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Optimizing the Cost of Mass Timber Buildings

November 2019 • Melissa Kroskey, AIA, SE • Technical Director, WoodWorks

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

Contractual Considerations

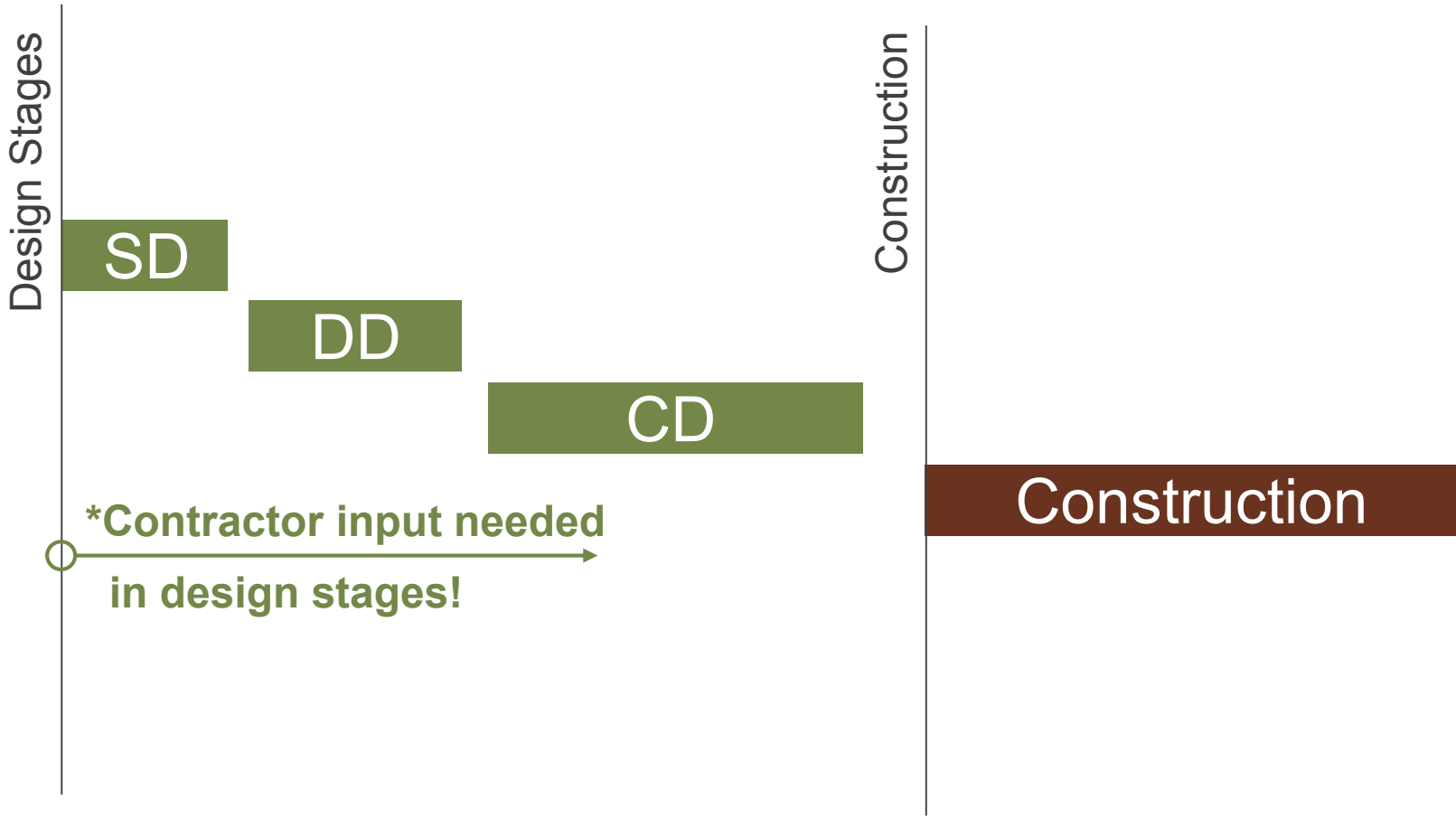
Prefabricated Approach

Avoid:

- Design-bid-build

Consider:

- CM at risk
- Design-assist
- IPD
- Design-build



Potential Benefits	Project Goal ✓	Value Add ✓
Fast construction		
Aesthetic Value (Leasing velocity/ premiums) Healthy Building / Biophilia		
Lightweight structure		
Labor shortage solution • small crews • entry level workers		
Just-in-time delivery (ideal for dense urban sites)		
Environmentally friendly (low carbon footprint)		
Healthy forests/ wildfire resiliency & support rural economies		

Seattle Mass Timber Tower: Detailed Cost Comparison

Fast Construction

- Textbook example done by industry experts
- Mass timber vs. PT conc
- 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]

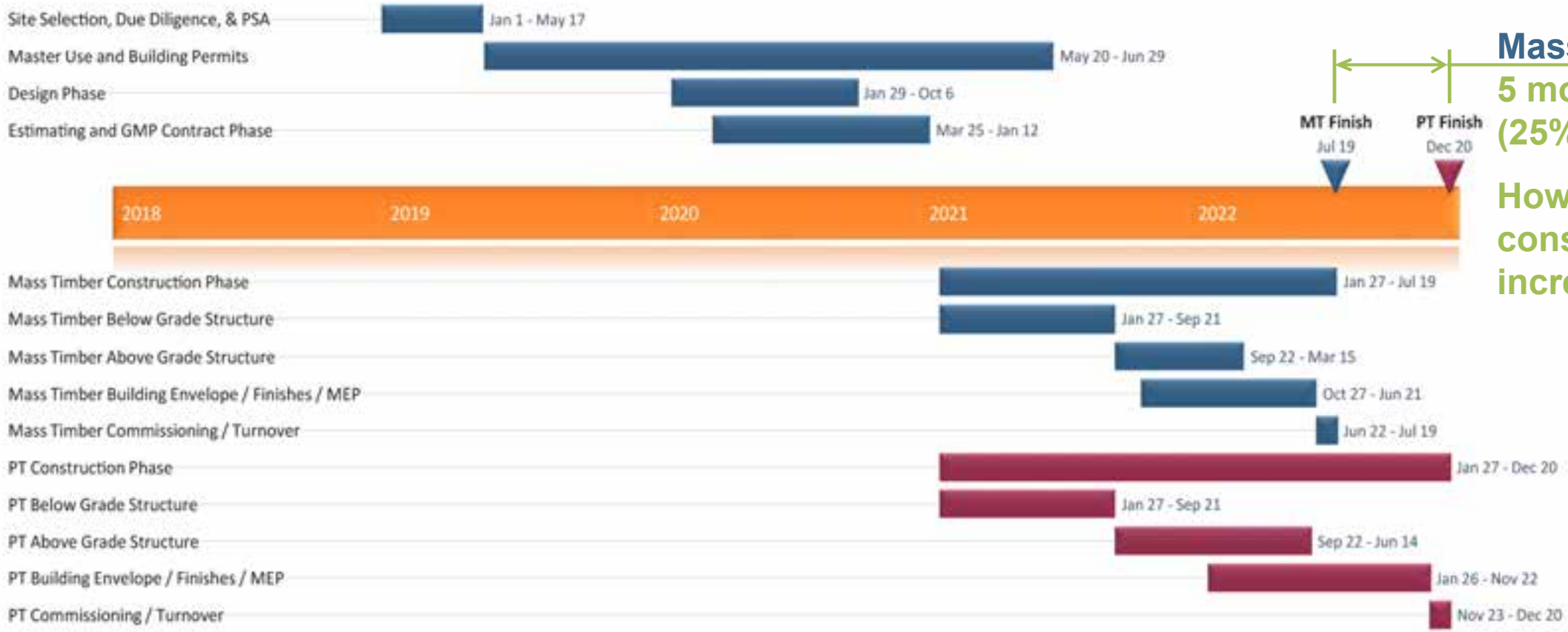
Download Case Study:

