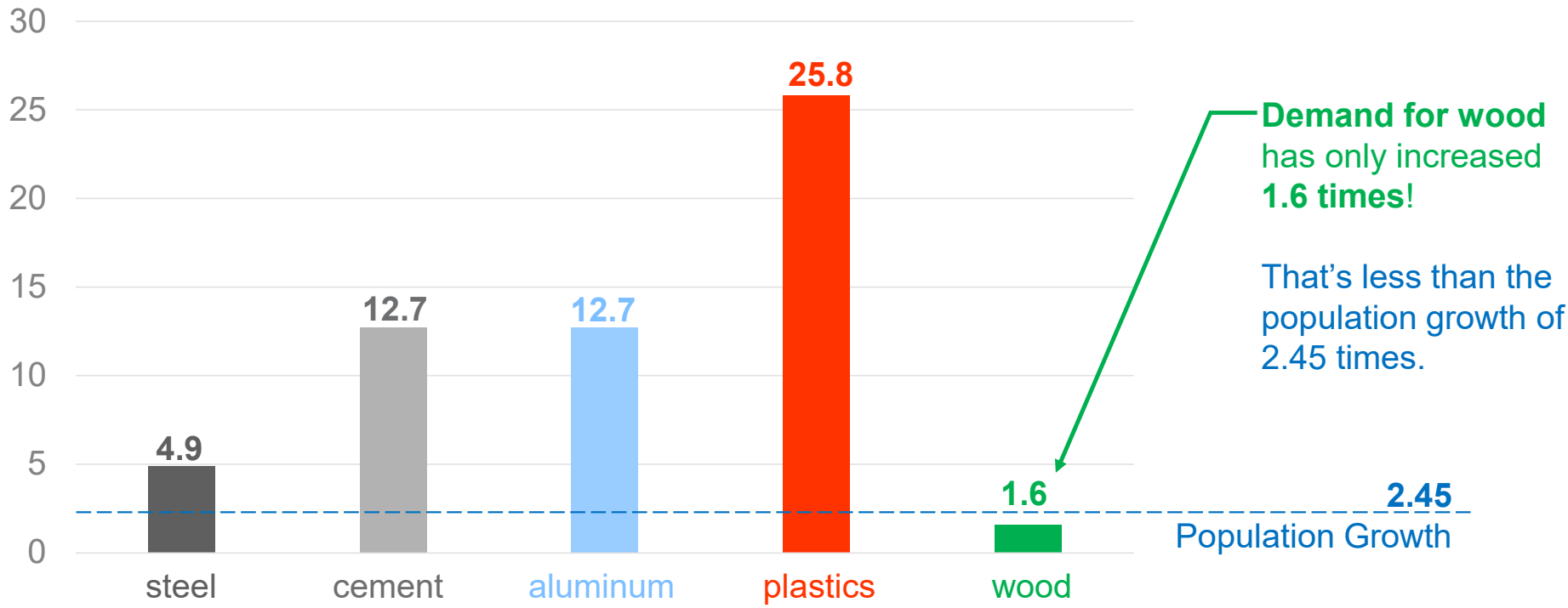
# Regeneration vs. Deforestation



Deforestation is the permanent conversion of forest land to non-forest land uses. Worldwide, agricultural expansion is the main driver of deforestation, but in the U.S., the rate of deforestation has been virtually zero for decades.

Source: State of the World's Forests—2020— FAO and UNEP, USDA Forest Service, US Forest Resource Facts and Historical Trends FS-1034 (2014)

# World Growth in Consumption of Raw Materials 1961-2017

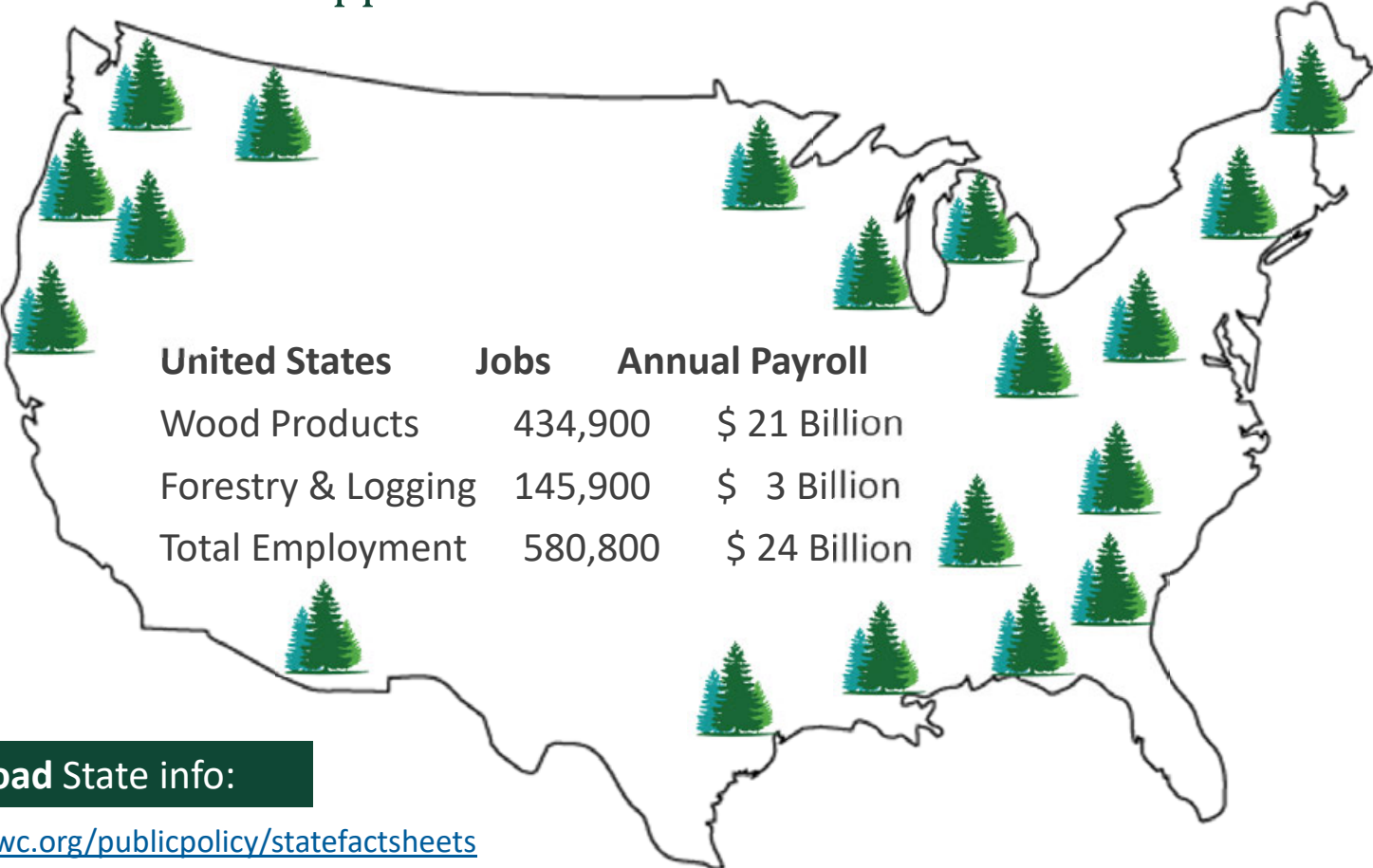


Demand Has Multiplied 'x' Times (1961-2017)

Source: An Introduction To The Circular Economy  
Dovetail Partners, Inc.  
<https://dovetailinc.org/portfoliodetail.php?id=5e6f6fff64cb3>

