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Mass Timber Construction Management:
Economics, Logistics & Risk Analysis

Archie Landreman, CSI
WoodWorks

1

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

2

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.

3

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 and building official interaction on code compliance topics that keep mass timber options on the table.
3. Discuss potential construction schedule savings and construction fire safety practices 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.

4

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)

5

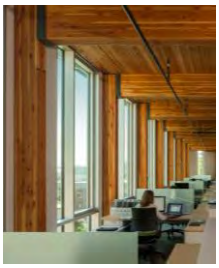
MASS TIMBER OVERVIEW

6

OVERVIEW | TIMBER METHODOLOGIES

Light Wood-Frame
Photo: WoodWorks

Heavy Timber
Photo: Benjamin Benschneider



Mass Timber
Photo: John Stamets

7

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

8

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Nail-Laminated Timber (NLT)

Photo: Think Wood

Glue-Laminated Timber (GLT)
Plank orientation

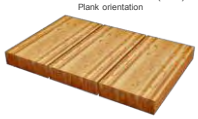


Photo: StructureCraft

Photo: StructureCraft

Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

9

OVERVIEW | MANUFACTURING

10

Photo: Ema Peter

STRUCTURAL SOLUTIONS | POST, BEAM + PLATE

11

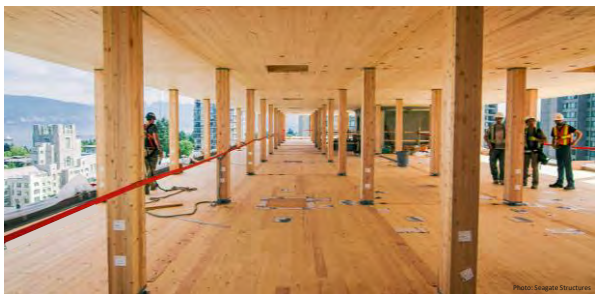


Photo: Seagate Structures

STRUCTURAL SOLUTIONS | POST + PLATE

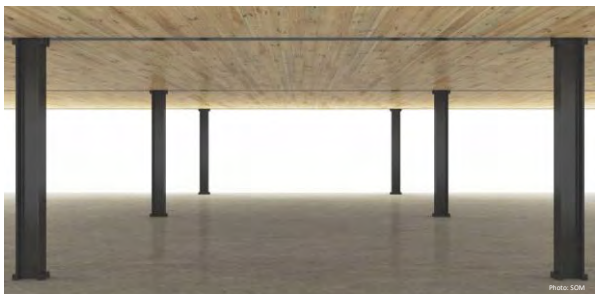
12

STRUCTURAL SOLUTIONS | HONEYCOMB

13

STRUCTURAL SOLUTIONS | HYBRID LIGHT-FRAME + MASS TIMBER

14



STRUCTURAL SOLUTIONS | HYBRID STEEL + MASS TIMBER

15

STRUCTURAL SOLUTIONS | HYBRID CONCRETE + MASS TIMBER

16

OVERVIEW | CONNECTIONS

Concealed Connectors

Self Tapping Screws

Photos: Rothoblaas

17

OVERVIEW | CONNECTIONS

Beam to Column

Photo: StructureCraft

Photo: Structurlam

18

OVERVIEW | CONNECTIONS

Column to Foundation

Photo: Alex Schreyer

19

OVERVIEW | CONNECTIONS

Panel to Panel & Supports

Photo: Charles Judd

Photo: Alex Schreyer

20

CURRENT STATE OF MASS TIMBER PROJECTS

As of July 2019, **599** multi-family, commercial, or institutional projects have been constructed out of mass timber across the U.S., or they're currently in design.