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

Seattle Mass Timber Tower

Fast Construction

Construction Schedule:



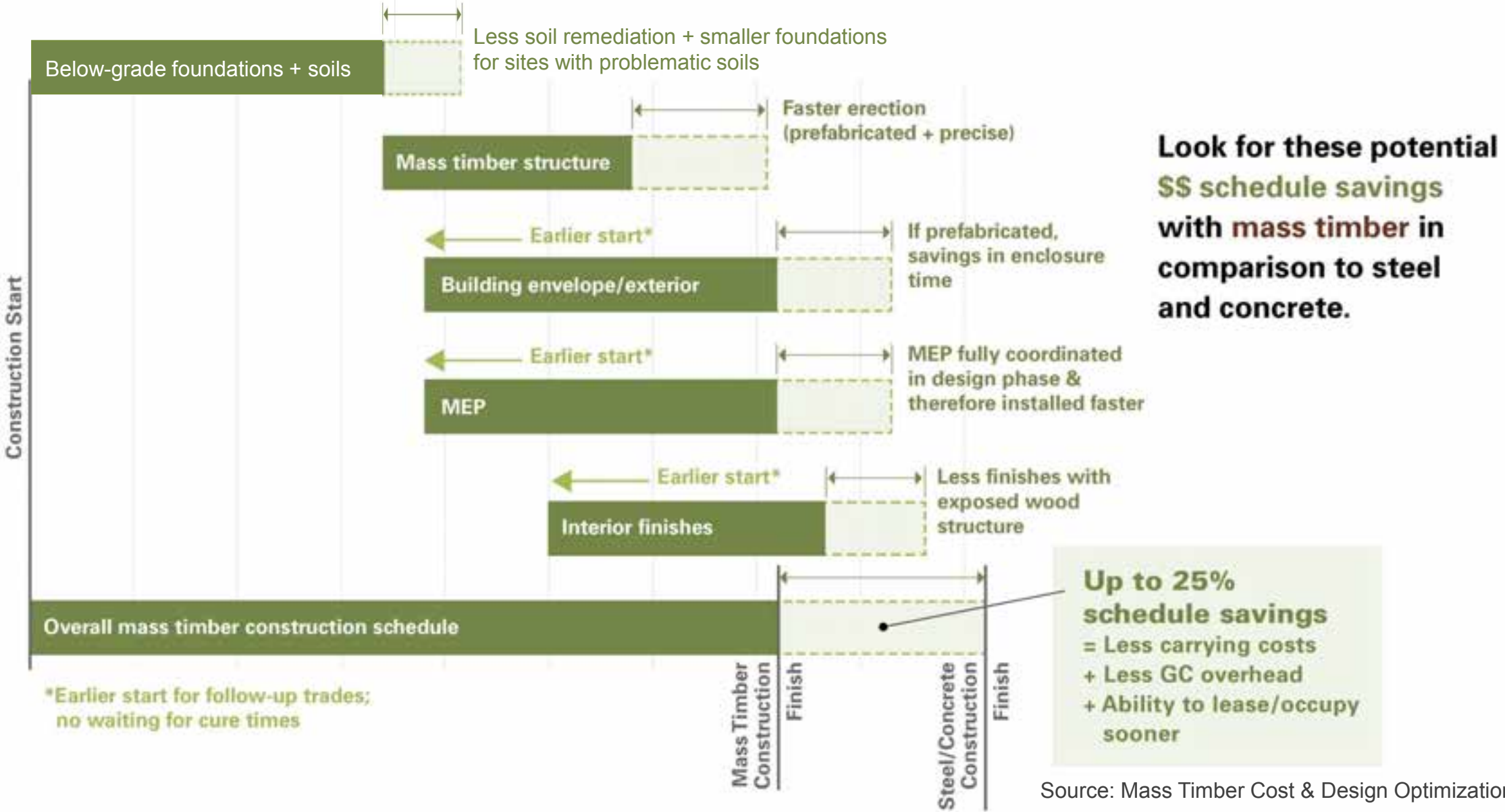
Mass Timber
5 months
(25%) faster

How can faster construction increase your ROI?

Source: Tall With Timber
A Seattle Mass Timber Tower Case Study by DLR Group[1]