# Wood Products

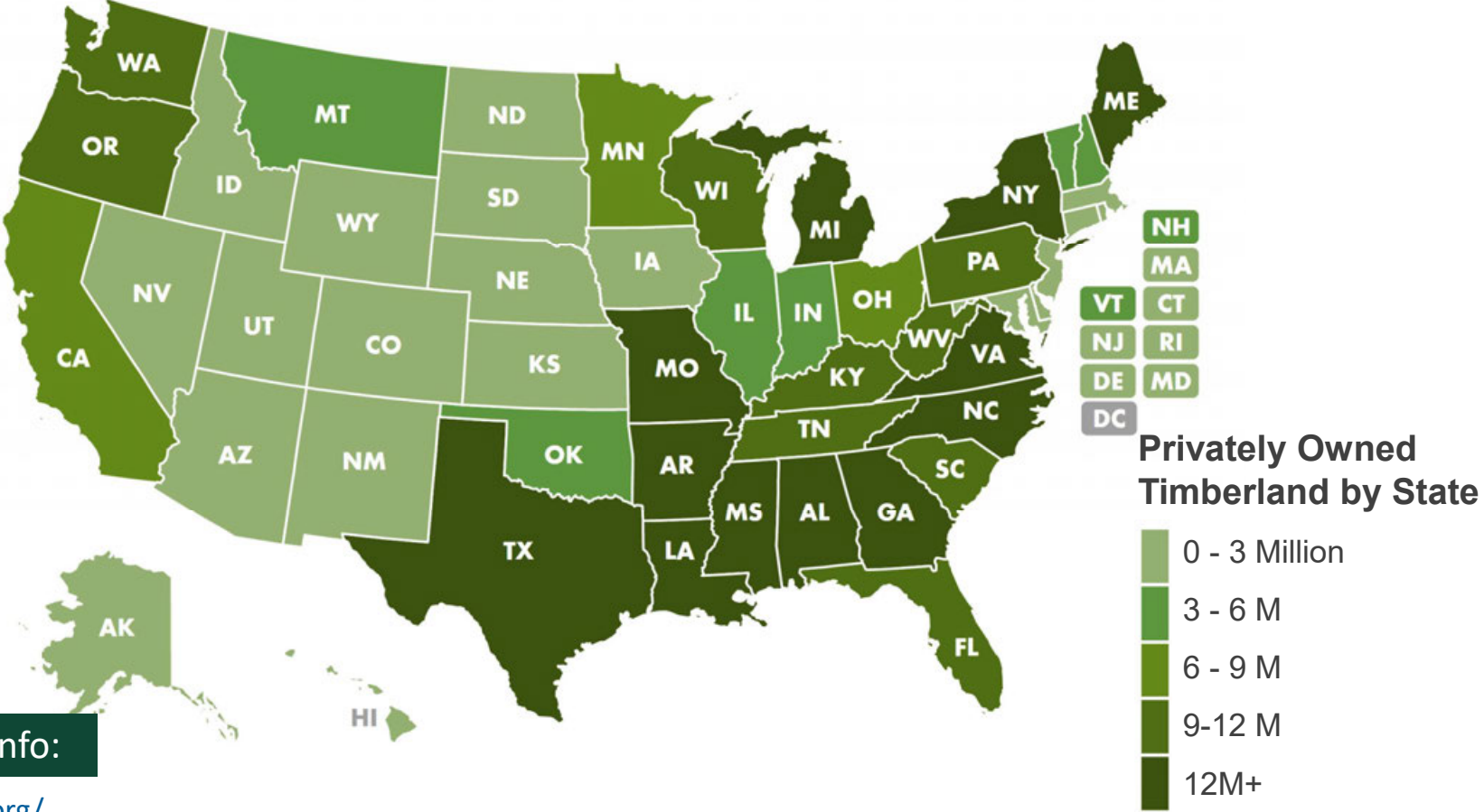
Increase Forest Value & Support Rural Economies



**Download State info:**

<https://www.awc.org/publicpolicy/statefactsheets>

# Private Working Forests



Download State info:

<https://nafoalliance.org/>

# ULI Report: The Materials Movement

## Office Occupier Demand for Healthy Materials:

- » Powerful expression of tenant's brand
- » Helps recruit top talent
- » Healthy air quality supports worker productivity, cognitive performance, mental & physical health

## Enhanced Building Value:

- » Office green premium on rents: from 2% to >15%
- » Certified healthy buildings transact 4.4% to 7.7% higher rent per SF than noncertified buildings

**“Building with mass timber provides a host of benefits to stakeholders across the real estate value chain.”**

<https://knowledge.uli.org/reports/research-reports/2023/the-materials-movement-creating-value-with-better-building-materials>





# Featured Project – Prologis Evergreen Warehouse

## ULI Report: The Materials Movement

- » 246,000 SF speculative logistics warehouse
- » Brampton, Ontario (Greater Toronto Area)
- » CLT roof panels over glulam beams & columns
- » 52'x50' bay sizes w/ 60' staging bay
- » 36' clear height
  
- » Mass timber in lieu of steel deck & framing - **reduced embodied carbon footprint by 62%**
- » Helps Prologis meet their net zero goals & responds to increasing customer interest in sustainable buildings that go beyond operational efficiency.
- » Provides a differentiated asset in competitive market
  
- » Developer: Prologis
- » Completion: December 2024 (expected)

# Mass Timber as a Sustainable Investment

## Research Commentary by |

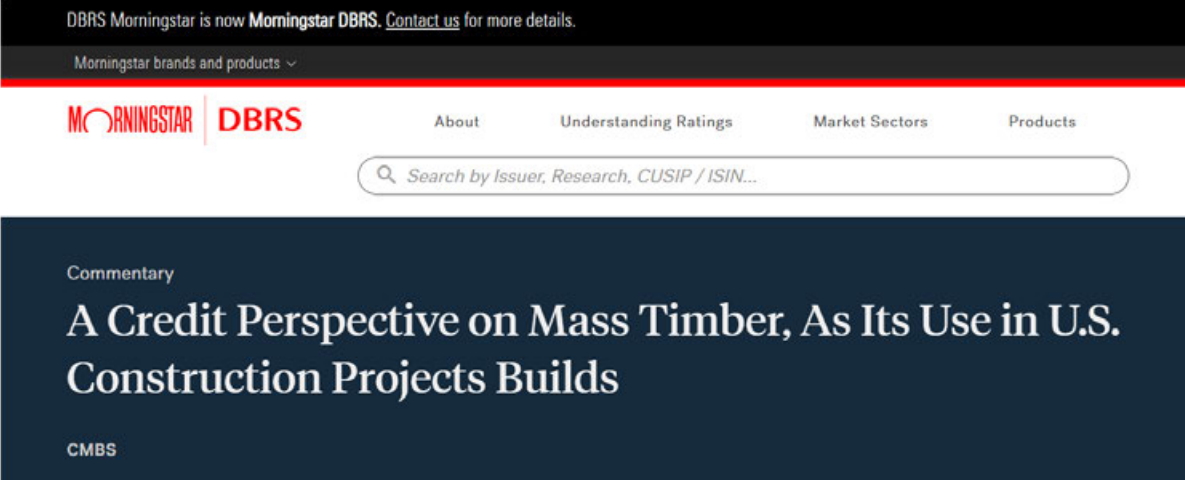
### Traditional Investment Considerations:

- » Can mass timber outperform market? Achieve higher rents & faster lease up? Lower cap rates?
- » If so, rating agencies & investors can modify net cash flow projections & cap rates.
- » Expect this could happen over time, but not enough quantitative data available yet

### Environmental & Social impact:



- » E: Low carbon
- » S: healthy/ well & labor benefits

<https://dbrs.morningstar.com/research/427032/a-credit-perspective-on-mass-timber-as-its-use-in-us-construction-projects-builds>



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🔍 Search by Issuer, Research, CUSIP / ISIN...

