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Mass Timber Construction Management:

Economics, Logistics & Risk Analysis

Bruce Lindsey

Regional Director

Design & Construction Services

Photo: Structurlam

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

Course Description

How do contractors answer the ever-growing demand from architects and ownership groups for mass timber buildings? The growth of this budding industry can be slowed by a lack of will and lack of know-how among seasoned construction professionals who know how to build, understand the onus of “architectural intent,” and must ultimately take on financial responsibility to deliver the dream of a new building system. This presentation will introduce mass timber products and building systems and then consider why some mass timber projects die at concept, what leads to the resistance, and how the development, architectural, engineering, and construction community can overcome assumptions to achieve success with mass timber projects of various scales and typologies. Particular emphasis will be given to preconstruction coordination, holistic approaches to costing and scheduling studies, project delivery methods, and how to achieve the highest level of cost efficiency.

Learning Objectives

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

PRESENTATION OUTLINE

1. MASS TIMBER OVERVIEW

- Structural Solutions
- Connections
- Projects
- Products

2. CONSTRUCTION MANAGEMENT

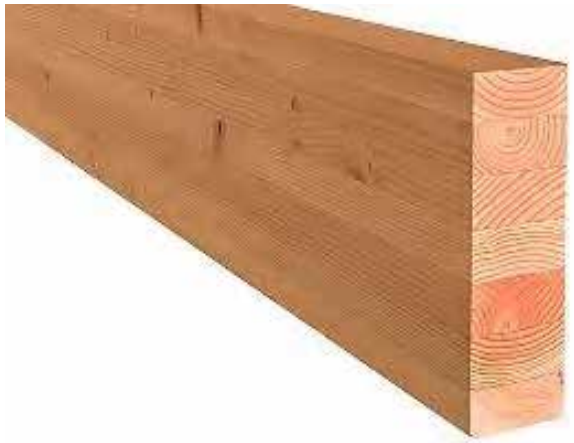
- Risk Analysis (Risks & Solutions)
- Economics (What does it cost?)
- Logistics (Schedule & Coordination)

MASS TIMBER OVERVIEW

Heavy Timber
Photo: Benjamin Benschneider

Mass Timber
Photo: John Stamets

Glue Laminated Timber (GLT)



Cross-Laminated Timber (CLT)

Nail-Laminated Timber (NLT)

Photo: Think Wood

Photo: StructureCraft

Photo: LendLease

Photo: Ema Peter

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Mass plywood panels (MPP)

Photo: Freres Lumber

Decking

Photo: StructureCraft

Photo: LEVER Architecture

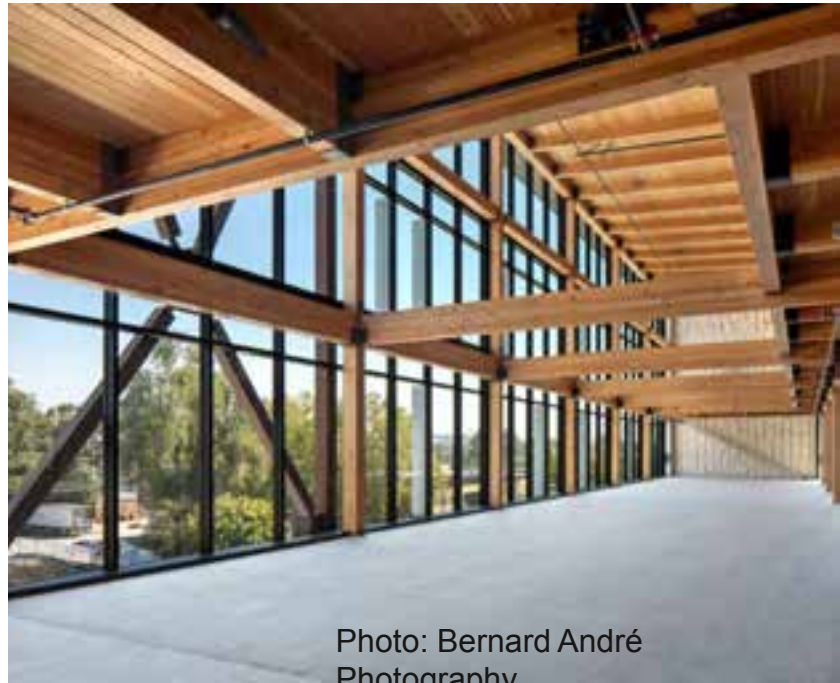


Photo: Bernard André Photography

Photo: Ema Peter

STRUCTURAL SOLUTIONS | POST, BEAM + PLATE

Photo: Seagate Structures

Photo: Lendlease

STRUCTURAL SOLUTIONS | HYBRID LIGHT-FRAME + MASS TIMBER

STRUCTURAL SOLUTIONS | HYBRID STEEL + MASS TIMBER

STRUCTURAL SOLUTIONS | HYBRID CONCRETE + MASS TIMBER

Concealed Connectors

Self Tapping Screws

Photos: Rothoblaas

Beam to Column

Photo: StructureCraft

Photo: Structurlam

Column to Foundation

Photo: Alex Schreyer

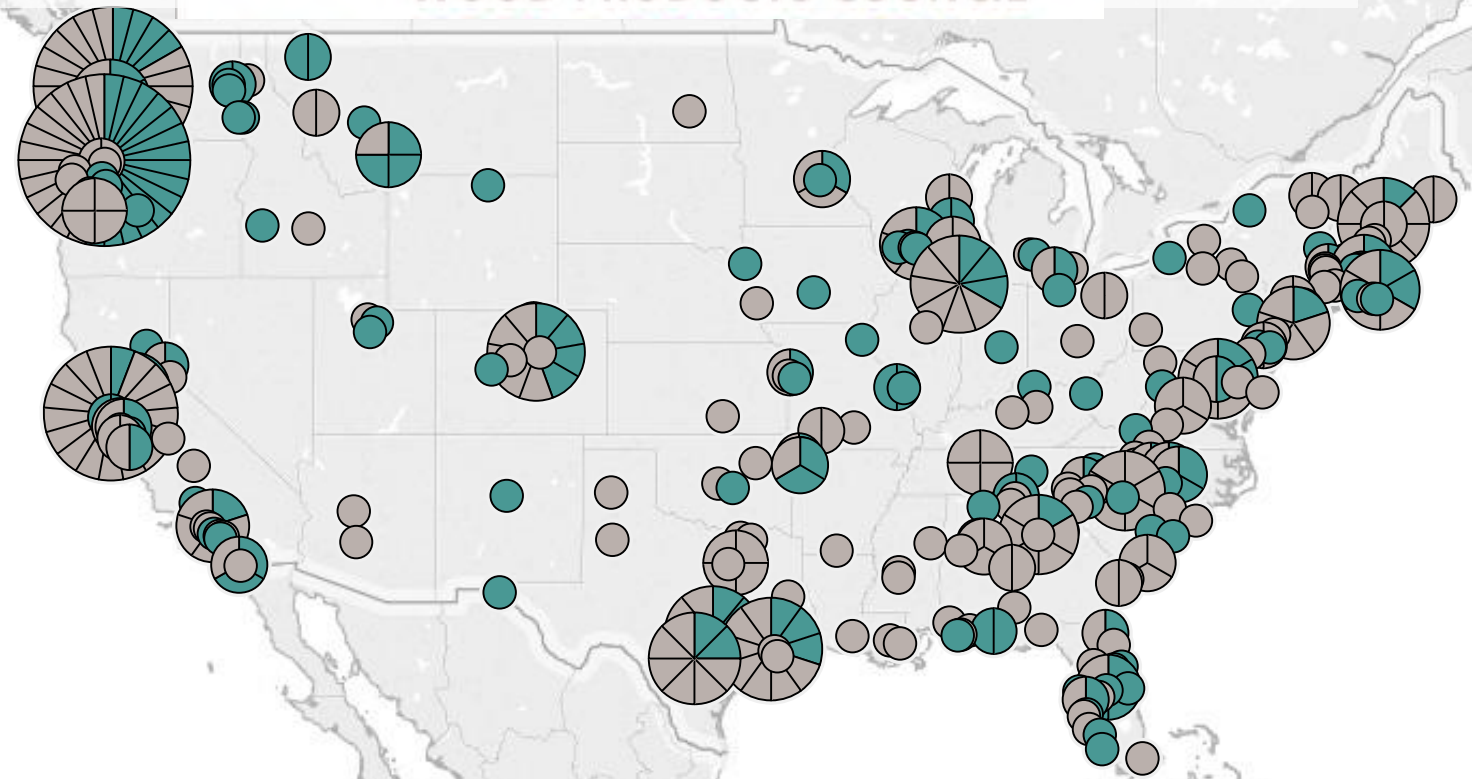
Panel to Panel & Supports

Photo: Charles Judd

Photo: Alex Schreyer

CURRENT STATE OF MASS TIMBER PROJECTS

As of March 2020, **784** multi-family, commercial, or institutional projects have been constructed out of mass / heavy timber across the U.S., or they're currently in design.