Compressing the Typical Schedule

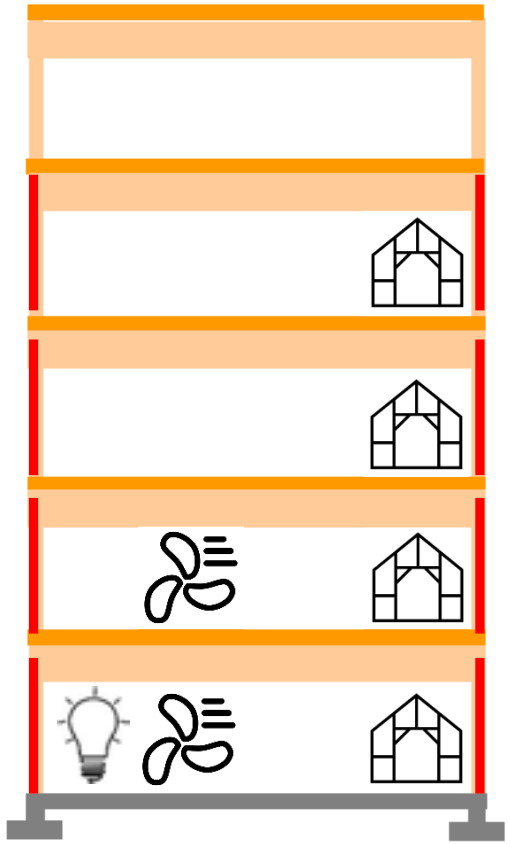
Fast Construction



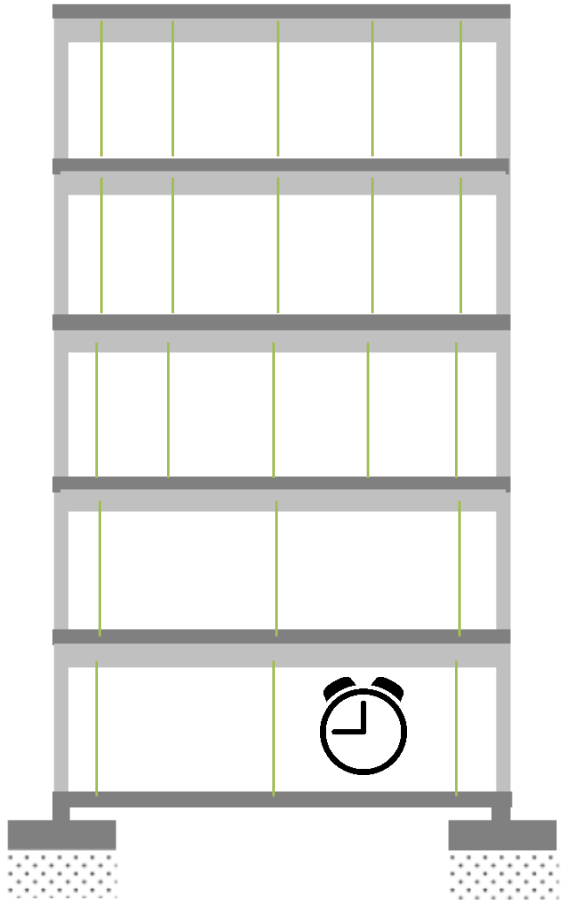
Source: Mass Timber Cost & Design Optimization, WoodWorks[2]

Schedule Savings for Rough-In Trades

Fast Construction



NO curing
(mass timber)



Curing & maze of shores (concrete)

Photo: WoodWorks

Schedule Examples

Fast Construction

Example Timeframes for Mass Timber Projects					
Project	Stories	Area	Type	Time to Erect the Mass Timber Structure	Overall Construction Schedule
First Tech Credit Union *(Swinerton[8])*	5	150,000 sf	Office	12 weeks	14 months
Candlewood Suites at Redstone Arsenal *(Lendlease[9])*	4	62,700 sf	Military hotel	16 weeks	12 months
Seattle Mass Timber Tower *(DLR Group hypothetical case study[10])*	12	305,000 sf	Mixed-use office and hotel	24 weeks	18 months

Source: Mass Timber Cost & Design Optimization, WoodWorks[2]

Candlewood Suites: Military Hotels
Labor Shortage Solutions

Redstone Arsenal:

- 37% faster overall[2]
- 40% fewer construction workers[2]
- Trained unemployed veterans

Prefab Assemblies:

- Bathroom Pods
- Facades
- MEP Racks

Developer, Asset Manager, Design Builder: Lendlease
Locations: Redstone Arsenal, Huntsville, Alabama

ULI Report: The Business Case for Healthy Buildings

Healthy Building/ Biophilia

Global Wellness Real Estate Industry:

- $134 billion industry in 2017
- 6.4% annual increase since 2015
- $180 billion industry by 2022

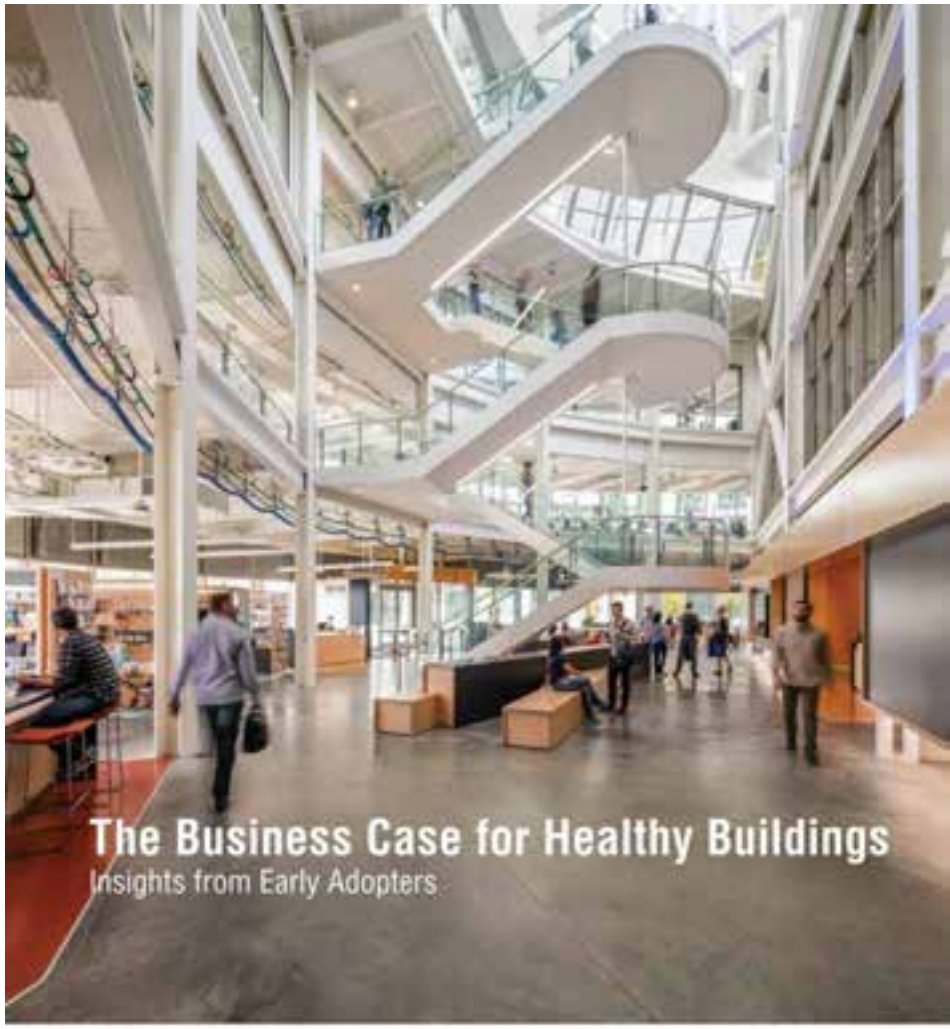
Healthy Bldgs ROI (Survey of 200 Canadian Bldg Owners):

- 46% easier to lease
- 28% command premium rents
- 38% of those who reported value in healthy bldgs said they are worth 7% more than conventional ones

Millennials:

- 78% say workplace quality is important
- 69% would trade other benefits for good workplace

"**Health and wellness-focused environments**…can help **reduce company operating costs** and **increase revenues and profits**."



