

Mass Timber Constructability and Costing



May 21, 2026

Presented by:
Michael J. Muller, PE, SE
WoodWorks

WoodWorks | The Wood Products Council

is a registered provider of AIA-approved continuing education under Provider Number G516. All registered **AIA CES** Providers must comply with the AIA Standards for Continuing Education Programs. Any questions or concerns about this provider or this learning program may be sent to AIA CES (cessupport@aia.org or (800) AIA 3837, Option 3).

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

AIA continuing education credit has been reviewed and approved by **AIA CES**. Learners must complete the entire learning program to receive continuing education credit. AIA continuing education Learning Units earned upon completion of this course will be reported to **AIA CES** for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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



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.

Outline

- » Products and Connections
- » Fasteners, Hardware and Equipment
- » Safety Considerations
- » Planning and Coordination
- » Installation and Material Protection
- » Repairs, Finishes and As-Builts

Outline

- **Products and Connections**
 - » Fasteners, Hardware and Equipment
 - » Safety Considerations
 - » Planning and Coordination
 - » Installation and Material Protection
 - » Repairs, Finishes and As-Builts

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

Wood Construction Terminology

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

Wood Construction Terminology

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

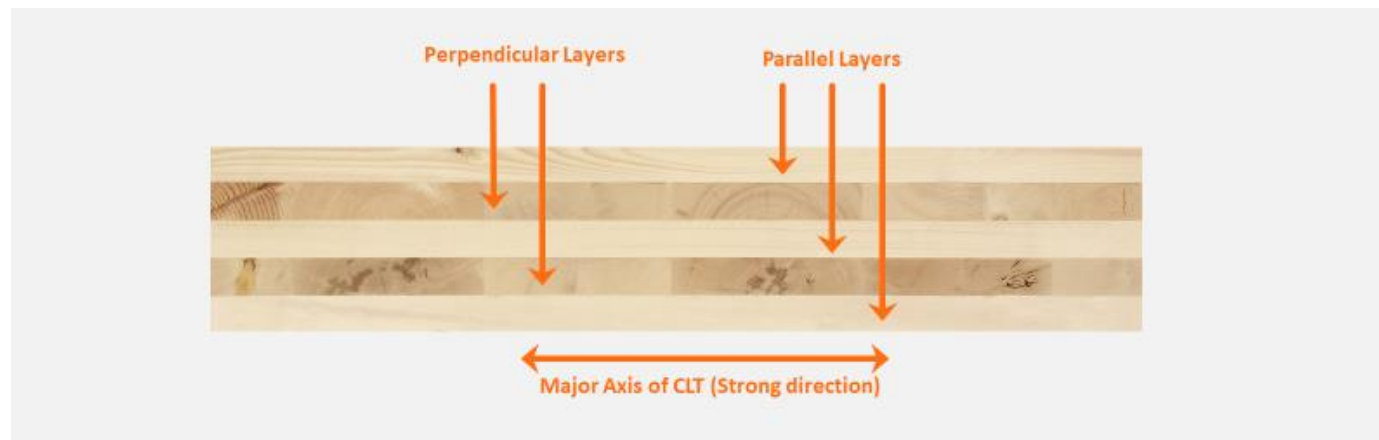


Photo: Manasc Isaac Architects/Fast + Epp

CLT Panels

CLT panels offer exceptional strength, stability and rigidity, and can be used in many applications.

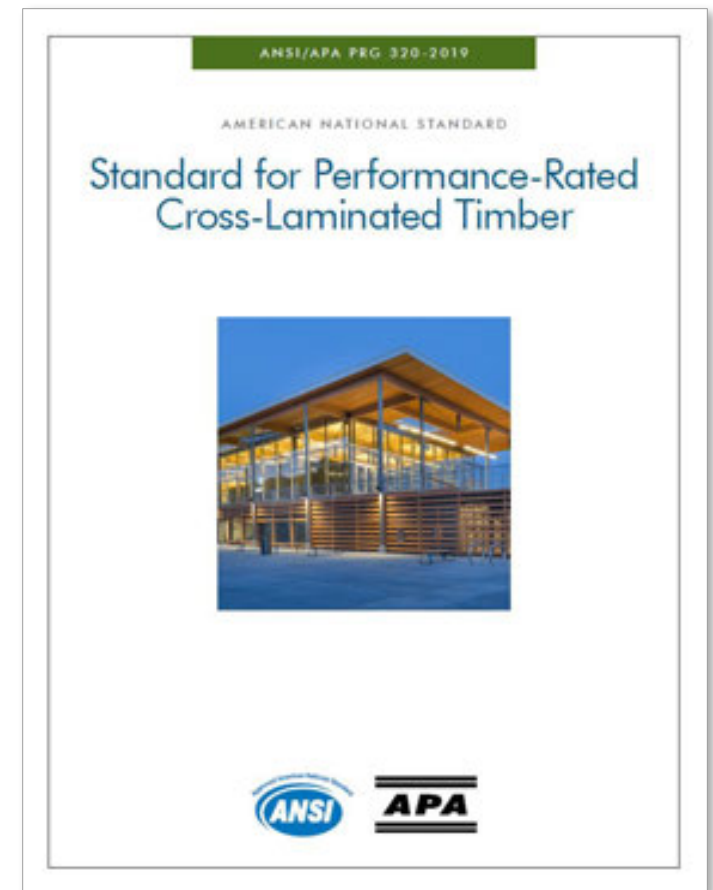
- » Layers of solid sawn lumber (typically 3 or 5) or structural composite lumber are oriented at right angles to one another and glued to form structural panels.
- » Lamination thicknesses vary by manufacturer, lumber species, and project requirements (structural and architectural).
- » Panel sizes vary by manufacturer and shipping constraints.



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

- » $\pm 1/16''$

Depth

- » $\pm 1/8''$ per foot of depth
- » Minus $3/16''$ or $1/16''$ per foot of depth, whichever is larger

Length

- » Up to 20 feet: $\pm 1/16''$
- » Over 20 feet: $\pm 1/16''$ per 20 feet of length or fraction thereof

Reasons CLT is two-dimensional

Boards in each layer of CLT are oriented 90 degrees/perpendicular to layer below.

An engineered “spline” transfers forces between panels.

Two-way bending occurs when the spans are nearly the same. For wood, a good rule of thumb is this:

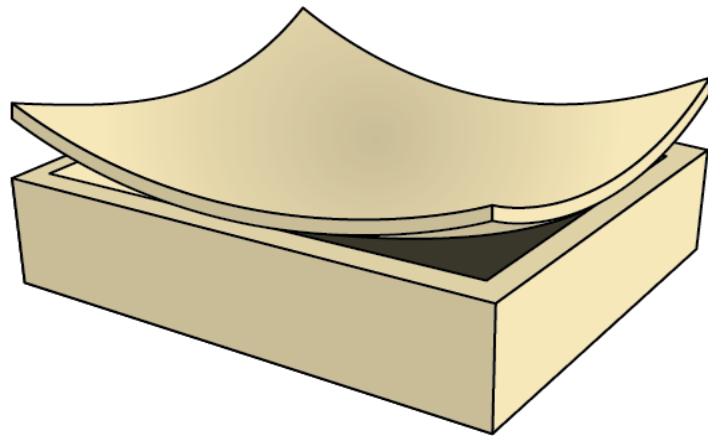
If the long span/short span ratio is 1.0 – 2.5, then it is a two-way span. If the ratio is over 2.5, then the span is one way.



Internal spline
between abutted
CLT panels

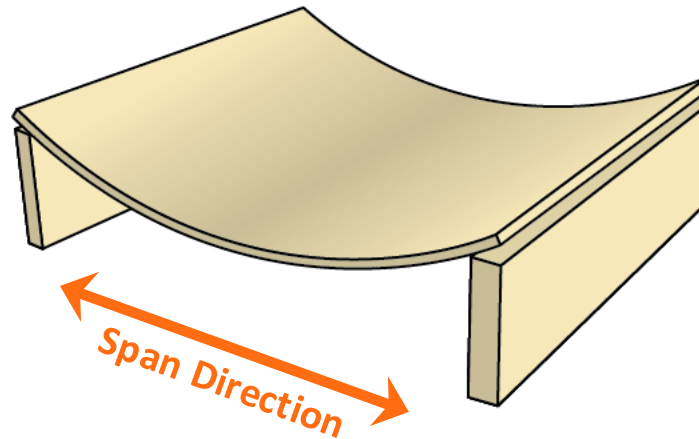
Deformation

CLT
bends in two directions



Deformation of two-way slab

GLT, DLT and NLT
bend in one direction only



Deformation of one-way slab

This situation is also encountered in concrete slabs, where contractors are required to lay down reinforcing steel (rebar) in the correct direction for bending.

CLT Panels

In addition to floor and roof applications, CLT panels can be used as shear walls due to their ability to transfer high wind and seismic forces, effectively and efficiently, to the foundation.



Candlewood Suites at Redstone Arsenal / Photos: Lendlease

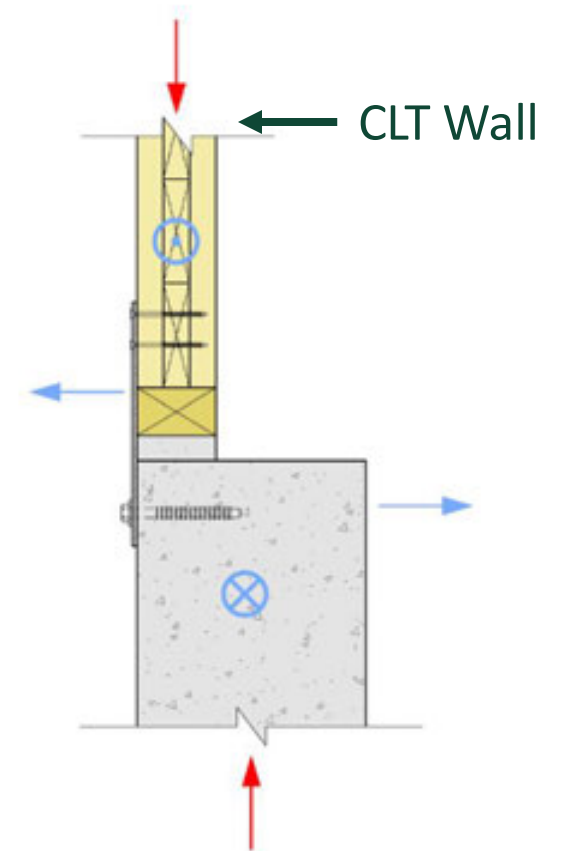


Image WoodWorks

GLT Basics

- » Solid sawn lumber laminations (typically 2x) are bonded together.
- » One method is to have the “visual width” of one board equal to 1-3/8”.
- » This dimension is achieved by sanding a typical 1.5" nominally thick “2x” board to precisely 1-3/8”.
- » Adhesive adds FP, Moisture mgmt., dimensional stability



NLT Basics

- » NLT is like DLT but fastened with nails or screws instead of dowels.
- » Plywood sheathing is often added to one face of the panel to act as a structural diaphragm. This also allows the product to be used as a floor diaphragm or shear wall.
- » NLT qualifies for Type IV construction (e.g., heavy timber) provided the depth is at least 2" thick nominal for a roof and 3" thick nominal for a floor, has a plywood or particle board covering, and fastened per the requirements in IBC 2304.9.3.2.



Dowel Laminated Timber (DLT) Panels

What is it?

- » Similar to NLT
 - » Dowels instead of Nails connecting lams
- » Lams usually finger jointed
- » Common in Europe
- » Not recognized in IBC

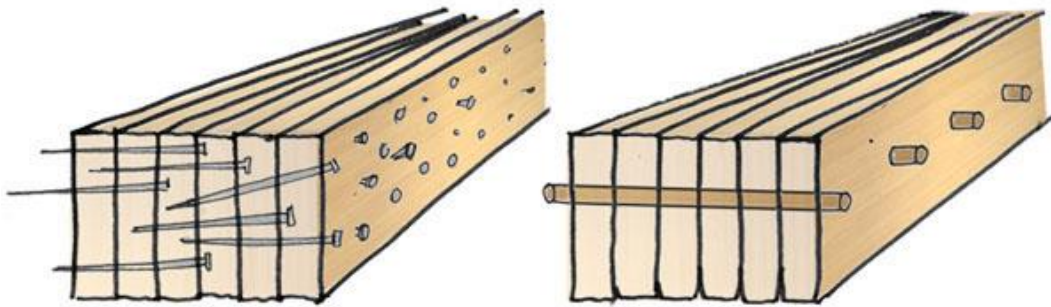


Photo credit: StructureCraft



Mass Timber Building Options



Photo: Blaine Brownell

Post and Beam



Photo: acton ostry architects

Flat Plate



Photo: : LendLease

Honeycomb

Mass Timber Building Options



Photo: John Klein

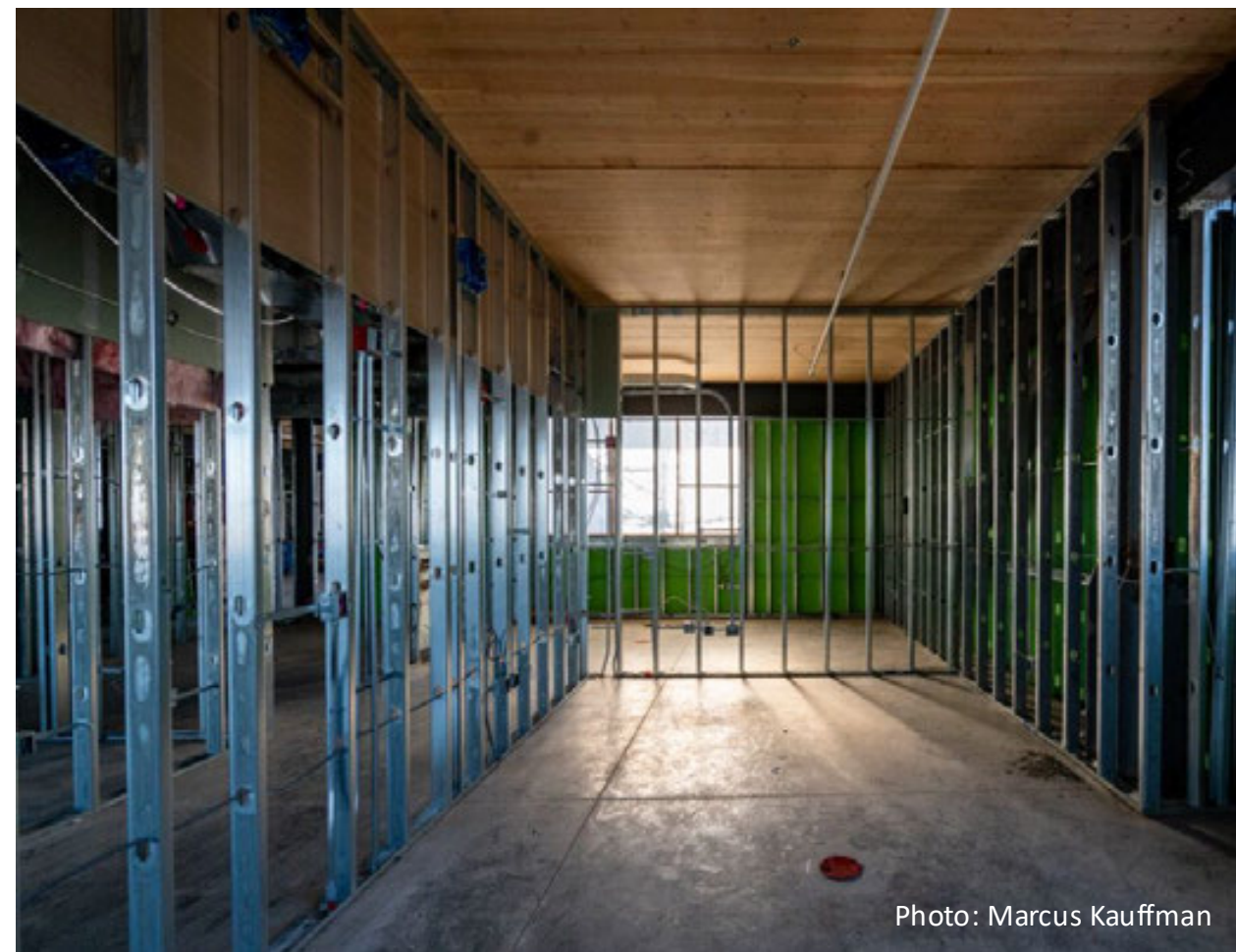


Photo: Marcus Kauffman

Hybrid: Mass Timber + Light-frame

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



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 | <table border="1"> <tr> <td>Rod</td> <td>Hole Diameter</td> </tr> <tr> <td>3/4"Ø</td> <td>1-5/16"Ø</td> </tr> <tr> <td>7/8"Ø</td> <td>1-9/16"Ø</td> </tr> <tr> <td>1"Ø</td> <td>1-7/8"Ø</td> </tr> <tr> <td>1-1/4"Ø</td> <td>2-1/8"Ø</td> </tr> <tr> <td>1-1/2"Ø</td> <td>2-3/8"Ø</td> </tr> <tr> <td>1-3/4"Ø</td> <td>2-7/8"Ø</td> </tr> <tr> <td>2"Ø</td> <td>3-1/4"Ø</td> </tr> <tr> <td>2-1/2"Ø</td> <td>3-3/4"Ø</td> </tr> </table> | 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) |
| 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 | | | | | | | | | | | | | | | | | | | | | |
| Steel Column Location at Base | Steel Column | <p>Maximum "out of plumbness" of the column, per AISC 360 Section C2 $\Delta 1 = \pm 1/4"$</p> | | AISC-360 (Recommended Sizes for Anchor Rod Holes) | | | | | | | | | | | | | | | | | | |
| Edge Location of All Openings Deviation from Plan | Slab Opening | $\Delta 1 = \pm 1/2"$ | | ACI-117-10 | | | | | | | | | | | | | | | | | | |
| Vertical Deviation for Wall or Opening | Wall & Column | $\Delta 1 = \pm 1"$ | | ACI-117-10 | | | | | | | | | | | | | | | | | | |
| Horizontal & Vertical Deviation for Wall Opening | Wall Opening | $\Delta 1 = \pm 1/2"$ | | ACI-117-10 | | | | | | | | | | | | | | | | | | |

Field Fabrication and Penetrations

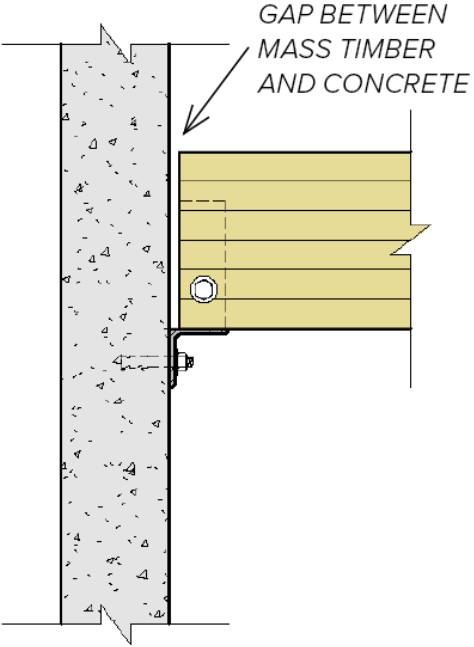
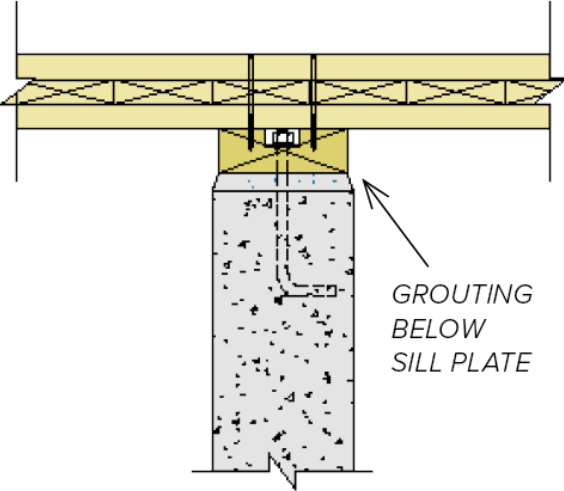
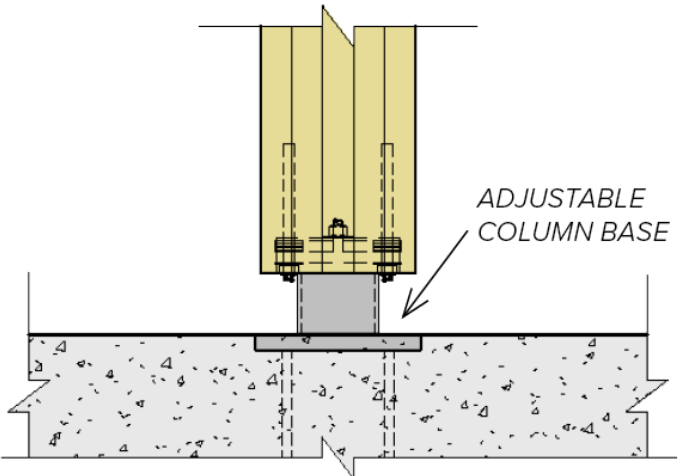
Holes, notches and other alterations should be made during fabrication to the greatest extent possible, but some may also be done in the field.



INTRO

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

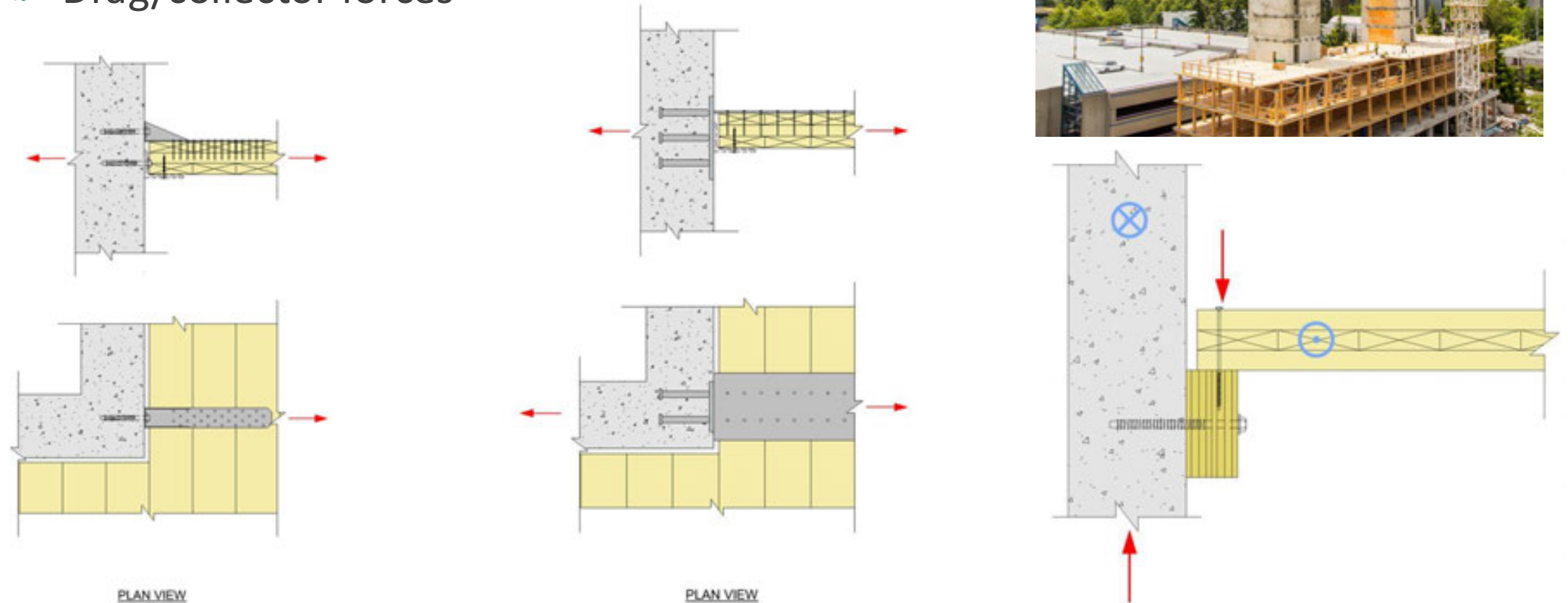
Tolerance Solutions

| 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 |  <p>GAP BETWEEN MASS TIMBER AND CONCRETE</p> |  <p>GROUTING BELOW SILL PLATE</p> |  <p>ADJUSTABLE COLUMN BASE</p> |
| | Beam Perpendicular to Wall Connected to Face of Wall | Panel Bears at Top of Wall | Column Bears on Concrete with Adjustable Standoff Base |

Lateral System Choices

Connections to concrete core

- » Tolerances & adjustability
- » Drag/collector forces



Manufacturer Tolerances: Glulam Beams, Columns ANSI A190.1

Width

» $\pm 1/16''$

Depth

» $\pm 1/8''$ per foot of depth

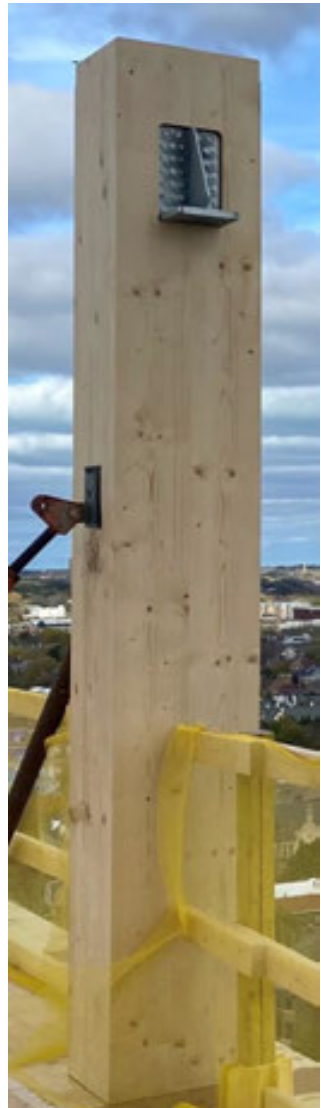
» Minus $3/16''$ or $1/16''$ per foot of depth, whichever is larger

Length

» Up to 20 feet: $\pm 1/16''$

» Over 20 feet: $\pm 1/16''$ per 20 feet of length or fraction thereof

NOTE: As-received materials typically have tolerances even LESS than those above.



