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WOOD PRODUCTS COUNCIL

Mass Timber Construction Management:
Economics, Logistics & Risk Analysis

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WoodWorks Regional Director


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 (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo: Freres Lumber

Photo: StructureCraft

Photo: LendLease

Photo: LEVER Architecture

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Nail-Laminated Timber (NLT)

Photo: Think Wood

Glue-Laminated Timber (GLT)

Photo: StructureCraft

Photo: StructureCraft

Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

Photo: Ema Peter

STRUCTURAL SOLUTIONS | POST, BEAM + PLATE

Photo: Seagate Structures

Photo: Lendlease


Photo: John Klein

FRAMING OPTIONS | HYBRID STEEL + 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

CURRENT STATE OF MASS TIMBER PROJECTS

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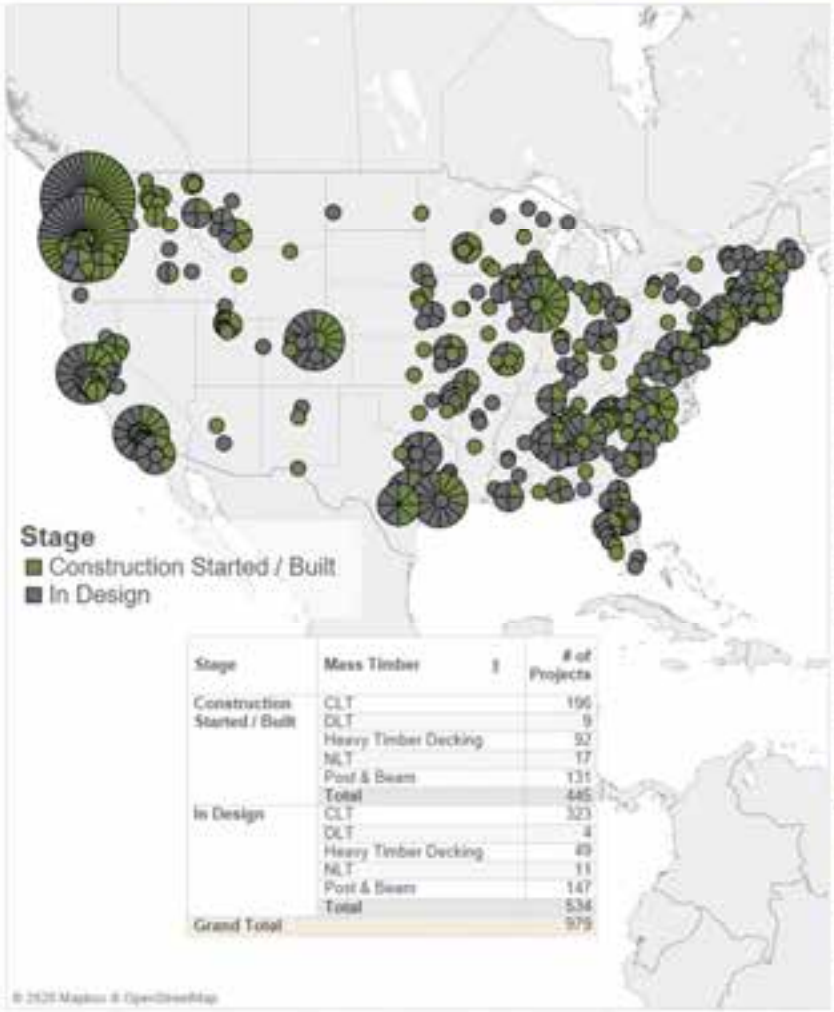
Mass Timber Projects In Design and Constructed in the US (September 2020)



Stage	Mass Timber	# of Projects
Construction Started / Built	CLT	196
	DLT	9
	Heavy Timber Decking	92
	NLT	17
	Post & Beam	131
	Total	445
In Design	CLT	323
	DLT	4
	Heavy Timber Decking	49
	NLT	11
	Post & Beam	147
	Total	534
Grand Total		979

State	Stage	
AK	In Design	2
AL	Construction Started / Built	5
	In Design	13
AR	Construction Started / Built	6
	In Design	7
AZ	Construction Started / Built	1
	In Design	1
CA	Construction Started / Built	57
	In Design	90
CO	Construction Started / Built	17
	In Design	20
CT	Construction Started / Built	6
	In Design	4
DC	Construction Started / Built	4
	In Design	6
DE	In Design	2
FL	Construction Started / Built	13
	In Design	29
GA	Construction Started / Built	9
	In Design	18
HI	Construction Started / Built	2
	In Design	1
IA	Construction Started / Built	3
	In Design	4
ID	Construction Started / Built	5
	In Design	5
IL	Construction Started / Built	11
	In Design	13
IN	Construction Started / Built	3
	In Design	1
KS	Construction Started / Built	2
	In Design	3
KY	Construction Started / Built	2
	In Design	4
LA	Construction Started / Built	1
	In Design	4
MA	Construction Started / Built	21
	In Design	31
MD	Construction Started / Built	3
	In Design	5
ME	Construction Started / Built	4
	In Design	13
MI	Construction Started / Built	2
	In Design	8
MN	Construction Started / Built	8
	In Design	2
MO	Construction Started / Built	7
	In Design	9

State	Stage	
MS	In Design	4
MT	Construction Started / Built	8
	In Design	7
NC	Construction Started / Built	19
	In Design	25
ND	In Design	1
NE	Construction Started / Built	3
	In Design	4
NH	Construction Started / Built	1
	In Design	2
NJ	Construction Started / Built	1
	In Design	7
NM	Construction Started / Built	1
	In Design	1
NV	In Design	1
NY	Construction Started / Built	9
	In Design	26
OH	Construction Started / Built	6
	In Design	9
OK	Construction Started / Built	2
	In Design	1
OR	Construction Started / Built	49
	In Design	16
PA	Construction Started / Built	5
	In Design	3
RI	Construction Started / Built	2
	In Design	2
SC	Construction Started / Built	14
	In Design	8
TN	Construction Started / Built	4
	In Design	3
TX	Construction Started / Built	26
	In Design	40
UT	Construction Started / Built	5
	In Design	8
VA	Construction Started / Built	7
	In Design	8
VT	Construction Started / Built	2
	In Design	9
WA	Construction Started / Built	59
	In Design	43
WI	Construction Started / Built	19
	In Design	10
WV	Construction Started / Built	2
WY	Construction Started / Built	2

Considering mass timber for a project?
Ask us anything.