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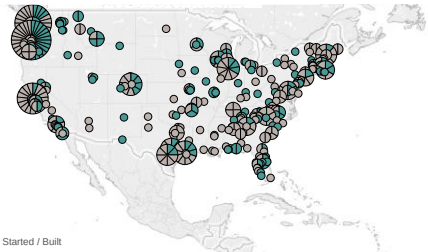


http://www.woodworks.org/publications-media/building-trends-mass-timber/

21

Photo: Nordic Structures

PRECEDENT PROJECTS | UMASS AMHERST DESIGN BUILDING

22

Photo: ©Albert Vecerka/Esto

PRECEDENT PROJECTS | UMASS AMHERST DESIGN BUILDING

23

Photos: Baumberger Studio/PATH Architecture

PRECEDENT PROJECTS | CARBON 12 | PORTLAND, OR

24

Photo: Hines

PRECEDENT PROJECTS | T3 MINNEAPOLIS

25

Photo: Corey Gaffer courtesy Perkins + Will

PRECEDENT PROJECTS | T3 MINNEAPOLIS

26

Photos: StructureCraft

Photo: Hartshorne Plunkard Architecture

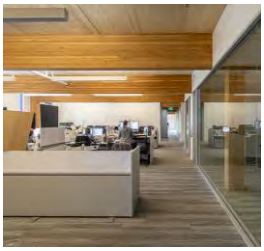
PRECEDENT PROJECTS | T3 ATLANTA

27

Photos: Flank

PRECEDENT PROJECTS | 360 WYTHE BROOKLYN, NY

28



Photos: Swinerton | DJC Orego

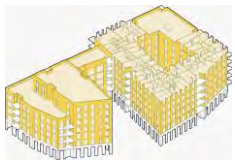
PRECEDENT PROJECTS | FIRST TECH CREDIT UNION HILLSBORO, OR

29

Photos: Michael Elkan | Naturally Wood | UB

PRECEDENT PROJECTS | BROCK COMMONS

30



Photos: Daniel Shearin | Waugh Thistleton Architects

PRECEDENT PROJECTS | DALSTON WORKS

31

Photos: Bygg Mesteren | Voll Arkitekter

PRECEDENT PROJECTS | MJOSTARNET NORWAY

32

MASS TIMBER PRODUCTS

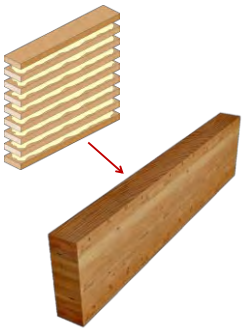
33

Glue Laminated Timber (GLT)

34

Glue Laminated Timber (GLT)

Photo: Manasc Isaac Architects/Fast + Epp



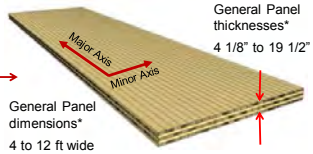
35

Cross-Laminated Timber (CLT)

36

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

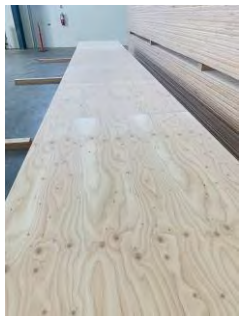
*Consult with manufacturers for available panel sizes

37

Cross-Laminated Timber (CLT)

With SCL laminations

Photos: Freres Lumber



38

Nail-Laminated Timber (NLT)

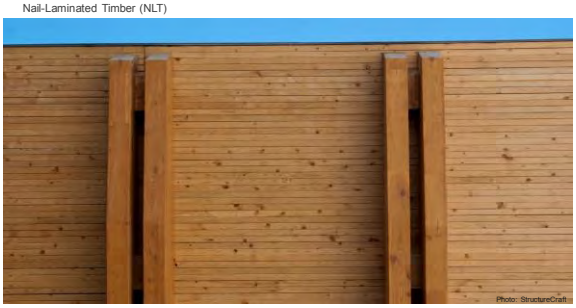


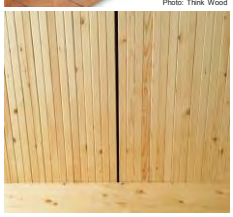
Photo: StructureCraft

39

Nail-Laminated Timber (NLT)