Stage
- Construction Started / Built
- In Design

http://www.woodworks.org/publications-media/building-trends-mass-timber/

Photo: Nordic Structures

PRECEDENT PROJECTS | UMASS AMHERST DESIGN BUILDING

Photo: ©Albert Vecerka/Esto

Photos: Baumberger Studio/PATH Architecture

PRECEDENT PROJECTS | CARBON 12 | PORTLAND, OR

Photo: Hines

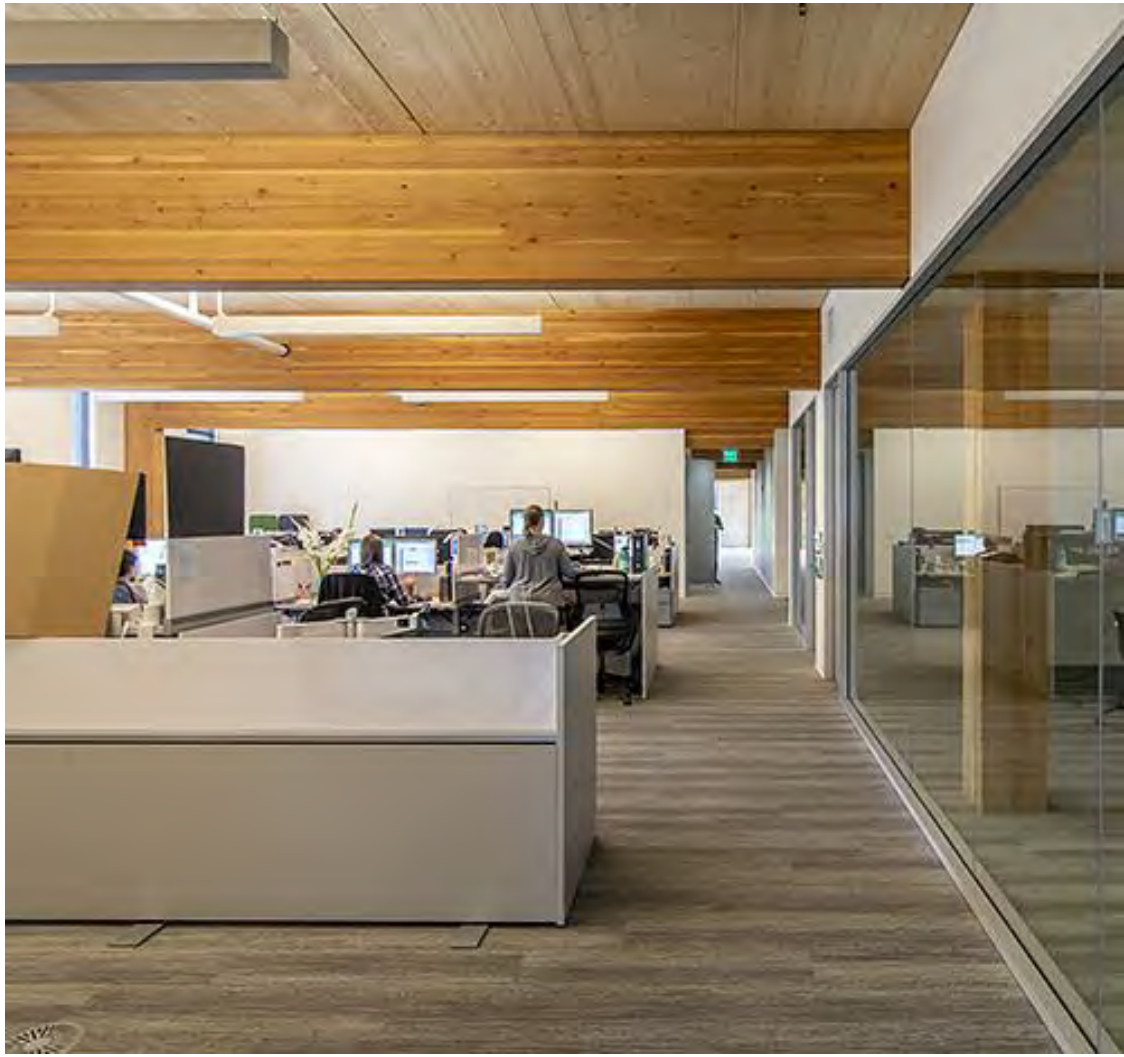
Photo: Corey Gaffer courtesy Perkins + W

Photos: StructureCraft

Photo: Hartshorne Plunkard Architectur

Photos: Flank

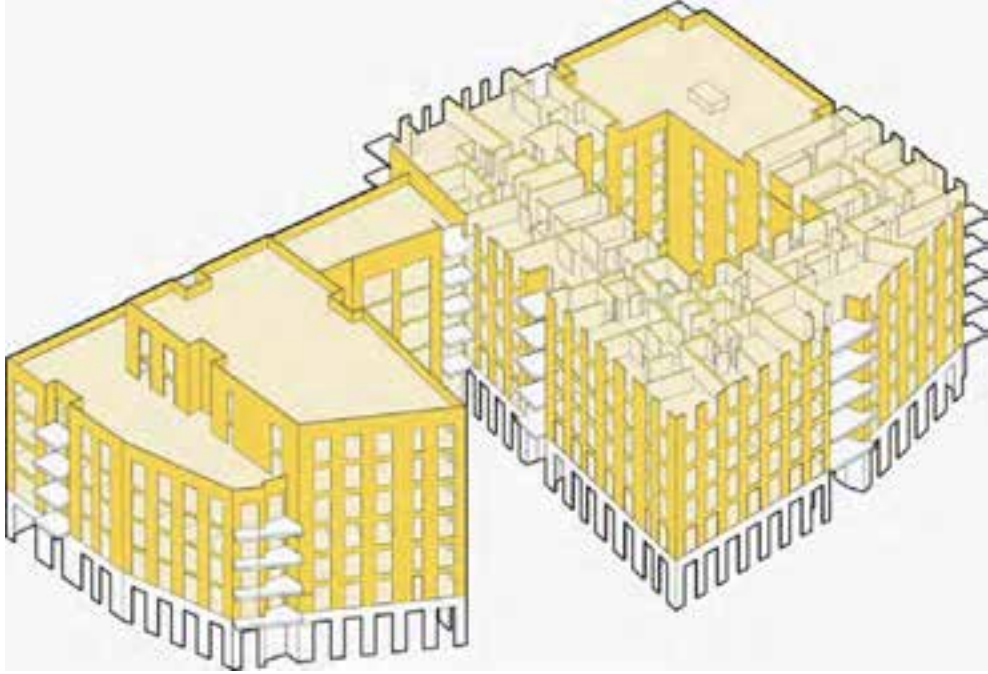
PRECEDENT PROJECTS | 360 WYTHE BROOKYLN, NY



Photos: Swinerton | DJC Orego

PRECEDENT PROJECTS | FIRST TECH CREDIT UNION HILLSBORO, OR

Photos: Michael Elkan | Naturally Wood | UB



Photos: Daniel Shearin | Waugh Thistleton Architec

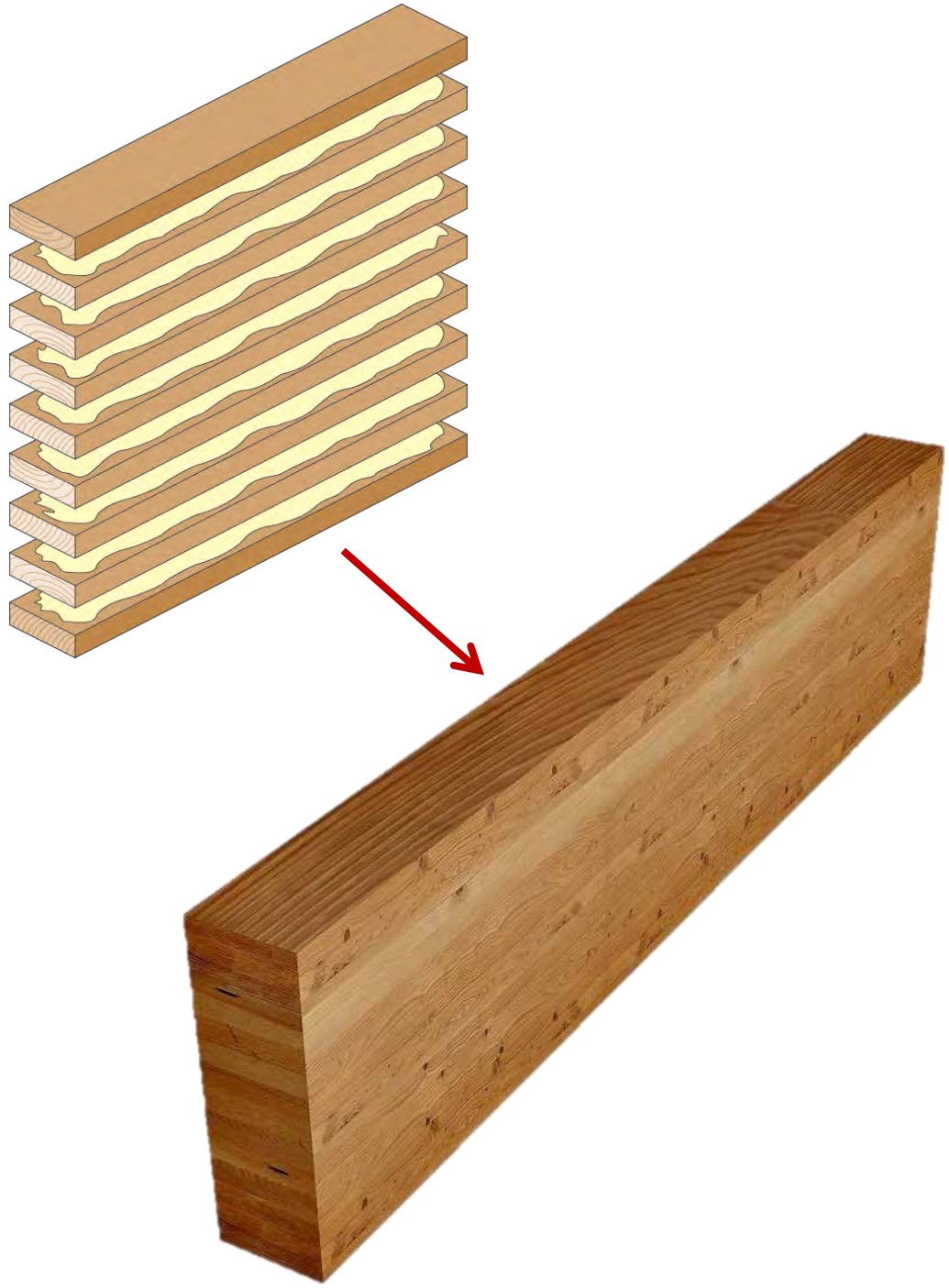
Photos: Bygg Mesteren | Voll Arkitekte

MASS TIMBER PRODUCTS

Glue Laminated Timber (GLT)

Glue Laminated Timber (GLT)

Photo: Manasc Isaac Architects/Fast + Epp



Cross-Laminated Timber (CLT)