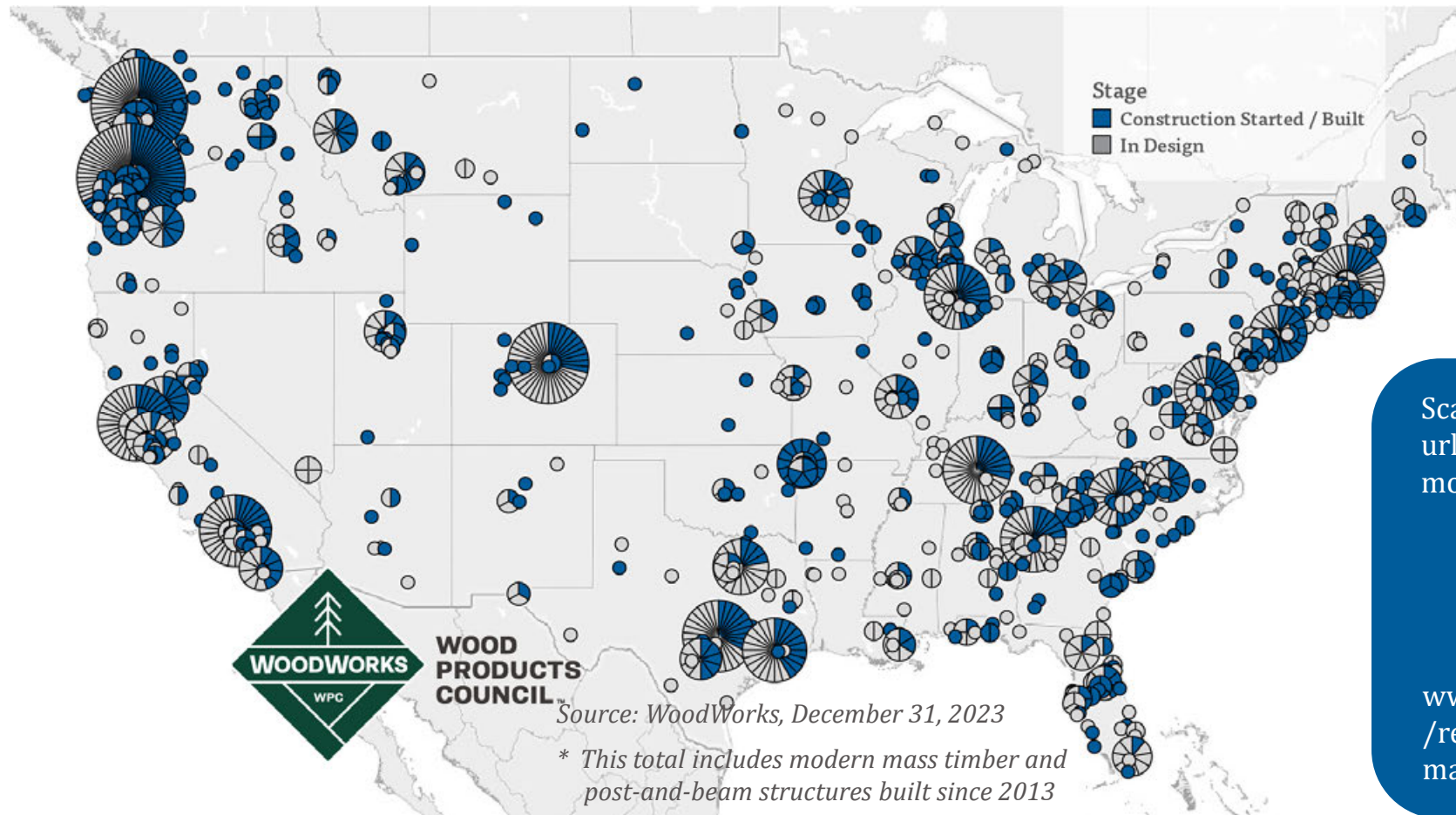
Commentary

## A Credit Perspective on Mass Timber, As Its Use in U.S. Construction Projects Builds

CMBS

# Current State of Mass Timber Projects

As of year-end 2023, in the US, **935** multi-family, commercial, or institutional projects have been constructed with mass timber. Including those in design, the total is **2,035**.



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



[www.woodworks.org/resources/mapping-mass-timber/](http://www.woodworks.org/resources/mapping-mass-timber/)

# Topics

- » Resources for Developers/ Owners
- » Forest to City, A Mass Timber Introduction
- » Sustainability & Forestry
- **Tall Wood**
  - » Construction Management
  - » Insurance
  - » Mass Timber Buildings Sold
  - » Business Case Studies

# TALL WOOD

## LEGEND :

STORIES OF WOOD /  
MASS TIMBER

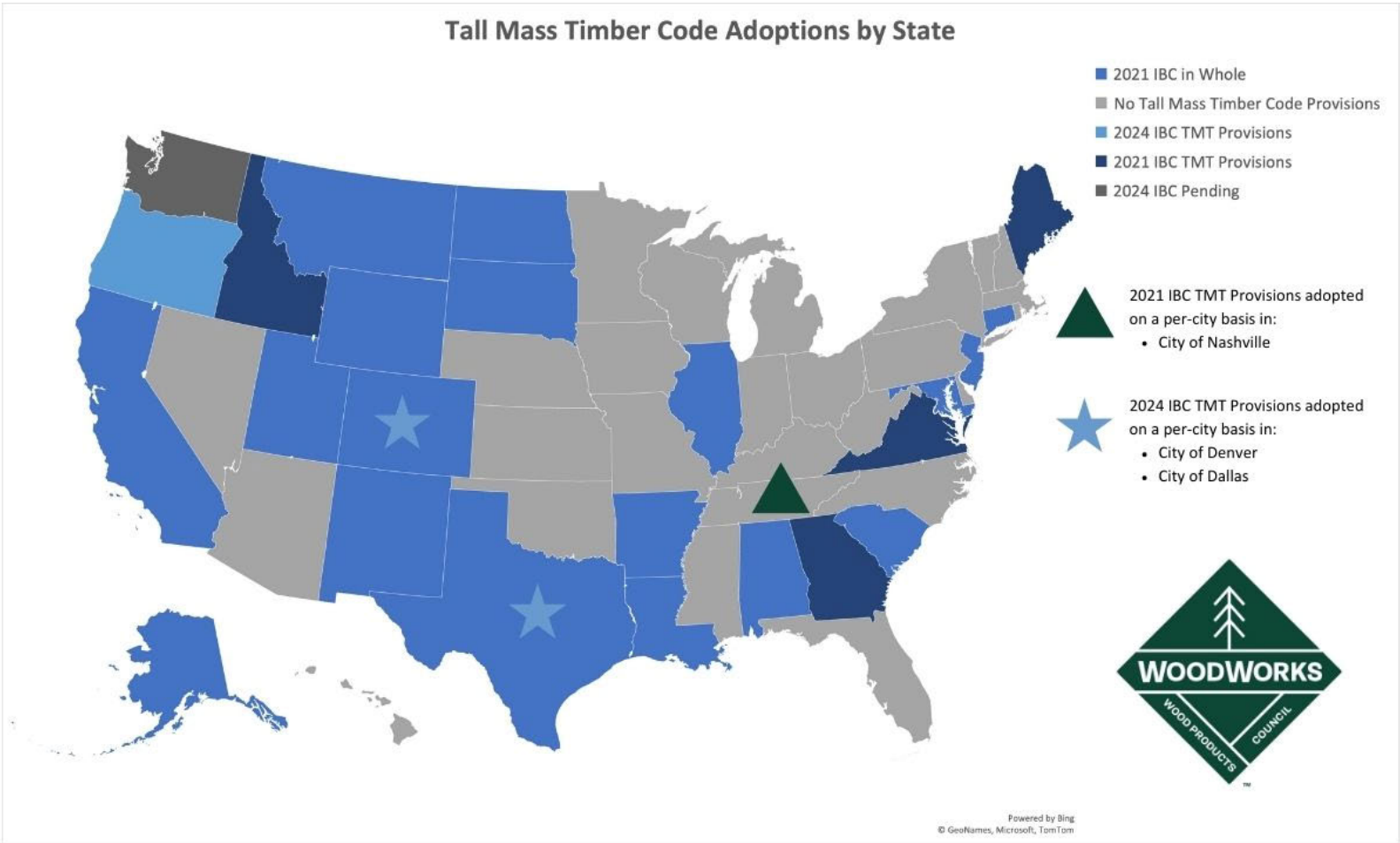
TOTAL STORIES  
OF BUILDING

# / #

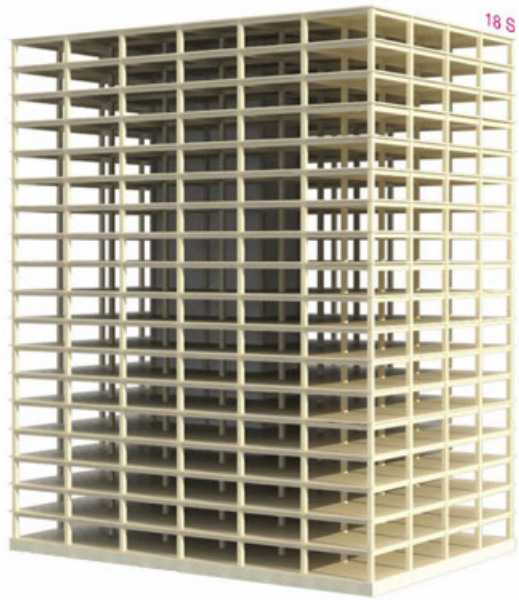
WoodWorks is supporting 217 tall wood projects in design 14 projects under construction or built.