Photo: StructureCraft

Photo: Think Wood



40

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

41

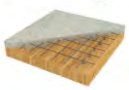
Other Mass Timber Product Options

Glue Laminated Timber GLT

Laminated Veneer Lumber LVL

Parallel Strand Lumber PSL

Laminated Strand Lumber LSL



Timber Concrete Composite TCC

Decking

Photos: StructureCraft

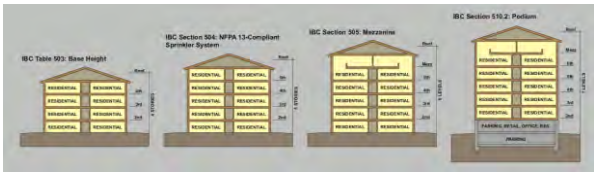
42

MASS TIMBER IN THE CODE

43

BUILDING CODE APPLICATIONS | CONSTRUCTION TYPE

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



44

BUILDING CODE APPLICATIONS | CONSTRUCTION TYPE

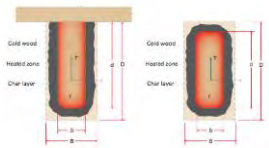
Tall Mass Timber: Up to 18 Stories in Construction Types IV-A, IV-B or IV-C

Credit: Susan Jones, atelierjones

45

BUILDING CODE APPLICATIONS | FIRE RESISTANCE

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



Source: AWC's TR 10

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

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

Source: AWC's NDS

Credit: Dave Barker, KRUP

46

BUILDING CODE APPLICATIONS | FIRE RESISTANCE

Mass Timber Fire Design Resource

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

47

MASS TIMBER CONSTRUCTION MANAGEMENT

48

MASS TIMBER CONSTRUCTION MANAGEMENT

RISK ANALYSIS
Threats to mass timber projects
Strategic project delivery

ECONOMICS
Holistic project estimating
Anatomy of a mass timber package

LOGISTICS
Design Engagement
Schedule
Site Planning

49

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.

50

Risk: Cost Analysis of Structure Only

$/SF

$/SF

Image: GBD Architects

51

Risk Mitigation: Total Project Cost Analysis

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

52

Risk: Design-Bid-Build Procurement

53

Risk Mitigation: Trade Partner/Master Builder Approach

54

Procurement Strategy is Key to Success

55

Risk: Perception of a Commoditized Material

56

Risk Mitigation: Embrace the Prefab Advantage

57

Risk: Lack of Supply Chain Understanding

58

Risk Mitigation: Complementary Procurement

59

Schedule Savings for Rough-In Trades

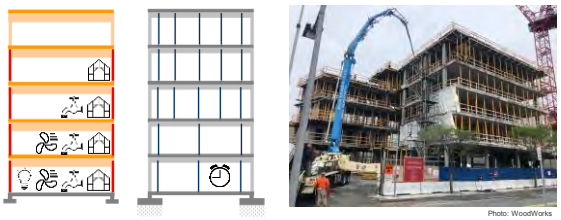
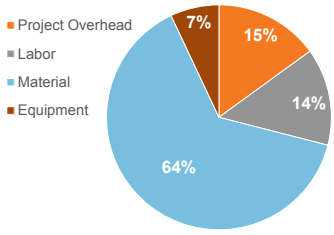


Image: Swinerton

60

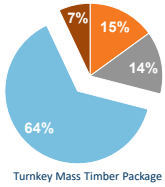
Anatomy of a Turnkey Mass Timber Package



Source: Swinerton

61

Material (Direct Cost)



or

Source: Swinerton

62

Labor (Direct Cost)

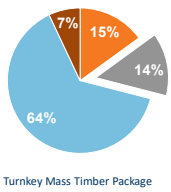


Photo: Swinerton

Source: Swinerton

63

Equipment (Direct Cost)

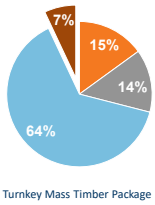


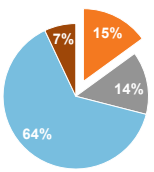
Photo: Swinerton

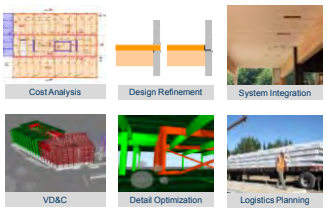
Photo: Alex Schreyer

Source: Swinerton

64

Project Overhead





Photos: Swinerton

Source: Swinerton

65

Value Analysis

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

66

Value Analysis

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

67

Value: Program

68

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.