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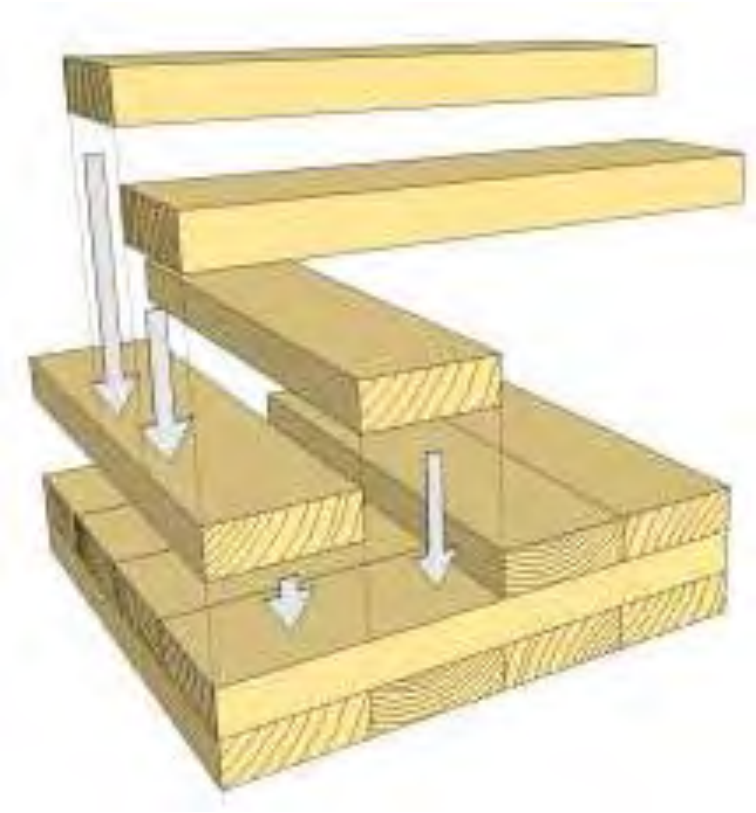
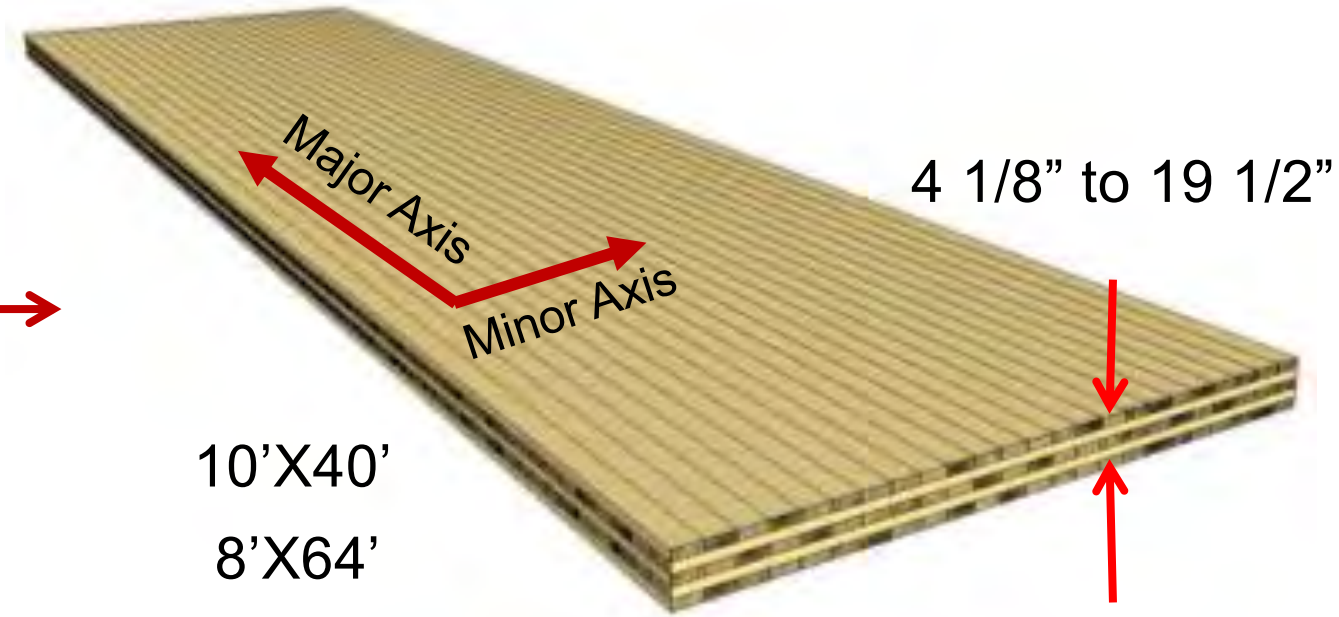




Nail-Laminated Timber (NLT)

Nail-Laminated Timber (NLT)

Photo: StructureCraft

Photo: Think Wood

Dowel-Laminated Timber (NLT)

Photo: StructureCraft

Mass Plywood Panels (MPP)

Photos: Freres Lumber

Other Mass Timber Product Options

Glue Laminated Timber
GLT

Laminated Veneer Lumber
LVL

Parallel Strand Lumber
PSL

Laminated Strand Lumber
LSL

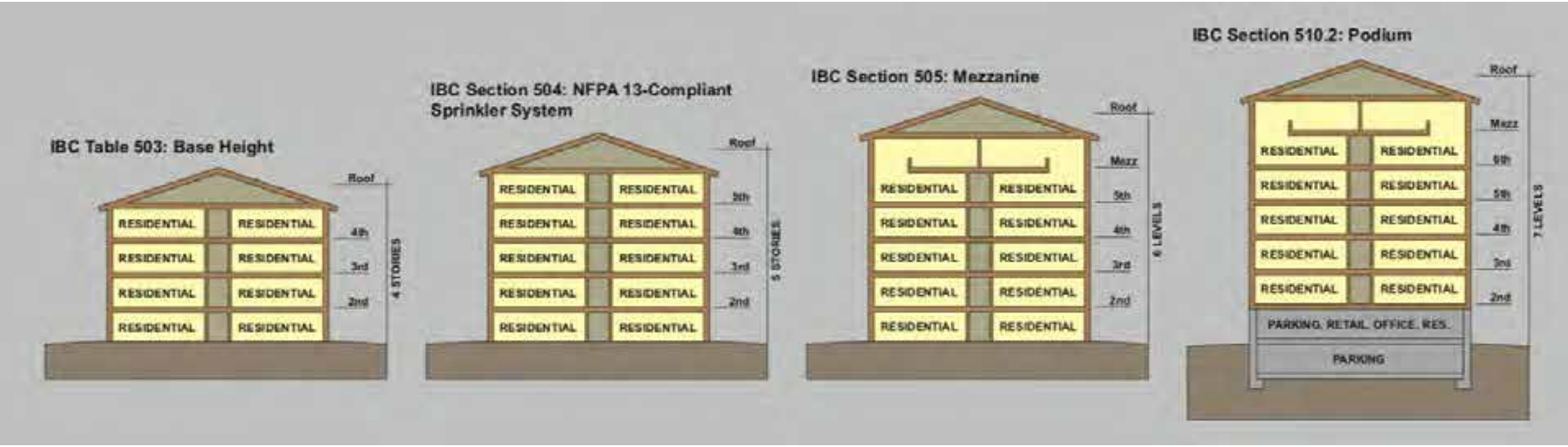
Timber-Concrete Composite
TCC

Decking

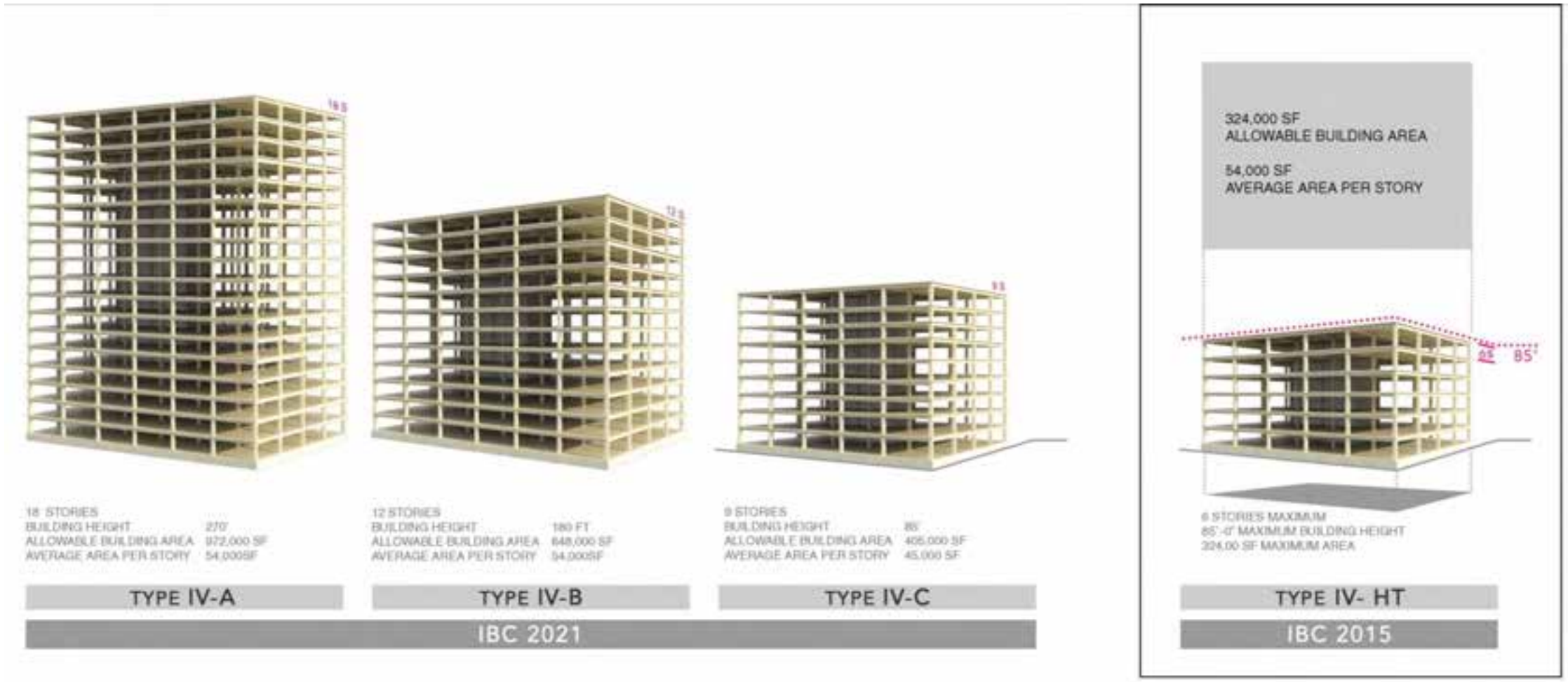
Photos: StructureCraft

MASS TIMBER IN THE CODE

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



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



Credit: Susan Jones, atelierjones

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

Scott Breneman, PhD, SE, WoodWorks – Wood Products Council • Matt Timmers, SE, John A. Martin & Associates • Dennis Richardson, PE, CBO, CASp, American Wood Council

In January 2019, the International Code Council (ICC) approved a set of proposals to allow tall wood buildings as part of the 2021 International Building Code (IBC). Based on these proposals, the 2021 IBC will include three new construction types—Type IV-A, IV-B and IV-C—allowing the use of mass timber or noncombustible materials. These new types are based on the previous Heavy Timber construction type (renamed Type IV-HT) but with additional fire-resistance ratings and levels of required noncombustible protection. The code will include provisions for up to 18 stories of Type IV-A construction for Business and Residential Occupancies.

