Mass Timber Constructability and Costing

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Presented by
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WoodWorks

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

AIA Approved Continuing Education

Course Description

How do general contractors meet the growing demand for mass timber buildings? With widespread adoption of building codes that allow the expanded use of mass timber, and more successful U.S. projects, many seasoned construction professionals are seeking to expand their knowledge and pursue this market. These firms often have limited familiarity with the products and practicalities of design, potential sourcing opportunities, and differences in applying trades to a modern mass timber structure vs. steel or concrete. This presentation is intended to help contractors better understand the nuances involved in a mass timber project and provide a basis for training installation crews and sub-contractors new to these systems. Topics include mass timber products, connection considerations, preconstruction coordination and interactions between the manufacturer and design/construction teams, material installation and protection, safety, and where to seek additional cost and schedule efficiencies.

Learning Objectives

1. Discuss and compare mass timber systems commonly used for buildings in the U.S.

2. Describe the variety of connections that may be used to connect columns, beams, and panels on a mass timber project.

3. Evaluate the objectives and impacts of preconstruction coordination and how the planning and design process differs from projects built with other materials.

4. Summarize the proper installation of mass timber elements, and methods for protecting the materials from moisture, dirt, and damage on site.

Topics

1. Products and Connections
2. Fasteners, Hardware and Equipment
3. Safety Considerations
4. Planning and Coordination
5. Installation and Material Protection
6. Repairs and Finishes

Products and Connections

Introduction

Mass timber products come premanufactured in many forms, including:

- Large panels (floor or wall "planks")
- Glue-laminated timber (glulam) beams and columns
- Structural composite lumber (SCL) beams and columns

Mass timber refers to a category of wood framing styles typically characterized by large, engineered wood panels paired with glulam beams and columns. Due to their premanufacturing, SCL and T&G may also be considered mass timber.

Catalyst
MGA | Michael Green Architecture / KPFF
Photo Benjamin Benschneider

Mass Timber Products

Panels

» Cross-Laminated Timber / CLT

» Glue-Laminated Timber / GLT

» Dowel-Laminated Timber / DLT

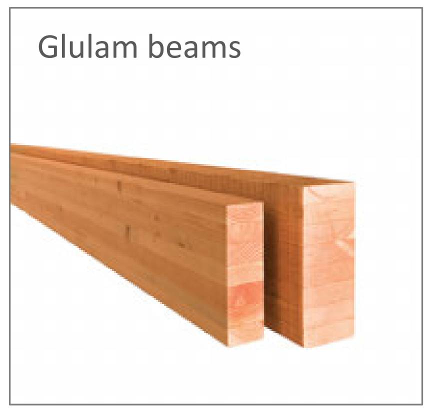
» Nail-Laminated Timber / NLT

The Canyons
Kaiser+Path / catena consulting engineers / R&H Construction
Photo Marcus Kauffman

Columns and Beams

» Glue-Laminated Timber / Glulam

» Structural Composite Lumber / SCL



Boise Cascade

Weyerhaeuser

Glue Laminated Timber (Glulam)
Beams and Columns

Cross-Laminated Timber (CLT)
Solid Sawn Laminations

Cross-Laminated Timber (CLT)
SCL Laminations

Photo: Freres Lumber

Photo: StructureCraft

Photo: LendLease

Photo: LEVER Architecture

Nail-Laminated Timber (NLT)

Photo: Think Wood

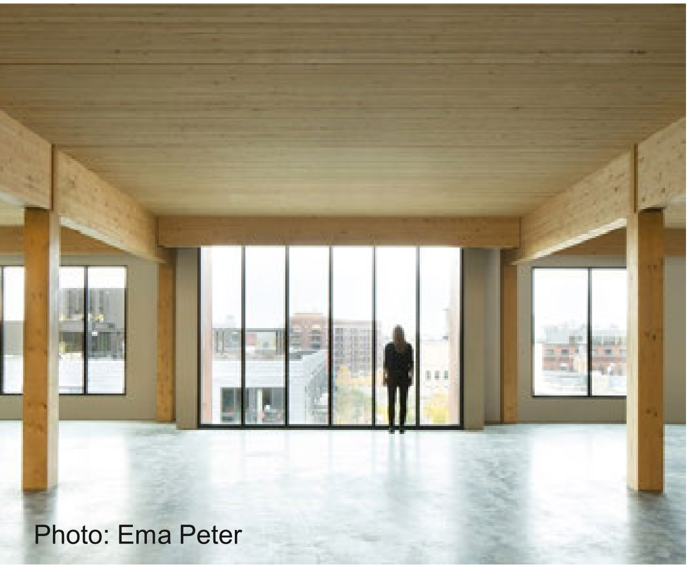


Photo: Ema Peter

Dowel-Laminated Timber (DLT)

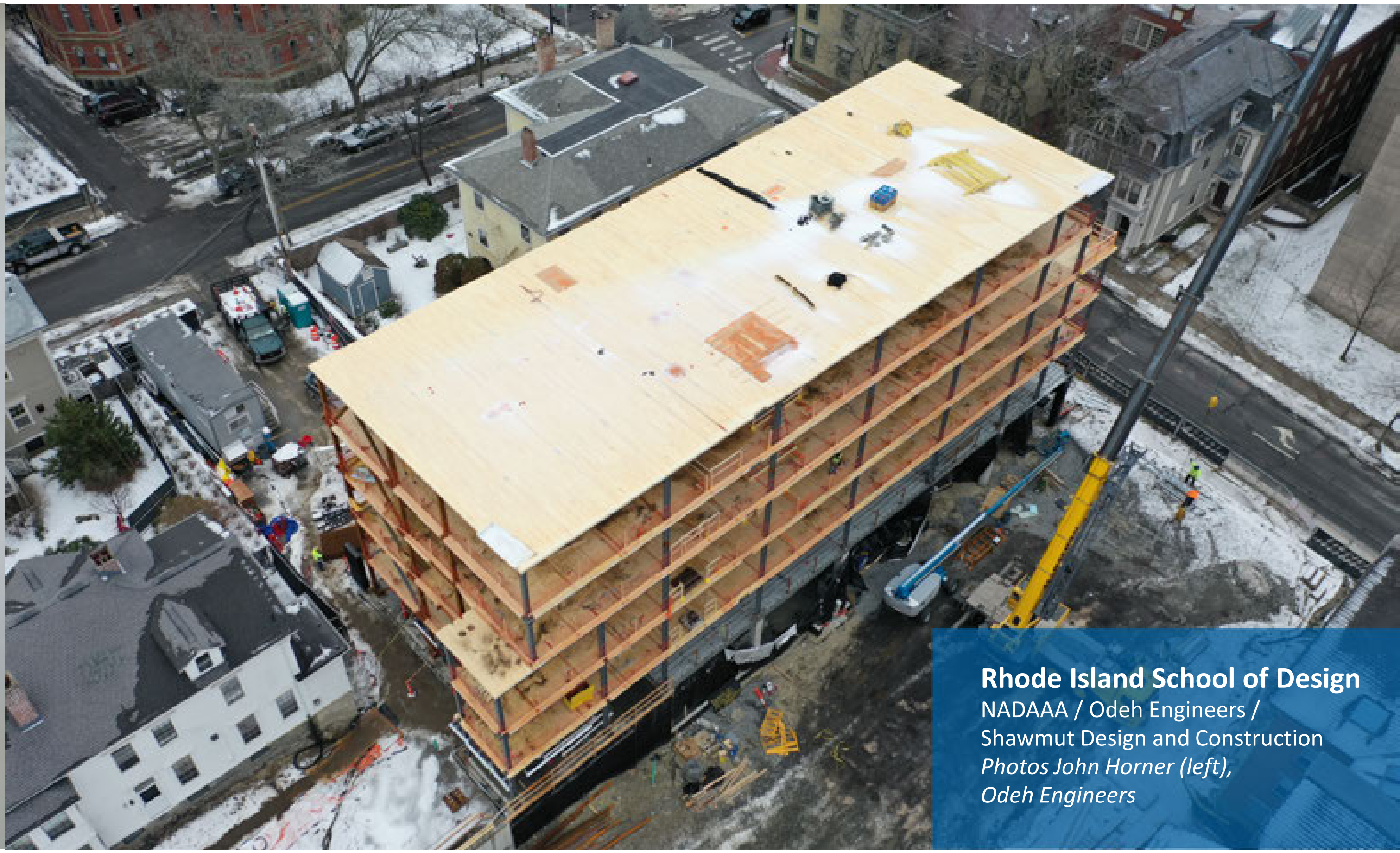
Photo: StructureCraft

Photo: StructureCraft

Decking

Photo: Bernard André Photography

Mass Timber Hybrids



Rhode Island School of Design
NADAAA / Odeh Engineers /
Shawmut Design and Construction
Photos John Horner (left),
Odeh Engineers

Southfield Park 35 Warehouse
USAA Real Estate / PDMS Group
Timberlab / Clayco / *Photo Erika Brown Edwards courtesy Timberlab*

Timber-Concrete Composite (TCC) Floor Systems

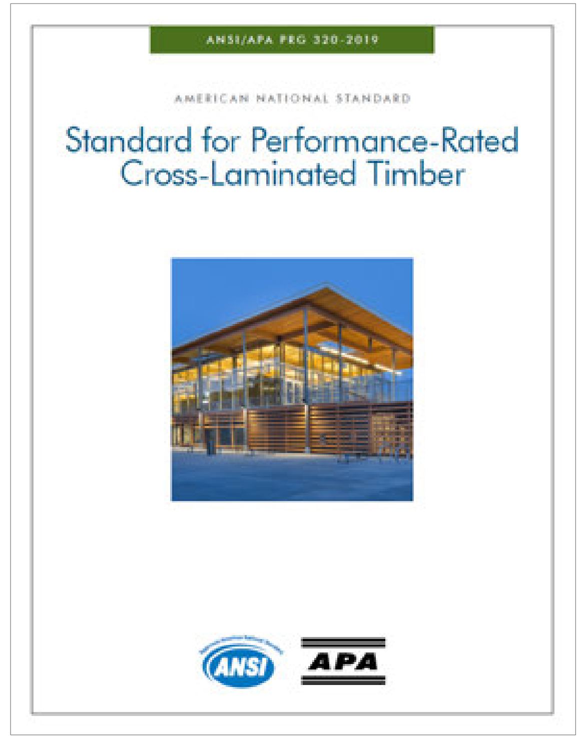
- Two distinct layers—timber layer and concrete layer—joined by shear connectors
- Timber layer can be CLT, GLT, SCL, another engineered wood product, or solid sawn lumber
- Shear connectors can be common fasteners (e.g., nails or screws), notches cut in the wood, connectors such as embedded plates or glue that transfer the load to a larger surface

John W. Olver Design Building / Photo Alex Schreyer

CLT product standard:

ANSI/APA PRG 320 Standard for Performance-Rated Cross Laminated Timber

- » Manufacturers – Comply with the standard for manufacturing + quality assurance
- » Structural engineers – Use reference design values, etc. + design guidance from the National Design Specification® (NDS®) for Wood Construction + manufacturer materials to specify the products to be used (e.g., grades, species)
- » Contractor – Verifies the products/grades with the supplier and purchases the materials
- » Small notches in the wood panel can be easily made with an appropriate saw. IMPORTANT: Get the engineer of record’s approval before making any cuts in the field.



Width

- » ± 1/16"

Depth

- » ± 1/8" per foot of depth
- » Minus 3/16" or 1/16" per foot of depth, whichever is larger

Length

- » Up to 20 feet: ± 1/16"
- » Over 20 feet: ± 1/16" per 20 feet of length or fraction thereof

Field Fabrication and Penetrations

Holes, notches and other alterations should be made during fabrication to the greatest extent possible, but some may also be done in the field.

INTRO
Harbor Bay Ventures / Hartshorne Plunkard Architecture / Forefront Structural Engineers / Fast + Epp / Panzica Construction
Photo WoodWorks

Fabrication and Connection Considerations

- Factory vs. field
- Tolerances
- Connection classes
- Fire resistance
- Inspections

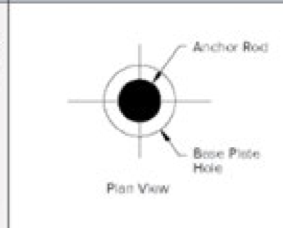
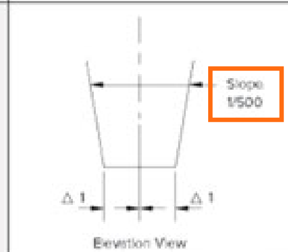
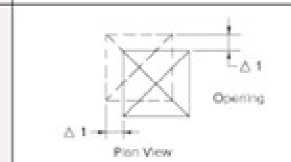
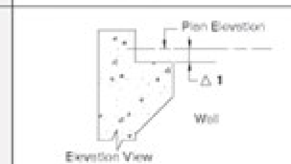
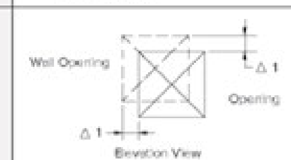
John W. Olver Design Building at UMass Amherst
Leers Weinzapfel Associates / Equilibrium Consulting / Simpson Gumpertz & Heger (EOR) / Suffolk Construction
Photo Alex Schreyer

Tolerances Between Materials

- » **Strict tolerances must be met between mass timber and other materials.***
- » WHY? Because mass timber elements are pre-constructed with precision equipment to produce a highly engineered and well-performing structure.
- » See the table → for examples of tolerances for steel and concrete.

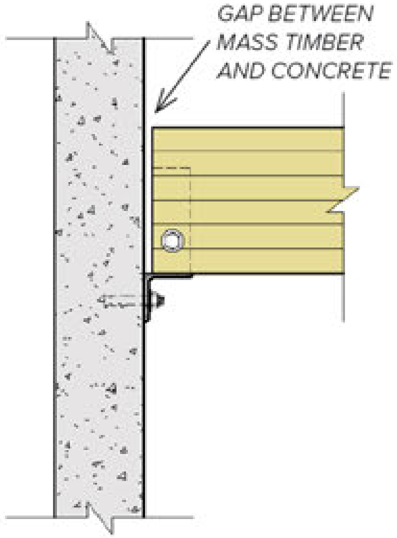
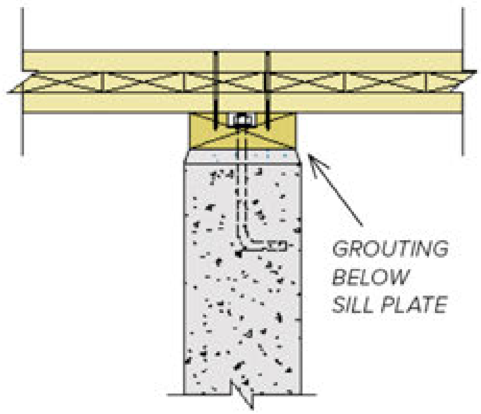
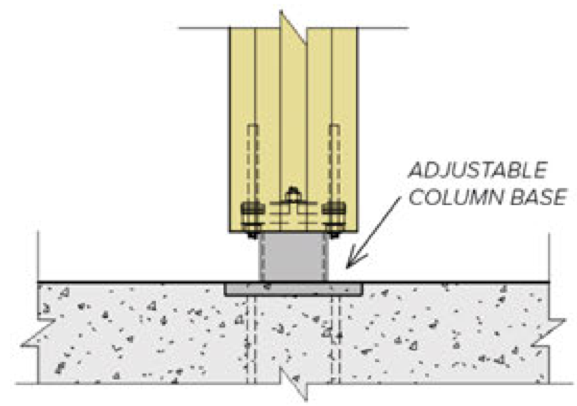
* **If a tolerance isn't met, mass timber installation can still be successful** if key elements are adjustable—e.g., a column baseplate, or concealed beam connector.