For free project support, contact:
help@woodworks.org
woodworks.org/project-assistance

Check out our Interactive project map at Woodworks.org;
"Publications & Media Tab";
"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

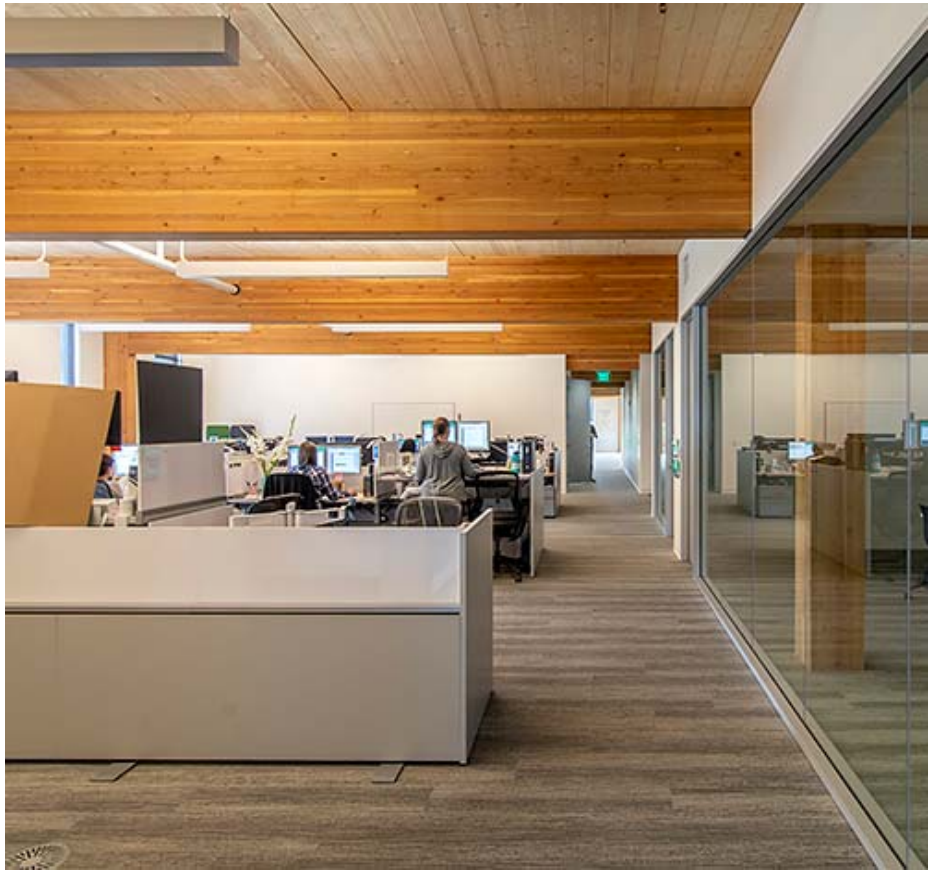
Photo: Corey Gaffer courtesy Perkins + Will

Photos: StructureCraft

Photo: Hartshorne Plunkard Architecture

Photos: Flank

PRECEDENT PROJECTS | 360 WYTHE BROOKYLN, NY



Photos: Swinerton | DJC Oregon

PRECEDENT PROJECTS | FIRST TECH CREDIT UNION HILLSBORO, OR

Photos: Michael Elkan | Naturally Wood | UBC

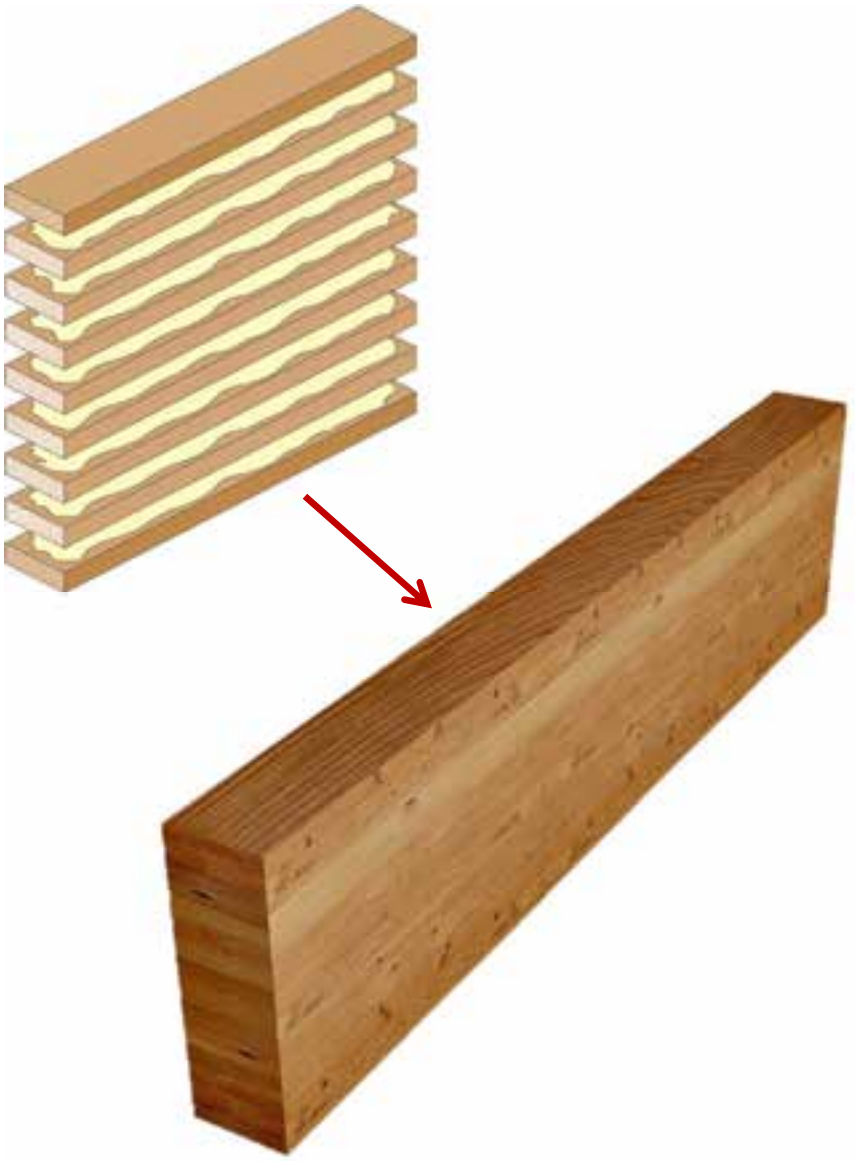
Photos: Bygg Mesteren | Voll Arkitekter

MASS TIMBER PRODUCTS

Glue Laminated Timber (GLT)

Glue Laminated Timber (GLT)

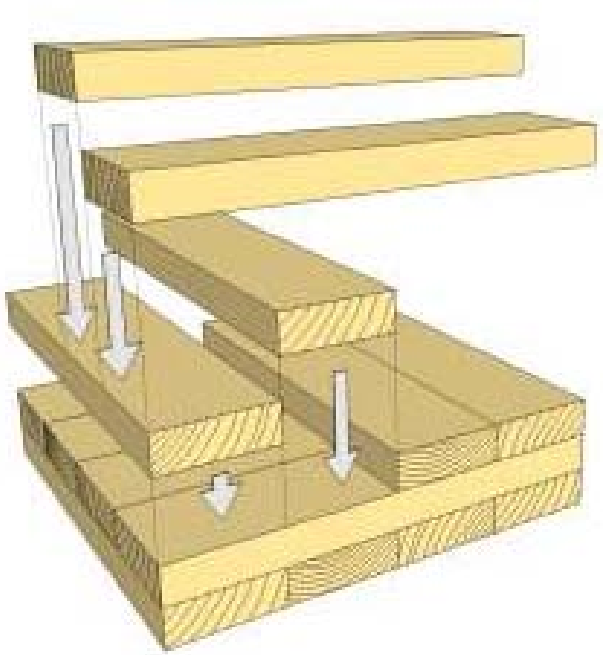
Photo: Manasc Isaac Architects/Fast + Epp