Based on information first published in the Structural Engineers Association of California (SEAOC) 2018 Conference Proceedings, this paper summarizes the background to these proposals, technical research that supported their adoption, and resulting changes to the IBC and product-specific standards.

Background: ICC Tall Wood Building Ad Hoc Committee

Over the past 10 years, there has been a growing interest in tall buildings constructed from mass timber materials (Breneman 2013, Timmers 2015). Around the world there

Via Cenni	Milan, Italy	9	2013

WoodWorks Tall Wood Design Resource

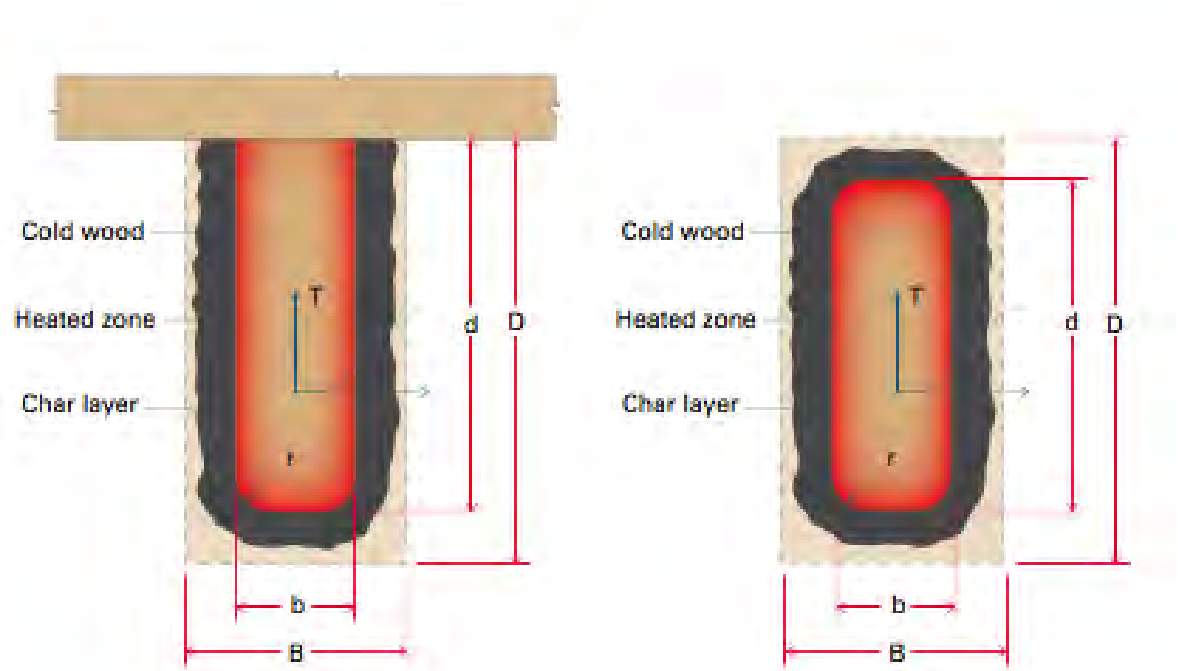
http://www.woodworks.org/wp-content/uploads/wood_solution_paper-TALL-WOOD.pdf

Mass Timber's Fire-Resistive Performance is Well-Tested, Documented and Recognized via Code Acceptance

Table 16.2.1A Char Depth and Effective Char Depth (for β_n = 1.5 in./hr.)

Required Fire Resistance (hr.)	Char Depth, a_{char} (in.)	Effective Char Depth, a_{eff} (in.)
1-Hour	1.5	1.8
1½-Hour	2.1	2.5
2-Hour	2.6	3.2

Source: AWC's NDS



Source: AWC's TR 10

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Fire-Resistive Design of Mass Timber Members

Code Applications, Construction Types and Fire Ratings

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

Today, one of the exciting trends in building design is the growing use of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction. Like heavy timber, mass timber products have inherent fire resistance that allows them to be left exposed and still achieve a fire-resistance rating. Because of their strength and dimensional stability, these products also offer a low-carbon alternative to steel, concrete, and masonry for many applications. It is this combination of exposed structure and strength that developers and designers across the country are leveraging to create innovative designs with a warm yet modern aesthetic, often for projects that go beyond traditional norms of wood design.

This paper has been written to support architects and engineers exploring the use of mass timber for commercial and multi-family construction. It focuses on how to meet fire-resistance requirements in the International Building Code (IBC), including calculation and testing-based methods. Unless otherwise noted, references refer to the 2018 IBC.

Mass Timber & Construction Type

Before demonstrating fire-resistance ratings of exposed mass timber elements, it's important to understand under what circumstances the code currently allows the use of mass timber in commercial and multi-family construction.

A building's assigned construction type is the main indicator of where and when all wood systems can be used. IBC Section 602 defines five main options (Type I through V) with all but Type IV having subcategories A and B. Types III and V permit the use of wood framing throughout much of the structure and both are used extensively for modern mass timber buildings.

Type III (IBC 602.3) – Timber elements can be used in floors, roofs and interior walls. Fire-retardant-treated wood (FRTW) framing is permitted in exterior walls with a fire-resistance rating of 2 hours or less.

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

Type IV (IBC 602.4) – Commonly referred to as "Heavy Timber" construction, this option

Mass Timber Fire Design Resource

- Code compliance options for demonstrating FRR
- Updated as new tests are completed
- Free download at woodworks.org

MASS TIMBER CONSTRUCTION MANAGEMENT

RISK ANALYSIS

ECONOMICS

LOGISTICS

THREE KEY POINTS:

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

Risk: Cost Analysis of Structure Only

$/SF

$/SF

Image: GBD Architects

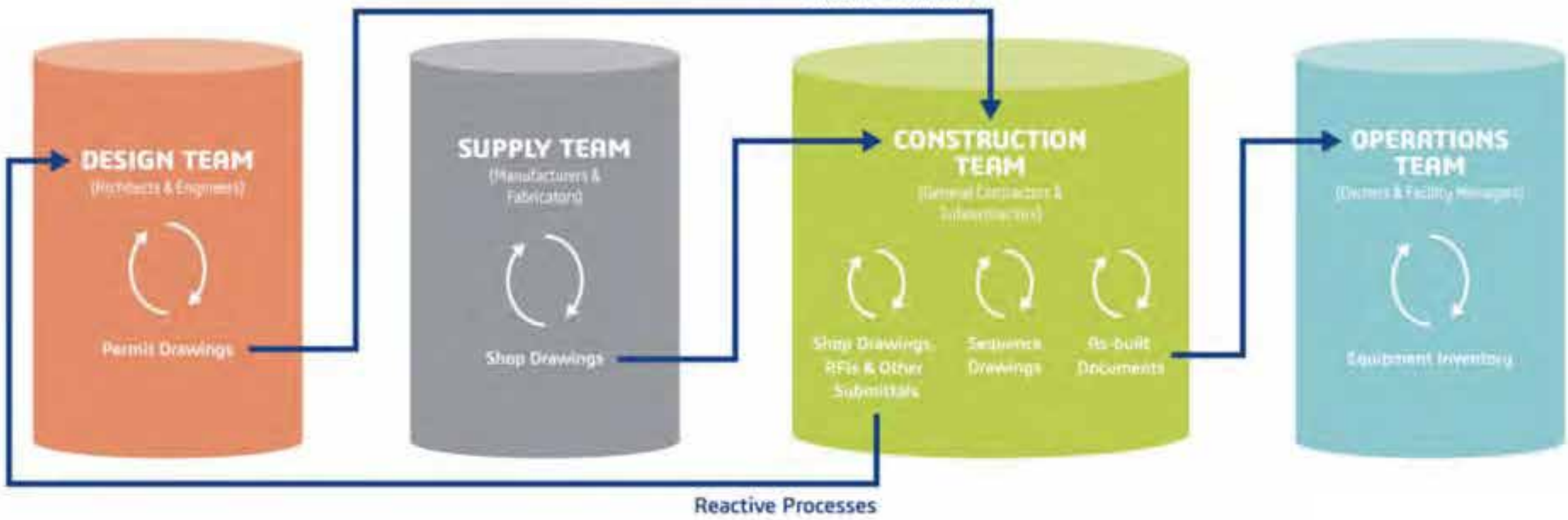
Risk Mitigation: Total Project Cost Analysis

CONSIDERATIONS:

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

Credit: Hacker Architects

Risk: Design-Bid-Build Procurement



Risk Mitigation: Trade Partner/Master Builder Approach

Procurement Strategy is Key to Success

5% Savings

Neutrality

10% Premium

Risk: Perception of a Commoditized Material

Risk Mitigation: Embrace the Prefab Advantage

Photo: Swinerton

Risk: Lack of Supply Chain Understanding

Photo: Swinerton

Risk Mitigation: Complementary Procurement

GC Hires Turnkey Mass Timber Subcontractor	GC Buys Material GC Self-Performs Install GC Coordinates	GC Buys Material GC Subcontracts Labor GC Coordinates

+ Hiring Experience Single Point of Responsibility	+ Hiring Experience Single Point of Responsibility Financial Security of strong GC	+ Potential Added Mark-Up
– Prequalified Capacity of Sub Less Potential for Mark-Up	– Lack of familiarity with supply chain Steep learning curve for coordination	– Multiple layers of coordination Prequalified Capacity of Sub