APPENDIX 1: Industry Tolerance Standards for Mass Timber

Tolerance Condition	Construction	Allowable Tolerances		Standard Reference
Anchor Rod Holes in Base Plates	Steel Base Plate	Rod / Hole Diameter 3/4"Ø / 1-5/16"Ø 7/8"Ø / 1-9/16"Ø 1"Ø / 1-7/8"Ø 1-1/4"Ø / 2-1/8"Ø 1-1/2"Ø / 2-3/8"Ø 1-3/4"Ø / 2-7/8"Ø 2"Ø / 3-1/4"Ø 2-1/2"Ø / 3-3/4"Ø		AISC-360 (Recommended Sizes for Anchor Rod Holes)
Steel Column Location at Base	Steel Column	Δ1=+1/4"		AISC-360 (Recommended Sizes for Anchor Rod Holes)
Edge Location of All Openings Deviation from Plan	Slap Opening	Δ1=±1/2"		ACI-117-10
Vertical Deviation for Wall or Opening	Wall & Column	Δ1=±1"		ACI-117-10
Horizontal & Vertical Deviation for Wall Opening	Wall Opening	Δ1=±1/2"		ACI-117-10

Maximum "out of plumbness" of the column, per AISC 360 Section C2

Tolerance Solutions

Solution	**Gap Between Mass Timber Beam and Concrete Wall**	**Grouting Below Sill Plate at Mass Timber Panel to Concrete Wall**	**Adjustable Column Base at Mass Timber Column to Concrete**
Connection example			
	Beam Perpendicular to Wall Connected to Face of Wall	Panel Bears at Top of Wall	Column Bears on Concrete with Adjustable Standoff Base

Connection Classes and *Fire Ratings*

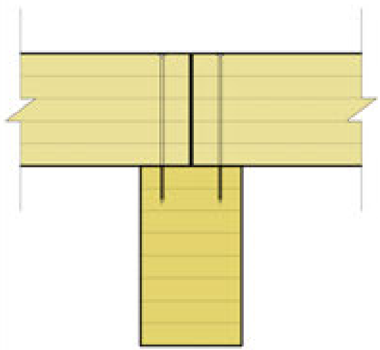
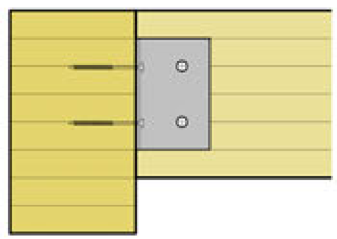
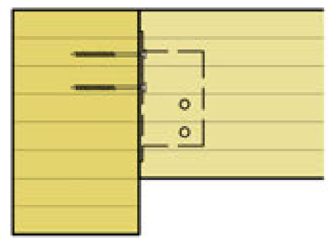
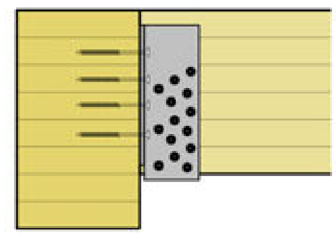
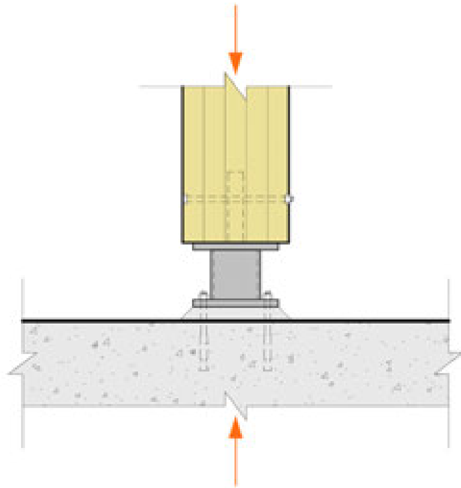
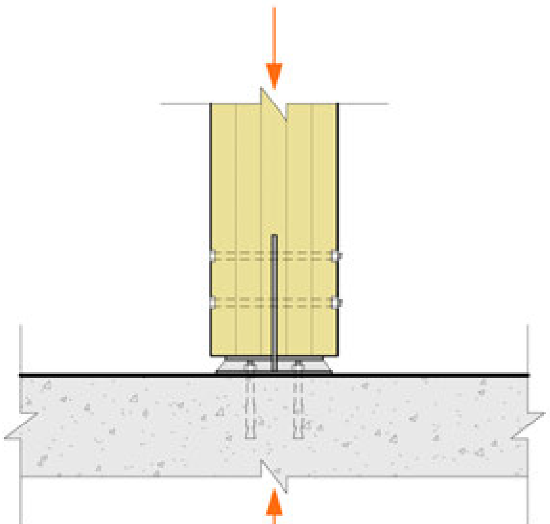
Connection class	**Class 1**	**Class 2**	**Class 3**	**Class 3**
Fire resistance	May be inherently fire resistant according to NDS calculations	Requires additional protection to meet fire-rating requirements	Tested fire-resistance rating (as specified by manufacturer)	Requires additional protection to meet fire-rating requirements
Connection example				
	Beam Bears on Girder*	Beam Connected to Girder with Steel Angles*	Beam Connected to Girder with Concealed Face-Mounted Knife Plate Connector*	Beam Connected to Girder with Proprietary Hanger*

*Table 8 in the **Index***

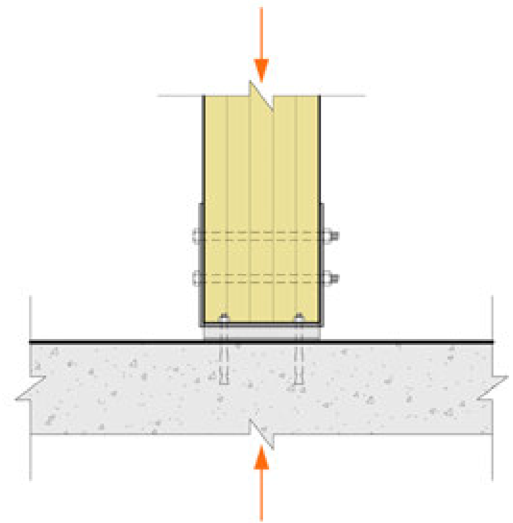
INTRO
Harbor Bay Ventures /
Hartshorne Plunkard Architecture /
Forefront Structural Engineers /
Fast + Epp / Panzica Construction
Photos WoodWorks



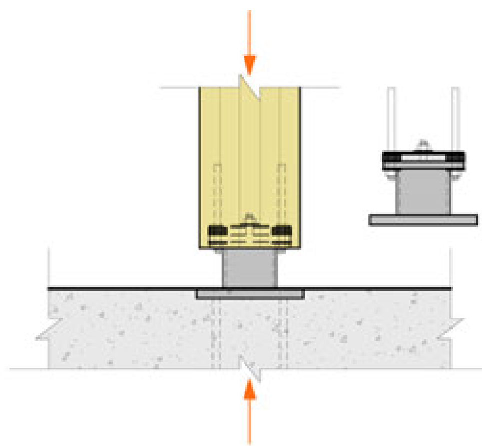
Custom Standoff



Knife Plate



Side Plates



Adjustable Standoff

Images WoodWorks

Horizontal floor and roof panels connections:

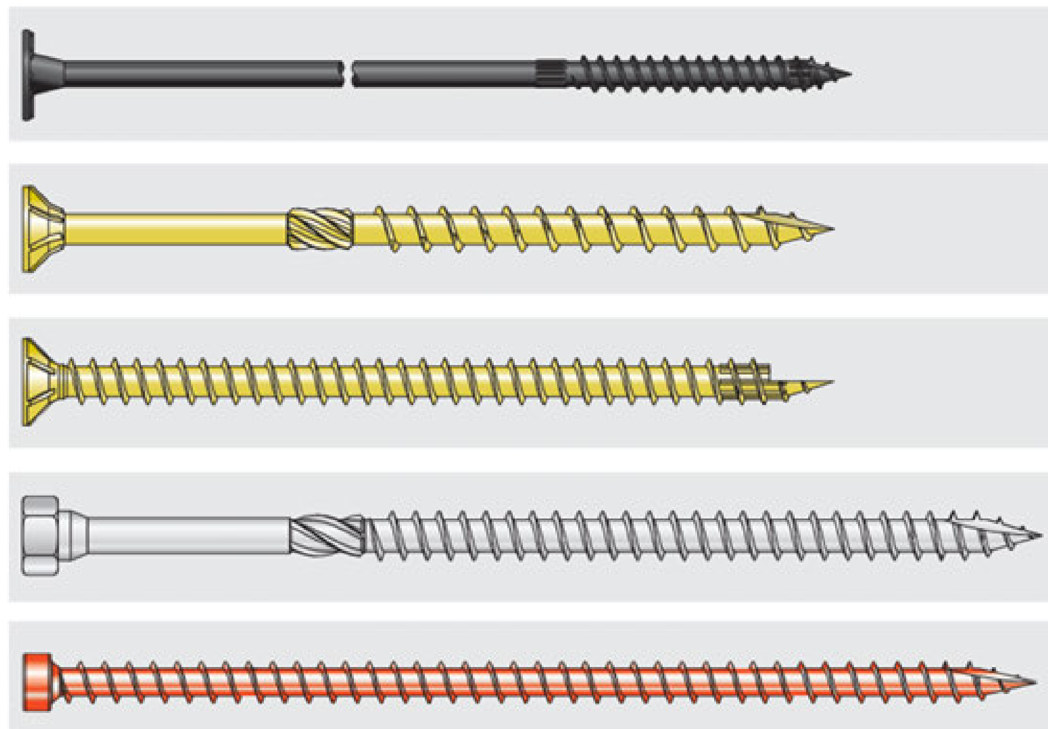
- Butt-jointed with a surface spline
- Double-splined for more strength
- Half-lapped and screwed or nailed

INTRO
Harbor Bay Ventures / Hartshorne Plunkard Architecture / Forefront Structural Engineers / Fast + Epp / Panzica Construction
Photo WoodWorks

Fasteners, Hardware and Equipment

Screws are the most common fastener type in mass timber construction.

- Lag or proprietary
- Partially or fully threaded
- Fabricators may have preferred screw manufacturers
- Proprietary screws specified by the manufacturer and usually self-tapping
- Diameter typically 1/4" or greater; wide range of lengths



Images Simpson Strong-Tie

Partially or Fully Threaded

Partially-threaded screws

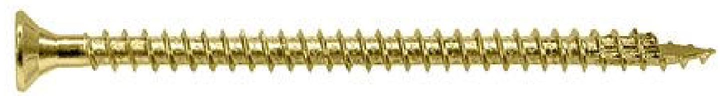
» Fasten two members to each other

» Pull the members together

Fully-threaded screws

» Used where thread withdrawal capacity is needed—both sides of a connection joint or possible failure plane within a single member

» ***Do not*** pull members together; gaps caused by improper installation



Images Simpson Strong-Tie

Hardware

- Plates
- Hangers
- Straps
- Angle Brackets
- Tie-Rod Systems
- Concealed Connectors
- Lifting Hardware

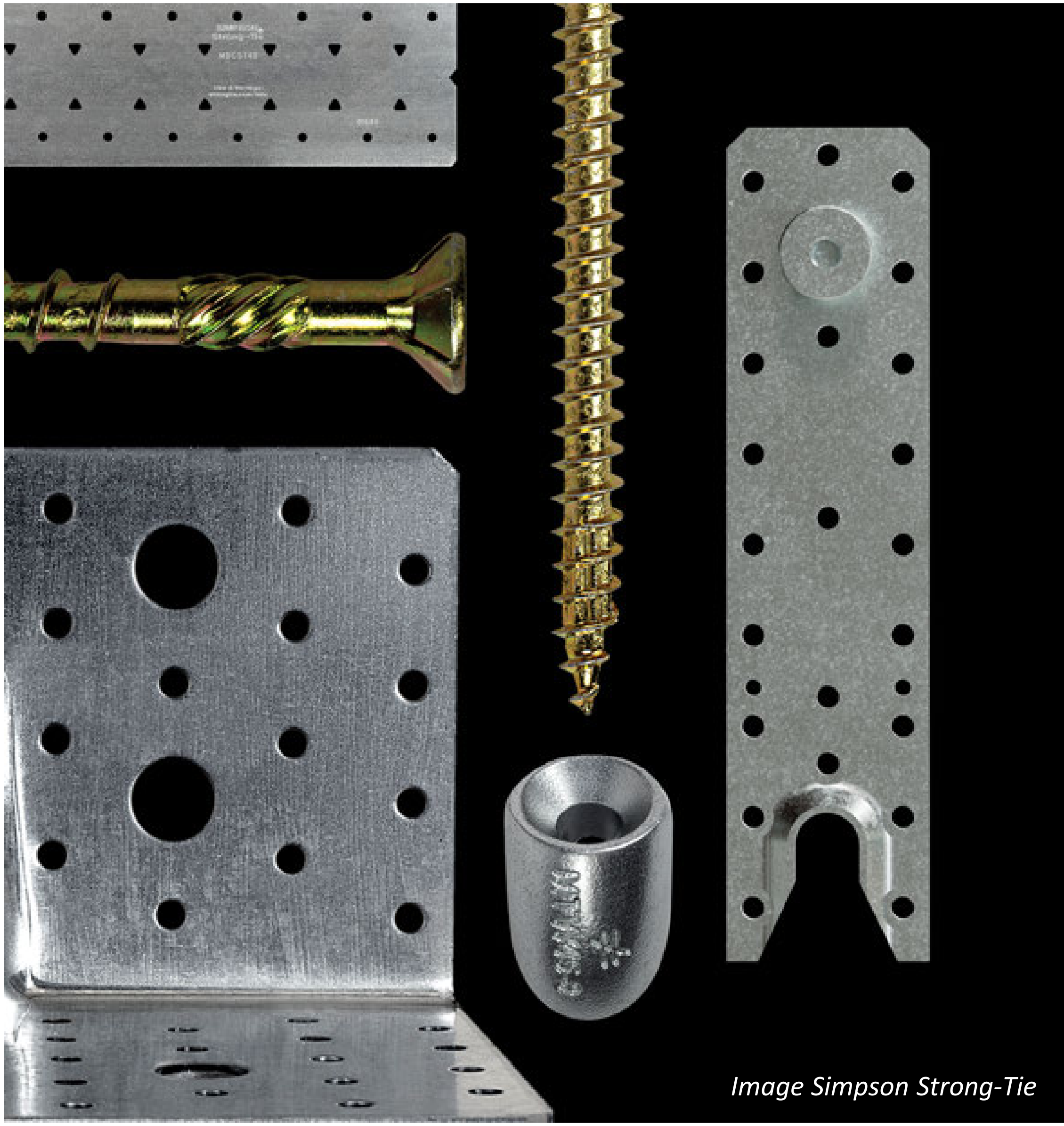


Image Simpson Strong-Tie

Concealed Hook Connectors

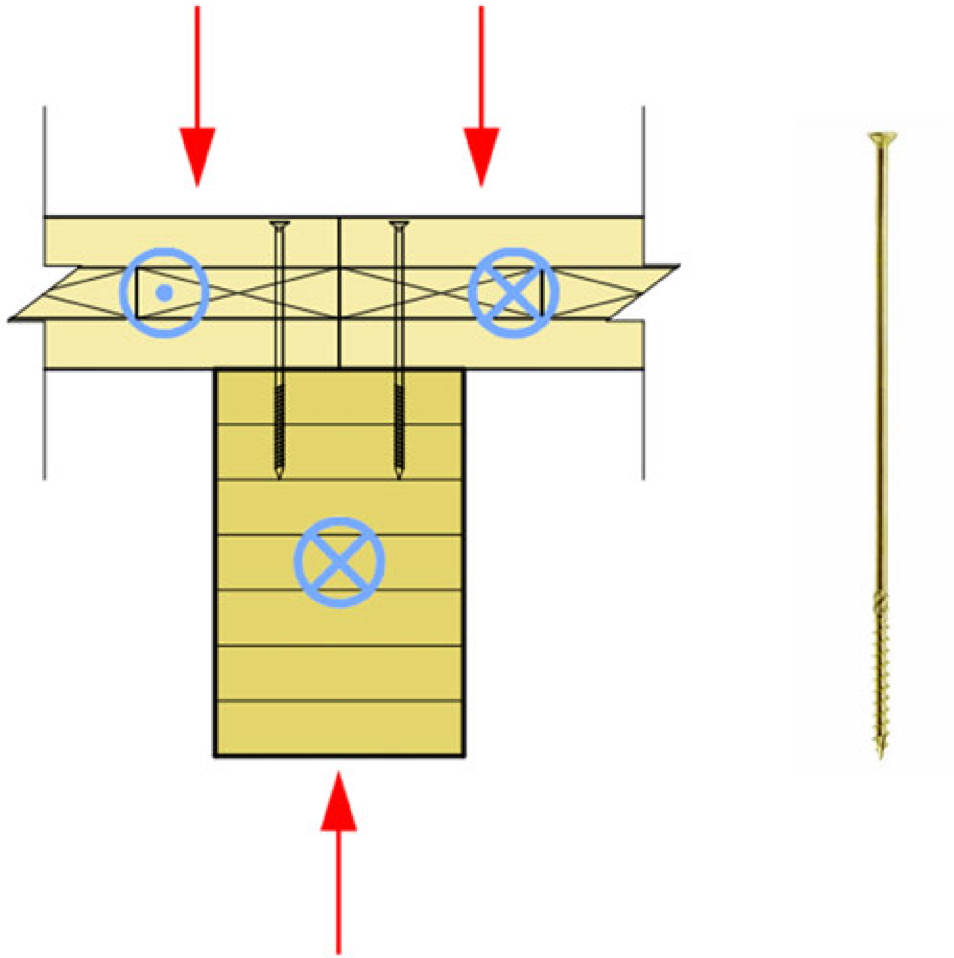
Images Rothoblaas

Concealed Knife Plates

Images Simpson Strong-Tie

Panel to Beam

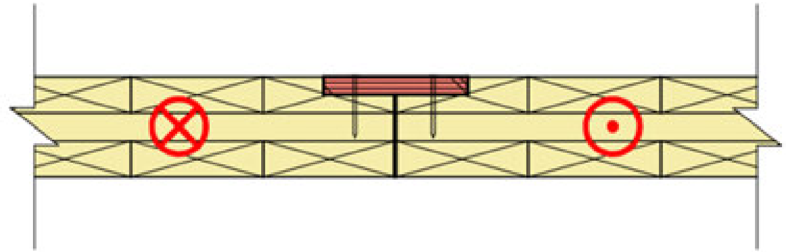
- Floor or roof panel bears on wood beam
- Attachment is made with partially-threaded screws, typically 12" to 18" depending on panel thickness