# Tall Mass Timber Code Adoptions



# Type IV-A



**18 Stories**

Height = 270'

Wood covered/ not exposed

Image: Susan Jones, atelierjones



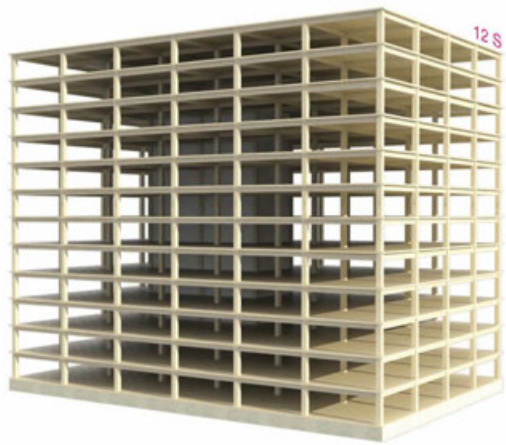
**1510 Webster**

Oakland, CA

Developer/Architect/Builder: oWOW

Images: Andrew Nelson

# Type IV-B



**12 Stories**

Height = 180'

Wood partially exposed

Image: Susan Jones, atelierjones



**Baker's Place**

Madison, WI

Developer: The Neutral Project

Images: Michael Green Architecture



# Type IV-C



**8 Stories**

Height = 85'

Wood fully exposed

Image: Susan Jones, atelierjones



**Heartwood**

Seattle, WA

Community Roots Housing | Skipstone

Images: Susan Jones, atelierjones

# Topics

- » Resources for Developers/ Owners
- » Forest to City, A Mass Timber Introduction
- » Sustainability & Forestry
- » Tall Wood
- **Construction Management**
- » Insurance
- » Mass Timber Buildings Sold
- » Business Case Studies

# Cost & Design Optimization Checklists

- » Distribute to entire design & builder team
- » Reduce risk/ cost surprises
- » Developers/ owners - read Pre-design & SD sections



## 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](http://woodworks.org), many of which are referenced in this document. We also recommend that designers and builders download the following:

**Mass Timber Design Manual<sup>1</sup>** – Includes technical papers, continuing education articles, expert Q&As and more, and is updated regularly. Published in partnership with Think Wood.

**U.S. Mass Timber Construction Manual<sup>2</sup>** – Provides a framework for the planning, procurement and management of mass timber projects.



Photo: David Wakely

# Potential Benefits

**Project Goal**



**Value Add**



Fast construction

Aesthetic Value (Potential leasing velocity/ premiums)

Healthy Building / Biophilia

Lightweight structure (multi-story, poor soils, tilt-walls, vertical additions)

Labor shortage solution

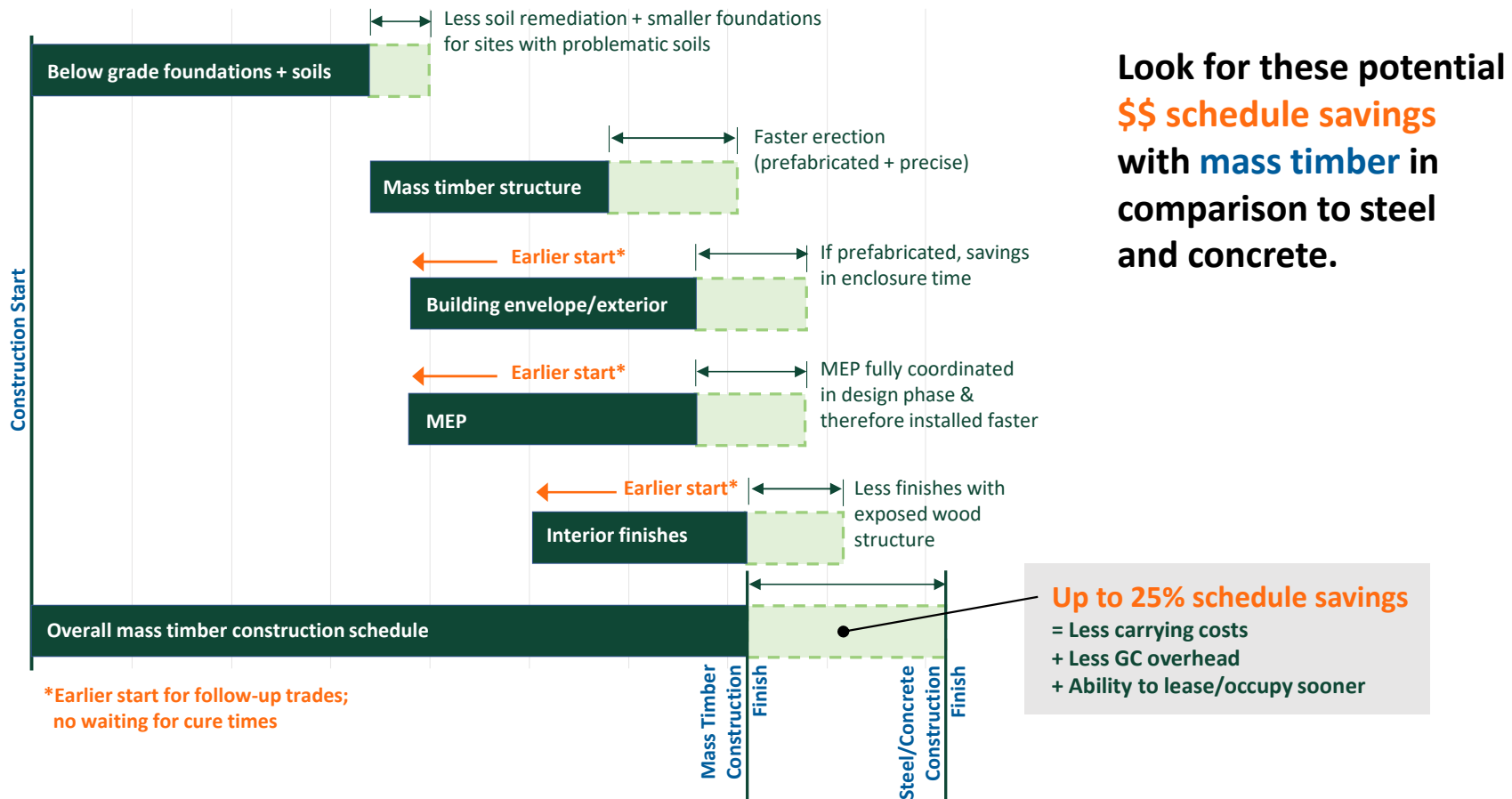
- small crews
- entry level workers

Just-in-time delivery (ideal for dense urban sites)

Environmentally friendly (low carbon footprint)