Schedule Savings for Rough-In Trades

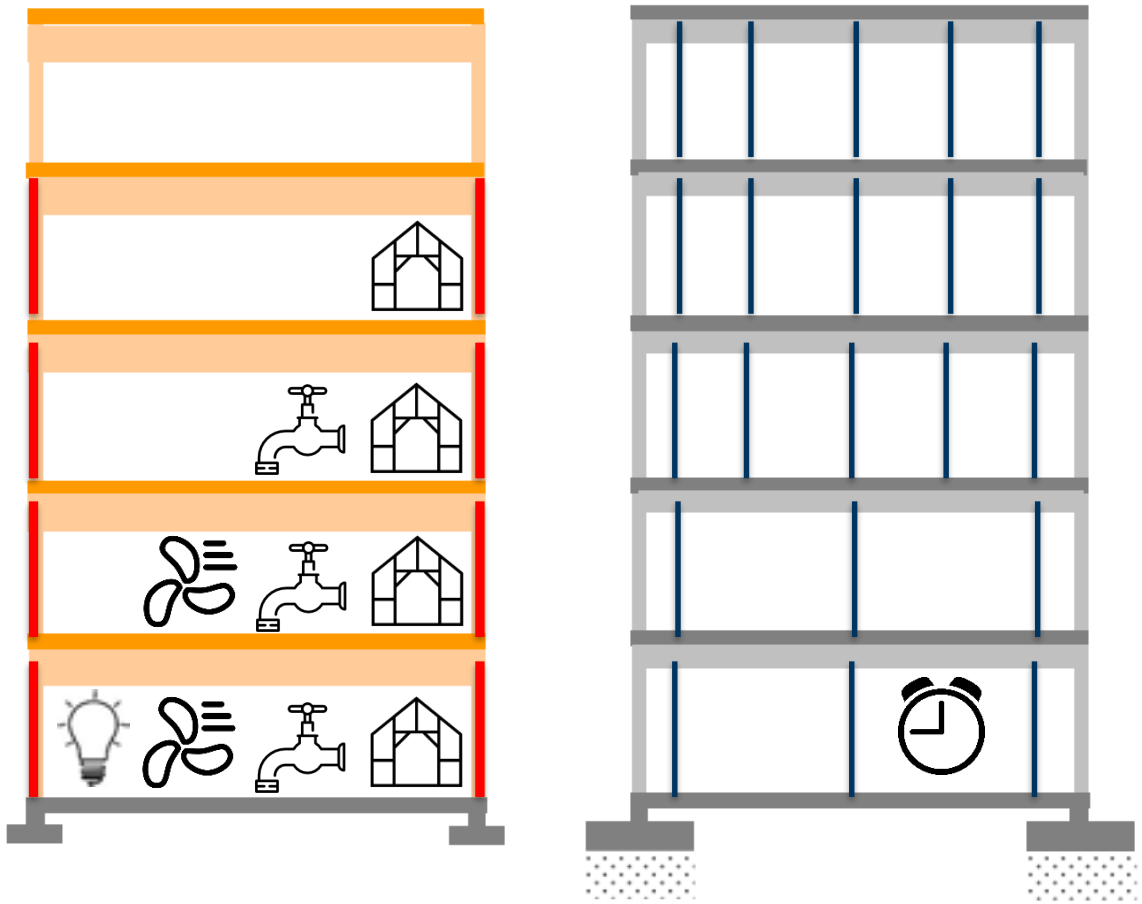
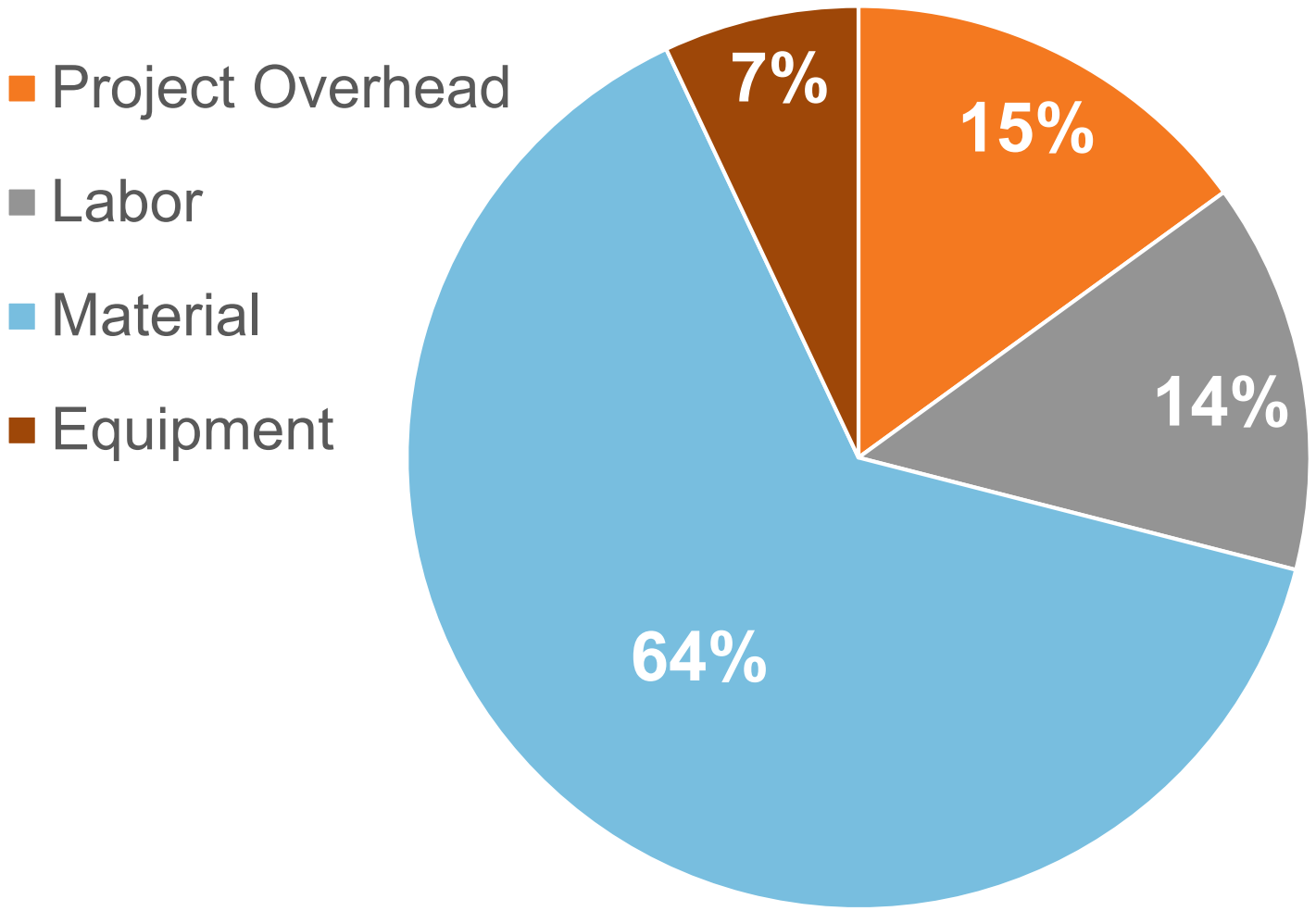


Image: Swinerton

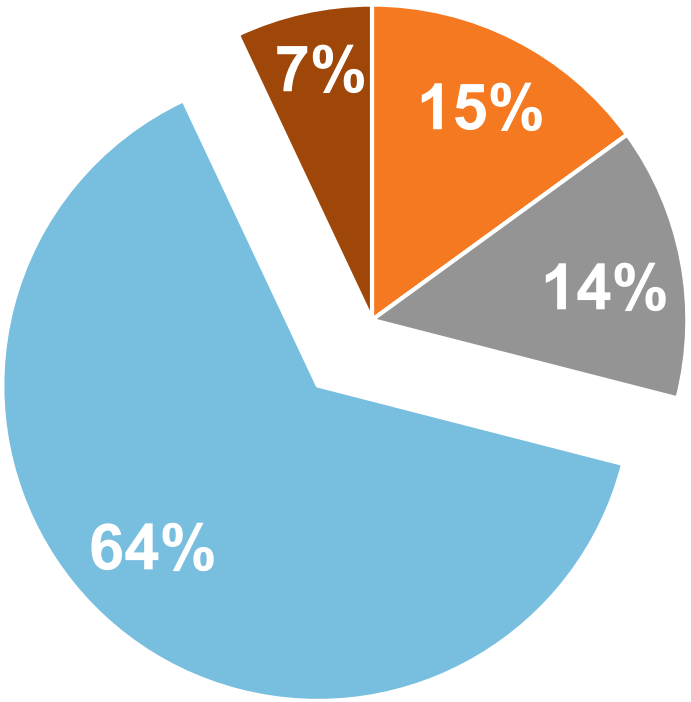
Photo: WoodWorks

Anatomy of a Turnkey Mass Timber Package



Source: Swinerton

Material (Direct Cost)

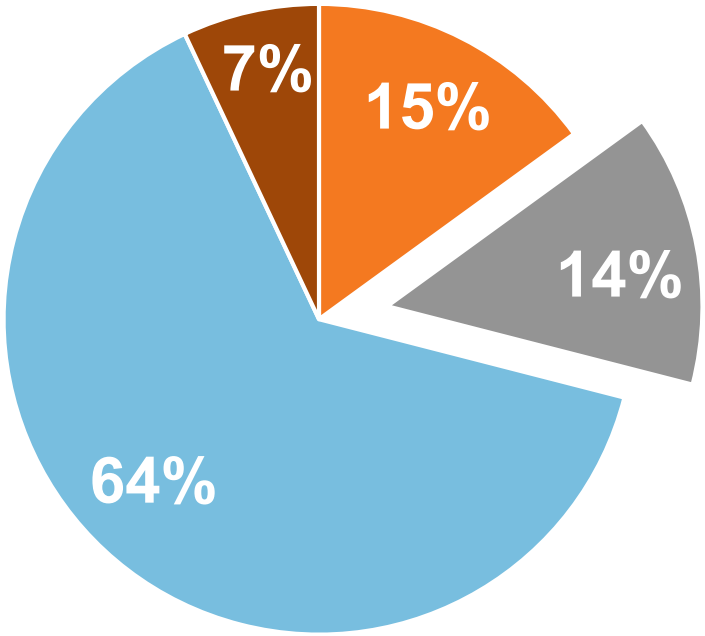


Turnkey Mass Timber Package

or

Source: Swinerton

Labor (Direct Cost)

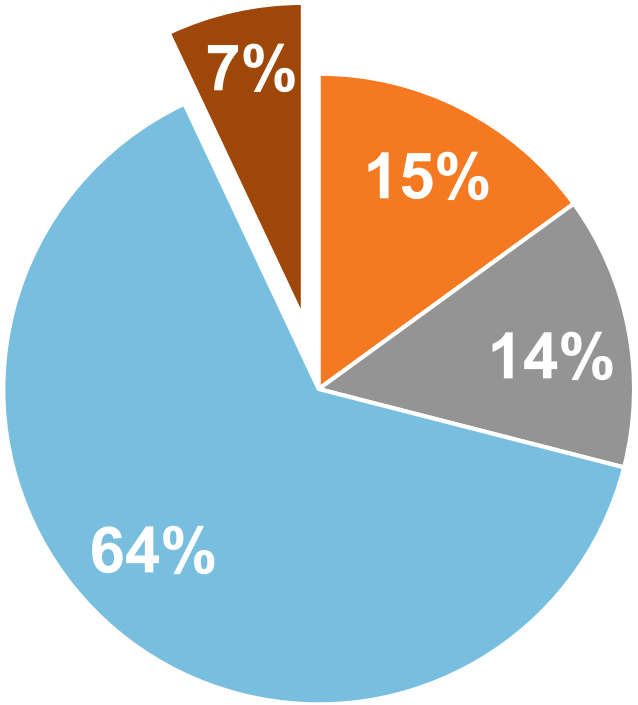


Turnkey Mass Timber Package

Photo: Swinerton

Source: Swinerton

Equipment (Direct Cost)