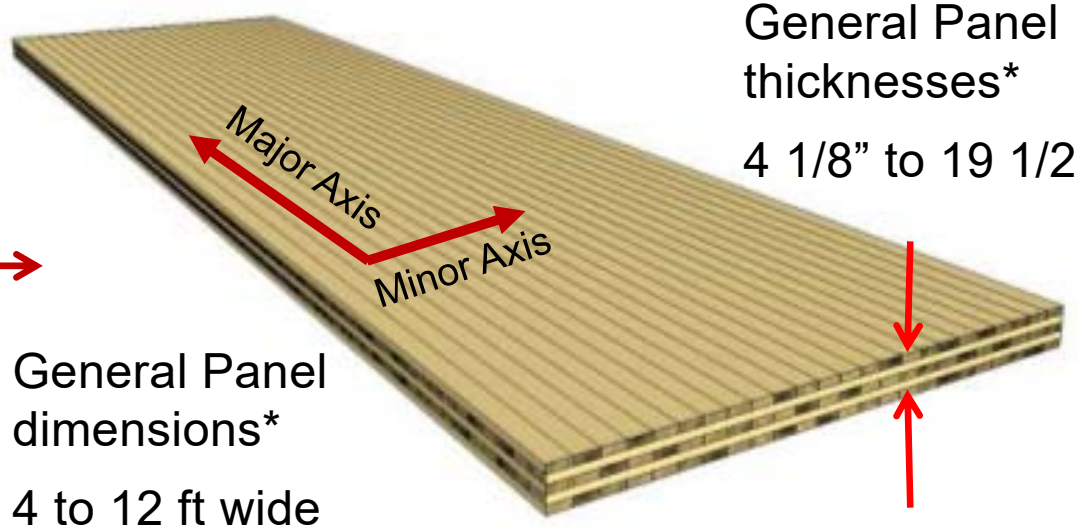


Cross-Laminated Timber (CLT) - Solid sawn laminations

Cross-Laminated Timber (CLT)

With solid sawn laminations





General Panel thicknesses*

4 1/8” to 19 1/2”

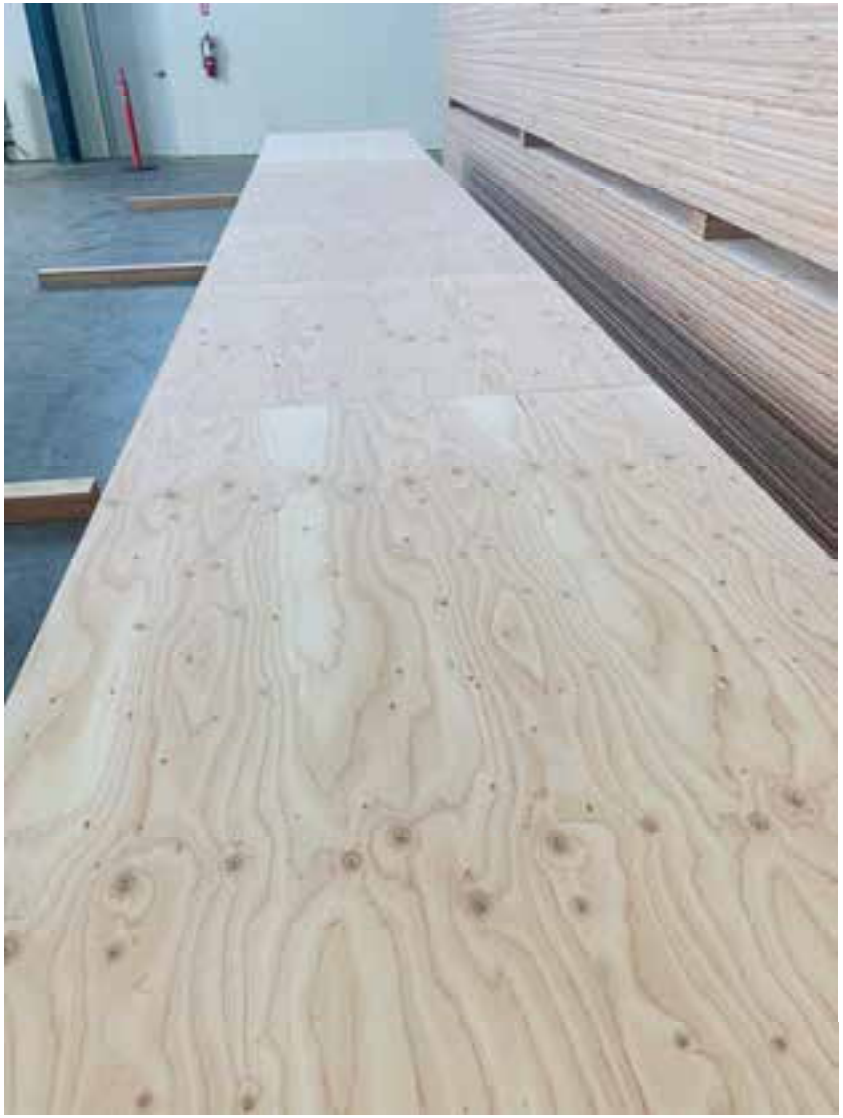
General Panel dimensions*

4 to 12 ft wide

24 to 64 ft long

*Consult with manufacturers for available panel sizes

Cross-Laminated Timber (CLT) - with SCL laminations



Photos: Freres Lumber

Nail-Laminated Timber (NLT)

Photo: StructureCraft

Nail-Laminated Timber (NLT)