Ascent

New Land Enterprises

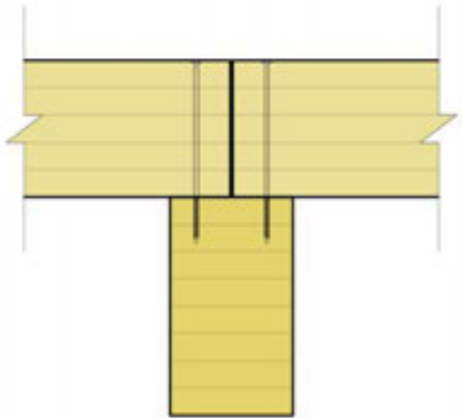
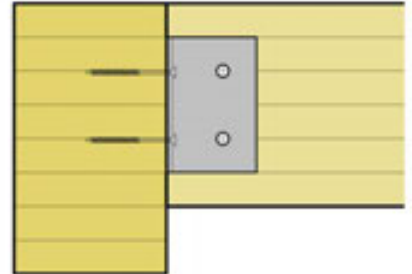

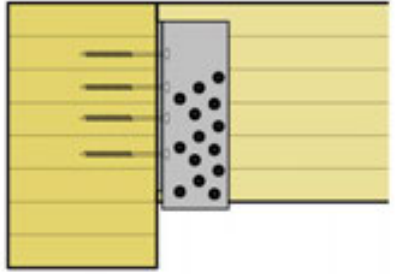
Korb + Associates / Thornton

Tomasetti / Swinerton Mass Timber /

C.D. Smith Construction

Photo WoodWorks

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



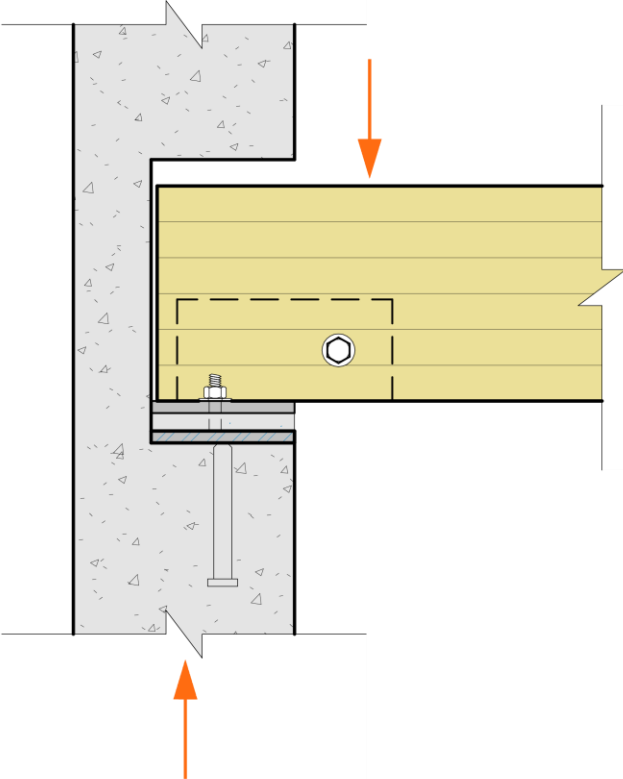
WoodWorks Index of Mass Timber Connections

*A compilation of connections
used in mass timber construction*

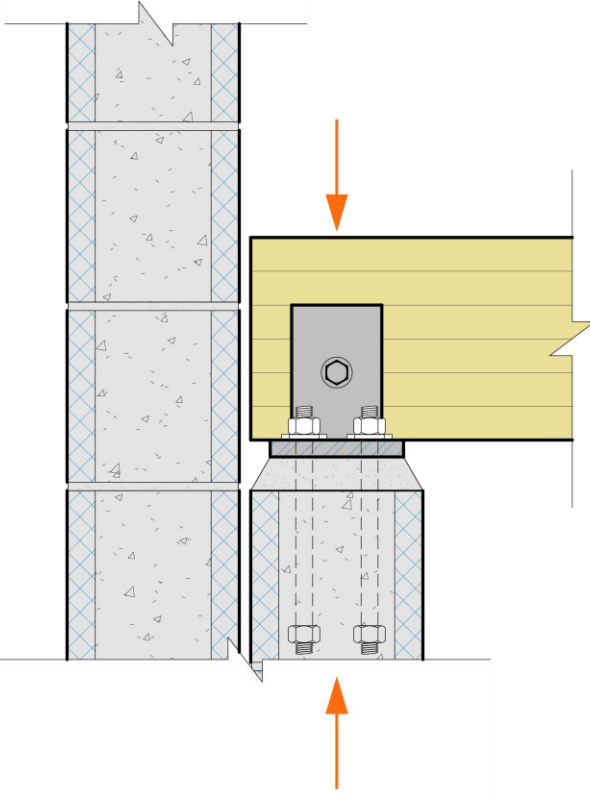
Platte Fifteen / OZ Architecture / KL&A Engineers & Builders
Photo Alan Ferrin

<https://www.woodworks.org/resources/index-of-mass-timber-connections/>

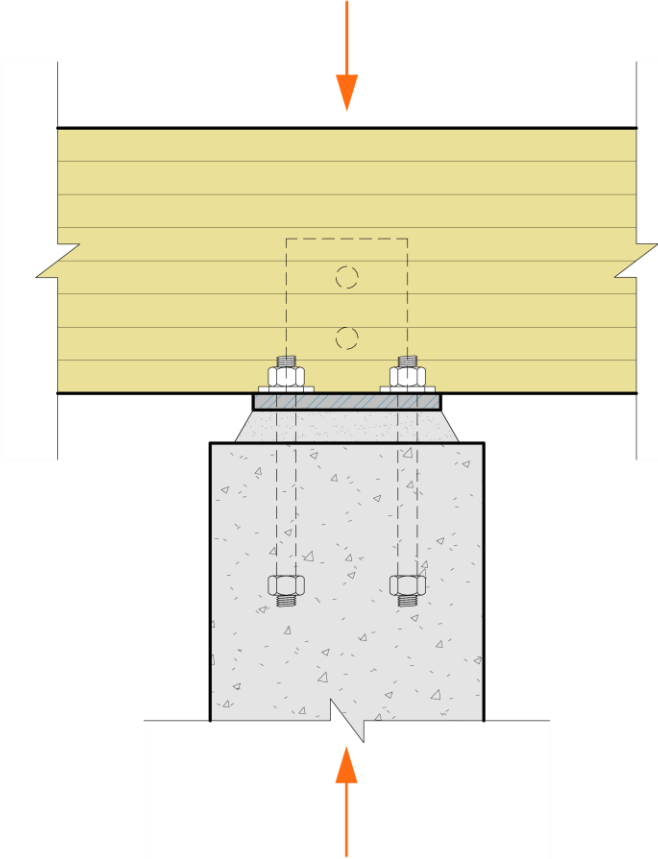
Mass Timber Beams to Concrete



Beam Bears in Wall Pocket



Beam Bears on Pilaster

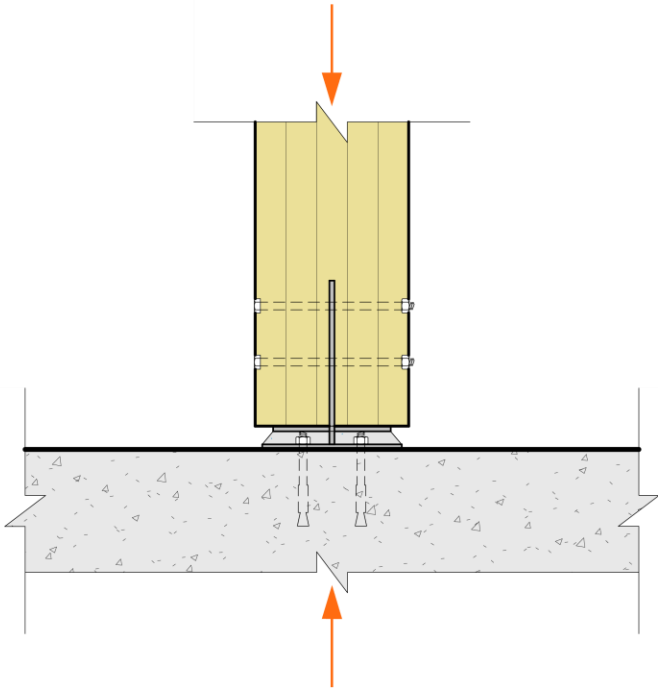


Beam Bears at Top of Column or Wall

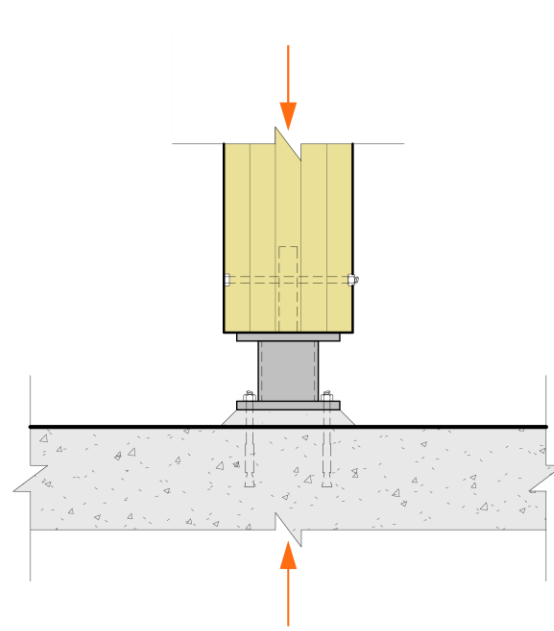


INTRO

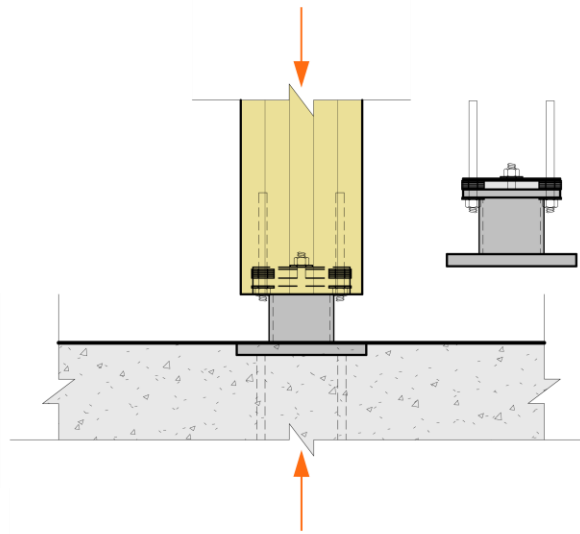
Harbor Bay Ventures /
Hartshorne Plunkard Architecture /
Forefront Structural Engineers /
Fast + Epp / Panzica Construction
Photos WoodWorks



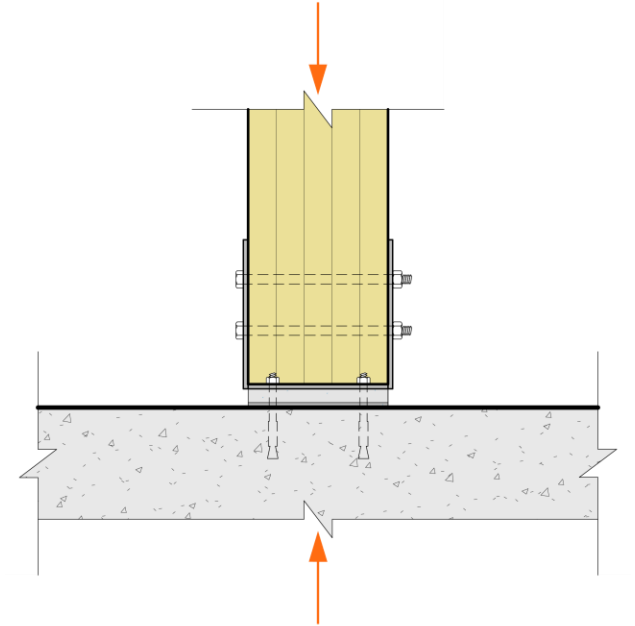
Knife Plate



Custom Standoff



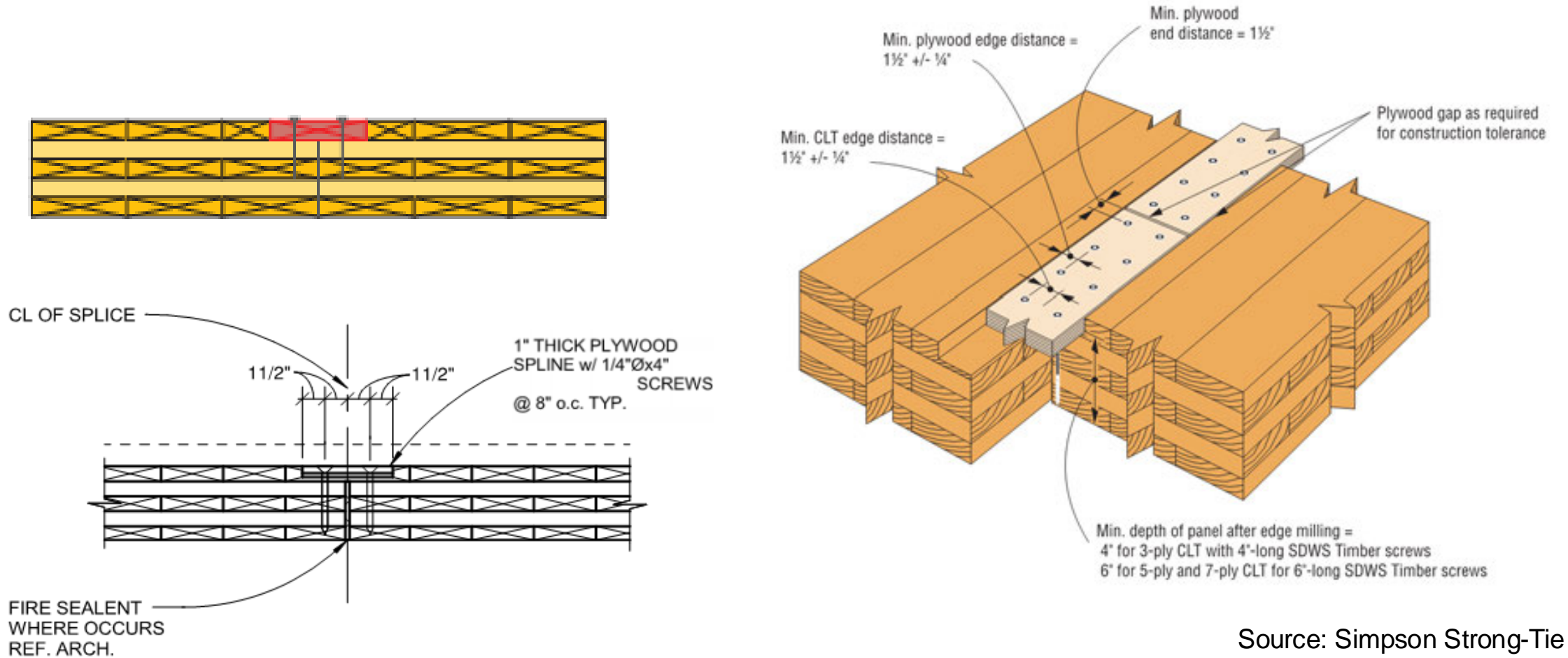
Adjustable Standoff



Side Plates

Panel to Panel Connection Styles

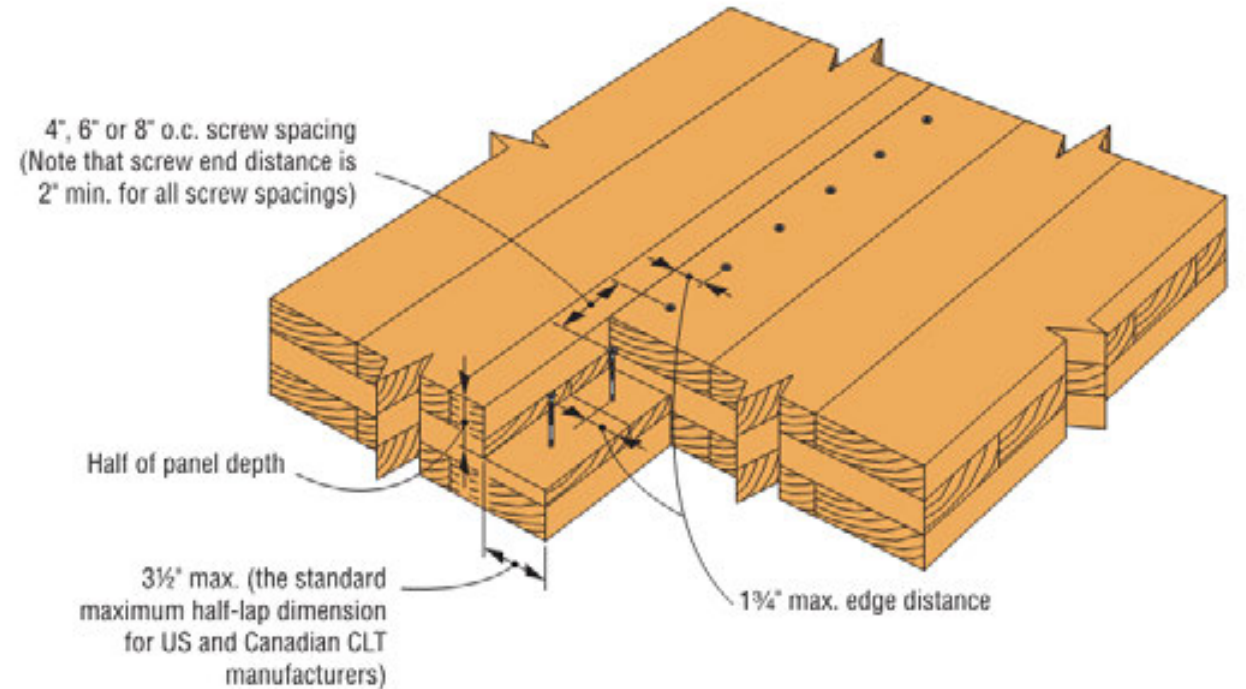
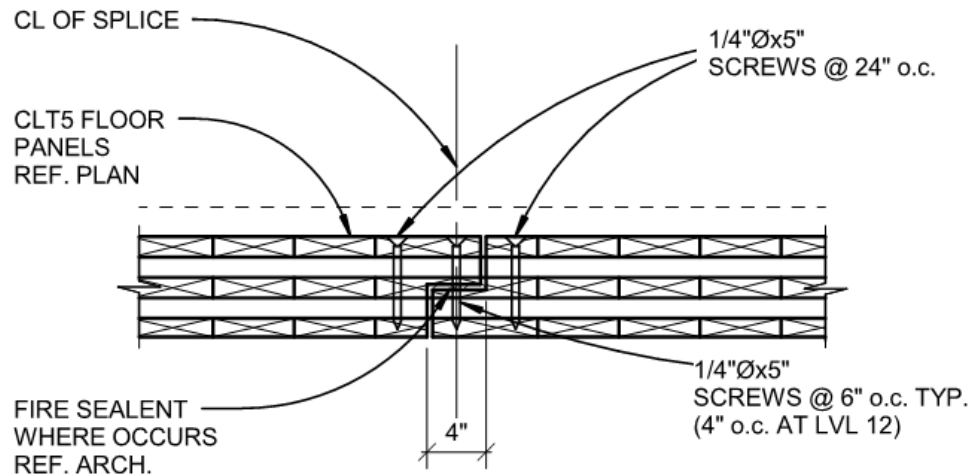
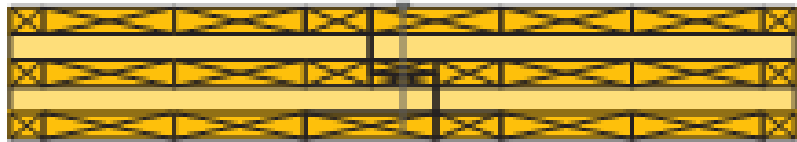
- Single Surface Spline



Source: Simpson Strong-Tie

Panel to Panel Connection Styles


- Half-Lap



Source: Simpson Strong-Tie

Vendor Specific Steel Spline Straps

Source: Simpson Strong-Tie

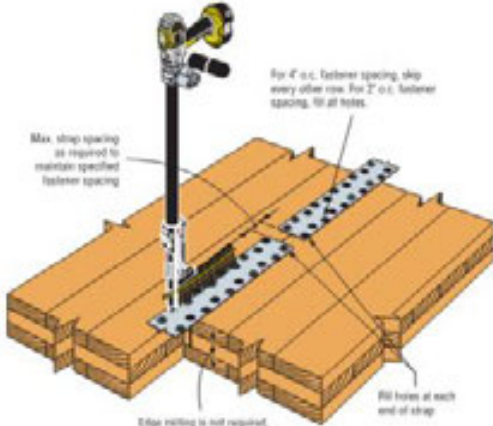


Quik Drive® Tool Setup

1. Assemble the Quik Drive PRO300503 cordless driver tool.
2. Remove the standard Quik Drive noseclip and replace with the PNOSECLIP-LDSS.
3. Calibrate the drive depth of the screw according to the instructions provided with the PNOSECLIP-LDSS. The ideal depth setting locates the bottom of the countersunk head just above the hole in the embossed feature.

Installation

1. Place the strap on the surface of the mass timber panels with the centerline notches aligned with joint between adjacent panels.
2. From a standing position, hold tool perpendicular to the face of the strap and place the noseclip over the embossed feature. Drive the screw. Repeat.
3. Use all specified fasteners.