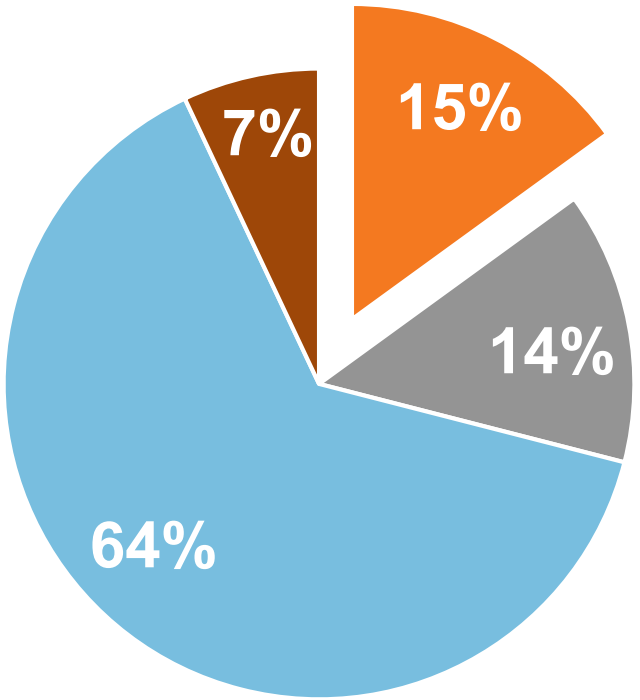
Turnkey Mass Timber Package

Photo: Swinerton

Photo: Alex Schreyer

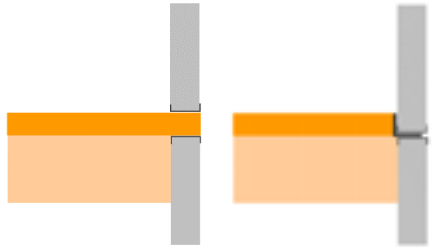
Source: Swinerton

Project Overhead



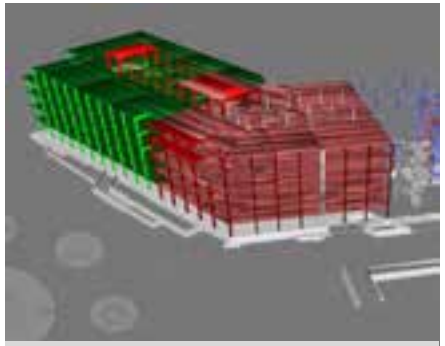
Turnkey Mass Timber Package

Cost Analysis

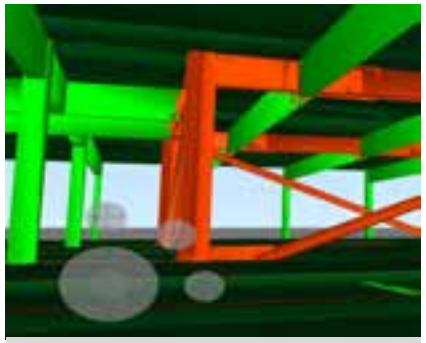


Design Refinement

System Integration



VD&C



Detail Optimization

Logistics Planning

Photos: Swinerton

Source: Swinerton

Value Analysis

$$Value = \frac{\uparrow Function \quad + \uparrow Aesthetics}{\downarrow Cost}$$


Photo: RMW Architecture & Interiors

Value Analysis

$$Value\ Engineering = \frac{\downarrow Function\ + \downarrow Aesthetics}{\downarrow Cost}$$

Value: Program

Level 1

Level 2

Concept Plan

Hillsboro Community Center at 53rd Ave.

May 03, 2018

opsis

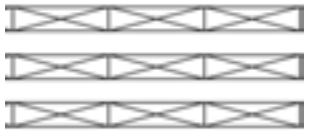
Cost: Construction Type

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

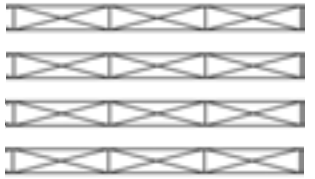
Building Element	I-A	I-B	III-A	III-B	IV-A	IV-B	IV-C	IV-HT	V-A	V-B
Primary Structural Frame	3*	2*	1	0	3*	2	2	HT	1	0
Ext. Bearing Walls	3*	2*	2	2	3*	2	2	2	1	0
Int. Bearing Walls	3*	2*	1	0	3*	2	2	1/HT	1	0
Floor Construction	2	2*	1	0	2	2	2	HT	1	0
Roof Construction	1.5*	1*	1	0	1.5	1	1	HT	1	0
Exposed Mass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

Baseline
0hr & HT

+$10/SF
1hr & maybe 2hr



+$12-15/SF
2hr FRR



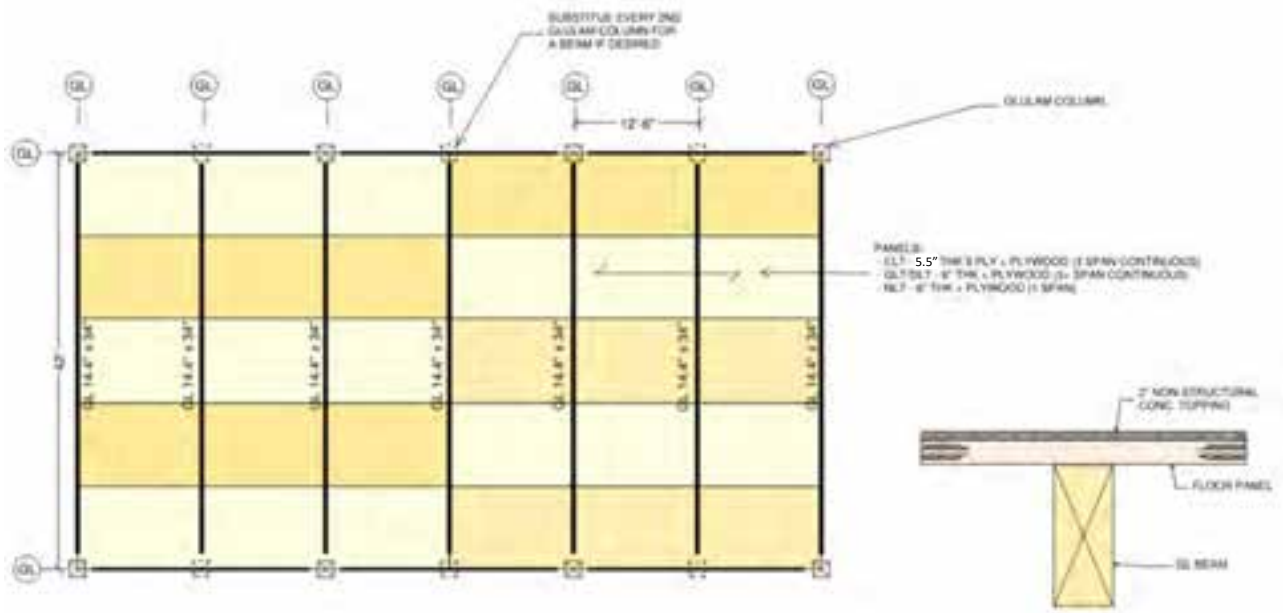
Cost Source: Swinerton

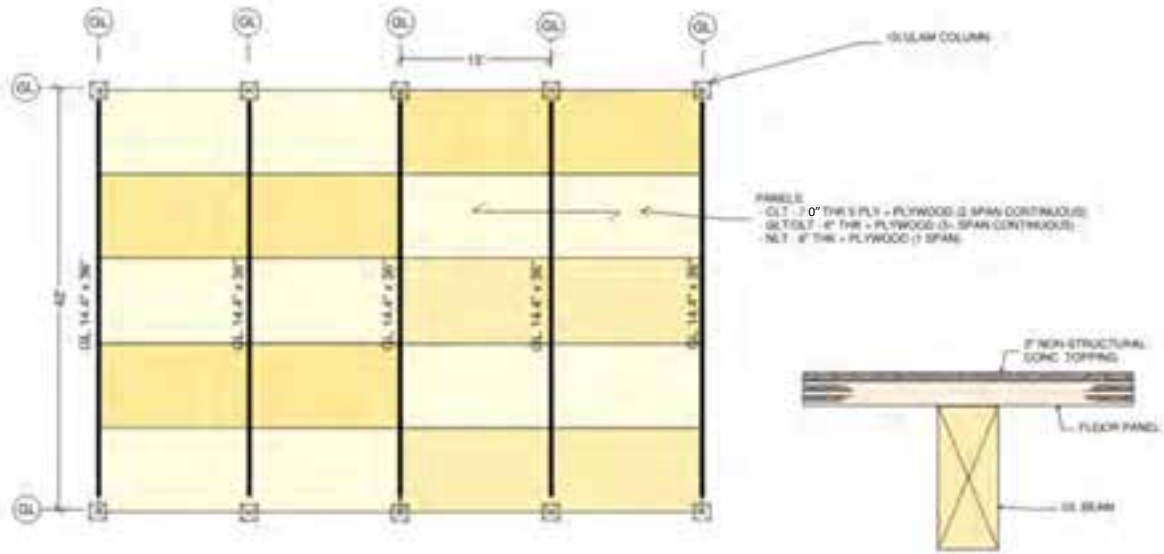
*These values can be reduced based on certain conditions in IBC 403.2.1, which do not apply to Type IV buildings.