Healthy forests/ wildfire resiliency & support rural economies

# Compressing the Typical Construction Schedule



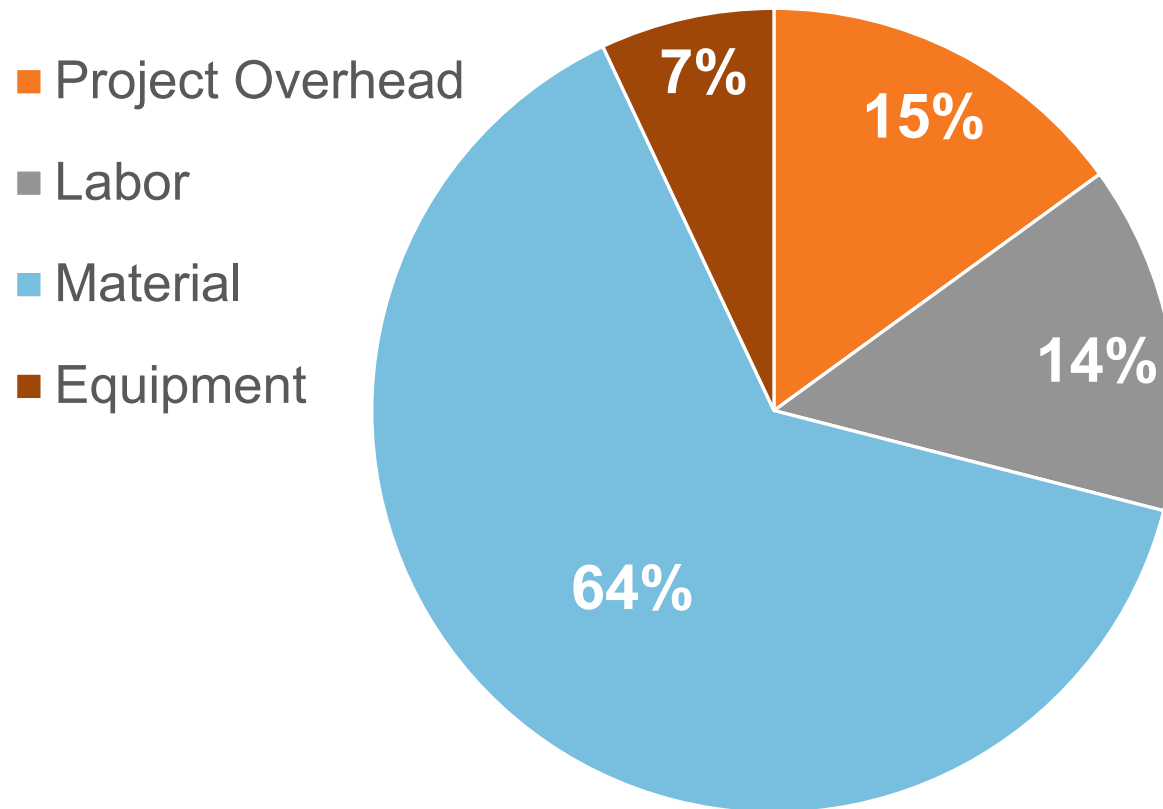
Look for these potential **\$\$ schedule savings** with **mass timber** in comparison to steel and concrete.

## Pre-design for developers/ owners

Builder input  
during pre-design  
is essential to  
optimizing costs.

- » Assemble Design & Builder Team
- » Contract model: consider CM at risk, design-assist, IPD, or design-build
- » Establish project goals through discussions with owner, designer and builder.
- » Cost estimating considerations
- » 3D modeling & coordination of structural, MEPF & architectural systems

# Anatomy of a Turnkey Mass Timber Package



Source: Swinerton

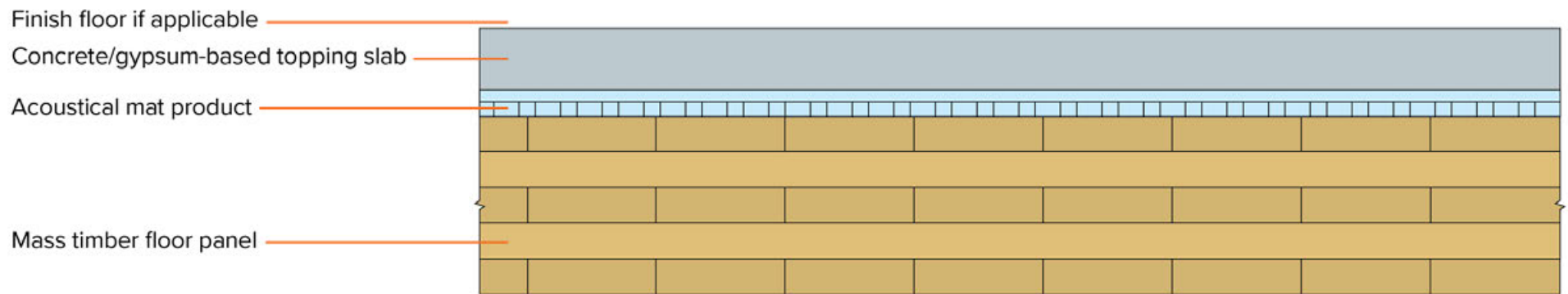
# Design for developers/ owners

## Plan for early conversations with building & fire departments

- » Acoustics – set expectations
- » If it hasn't already been done, decide whether the GC or subcontractor will install the framing.
- » Ensure safety policies are in place to protect against construction fires.
- » Determine “shop or field” for connectors and finishes.
- » Decide how wood will be protected during transportation and construction.