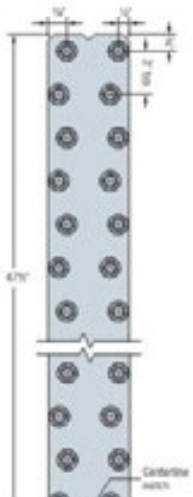


Typical LDSS48 Installation with WSV35 Screws at 4' o.c. in a Three-Ply CLT Panel (five-ply and seven-ply panel similar)

The LDSS has also been tested with 0.148" x 2 1/8" nails for specifiers or contractors who prefer a nailed connection. This embossed hole allows for the use of a power framing nailer using concentric, full round-head nails.

Light Diaphragm Spline Strap (LDSS) for Mass Timber

| Model No. | Ga. | CLT Layer (min.) | Fasteners | Fastener Spacing (ft.) | Allowable Shear Load (lb./ft.) | | | | Slip Modulus Y (lb./in.) |
|-----------|-----|------------------|-------------|------------------------|--------------------------------|-------|---------|-------|--------------------------|
| | | | | | Wind | | Seismic | | |
| | | | | | DF/SP | SP/WF | DF/SP | SP/WF | |
| LDSS48 | 18 | Three-ply | #9 x 3" WSV | 4 | 1,030 | 1,030 | 1,030 | 1,030 | 6,330 |
| | | | | 2 | 2,240 | 2,240 | 2,240 | 2,240 | 6,330 |
| | | | | 4 | 430 | 430 | 430 | 430 | 7,683 |
| | | | | 2 | 820 | 820 | 820 | 820 | 7,683 |



1. Allowable loads are based on the use of cross laminated timber (CLT) grades LT-E4 and V1-V6 material conforming to APA PRG 320.
2. Allowable loads have been increased for wind or seismic loading with no further increase allowed, unless other loads govern.
3. Allowable loads are based on lesser of calculations per IBC/MS 2021 or assembly tests with a safety factor.
4. Fastener failure modes are Mode IIIa or Mode IIIb.
5. Nails: 0.148" x 2 1/8" = nail dimension listed diameter by length. Screws: #9 x 3" WSV = model WSV35.
6. CLT panel minimum thickness is three-ply = 4.125".
7. The component of diaphragm deflection due to fastener slip at panel to panel joints calculated as $s_y = C \cdot s_{y0}$, where:
 - $C = (1/P_1) + (1/P_2) \cdot 1/2$
 - P_1 = Length of individual CLT panel (ft.); P_2 = Width of individual CLT panel (ft.)
 - L = Diaphragm length (ft.)
 - s_y = Design load per fastener (lb.) / Slip Modulus, Y (lb./in.)

(Reference — Applied Technology Council, 1981, Guidelines for the design of horizontal wood diaphragms, Redwood City, CA)

Product Information

| Ordering SKI | Description | Quantity |
|--------------|---|--------------|
| LDSS48 | Light Diaphragm Spline Strap 0.148" x 4 1/8" x 18' (assembly) | 1, 10 or 500 |



Source: Rothoblaas

Horizontal panel

Connections should:

- » Allow for slight panel expansion or contraction
- » Allow for minor adjustments during installation
- » Be able to transfer in-plane shear forces (called diaphragm forces in floors) between panels, if engineered to do so

Fasteners attach the spline to each panel and transfer shear forces between panels

Steel straps can be used if additional shear transfer is required at key areas, such as perimeters



Timber House

Mesh Architectures / Silman /
Rise Construction / T3 Timbers
Photo Silman

Steel Plate Connections

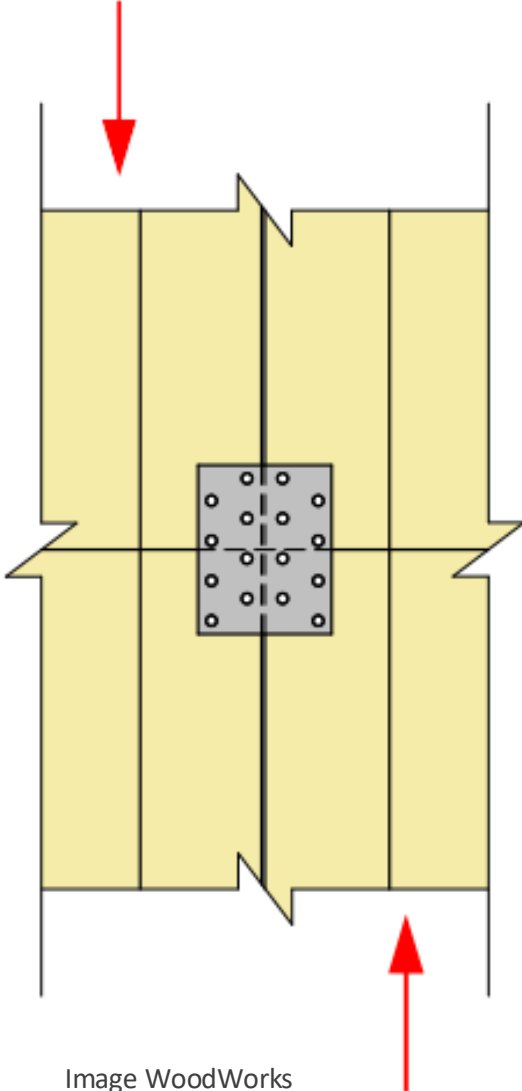


Image WoodWorks



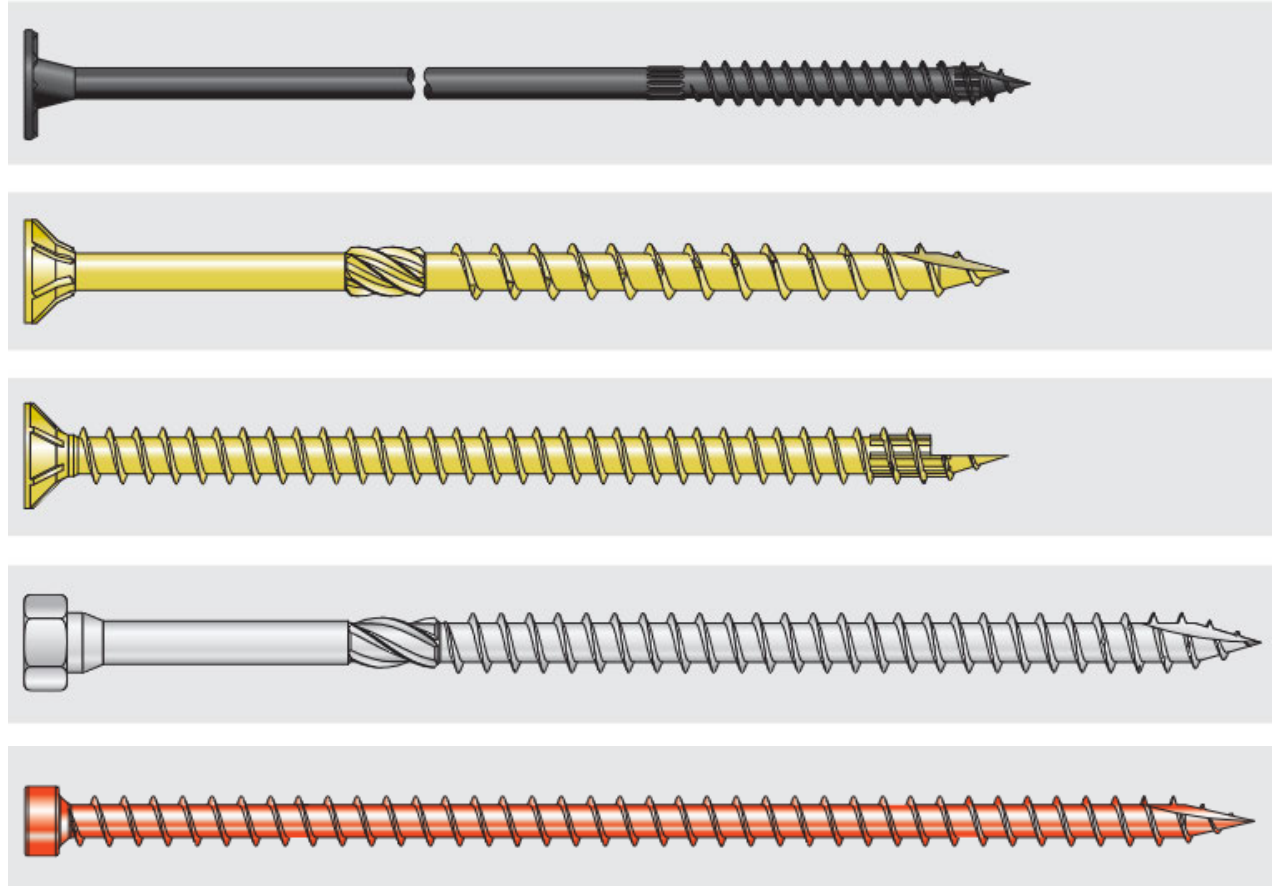
Photo Rothoblaas

Outline

- » Products and Connections
- **Fasteners, Hardware and Equipment**
- » Safety Considerations
- » Planning and Coordination
- » Installation and Material Protection
- » Repairs, Finishes and As-Builts

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



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



Hardware

Wide range of plates, hangers, straps, angle brackets, tie-rod systems, concealed connectors, lifting hardware and more, both standard and proprietary



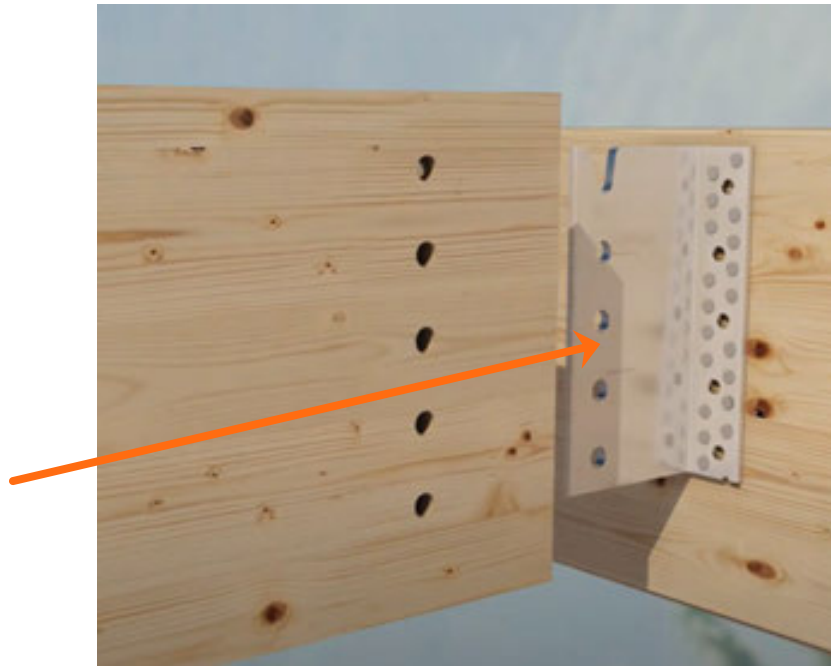
Concealed Hook Connectors



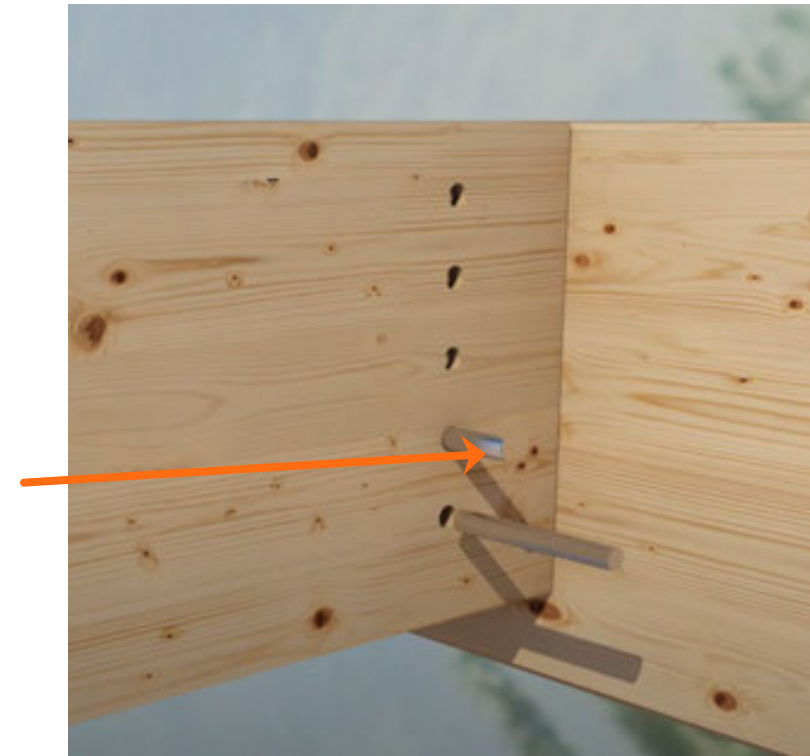
Knife Plate Assembly with Dowel-Type Fasteners

- » Concealed knife plate connection
- » Perforated knife plate
- » Dowel-type fasteners connect knife plate to beam
- » Can also be used to attach beams to columns

Perforated knife plate with four pre-drilled holes, and one slotted hole above

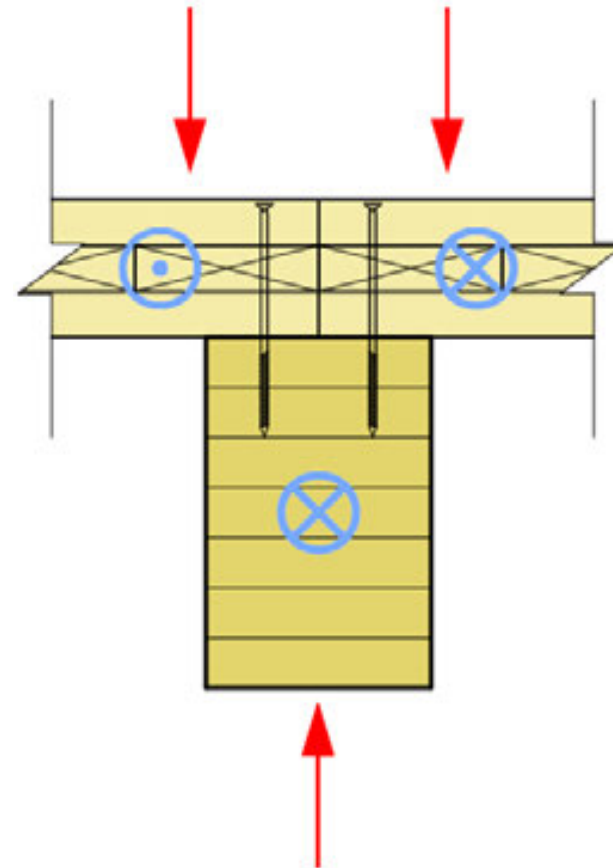


Five metal dowels will connect the knife plate assembly to the beam



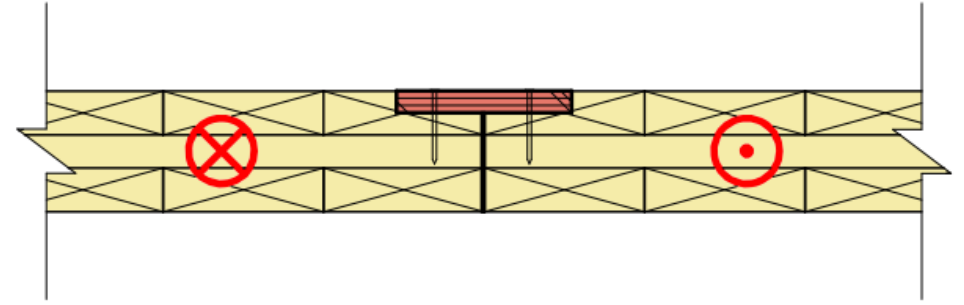
Panel to Beam

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



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

Material Handling

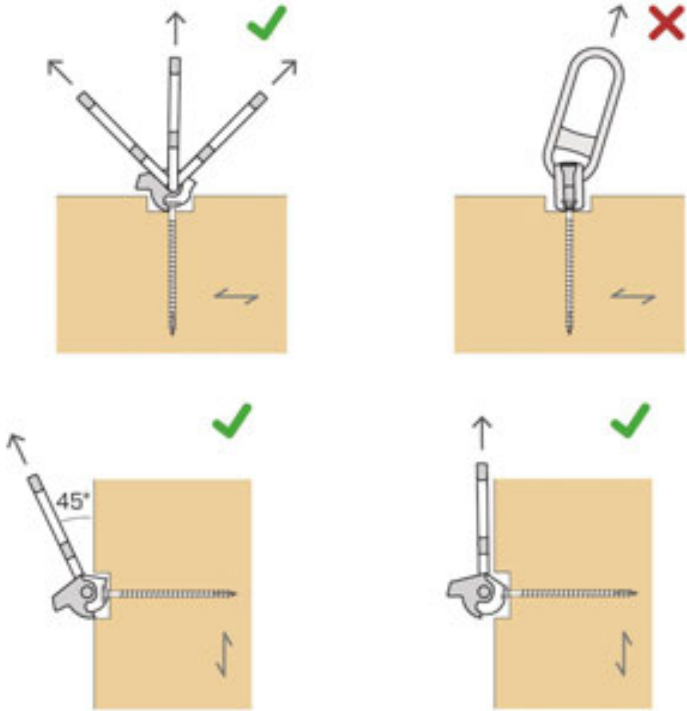
- » Lifts provide safe access for workers at height.
- » Lift type depends on building size and configuration, site logistics, etc.
- » Forklifts (including standard, all-terrain and high capacity), boom lifts and scissor lifts are all commonly used.



Bullitt Center

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

Specialty Lifting Connectors



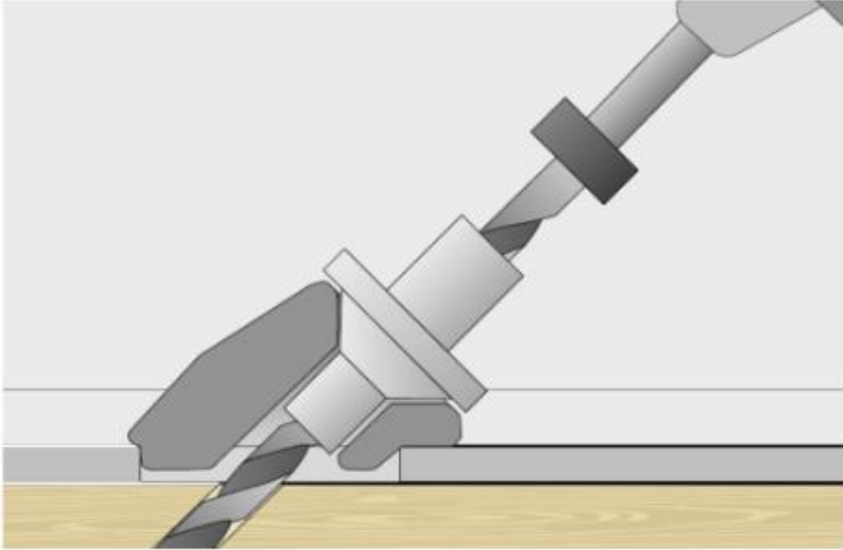
You need to account for the lifting connector screw limitations

Image Rothoblaas (above)



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

Templates and Jigs and Installation Devices



Possible Reasons for Field Adjustments

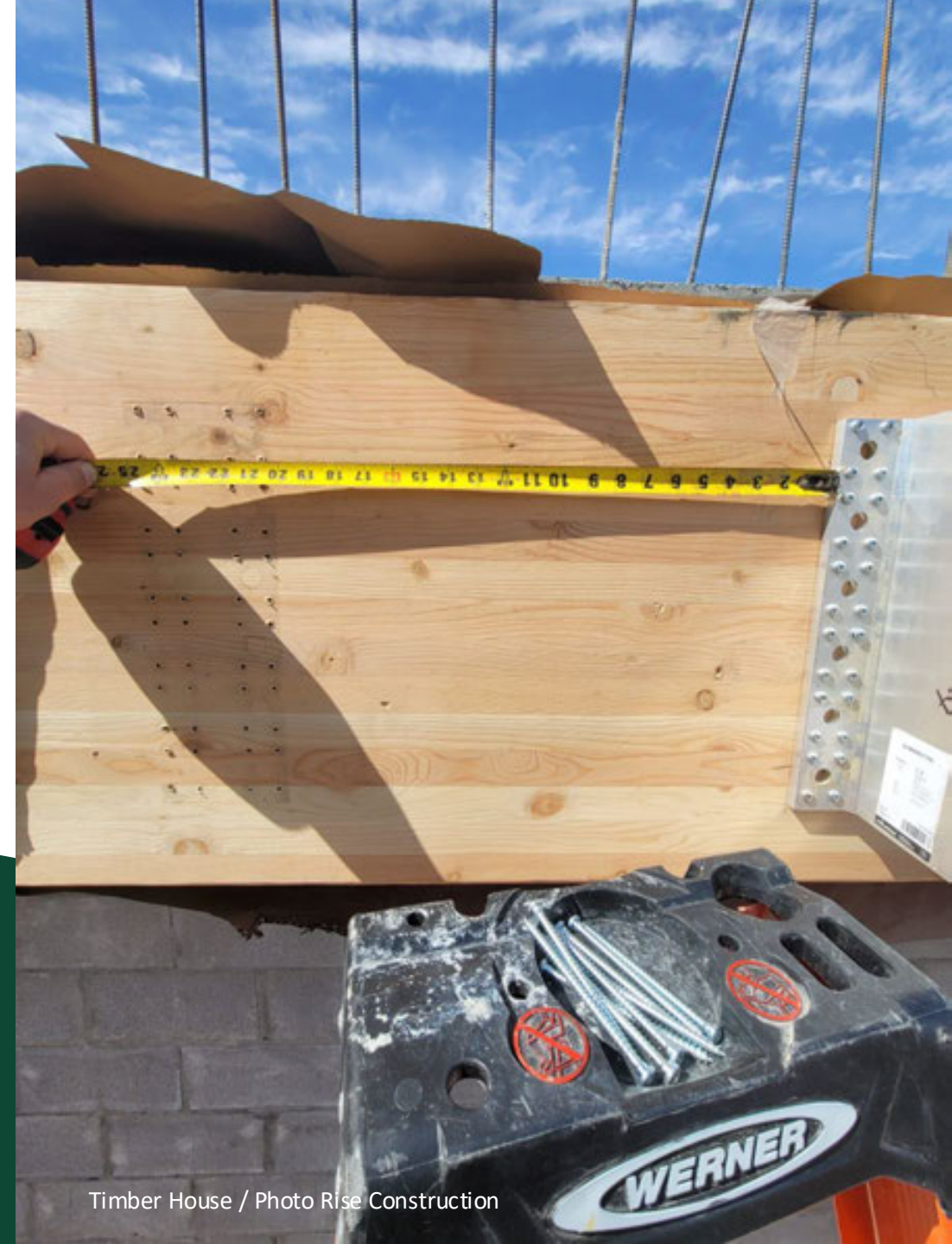
- » Manufactured/fabricated incorrectly
- » Damaged during transport
- » To create small MEPF openings (intentionally not done in advance)
- » Constructability issues at difficult connections, intersections, etc.
- » Coordination oversights during design or modeling
- » Changes to the project layout
- » Out of tolerance with other materials

Field Adjustments

Connector pre-installed in the wrong location

- » If needed, fill original holes with an approved epoxy.
- » Drill new holes.
- » Realign the connector and fasten.