Value: Open Floor Plan

Photo: Swinerton

Cost: Structural System & Grid





Baseline

12’-6” Glulam Spacing

5.5” CLT

$ +5%

15’ Glulam Spacing

7” CLT

Source: Seattle Mass Timber Tower Book

Value: Perimeter Glazing

Photos: Mark Bitterman

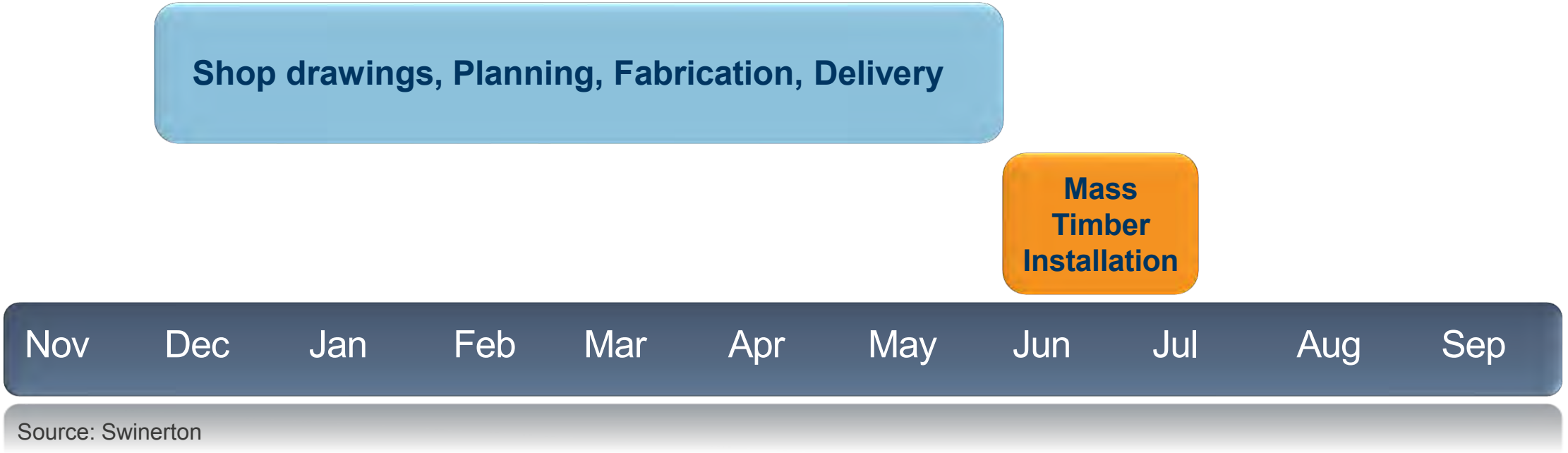
Tolerances: Interface with Other Structural Materials

Photos: Swinerton

SCHEDULE

Photo: Swinerton

Procurement Logic for Scheduling



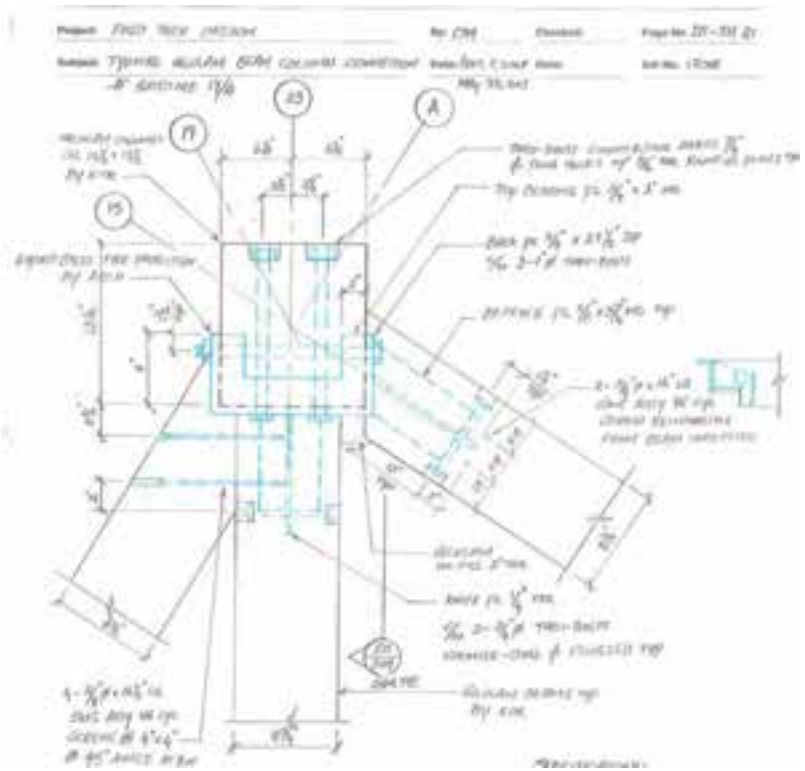
Source: Swinerton

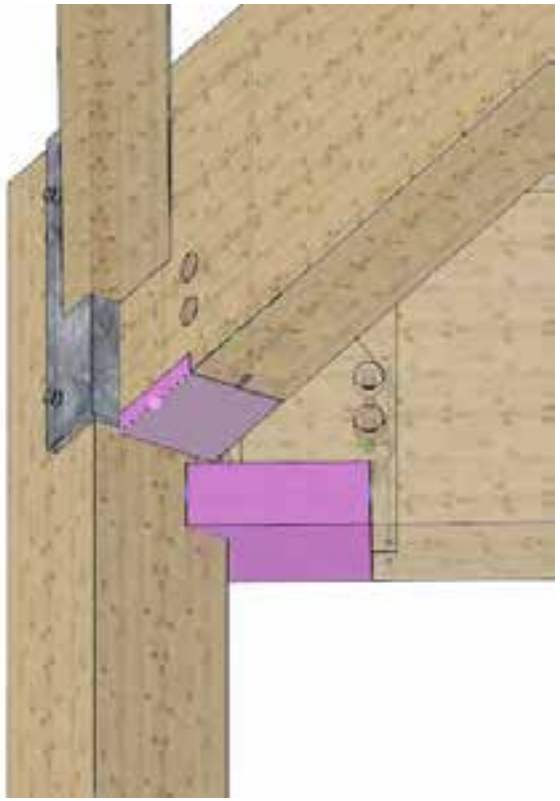
Example 6 Story Type IIIA Project

What are the schedule drivers on a mass timber project?

Photo: Lendlease

Schedule Impacts: Translating 2D to 3D



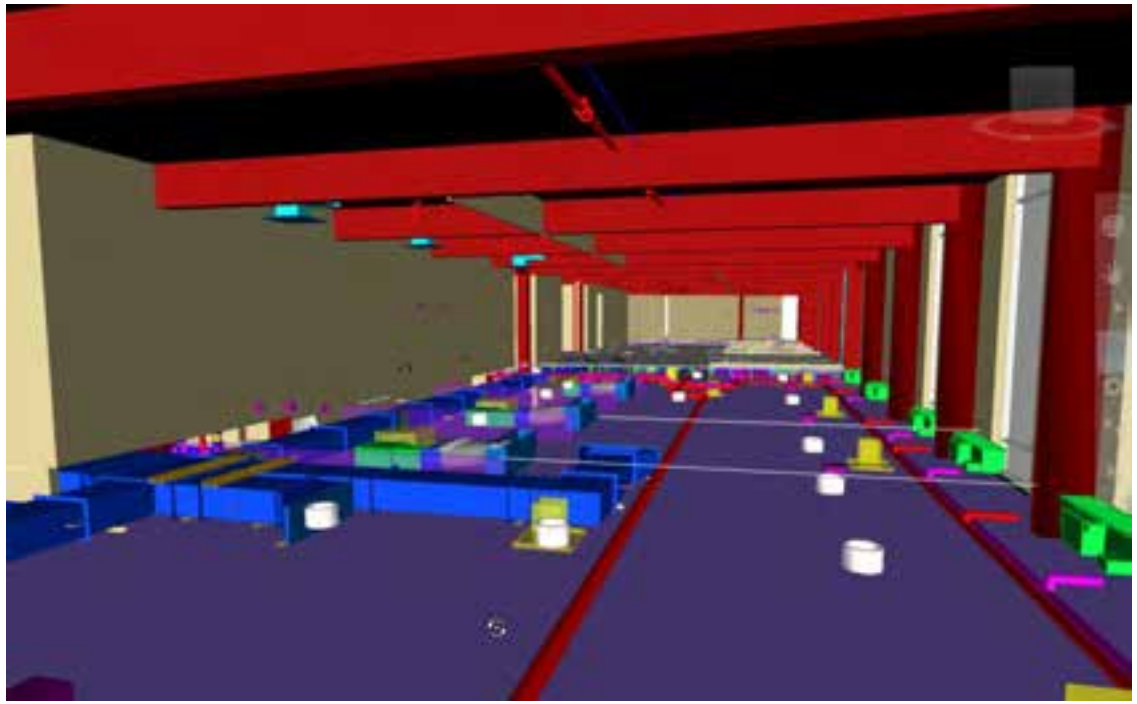


Photos: Swinerton

Schedule Impacts: Hybrid Structures

Photos: Swinerton

Embracing BIM for Fabrication



Photos: Swinerton

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

Photo: StructureCraft Builders

Overall Project Cost Analysis: 12 Story Type IV-B

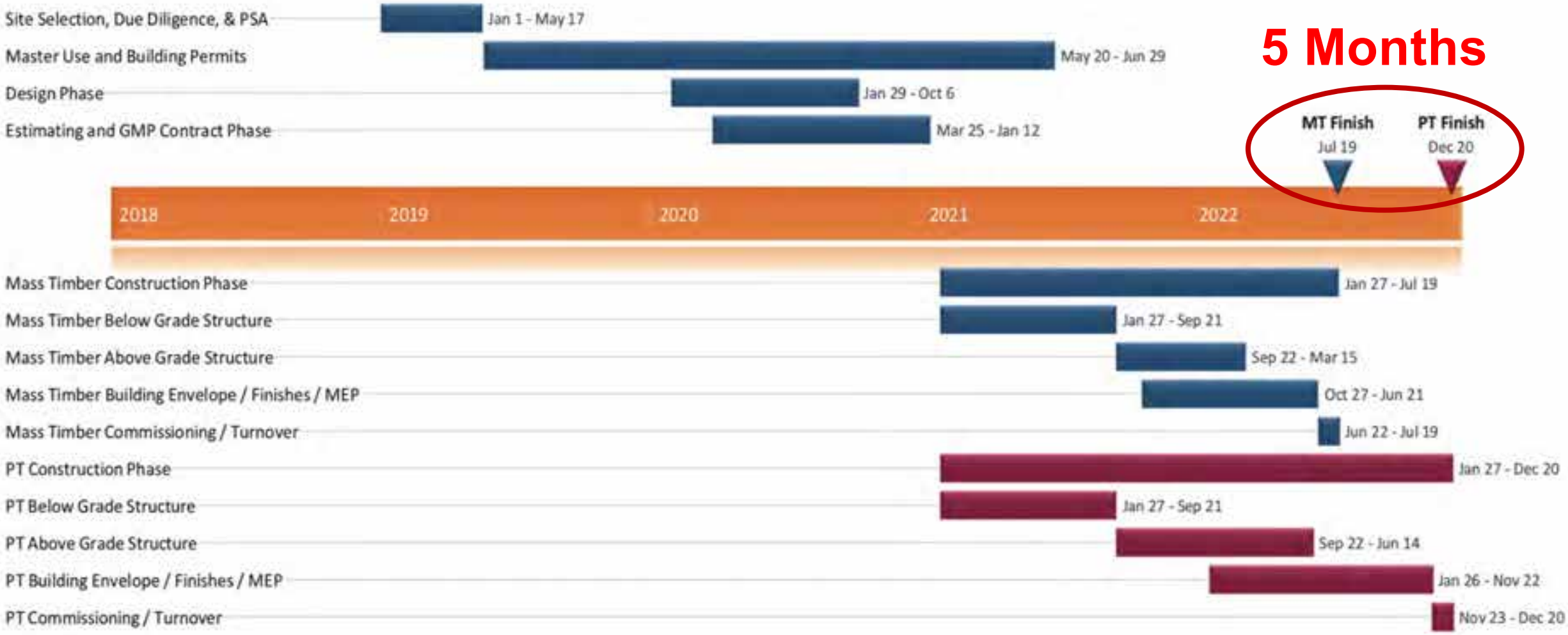
	MASS TIMBER	PT CONCRETE	MASS TIMBER SAVINGS VS. PT CONCRETE (%) *
DIRECT COST OF WORK	86,997,136	85,105,091	2.2%
PROJECT OVERHEAD	9,393,750	11,768,750	-20.2%
ADD-ONS	8,387,345	8,429,368	-0.5%
Total	*104,778,231*	*105,303,209*	*-0.5%*

Source: Swinerton

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

Credit: DLR Group | Fast + Epp | Swinerton

Overall Project Schedule Analysis: 12 Story Type IV-B



Source: Swinerton

Schedule Impact on Cost | Value of Time

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

Source: Swinerton
Photo: Alex Schreyer

Early Move-In for Rough-In Trades.