Urban Land Institute Center for Sustainability and Economic Performance

2018 Report

Employee Retention

Healthy Building/ Biophilia

Cost of losing an employee (assume: $33/ hr):

$ 1,000 termination
$ 9,000 replacement
$15,875 lost productivity
$25,875 total

Healthy Indoor Environments:

- Reduces stress*
- Increases creativity & ability to think/ learn*
- Psychological health & better performance*

Sources by Terrapin Bright Green:

- *Economics of Biophilia*, 2012
- *14 Patterns of Biophilic Design*, 2014
  (includes list of testing citations)

The Hudson
Mackenzie | Photo: Christian Columbres

Leading Developer Embraces Mass Timber Offices

T3 = Timber, Transit & Technology

IV (HT)

- 6 stories wood over podium
- 220,000 sf
- *Finance & Commerce* reports:
  $25 to 50 million project cost[3] (2016 completion)
  $87 million purchase price (May 2018 sold to LaSalle)[4]

Location: Minneapolis, MN
Architect: Michael Green Architecture, DLR Group
Structural Engineer: Magnusson Klemencic Associates
Mass Timber Engineer: StructureCraft

Leading Developer Embraces Mass Timber Offices

T3 Minneapolis

Location: Minneapolis, MN
Architect: MGA | Michael Green Architecture, DLR Group
Structural Engineer: Magnusson Klemencic Associates
Mass Timber Engineer: StructureCraft

IV (HT)

- 20’ x 25’ grid
- 2x8 NLT spanning 20 ft
- MEP mains routed around core w/ a shorter bay spacing & shallower beam
- Timber erection:
  - 2.5 months total
  - 9 days per 30,000-sf floor
- **Foundation $ savings**:
  - **30% lighter** than steel
  - **60% lighter** than conc[5]

Tenant Build Outs – Potentially Lower Costs

Starting with Aesthetic Value of Structure

T3 Minneapolis | Architects: Michael Green Architecture, DLR Group | Photo: Ema Peter

55 Southbank: Add Vertical Density over Existing Bldgs Lightweight

Location: Melbourne, Australia
Architect: Bates Smart
Engineer: Vistek

- Existing building constructed to accommodate future 6-story concrete addition
- Owner wanted 220 key hotel addition:
  6-stories conc = no deal
  10-stories wood = deal[6]
- Research shows ¼ of urban buildings in the world are strong enough to carry additional floors of wood[7]
- Low embodied carbon footprint

Fully Prefabricated: North America's First DLT Office
111 East Grand


Image: Neumann Monson Architects courtesy of Ryan Companies

IIIB

- 4 Story
- 64,000 sf
- First DLT office in the US
- 1st spec office in Des Moines in over a decade[8]
- Superstructure all prefabricated for fast erection.
- Lateral system – precast concrete walls & core

Location: Des Moines, IA
Architect: Neumann Monson
Structural Engineer: Raker Rhodes
Mass Timber Engineer: StructureCraft

Fully Prefabricated: North America's First DLT Office

111 East Grand

IIIB

- 20' x 25' grid
- 2x8 DLT spanning 20 ft
- 40' x 6'-4" DLT panels
- Glulam beams & cols

Just-in-time delivery
ideal for tight sites and urban locations

Location: Des Moines, IA
Architect: Neumann Monson
Structural Engineer: Raker Rhodes
Mass Timber Engineer: StructureCraft

Wood Products

Increase Forest Value & Support Rural Economies

United States	Jobs	Annual Payroll
Wood Products	434,900	$ 21 Billion
Forestry & Logging	145,900	$ 3 Billion
Total Employment	580,800	$ 24 Billion

Source:
American Wood Council, Wood Products Industry at a Glance California 2018

Carbon Storage: Wood = 50% Carbon (dry weight)

Environmentally Friendy

Image: Kaiser + Path

Image: Lever Architecture


Millennials
50% of US workforce!
Attract talent w/ craft coffee & exposed timber offices


Microsoft Campus
Image: Microsoft | WRNS Studio


Sidewalk Labs, Toronto
Image: Picture Plane for Heatherwick Studio for Sidewalk Labs

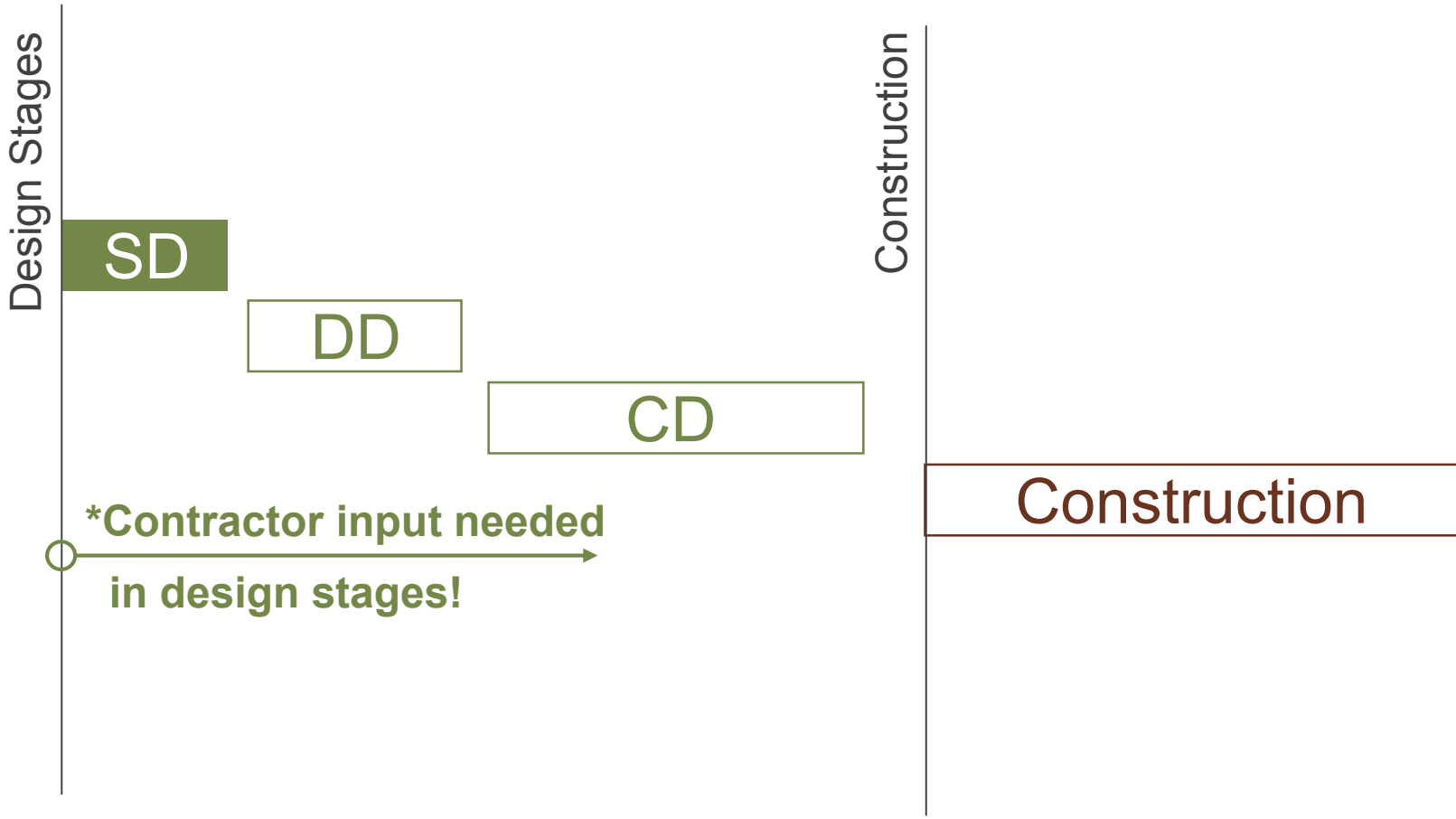

Google HQ, UK
Image: Google | Lendlease HayesDavidson for BIG & Heatherwick Studios

Schematic Design (SD) Phase

Prefabricated Mass Timber

- Structural & MEP require more detailed input from engineers and builders
- Estimating: Not enough data for unit cost method; more detailed approaches req'd

Publicly-funded projects to be competitively bid, make the "go/ no go" decision on mass timber by end of SD.