Photo: StructureCraft

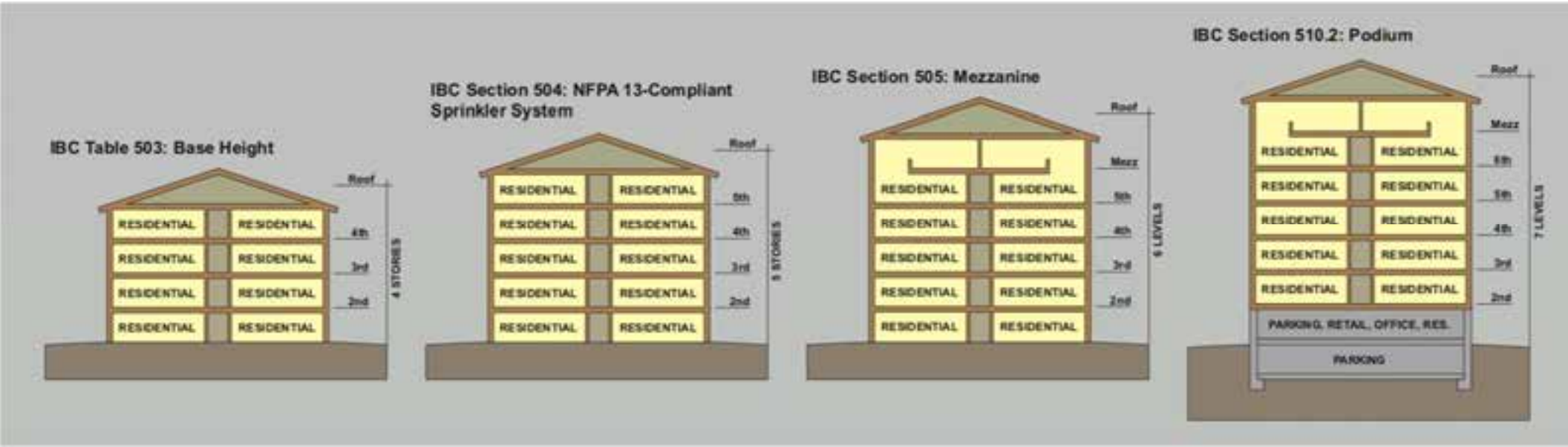
Photo: Think Wood

Dowel-Laminated Timber (DLT)

Photo: 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

MASS TIMBER CONSTRUCTION MANAGEMENT

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

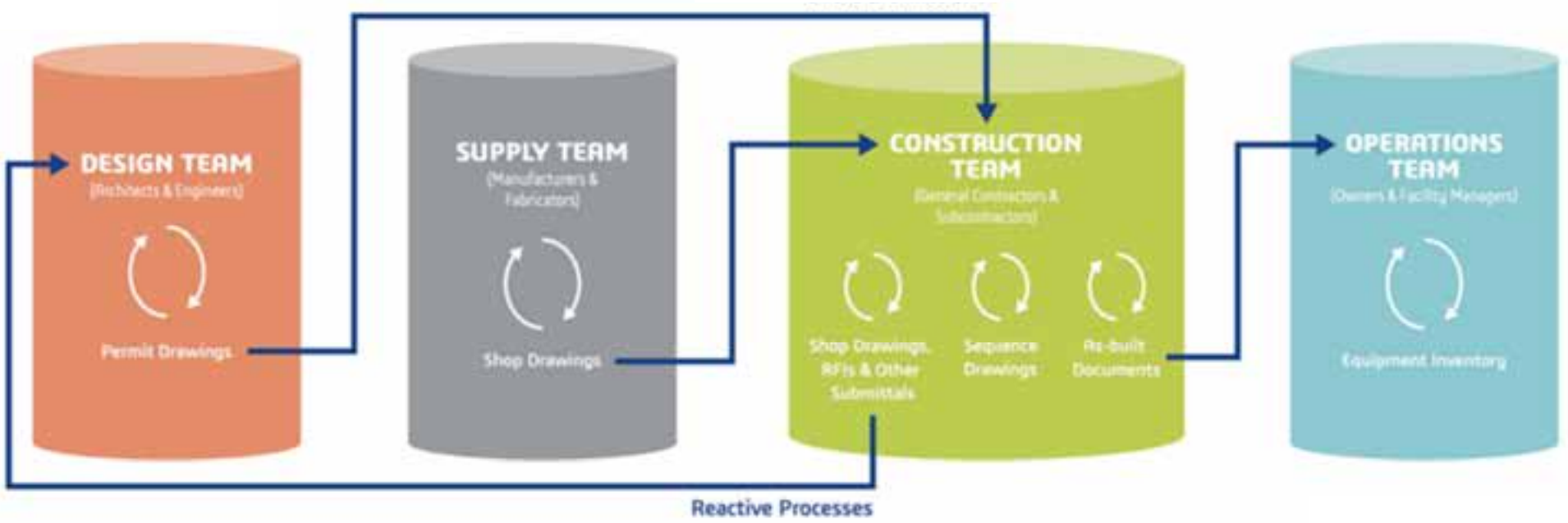
Risk Mitigation: Total Project Cost Analysis