Images WoodWorks / Simpson Strong-Tie

Splines

- Adjacent panels with routed surfaces butted together
- Plywood spline fastened to both panels using partially-threaded screws or nails, typically 3" to 5"
- Nail gun nails or collated screws can improve constructability



Continuous Spline and Fasteners

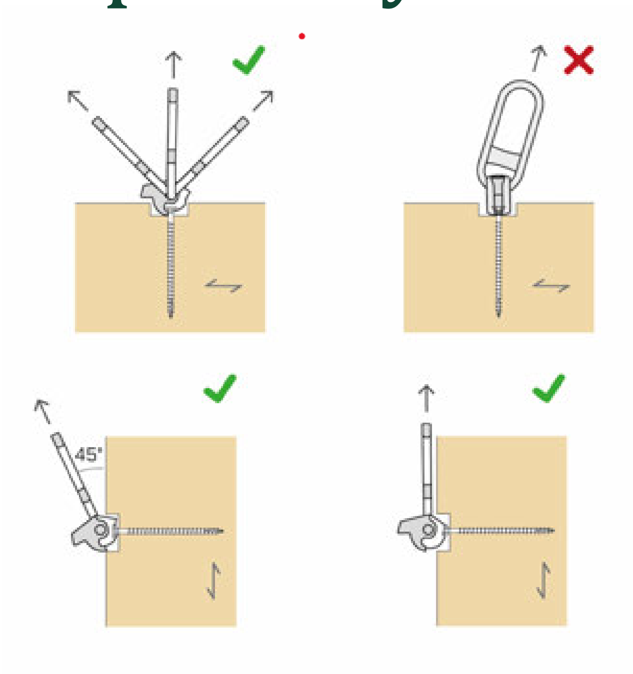
Images WoodWorks (top) / T3 Timbers

Material Handling

- Lifts provide safe access for workers at height.
- Lift type depends on building size and configuration, site logistics, etc.
- Forklifts (including standard, all-terrain and high capacity), boom lifts and scissor lifts are all commonly used.

Bullitt Center
The Miller Hull Partnership / DCI Engineers / Schuchart Construction
Photo John Stamets

Specialty Lifting Connectors

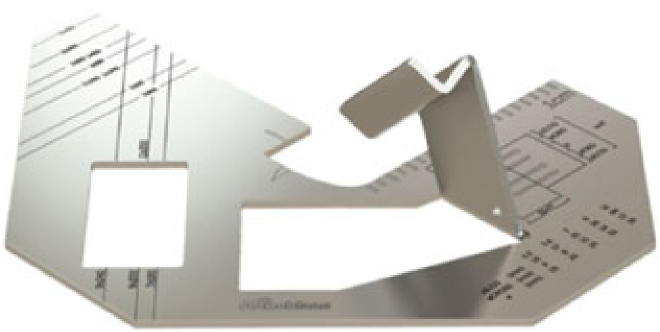


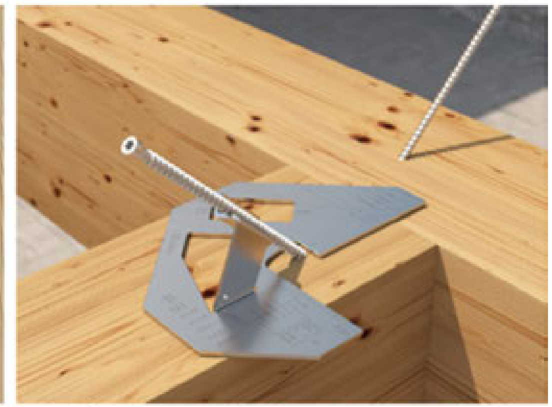
You need to account for the lifting connector screw limitations

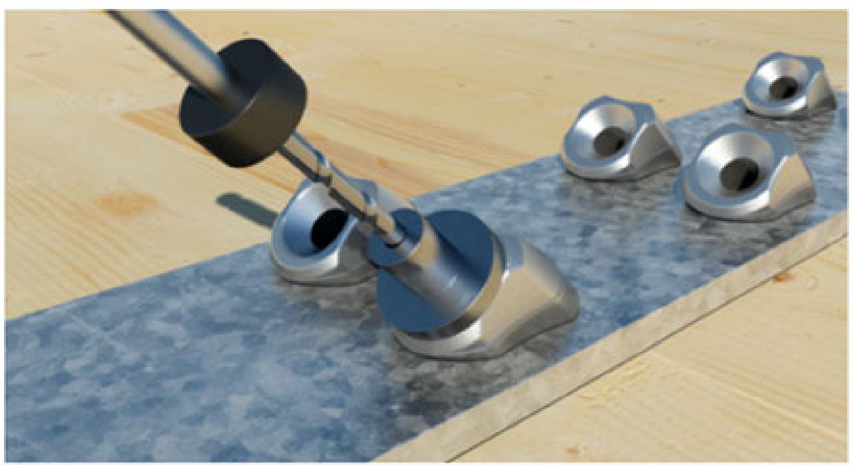
Image Rothoblaas (above)

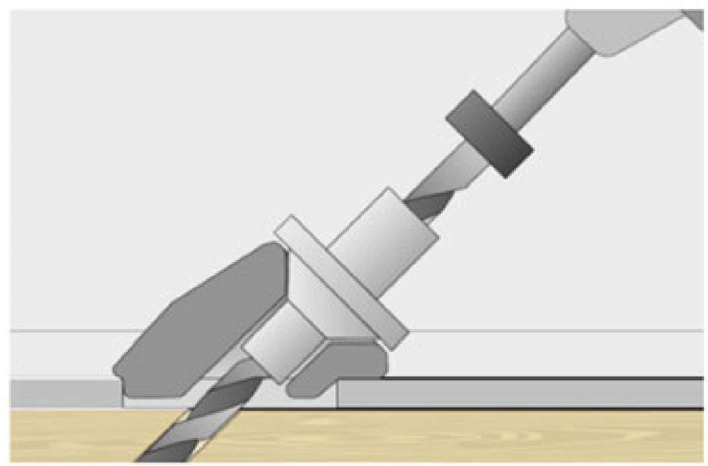
The Canyons
Kaiser + Path / catena consulting engineers / R&H Construction
Photo Marcus Kauffman

Templates and Jigs and Installation Devices









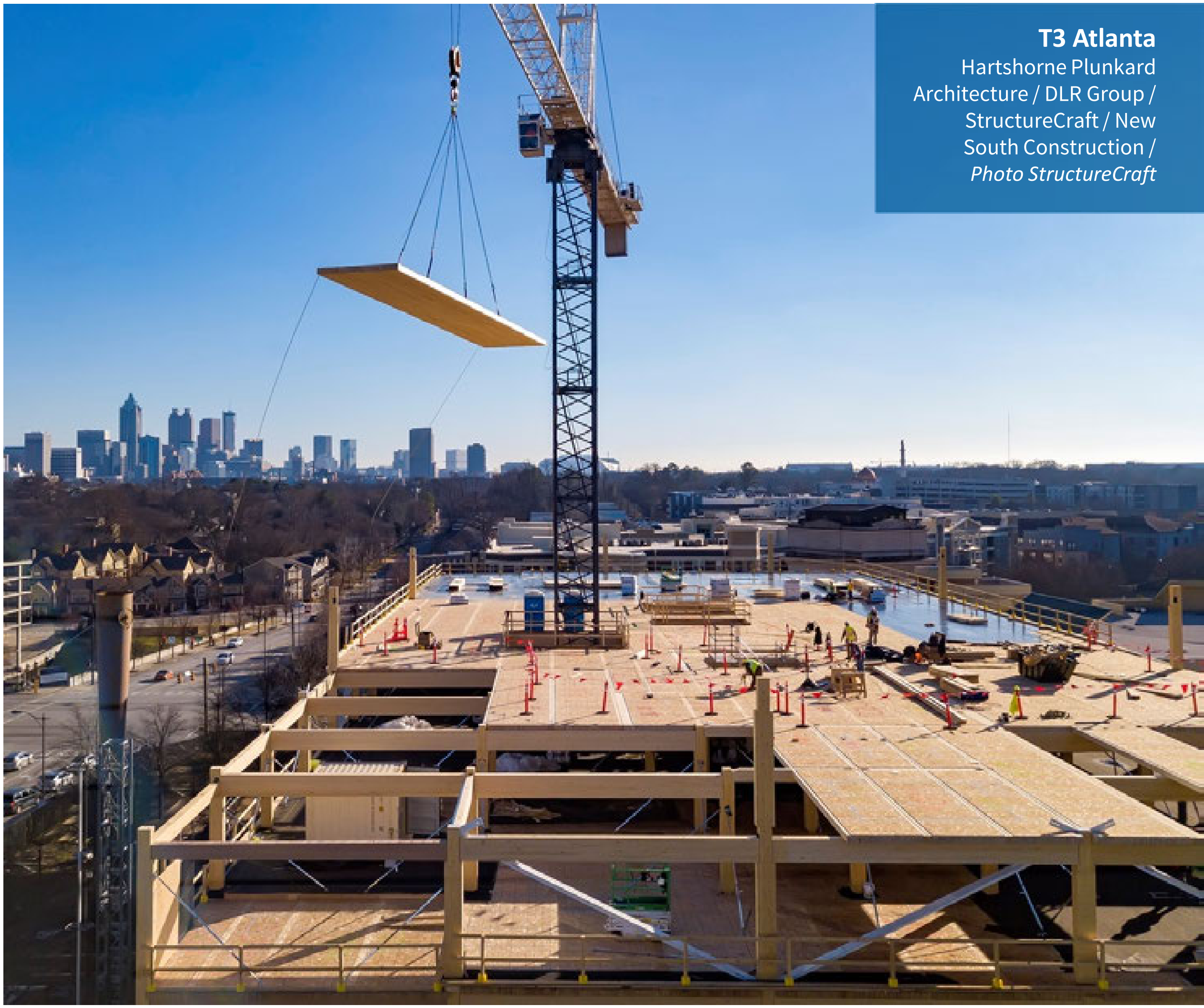
Images Rothoblaas

Safety Considerations

Construction Benefits

Qualified Operators

» Ensure that all equipment operators are trained and understand the capabilities, limitations, hazards, safety features, emergency conditions and environmental impacts of equipment before use.



T3 Atlanta
Hartshorne Plunkard Architecture / DLR Group / StructureCraft / New South Construction /
Photo StructureCraft

Fire Safety in the 2021 IBC

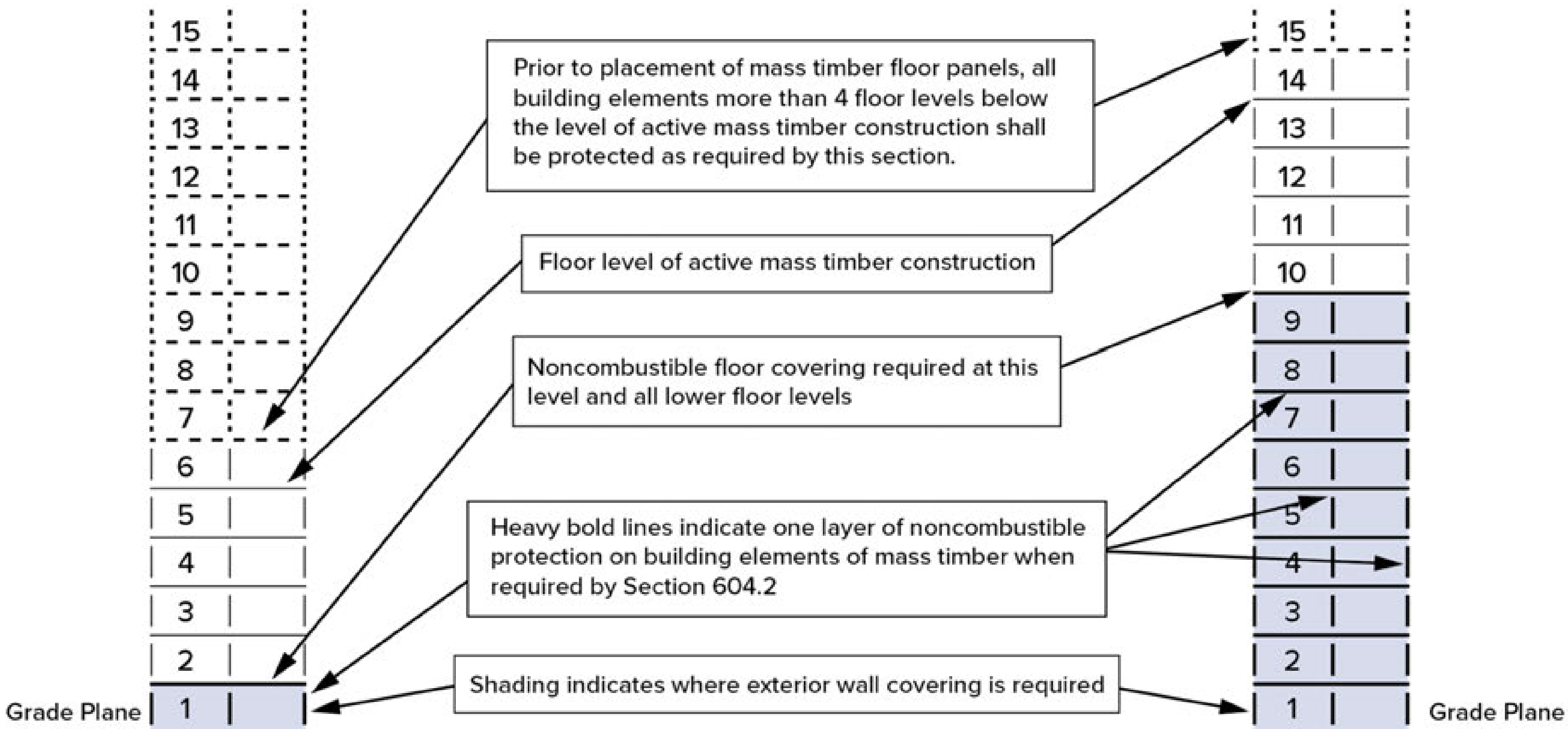


Image International Code Council

Planning and Coordination

Pre-design

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

- Identify and coordinate with MEP/FP subs and other material trades.
- Coordinate site logistics/planning and schedule.
- Establish design goals through discussions with owner, designer and builder.
- Undertake 3D modeling for discussion between designers and builders during design.
- Schedule steel component modeling so it doesn't delay the mass timber.

During Design

Builder input continues through design.

- Consider/discuss tolerances.
- 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.