Mass Timber Cost & Design Optimization Checklists

Schematic Design

SD Design Optimization Checklist:

- ☑ Material Optimization/ Grids
- ☑ System Coordination
  - Structural
  - Acoustics/ Vibration
  - Fire Resistance
- ☑ Finish Quality

SD Cost Optimization Checklist:

- ☑ Schedule Savings = Cost Savings
- ☑ Aesthetic Value
- ☑ Less Weight = Cost Savings
- ☑ Fabrication
- ☑ Shipping/ Trucking
- ☑ Installation & Labor

Design Phases
Schematic Design (SD)

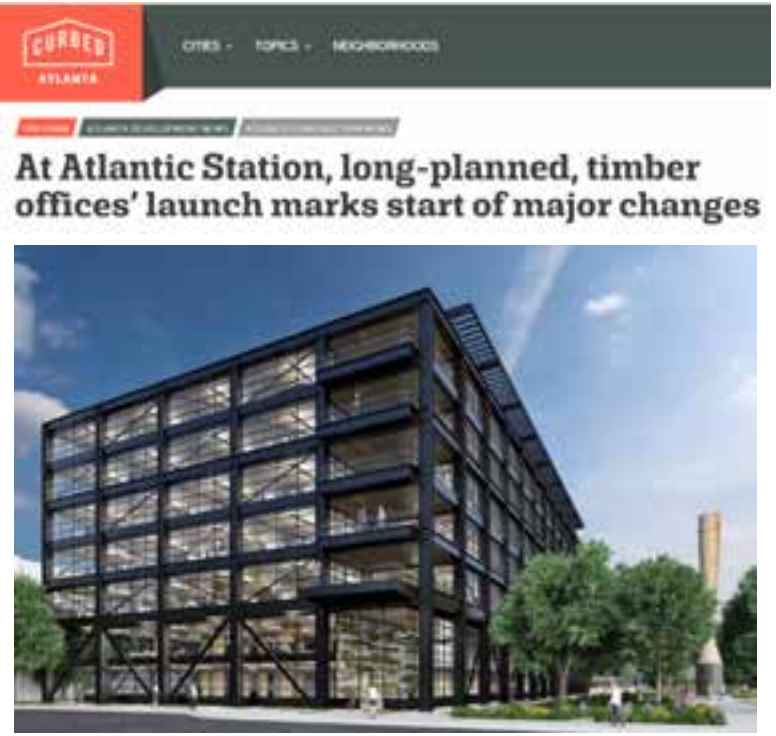
- Select lateral system in SD!!
  - Compatibility w/ fast speed of mass timber
- Responsibility
  - design engineer
  - fabrication
- Installation
  - GC self install?
  - Subcontractor?


The Soto, San Antonio| Photo: StructureCraft


T3 Atlanta | Photo: StructureCraft

Hines' Mass Timber Offices Rising in Southeast

T3 West Midtown, Atlanta



IV (HT)

- 6 stories Type IV over podium
- 205,000 sf
- DLT floors, glulam frame
- T3 Atlanta replaces concrete with steel braced-frame lateral system to keep up with **fast speed of mass timber erection**

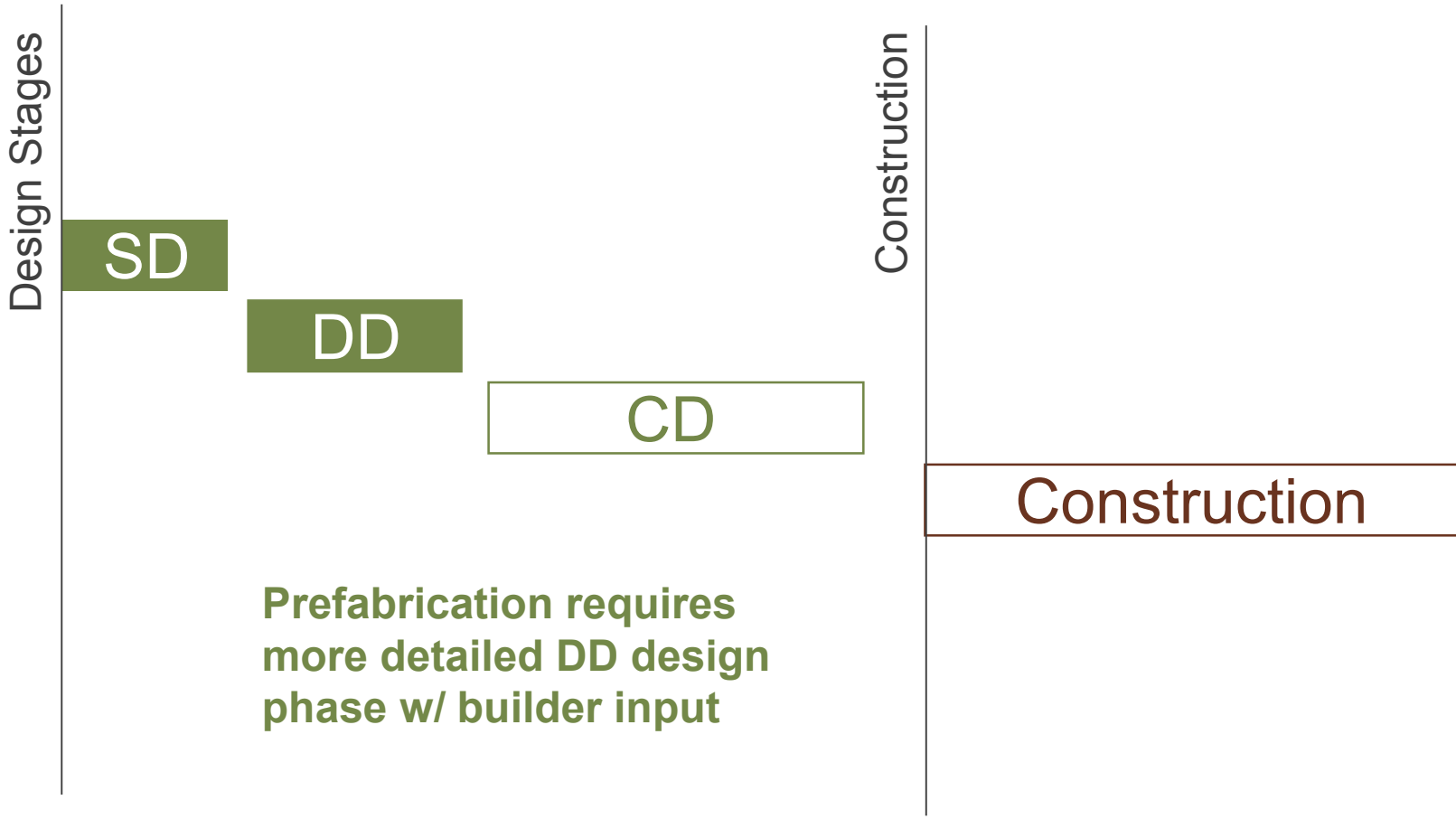
Location: Atlanta, GA
Architect: Hartshorne Plunkard Architects + DLR Group
Structural Engineer: Magnusson Klemencic Associates
Mass Timber Engineer: StructureCraft