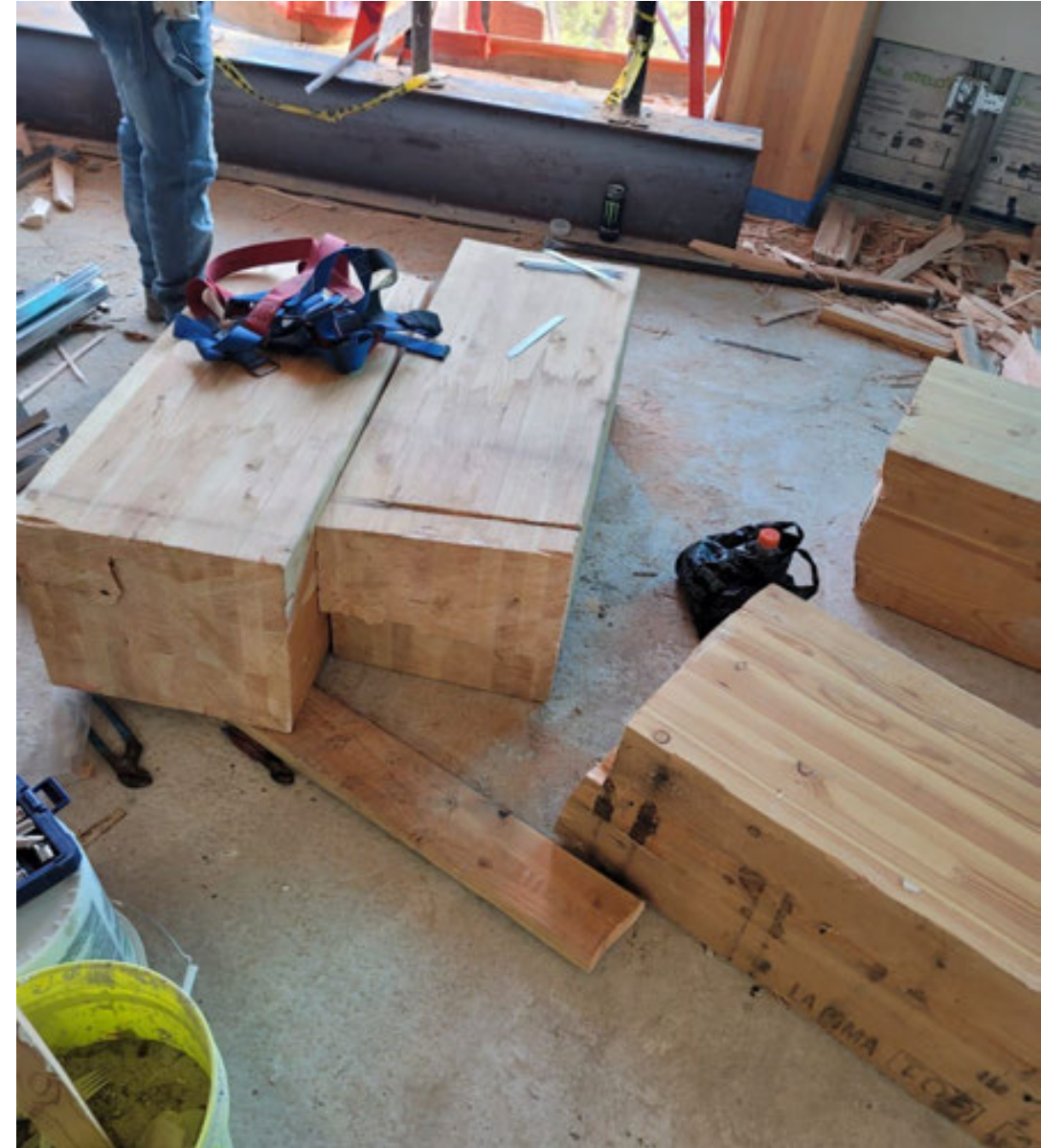
Engineer of Record inspects the repair and signs off before the structural member is set.



Field Adjustments

Cutting, shaving and notching wood elements

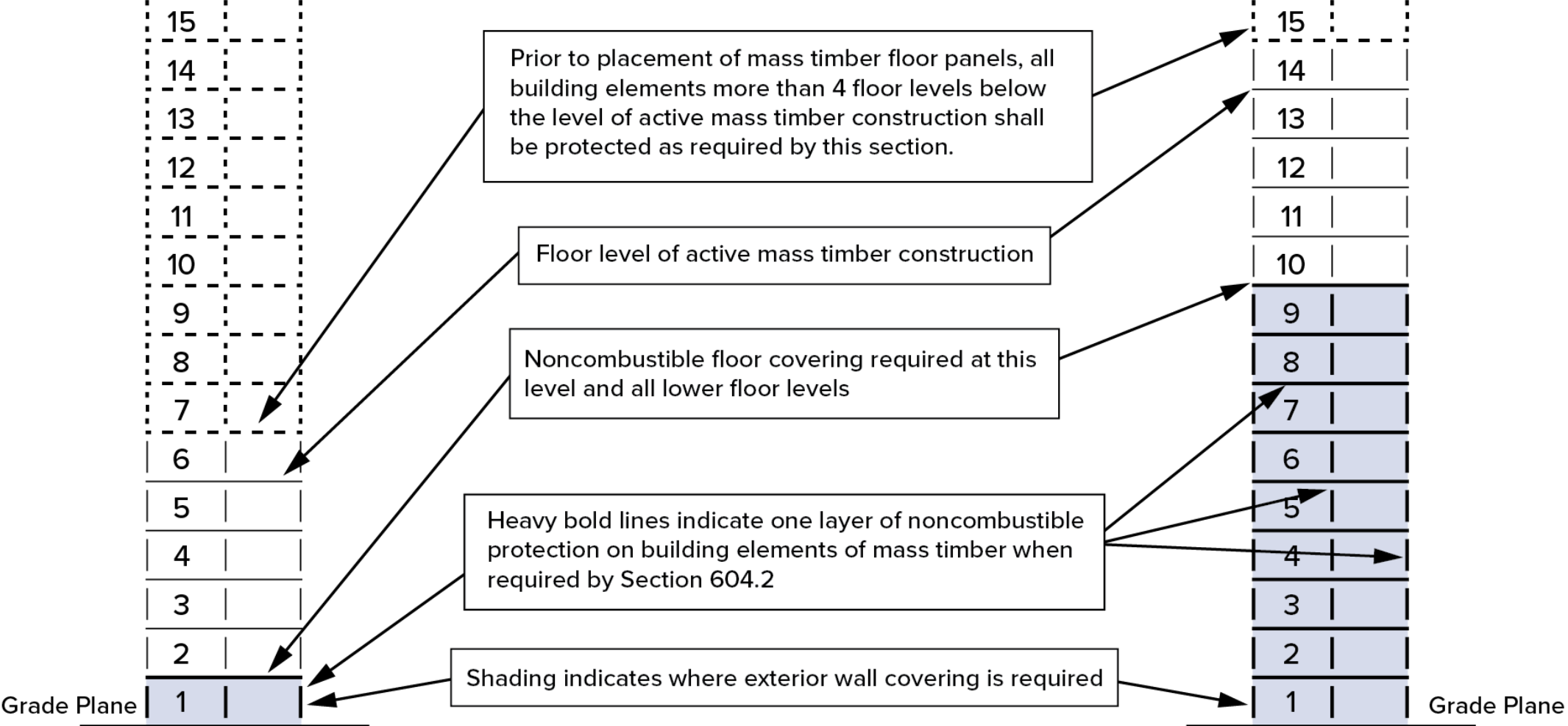
- » Length can potentially be reduced on site using a worm drive chainsaw (which is capable of squarely trimming a column or beam).
- » Slots can potentially be shaved or otherwise adjusted to accommodate small variances.
- » In both cases, the wood element may need to be replaced.



Outline

- » Products and Connections
- » Fasteners, Hardware and Equipment
- Safety Considerations**
 - » Planning and Coordination
 - » Installation and Material Protection
 - » Repairs, Finishes and As-Builts

Fire Safety in the 2021 IBC



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

Outline

- » Products and Connections
- » Fasteners, Hardware and Equipment
- » Safety Considerations
- Planning and Coordination**
 - » Installation and Material Protection
 - » Repairs, Finishes and As-Builts

More Work Up Front / Less Later

- » Early planning and coordination among all project team members
- » Builder input early in design
- » All engineering completed before mass timber products are produced

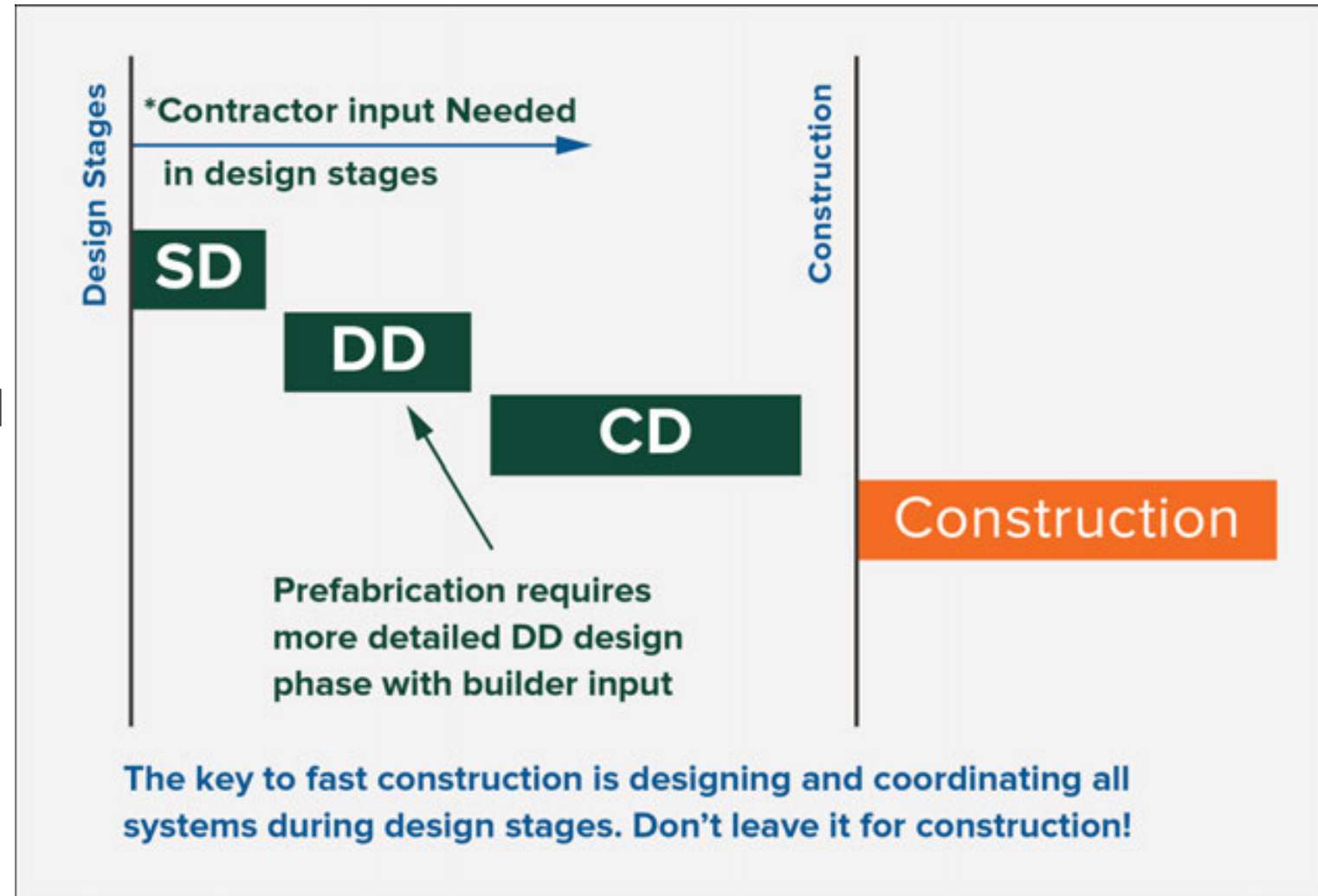




Photo: Erika Brown Edwards



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.

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

Mass Timber Design Manual[®] – 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[®] – Provides a framework for the planning, procurement and management of mass timber projects.

1 De Mars
San Francisco, CA
ARCHITECT
PERKINS+WILL
ENGINEER
DCI Engineers
CONTRACTOR
Hatheway Group/llc



Photo: David Wainy

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.

Responsibility Matrix

Who is responsible for:

- » Material protection
- » Connectors and hoisting hardware
- » Crane operation
- » Fire protection requirements
- » Tolerances and adjustments
- » Building survey control
- » Delays (and associated costs)
- » Schedule summary/milestones
- » Construction sequencing



John W. Olver Design
Building at UMass Amherst

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

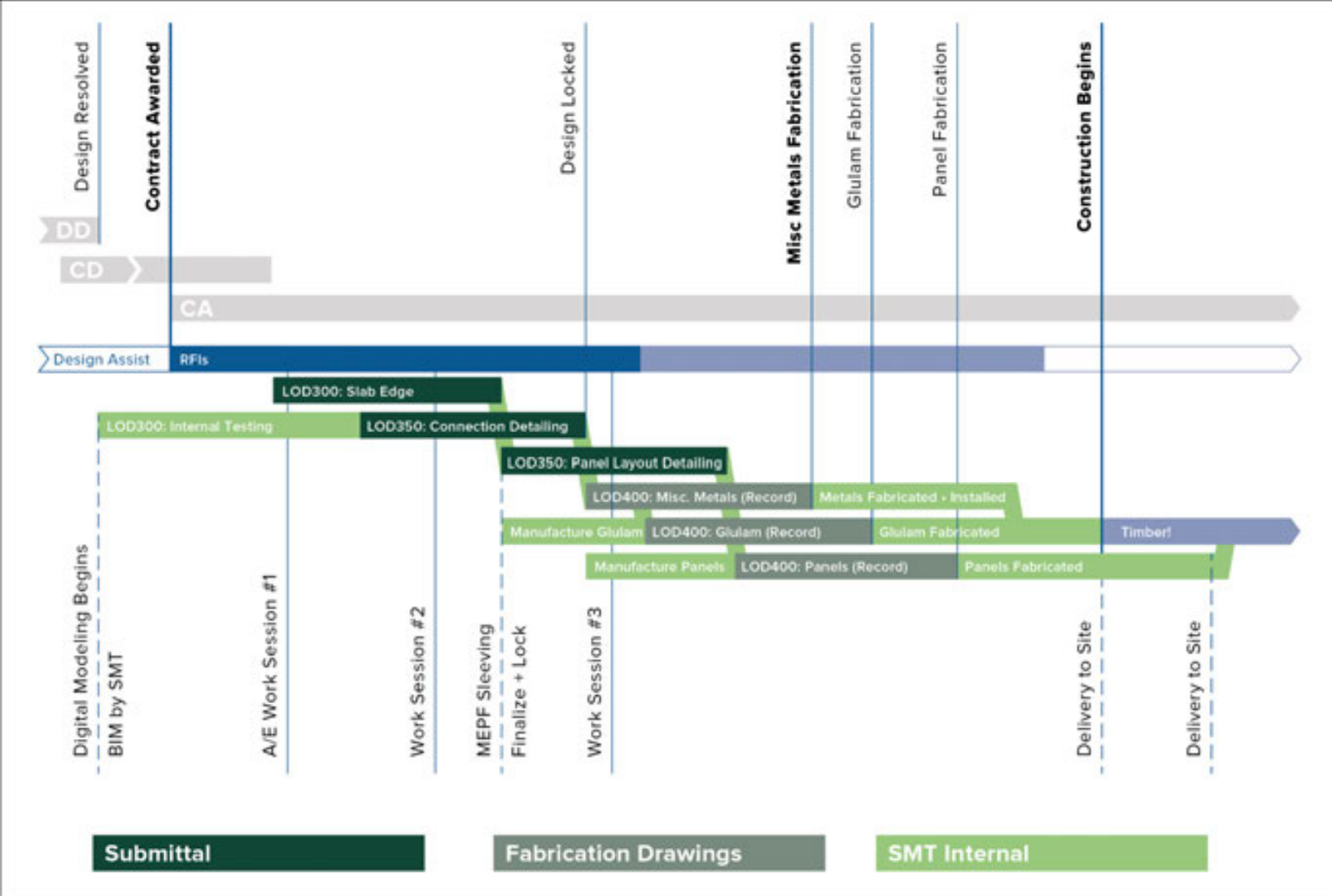
Photo Alex Schreyer

During Design

Builder input continues through design.

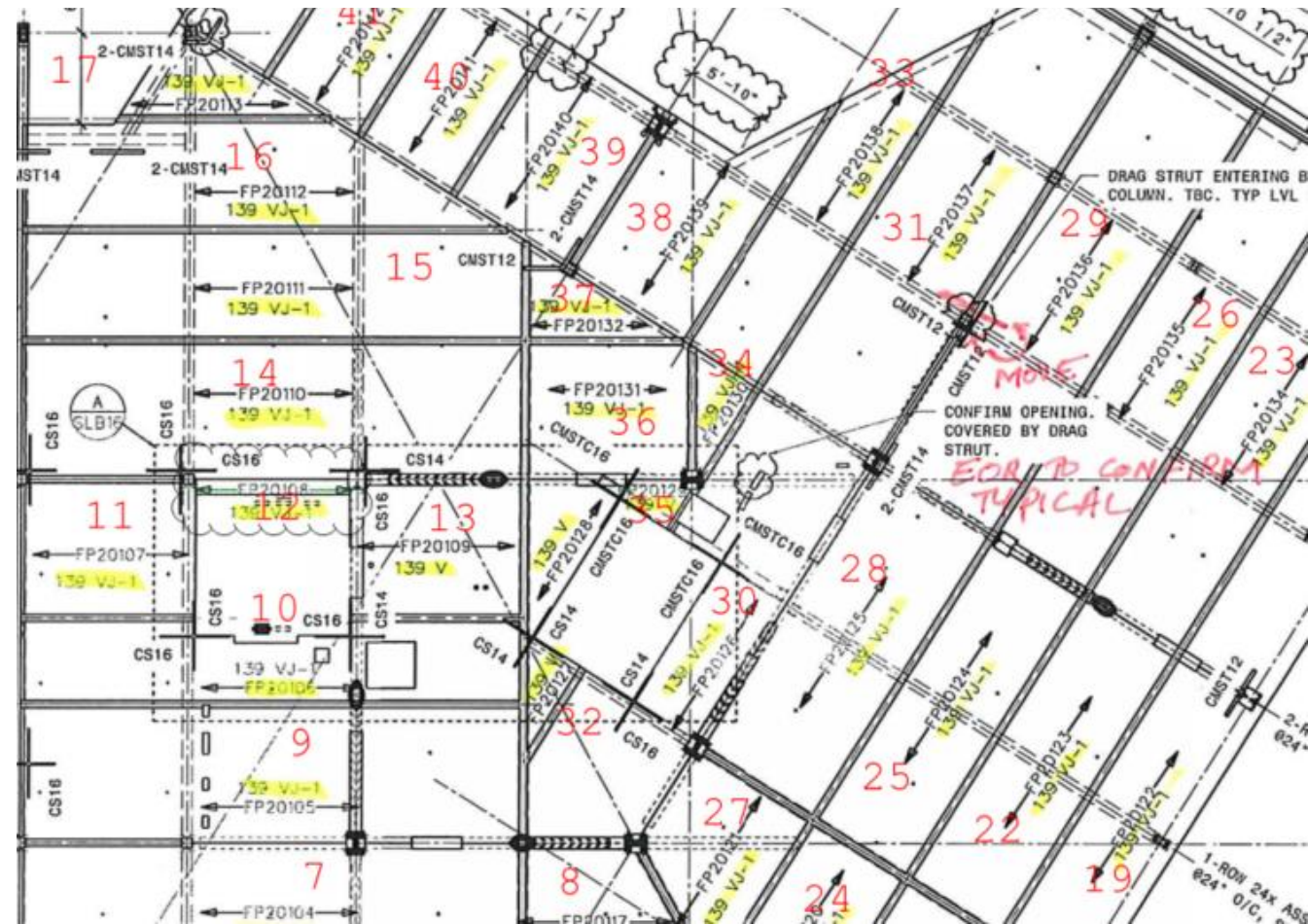
- » Consider/discuss tolerances.
- » If it hasn't already been done, decide whether the GC or subcontractor will install the framing.
- » Ensure safety policies are in place to protect against construction fires.
- » Determine “shop or field” for connectors and finishes.
- » Decide how wood will be protected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

Modeling/Fabrication Schedule



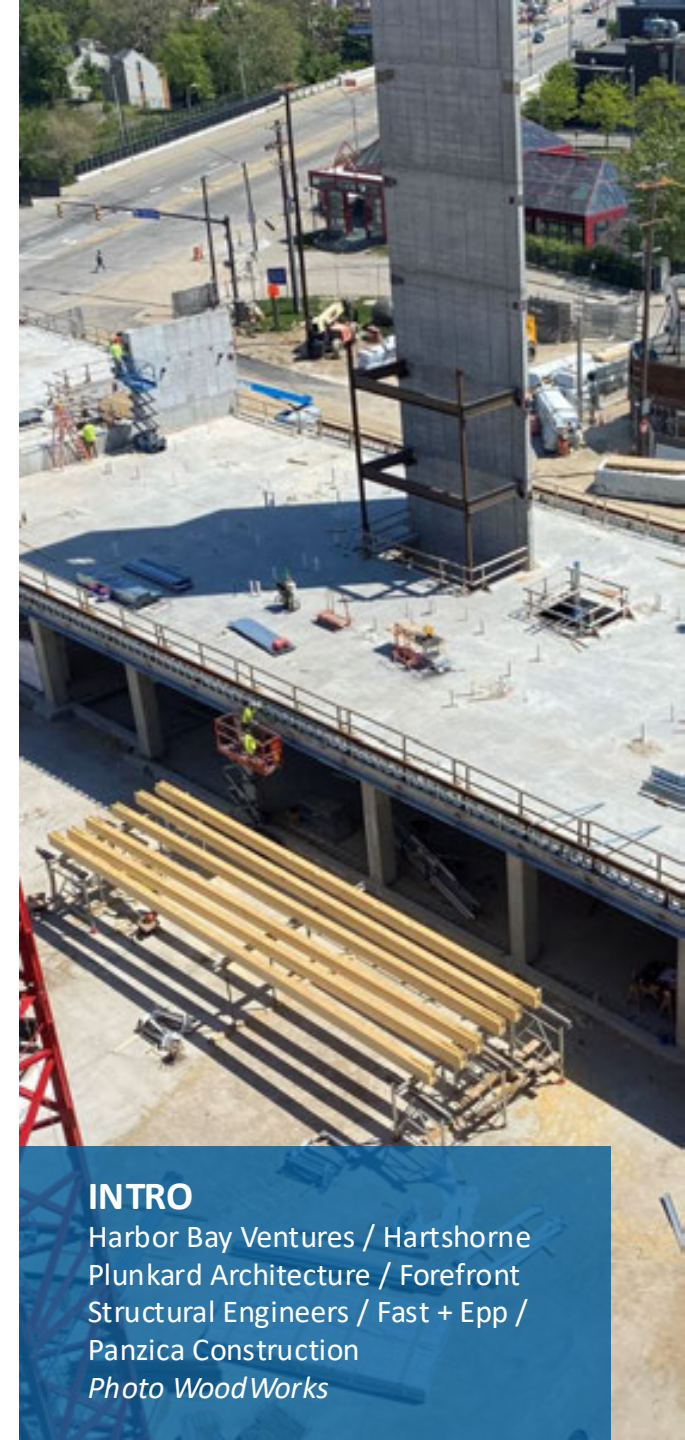
Site Planning

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



Pre-Installation Tasks

- » Review site conditions.
- » Verify drawings, virtual building model.
- » Perform additional layout if needed.
- » Verify connections embedded in concrete or affixed to structural steel.
- » Provide a discrepancy list—errors should be fixed before installation.
- » Assess pre-installation needs; establish schedule and work areas.
- » Review manufacturer requirements to correctly install connections, anchors, screws, etc.
- » Confirm all materials and tools.