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

Risk Mitigation: Complementary Procurement

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

RISK SPECTRUM

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

Schedule Savings for Rough-In Trades

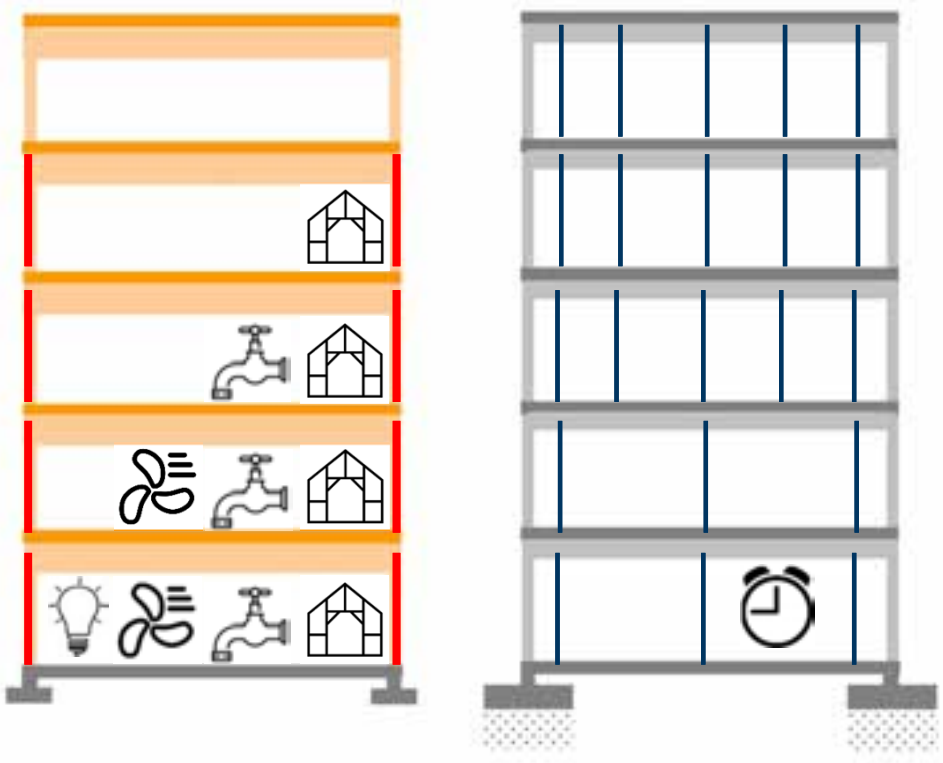
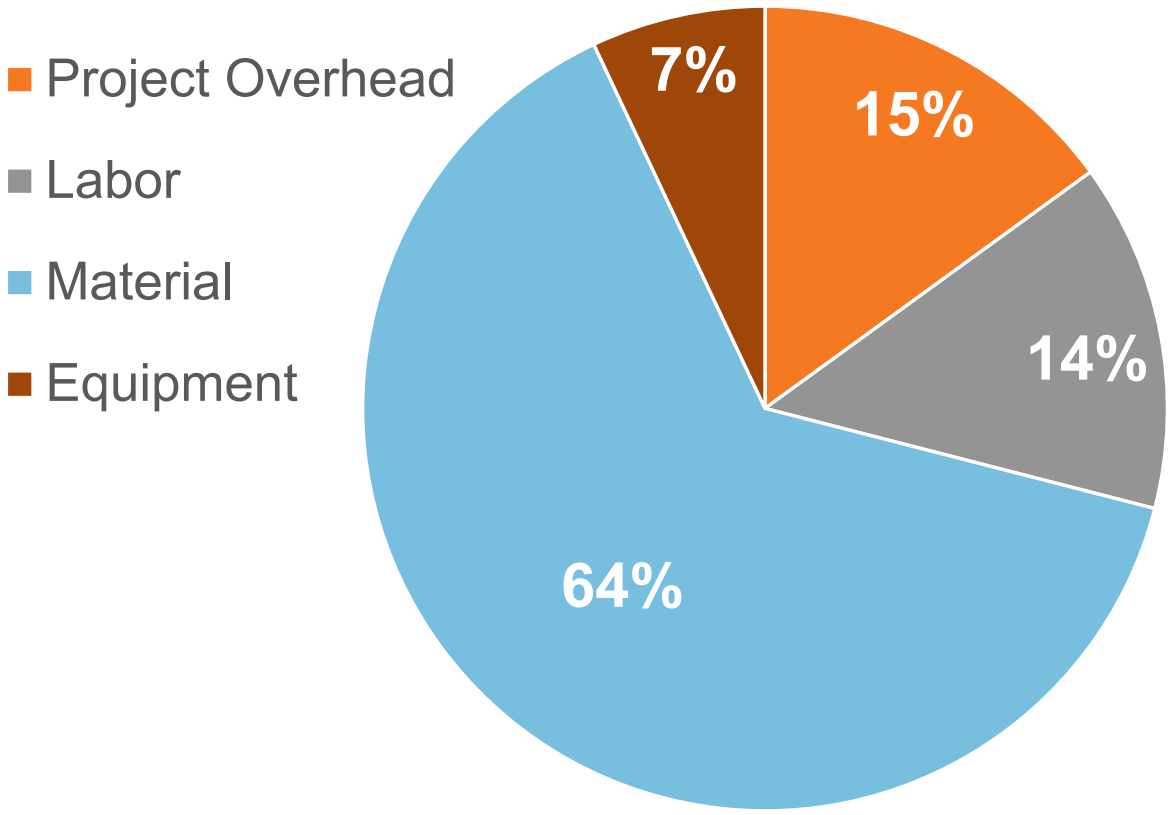


Image: Swinerton

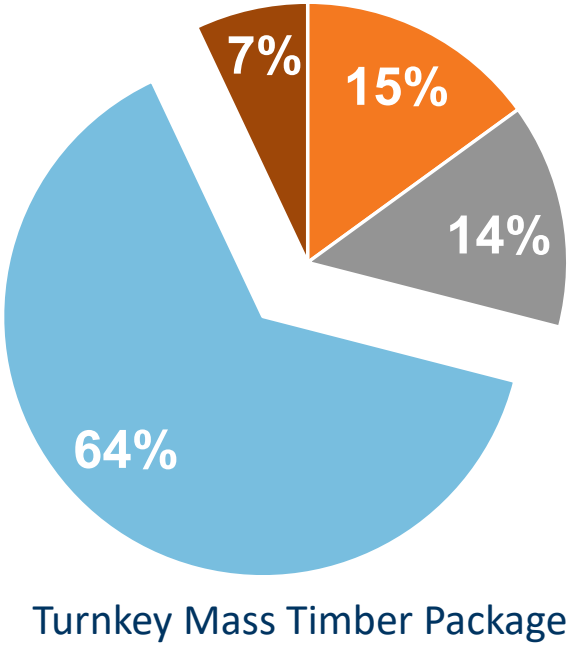
Photo: WoodWorks

Anatomy of a Turnkey Mass Timber Package



Source: Swinerton

Material (Direct Cost)

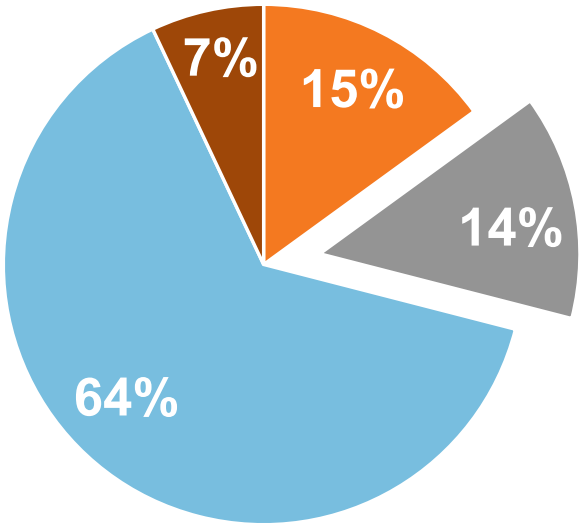


Turnkey Mass Timber Package

or

Source: Swinerton

Labor (Direct Cost)

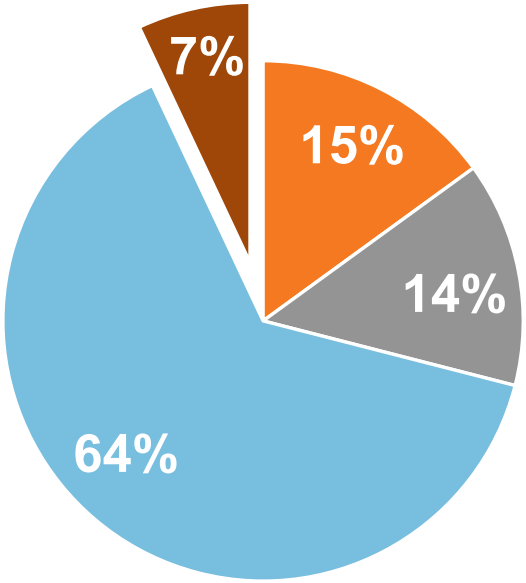


Turnkey Mass Timber Package

Photo: Swinerton

Source: Swinerton

Equipment (Direct Cost)