Design Development (DD) Phase

Prefabricated Mass Timber

- Structural & MEP require more detailed designs from engineers and builders
- More Key Details need to be developed

Publicly-funded projects to be competitively bid, early bid the mass timber supplier at end of DD or by 50% CD at latest



Mass Timber Cost & Design Optimization Checklists

Design Development

DD Design Optimization Checklist:

- ☑ Material Optimization/ Grids
- ☑ Hybrid Considerations
- ☑ System Coordination
- ☑ Fire Resistance
- ☑ MEP Systems
- ☑ Finish Quality
- ☑ Key Details

DD Cost Optimization Checklist:

- ☑ Less Weight = Cost Savings
- ☑ Schedule Savings = Cost Savings
- ☑ Cost & Value
- ☑ Fabrication
- ☑ Installation & Labor
- ☑ Protection

Digital Fabrication
Design Development (DD)

- Prefabricated panels
- Coordinate all MEP & fire protection penetrations
- Tolerances for wood tighter than steel, conc, & other materials
- Structural connections
- Schedule steel shops so they don’t delay mass timber fabrication
- Plan now to reduce on-site labor

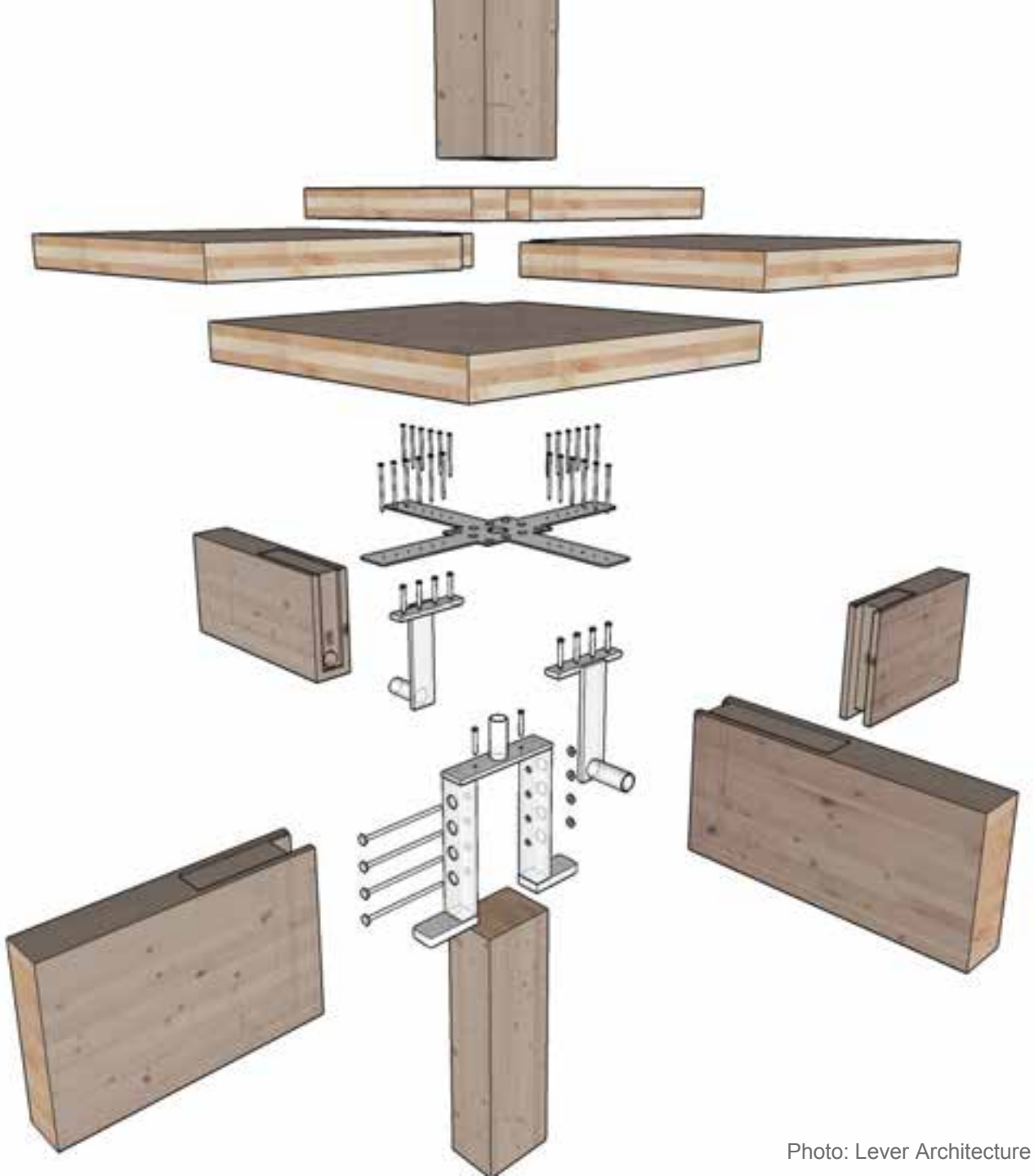


Photo: Lever Architecture

Austin's 1st CLT Office: Built to Attract Millennial Talent

901 E 6th Street


Photo: Structurlam

Location: Austin, TX
Architect: Thoughtbarn / Delineate Studio
Engineer: LEAP! Structures

IIIA

- 5 Story
- 129,000 sf
- CLT & steel frame **hybrid**
- 14-ft Floor to ceiling heights w/ 9' windows
- "Leasing broker feedback… **CLT helped generate interest,** assisted in **faster leasing** and helped support **higher lease rates**."[9]