Modeling/Fabrication Schedule

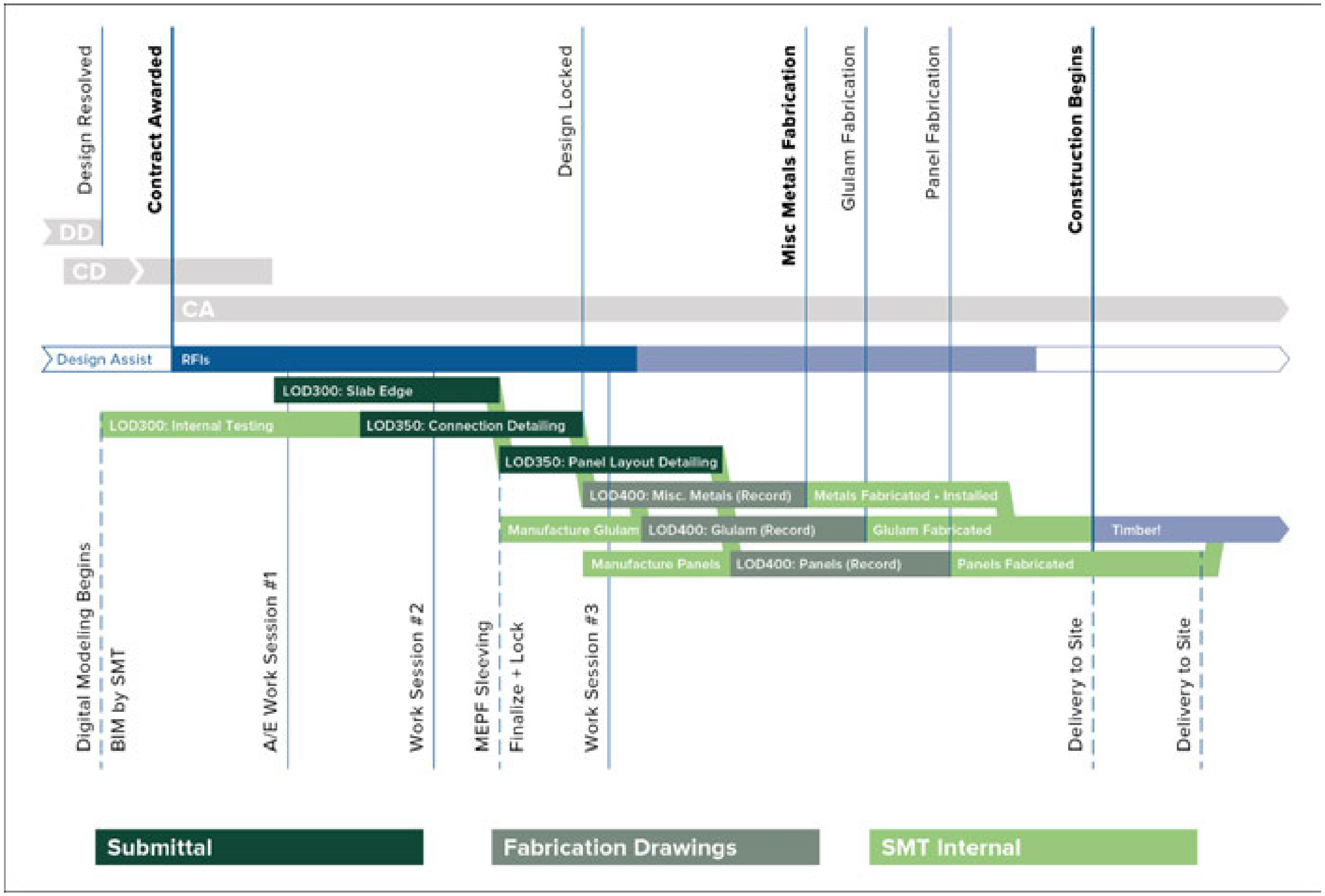


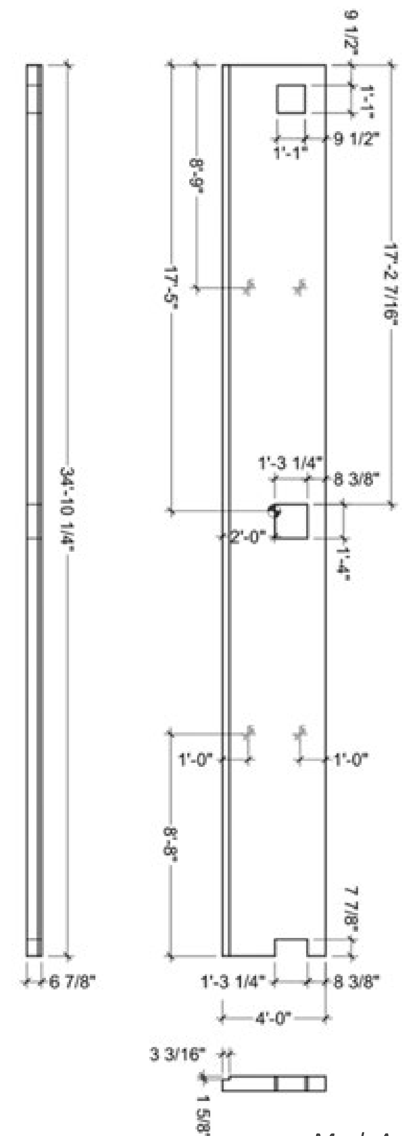
Image Timberlab

Site Planning

- Sequencing plan > **Installation sequence dictates delivery sequence**
- Staging plan
- Weatherproofing strategies
- Lift (or pick) plan
- Resilient Planning for Disruption

Shop Drawings

- **CNC data** for the fabricator, including connections
- **Material information**, including grades, dimensions and finishes
- **Locations** of openings, cuts, holes and connections
- **Weight and center of gravity** for all members
- **Connection hardware** if possible – similar processes
- **Sequencing** if determined (may be later)
- **Rigging connections** requested by the mass timber installer
- **Installation drawings** showing all member piece marks, locations, elevations and connection details (including gaps if required to accommodate shrinkage and swelling)



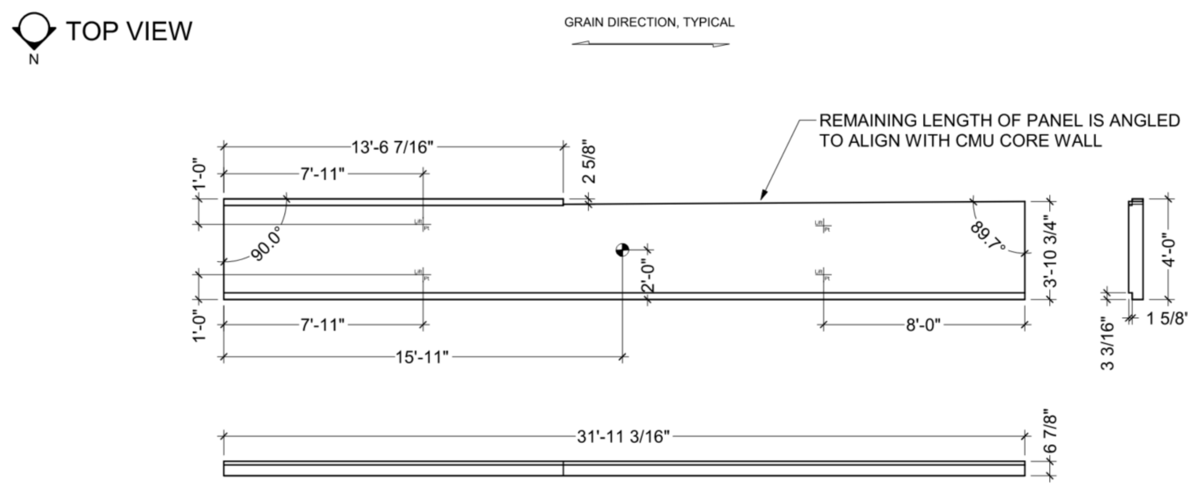
Mesh Architectures

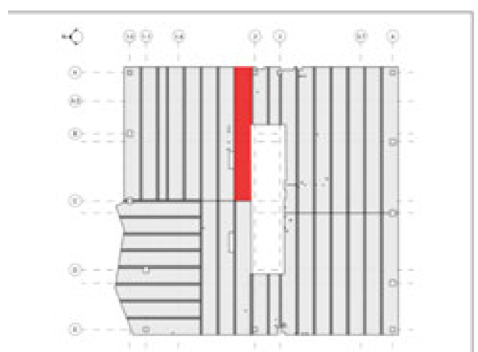
Items to Consider

- Duct, conduit and pipes above ceilings and through adjoining wall assemblies
- Plumbing drops at restrooms
- Mechanical chases
- Need for additional structural members at shaft openings
- Routing at floors and walls to accommodate conduits
- Exposure of materials and trades that may not be typically exposed

T3 Minneapolis
MGA | Michael Green Architecture / DLR Group / Magnusson Klemencic Associates / Krause-Anderson Construction Company / StructureCraft / Perkins & Will (interior)
Photo Corey Gaffer

An individual shop drawing should exist for each <u>unique</u> floor panel.





Description: 6 7/8" GLT		Weight: 2446
Quantity:	Grade: Combo L2	Length: 31'-11 3/16"
1	Material: Douglas Fir / Larch	Width: 4'-0"
	Treatment: Sansin KP-12 @ Edges & Underside	Depth: 6 7/8"
		Lifting: —

Image AEC Inc.

Penetrations

These drawings are:

- Used by the manufacturer to pre-cut holes
- Coordinated by the GC with input from the:
    - Architect
    - Engineer
    - Mass timber manufacturer(s)
    - Specialty subs
    - Digital drafting crew (if different from the manufacturer)

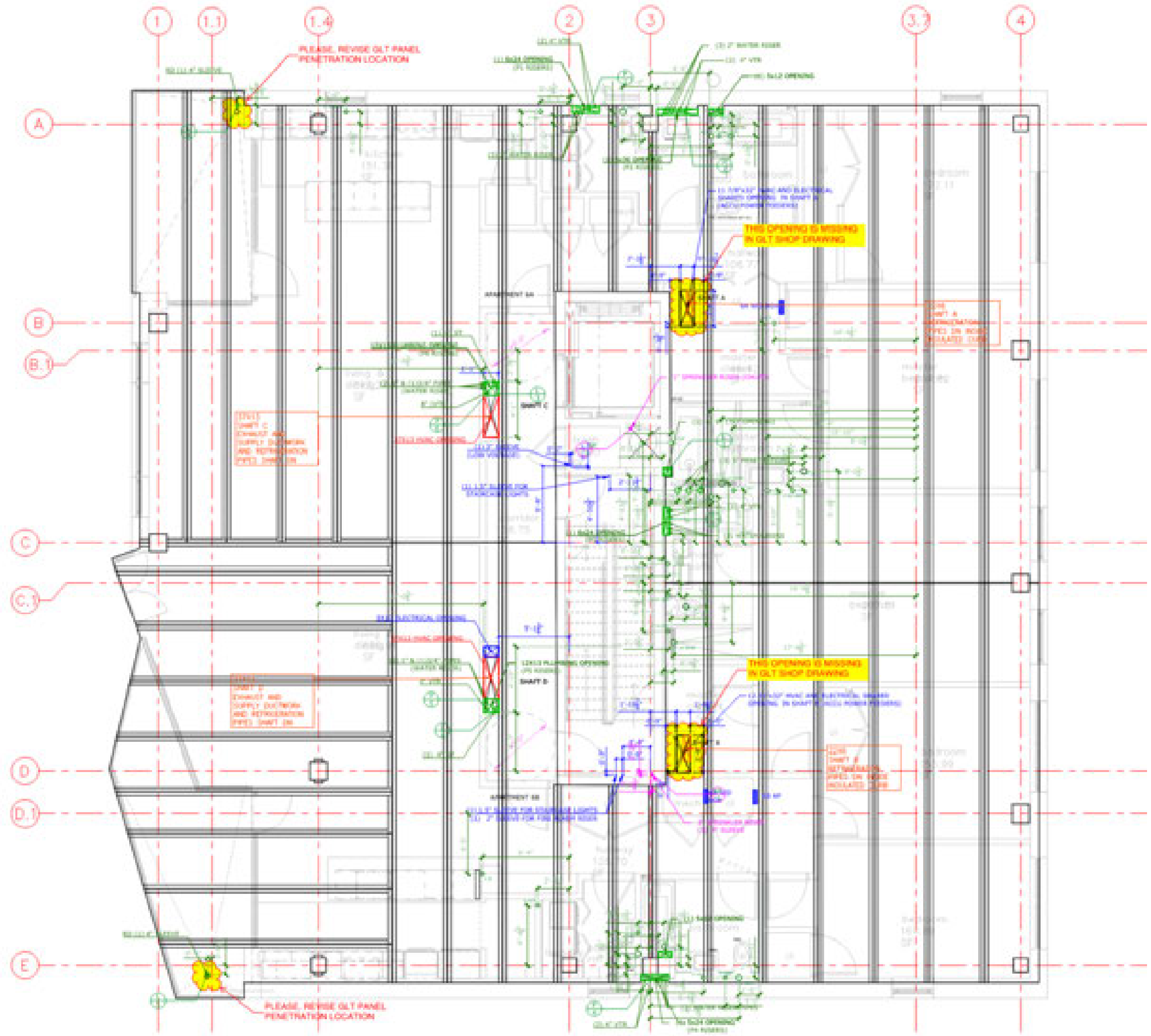


Image AEC Inc.

Delivery, Site Organization & Staging

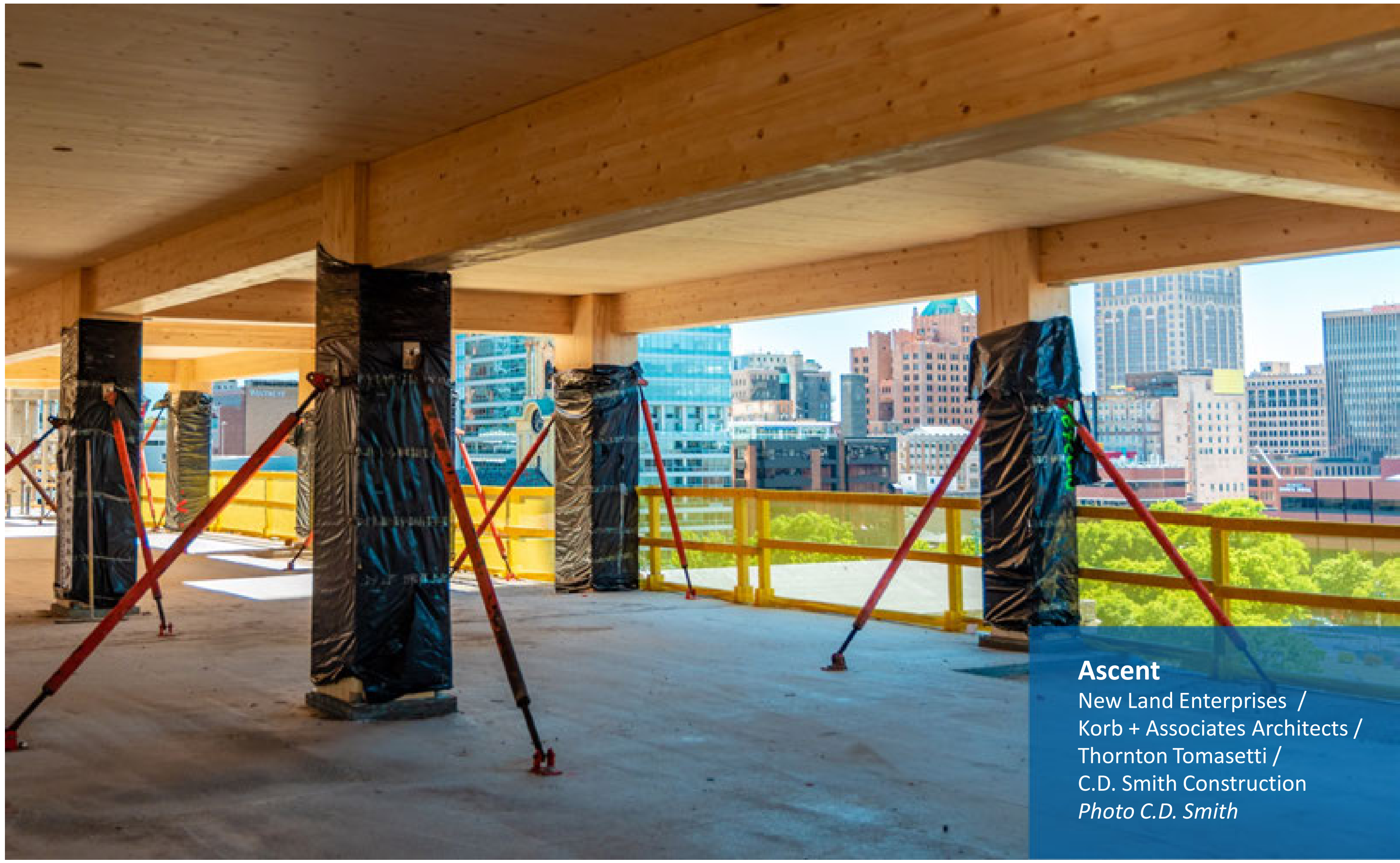
KK Law courtesy naturallywood.com

Photo Swinerton

Installation and Material Protection

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 Plan

Planning starts at the earliest stage and is collaborative.