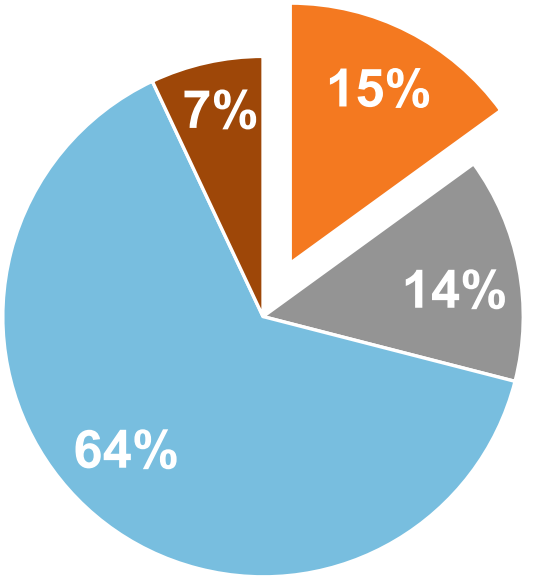
Turnkey Mass Timber Package

Source: Swinerton

Photo: Swinerton

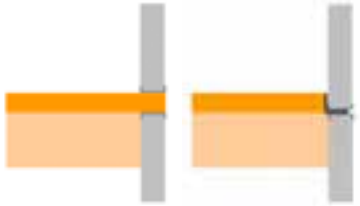
Photo: Alex Schreyer

Project Overhead



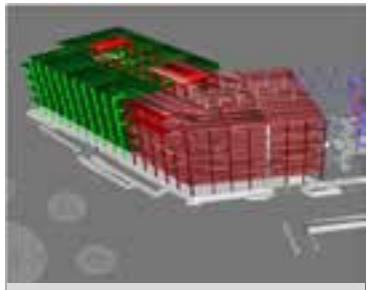
Turnkey Mass Timber Package

Cost Analysis

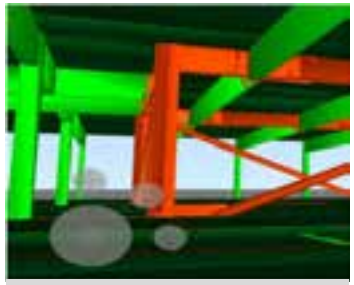


Design Refinement

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

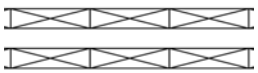
$$Value\ Engineering = \frac{\downarrow Function\ + \downarrow Aesthetics}{\downarrow Cost}$$

Cost: Construction Type

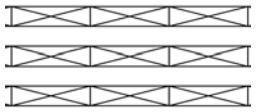
TABLE 601
Fire Resistance Rating Requirements for Building Elements (Hours)

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		

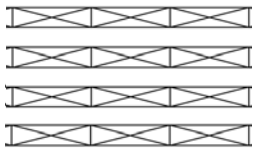
Baseline
0hr & HT



+$10/SF
1hr & maybe 2hr



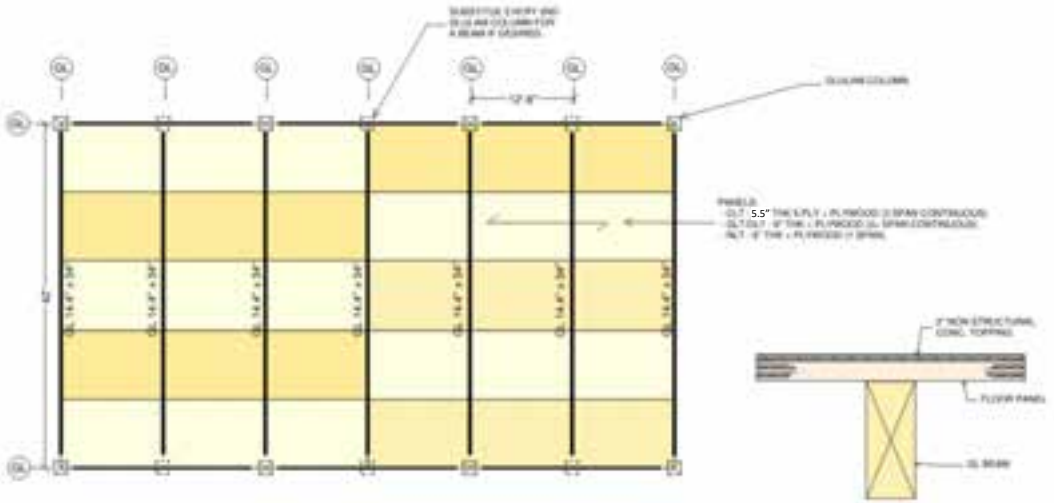
+$12-15/SF
2hr FRR



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.

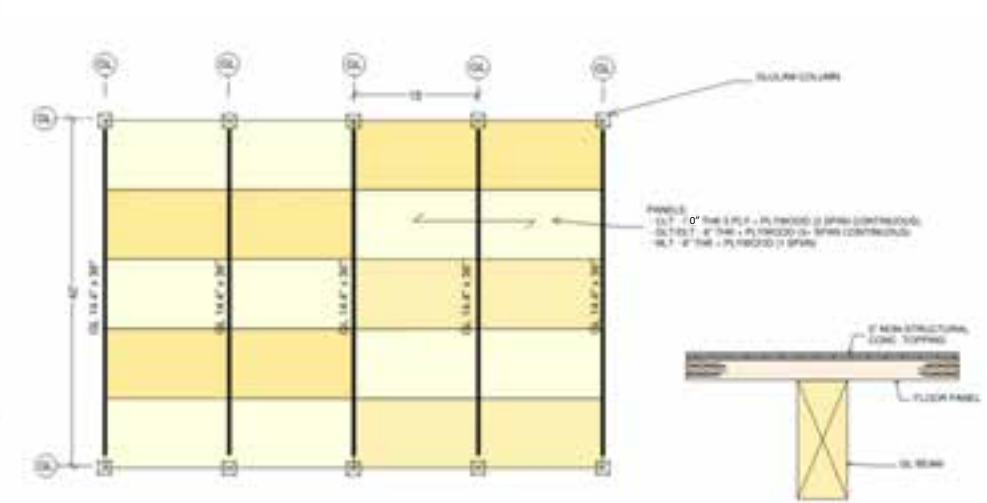
Cost: Structural System & Grid



Baseline

12’-6” Glulam Spacing

5.5” CLT



$ +5%

15’ Glulam Spacing

7” CLT

Source: Seattle Mass Timber Tower Book

How can I create an efficient structural grid for a mass timber building?

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

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

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

Grid Selection

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

View All Expert Tips

Project Assistance

Our technical experts offer free project support from design through construction, on issues ranging from allowable heights and areas to structural design, lateral systems and fire- or acoustical-rated assemblies.

Get Assistance >

Ask an Expert

Q: What design and detailing considerations exist when splicing shear wall top plates at wall discontinuities?