Moisture Management

Keep Wood Dry & Schedule on Track

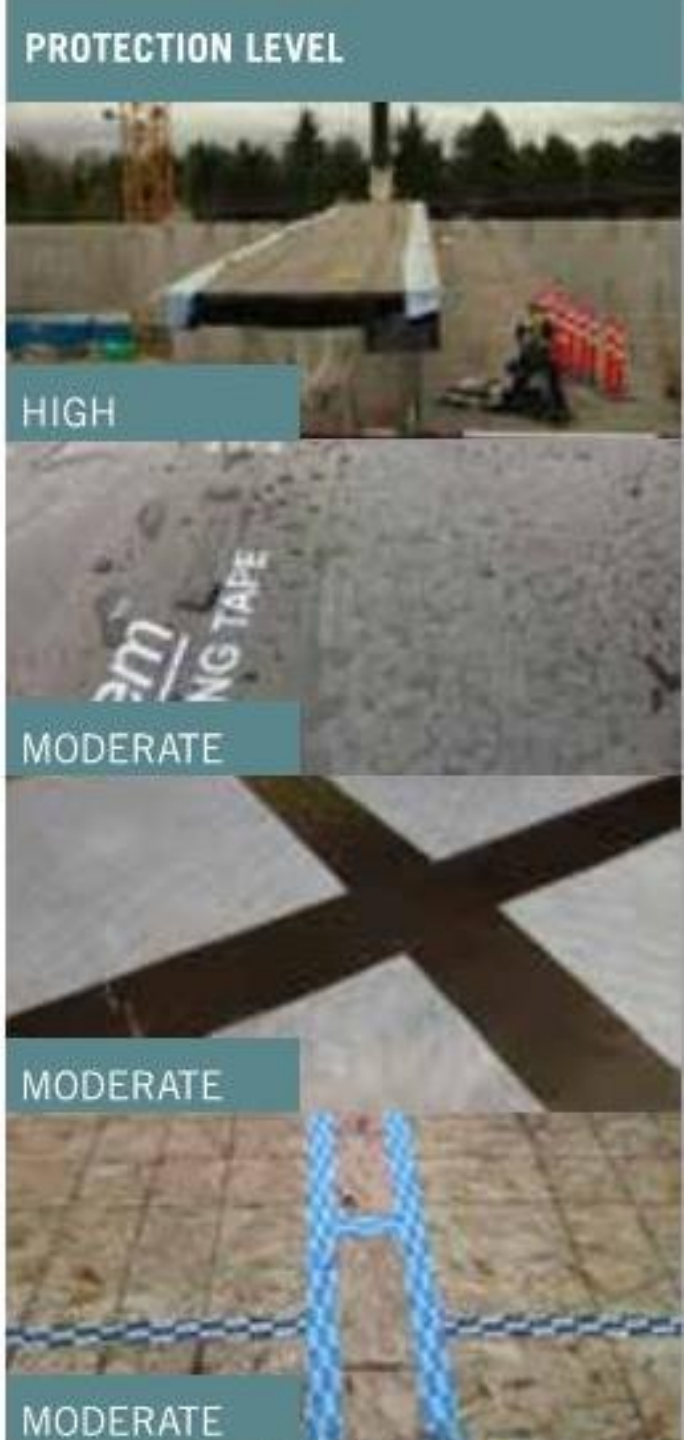
- Just-in-time delivery, no storage - wood installed directly from trucks
- Protect connections/ connectors
- Moisture management plan
- Reuse panel wraps for covering wood end grains & connections

Construction Phase Moisture Management,
Section 7.6 NLT Guide (Good Tips for all MT)

Download:

https://www.thinkwood.com/products-and-systems/mass-timber/nltguide

https://info.thinkwood.com/nlt-design-and-construction-guide-u.s.-version-think-wood-0



Moisture Management

Keep Wood Dry & Schedule on Track

- Mass timber & light frame
- Design & Construction Moisture Mgmt Checklists in Appendix I & II
- Categorizes material
  - by wetting & drying potential
  - for on-site protection strategies

Moisture Management Guide

Download:

https://www.bchousing.org/publications/Wood-Construction-Moisture-Management-Guide.pdf

https://www.bchousing.org/publications/Wood-Construction-Moisture-Management-Guide.pdf

Remove Snow ASAP

Photo: Lendlease

Panels protected until needed

Photo: Alex Schreyer

Finish Quality: Exposed Structure

Protect the Investment

- Industrial grade appearance, save $
- Surface coatings
- Temporary Protection
  - Moisture
  - Construction trades