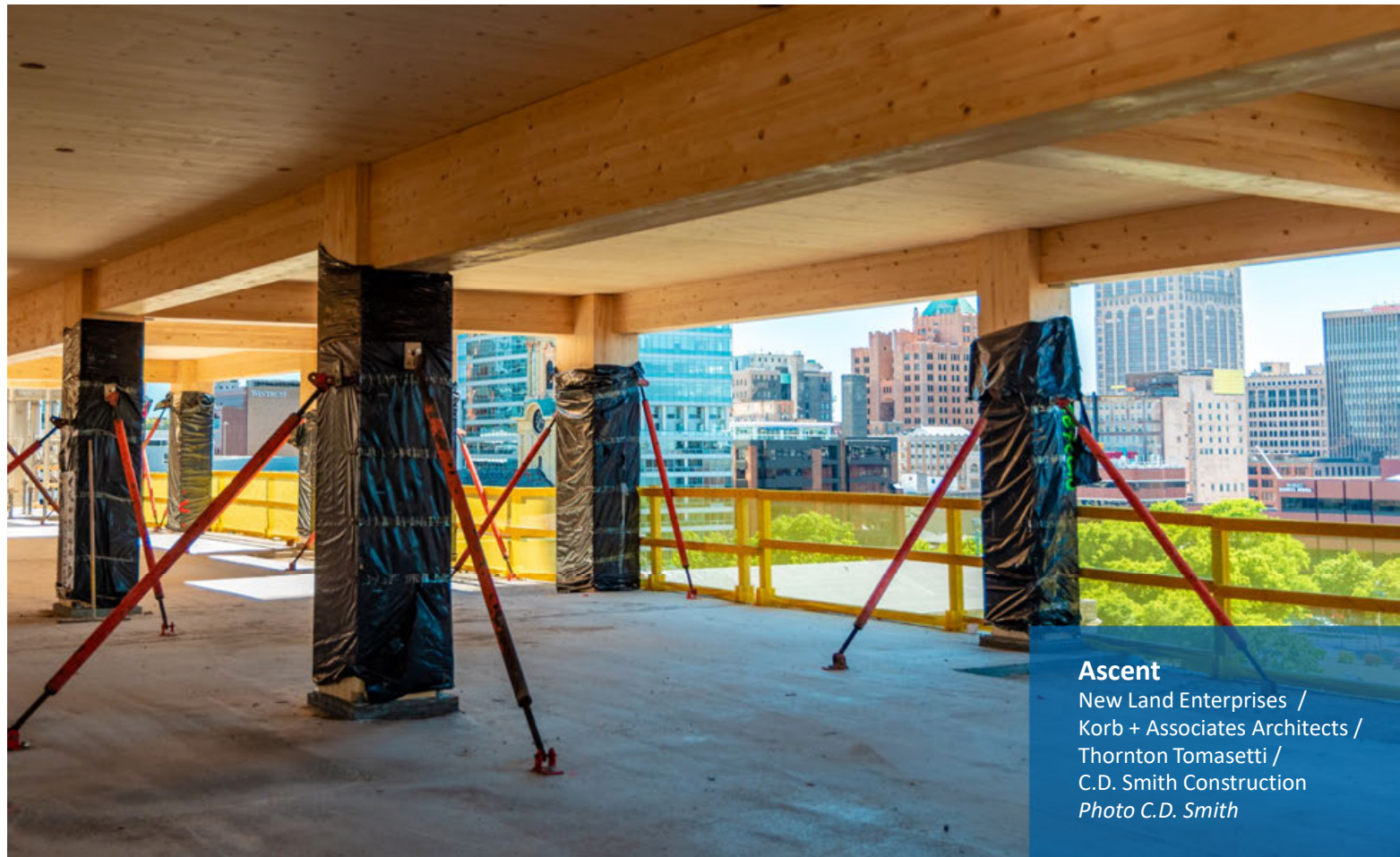
# Acoustic Performance



Typical mass timber floor assembly

# Material Protection

- » Moisture
- » UV rays
- » Damage



## **Ascent**

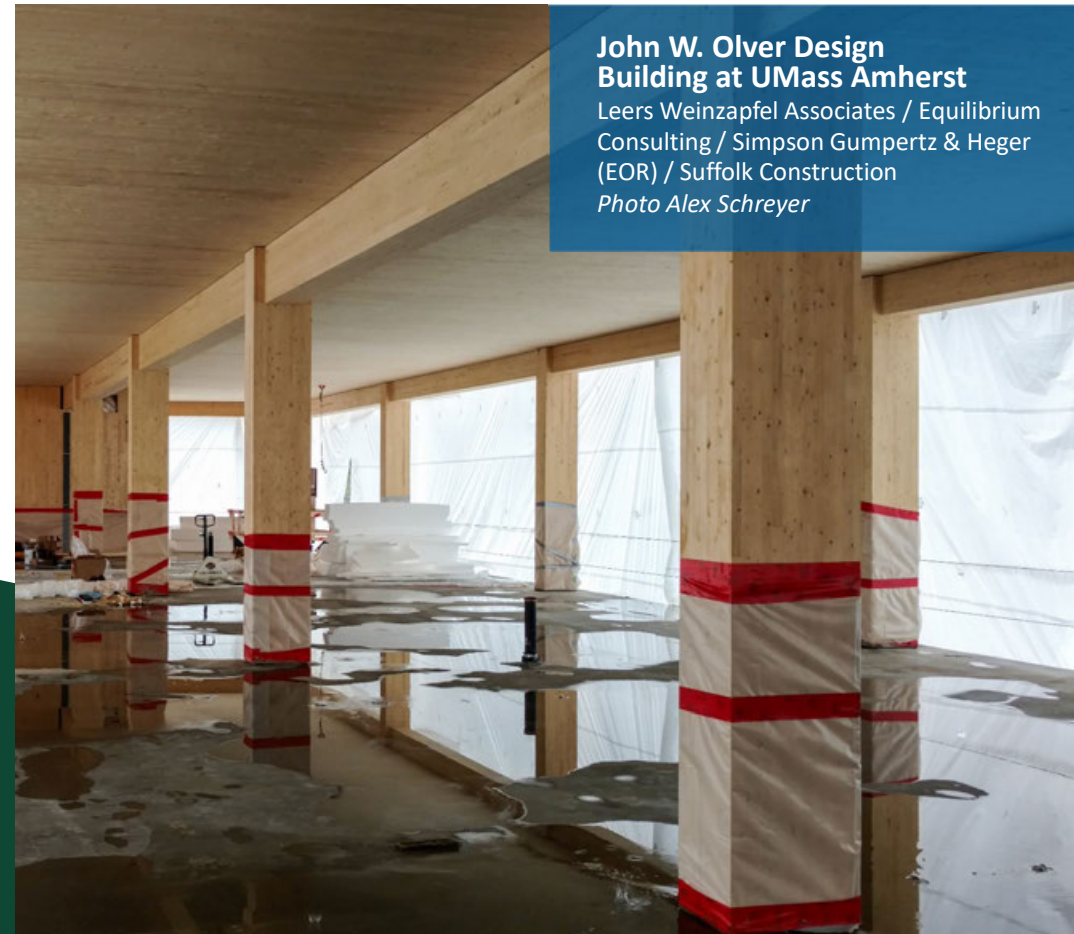
New Land Enterprises /  
Korb + Associates Architects /  
Thornton Tomasetti /  
C.D. Smith Construction  
*Photo C.D. Smith*

# Moisture Management

Keep wood as dry as possible to avoid:

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

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



**John W. Olver Design  
Building at UMass Amherst**

Leers Weinzapfel Associates / Equilibrium  
Consulting / Simpson Gumpertz & Heger  
(EOR) / Suffolk Construction

*Photo Alex Schreyer*

# Factory-Applied Sealants & Coatings



**Adidas Headquarters**  
LEVER Architecture / KPFF /  
Turner Construction Company  
*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/>



Photo: Christian Columbres



The Hudson | Vancouver, WA | Mackenzie | Turner Construction

# Looking to source mass timber products?

Connect with a WoodWorks Partner to scout products for your next mass timber project.



---

## Education / Resources / Free Project Support

Working on a commercial or multifamily wood building in the U.S.? Get the information and support you need at [woodworks.org](https://www.woodworks.org).



# Topics

- » Resources for Developers/ Owners
- » Forest to City, A Mass Timber Introduction
- » Sustainability & Forestry
- » Tall Wood
- » Construction Management
- » Insurance**
- » Mass Timber Buildings Sold
- » Business Case Studies

# Insurance Resources

WoodWorks resources for mass timber insurance:

- » Video series on MT Builder's Risk insurance challenges
- » Mass Timber Project Questionnaire for Builder's Risk Insurance – download & fill it out!
- » Insurance for Mass Timber Construction: Assessing Risk and Providing Answers (white paper)
- » Discuss with WoodWorks Regional Director:
  - » Lists of experienced insurance brokers
  - » Help answering questions from brokers & insurers



[www.woodworks.org/learn/mass-timber-clt/mass-timber-building-insurance/](http://www.woodworks.org/learn/mass-timber-clt/mass-timber-building-insurance/)



# Insurance Challenges

What is causing the challenges with insurance for mass timber projects?

- » Insurance industry volatility & hard market
- » Lack of loss data
- » ISO building classifications (none specific to mass timber)
- » Variation of mass timber knowledge among insurance industry

## ISO Types 1-6: Construction Code Descriptions

### ISO 1 – Frame (combustible walls and/or roof)

#### Typically RIMS Class 1

Wood frame walls, floors, and roof deck  
Brick Veneer, wood/hardiplank siding, stucco cladding

#### Wood frame roof with wood decking and typical roof covers below:

- \*Shingles
- \*Clay/concrete tiles
- \*BUR (built up roof with gravel or modified bitumen)
- \*Single-ply membrane
- \*Less Likely metal sheathing covering
- \*May be gable, hip, flat or combination of geometries

#### Roof anchorage

- \*Toe nailed
- \*Clips
- \*Single Wraps
- \*Double Wraps

**Examples:** Primarily Habitational, max 3-4 stories

### ISO 2 – Joisted Masonry (JM) (noncombustible masonry walls with wood frame roof)

#### Typically RIMS Class 2

Concrete block, masonry, or reinforced masonry load bearing exterior walls

- \*if reported as CB walls only, verify if wood frame (ISO 2) or steel/noncombustible frame roof (ISO 4)
- \*verify if wood frame walls (Frame ISO 1) or wood framing in roof only (JM ISO 2)

Stucco, brick veneer, painted CB, or EIFS exterior cladding

Floors in multi-story buildings are wood framed/wood deck or can be concrete on wood or steel deck.