A: Disruption of shear wall top plates can occur for many reasons—e.g., the presence of a continuous structural steel column within the wall, installation of plumbing vents, change in wall widths, or a slight jog in wall position. In some cases, a shear wall's top plates are used as chords and/or collectors for a diaphragm, meaning that discontinuities in the top plates create discontinuities in lateral load paths

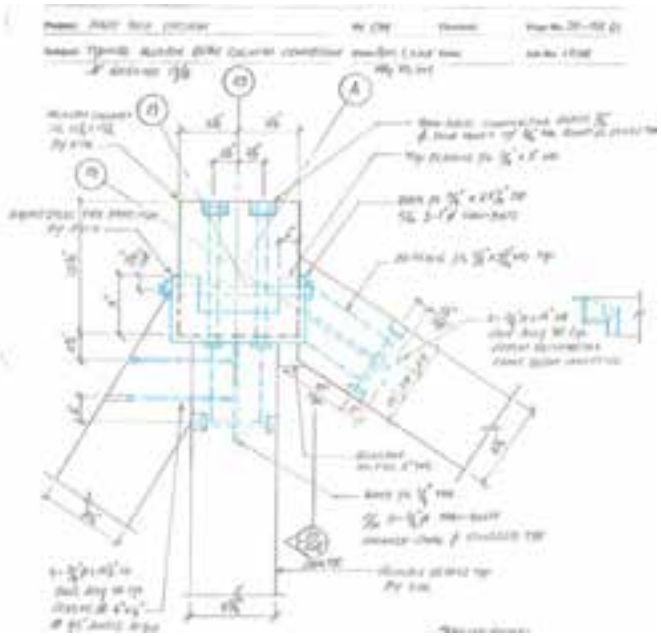
Tolerances: Interface with Other Structural Materials

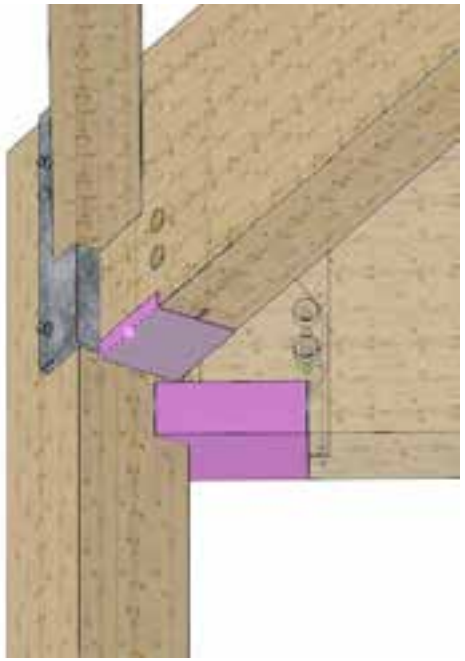
SCHEDULE

Photo: Swinerton

What are the schedule drivers on a mass timber project?

Schedule Impacts: Translating 2D to 3D





Photos: Swinerton

Schedule Impacts: Hybrid Structures

Photos: Swinerton

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

Photo: StructureCraft Builders

Seattle Mass Timber Tower: Detailed Cost Comparison

Fast Construction

- Textbook example done by industry experts
- Mass timber vs. PT concrete
- Detailed cost, material takeoff & schedule comparisons

"The initial advantage of Mass Timber office projects in Seattle will come through the

leasing velocity

that developers will experience."

- Connor Mclain, Colliers[1]

Download Case Study:

http://www.fastepp.com/wp-content/uploads/181109-Seattle-Mass-Timber-Tower-Book.pdf

Overall Project Cost Analysis: 12 Story Type IV-B

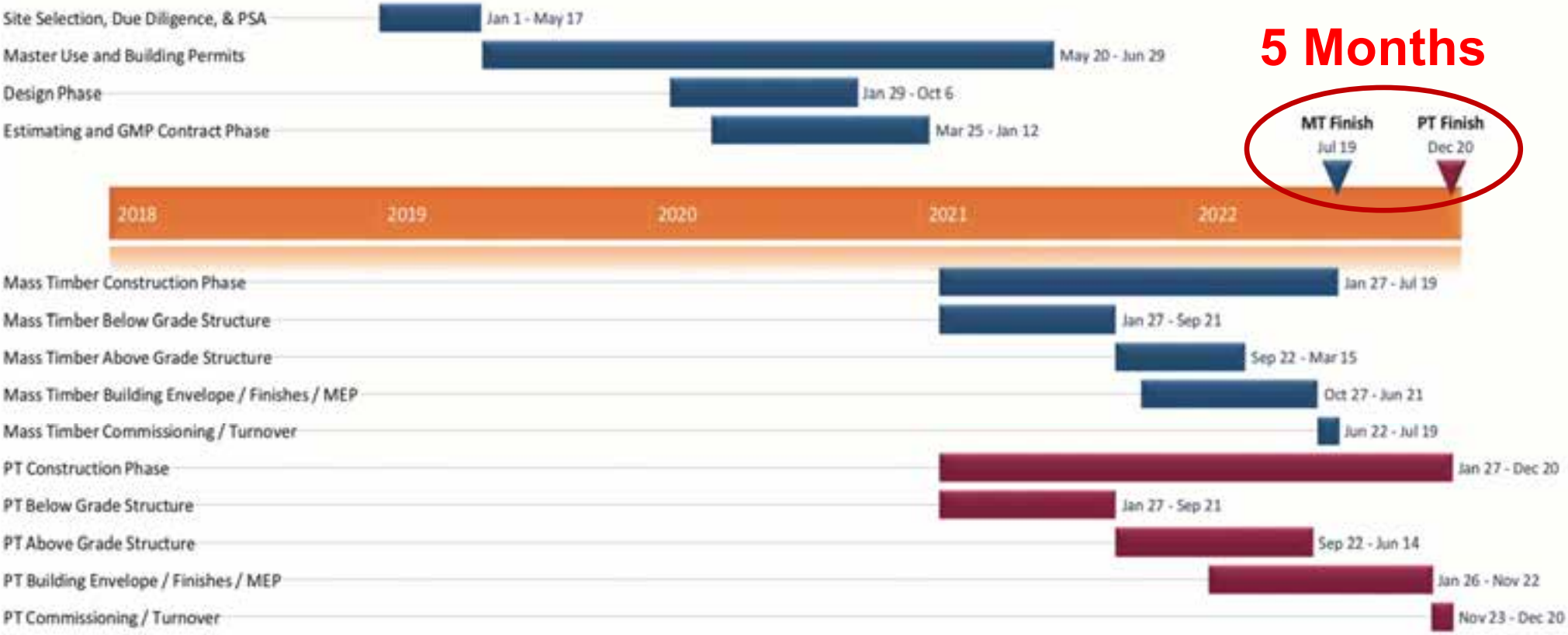
	MASS TIMBER	PT CONCRETE	MASS TIMBER SAVINGS VS. PT CONCRETE (%) *
DIRECT COST OF WORK	86,997,136	85,105,091	2.2%
PROJECT OVERHEAD	9,393,750	11,768,750	-20.2%
ADD-ONS	8,387,345	8,429,368	-0.5%
Total	*104,778,231*	*105,303,209*	*-0.5%*