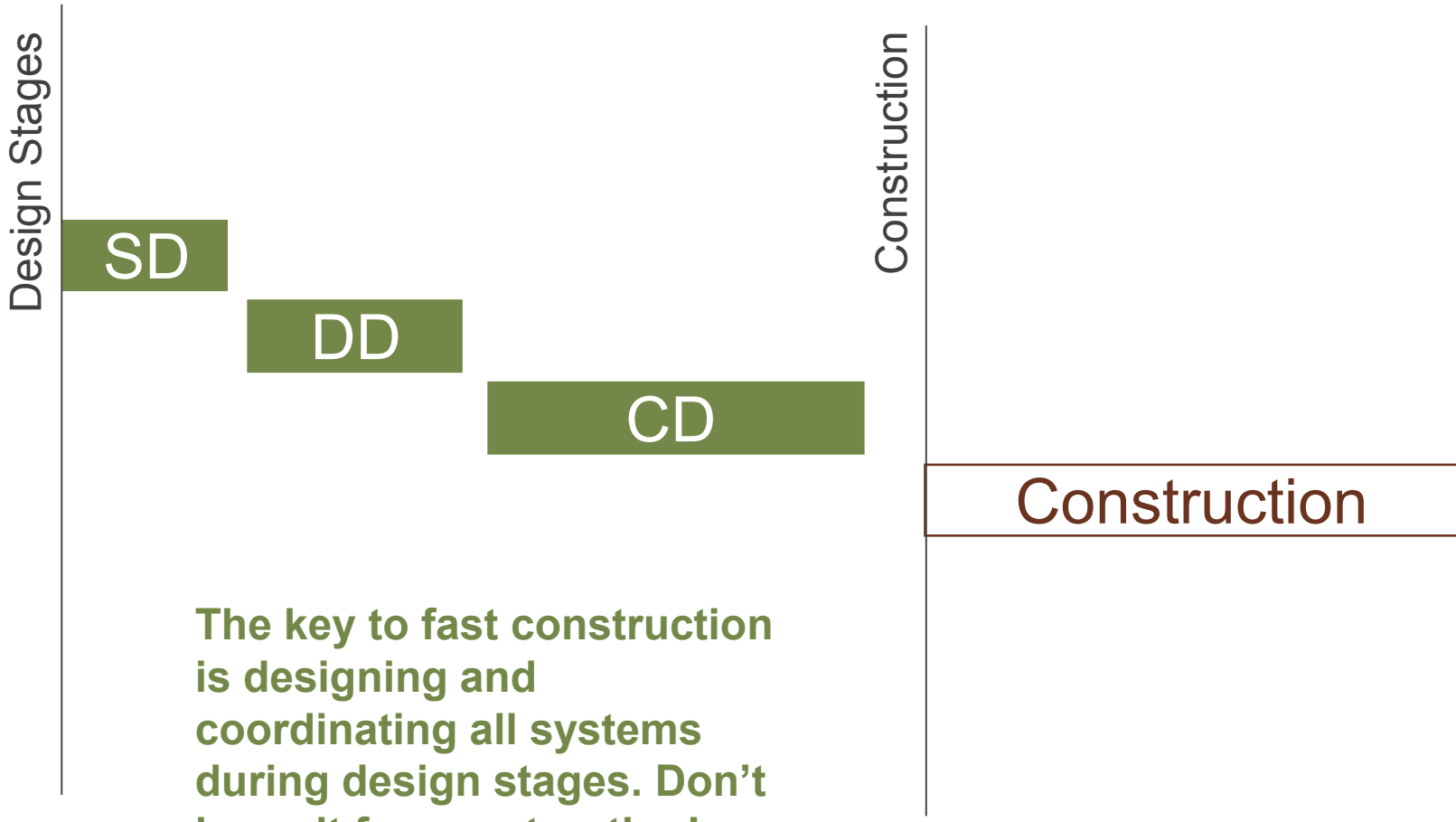
Photo: Christian Columbres

The Hudson | Vancouver, WA | Mackenzie | Turner Construction

Construction Document (CD) Phase

Prefabricated Mass Timber

- Everything is in 3D Model: Structural, MEP & Fire Protection
- Pay extra attention to material systems interaction: timber to concrete to steel including tolerances, timing of shop drawings & responsibility



The key to fast construction is designing and coordinating all systems during design stages. Don't leave it for construction!

Additional Benefits
Mass Timber

- No shoring – less obstacles, smoother workflow
- Quicker fastening
- Quieter sites
- Less waste


The Soto | San Antonio | Lake Flato | BOKAPowell


Photo: Myticon

Mass Timber Provides Market Differentiation in San Antonio
The Soto


Image: Lake Flato/ BOKAPowell

IIIA

- 5 Stories wood over podium
- 150,000 sf
- 20’ x 30’ typical grid
  20’x15’ at perimeter
- DLT panels, glulam frame
- Raised floor w/ underfloor air distribution

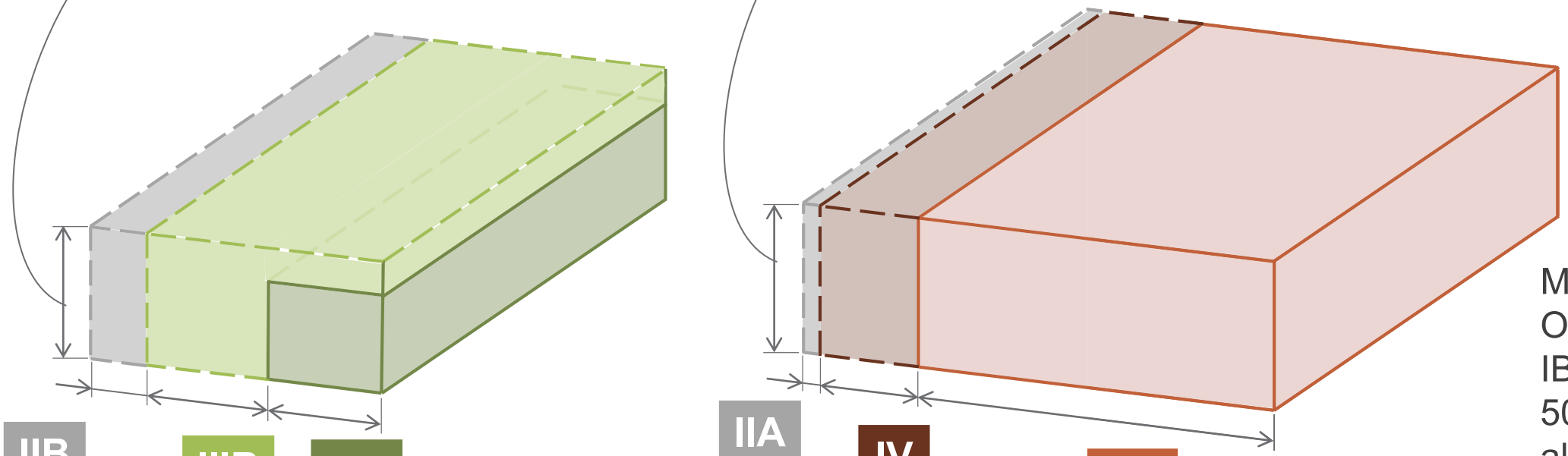
Location: San Antonio, TX
Architect: Lake Flato / BOKAPowell
Structural Engineer: Danysh & Associates
Mass Timber Engineer: StructureCraft

You Don't Have to Start Tall! Wood Allows for Sizeable Buildings

Heights & Areas: 2015 IBC up to 6 Stories (Not incl. new tall wood provisions)

3-4 Stories, 60-75 ft Tall
(wood shear walls limited to 65' in SDC D, E & F)

6 Stories, 85-ft Tall
(wood shear walls limited to 65' in SDC D, E & F)



Multi-story Business Occupancy (B)
IBC 2015/ 2018 Tables 504.3, 504.4, 506.2 w/ allowable increases

Assumptions:
[1] NFPA 13 sprinkler increase (IBC 504.2)
[2] NFPA 13 sprinkler increase (IBC 506.3)
[3] Stories 3 or more (IBC 506.4)

Heavy Timber Revolution: California's Hip New Commercial Block ICE Block I

Photo: Bernard Andre

Location: Sacramento, CA
Architect: RMW Architecture & Interiors
Engineer: Buehler Engineering

IIIB

- 3 Story heavy timber over podium
- 87,460 sf
- Traditional heavy timber
- Aesthetic value is same for heavy & mass timber
- **Consider traditional timber approaches! Innovative mass timber is not the only option.**

Heavy Timber Revolution: California's Hip New Commercial Block
ICE Block I

Location: Sacramento, CA
Architect: RMW Architecture & Interiors
Engineer: Buehler Engineering

IIIB

- 20' x 24' grid
- 3x T&G decking
- Beam depths minimized
  cantilevered beams over columns w/ offset connection
- Exposed connectors

"The **building sold itself** because of its unique character. There really was no true competition in the market. **A lot of the credit goes to the fact that it is a timber building**."

– Mike Heller, Heller Pacific

Office Wythe Ave Buildings, NY | Flank Architecture + Development

Hospitality Lark Hotel, Bozeman | Thinktank Design | Photo: Dan Armstrong

Multi-family Carbon 12, Portland | Path Architecture | Photo: Andrew Pogue

Industrial StructureCraft Plant, Abbotsford, BC

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

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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.

Most resources listed in this paper can be found on the WoodWorks website. Please see the end notes for URLs.

Questions?

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T3 Atlanta | Architects: Hartshorne Plunkard Architects, DLR Group | Photo: StructureCraft

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