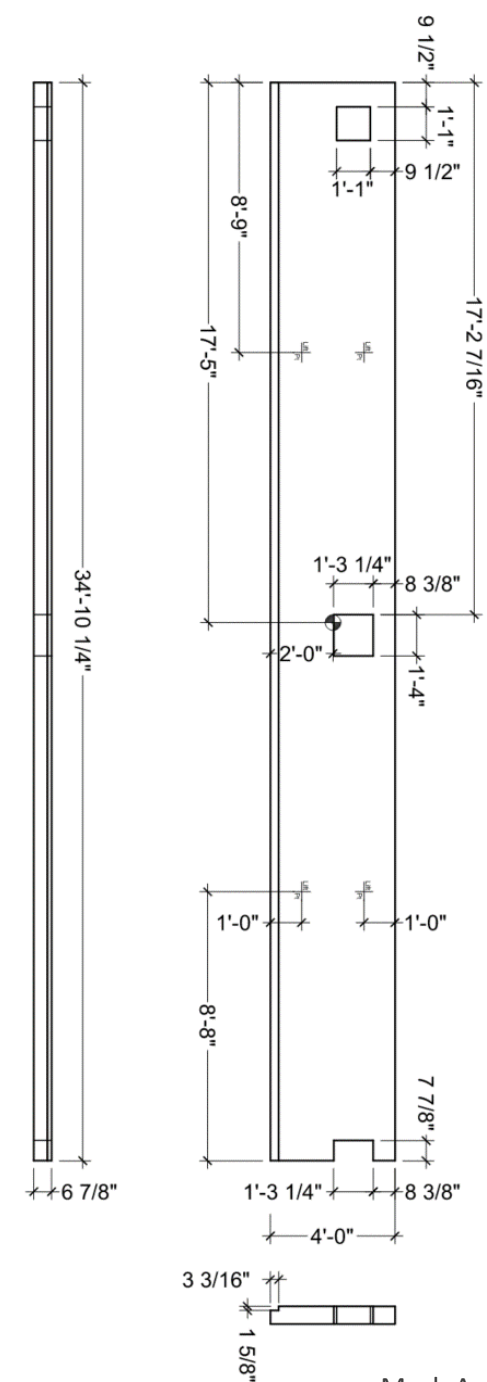


INTRO

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

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)

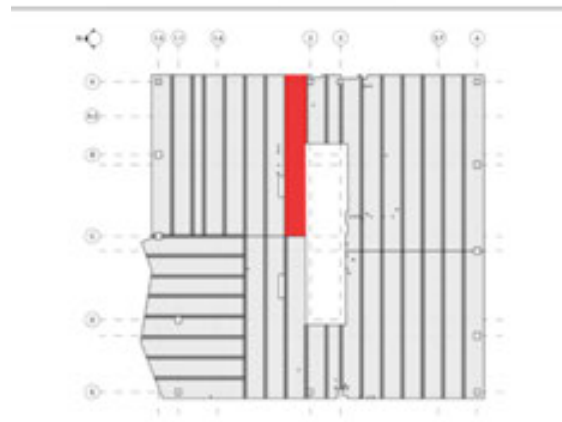
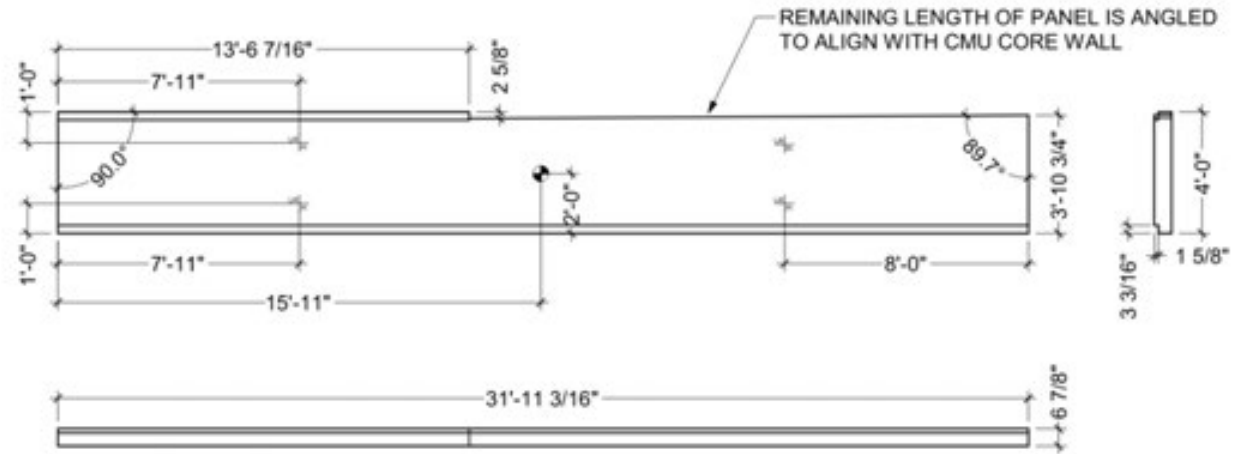


Shop Drawings

An individual shop drawing should exist for each **unique** floor panel.

TOP VIEW

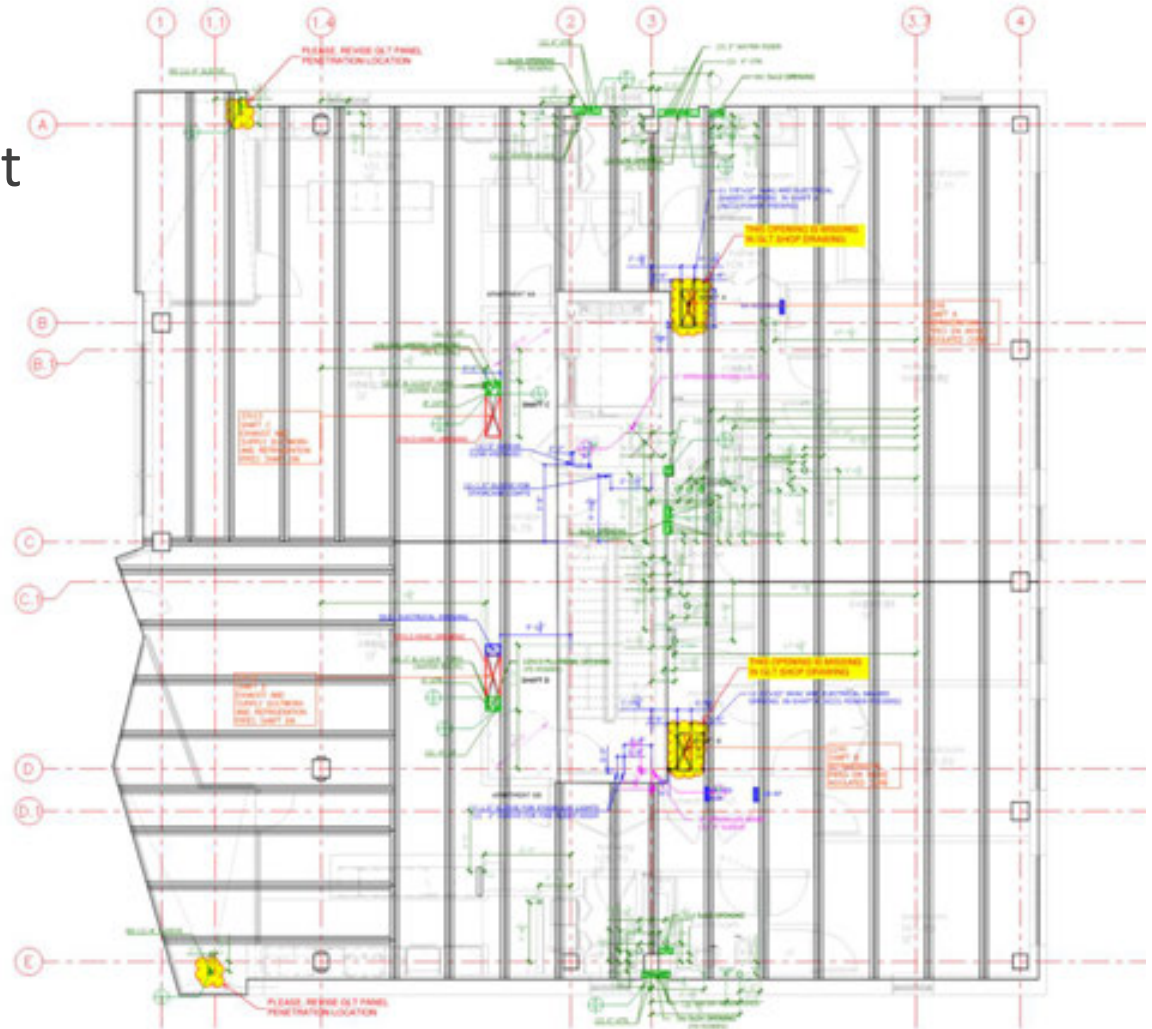
GRAIN DIRECTION, TYPICAL



| | | |
|-------------------------|---|----------------------|
| Description: 6 7/8" GLT | | Weight: 2446 |
| Quantity | Grade: Combol2 | Length: 31'-11 3/16" |
| 1 | Material: Douglas Fir / Larch | Width: 4'-0" |
| | Treatment: Sarsin KP-12 @ Edges & Underside | Depth: 6 7/8" |
| | Lifting: -- | |

Penetrations

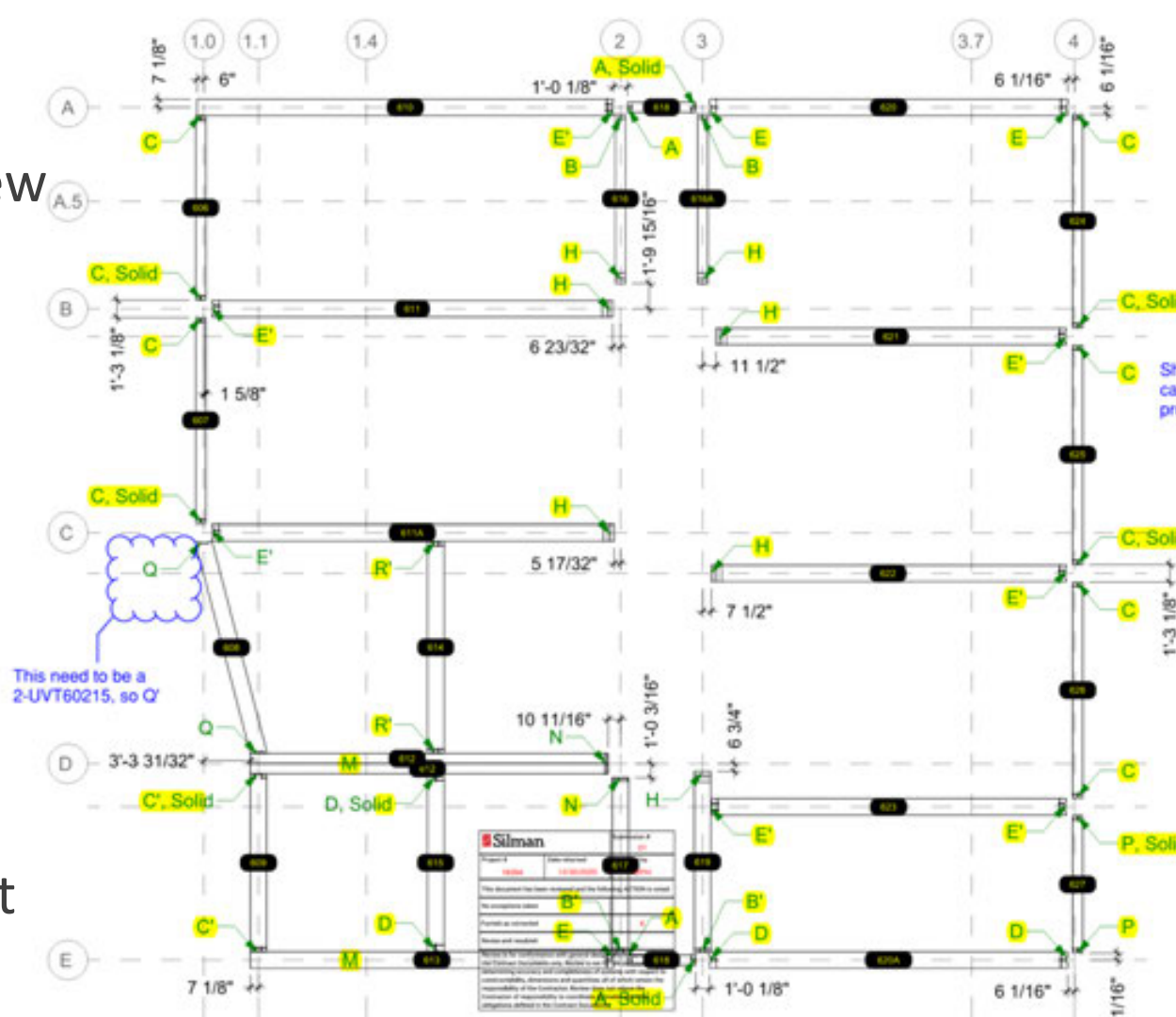
- » These drawings are:
- » Used by the manufacturer to pre-cut holes
- » Coordinated by the GC with input from the:
 - » Architect
 - » Engineer
 - » Mass timber manufacturer(s)
 - » Specialty subs
 - » Digital drafting crew (if different from the manufacturer)



Connections

This page allowed a review of the proper location of concealed beam connectors.

- » Shop drawings should include:
- » Plan views of all areas under consideration
- » Individual members
- » Detailed dimensions at connection points



This need to be a 2-UVT60215, so Q'

Should be Q', every case of a UVT on this project is a dual

Issue 3/4/21
12:01 PM
This review is for [redacted] contractor type only.
This review will not release the contractor for responsibility in determining beam dimensions based on the as-built conditions of the foundation as well as other non-steel building elements such as masonry.
Approved as noted - see circled areas for any changes

NOTES:

| | |
|----|---------------------|
| A | MIDI 200 |
| B | MIDI 240 |
| B' | DUAL MIDI 240 |
| C | MIDI 320 |
| C' | DUAL MIDI 320 |
| D | MAXI 384 |
| D' | DUAL MAXI 384 |
| E | MAXI 448 |
| E' | DUAL MAXI 448 |
| F | 27 KIP CONNECTION |
| G | LVL 2 WOOD TO STEEL |
| H | BEAM POCKET @ CMU |
| I | LVL 1 COLUMN BASE |
| M | COLUMN TO COLUMN |
| N | NW CORNER - SSK-05 |
| P | MIDI 280 |
| Q | LVT60215 |
| R | MIDI 360 |
| R' | DUAL MIDI 360 |
| T | COLUMN TO STL BEAM |
| U | COLUMN TO GL BEAM |

APPROVED BY: [redacted] DATE: [redacted]

PROJECT: 670 Union St Condominiums
670 Union St, Brooklyn, NY 11215

PART ID: MT-3.61

AEC
Digital Construction

Delivery, Site Organization & Staging



KK Law courtesy naturallywood.com



Photos: Swinerton

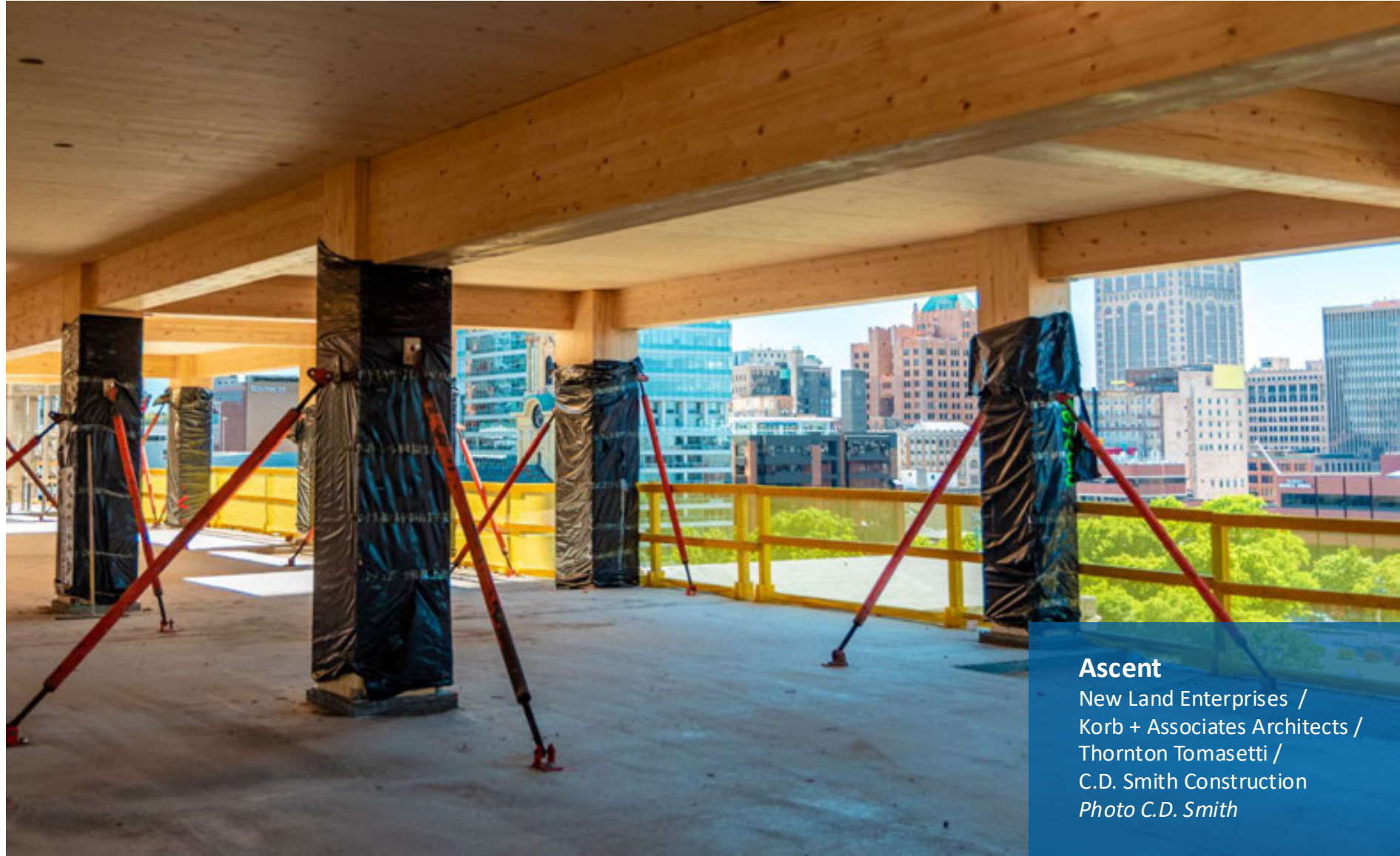


Outline

- » Products and Connections
- » Fasteners, Hardware and Equipment
- » Safety Considerations
- » Planning and Coordination
- Installation and Material Protection**
- » Repairs, Finishes and As-Builts

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

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

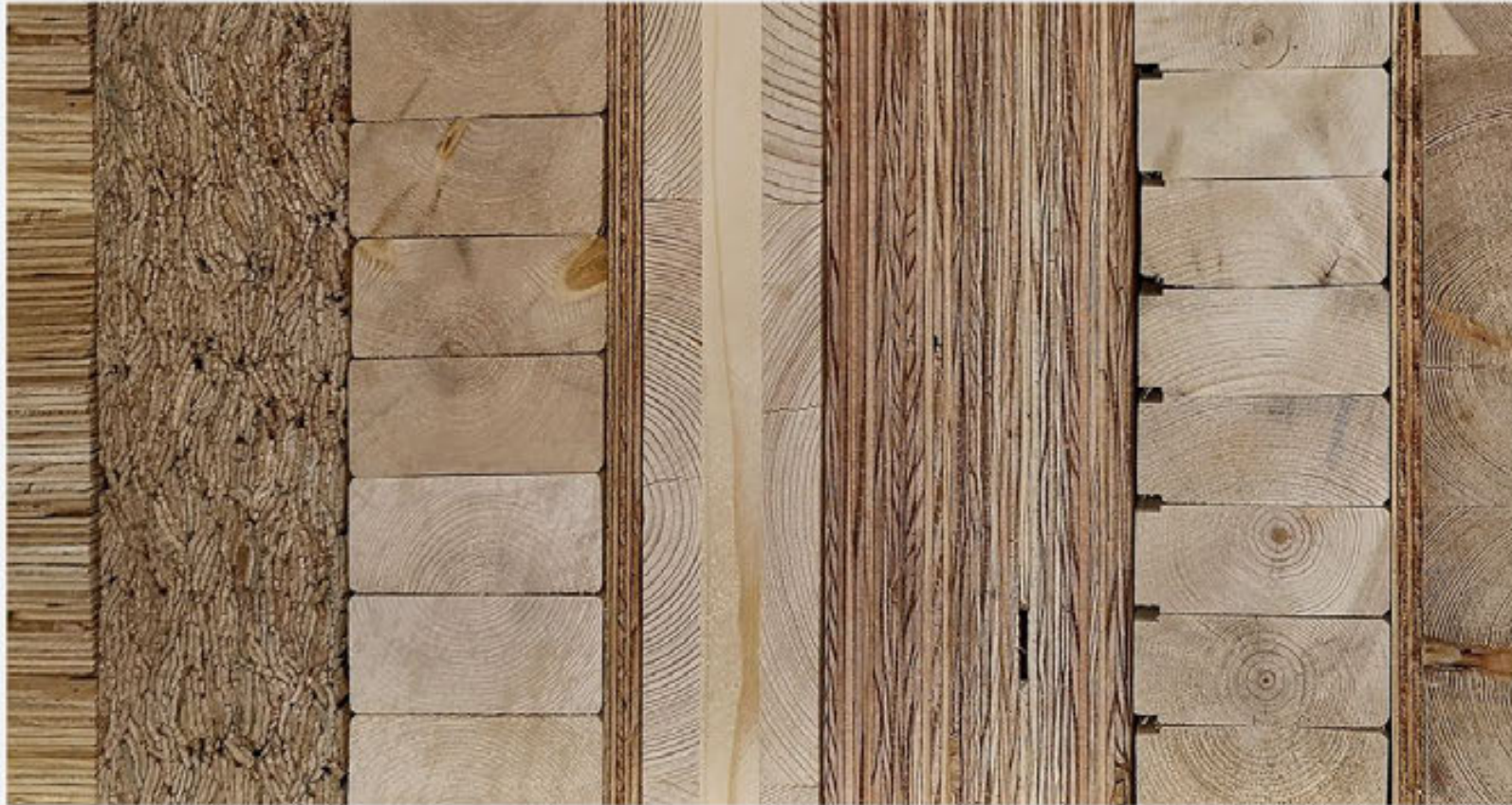
Moisture Management Responsibility and Risk

- 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

Mass Timber Moisture Management for Construction



*Strategies for
managing the
unique moisture
risks of mass timber
building projects*