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

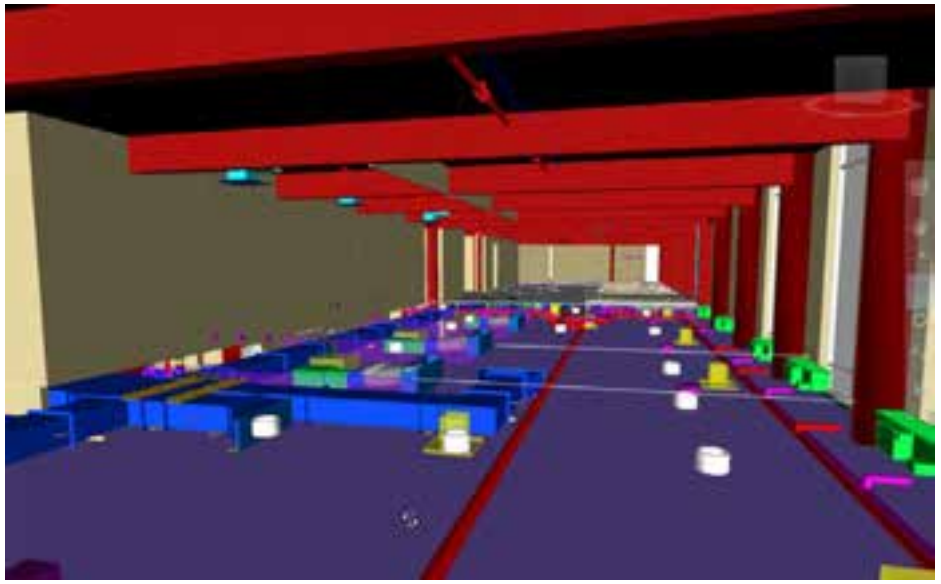


Source: Swinerton

Early Move-In for Rough-In Trades.

Photos: Swinerton

Embracing BIM for Fabrication



Photos: Swinerton

Holistic Schedule Analysis

Shorter Schedule = Lower General Conditions Costs

Photo: Swinerton


UBC

Reduce Risk
Optimize Costs

- For the entire project team, not just builders
- Lots of reference documents

Download Checklists at

www.woodworks.org

www.woodworks.org/wp-content/uploads/wood_solution_paper-Mass-Timber-Design-Cost-Optimization-Checklists.pdf

Mass Timber Cost & Design Optimization Checklists

Overview

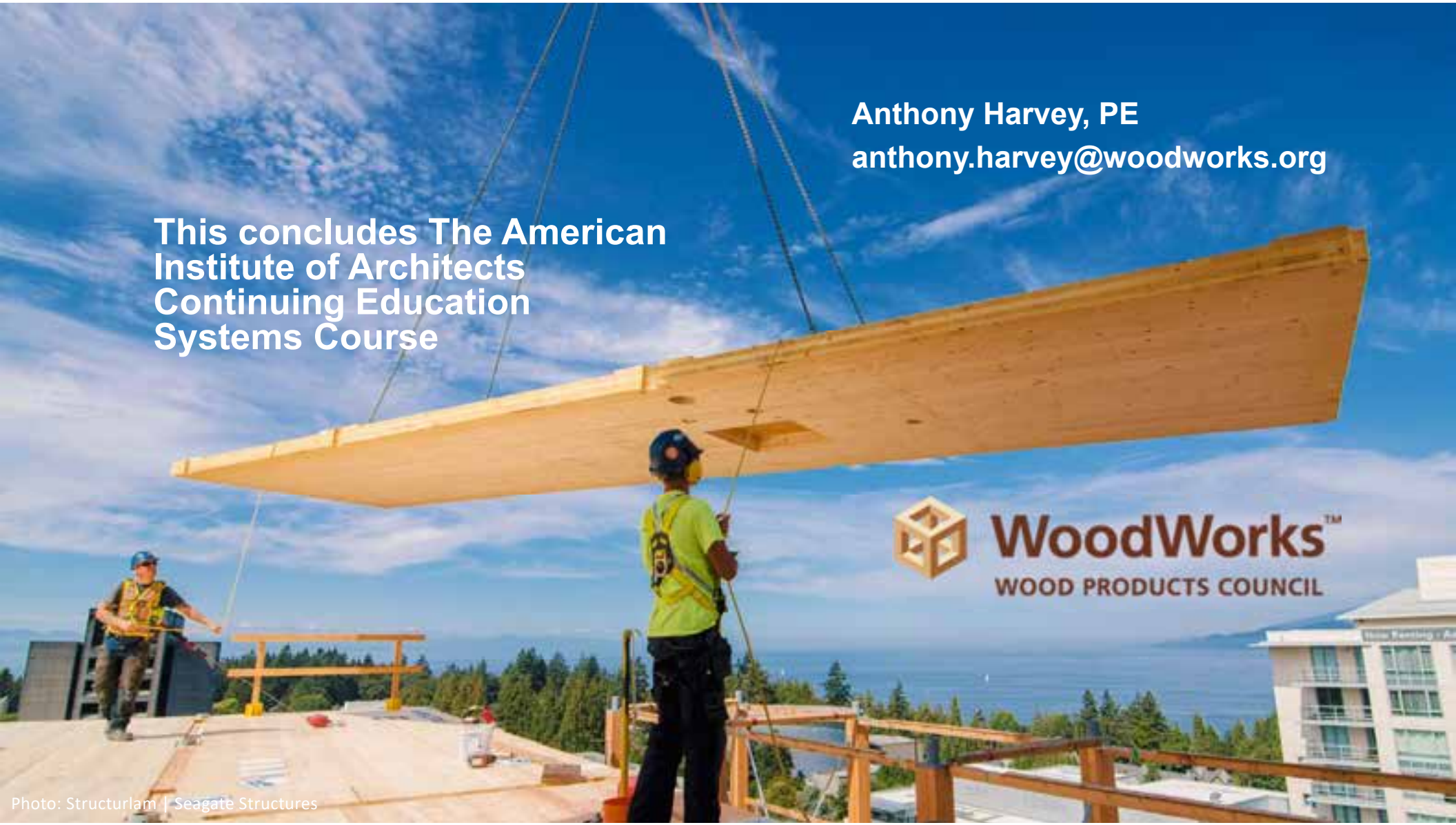
- Aid in design & cost optimization of mass timber projects
- Guiding discussions between:
  - Designers (architects & engineers)
  - Builders (general contractors, estimators, fabricators & installers)
  - Owners (developers & construction managers)

Pre-Design Checklist:

- ☑ Design & Builder Team
- ☑ Cost Estimating Considerations
- ☑ Contractual Considerations
- ☑ Design Goals
- ☑ Contact WoodWorks

Download Checklists at
www.woodworks.org

www.woodworks.org/wp-content/uploads/wood_solution_paper-Mass-Timber-Design-Cost-Optimization-Checklists.pdf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This concludes The American Institute of Architects Continuing Education Systems Course
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