Construction team responsibilities include:

» Construction phase plan; on-site strategies based on risk evaluation
  » Coverings
  » Deflection/diversion
  » Ventilation/drying

» Anticipating and troubleshoots issues

» Monitoring

Type and Extent of Protection
- Decision by architect/contractor
- Appearance requirements
- Extent and cost of protection methods
- Protection in fabrication plant and/or on jobsite
- Capability of fabricator
- Capability of installer/moisture protection subcontractor
- Schedule protection plan
- Protection prior to installation
- Protection during installation
- Protection after installation

Moisture Management Responsibility and Risk
- Responsibility for managing and cost of the plan
- Contractor and/or fabricator
- Conditions to be considered
- Schedule delays and revisions
- Construction weather conditions (worst case)

Monitoring Moisture Before, During and After Construction
- Coordination with concrete topping activities
- Roofing material
- Columns, beams and floor/wall panels

U.S. Mass Timber Construction Manual / WoodWorks

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

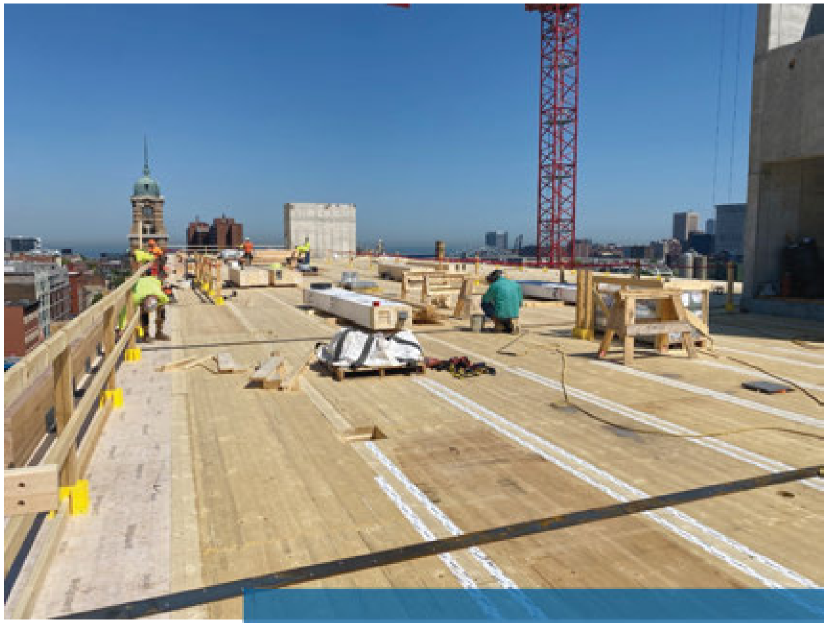
Factory-Applied Sealants & Coatings

Adidas Headquarters
LEVER Architecture / KPFF /
Turner Construction Company
Photo Jeremy Bittermann

Transportation & Storage

Photos Paul Alberts / Ardor Media / naturallywood.com

Panel Joint Treatment

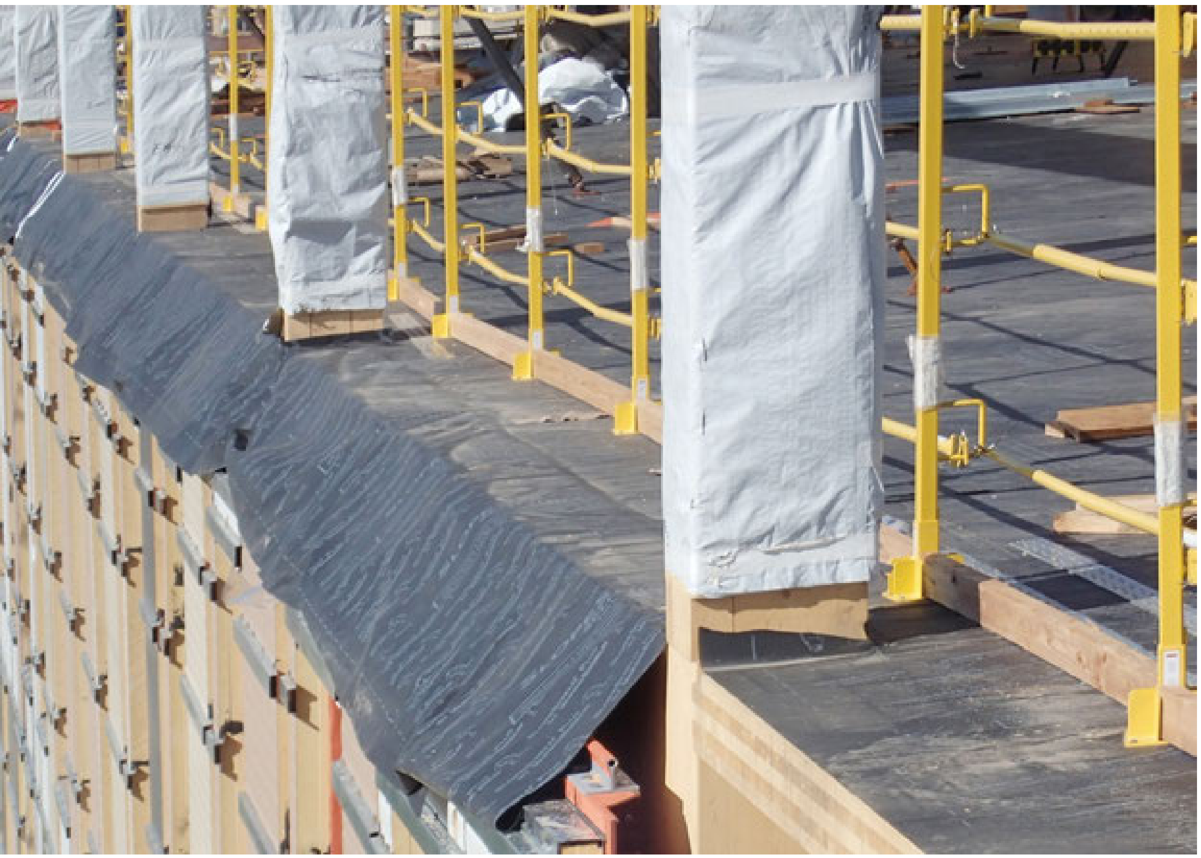


INTRO
Harbor Bay Ventures / Hartshorne Plunkard Architecture / Forefront Structural Engineers / Fast + Epp / Panzica Construction
Photos WoodWorks

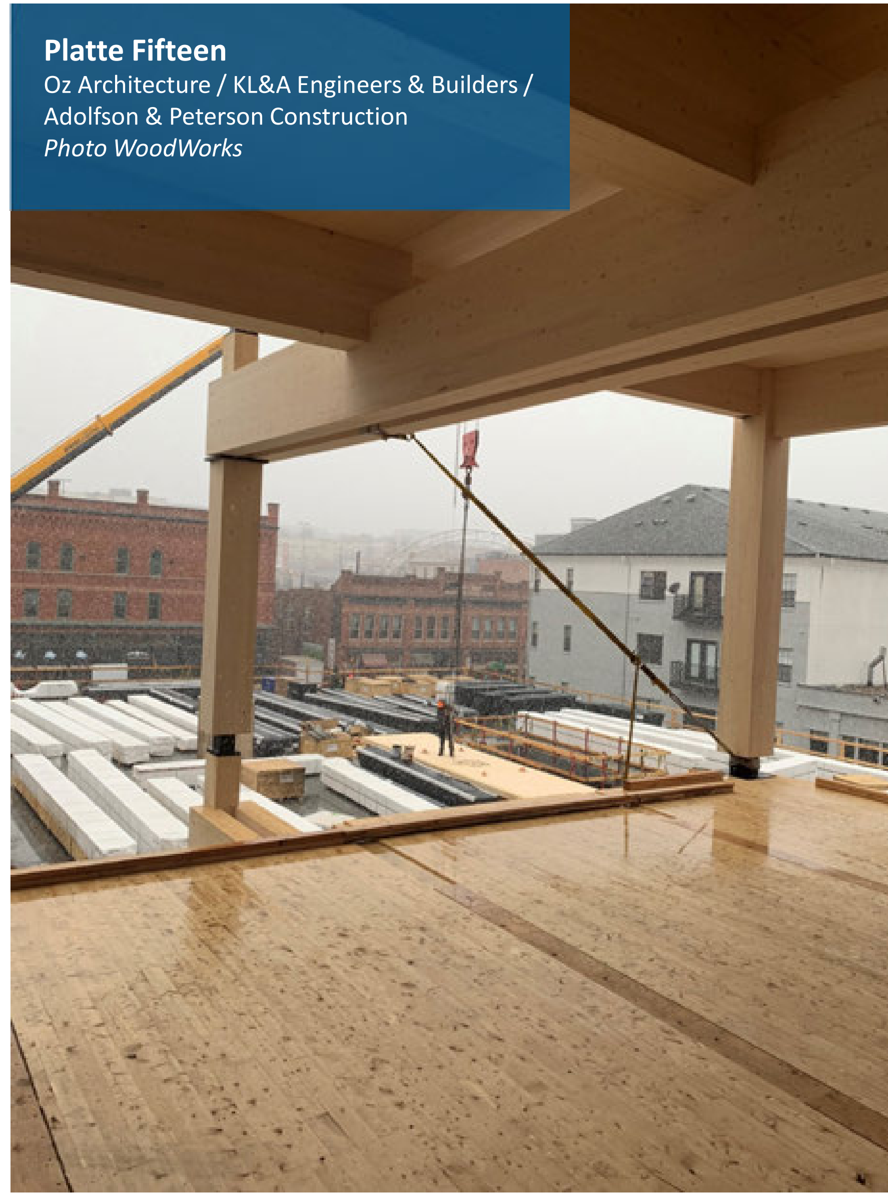
Membranes can be spray-applied, sheet product (adhesive or non), or board/sheathing product.

Vaproshield

Deflection & Diversion



From Moisture Risk Management Strategies for Mass Timber Buildings,
© 2020 RDH Building Science Inc.



Platte Fifteen
Oz Architecture / KL&A Engineers & Builders /
Adolfson & Peterson Construction
Photo WoodWorks

Moisture Monitoring

Monitor the moisture content (MC) of wood materials throughout construction.

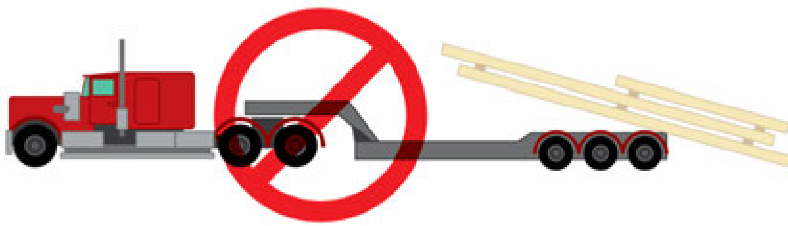
- When materials are received
- Regular intervals
- After rainfall
- Before drying in

Product	MC at Manufacture	Desired MC at Project Close-in with Direct-Applied Concrete Toppings
CLT	12% +/- 3%[a]	<16%
GLT	12-16%[b]	<16%
NLT	<19%[c]	<16%
DLT	15-19%[d]	<16%

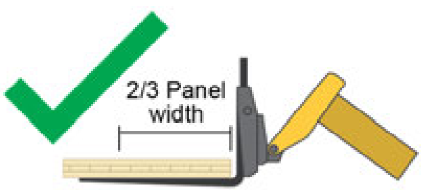
Sources: [a]PRG-320 standard, [b]ANSI A190.1, [c]Nail-Laminated Timber Design Guide – U.S. Edition, and [d]DLT Design and Profile Guide

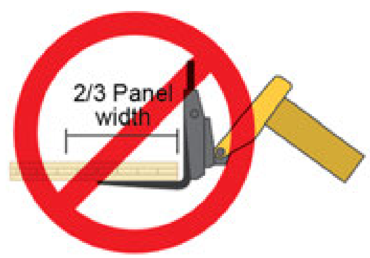
Material Handling

Never dump or drag panels off trucks



Forklifts and Telescoping Handlers





Use forks at least 2/3 of panel width

INTRO / Photo WoodWorks

Avoid Rust and Stains

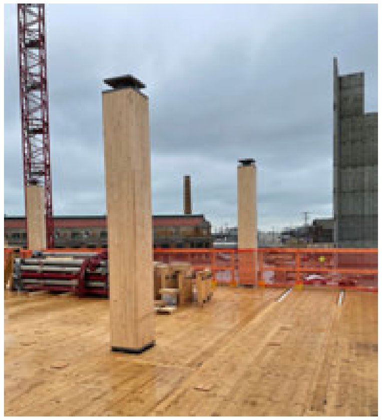
Remove metal shavings from holes when drilling plates.

- **Grind metal away from mass timber** elements (also protects against fire).
- For high-strength connections that require oil to install, **wipe off excess oil** immediately after installation.
- **Paint utilities before installing** on a mass timber ceiling and touch up afterwards.

Kendeda Building for Innovative Sustainable Design
The Miller Hull Partnership with Lord Aeck Sargent / Uzun + Case / Skanska USA
Photo Jonathan Hillyer

Installing Columns

- » Remove protection material as needed
- » Set column to the correct elevation and location
- » Install column braces
- » Plumb the column



Ascent / *Photo WoodWorks*

Installing Beams

Set the beam

» Remove protection material as needed.

» Set the beam and connect to supporting material.

INTRO / Photo Ohio Carpenters Apprentice and Training Program

Platte Fifteen
Oz Architecture / KL&A Engineers & Builders / Adolfson & Peterson Construction
Photo JC Buck

Installing Panels

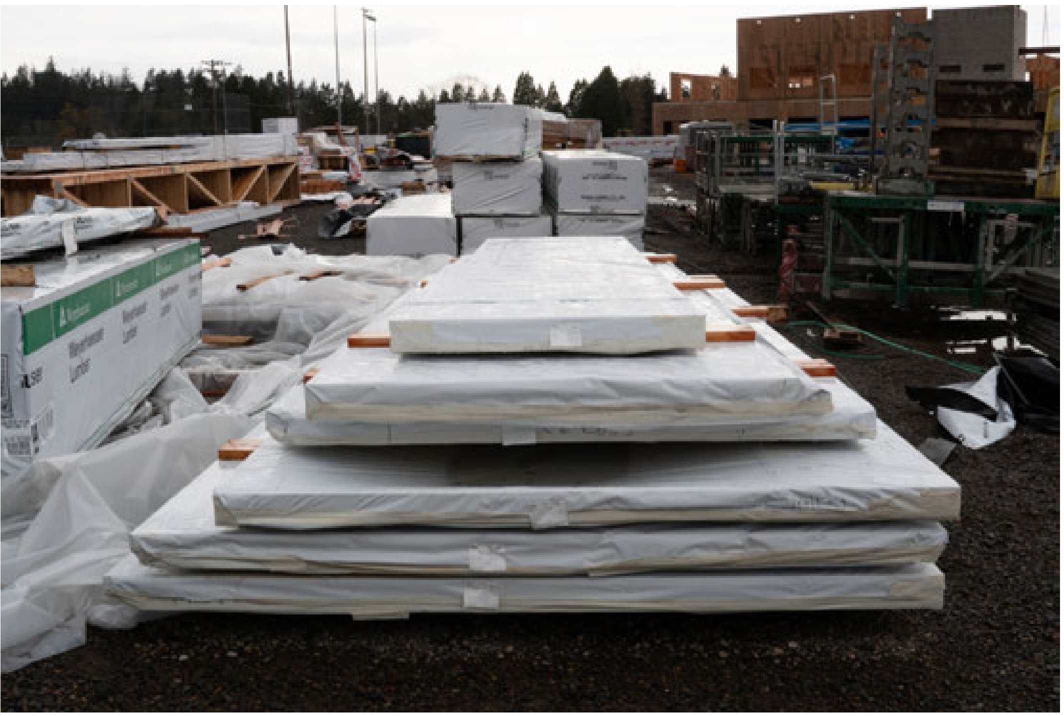


Photo Marcus Kauffman

Photo WoodWorks

Tall Mass Timber Special Inspections

TABLE 1705.5.3
REQUIRED SPECIAL INSPECTIONS OF MASS TIMBER CONSTRUCTION

Type	Continuous Special Inspection	Periodic Special Inspection
1. Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.		X
2. Inspect erection of mass timber construction		X
3. Inspection of connections where installation methods are required to meet design loads		
3.1. Threaded fasteners		
3.1.1. Verify use of proper installation equipment.		X
3.1.2. Verify use of pre-drilled holes where required.		X
3.1.3. Inspect screws, including diameter, length, head type, spacing, installation angle, and depth.		X
3.2. Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads	X	
3.3. Adhesive anchors not defined in 3.2.		X
3.4. Bolted connections		X
3.5. Concealed connections		X

Source: International Building Code

Table is only required for <u>Type IV-A, IV-B, and IV-C</u>

Repairs and Finishes

Cleaning Mass Timber

Sanding and cleaning solutions are the most common ways to remove stains.

Photos WoodWorks

Applying Finishes

Below, glulam panels are coated in the controlled environment of a fabrication facility. On the right, a coating is being applied on the jobsite.