#### Wood frame roof with wood decking and typical roof covers below:

- \*Shingles
- \*Clay/concrete tiles
- \*BUR (built up roof with gravel or modified bitumen)
- \*Single-ply membrane
- \*Less Likely metal sheathing covering
- \*May be gable, hip, flat or combination of geometries

#### Roof anchorage

- \*Toe nailed
- \*Clips
- \*Single Wraps
- \*Double Wraps

**Examples:** Primarily Habitational, small office/retail, max 3-4 stories

If "tunnel form" construction meaning there is a concrete deck above the top floor ceiling with wood frame roof over the top concrete deck, this will react to wind forces much the same way as typical JM construction. It is slightly better from a fire rating standpoint and from a wind standpoint in terms of potential damage if the wood frame is damaged. Please provide comments in the construction details of SOV for this type of construction.

# Insurance Perspective on Mass Timber

- » Lack of historic loss data = Unknowns
  - » Unknowns = Risk
  - » Risk = Higher Premiums
  - » Some take a 'wood is wood' approach
- 
- » Important to understand the significant differences in how mass timber performs in the event of a fire, etc. when compared to light wood-frame and all other building materials



Photo Credit: StructureCraft



Photo Credit: GLI Partners

# Insurance Perspective on Mass Timber

## How do we address the perceived unknowns?

- » Demonstrate extensive testing, research and use
- » Provide clarification on commonly misunderstood topics
- » Highlight building code recognition and approvals
- » Reference product reports, evaluations and 3rd party verifications
- » Generate project-specific mitigation strategies

**APA PRODUCT REPORT**  
www.apawood.org

**DRJ Cross-Laminated Timber** **PR-L320**  
**D.R. Johnson Wood Innovations** Revised February 14, 2019

Products: DRJ Cross-Laminated Timber  
D.R. Johnson Wood Innovations, 1991 Pruner Road, P.O. Box 66, Riddle, OR 97468  
(541) 874-8267  
[www.drjlumber.com](http://www.drjlumber.com)

1. Basis of the product report:

- 2018 and 2015 International Building Code (IBC): Section 2303.1.4 Structural Glued Cross-Laminated Timber
- 2012 IBC: Section 104.11 Alternative materials
- 2018 and 2015 International Residential Code (IRC): Sections R502.1.6, R602.1.6, and R802.1.6 Cross-Laminated Timber
- 2012 IRC: Section R104.11 Alternative materials
- ANSI/APA PRG 320-2018 Performance Rated Cross-Laminated Timber
- ANSI/APA PRG 320-2017, PRG 320-2012, and PRG 320-2011 Performance Rated Cross-Laminated Timber, recognized in the 2018 IBC and IRC, 2015 IRC, and 2015 IBC, respectively
- APA Reports T2015P-27 and T2017P-01, and other qualification data



Photo Credit: US Forest Products Laboratory

# Mass Timber Testing and Research - Fire

Mass timber has undergone extensive fire testing & evaluation. Elements, assemblies, connections, penetrations, compartments & more



Photo: AWC/FPIInnovations



Photos: LendLease



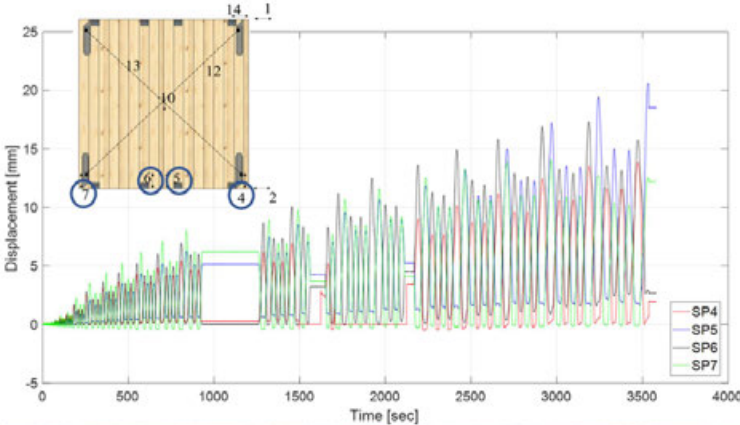
Photo: ARUP



Photo: SLB/ARUP

# Mass Timber Testing and Research – Wind/ Impact

Mass timber has been evaluated for wind loading, cyclic pressure, uplift, debris impact & more. Results used to justify uses in areas such as Miami’s High Velocity Hurricane Zone



Photos: Clemson University / Michael Stoner

# Mass Timber Project Risk Mitigation

Each project should evaluate its specific conditions and constraints and create a project-specific risk mitigation plan that addresses items such as:

- » Construction phase moisture protection – have a plan
- » Long term moisture protection – traditional building envelope
- » Construction site fire safety & other safety measures – have a plan
- » Construction schedule impacts – shorter schedules help reduce risk

## **Sample Safety Plan**

### **Address & Location**

Site Specific Safety Plan – Con't.

### **Table of Contents**

<b>1) Introduction</b>	
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# Risk Mitigation – Construction Moisture

Construction phase moisture protection strategies

- » Sealers: factory applied, site applied? Type, application strategies
- » Stain control, remediation strategies
- » What to do at joints, intersections, connections
- » Plans for finishing, drying

Credit: Andersen Construction



Photo: Swinerton Mass Timber



Photo: Andersen Construction

Andersen Construction MASS TIMBER Construction Moisture Management Plan	
<b>Plan Components:</b>	
<b>1. Sealers</b>	
<b>2. Stain Prevention</b>	
<b>3. Moisture Control</b>	
<b>4. Dry out</b>	
<b>1.</b>	<b>Sealers at Timber Elements:</b>
a.	Shop Sealer will be applied to the following elements and surfaces (all sealers hand rolled, not sprayed): <ul style="list-style-type: none"><li>• CLT ends, edges, cuts</li><li>• Clear sacrificial sealer on top sides of CLT floor panels</li><li>• Glulam Columns and Beams (Sansin KP12-UVW)</li></ul>
b.	NO Shop applied sealer will be applied to the bottom faces of CLT floor panels.
<b>2.</b>	<b>Staining Prevention Measures:</b>
a.	All CLT and Glulam elements will be wrapped during transportation.
b.	Wrap at timber elements will be removed as soon as they are set in place. (To prevent the trapping of moisture.)
c.	Only galvanized steel or painted connectors will be used. No raw steel will be allowed on site (except rebar) once the timber structure is going up.
d.	NO cutting of steel allowed within the wood structure portion of the building. (Cutting in basement is acceptable.)
e.	On site storage: <ul style="list-style-type: none"><li>• Timber members will be wrapped until installed and be stored off the ground with a secondary cover.</li><li>• Wood stickers will be used between the layers of stacked elements.</li></ul>
<b>3.</b>	<b>Moisture Control:</b>
a.	Rothoblaas adhesive tape will be installed at all deck seams (CLT to CLT and CLT to plywood) during the course of installation. Tape to also be installed at penetrations in floor panels to prevent water transfer and staining.
b.	Concrete topping slabs will be placed deck by deck closely behind the timber erection. No concrete will be placed until timber is in place.