Photo RDH Building Science

Factory-Applied Sealants & Coatings



Adidas Headquarters

LEVER Architecture / KPFF /
Turner Construction Company

Photo Jeremy Bittermann

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



Transportation & Storage



Photos Paul Alberts / Ardor Media / naturallywood.com

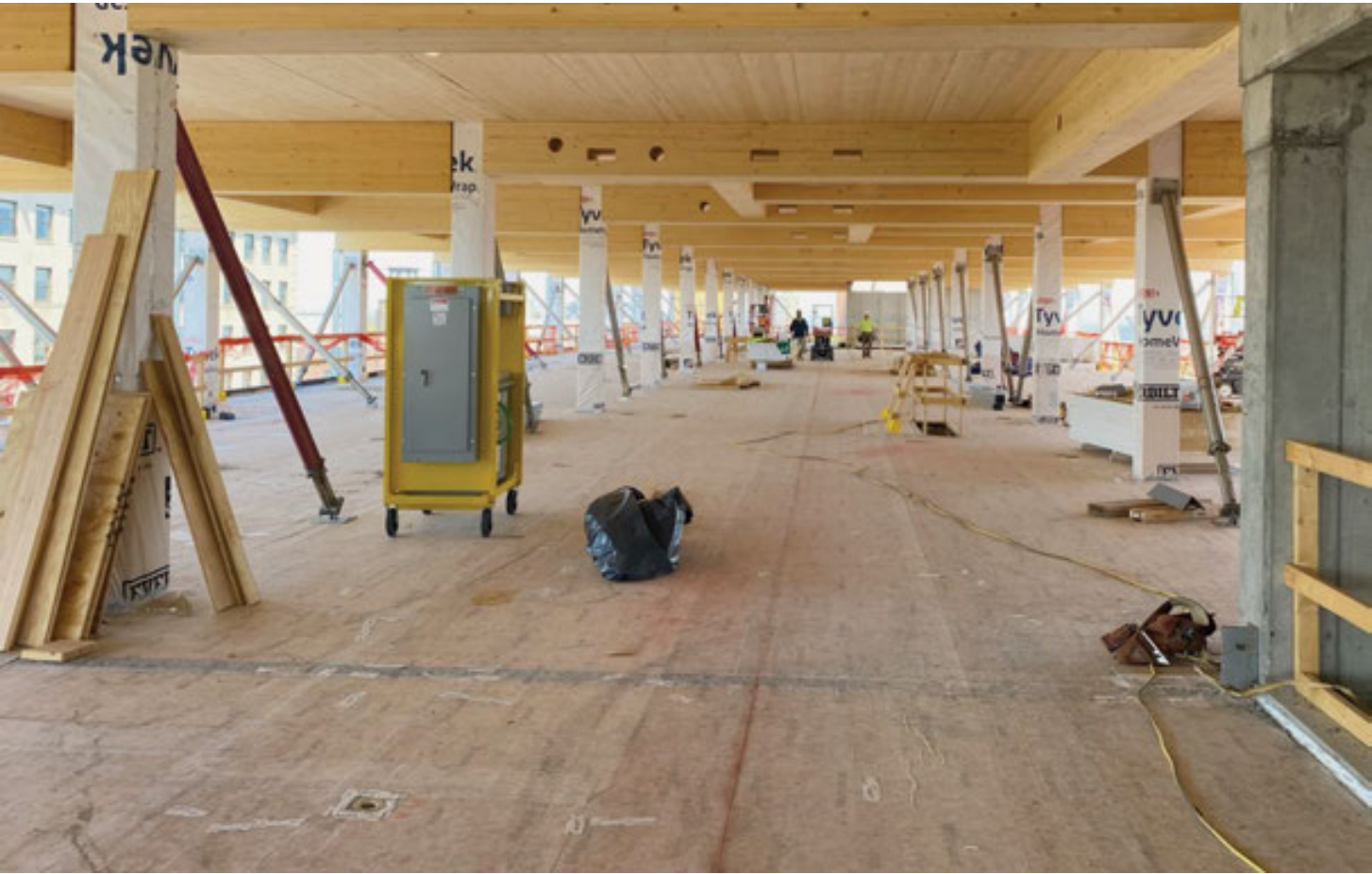
Panel Joint Treatment



INTRO

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

Coverings



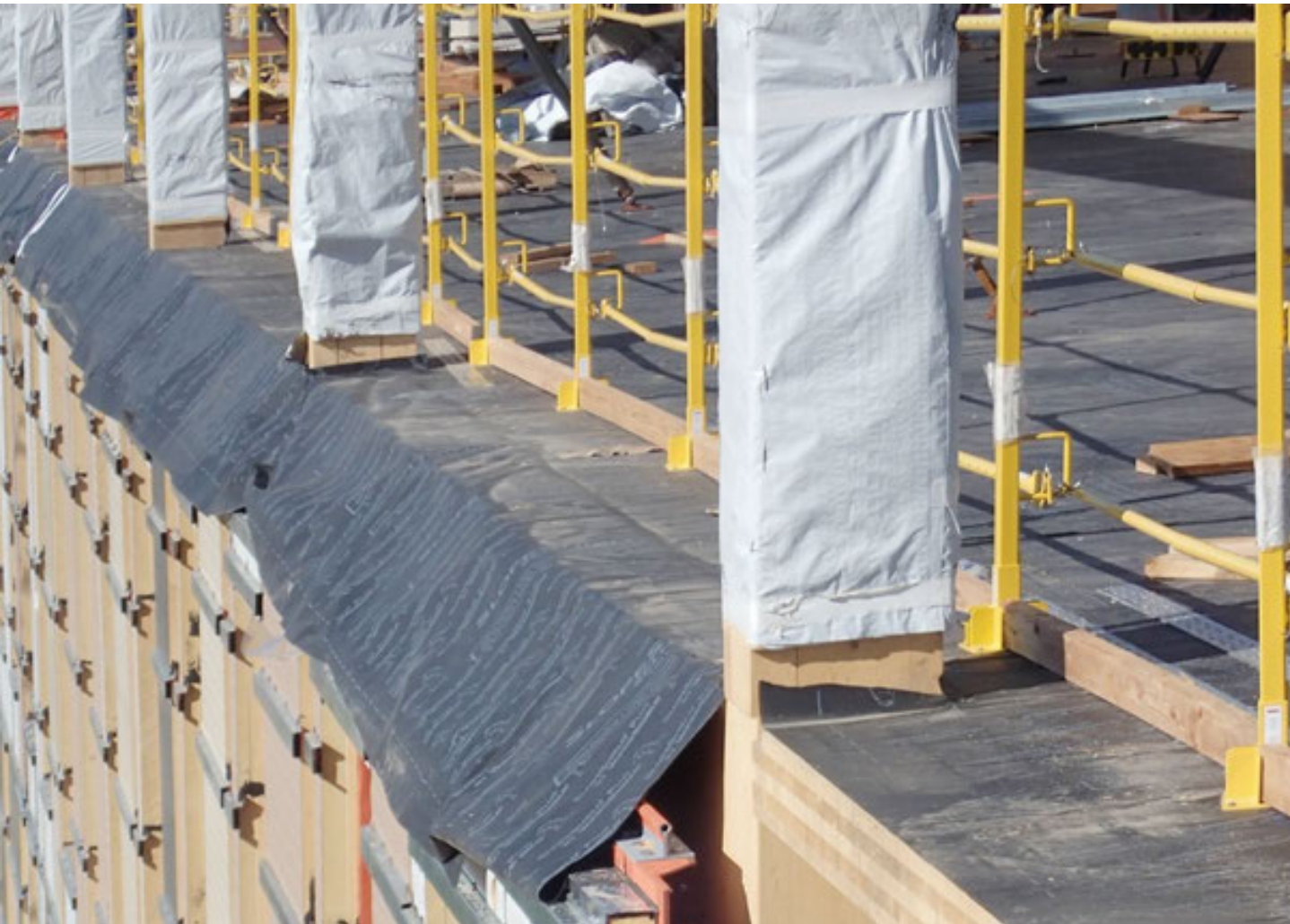
INTRO / Photos WoodWorks



Deflection & Diversion

Platte Fifteen

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



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

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: ^aPRG-320 standard, ^bANSI A190.1, ^cNail-Laminated Timber Design Guide – U.S. Edition, and ^dDLT Design and Profile Guide

The best way to minimize exposure to moisture is to close in the project quickly.



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

Set the column

- » Remove protection material as needed
- » Set column to the correct elevation and location
- » Connect the column base to its support

Install column braces in accordance with bracing plans

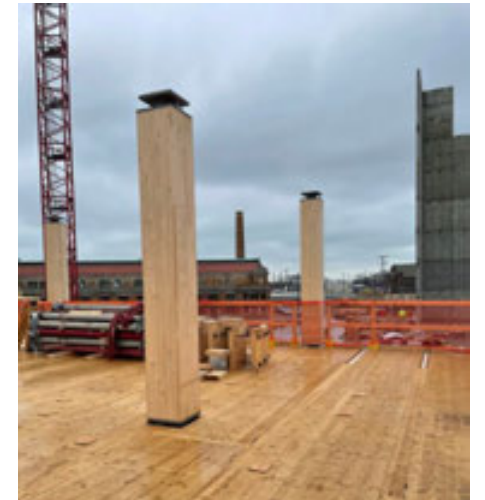
- » Use adjustable steel or wood braces.
- » Refer to drawings for size, location and connections.
- » Attach bottom of brace to slab, footing, deadman, helical anchor or other mass timber element.
- » Attach top of brace to column with a manufacturer-specified fastener.



Installing Columns

Plumb the column

- » Use the primary control surface or centerline of column.
- » Measure using actual size of the column.
- » Check exterior vs. interior plumb tolerances.
- » Once plumb, tighten anchor bolts and/or connection bolts, or weld to embed.
- » Disconnect crane/rigging only after all connections are fully complete and confirmed to be plumb, square and level.

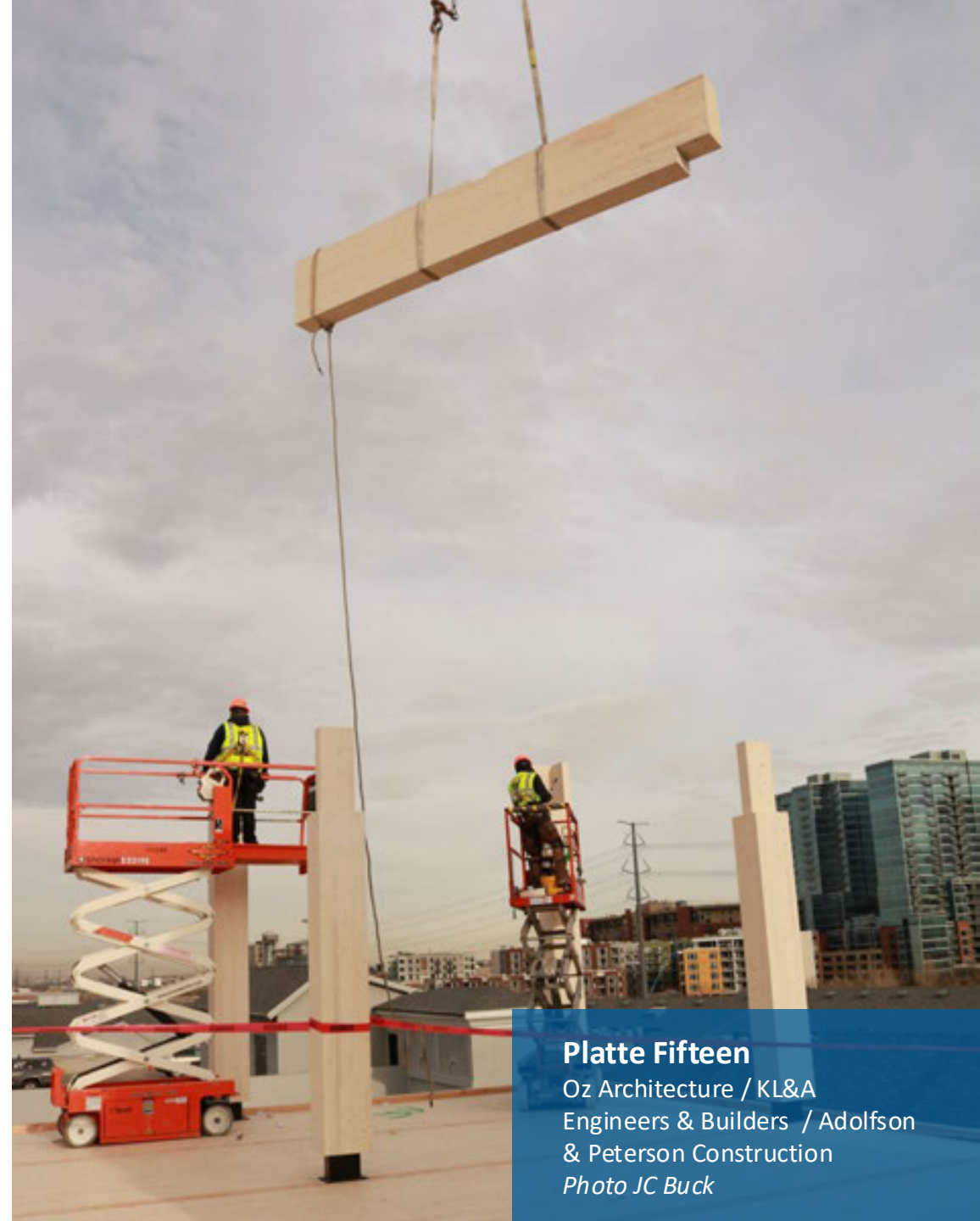


Ascent / Photo WoodWorks

Installing Beams

Set the beam

- » Remove protection material as needed.
- » Set the beam and connect to supporting material.



Installing Panels



Photo Marcus Kauffman



Photo WoodWorks

Installing Panels

- » Use shores to plumb panels
- » Measure for plumbness
 - » Use primary control surface or centerline of panel
- » Check allowable tolerances
 - » Building exterior
 - » Elevator shaft, shear wall and stairwell
- » Appearance face awareness



Coordination with Other Subs



John W. Olver Design Building / Photos Alex Schreyer (left and top)
The Bullitt Center / Photo John Stamets

Concealed Spaces



John W. Olver Design Building / Photos Alex Schreyer

MEP Layout & Integration

In raised access floor (RAF) above MT

- » Impact on head height
- » Concealed space code provisions



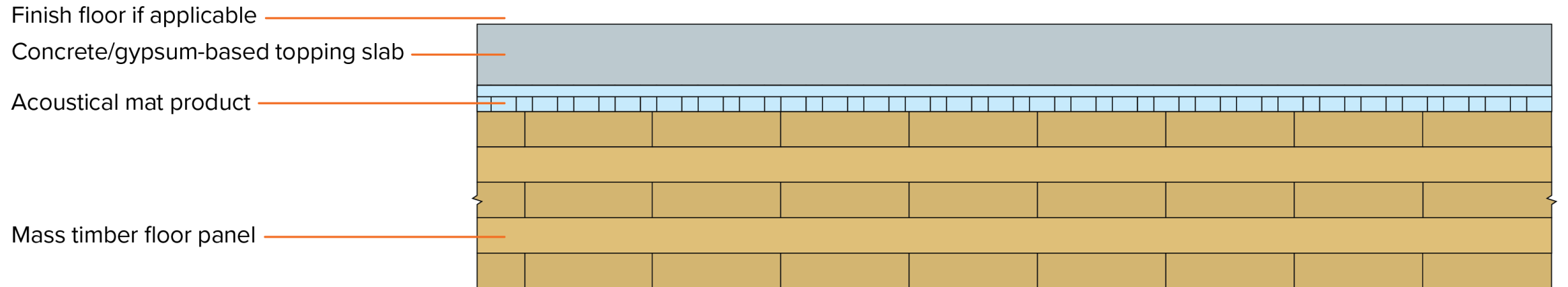
Firestopping

Fire stopping maintains fire-resistance rating (FRR) continuity of mass timber assemblies at penetrations and joints.

- » Joints between assemblies
- » Penetrations of pipes and conduits



Acoustic Performance



Typical mass timber floor assembly

Tall Mass Timber Special Inspections

**TABLE 1705.5.3
REQUIRED SPECIAL INSPECTIONS OF MASS TIMBER CONSTRUCTION**

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

Source: International Building Code

Table is only required for Type IV-A, IV-B, and IV-C



Developed by Woodworks
in collaboration with
Alex Lega, PE, SE
PCS Structural Solutions

Construction Quality Assurance on Mass Timber Projects: Inspection and Observation

Considerations for project teams developing inspection and observation plans

Quality assurance for mass timber projects involves many considerations, which can create a learning curve for teams new to these materials. For example, in addition to code-required inspections that apply to almost any project, mass timber projects benefit from other types of inspections—but it can be challenging to find information on what they entail. While inspection standards and methods have long been codified for other structural materials (including other types of wood construction), mass timber is relatively new to the United States. And although mass timber projects are subject to many of the existing inspection requirements, the 2021 International Building Code (IBC) was the first version to include requirements specific to these materials.

This paper explores inspection considerations for mass timber projects, including special inspections and structural observations, and how to effectively communicate the requirements and review the results. It is intended to provide a basis for conversation that helps teams comply with the building code and develop Construction Documents (CDs) specific to the project by finishing their approaches to construction quality assurance.

This publication references the 2024 IBC, but most references are identical in the 2021 code.

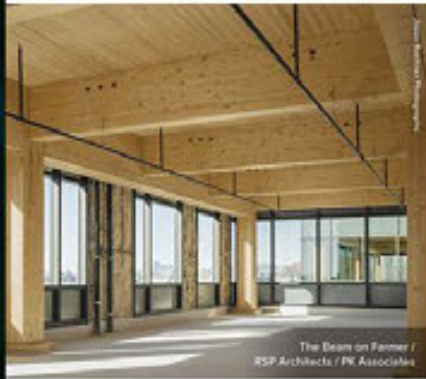
Inspections Performed by the Building Official

The building official, or Authority Having Jurisdiction (AHJ), performs a set of inspections focused on the administration and enforcement of the building code. These are not the same as special inspections and undertaking one type does not preclude the other. Provisions for building official inspections are included in IBC Section 110 and apply to most projects, regardless of structural material. Section 110.1 notes:

Construction or work for which a permit is required shall be subject to inspection by the building official and such construction or work shall remain visible and able to be accessed for inspection purposes until approved.

This section also notes the importance of leaving the work in a condition that allows easy inspection until approved:

It shall be the duty of the owner or the owner's authorized agent to cause the work to remain visible and able to be accessed for inspection purposes. Neither the building official nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.



The Beam on Farmer / RSP Architects / PK Associates

Outline

- » Products and Connections
- » Fasteners, Hardware and Equipment
- » Safety Considerations
- » Planning and Coordination
- » Installation and Material Protection
- Repairs, Finishes and As-Builts**

Cleaning Mass Timber

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



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 /
KPF Consulting Engineers /
Bremik Construction
Photo Daniel Kaven

As-Built Surveys

- » Traditional hand-held or analog field measurements using tapes, levels and plumb bobs
- » Digital hand-held laser measuring tool with hand-recorded measurements
- » Theodolites
- » Transit
- » Total station



Trimble, Microdrones, University of Idaho (clockwise from left)



Back in 10!



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.



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.

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

Speed of Construction

Market Distinction

Sustainability

KNOW

Lightweight

YOUR WHY

Leasing Velocity

Cost

Urban Density

Healthy Buildings & Biophilia

Do Your Homework
Understand the “Why”



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>



Do Your Homework

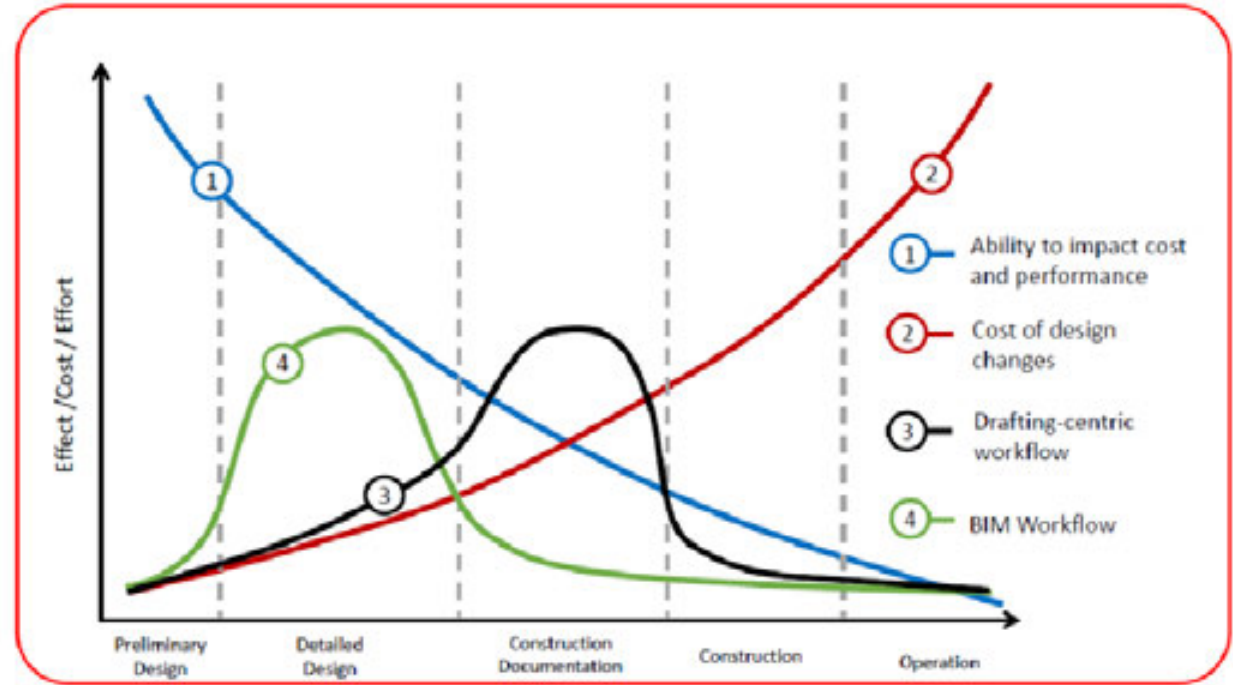
Factors Influencing Cost Estimation

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

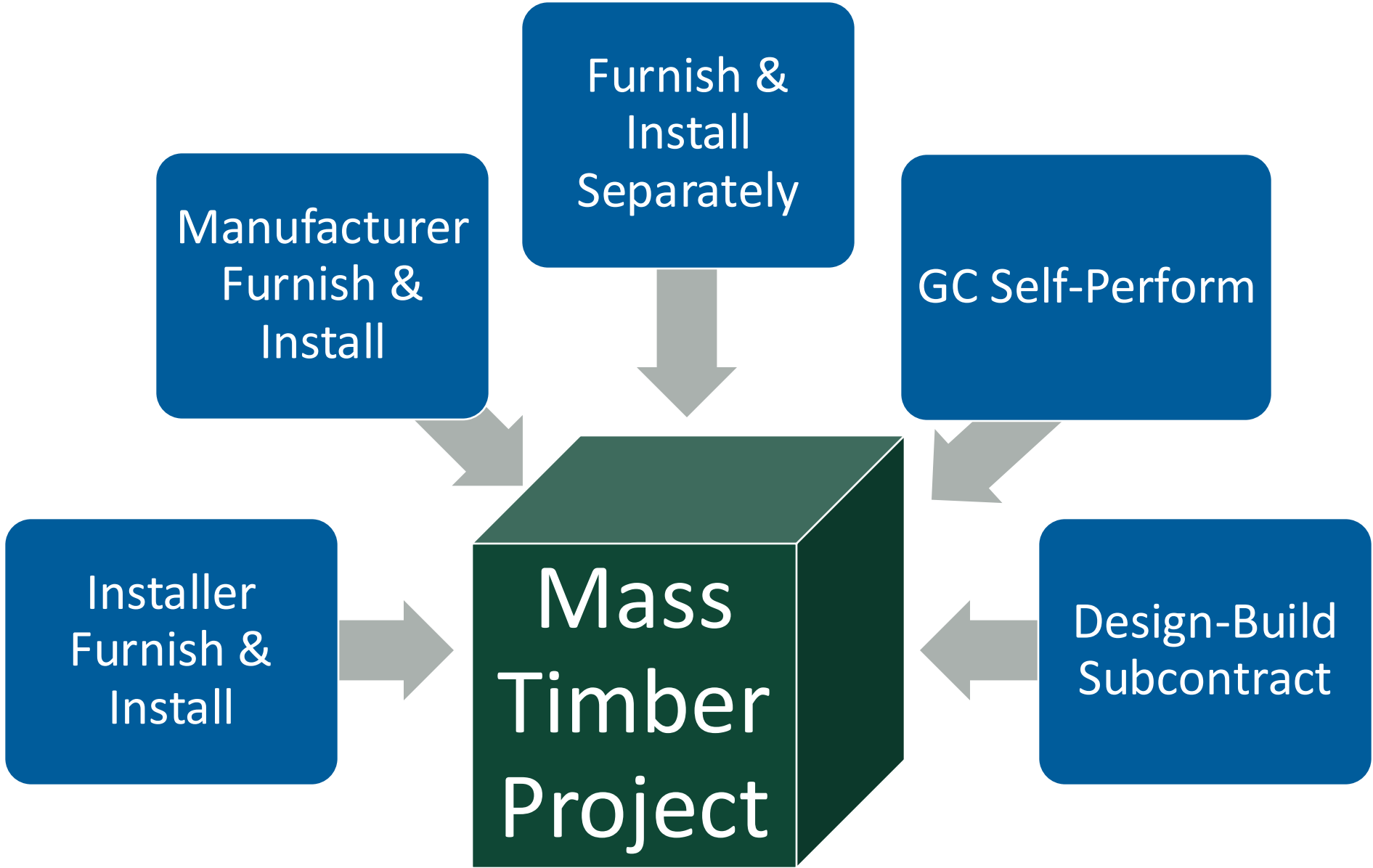


Do Your Homework

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

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 impact 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

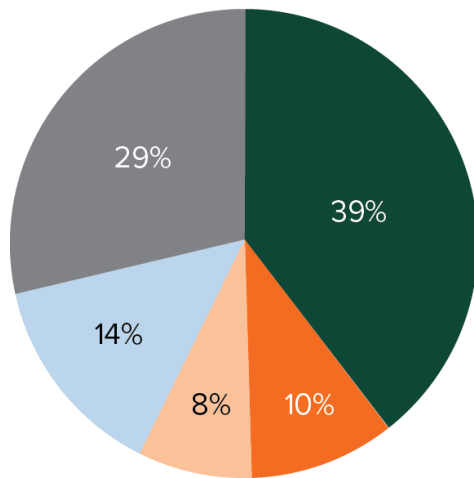
Step 2: Establish a Reliable Pre-Design Budget

Step 3: Manage Project Costs

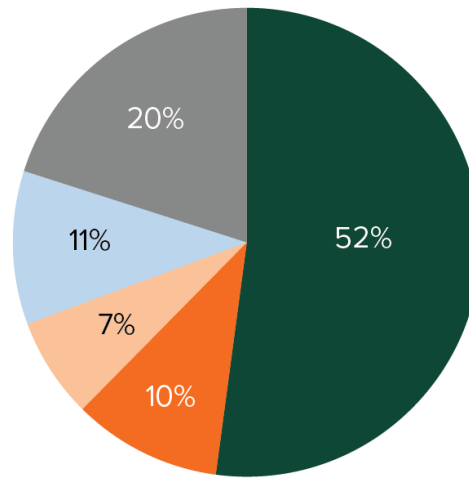
Establishing a Reliable Pre-Design Budget

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

Separate Supply/ Install
Residential:
Point Supported High-Rise



Installer Furnish Install
Commercial Office:
Post & Beam Mid-Rise



- Timber
- Hardware
- Shipping
- Other
- Installation

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 |
| | Hardware | Certification premium |
| | | Connectors |
| | | Preassembly |
| | | Fasteners and splines |
| | Logistics | Hardware shipping |
| | | CLT shipping |
| | | Glulam shipping |
| | Other | Temporary storage |
| | | 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?