Photo Sansin Corporation, Western Archrib

Silica
William / Kaven Architecture / KPFF Consulting Engineers / Bremik Construc8on
Photo Daniel Kaven

ACKNOWLEDGEMENTS

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StructureCraft – Abbotsford, BC – Gerald Epp Jr., Lucas Epp
Vaagen Timbers – Colville, WA – Russ Vaagen, Tom Baun, Greg Knight

General Contractors/Timber Fabricators/Installers

Andersen Construction – Portland, OR – Brad Nile
Bell Structural Solutions – New Brighton, MN – Jim Abrams, Dustin Imholte, Roland Hernandez, Mike Price, Michael Price II
Cascade Joinery – Ferndale, WA – John Miller
Granger Construction – Lansing, MI – Bill Bofysil
HITT Contracting – Falls Church, VA – Brian Lantz
Lendlease – Nashville, TN – Charles Starck, Bill Tobin
Nabholz Construction – Rogers, AR – Rob Dodd
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Training Centers

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Course Description

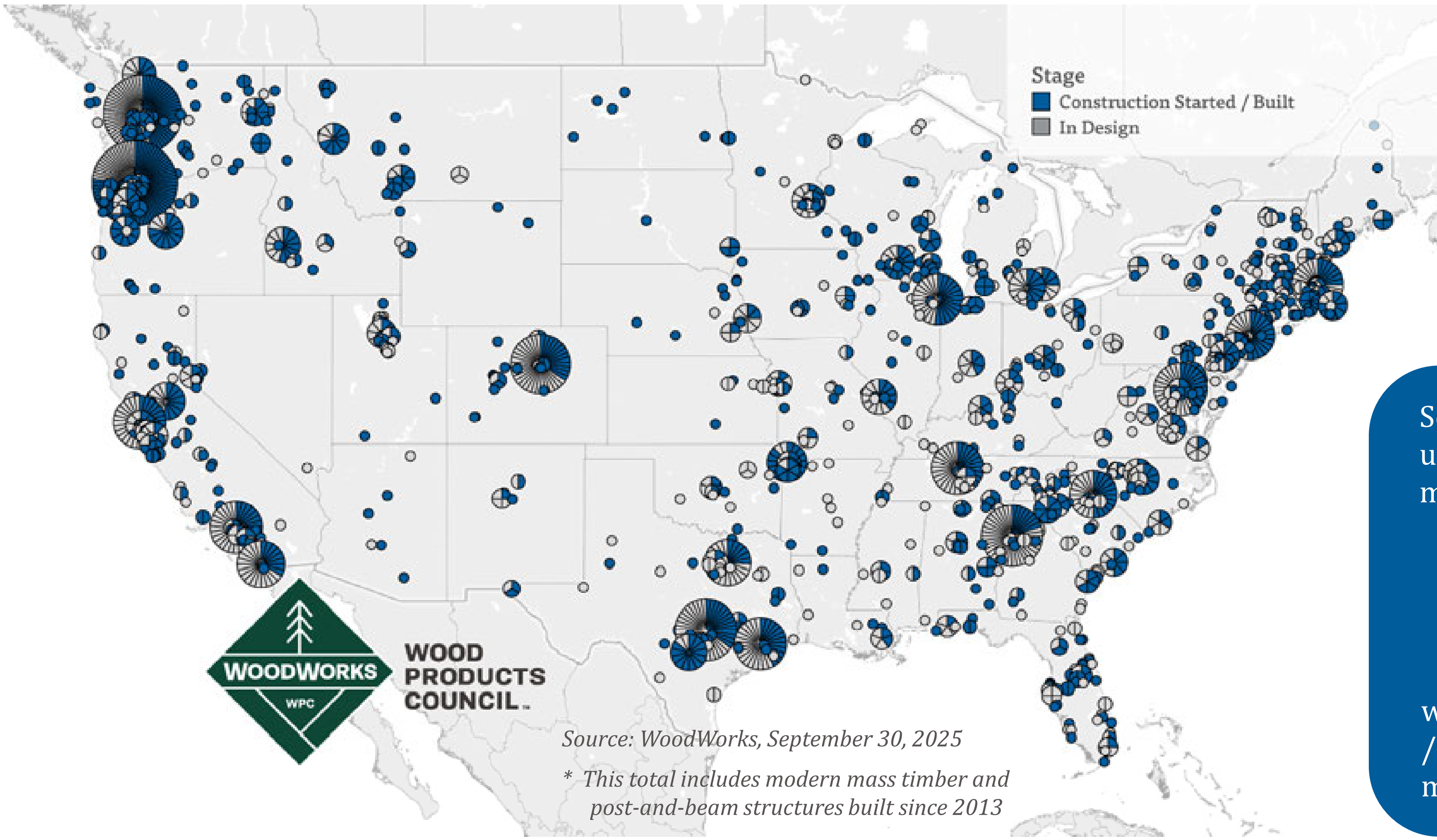
Accurate costing is critical to the success of mass timber projects. This presentation reviews essential resources for design teams to help clarify pricing, bidding, and project delivery methods. These aspects put together, are all decisions that influence cost-efficiency and overall project outcomes. Participants will learn how to navigate the complexities of costing and make more informed decisions that benefit their mass timber projects.

Learning Objectives

1. Identify and review available resources for accurately pricing mass timber projects, ensuring clarity in bidding, and project delivery methods that enhance financial planning and project viability.
2. Analyze different project delivery methods for mass timber construction, understanding their financial implications and how to choose the most suitable approach for your project.
3. Learn about the critical decisions and strategies that can impact the cost-efficiency and success of mass timber projects, ensuring adherence to health, safety, and welfare standards.
4. Review strategies to effectively implement best practices in costing and project delivery for mass timber projects, improving overall project outcomes and ensuring economic sustainability.

Current State of Mass Timber Projects

As of Q3 2025, in the US, **2,598** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.

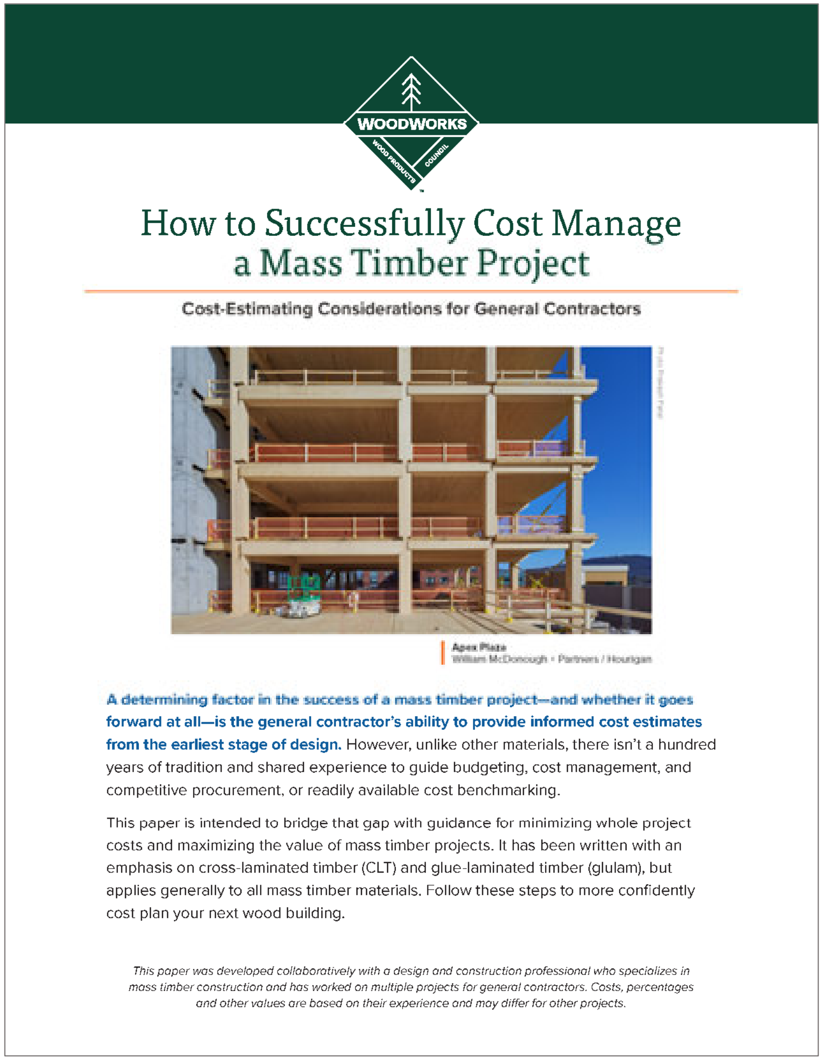


Source: WoodWorks, September 30, 2025

** 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/



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How to Successfully Cost Manage a Mass Timber Project

Cost-Estimating Considerations for General Contractors

Apex Plaza
William McDonough + Partners / Hourigan

A determining factor in the success of a mass timber project—and whether it goes forward at all—is the general contractor's ability to provide informed cost estimates from the earliest stage of design. However, unlike other materials, there isn't a hundred years of tradition and shared experience to guide budgeting, cost management, and competitive procurement, or readily available cost benchmarking.

This paper is intended to bridge that gap with guidance for minimizing whole project costs and maximizing the value of mass timber projects. It has been written with an emphasis on cross-laminated timber (CLT) and glue-laminated timber (glulam), but applies generally to all mass timber materials. Follow these steps to more confidently cost plan your next wood building.

This paper was developed collaboratively with a design and construction professional who specializes in mass timber construction and has worked on multiple projects for general contractors. Costs, percentages and other values are based on their experience and may differ for other projects.

https://www.woodworks.org/resources/how-to-successfully-cost-manage-a-mass-timber-project/

Step 1: Do Your Homework
•Vetting potential subcontractors
•Determining the procurement model (with details on common models used in the U.S.)

Step 2: Establish a Reliable Pre-Design Budget
•Basic timber pricing dynamics
- Example of increasing detail recommended at different phases of project planning
- Information to supply for better pricing
- Insights for better budgeting

•Choosing your list of bidders
•Adjusting budgets for trades impacted by timber

Step 3: Manage Project Costs
•Establishing cost benchmarking
•Understanding the largest non-timber design cost levers

Cost Managing a Mass Timber Project

Step 1: Do your Homework

Step 2: Establish a Reliable Pre-Design Budget

Step 3: Manage Project Costs

Do Your Homework
Understand the "Why"

Healthy Buildings & Biophilia

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

Do Your Homework
Understand the "Why"

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

2024 Report

Do Your Homework

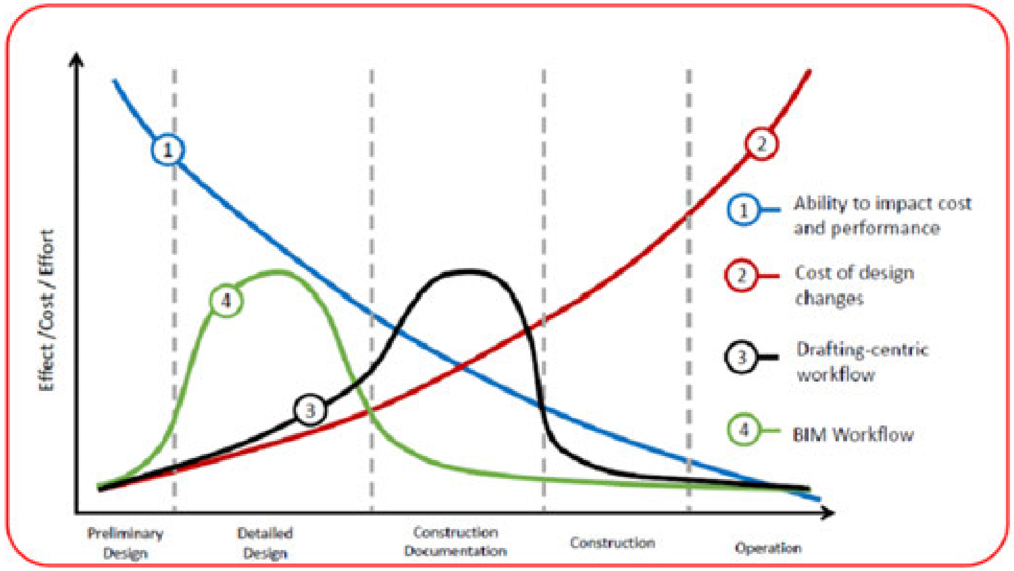
Factors Influencing Cost Estimation

Design Complexity: High impact on material and labor costs

Material Availability:

- Regional differences in availability and pricing
- Understand which suppliers and subcontractors are appropriate for your project and how best to use them

Procurement Model: Can impact the timber package price by as much as 30%—or more than 5% of total project hard costs



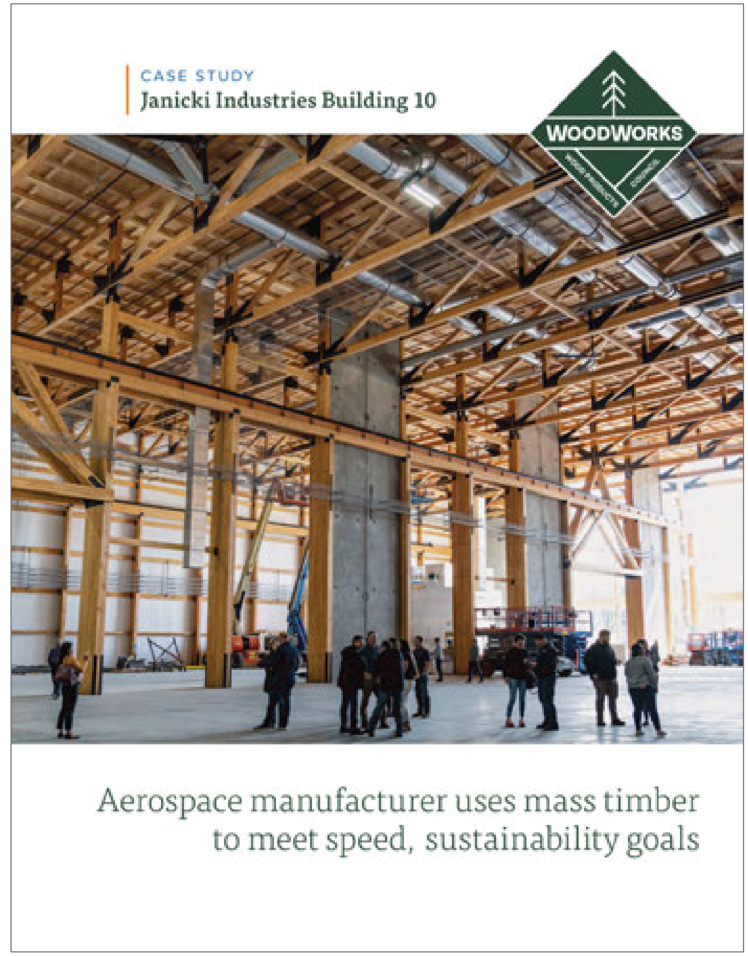
Do Your Homework

Vetting Potential Manufacturers and Subcontractors

- **Which products do you manufacture vs. which do you supply?**
- **What services do you typically provide?**
- **What is the ideal project for your company?**
- **What is your lead time?**
- **How does it differ for a smaller project**