# Topics

- » Resources for Developers/ Owners
- » Forest to City, A Mass Timber Introduction
- » Sustainability & Forestry
- » Tall Wood
- » Construction Management
- » Insurance
- **Mass Timber Buildings Sold**
- » Business Case Studies



# Framework: Portland, OR



- » 5-story speculative office
- » 25,000 sf
- » Developer: Urban Development + Partners
- » Completed: 2015
- » Both Framework & American Brush totaling 35,200 SF, were sold in February 2020 for \$502/SF at 100% occupancy.

source: The Registry PNW Real Estate: [UD+P Sells Portland's Framework and American Brush Buildings, February 26, 2020](#)

# T3 Minneapolis, MN



Architects: Michael Green Architecture, DLR Group | Engineer: MKA | Photos: Ema Peter, MGA

- » 7-story speculative office
- » (6) floors Type IV over podium
- » 220,000 sf
- » Developer: Hines
- » Completed: November 2016
- » NLT panels & glulam frame
- » In May 2018, sold to LaSalle Investment Management at a 3.75 cap rate, well below the market cap rate of ~6 for top of market product at the time

source: CBRE's Weekly Take Podcast,  
[Knock on Wood Why Timber is Safe | CBRE](#)

# 901 East 6th Street: East Austin, TX



- » 5-story speculative office
- » 129,000 sf
- » Developers: Endeavor Real Estate & Pegalo Partners
- » Completed: 2019
- » CLT & steel frame hybrid
- » Sold in 2019 to Clarion Partners
- » Local real estate experts believe it sold for record value in market

source: [Austin Business Journal article](#)

# Platte Fifteen: Denver, CO



- » 5-story speculative office
- » 153,000 sf
- » Developer: Crescent Real Estate
- » Completed: 2019
- » Lionstone Investments was Limited Partner & bought out Crescent

Architect: OZ Architecture | Engineer: KL&A Structural Engineers | Photo: OZ Architecture

# Topics

- » Resources for Developers/ Owners
- » Forest to City, A Mass Timber Introduction
- » Sustainability & Forestry
- » Tall Wood
- » Construction Management
- » Insurance
- » Mass Timber Buildings Sold
- **Business Case Studies**

# Mass Timber Business Case Studies



# Mass Timber Value Creation Analysis

## What's in a Business Case Study?

### Development Overview

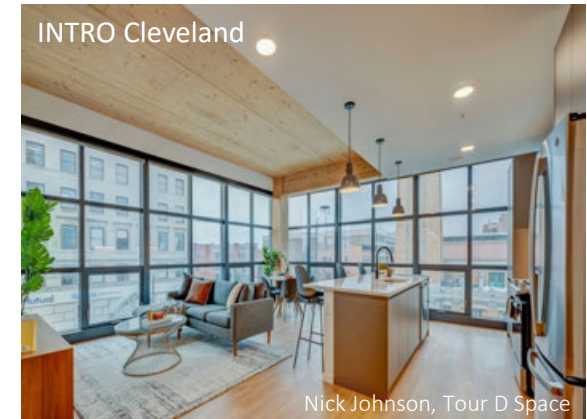
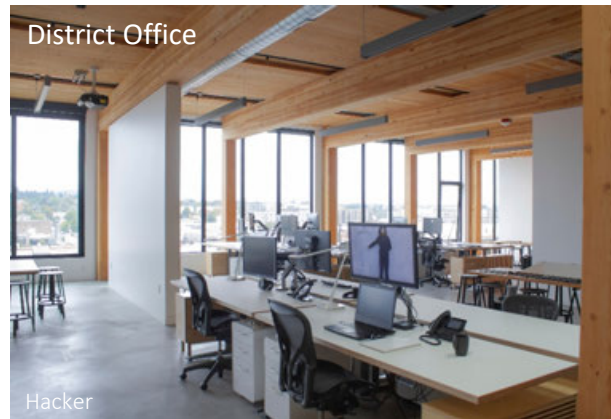
- Property information
- Product strategy
- Investment highlights

### Qualitative Discussion

- Challenges
- Lessons learned
- Successes

### Quantitative Overview

- Development timeline
- Costs
- Rents
- Lease-up



### Comparative Return Analysis

	Market	Pro Forma	Realized
Yield on cost	6.25%	7.00%	7.35%
Cap rate	4.75%	4.50%	TBD
Value/rentable SF	\$550/ RSF	\$717/ RSF	TBD (\$800+/ RSF)
Leverage	65%	65%	N/A



## Users:

- **Finance-side**  
(investors, developers/owners, appraisers, lenders)  
seeking to “make informed decisions”
- **Services-side**  
(architects, engineers, contractors)  
seeking to “influence decisions”
- **Government-side**  
(building code, policy or zoning)  
seeking to “regulate decisions”





# Contributors

## Contributing Developers/Owners & Investors

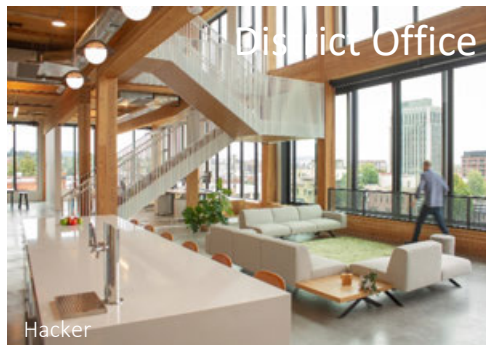
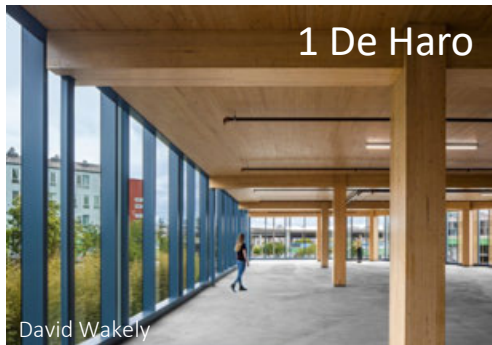
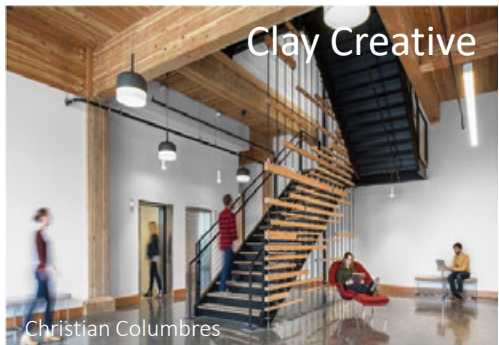
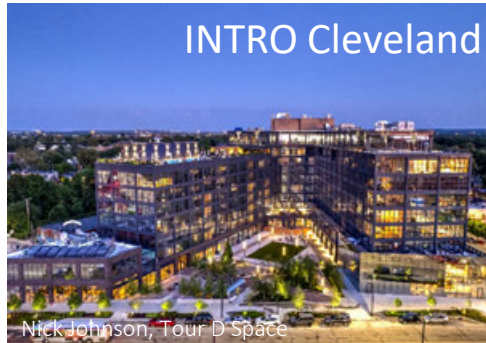


## Lead Analysis Team



We are grateful to the developers, owners and investors who have publicly shared their stories and financial data in these case studies.

# Mass Timber Business Case Studies: Value Creation Analysis



Scan to download



# Adohi Hall: Project Team

Owner

**University of Arkansas**



Architects:

**Leers Weinzapfel Associates**

LEERS  
WEINZAPFEL  
ASSOCIATES

**Modus Studio**

**Mackey Mitchell Architects**

modus studio  
ARCHITECTURE + PROTOTYPING

**OLIN** (Landscape)



**OLIN**

Structural Engineer

**Equilibrium Consulting, Inc.**

EQUILIBRIUM

Contractor

**Nabholz Construction**

**NABHOLZ**



Mass Timber Business Case Study

# Adohi Hall, University of Arkansas

## Development Overview

- Create a living-learning student community center competitive with off-campus housing
- Appeal to student identity/desires related to innovation and sustainability
- Demonstration project to help incentivize greater use of mass timber in state

### Property Information

Property timing	Completed 2019
Submarket	Fayetteville, AR
Construction Type	3B
Gross building area	202,491 SF
Residential area	154,554 SF
Program: Dorm Rooms	708 beds
Educational/Studio/Communal	22,360 SF
Mech/Accessory/Storage	16,093 SF



Timothy Hursley

## Adohi Hall: Context & Trends

# Fayetteville Market

- Located in the Ozark Plateau, with 600,000 person MSA, employment anchors include Walmart, JB Hunt, Tyson, and the University of Arkansas
- The university is a centerpiece to the city
- Northwest Arkansas is known as the mountain biking capital of the world with over 250 miles of trails



Mass Timber Business Case Study

# Questions? Ask us anything.



**Tino Kalayil, PE**

Regional Director | IL, IA, MN, WI  
(224) 639-2164

[Tino.kalayil@woodworks.org](mailto:Tino.kalayil@woodworks.org)



**Survey**



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



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