Photos: Swinerton

Holistic Schedule Analysis

Shorter Schedule = Lower General Conditions Costs

Photo: Swinerton

SITE PLANNING

Photo: Swinerton

QA/QC

Photo: Swinerton

PICK PLAN

Photo: Swinerton

LOGISTICS PLANNING

Photo: Swinerton

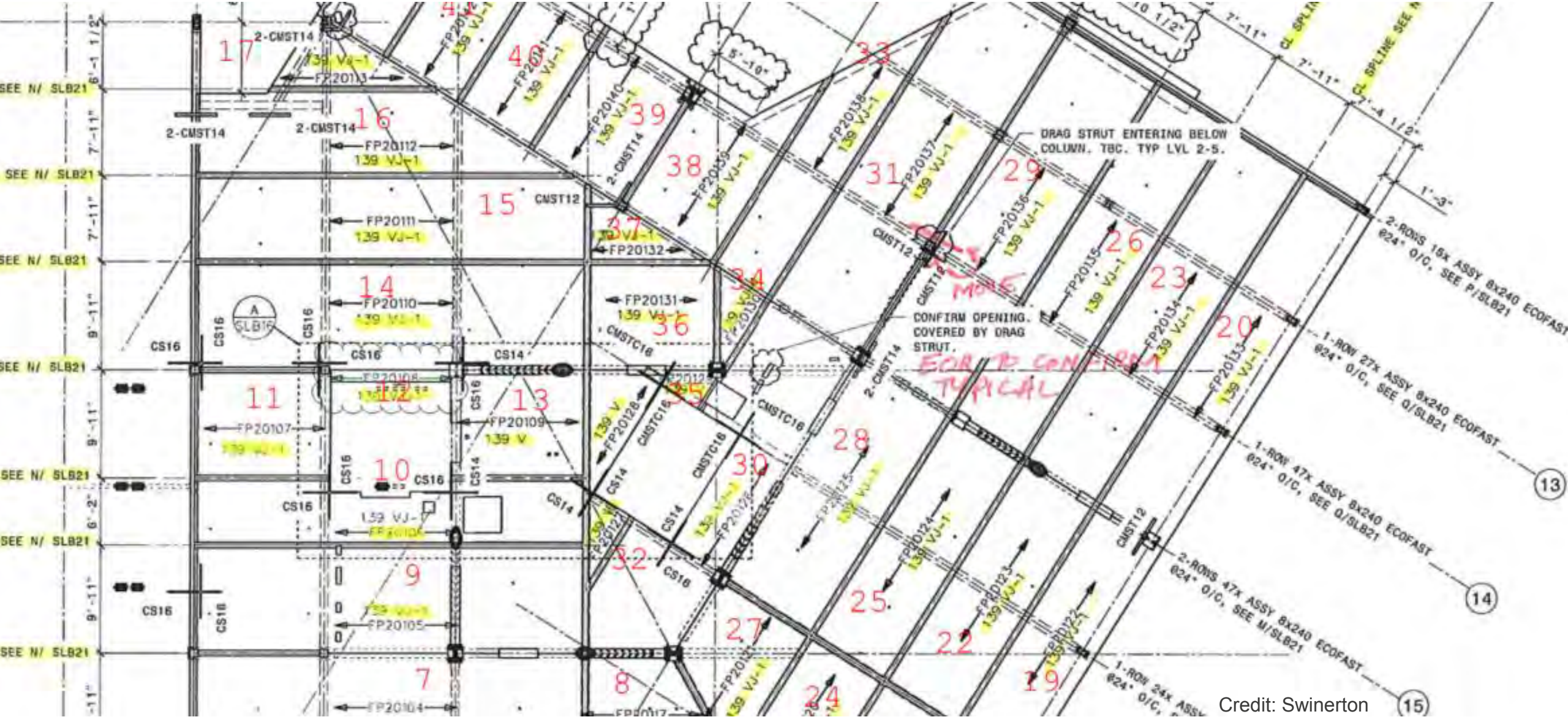
MATERIAL DELIVERY

Photo: Swinerton

SITE ORGANIZATION & STAGING

Photo: Swinerton

Sequencing



Credit: Swinerton

Photo: Swinerton

Material Protection

Painting steel

Taping joints

Protect end cuts of timber

Photo: Alex Schreyer

MASS TIMBER | TRAINING THE WORKFORCE

This concludes The American Institute of Architects Continuing Education Systems Course

Bruce Lindsey
phone: (704) 877- 6255
bruce@woodworks.org

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Designing a wood building? Ask us anything.

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FREE PROJECT SUPPORT | EDUCATION | RESOURCES

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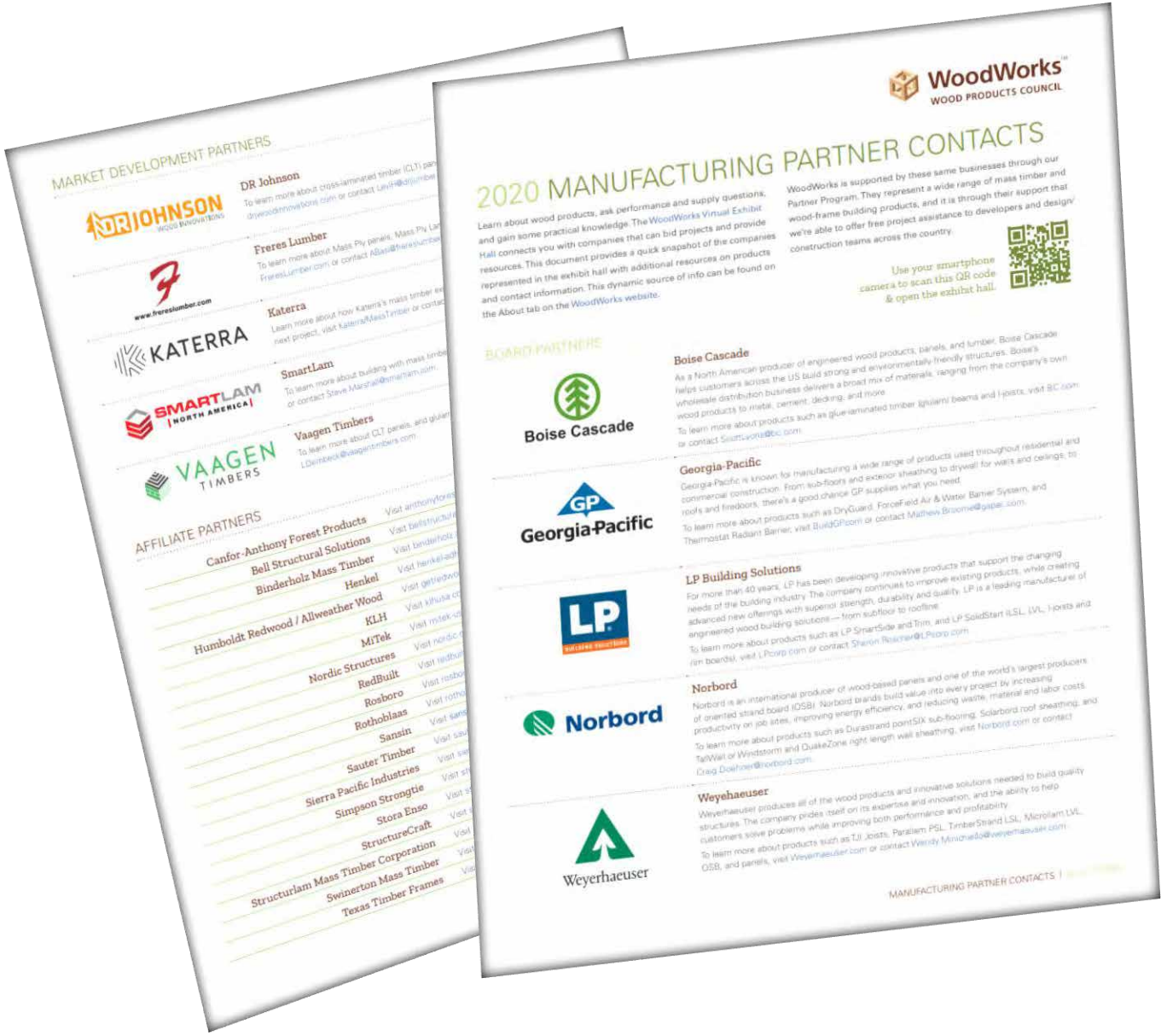

Mass Timber Construction Manual

(release scheduled for late 2020)

- Educational content aimed at the General Contractor and Developer to better understand, estimate, and construct profitably with mass timber.

Advancing Mass Timber Construction 2020

September 29th and 30th, 2020

- WoodWorks has partnered with Hanson-Wade to a provide a digital conference covering all aspects of mass timber buildings.
- Join dozens of building owners, designers, contractors, and timber manufacturers with a shared interest in innovative wood systems.
- Learn about best practices for every stage of the project lifecycle, from improving buy-in, through optimizing design, manufacture and installation to build faster, on budget and to scope every time.

For more information or to register, visit
Woodworks.org

Questions?

Bruce Lindsey
phone: (704) 877- 6255
bruce@woodworks.org

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