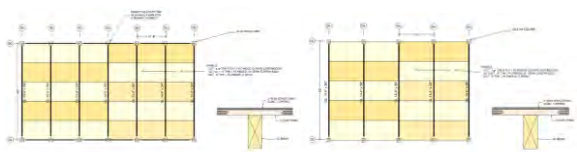
69

70

Value: Open Floor Plan

71

Cost: Structural System & Grid



Baseline
12'-6" Glulam Spacing
5.5" CLT

$ +5%
15' Glulam Spacing
7" CLT

Source: Seattle Mass Timber Tower Book

72

73

Value: Perimeter Glazing

74

Tolerances: Interface with Other Structural Materials

75

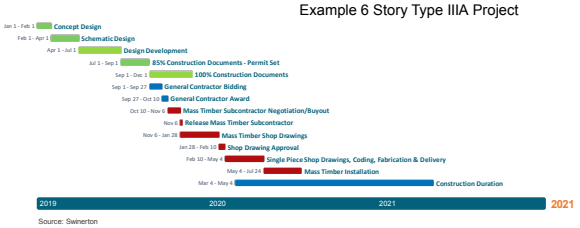
76

Procurement Approach Determines Schedule

77

Procurement Approach Determines Schedule

Example 6 Story Type IIIA Project



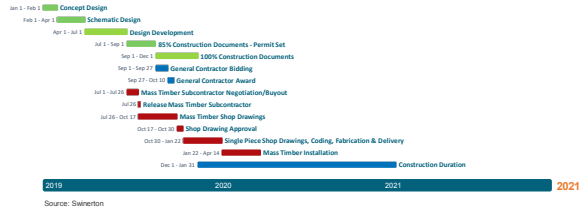
Source: Swinerton

Design-Bid-Build Procurement

78

Procurement Approach Determines Schedule

Example 6 Story Type IIIA Project



Source: Swinerton

Design-Build/Design-Assist Procurement

79

Procurement Logic for Scheduling

Source: Swinerton

Example 6 Story Type IIIA Project

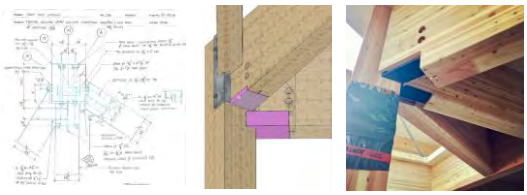
80

What are the schedule drivers on a mass timber project?

Photo: Lendlease

81

Schedule Impacts: Translating 2D to 3D



Photos: Swinerton

82

Schedule Impacts: Hybrid Structures

Photos: Swinerton

83

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

Photo: StructureCraft Builders

84

Overall Project Cost Analysis: 12 Story Type IV-B

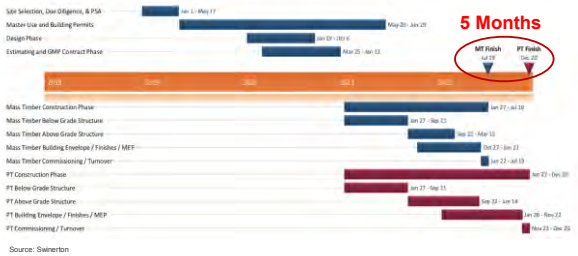
	MASS TIMBER	PT CONCRETE	MASS TIMBER SAVINGS VS. PT CONCRETE (%) *
DIRECT COST OF WORK	86,997,136	85,105,091	2.2%
PROJECT OVERHEAD	9,393,750	11,768,750	-20.2%
ADD-ONS	8,387,345	8,429,368	-0.5%
Total	*104,778,231*	*105,303,209*	*-0.5%*

Source: Swinerton

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

85

Overall Project Schedule Analysis: 12 Story Type IV-B



Source: Swinerton

86

Schedule Impact on Cost | Value of Time

87

Early Move-In for Rough-In Trades.

88

Embracing BIM for Fabrication

89

Holistic Schedule Analysis

90

91

92

93

94

95

96

Sequencing

97

Material Protection

Painting steel
Taping joints
Protect end cuts of timber

98

MASS TIMBER | TRAINING THE WORKFORCE

99

100

101

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102