Do Your Homework

Successful Subcontractor Vetting

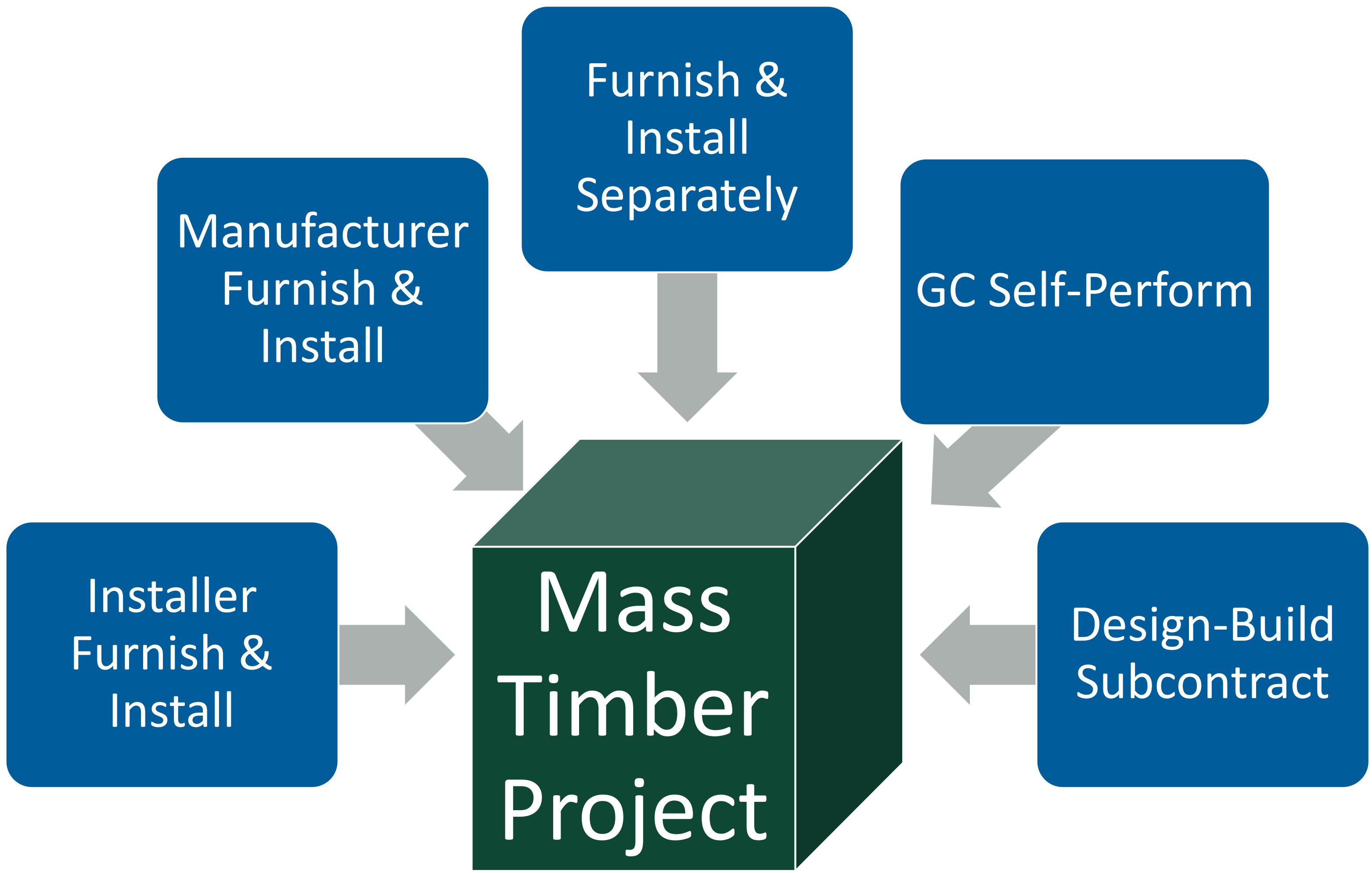


Janicki Industries Building 10

Lessons Learned: Schedule Drove Decisions

Originally slated to be just 60,000 square feet, the building tripled in size as Janicki's contract grew. Jordan Janicki, Principal of structural engineering firm DCG/Watershed (and John's nephew) said that meant they needed to focus even more on value engineering the project for speed. "It was a crazy schedule," said Jordan. "We started schematic design in February 2022; it became a 90,000-square-foot building in March, and then grew again in size from there. We finalized drawings at the end of March and applied for permits in May. Close coordination played a critical role throughout the entire process."

Analysis of **(a few)** Mass Timber Procurement Models



Installer Furnish Install

Single contract between GC and installer; installer supplies material and installation

ADVANTAGES

- Recommended for GCs/project teams with little mass timber experience and more complicated projects
- Streamlines the process, reduces GC risk and may contribute to overall savings if there is significant opportunity for improving design efficiency or complicated sequencing/logistics

DISADVANTAGES

- Can be more expensive because the material is managed and procured by the installer
- Often requires longer bidding time for installer/manufacturer coordination
- Less detail typically provided on supply cost in a combined supply-install proposal; ambiguity about cost allocation can impacts GC ability to control cost

Manufacturer Furnish Install

Single contract between GC and manufacturer; manufacturer (may) subcontract to installer

ADVANTAGES

- Recommended for all-timber structures where efficiency on site is straightforward and projects delivered under a design-bid-build contract where the GC has less opportunity for significant design modifications
- Can be less expensive than installer furnish/install because the material is not coordinated by a third party; manufacturer may charge for installation management

DISADVANTAGES

- Risk of prioritizing efficiency in the factory, which can be at the expense of on-site efficiencies
- Creates an inherent degree of separation between GC and installer

VARIATIONS

A variation is where the contracts are separately held (as in the furnish and install separately model) but the bid is a joint proposal

Furnish and Install Separately

GC procures material direct from manufacturer; separate contract with installer

ADVANTAGES

- Typically yields the most competitive pricing because it removes material handling costs from both the subcontractor and supplier and gives the GC the most flexibility to choose the bidder that's the best fit for each scope

DISADVANTAGES

- Requires much more GC coordination to ensure installer preferences are accommodated, deliveries are well coordinated and avoid schedule delay
- Creates more GC ownership of scheduling issues but also offer more control
- GC should have prior supply chain experience and have established relationships

GC Self-Perform

ADVANTAGES

- As with any self-perform, offers opportunity for better cost and schedule control; owner may not see full value of the savings if the GC uses this model for fee uplift

DISADVANTAGES

- GC must have prior supply chain experience, know the differences between manufacturers/suppliers, and have established relationships

VARIATIONS

A variation is the owner furnish/GC self-perform install. Owner-furnished supply contracts can be a way for the owner to save on GC fees, but the owner takes on the procurement risks and must be proactive and engaged.

Design-Build Subcontract

ADVANTAGES

- Good for elaborate, complex projects (or portions of projects) that require a high degree of fabrication or a design team without the timber experience to effectively coordinate design and fabrication efficiency

DISADVANTAGES

- Much bigger lift from a bidder's perspective and may limit the number of interested/qualified bidders
- Requires a more coordinated bidding process and longer bidding timeframe

Cost Managing a Mass Timber Project

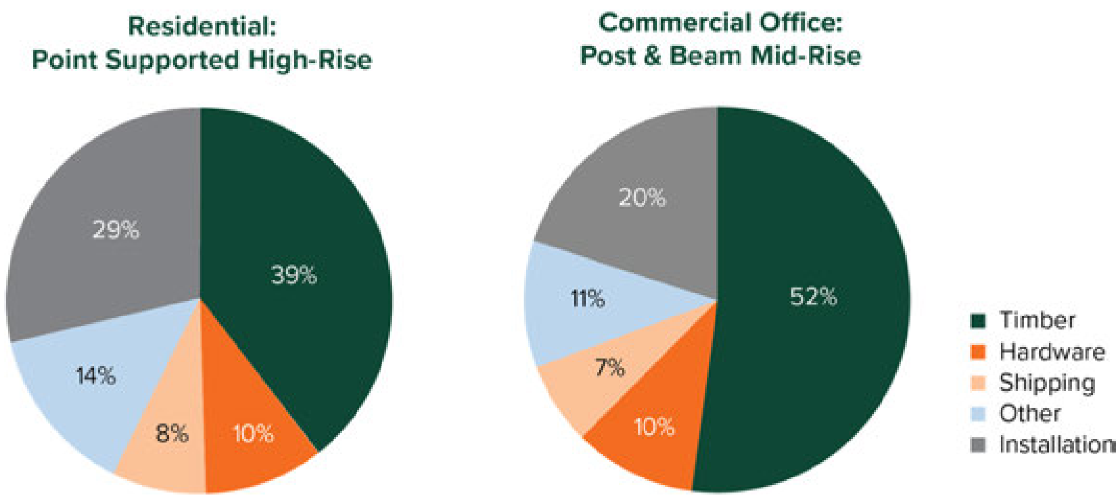
Step 1: Do your Homework

Step 2: Establish a Reliable Pre-Design Budget

Step 3: Manage Project Costs

Establishing a Reliable Pre-Design Budget

Problem: Most GCs don’t have access to enough benchmarking data to reliably provide a generic per square foot cost in the structure line item of a conceptual trade package build-up



Build up costs using first principles based on an informed set of assumptions

Pricing Breakdown		
Concept/ Schematic Design	**Design Development**	**Bidding**
Timber Supply Package	CLT	Floor/roof panels
		Wall panels
		Stair package
		Visual grade
		Temporary sealants
		Factory-applied membranes
		Predrilling/marking
	Glulam	Beams
		Columns
		Blocking/stair package
		Architectural finish
		Certification premium
	Hardware	Connectors
		Preassembly
		Fasteners and splines
		Hardware shipping
	Logistics	CLT shipping
		Glulam shipping
		Temporary storage
	Other	Project management/design assist
		Fabrication model/shop drawings
Installation	Labor and equipment	Schedule duration
		Crew size
		On-site moisture management
	Crane	Size
		Duration
	Staging yard	Duration
Taxes		

Items in green are not typically included in early pricing; develop separate budgets if needed

Establishing a Reliable Pre-Design Budget

+

Which components will be timber?

What elements do you assume will be exposed?

What is the grid size and structural typology?

−

What are the fire ratings?

Are there appearance classification requirements?

Is there a sourcing stipulation or forest certification requirement?

Regardless of the level of information you provide, <u>make sure you can apply volumes to the associated rough costs</u> as this will help further both design and cost refinement

Establishing a Reliable Pre-Design Budget

Insights For Supply Bids

- Aim for three or four qualified/interested bidders to cover both supply and installation scopes (if not bid together)
- Not every project is the right fit for every supplier or installer and producing good bids takes time
- If possible, create a flexible specification. Knowing that the project will be CLT doesn't mean that every CLT manufacturer can meet the requirements
  - Panel width/length/depth deltas are structural deltas
  - Material grade and species deltas are structural deltas
  - Schedules and competing projects
  - Services vis-à-vis Manufacturer/Supplier/Installers
  - Gluam:Panel number may impact bids

Establishing a Reliable Pre-Design Budget

Insights For Better Budgeting for Panels and Glulam

BB1

- **Commodity lumber pricing is an adequate benchmark *to a degree***
- **Choosing panel characteristics (size, species, grade, etc.) that do not limit your choice of manufacturer will help mitigate pricing volatility**
- **Raw material often makes up over 70% of a panel's cost but the most material-efficient solution isn't always the best or most cost-effective solution**
- **Understand the volumes of glulam and CLT separately as the project evolves, as glulam can cost up to 200% more per ft^3/m^3 than CLT**
- **Glulam costs are impacted by structural grade, species, finish, and sourcing, size can also be a significant factor**
- **Glulam members that exceed "standard" sizing will come at a premium**

Establishing a Reliable Pre-Design Budget

Insights For Better Budgeting

- **CLT and Glulam** – Usually between 40% and 55% of the installed timber package cost
- **Hardware** – Beam and column connectors are usually the largest contributor to the hardware line item and can be benchmarked against the cost per ton of steel. When building a budget from scratch, it is worthwhile to estimate the number of glulam intersections and assume a proprietary connector

Establishing a Reliable Pre-Design Budget

Insights For Better Budgeting

- **Shipping** – Roughly 4%-8%. It is common for shipping's contribution to be at the lower end when material is trucked from a nearby factory and at the upper end when shipped from overseas by container. Trucks are typically governed by weight and can carry an estimated 1,250 to 1,350 ft^3 of CLT and 1,000 to 1,200 ft^3 of glulam
- **Installation** – 15 to 30%. The cost of installation is a direct result of the number of pieces and how fast they can go together
- **Adjust budgets for OTHER trades impacted by mass timber**

Understanding Cost Impacts of Construction Type

Pre-Design Budget Example

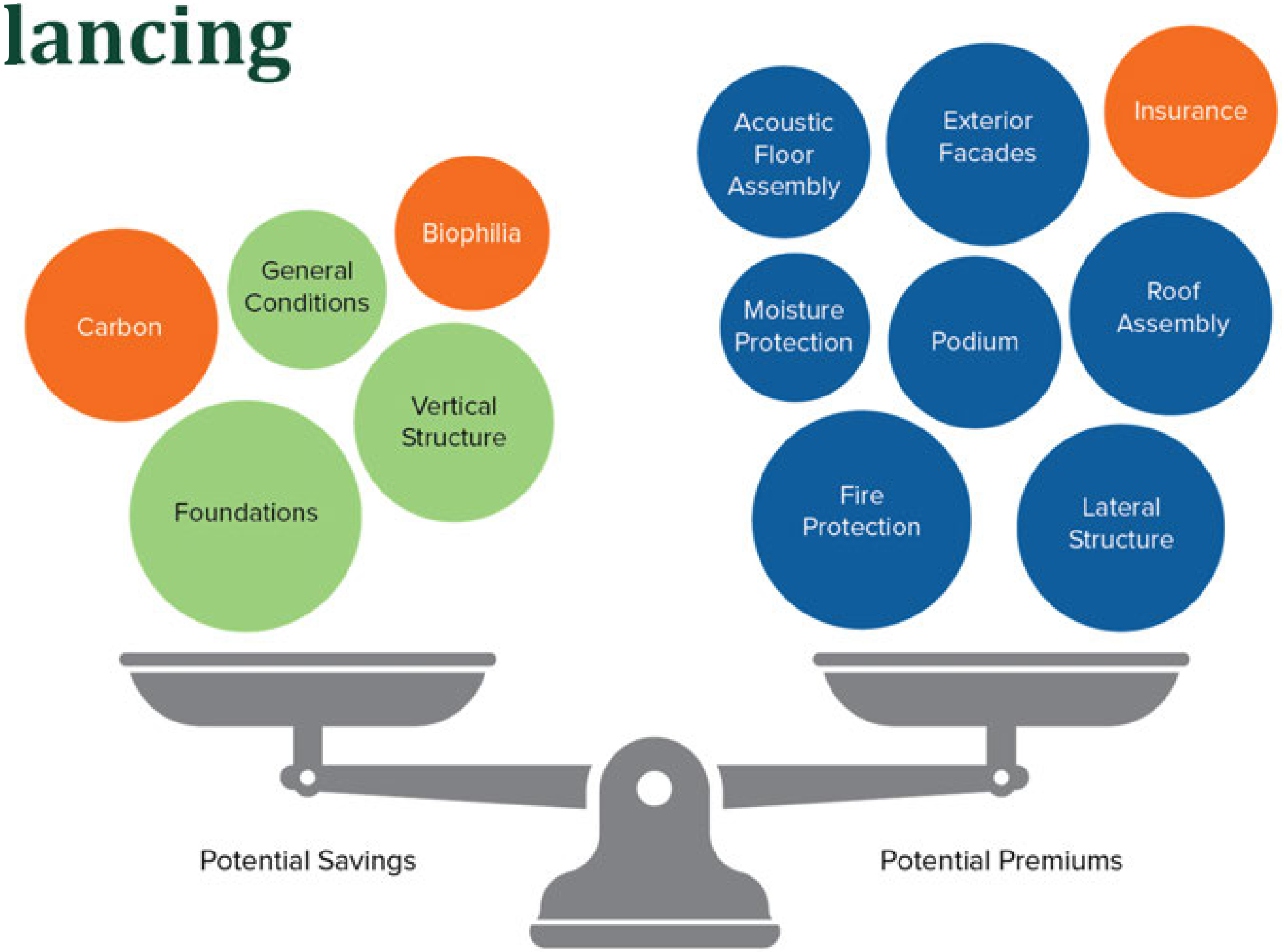
4-story building on college campus

Cost Impact of Assembly Occupancy Placement:

Location of Event Space	4th Floor	1st Floor
Construction Type	III-A	III-B
Assembly Group	A-3	A-3
Fire Resistive Rating	1-Hr	0-Hr
Connections	Concealed	Exposed
CLT Panel Thickness	5-Ply	3-Ply
Superstructure Cost/SF	**$65/SF**	**$53/SF**

The Canyons / Kaiser+Path, Cantena Consulting Engineers / Photo Jeremy Bittermann

Mass Timber Construction Cost Balancing



Cost Managing a Mass Timber Project

Step 1: Do your Homework

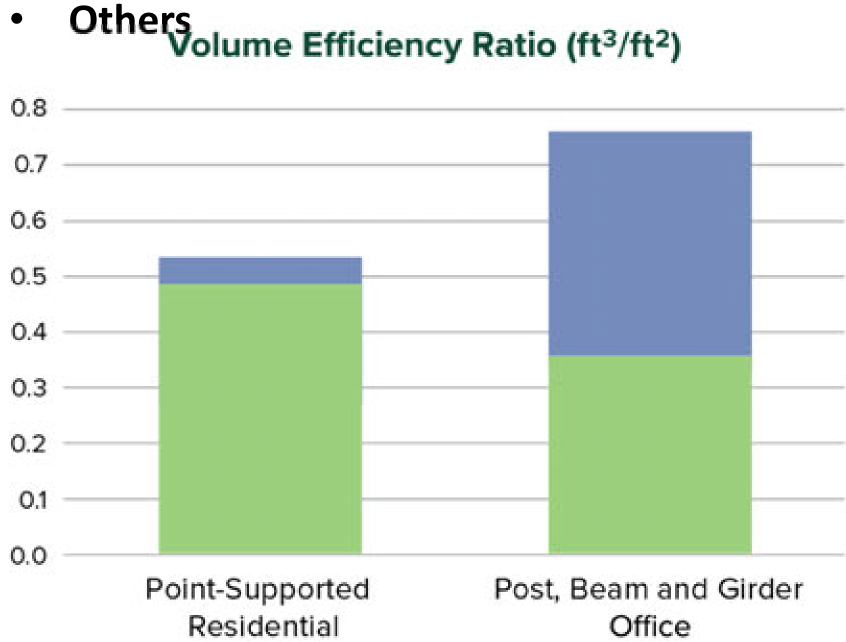
Step 2: Establish a Reliable Pre-Design Budget