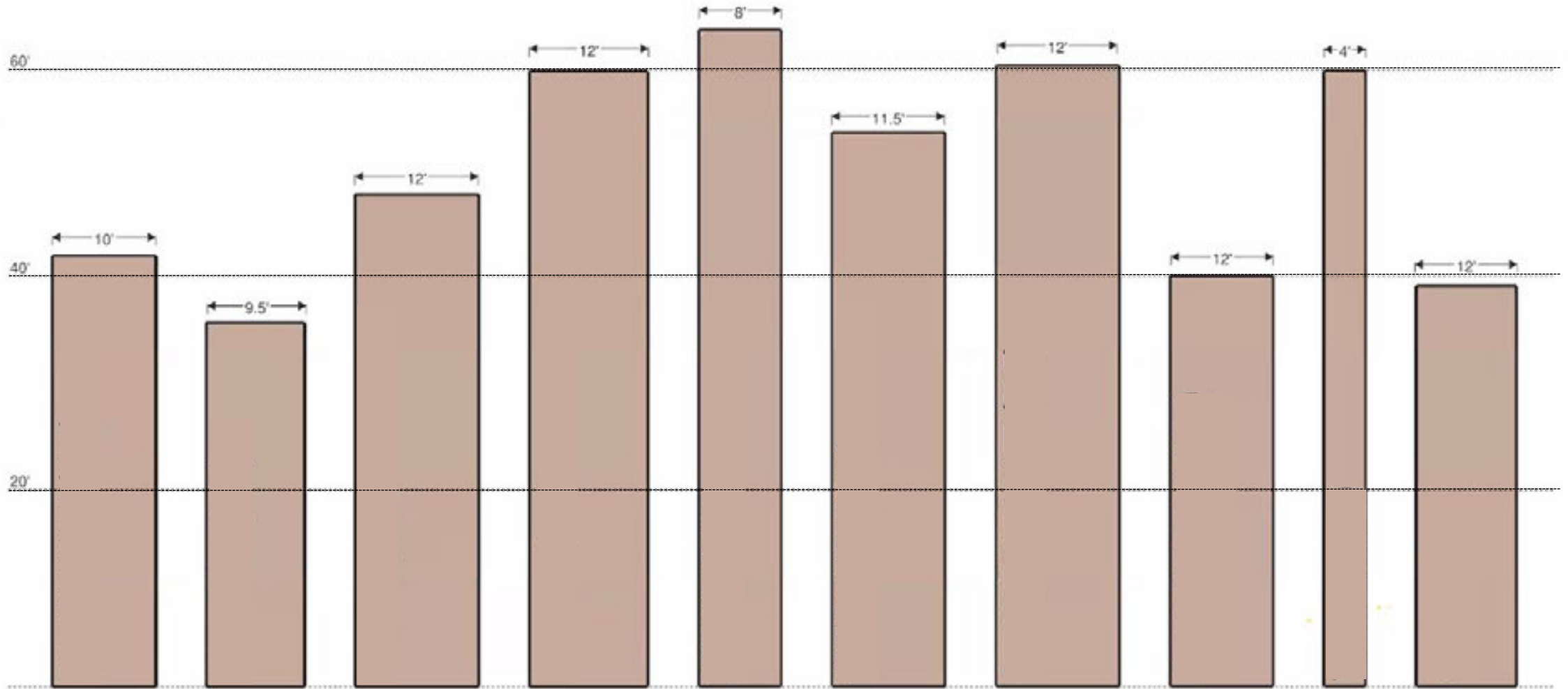
Regardless of the level of information you provide, make sure you can apply volumes to the associated rough costs as this will help further both design and cost refinement

Establishing a Reliable Pre-Design Budget

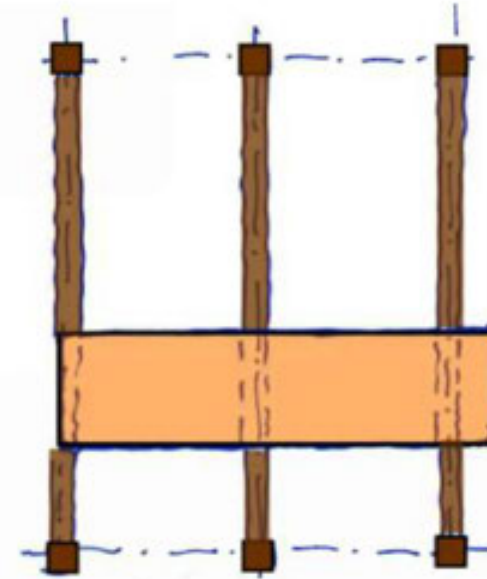
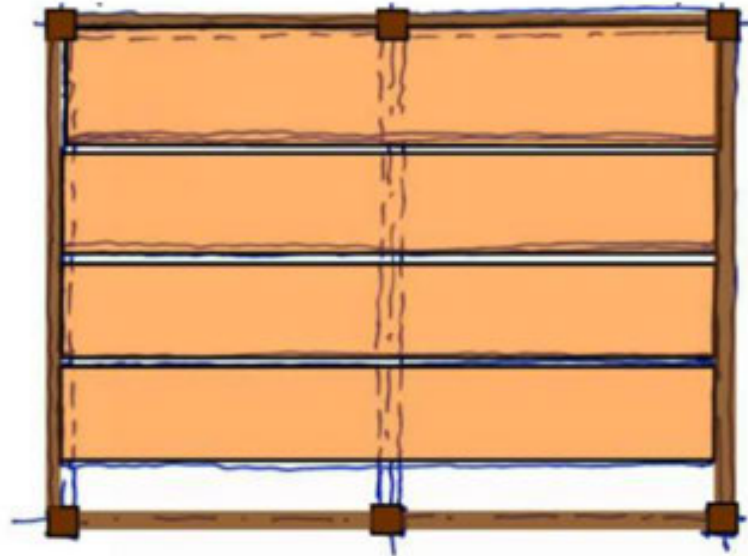
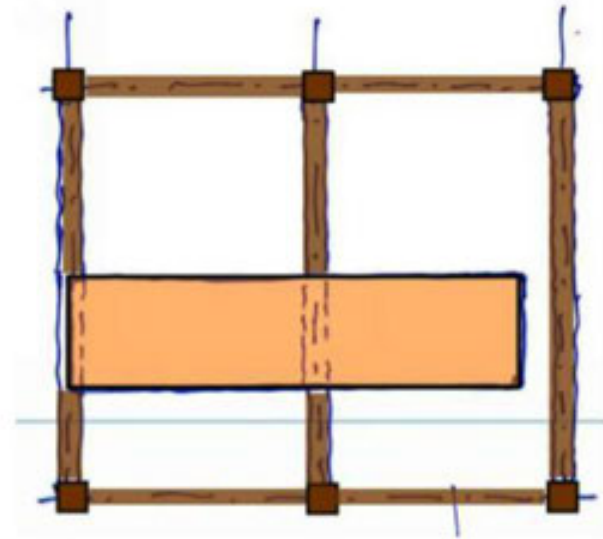
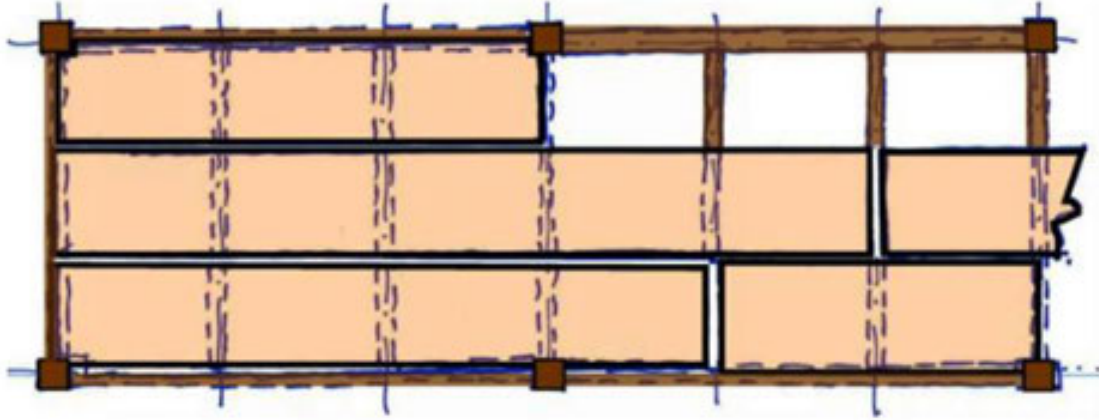
Insights For Supply Bids

- 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
 - Glulam:Panel number may impact bids

Understand Manufacturer's Capabilities



Credit: TimberLab



Credit: Tanya Luthi, Entuitive

Understand Manufacturer's Capabilities

Establishing a Reliable Pre-Design Budget

Insights For Better Budgeting for Panels and Glulam

- 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 ft³/m³ 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

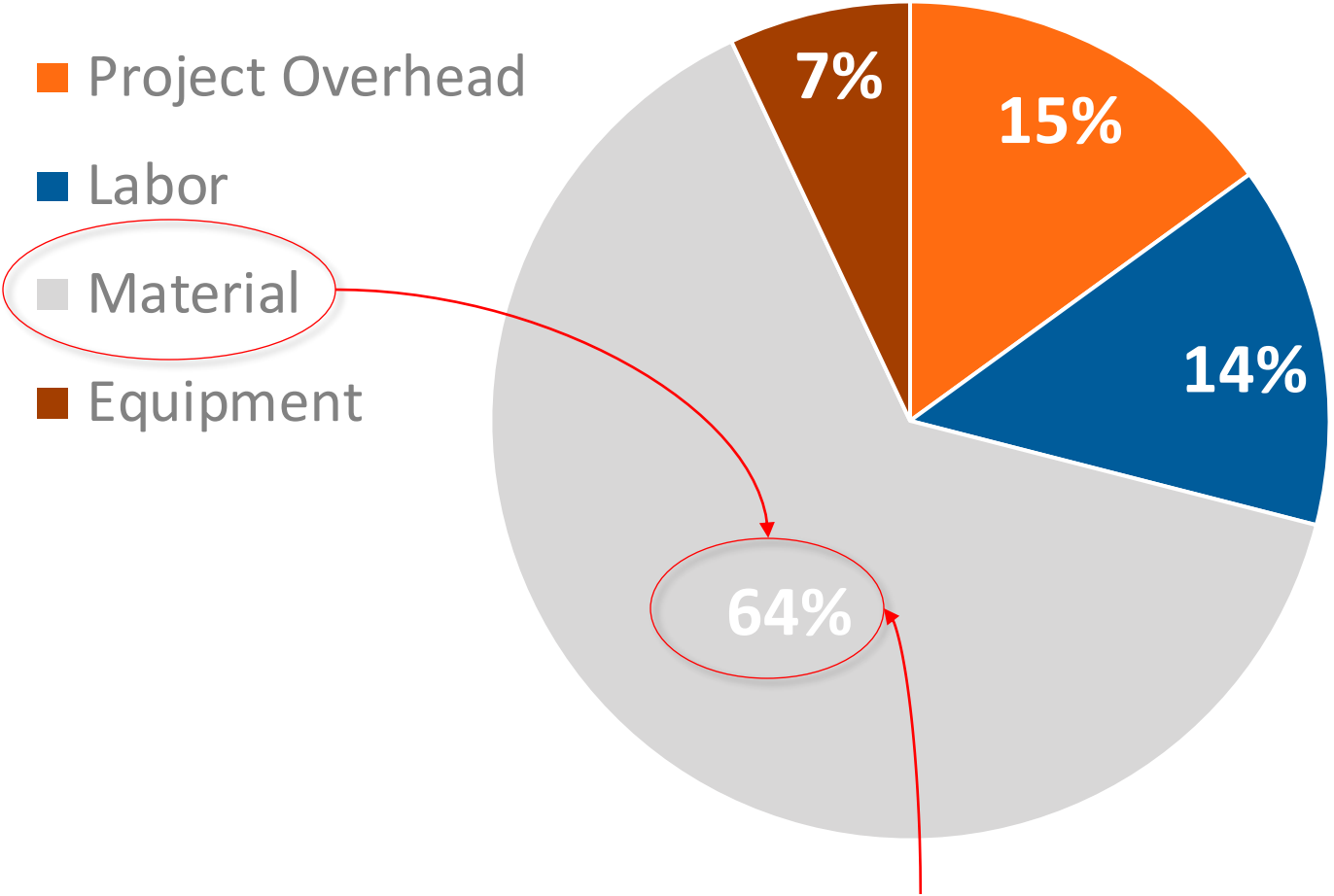
- **CLT and Glulam** – Usually between 40% and 55% of the installed timber package cost
- **Hardware** – Beam and column connectors are usually the largest contributor to the hardware line item and can be benchmarked against the cost per ton of steel. When building a budget from scratch, it is worthwhile 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 ft³ of CLT and 1,000 to 1,200 ft³ 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**

Typical MT Package Costs



Panels are the biggest part of the biggest piece of the cost pie

Understanding Cost Impacts of Construction Type

Pre-Design Budget Example

4-story building on college campus

- Mostly Group B occupancy, some assembly (events) space
- NFPA 13 sprinklers throughout
- Floor plate = 7,700 SF
- Total Building Area = 23,100 SF

Impact of Assembly Occupancy Placement:

Owner originally desires events space on top (4th) floor

- Requires Construction **Type IIIA**

If owner permits moving events space to 1st, 2nd or 3rd floor

- Could use **Type IIIB**

Panel volume usually 65-80% of MT package volume

Type IIIA

1-hr FRR

Purlin: 5.5"x28.5"

Girder: 8.75"x33"

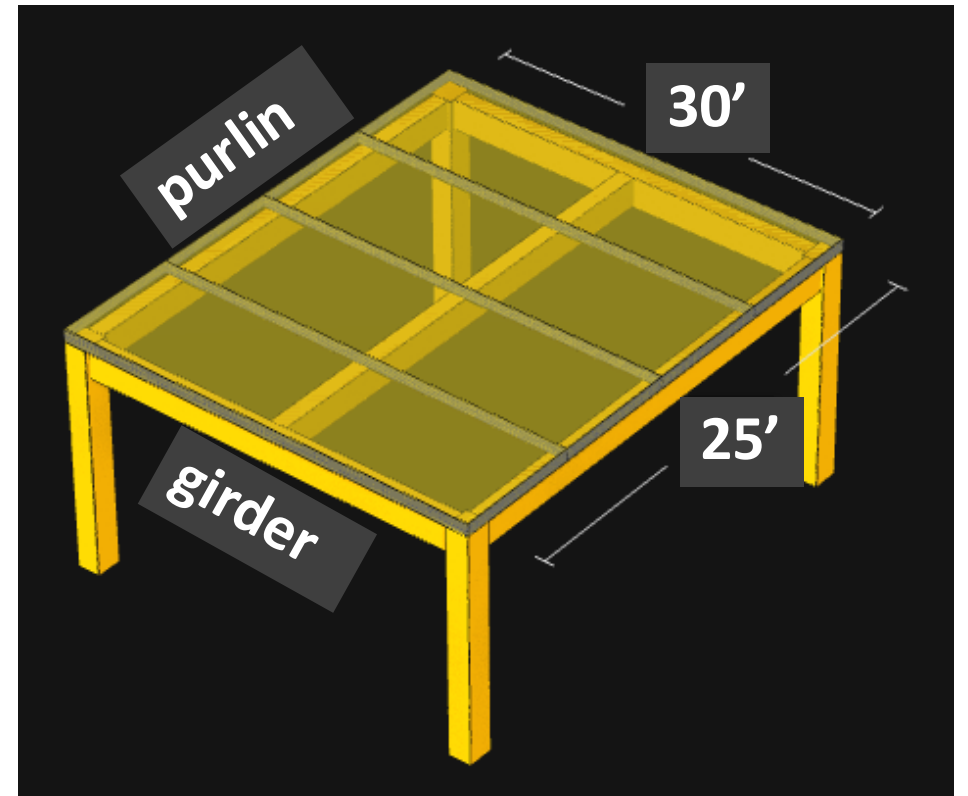
Column: 10.5"x10.75"

Floor panel: 5-ply

Glulam volume = 118 CF (22% of MT)

CLT volume = 430 CF (78% of MT)

Total volume = 0.73 CF / SF



Source: Fast + Epp, Timber Bay Design Tool

Panel volume usually 65-80% of MT package volume

Type III-B

0-hr FRR (min sizes per IBC)

Purlin: 5.5"x24" (IBC min = 5"x10.5")

Girder: 8.75"x33" (IBC min = 5"x10.5")

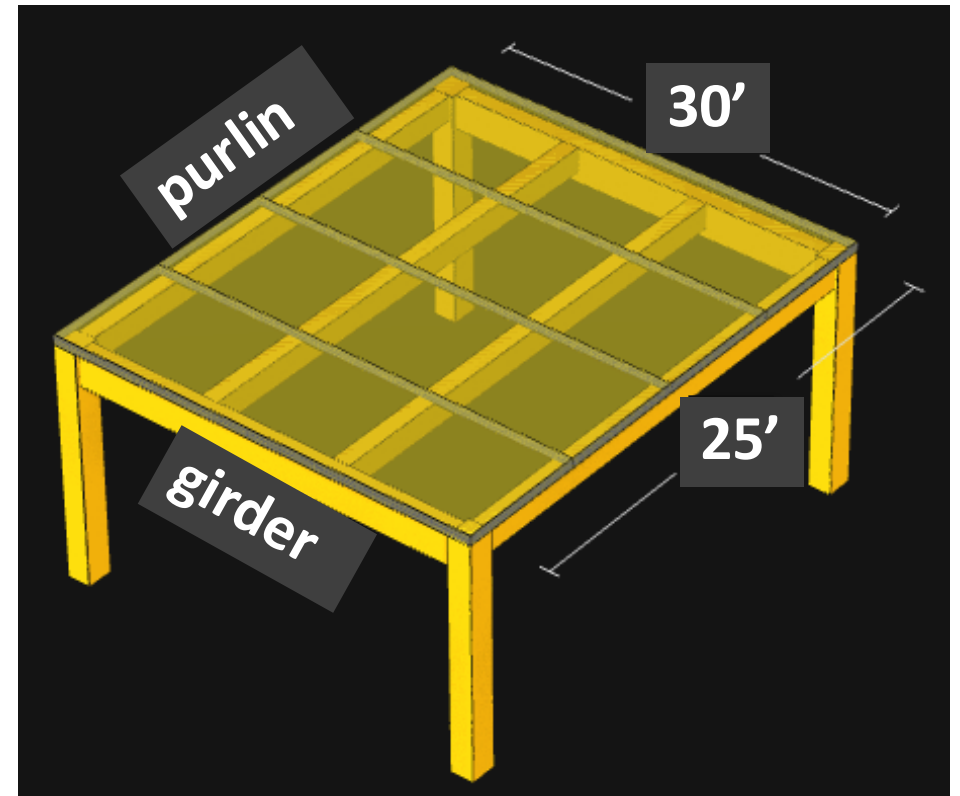
Column: 10.5"x10.75" (IBC min = 6.75"x8.25")

Floor panel: 3-ply (IBC min = 4" CLT)

Glulam volume = 120 CF (32% of MT)

CLT volume = 258 CF (68% of MT)

Total volume = 0.51 CF / SF



Source: Fast + Epp, Timber Bay Design Tool

Understanding Cost Impacts of Construction Type

Pre-Design Budget Example

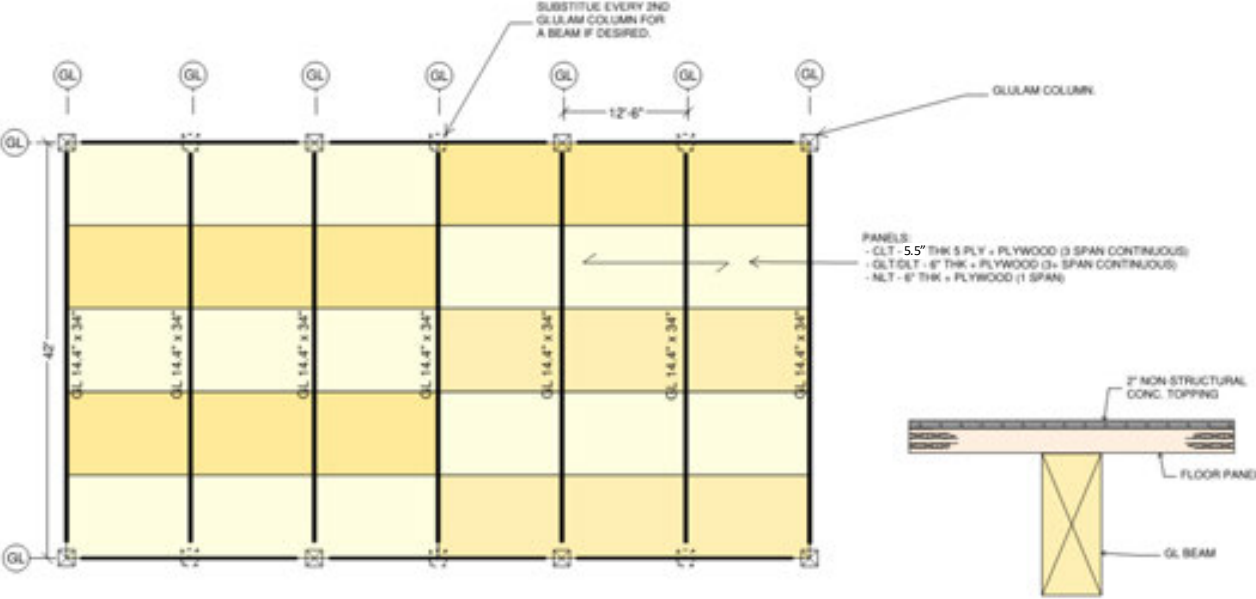
4-story building on college campus

Cost Impact of Assembly Occupancy Placement:

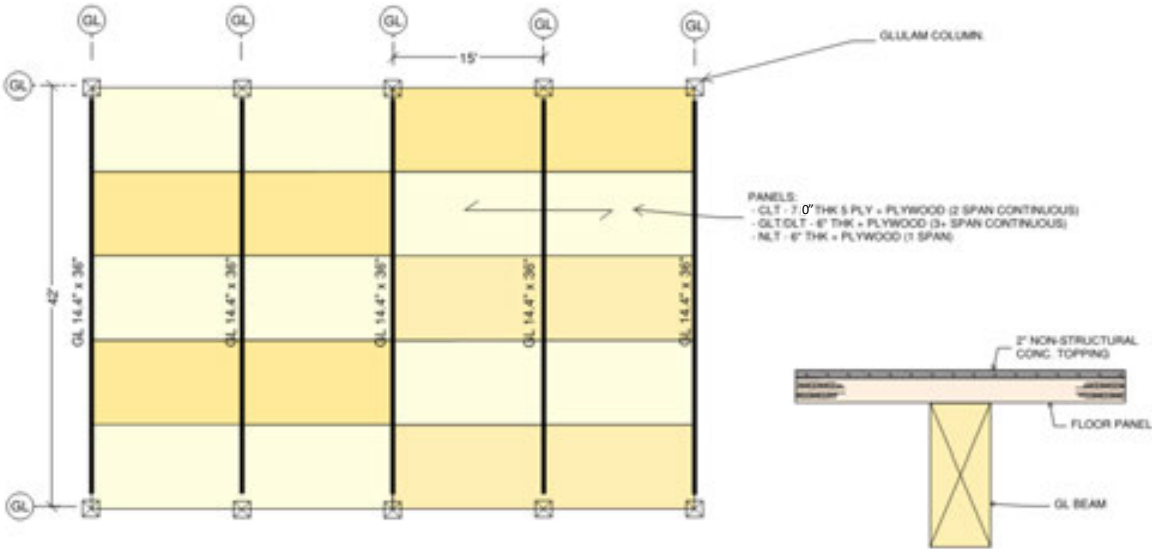
| Location of Event Space | 4th Floor | 1 st Floor |
|--------------------------------------|-----------------------|-----------------------|
| Construction Type | III-A | III-B |
| Assembly Group | A-3 | A-3 |
| Fire Resistive Rating | 1-Hr | 0-Hr |
| Connections | Concealed | Exposed |
| CLT Panel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



Cost: Structural System & Grid



Baseline
 12'-6" Glulam Spacing
 5.5" CLT

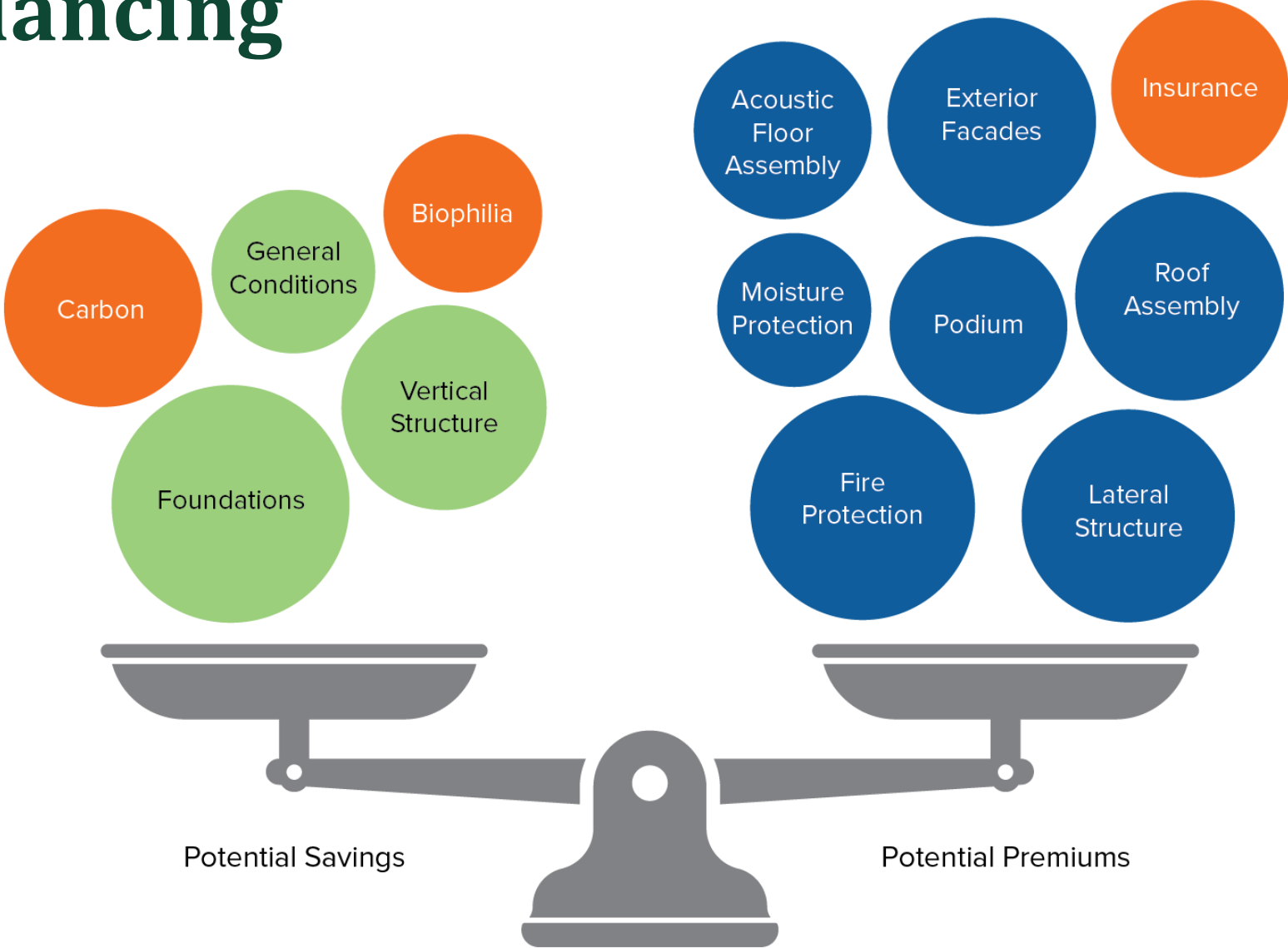


\$ +5%
 15' Glulam Spacing
 7" CLT

Source: Seattle Mass Timber Tower Book

Mass Timber Construction

Cost Balancing



Cost Managing a Mass Timber Project

Step 1: Do your Homework

Step 2: Establish a Reliable Pre-Design Budget

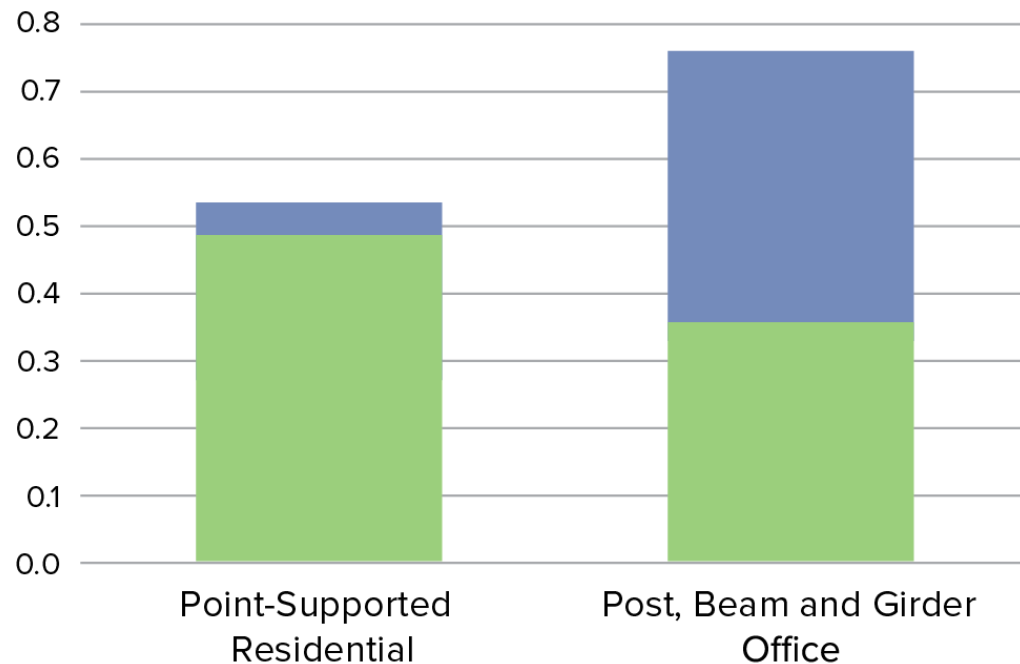
Step 3: Manage Project Costs

Manage Project Costs

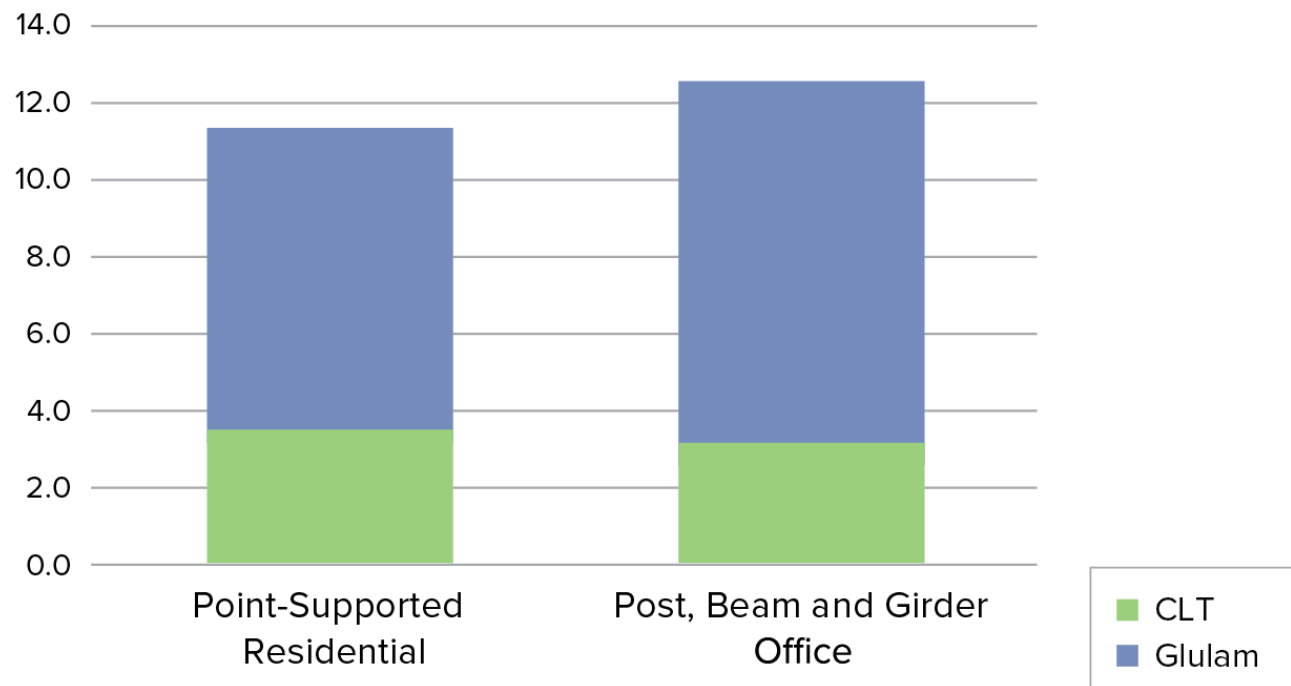
Cost Benchmarking

- 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

Volume Efficiency Ratio (ft^3/ft^2)

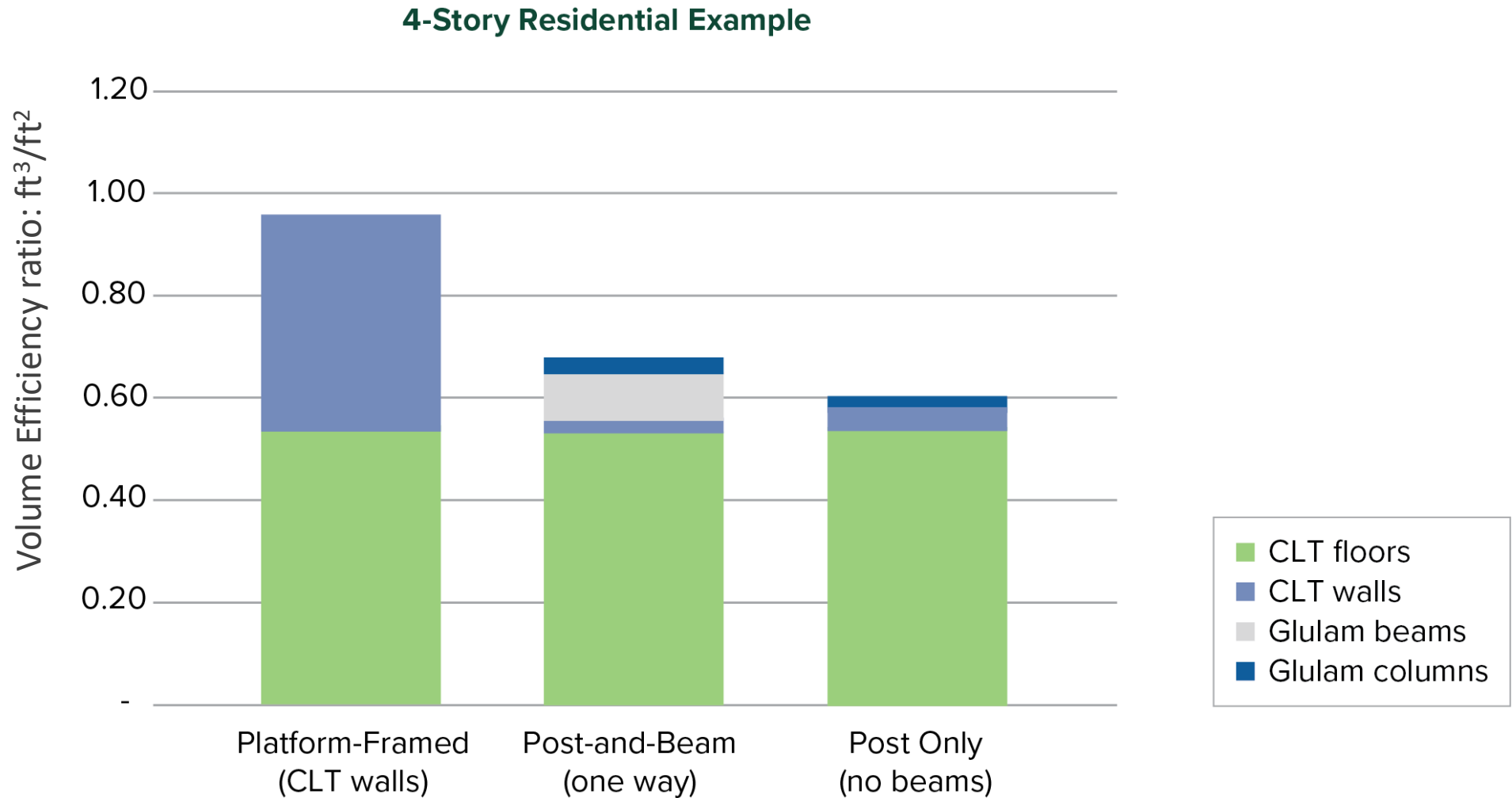


Piece Count Ratio (Piece/1000 ft^2)



Manage Project Costs

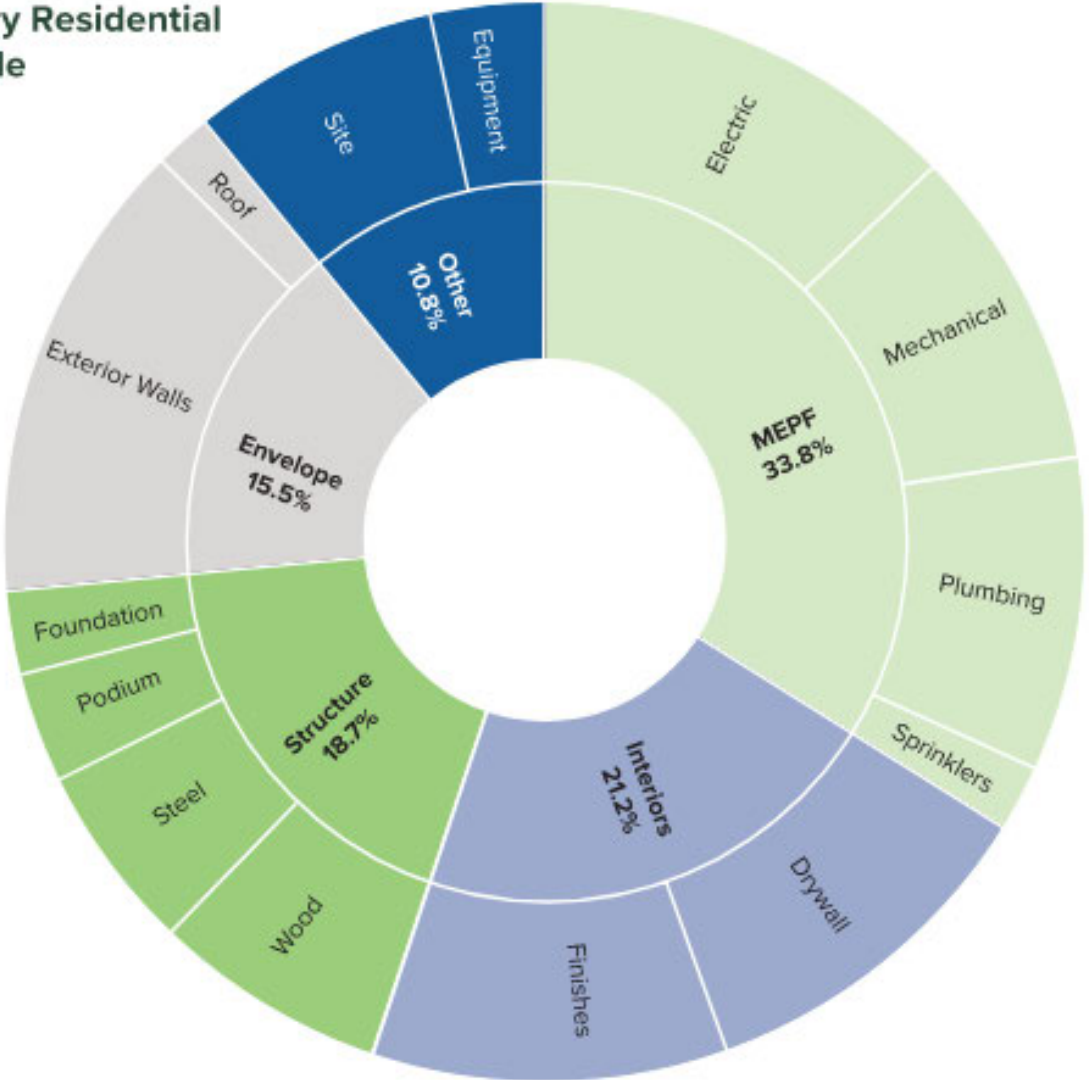
Cost Benchmarking



Manage Project Costs

Cost Benchmarking

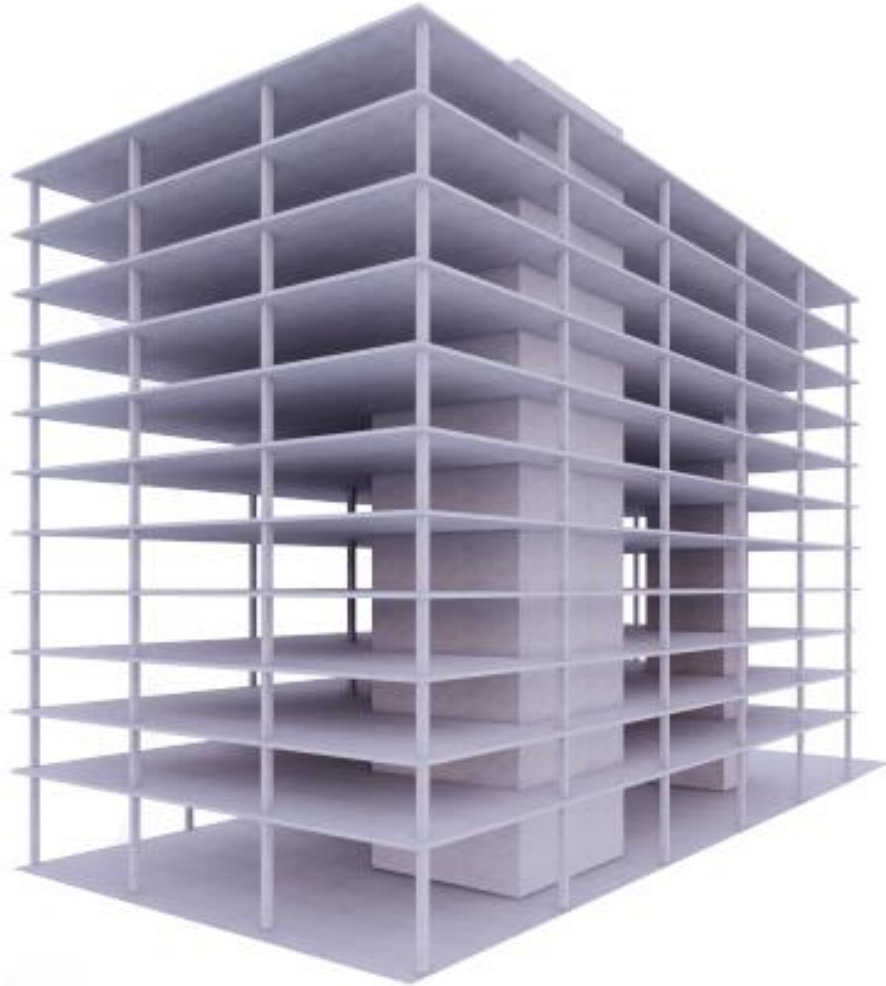
12-Story Residential Example



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



Holistic Costing



\$/SF



\$/SF

Manage Project Costs

Positive Non-Timber Design Cost Levers

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

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

Scan to Download



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 us anything.



Please take our survey!

Michael Muller, PE, SE
Regional Director | WA, AK, ID-North
(215) 292-4967

michael.muller@woodworks.org



Copyright Materials

This presentation is protected by US
and International Copyright laws.

Reproduction, distribution, display and use of
the presentation without written permission
of the speaker is prohibited.

© The Wood Products Council 2026

Funding provided in part by the Softwood Lumber Board

Disclaimer: The information in this presentation, including, without limitation, references to information contained in other publications or made available by other sources (collectively “information”) should not be used or relied upon for any application without competent professional examination and verification of its accuracy, suitability, code compliance and applicability by a licensed engineer, architect or other professional. Neither the Wood Products Council nor its employees, consultants, nor any other individuals or entities who contributed to the information make any warranty, representative or guarantee, expressed or implied, that the information is suitable for any general or particular use, that it is compliant with applicable law, codes or ordinances, or that it is free from infringement of any patent(s), nor do they assume any legal liability or responsibility for the use, application of and/or reference to the information. Anyone making use of the information in any manner assumes all liability arising from such use.