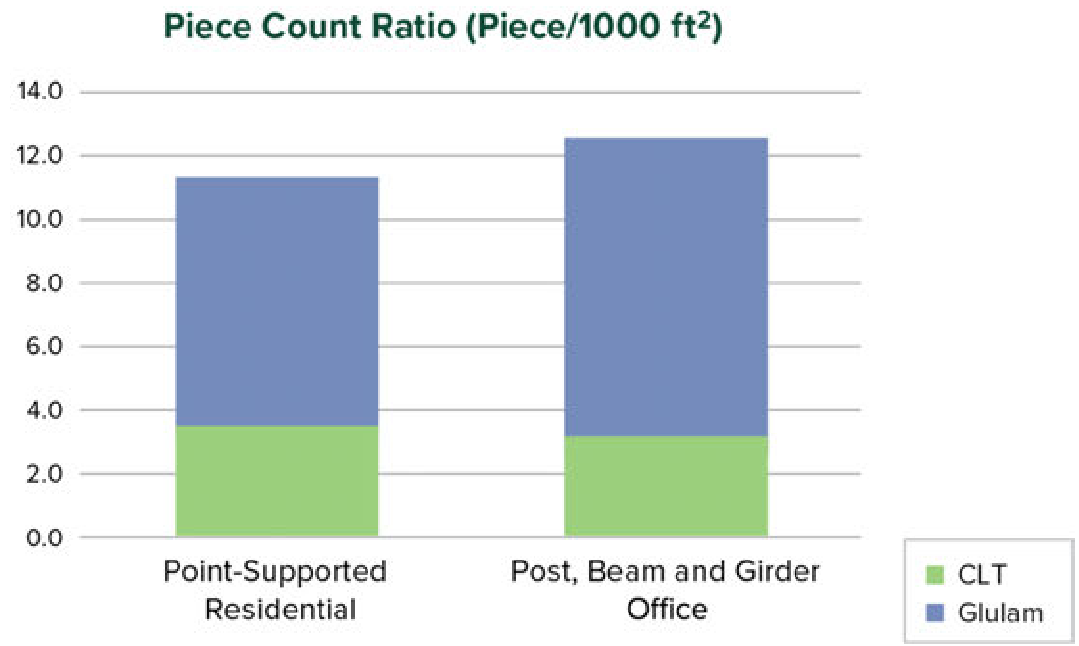
Step 3: Manage Project Costs

Manage Project Costs

Cost Benchmarking

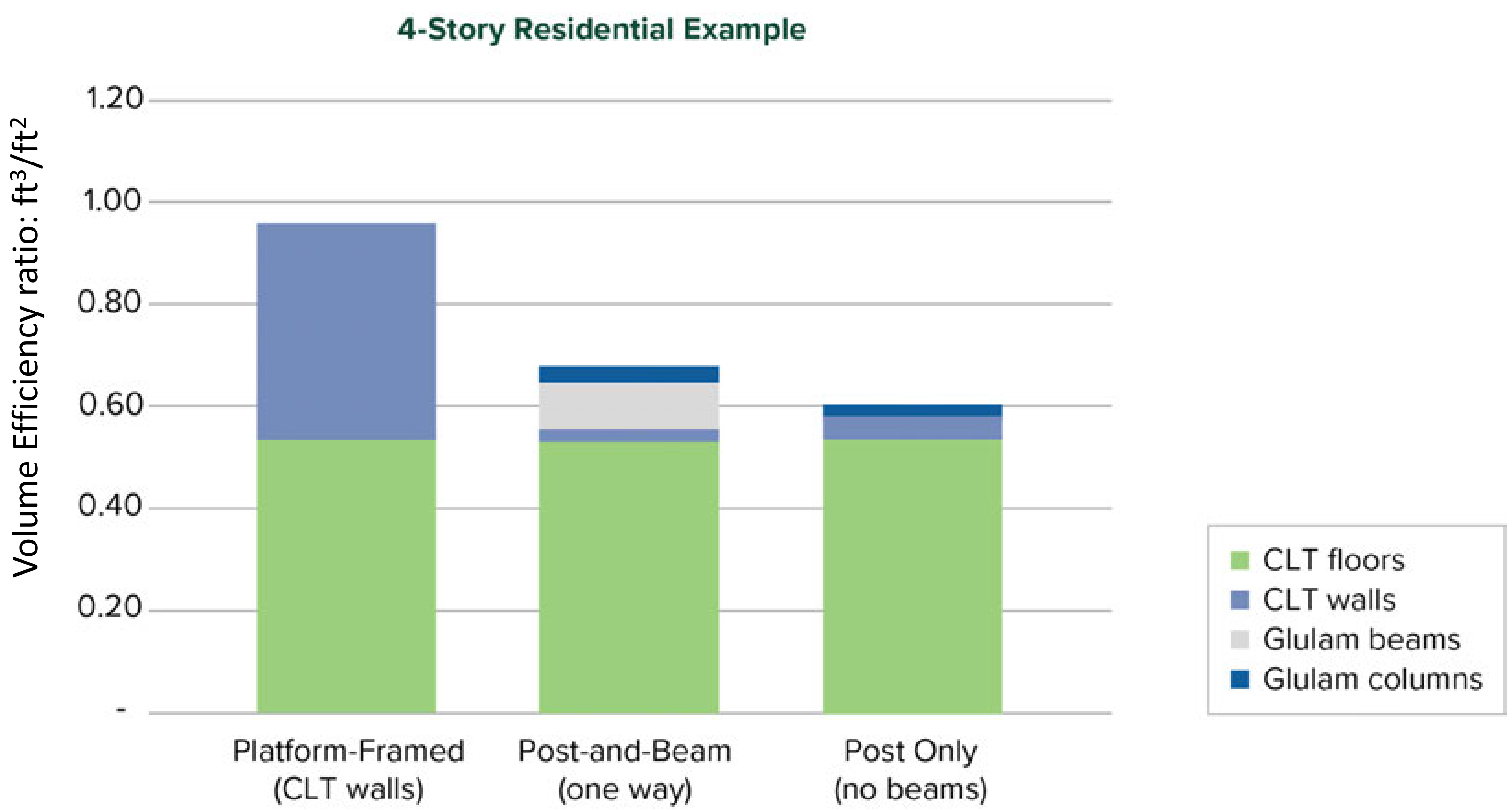
- Volume efficiency ratio: ft^3/ft^2 provides a simple rule of thumb for estimating future projects
- Piece count: cost/piece and piece count/nK ft^2 "What is the estimated number of pieces in relation to the installation cost?"
- Others





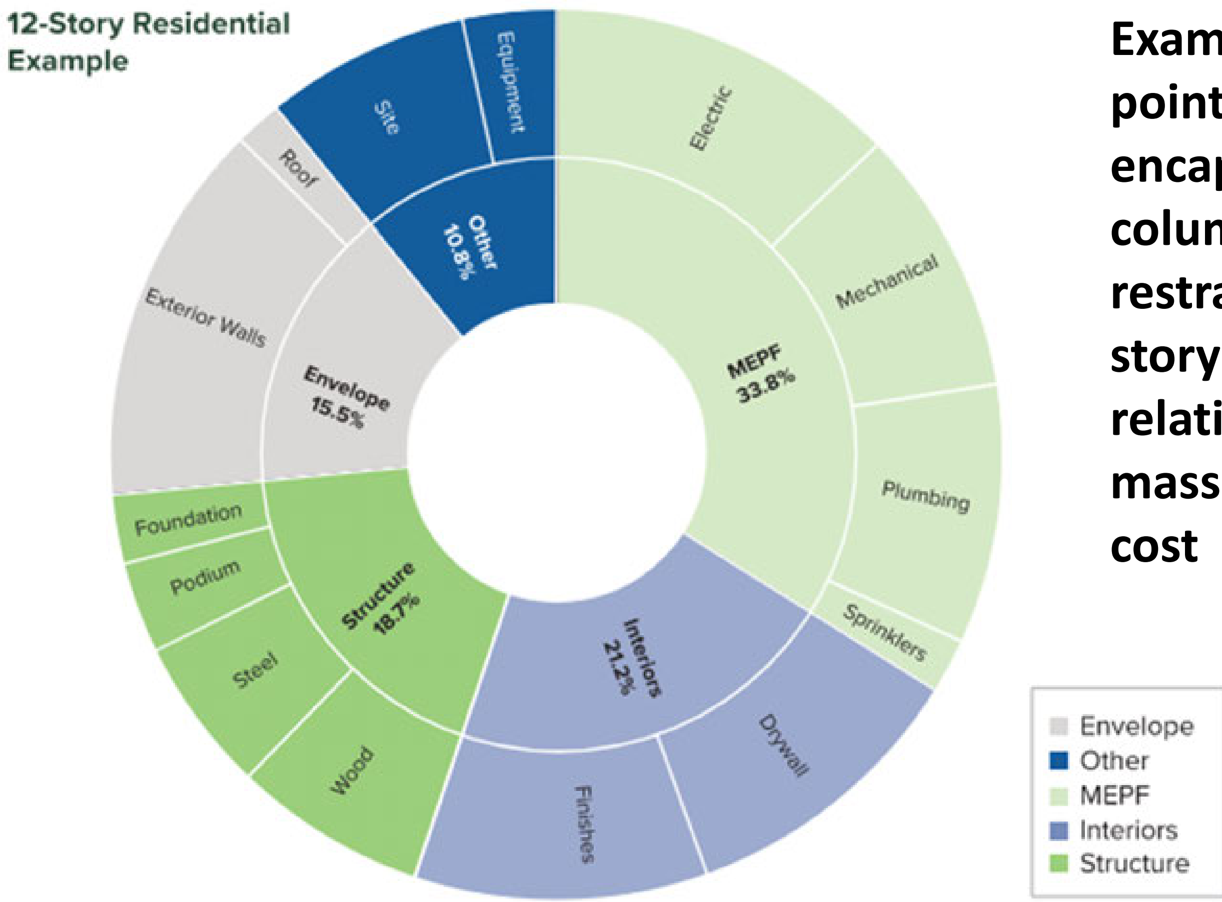
Manage Project Costs

Cost Benchmarking



Manage Project Costs

Cost Benchmarking



Example of a Type IV-B, 12-story, point-supported project with encapsulated glulam columns, steel buckling-restrained brace core, and single-story podium; demonstrates relatively small contribution of mass timber to overall building cost

Manage Project Costs

Positive Non-Timber Design Cost Levers

- **Mass timber's advantages—including light weight, tight tolerances, installation speed, reduced labor and prefabrication— <u>need to be leveraged in other areas</u> to achieve overall cost savings.**
- **In order, Foundations, the vertical load-carrying structure, and general conditions and requirements offer the greatest potential savings**

Manage Project Costs

Other Non-Timber Design Cost Levers

- Cost saving opportunities can be offset by increases in other areas of the construction budget.

- Compensating for these incremental increases and achieving real savings requires a focused effort to both actively leverage opportunities and minimize (in order of effect);

  Lateral systems

  Fire protection

  Acoustic floor assemblies

  Exterior facades

Wellesley College Science Complex / Skidmore, Owings & Merrill / Le Messurier / Photo Dave Burk © SOM

Take Aways

- A determining factor in the success of a mass timber project—and whether it goes forward at all—is the general contractor's ability to provide informed cost estimates.
- Mass timber is new compared to other methods and has limited but expanding shared experiences to help guide budgeting, cost management, and competitive procurement, or readily available cost benchmarking
- Presentation was designed to help bridge that gap with guidance for minimizing whole project costs and maximizing the value of mass timber projects. The obvious emphasis is on cross-laminated timber (CLT) and glue-laminated timber (glulam), but applies generally to all mass timber materials.

How to Successfully Cost Manage a Mass Timber Project:

Cost-Estimating Considerations for General Contractors

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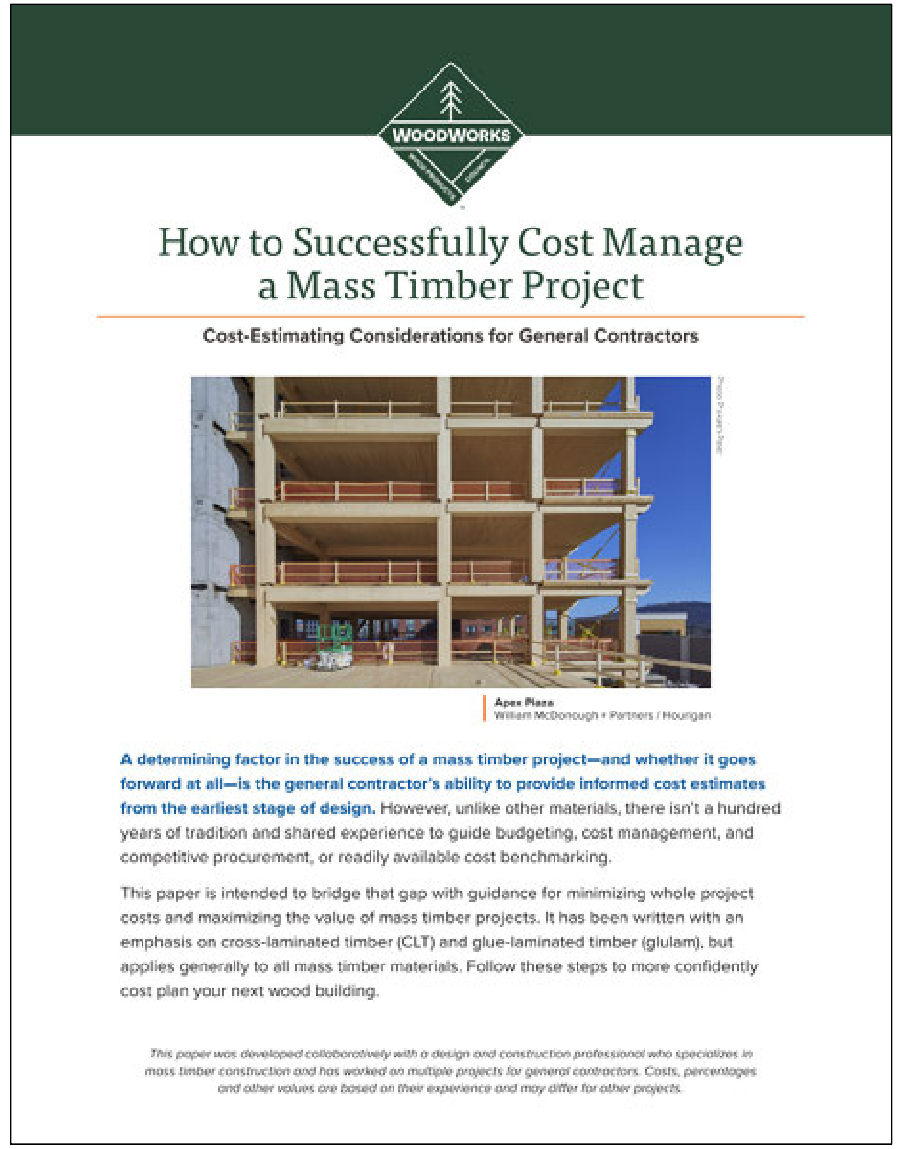

How to Successfully Cost Manage a Mass Timber Project

Cost-Estimating Considerations for General Contractors

Apex Plaza
William McDonough + Partners / Hourigan

A determining factor in the success of a mass timber project—and whether it goes forward at all—is the general contractor's ability to provide informed cost estimates from the earliest stage of design. However, unlike other materials, there isn't a hundred years of tradition and shared experience to guide budgeting, cost management, and competitive procurement, or readily available cost benchmarking.

This paper is intended to bridge that gap with guidance for minimizing whole project costs and maximizing the value of mass timber projects. It has been written with an emphasis on cross-laminated timber (CLT) and glue-laminated timber (glulam), but applies generally to all mass timber materials. Follow these steps to more confidently cost plan your next wood building.

This paper was developed collaboratively with a design and construction professional who specializes in mass timber construction and has worked on multiple projects for general contractors. Costs, percentages and other values are based on their experience and may differ for other projects.

Questions? Ask me anything.

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Please take our survey!

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

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